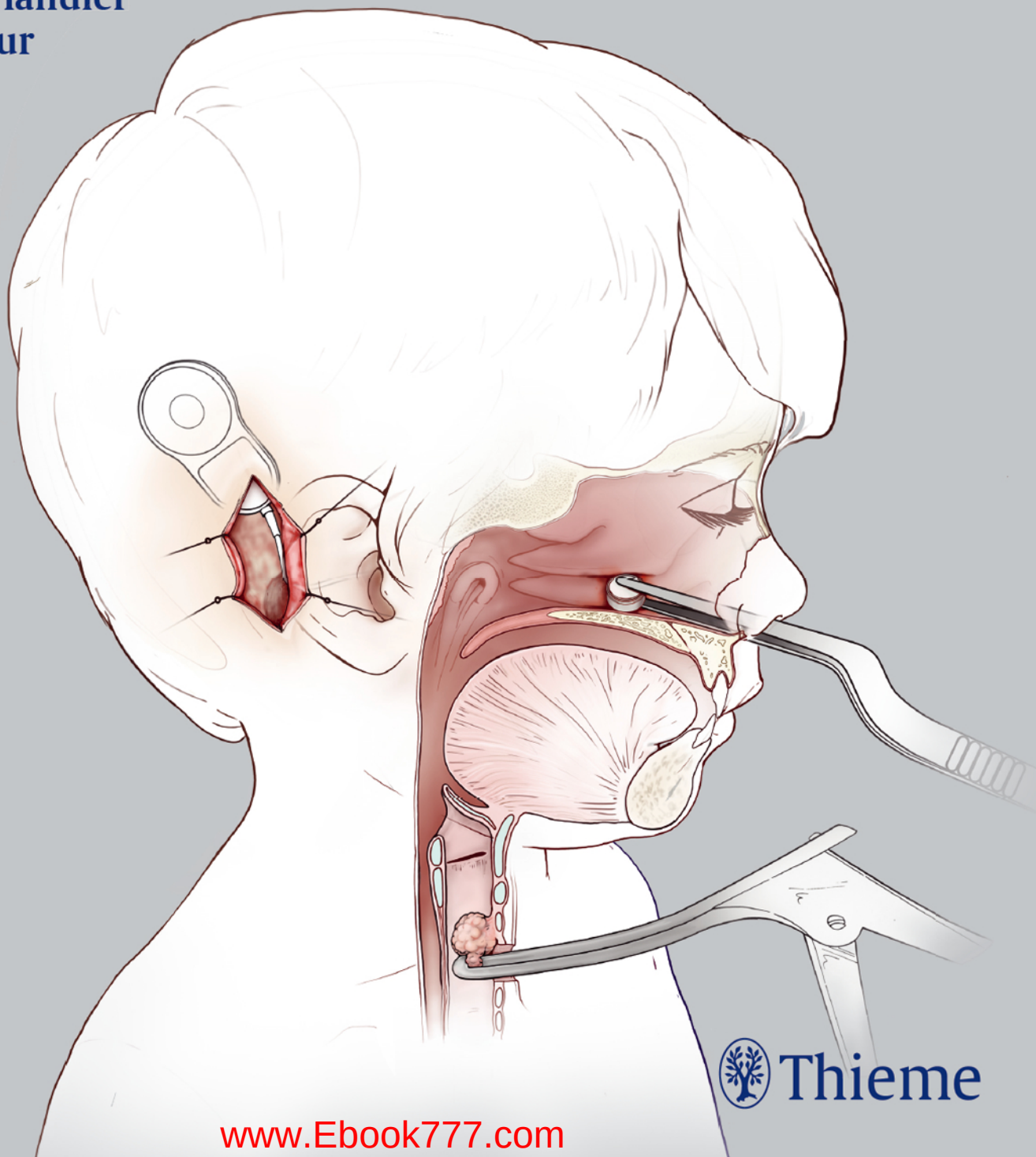
Surgical Pediatric Otolaryngology

Second Edition

William P. Potsic
Robin T. Cotton
Steven D. Handler
Karen B. Zur



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Surgical Pediatric Otolaryngology
Second Edition

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Dedicated to those children who have taught us and to all those children in the future who may benefit from these efforts.

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Foreword

It has been 19 years since the first edition of *Surgical Pediatric Otolaryngology* appeared. The goal of the first edition was to provide a reference for surgeons who care for children and perform operative procedures on the head and neck, airway, skull base, paranasal sinuses, and temporal bone. This collection of surgeons includes pediatric otolaryngologists, general otolaryngologists who care for children, and pediatric general and thoracic surgeons. The first edition was enthusiastically received by the fields of otolaryngology and bronchoesophagology, and copies of this atlas still occupy a place of prominence on the bookshelves of many of my colleagues.

Since 1997, the breadth of pediatric otolaryngology has changed little, but the complexity of many surgical techniques is now reflected in the advanced procedures required to return an affected child to a normal or nearly normal life. For example, refinements in the electronics of cochlear implant devices and improvements in surgical techniques, especially the utilization of binaural devices, have brought deaf children even further into the hearing world, while advances in pediatric airway reconstruction have allowed children to live their lives without a tracheostomy.

When the first edition was published, many pediatric surgeons included the entire repertoire of procedures listed in this atlas as proof that they could care for the entire breath of pediatric otolaryngology. Now, many of these procedures are performed by a smaller but more experienced team of surgeons who benefit from performing a larger number of these complicated cases than they would have done in the past. This subspecialization has improved the care and outcomes of patients with complex diseases. The best example of the value of subspecialization may be airway reconstruction. In the past, many surgeons in our practice performed a few airway cases a year; all of these cases are now treated by a group of four surgeons, three fellows, five nurses, and both a gastroenterologist and a pulmonologist with superior care and improved outcomes. Some practices may not have the resources to perform a substantial number of airway reconstructions, and so this book is dedicated to those surgeons who only do a few cases a year, but benefit from techniques and postoperative care suggested in this atlas.

While adhering to the basic format used in the first edition, there are several important upgrades to the second edition. One significant improvement in this atlas is that all of the chapters have been written by more than 20 experts in their fields. Many of these authors have both national and international reputations and clearly live on the cutting edge of surgical pediatric otolaryngology. In addition to being referred the most difficult cases, these experts have honed their skills through years of teaching other colleagues, fellows, residents, and students. While most of this edition is devoted to routine pediatric otolaryngology care, numerous chapters are dedicated to very complex procedures. For those practitioners who only do a few of these procedures a year, this atlas will serve as a great reference to review operative steps and pearls of wisdom that help to improve outcomes. Finally, many of the figures in the text have been revised by a current generation of illustrators who bring a whole new dimension to their work.

In the preface to the first edition of *Surgical Pediatric Otolaryngology*, the authors described the atlas as a “workhorse” for those who perform these procedures routinely and an invaluable resource for those who do only a few. The second edition follows closely in these footsteps, but serves to bring these pediatric surgical procedures well into the 21st century. For that reason, I am sure this atlas will find a prominent place on the bookshelves of many surgeons in the coming years.

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Preface

Welcome to the updated second edition of *Surgical Pediatric Otolaryngology*, a step-by-step, well-illustrated description of the surgical procedures required for treating children with otolaryngologic diseases and conditions. The purpose of this atlas is to help otolaryngologists–head and neck surgeons to learn (or to reacquaint themselves with) the basic steps of the commonly performed procedures in pediatric otolaryngology. While the ideal method of teaching surgery involves a one-on-one interaction between the teacher (experienced surgeon) and the student (who may be a resident, fellow, or beginning practitioner), this scenario occurs mainly in large teaching centers and rarely in the general practice of surgery. We decided to write this atlas as an aid to understanding procedures because many practitioners find themselves considering an operation that they might have seen only once, or perhaps one that they had last performed some time ago.

The operations described herein each include a series of surgical steps that have been selected through years of experience at The Children's Hospital of Philadelphia and Cincinnati Children's Hospital. The procedures are not necessarily original creations of the authors but rather represent the refinement of techniques that have worked well for our patients, with limited surgical complications and excellent outcomes. We have assumed that the operating surgeon already has knowledge concerning the etiologies and disease progression for which the particular operation is being planned. The surgeon who desires more in-depth information about a specific disease process should consult one of the many excellent comprehensive textbooks of pediatric otolaryngology and/or the current literature.

Most surgeons are visual and spatial in their orientation, and for this reason our book relies heavily on the wonderful line drawings of artists Susan Shapiro Brenman, Birck Cox, and Eo Trueblood. The figures are often so clear that they lead the reader through the procedure even without the accompanying text. The adage "one picture is worth a thousand words" is well demonstrated in this atlas. Each step of each surgical procedure is clearly delineated. The text accompanying the figures is organized in small, concisely worded steps. The citations for the figures within the text enable readers to refer to a specific drawing for clarification of a written instruction, and vice-versa.

This book focuses on the procedures that comprise the majority of surgeries performed by pediatric otolaryngologists–head and neck surgeons. We have therefore left out very uncommon procedures intended for esoteric, rare conditions. You will find that the techniques described and illustrated herein are easy to follow. We have found them easy to teach to our own residents and fellows, and our trainees have found the same in helping others.

We believe that this atlas can serve as a reference for the surgeon who infrequently performs pediatric otolaryngology procedures, or as the "workhorse" for those who concentrate more of their efforts in this rewarding field. In either case, we hope and expect that these techniques will help you to obtain the same satisfying results that we have been privileged to enjoy.

Acknowledgments

The four editors thank our families for their support and encouragement, without which this atlas would not have happened. We are grateful to all our colleagues, especially those who have contributed to this second edition, and to their advances in pediatric anesthesiology and airway management, audiology, head and neck imaging, and head and neck oncology.

The authors gratefully thank Beth Ann B. McCullough for her invaluable work in the preparation of the book manuscript. We are grateful for the efforts of Timothy Hiscock, J. Owen Zurhellen, and Kate Barron at Thieme Publishers.

The drawings created by artists Susan Shapiro Brenman, Birck Cox, and Eo Trueblood have brought clarity and depth to our operative descriptions, and we thank them. Mr. Trueblood especially has the combination of exceptional biomedical illustration skills and steady personality necessary to work with pediatric otolaryngologists.

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Section I

The Ear

I

1 Otitis Media with Effusion

Mark D. Rizzi

Otitis media with effusion (OME) is one of the most common chronic conditions of childhood. The primary complications of OME are (1) conductive hearing loss; (2) recurrent acute otitis media; and (3) middle ear atelectasis and cholesteatoma formation.

1-1 Myringotomy and Tube Placement

Indications

Myringotomy and tube placement is indicated (1) when fluid has been present for 8 to 12 weeks, despite medical therapy, causing a significant conductive hearing loss; (2) when recurrent acute otitis is debilitating by its frequency and severity; or (3) when tympanic membrane retraction is present to a degree that one suspects potentially imminent development of ossicular erosion, cholesteatoma, or atelectasis.

Preoperative Evaluation

The preoperative evaluation requires a complete pneumatic otoscopic examination and audiologic evaluation. Radiography is rarely, if ever, helpful.

Operative Technique

1. General anesthesia is usually administered by mask. The head is turned to the side opposite the ear being operated upon.
2. The largest speculum that will fit in the external meatus is placed in the ear. Wax is cleared from the external meatus to provide visualization of the entire tympanic membrane.
3. A radial (**Fig. 1.1a**) or circumferential (**Fig. 1.1b**) incision is made through the ear drum. Choice and site of incisions depend on surgeon preference and exposure obtained. For example, if there is a prominent anterior bony ear canal, a radial incision placed in the inferior quadrant is more easily performed.
4. Fluid is aspirated from the middle ear with a 5-French suction cannula, preferably without touching the tympanic membrane.
5. The anterior medial flange of the tube is inserted in the incision, and the posterior flange is rotated into the incision with an alligator forceps or suction tip (**Fig. 1.1c,d,e**).
6. The lumen and area around the tube are aspirated free of blood. Oxymetazoline or antibiotic-containing ear (or eye) drops can be placed in the ear to prevent reaccumulation of blood and subsequent plugging of the tube.
7. Large-flanged or T tubes are used in patients in whom standard tubes extrude prematurely or in those instances where it is felt that a child will need 3 to 5 years of middle ear ventilation. These tubes can be placed in a fashion similar to that used when inserting standard tubes, except that they require a larger myringotomy incision (**Fig. 1.1f,g**). Some surgeons prefer subannular tube placement in order to facilitate long-term ventilation. In this technique, a tympanomeatal flap is elevated after incising the ear canal approximately 5 mm lateral to the annulus and lifting the posterior inferior annulus from the tympanic ring (**Fig. 1.1h,i**). A T tube is placed through the incision taking care to avoid the ossicles with its two legs, and the flap is placed over the tube (**Fig. 1.1j**). The flap can be held in position with a small amount of Gelfoam (Pfizer) (or antibiotic-containing ointment).

Complications

1. Purulent otorrhea
2. Early extrusion
3. Permanent perforation
4. Granuloma
5. Tympanosclerosis
6. Cholesteatoma

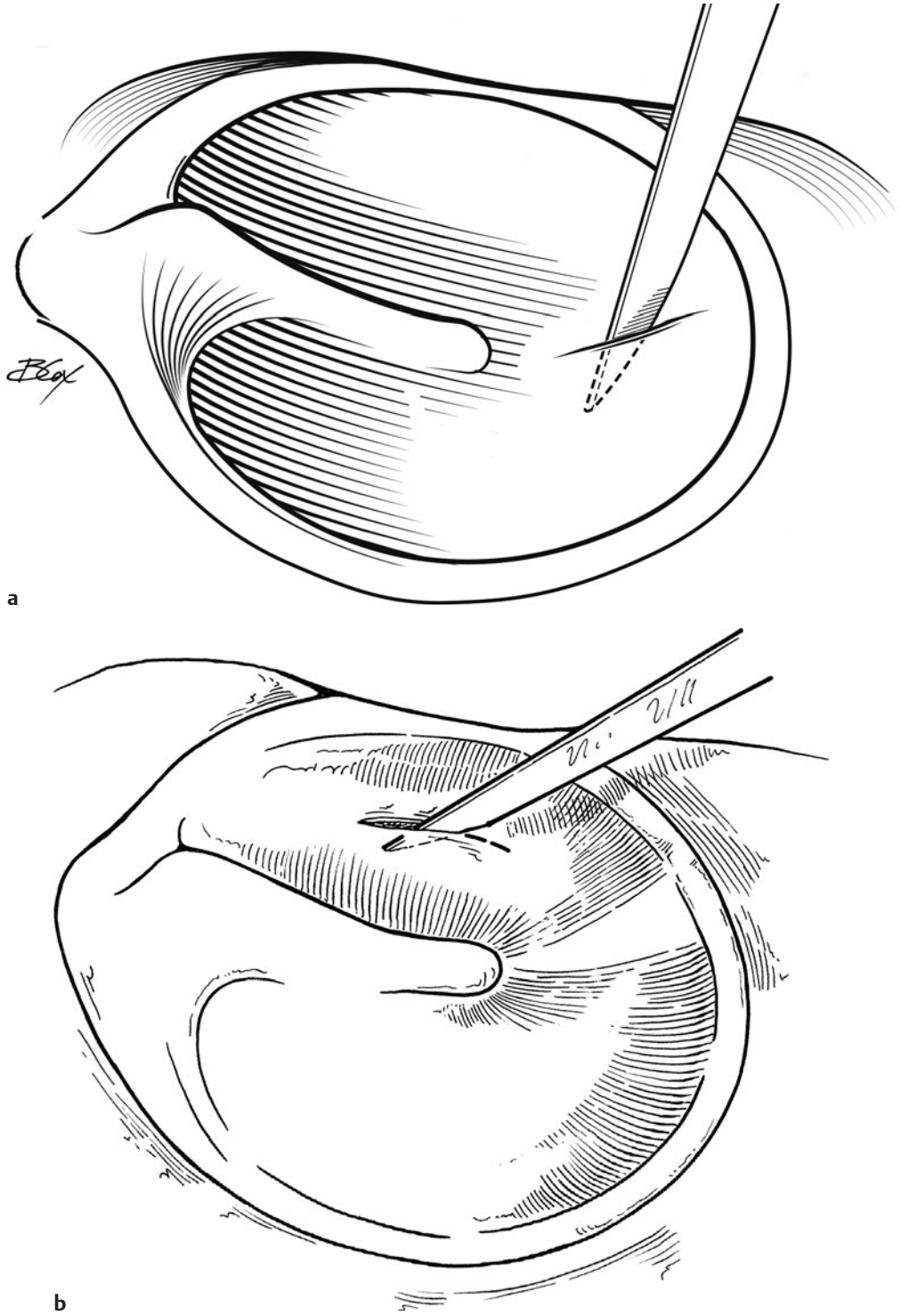


Fig. 1.1a,b

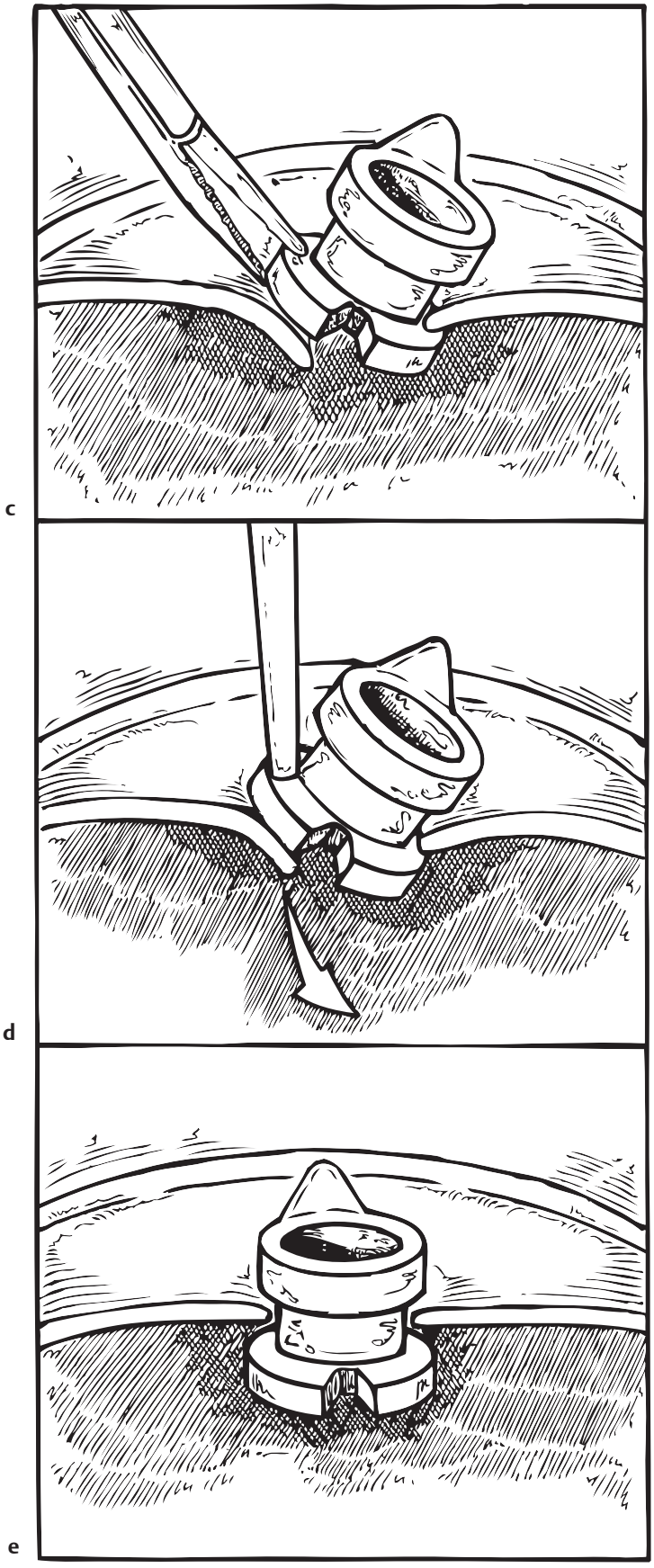
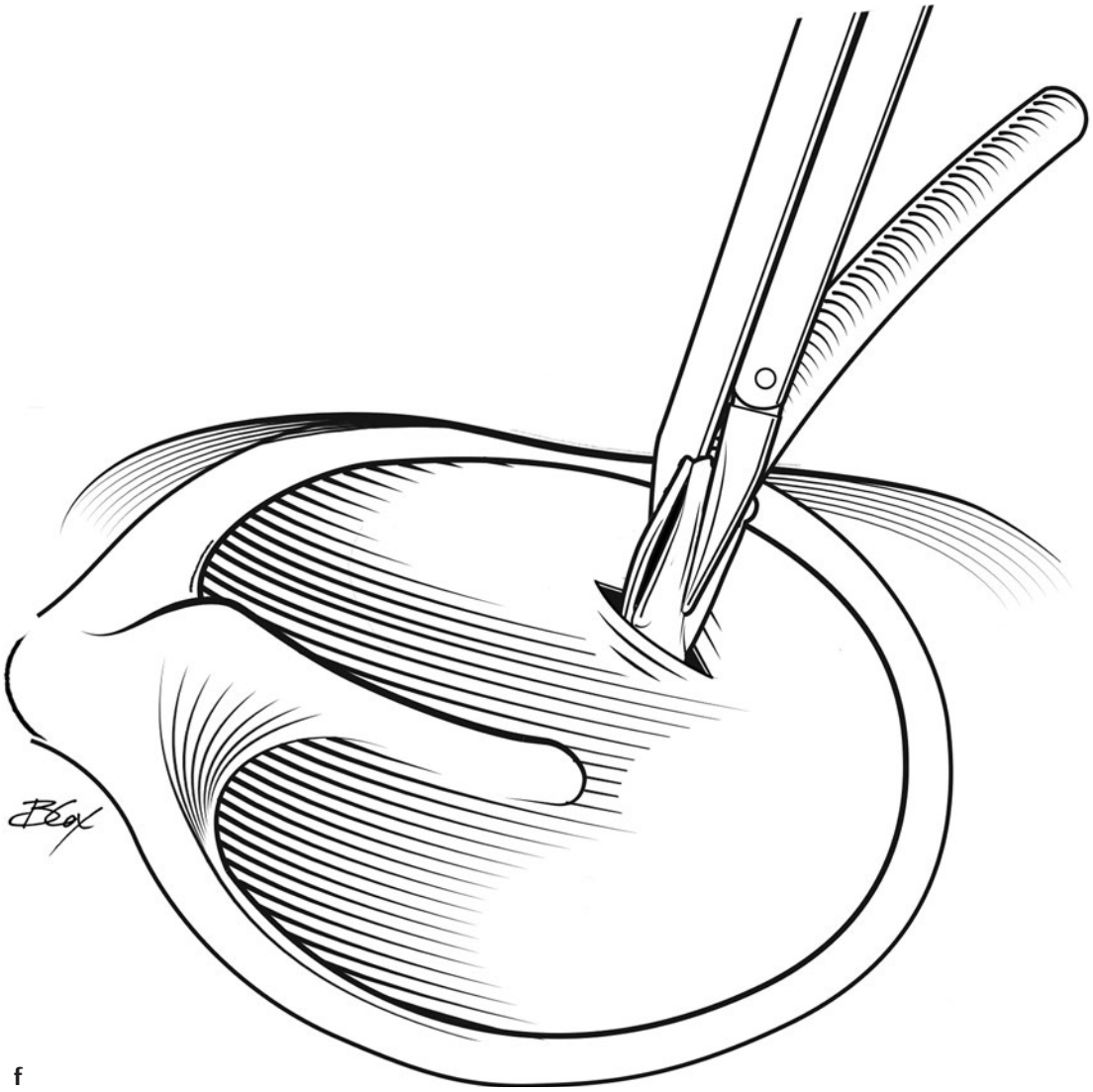
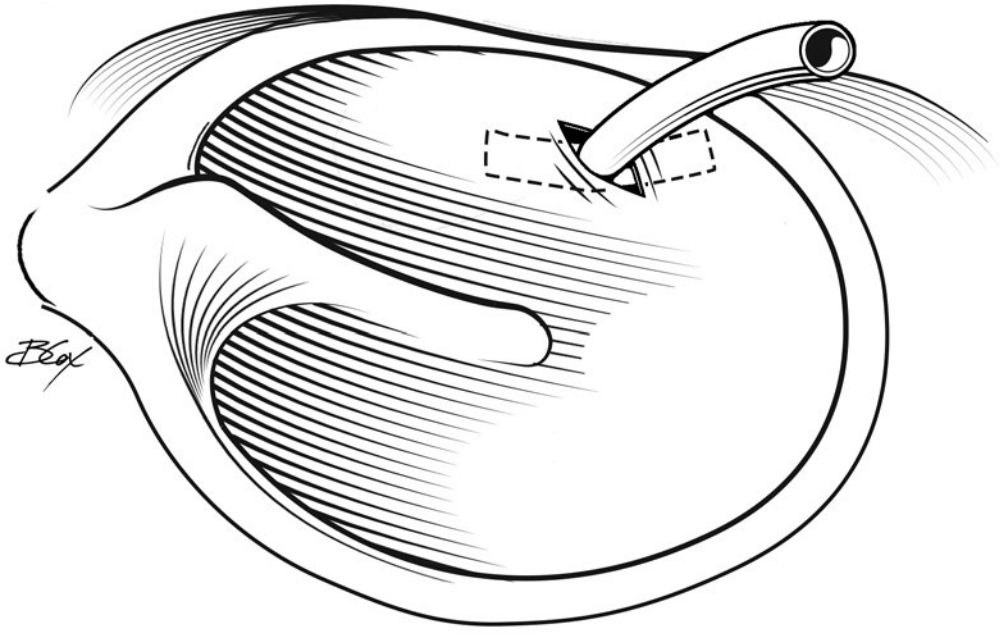


Fig. 1.1c,d,e

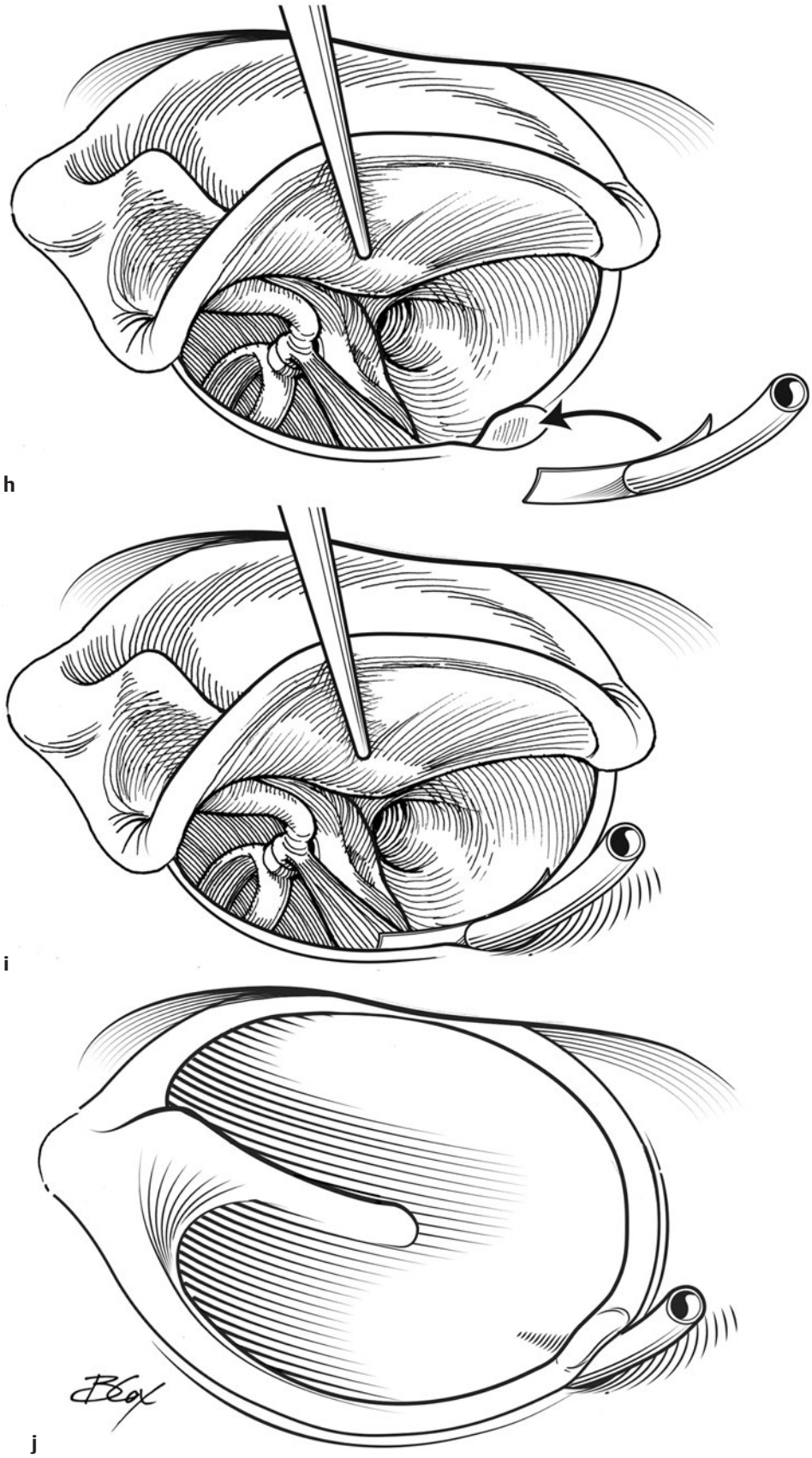


f



g

Fig. 1.1f,g



h

i

j

Fig. 1.1h,i,j

1-2 Management of Severe Tympanic Membrane Retraction

Indications

Surgical intervention should be considered when progressive retraction of the tympanic membrane (TM) results in concern for consequent development of ossicular erosion, cholesteatoma formation, or atelectasis of the middle ear. Tympanostomy tube placement as detailed above is often adequate if the process of retraction is intervened upon in its early stages. For more advanced disease, tympanoplasty may be necessary.

Preoperative Evaluation

The preoperative evaluation requires a complete pneumatic otoscopic examination and audiologic evaluation. In cases where ossicular discontinuity or cholesteatoma are suspected, computed tomography (CT) scanning can be performed.

Operative Technique

1. If the retraction is to be managed by tympanostomy tube placement, general anesthesia is induced by mask and the head is turned to the side opposite the ear being operated upon. General endotracheal anesthesia is necessary in children should tympanoplasty be required.
2. The largest speculum that will fit in the external meatus is placed in the ear, and wax is removed from the ear canal. It is important to thoroughly examine the entire TM and to attempt to visualize the depths of the pocket completely to assess for cholesteatoma formation. Retraction pockets in the posterior superior quadrant are at the highest risk for development of cholesteatoma.
3. An attempt can be made to lift the pocket from the medial surface of the middle ear with gentle suctioning. Administration of nitrous oxide by the anesthesiologist can facilitate this elevation as this gas will expand within the middle ear (**Fig. 1.2**).
4. The myringotomy should be made in an adequately ventilated portion of the ear and not at a site of adhesive retraction. A tube is placed, as previously detailed in Section 1-1.
5. If the middle ear is completely atelectatic, or if tympanostomy tube placement fails to restore the middle ear air cushion, tympanoplasty may be necessary, which is detailed in Section 3-2.

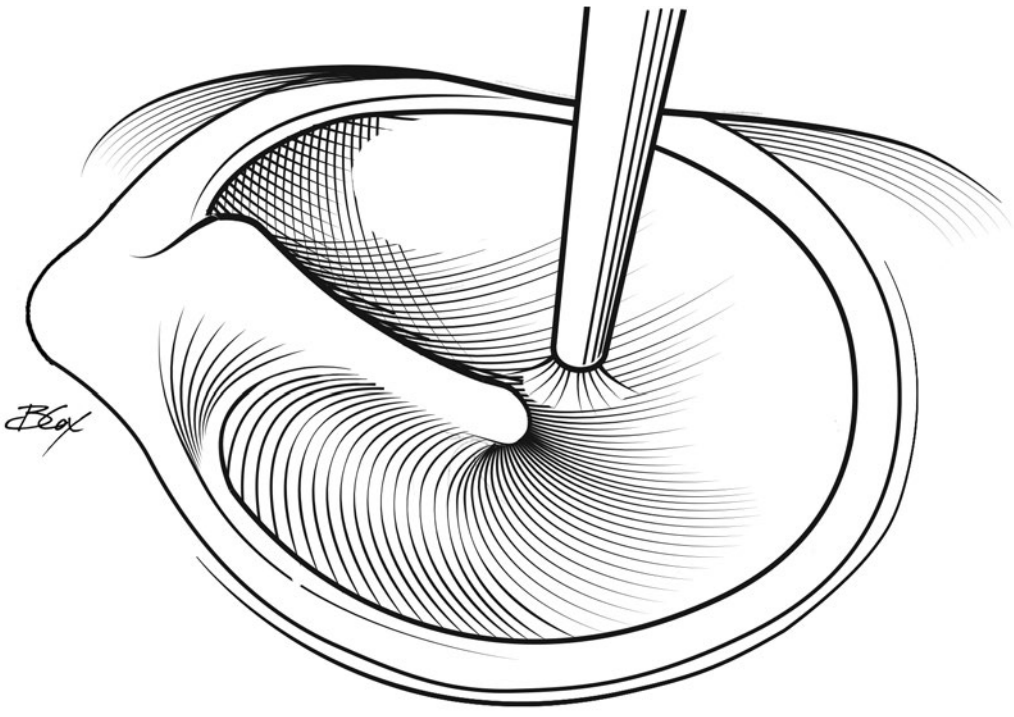


Fig. 1.2

2 Therapeutic (Wide-Field) Myringotomy

Mark D. Rizzi

When a patient has an impeding complication of acute purulent otitis media, a wide myringotomy provides drainage and access to material for culture and sensitivity.

2-1 Therapeutic (Wide-Field) Myringotomy

Indications

When a patient has facial nerve paralysis, vertigo, or intracranial complications (e.g., meningitis or cerebritis) caused by acute otitis media (AOM), a wide myringotomy for drainage and culture should be performed.

Preoperative Evaluation

Preoperative evaluation requires a complete pneumatic otoscopic examination. Audiologic evaluation may be difficult to obtain in an acutely ill child and is of limited value before this procedure.

Operative Technique

1. General anesthesia provides the maximum comfort and surgical exposure for therapeutic myringotomy. However, in some instances, depending on the child's condition, the procedure may be performed without anesthesia.
2. The ear canal should be cleared of wax to provide visualization.
3. A wide myringotomy should be made from the anteroinferior quadrant to the posteroinferior quadrant (**Fig. 2.1**).
4. The contents can then be aspirated and should be sent for culture if there is complicated acute infection.
5. A tympanostomy tube should be placed at the same time for long-term ventilation (see Section 1-1).

Complications

1. Purulent otorrhea
2. Early tube extrusion
3. Granuloma
4. Permanent perforation
5. Tympanosclerosis
6. Cholesteatoma

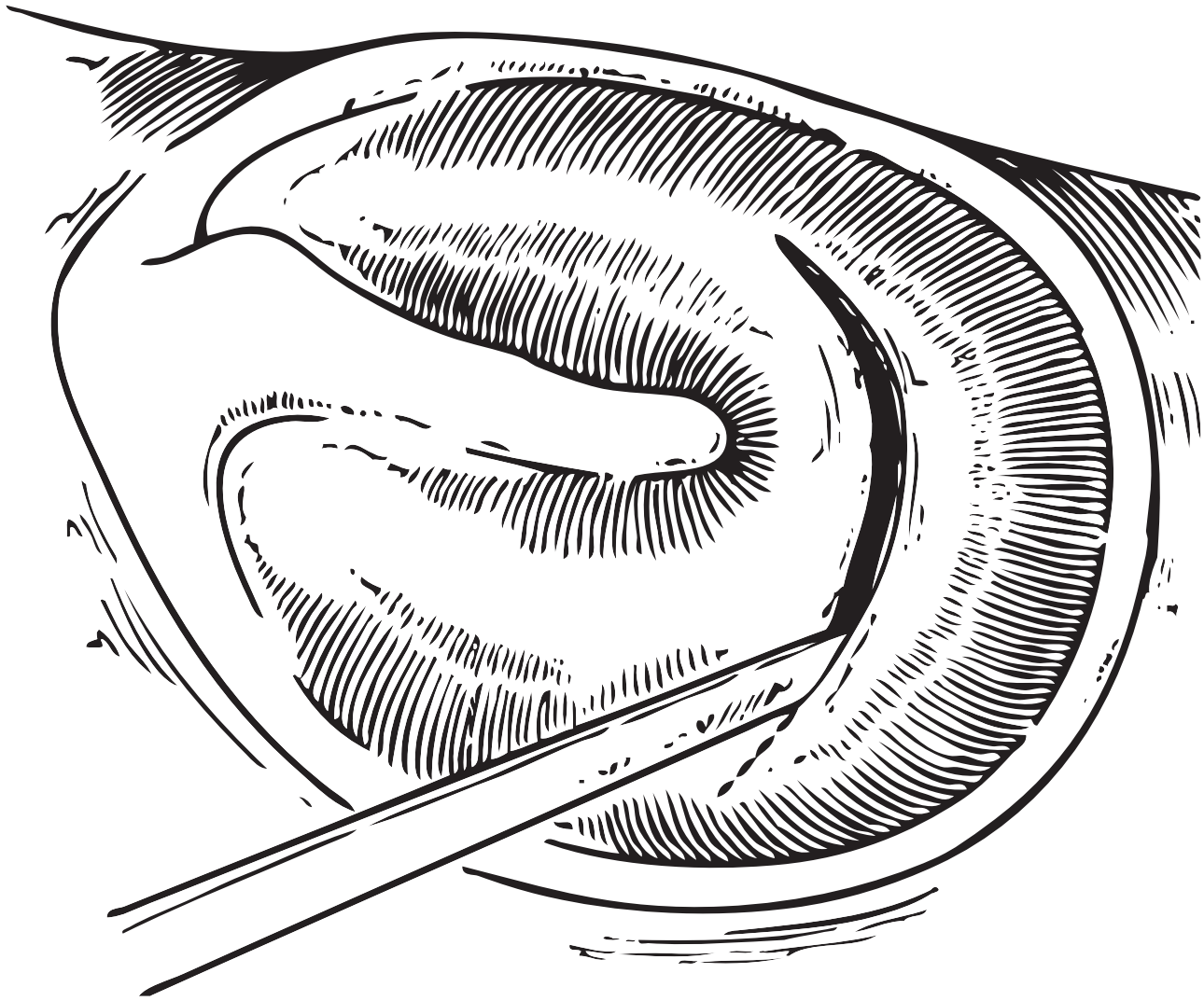


Fig. 2.1

3 Chronic Otitis Media

Daniel I. Choo

Throughout the history of otolaryngology, chronic otitis media (COM) has been described in a variety of ways, reflecting the varied presentations and clinical courses encountered by clinicians. As a result, it is reasonable to consider COM in the framework of a spectrum of diseases ranging from otitis media with effusion to chronic suppurative otitis media with cholesteatoma (as proposed by several authors). The voluminous and equally varied literature on this topic speaks to the tremendous clinical variations and challenges that are presented by this complex spectrum of ear diseases and to the wide array of management approaches that have evolved over the years.

From a clinically pragmatic perspective (and for the purposes of this chapter), COM can be divided into two categories, as described by Ian B. Thorburn in 1968. Type 1 disease involves a chronic perforation of the tympanic membrane (TM) that is not associated with chronic or recurrent infection and is typically associated with normal or near-normal hearing. Type 2 disease, in contrast, is associated with chronic mucosal infection, persistent or frequent otorrhea, as well as hearing loss. Cholesteatoma is often present or suspected in type 2 disease but is addressed specifically in another section due to the differences in management strategies.

For type 1 COM, closure of a chronic dry TM perforation is typically surgical in nature and can be achieved using several different techniques as described below. In type 2 disease, a combination of medical and surgical therapies is often required in order to attain a dry and safe ear with an intact TM and good hearing. The general strategy for approaching these ears is similarly outlined below.

3-1 Paper Patch Myringoplasty

Indications

A dry chronic perforation of the TM that has not spontaneously healed after a minimum of 3 to 4 months of observation can often be addressed through a simple paper patch myringoplasty.

Preoperative Evaluation

Following thorough microscopic exam of the ear in the clinic (with particular attention given to degree of myringosclerosis, mucosal disease, squamous debris, etc.), routine audiologic testing is requisite prior to myringoplasty.

Operative Technique

The vast majority of paper patch myringoplasties in children need to be performed under general anesthesia. In older patients, it is feasible to anesthetize the ear canal and drum using 1% lidocaine with epinephrine 1:100,000 in concentration, after which the procedure would be identical to the steps described here.

1. After cleaning the ear canal, the edges of the perforation are removed using a micro-pick or knife (e.g., Rosen pick or Sickle Knife). A common technique is to use a pick to methodically create a circumferential ring of stab incisions such that the rim of the perforation can be removed atraumatically (**Fig. 3.1a,b,c**).
2. Paper patches are fashioned by using a paper hole punch to create small disks out of cigarette paper. Some surgeons apply a liquid adhesive (e.g., Mastasol [Eloquest Healthcare]) to the undersurface of the patch.
3. The paper patch is applied directly over the freshened perforation (**Fig. 3.1d,e**).
4. Some surgeons will opt to patch then fill the ear canal with a viscous antibiotic ointment (e.g., mupirocin) to help hold the patch in place during the early postoperative period. Alternatively, Gelfoam (Pfizer) with or without a quinolone antibiotic solution can be used as packing to help hold the patch in position during the early healing period.

Alternative Techniques

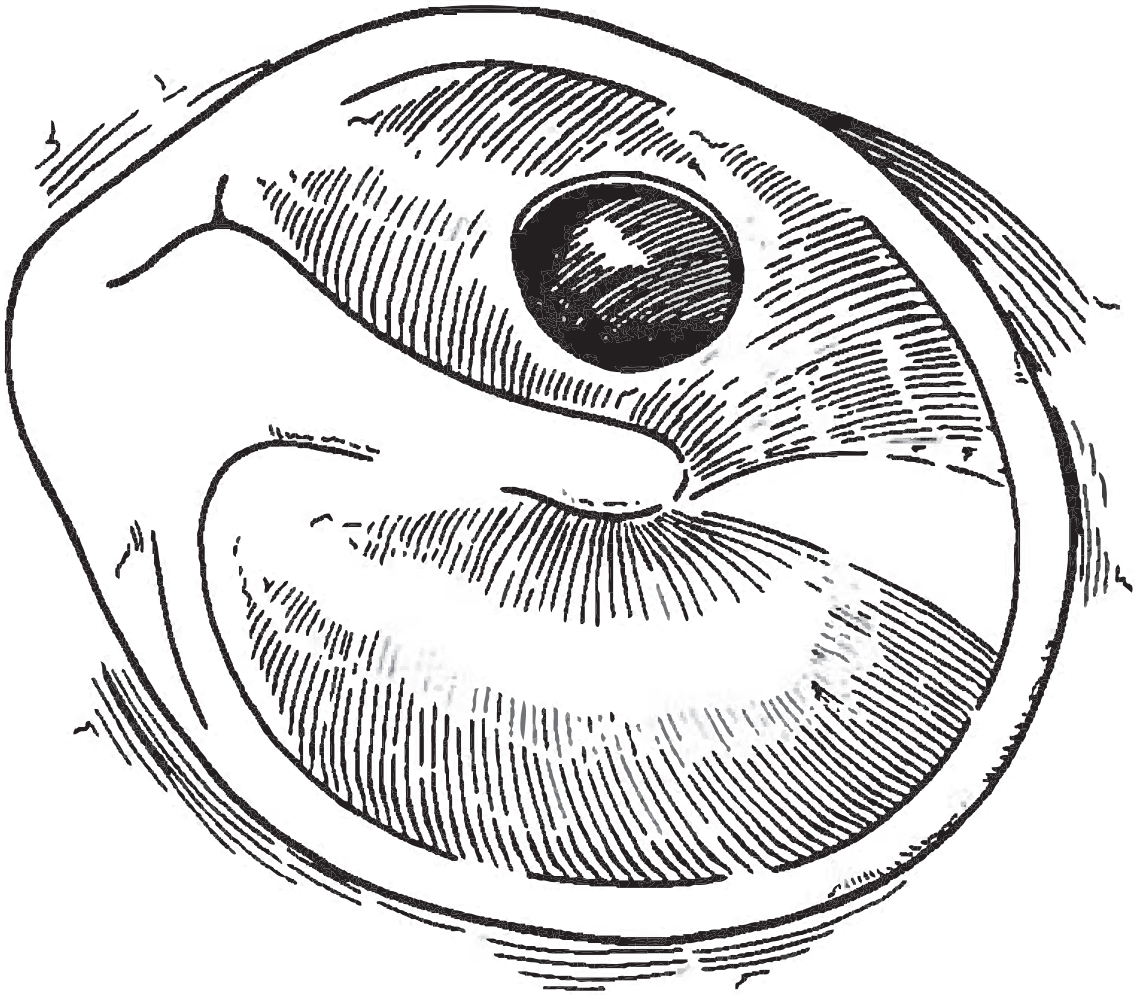
Variations of this basic approach for TM repair have included using different materials, such as Steri-Strips (3M), AlloDerm (LifeCells), Gelfoam, or gelatin film, as the scaffolding material as opposed to a paper patch. Results are very equivalent, with the more significant factors being proper patient selection for the procedure and a keen attention to detail in rimming the perforation and prepping the TM for patching.

Using a fat graft (from the ear lobule, the periumbilical region, or other convenient site) offers another effective option for repairing a chronically perforated TM and is attractive in its use of an autologous "biological" scaffolding that the body then remodels as it heals the TM defect.

Guidelines for the overall surgical technique are similar for all of the myringoplasty materials with a slight variation when using fat. In this instance, the fat is trimmed and then loosely packed into the defect in a dumbbell fashion with some redundant fat on the inner and outer aspects of the TM to help anchor it in position while healing.

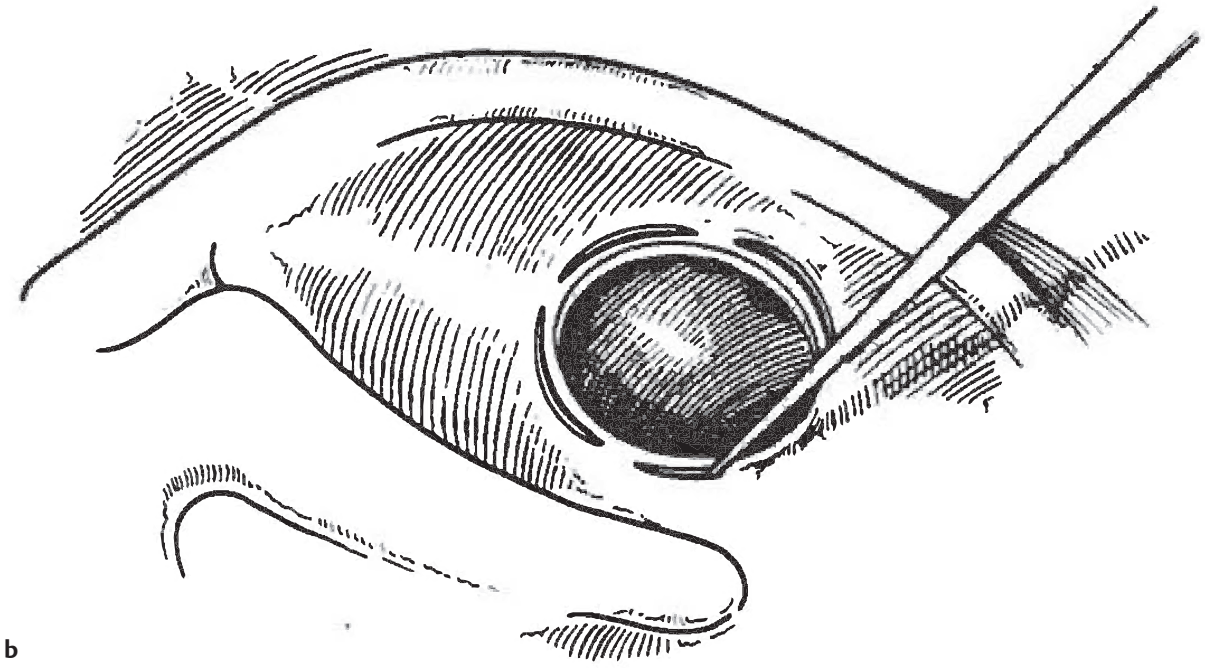
Complications

1. Persistent perforation
2. Purulent otorrhea

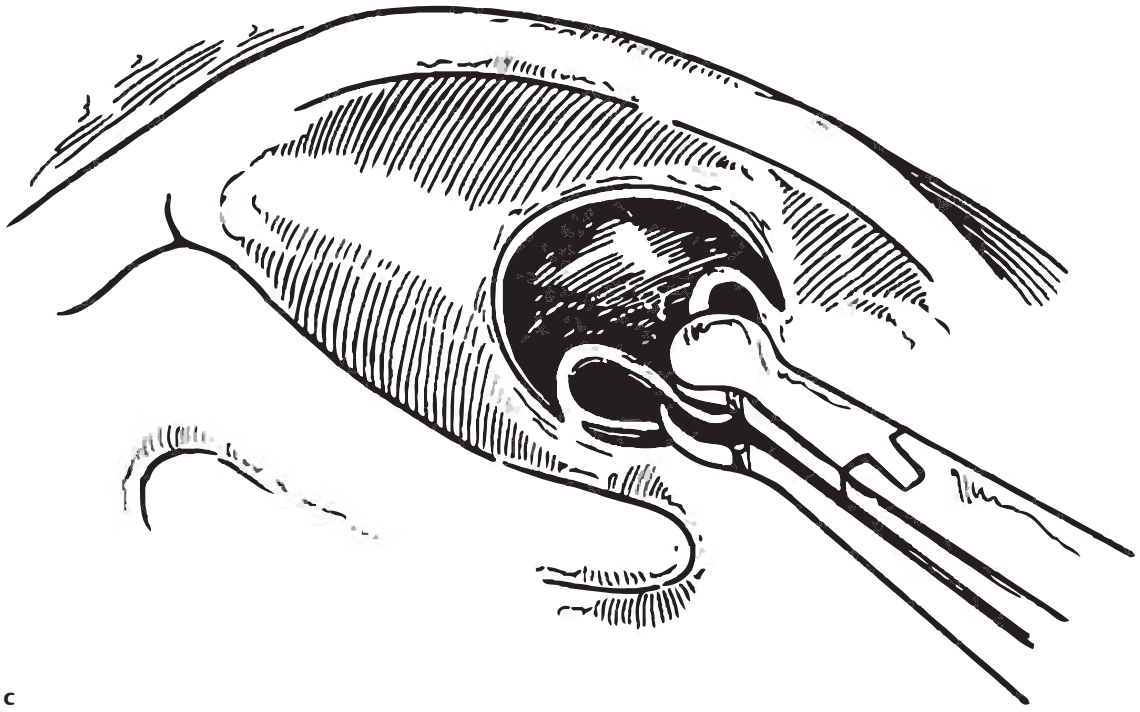


a

Fig. 3.1a,b

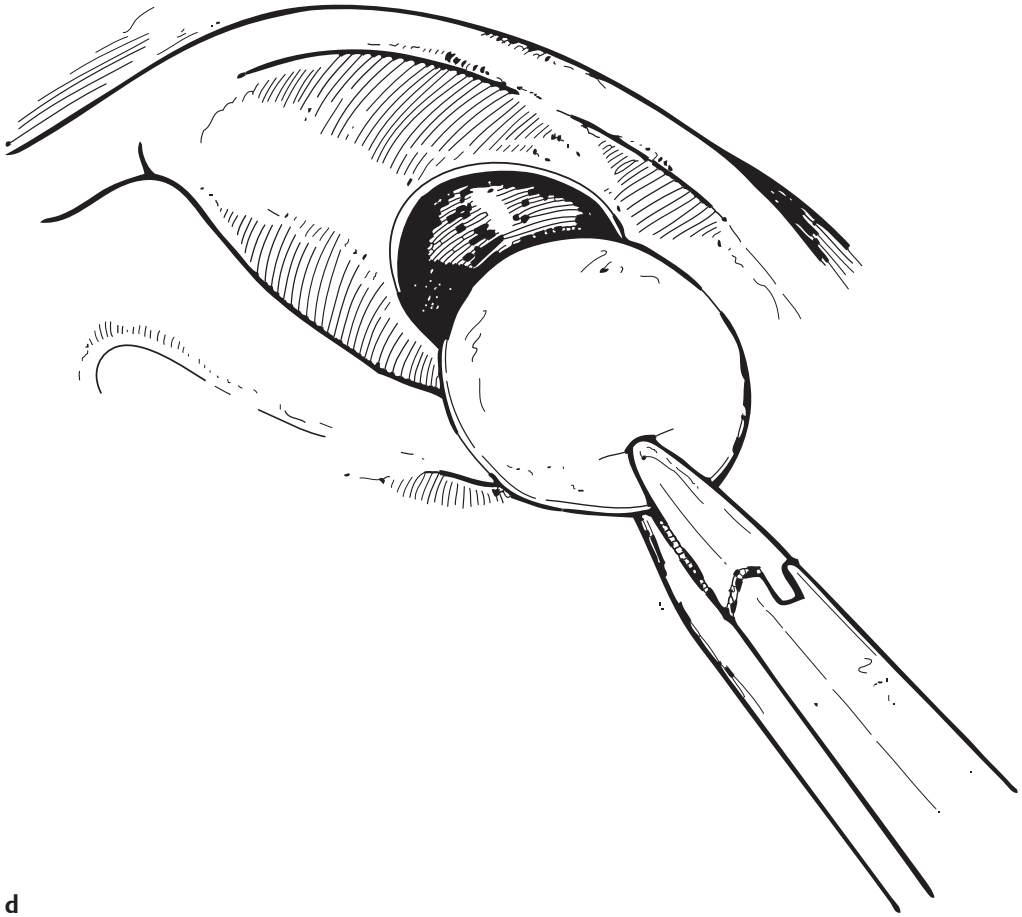


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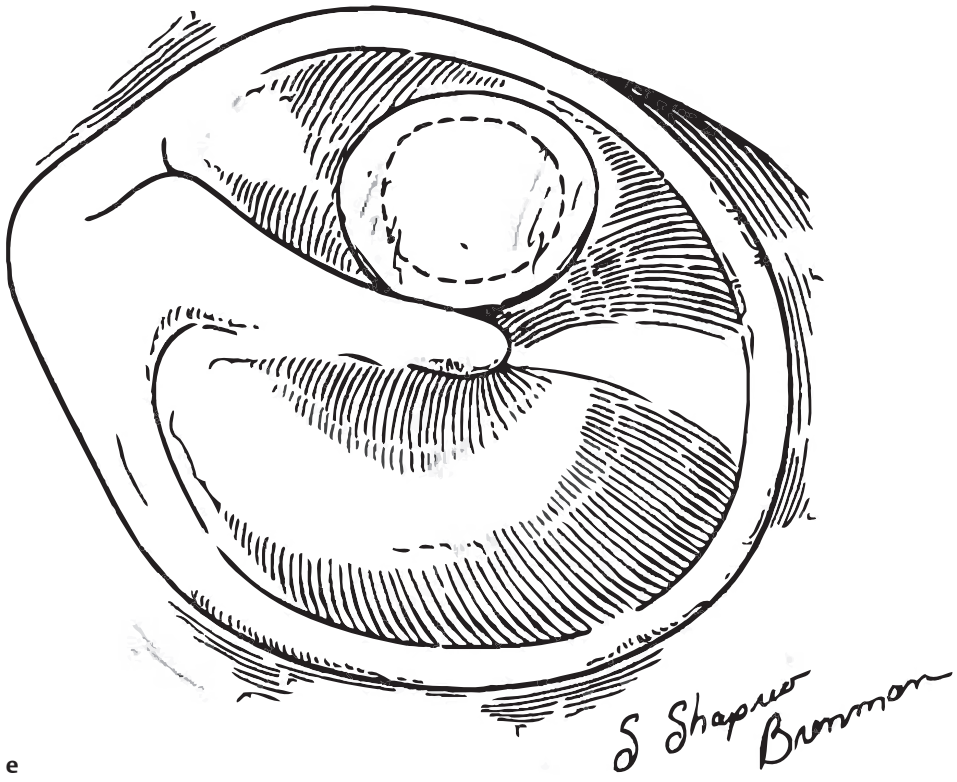


c

Fig. 3.1b,c



d



e

Fig. 3.1d,e

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3-2 Tympanoplasty

Introduction

Over the decades, tympanoplasty techniques have been described in extensive detail and with a huge number of variations to address the spectrum of pathologies encountered and to avoid pitfalls inherent with each of the technical approaches. However, one of the standard techniques for tympanoplasty is to employ areolar temporalis fascia that is placed medial to the TM (an underlay graft or medial graft technique) after elevating a tympanomeatal flap. This straightforward method typically yields > 90% perforation closure rate in properly selected patients and is often performed on an outpatient basis.

Indications

Tympanoplasty is usually considered for patients with type 1 COM that has not healed spontaneously after 6 months or more of conservative observation. In contrast to perforations in which paper patch myringoplasty is used to repair the defect, TM perforations that involve a larger portion of the TM (e.g., > 30% of the pars tensa) are better addressed through this formal tympanoplasty approach.

Preoperative Evaluation

As in most cases of COM, comprehensive history and physical examination, followed by microscopic exam of the ears, is required prior to surgery. Preoperative evaluation of the residual TM, the ossicular chain, the middle ear mucosa, signs of active infection, or cholesteatoma can significantly impact the surgical management at the time of tympanoplasty. Preoperative audiologic evaluation is also mandatory and is essential in counseling patients and families about anticipated hearing outcomes.

Operative Technique

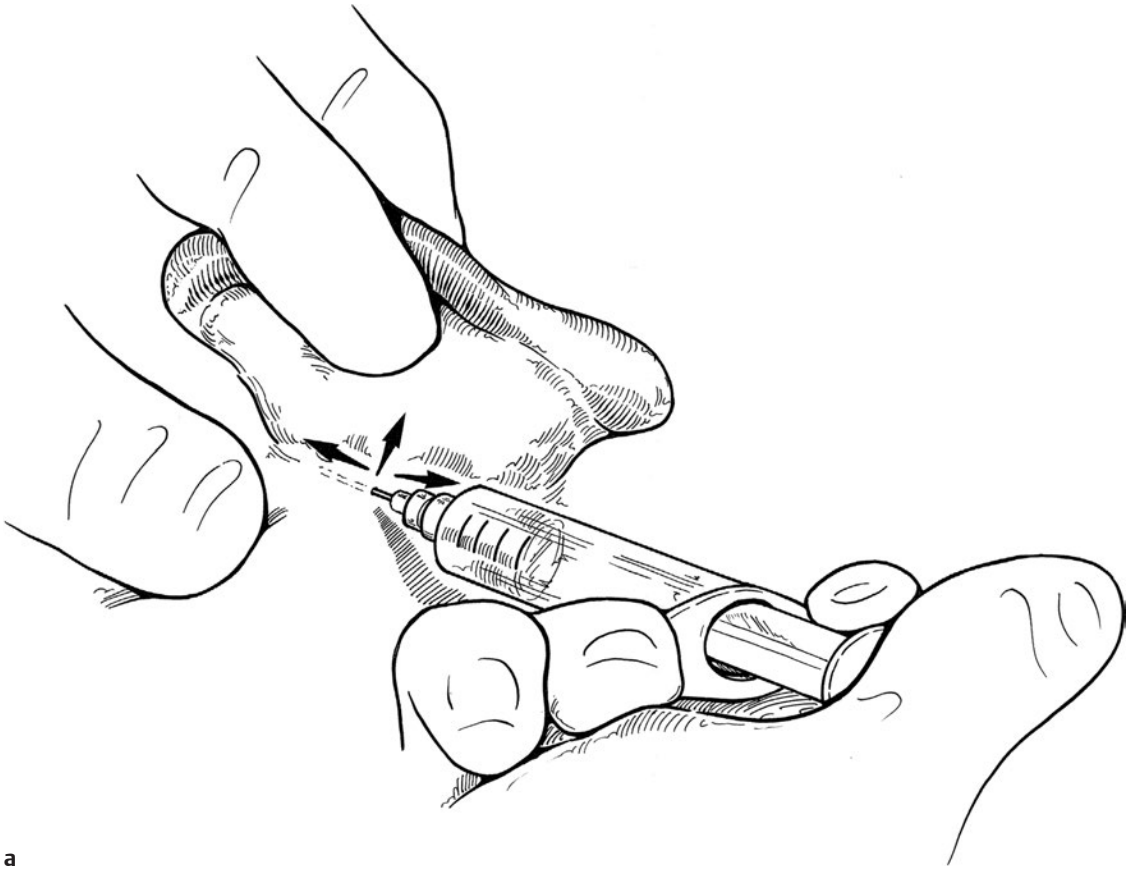
1. Meticulous injection of the ear canal and postauricular region with 1% lidocaine containing 1:100,000 epinephrine is critical to a smooth and well-executed tympanoplasty (**Fig. 3.2a,b**). Inadequate or ineffective infiltration of this local anesthetic and vasoconstrictive solution results in a constant need to obtain hemostasis during the procedure and/or the need to constantly suction away blood that obscures visualization. Such nuisance issues often incur more suction trauma to the delicate tissues that, in turn, can yield poorer wound healing and grafting results. The local anesthetic and vasoconstrictive effects of the lidocaine and epinephrine solution are also time-dependent. Accordingly, it is pragmatic to cleanse the areas to be injected with an alcohol swab, inject the solution, and then formally prep and drape the ear, thus allowing adequate time for the local agents to act. After sterile prep and drape, the ear canal is often re-injected while using the microscope to ensure a thorough infiltration of the entire ear canal and TM (**Fig. 3.2c**).
2. A standard postauricular incision is made approximately 0.5 cm behind the postauricular crease with sharp dissection continuing down to the level of the temporalis fascia. Firm retraction of the auricle laterally facilitates separation of the tissue planes and entry into the avascular plane of the loose areolar temporalis fascia (**Fig. 3.2d,e**). After undermining anteriorly, superiorly, and posteriorly, meticulous hemostasis should be obtained with the electrocautery.
3. Self-retaining retractors are placed at this point allowing harvesting of loose areolar temporalis fascia for grafting later on in the procedure. Injection of the previously used lidocaine solution is an effective way to hydrodissect a tissue plane that makes harvesting of the graft simple (**Fig. 3.2f,g**). The graft should be thinned to transparency and either pressed or set aside to dry on a nonstick surface (Teflon block).
4. The periosteum overlying the mastoid cortex is then incised with the electrocautery, classically in a C-shaped fashion, starting over the mastoid tip, extending posteriorly and superiorly before curving back anteriorly over the superior aspect of the ear canal. This Palva flap is then elevated anteriorly using a Lempert periosteal elevator and tucked into the front flange of the self-retaining retractor (**Fig. 3.2h,i,j**).
5. Under the microscope, the skin of the posterior ear canal is then gently elevated using microinstruments and suctions, with care being taken to avoid directly suctioning the elevated tissue flaps. After elevation of the posterior ear canal skin down to the level of the annulus, a vascular strip is incised and preserved by first making a transverse cut that parallels the curve of the TM approximately 3 mm lateral to the annulus from the 6 o'clock position (directly inferior) to the 12 o'clock position (directly superior) (**Fig. 3.2k**). Next, two releasing incisions are made starting at the superior and inferior apices of the first cut. These releasing incisions extend laterally out the ear canal, thereby mobilizing the vascular strip that provides the necessary blood supply to the TM and graft (**Fig. 3.2l**).
6. After placing a self-retaining retractor (**Fig. 3.2m**), proper incision and mobilization of the vascular strip typically provides a wide exposure of the entire TM area. Through this exposure, small releasing incisions are often used to facilitate turning of a tympanomeatal flap that does not require constant retraction out of the surgical field (**Fig. 3.2l**). The placement and extent of these releasing incisions can be adapted dependent on the location of the TM perforation and disease in the middle ear or ear canal.

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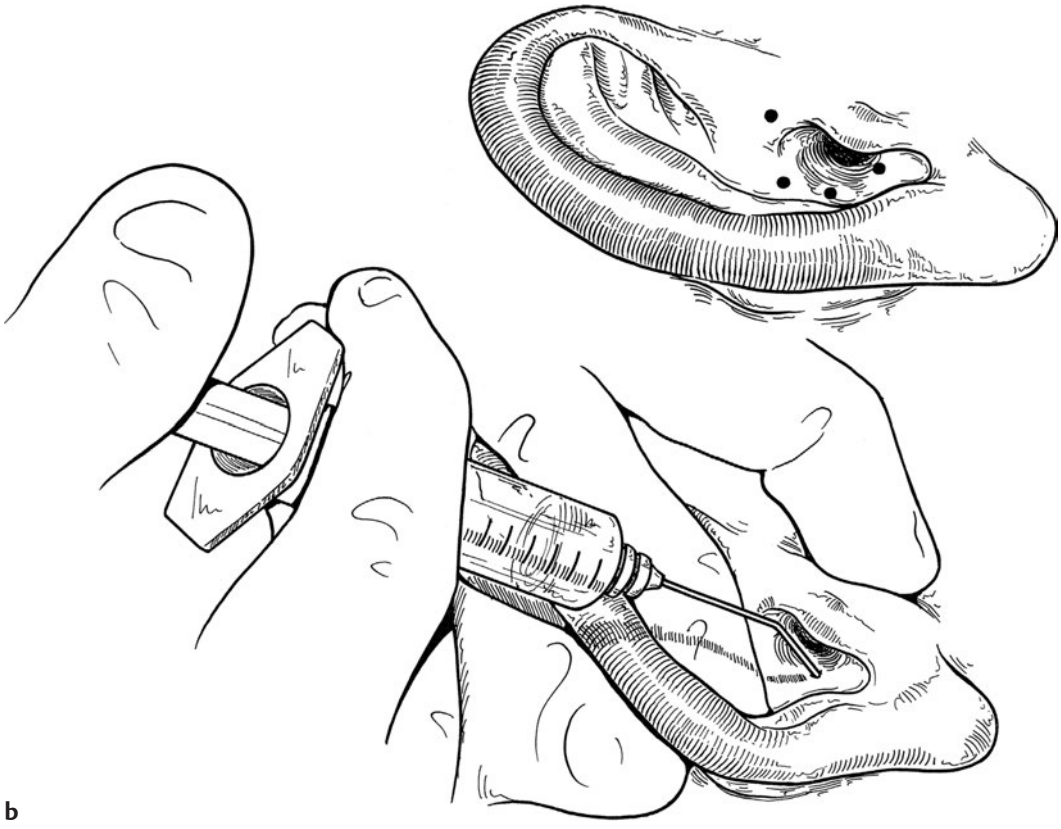
7. Prior to turning a tympanomeatal flap, it is often preferable to rim the edges of the perforation as previously described (**Fig. 3.2n,o**). The undersurface of the TM surrounding the perforation defect is also scraped prior to grafting (**Fig. 3.2p**).
8. Under higher magnification, a round knife or lancet knife can be used to carefully elevate the annulus and TM allowing entrance into the middle ear space (**Fig. 3.2q**). Initial dissection typically starts in the posteroinferior quadrant in order to avoid injuring the chorda tympani nerve during this initial maneuver. An annulus elevator, aka "gimmick," is then commonly used to sweep inferiorly and complete elevation of the inferior portion of the TM. More careful dissection is required in the posterosuperior quadrant in order to preserve the chorda tympani nerve and avoid damage to the ossicular chain deep to the TM.
9. Thorough evaluation of the integrity and mobility of the ossicles is routinely performed during tympanoplasty in order to avoid missing pathology that might impact healing and hearing (**Fig. 3.2r**).
10. A supporting bed of Gelfoam saturated with an antibiotic-steroid solution (e.g., ciprofloxacin with dexamethasone) is placed in the middle ear space against the promontory, filling the hypotympanum and around the ossicular chain (**Fig. 3.2s**). While an adequate amount of Gelfoam is required to maintain the graft in contact with the medial surface of the tympanomeatal flap, an excessive amount can hamper proper placement of the temporalis fascia graft.
11. After placing the supporting Gelfoam, the fascia is trimmed to the appropriate size to fill the defect with an additional 2 to 3 mm (minimum) beyond the edges of the perforation circumferentially. The graft is then placed under the tympanomeatal flap (underlay or medial graft fashion) (**Fig. 3.2t**). Placement of an inadequate graft (too small or improperly placed) such that the defect is just barely filling the TM defect is a frequent cause of failure in tympanoplasty.
12. With the graft in proper position, the tympanomeatal flap is then laid into its normal anatomical position on top of the temporalis fascia (**Fig. 3.2u**) and then secured using the same Gelfoam packing in the medial half of the ear canal (**Fig. 3.2v,w**).
13. Prior to closing, the self-retaining retractor(s) are released and the vascular strip gently stretched and unfurled so that it rests flat along the posterior canal wall.
14. The postauricular incision is closed using resorbable sutures (e.g., 3-0 chromic suture) at the periosteal and deep subcutaneous tissue layers, followed up a running subcuticular suture that is similarly resorbable in nature (e.g., 4-0 chromic) (**Fig. 3.2x,y**).
15. A final look through the operating microscope ensures that the vascular strip and grafts are all well-seated, and then the lateral half of the ear canal is filled with mupirocin ointment (**Fig. 3.2z**).
16. A standard mastoid compression dressing is applied and the procedure terminated at this point.

Complications

1. Persisting perforation
2. Hearing loss (typically conductive in nature)
3. Facial nerve injury
4. Vertigo
5. Dysgeusia from chorda tympani sacrifice
6. Cholesteatoma

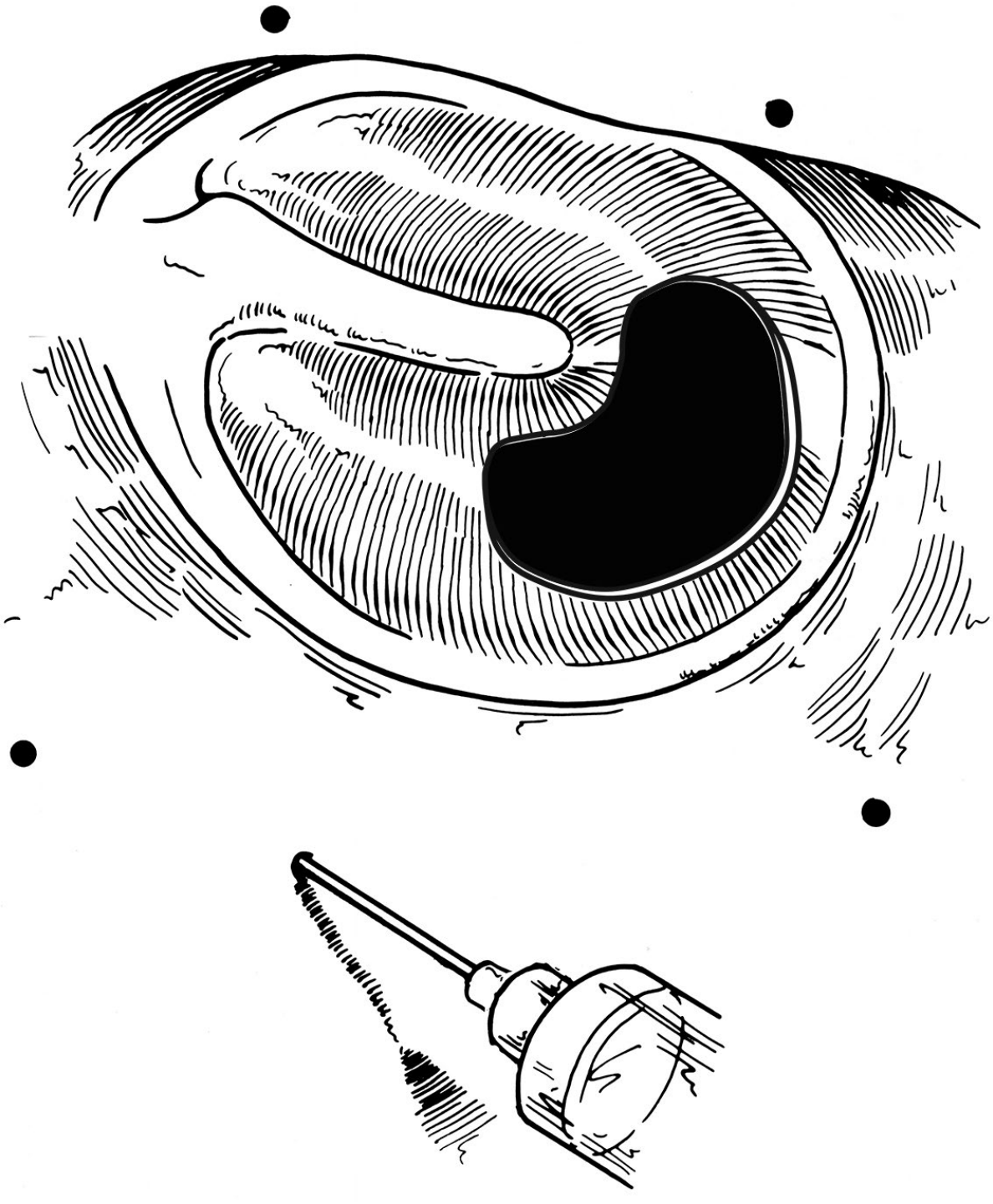


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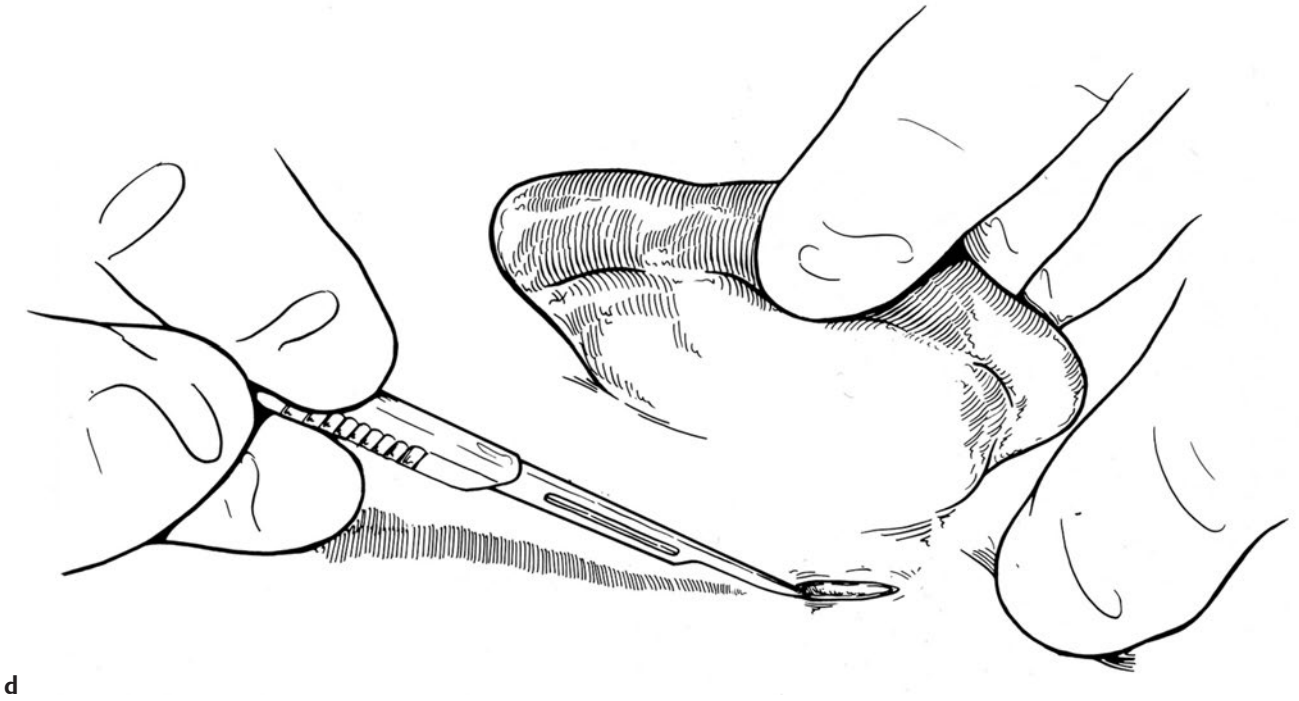
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Fig. 3.2a,b

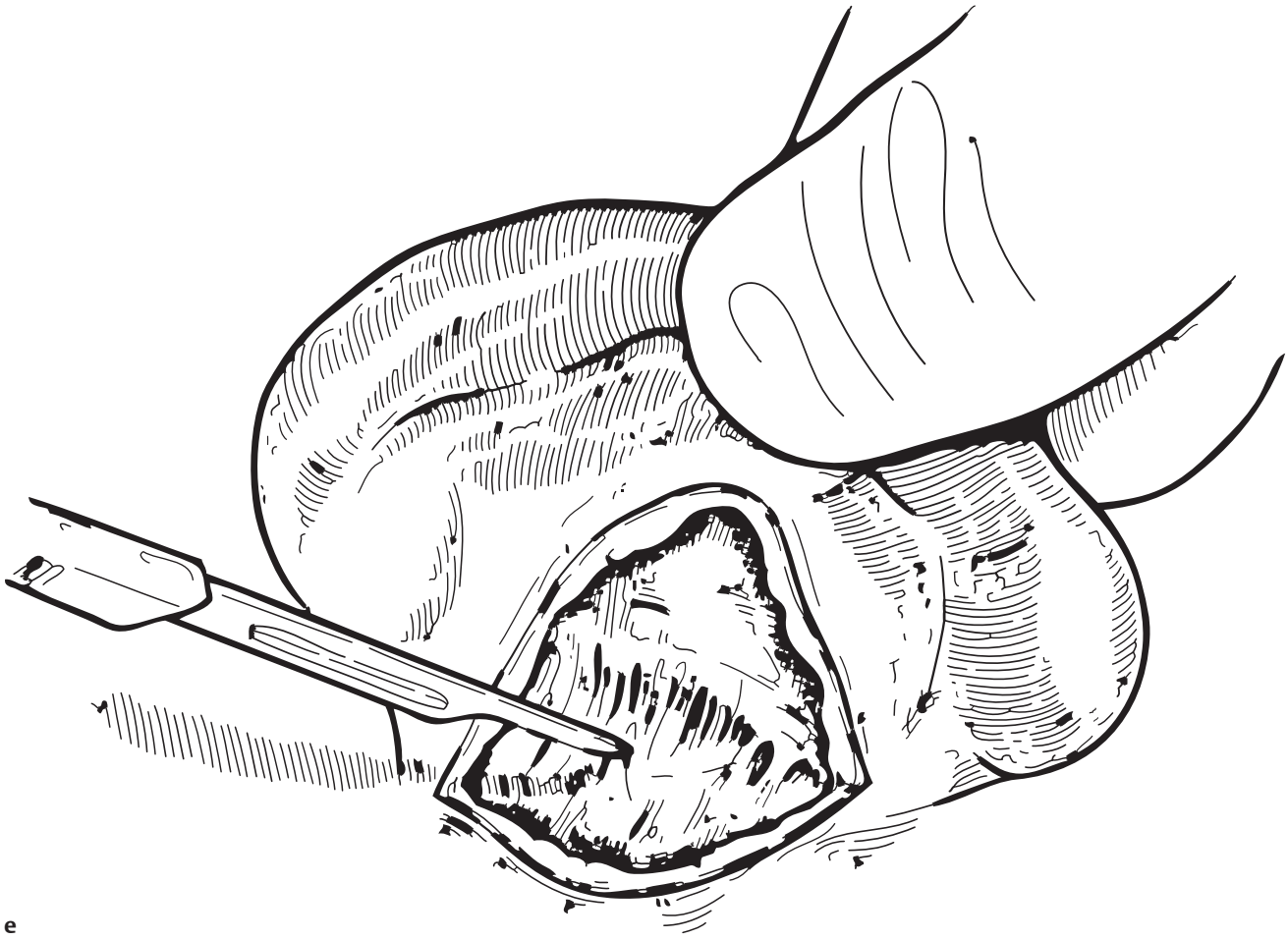


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Fig. 3.2c



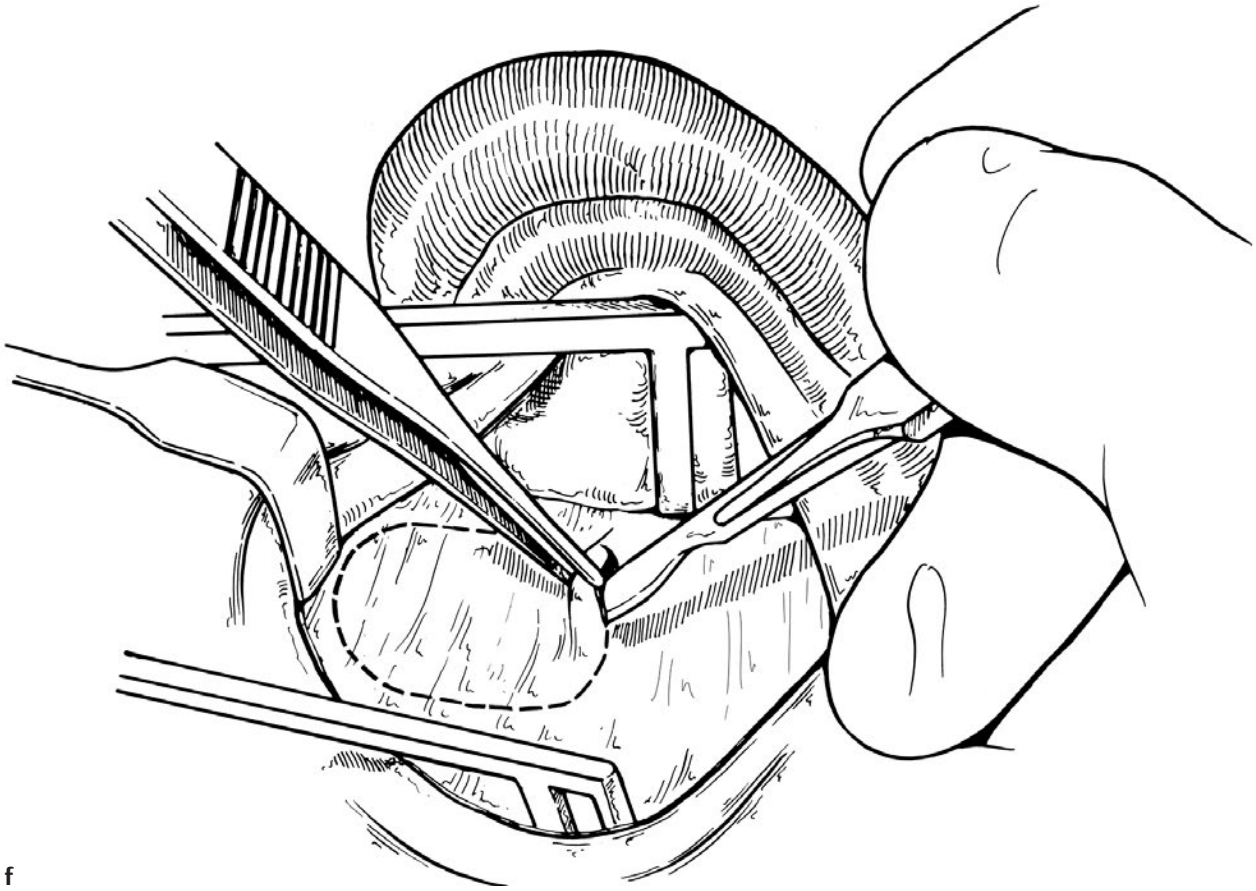
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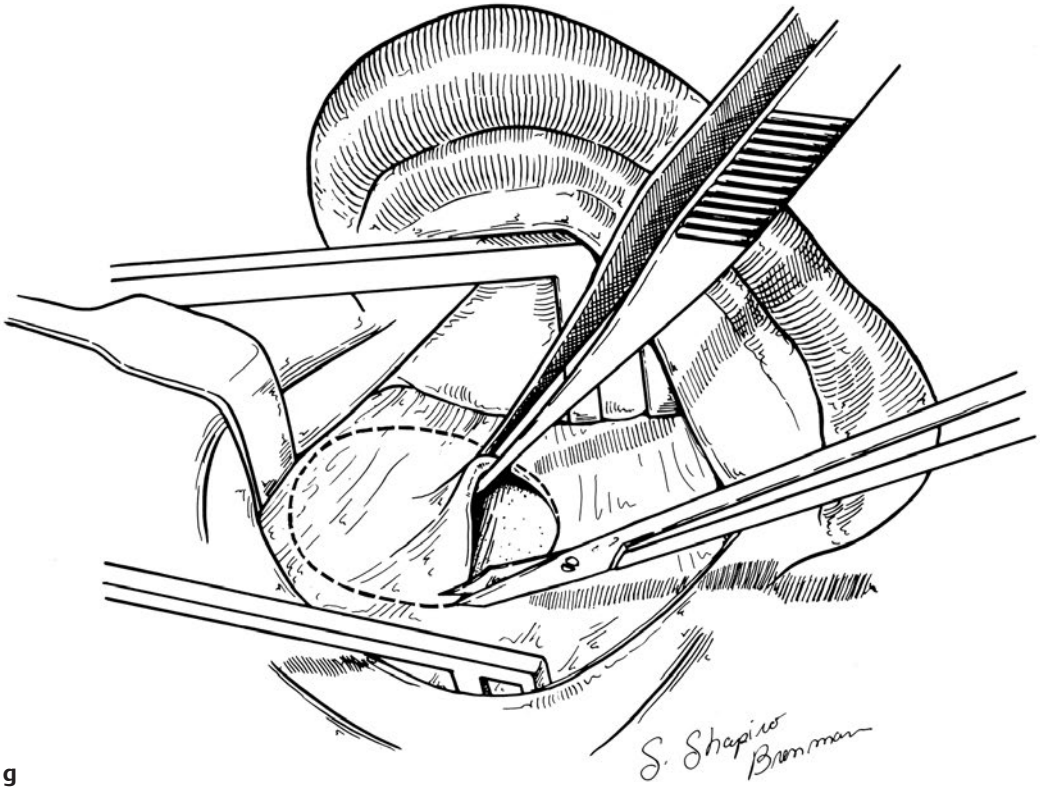
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Fig. 3.2d,e

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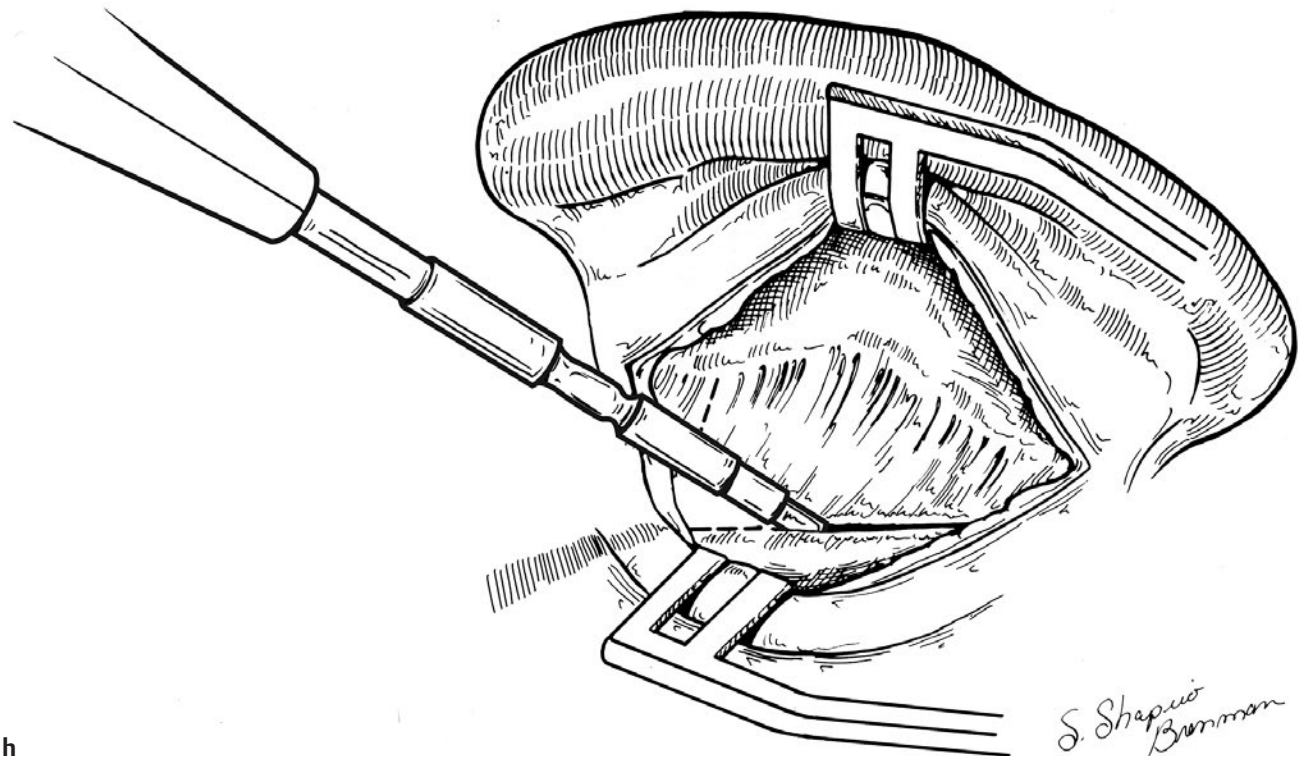
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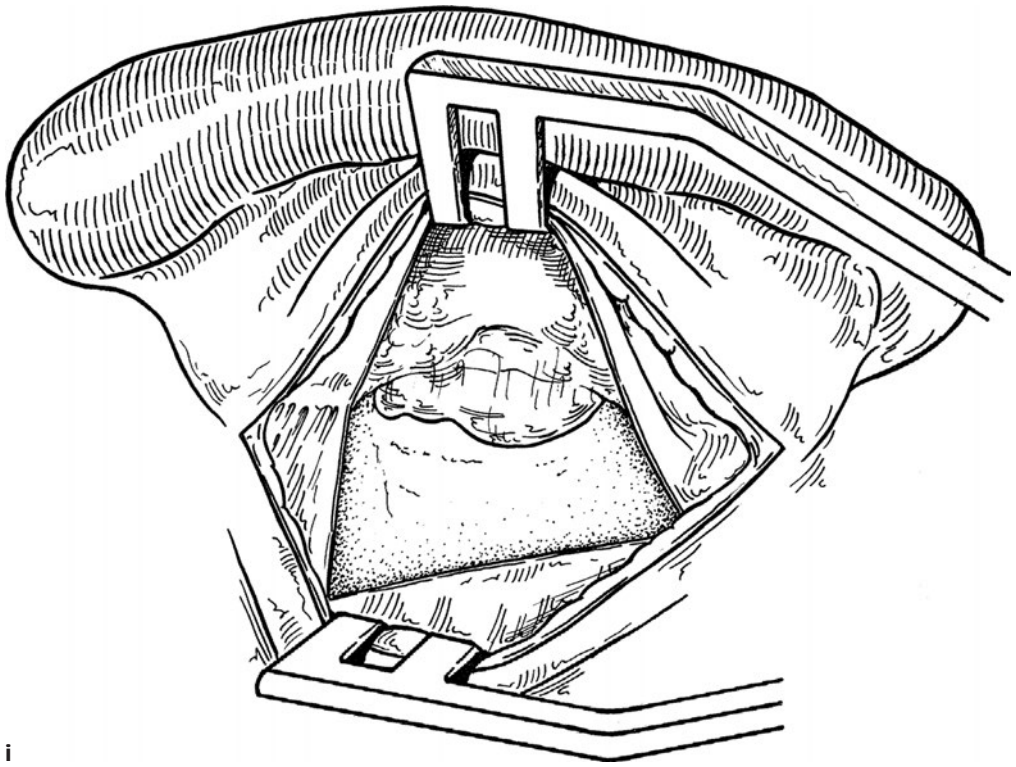
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Fig. 3.2f,g

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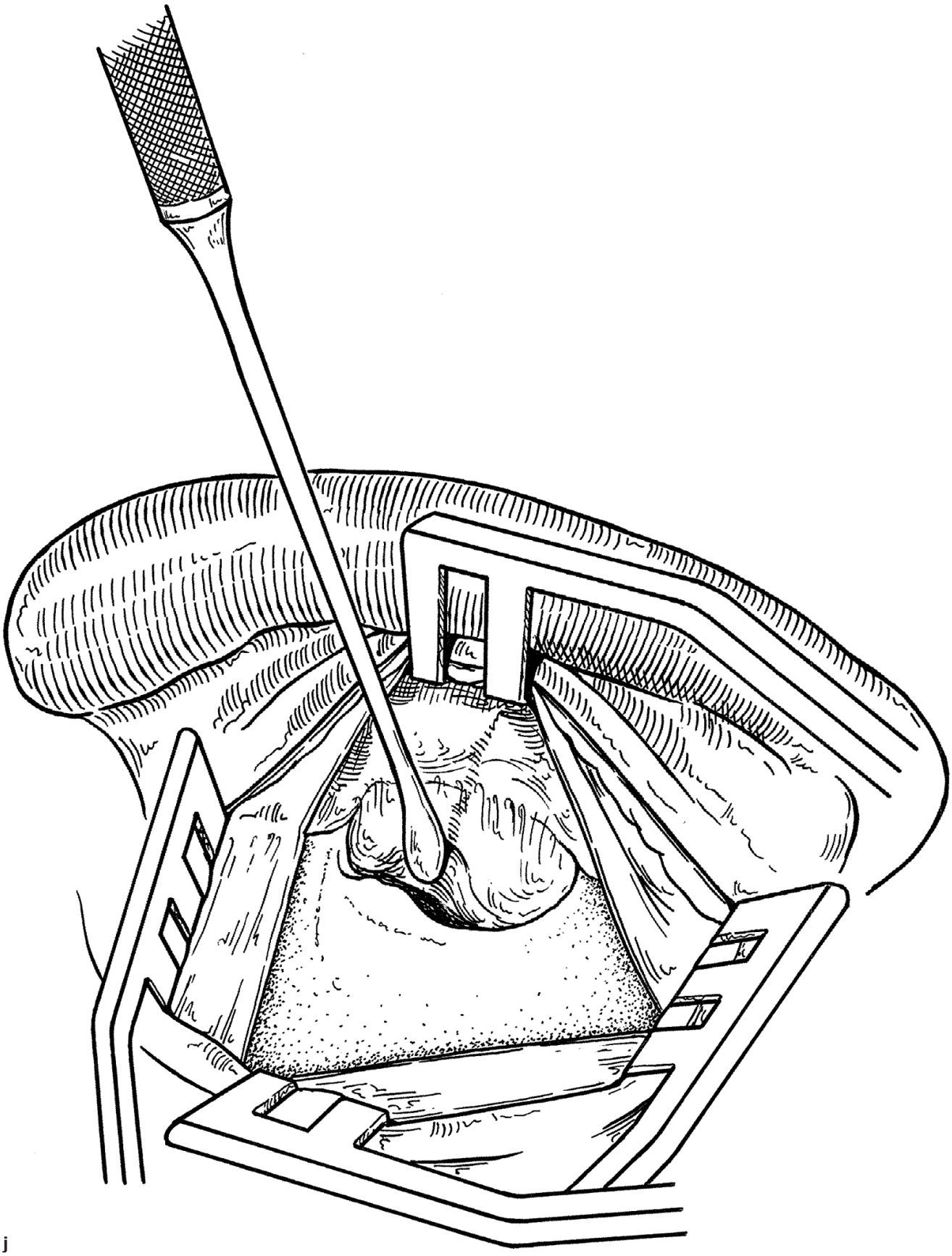


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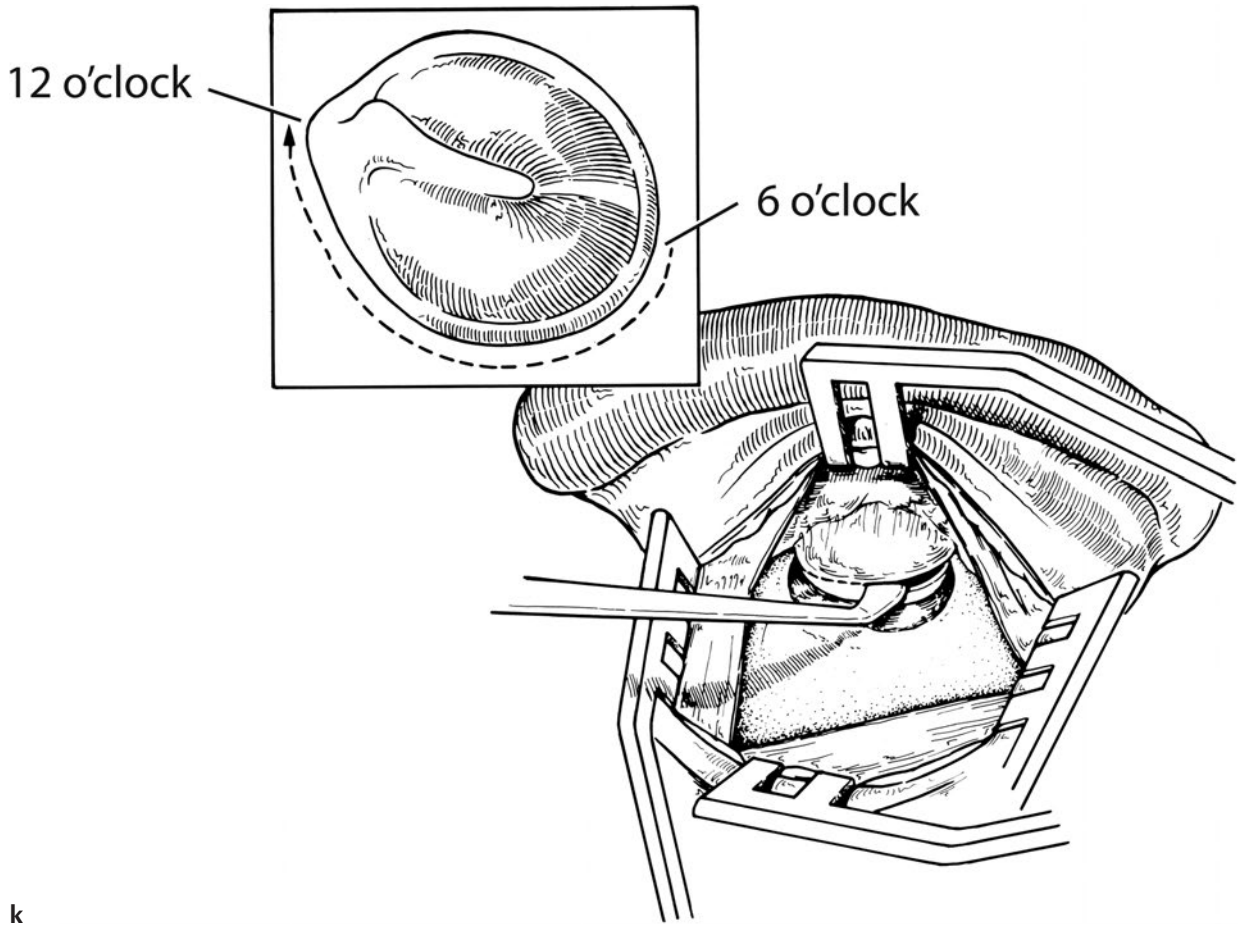
i

Fig. 3.2h,i

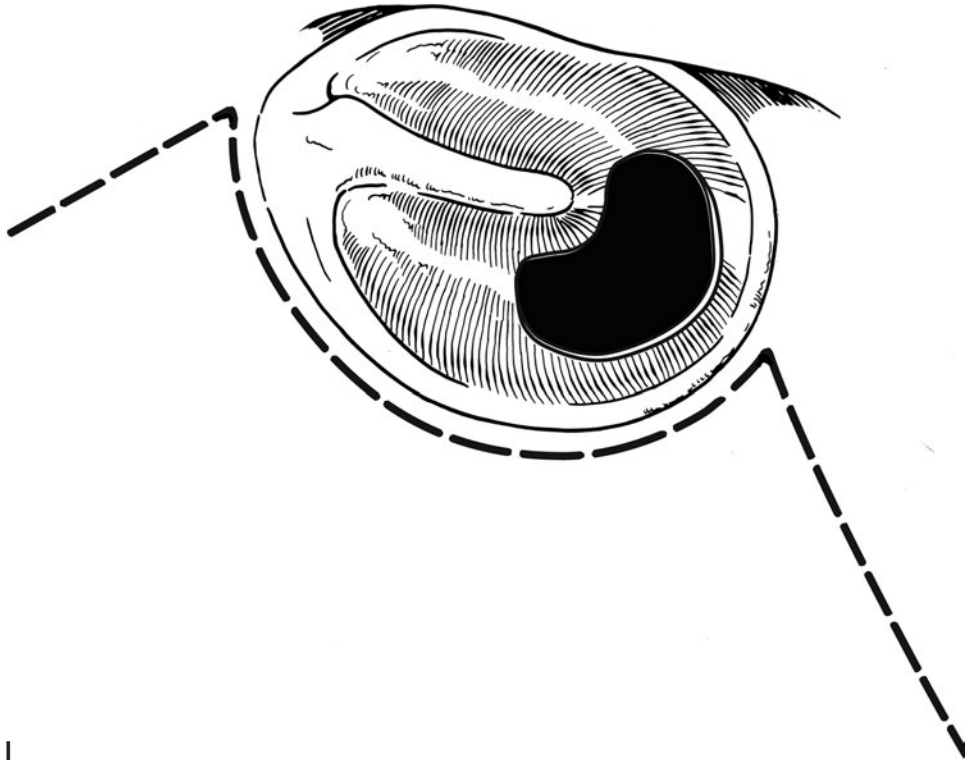


j

Fig. 3.2j

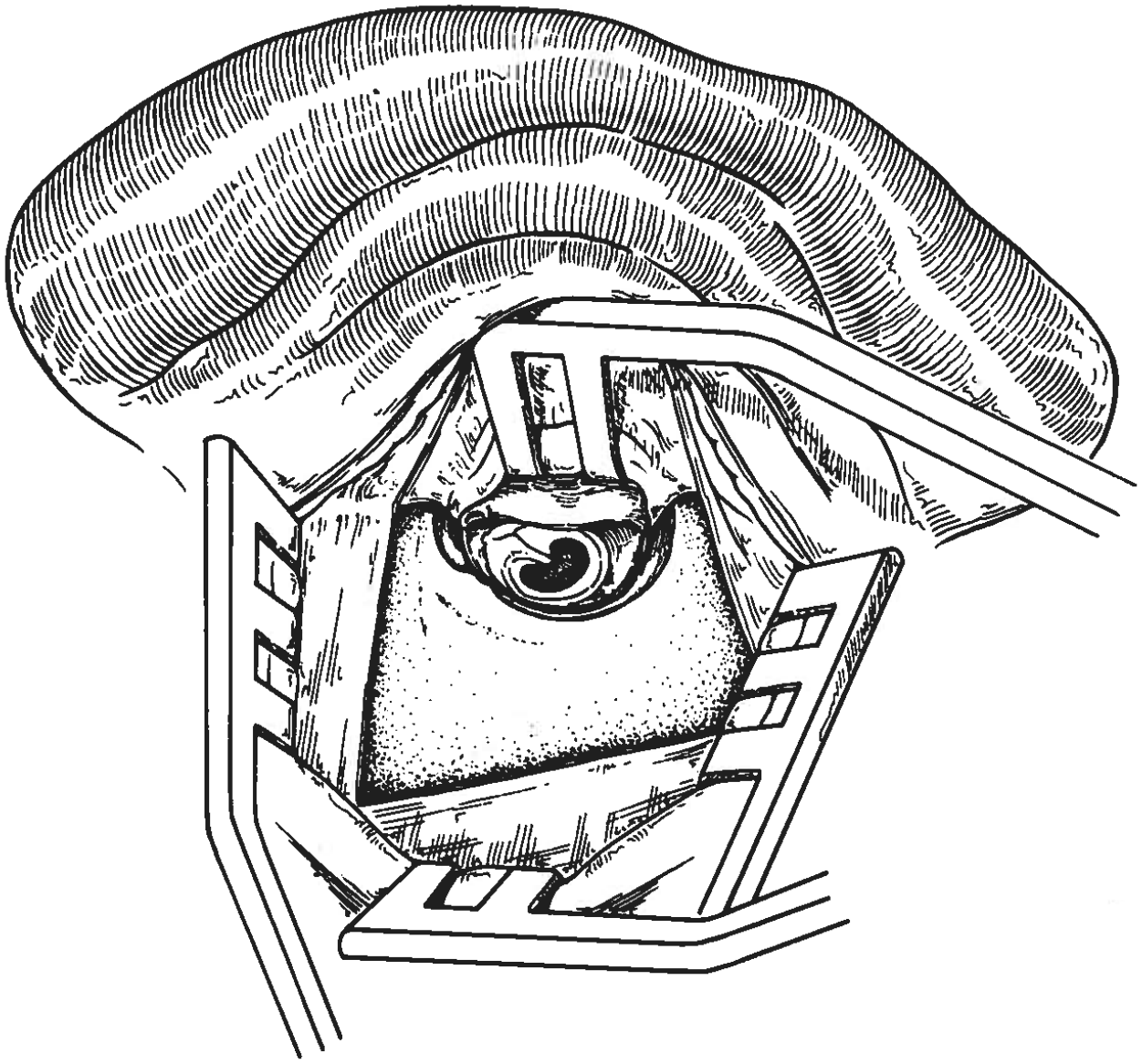


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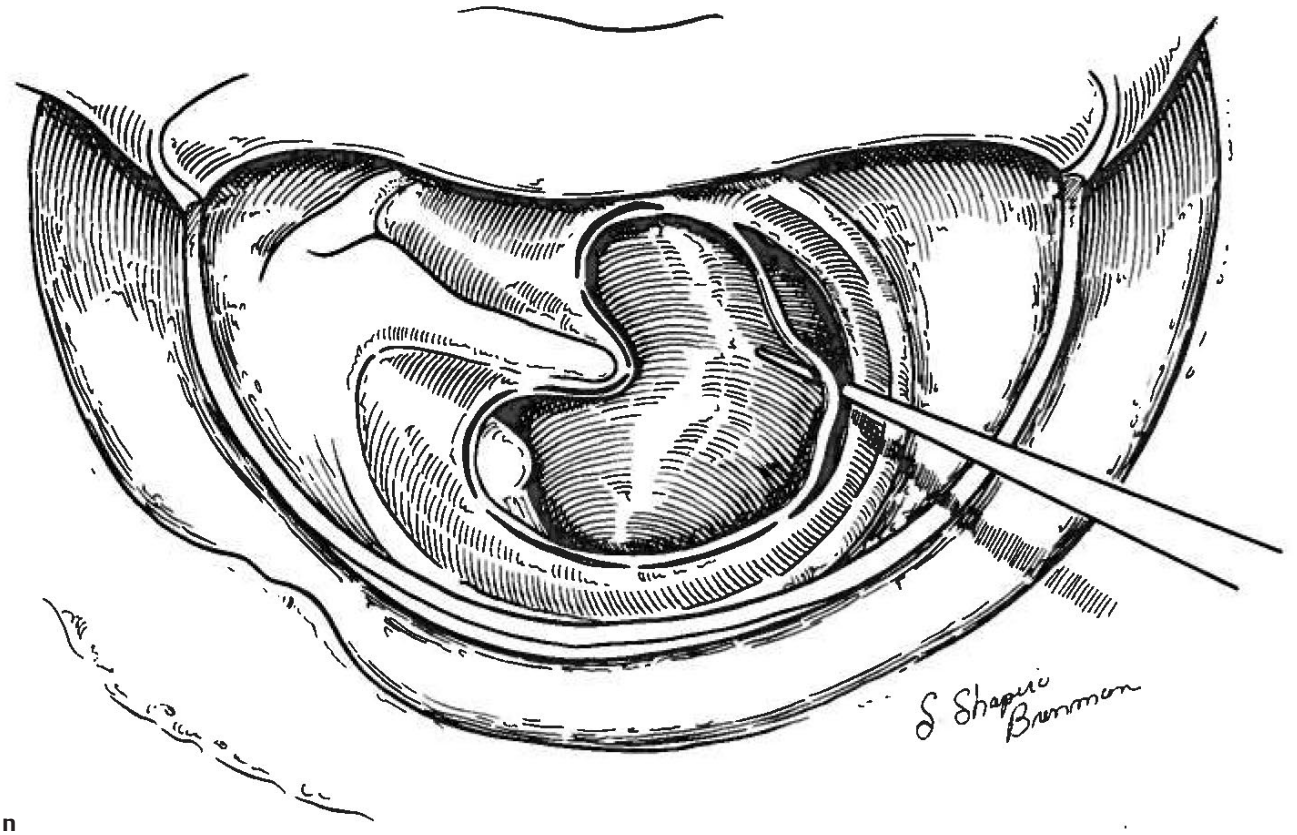
Fig. 3.2k,l



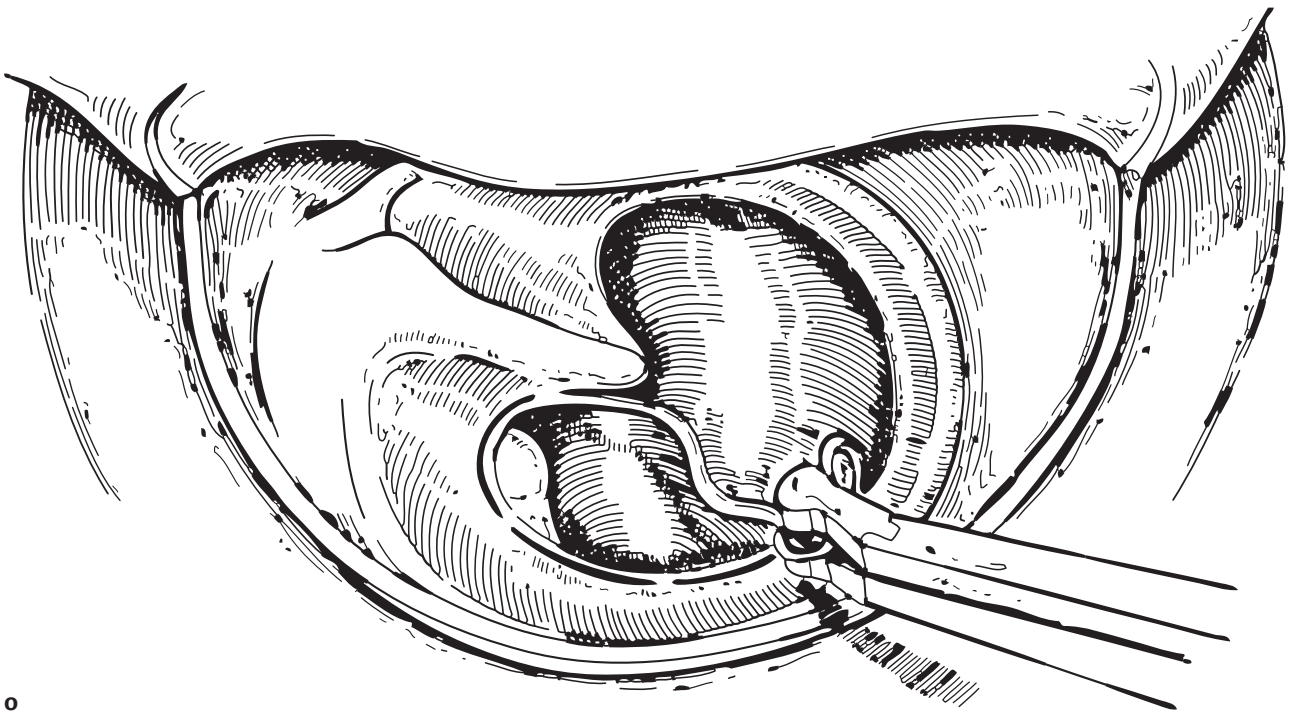
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Fig. 3.2m

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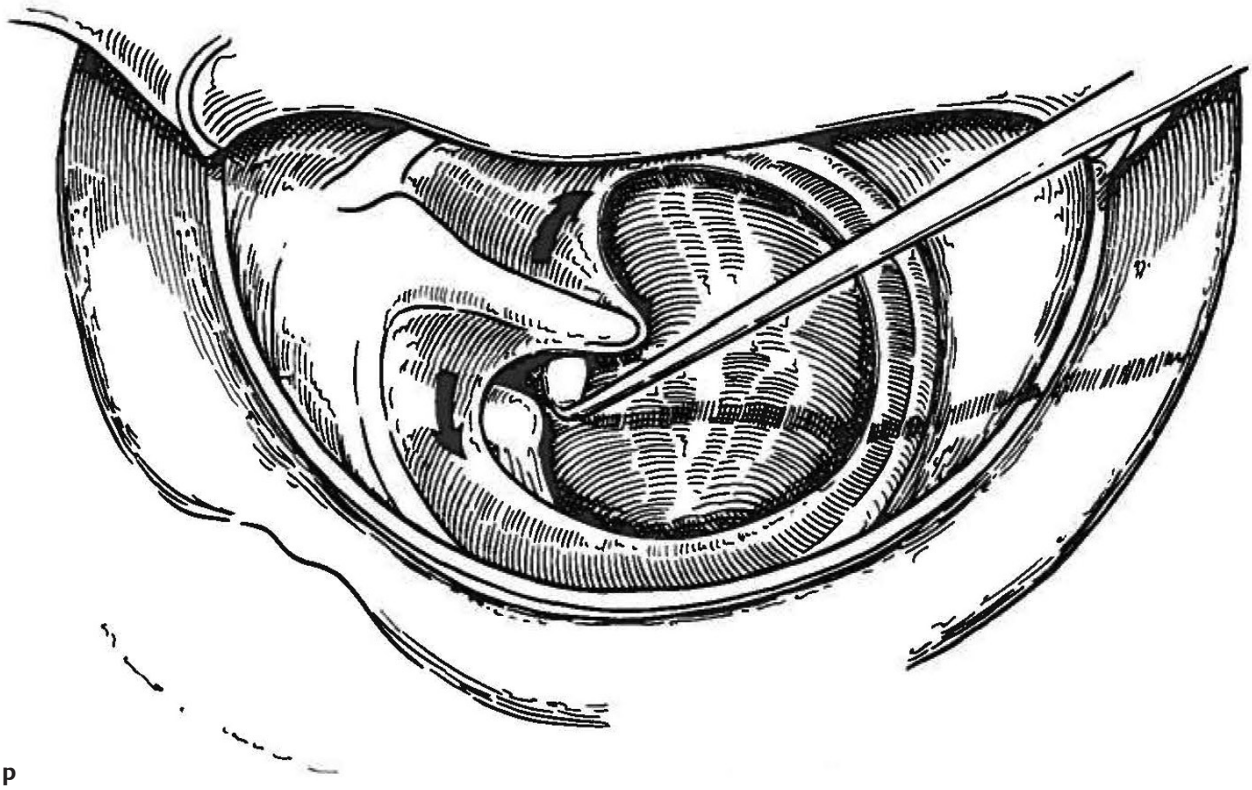
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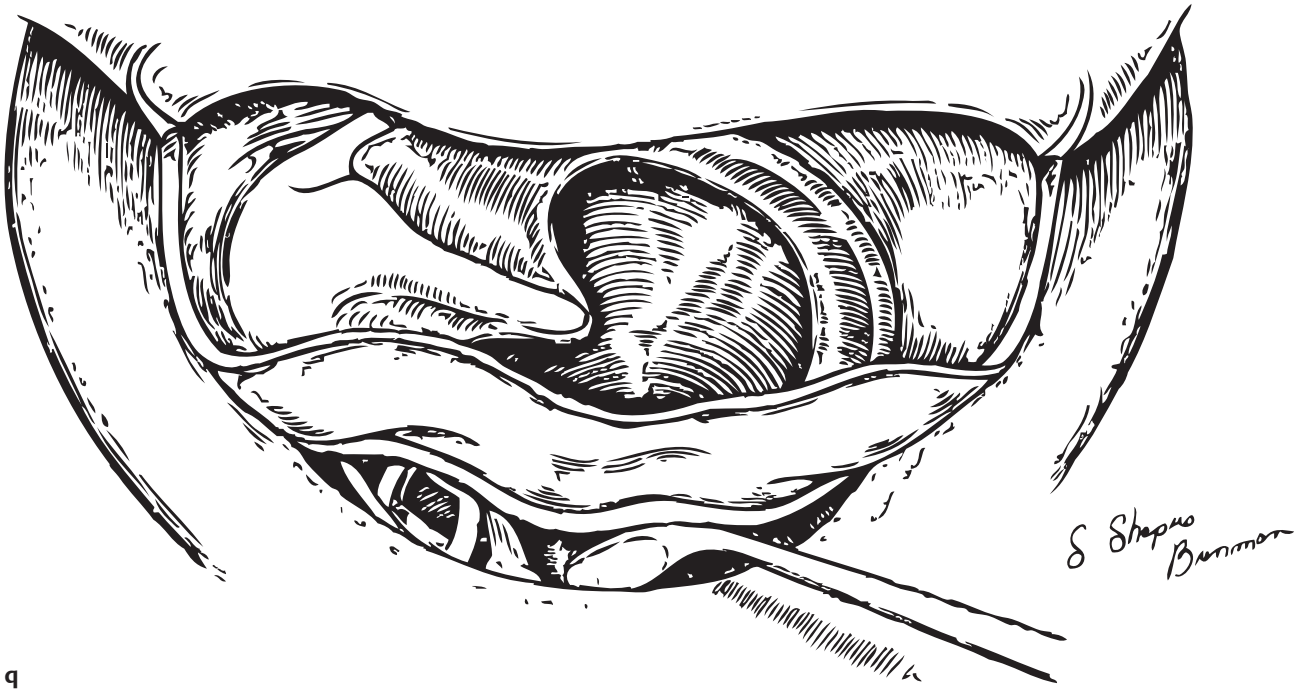
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Fig. 3.2n,o

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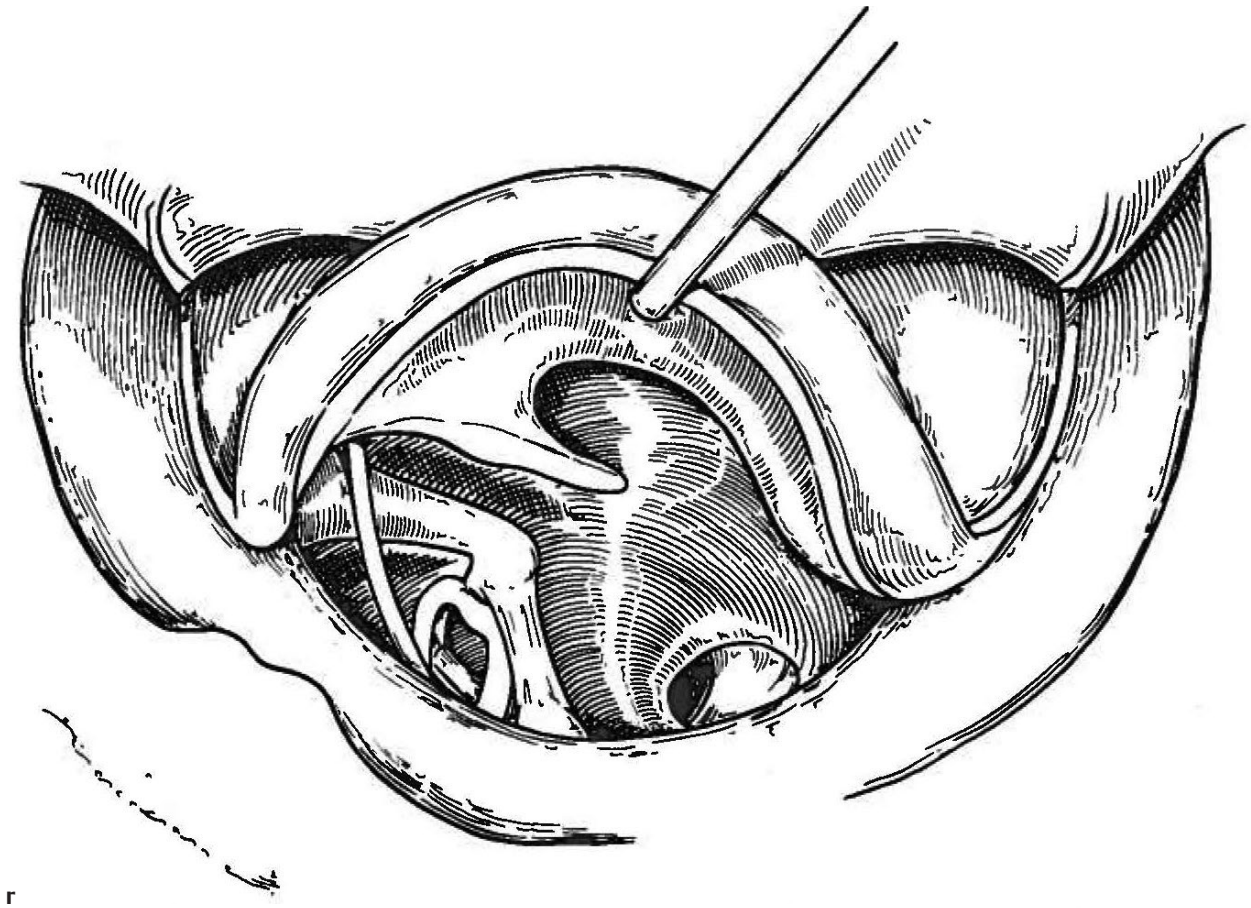


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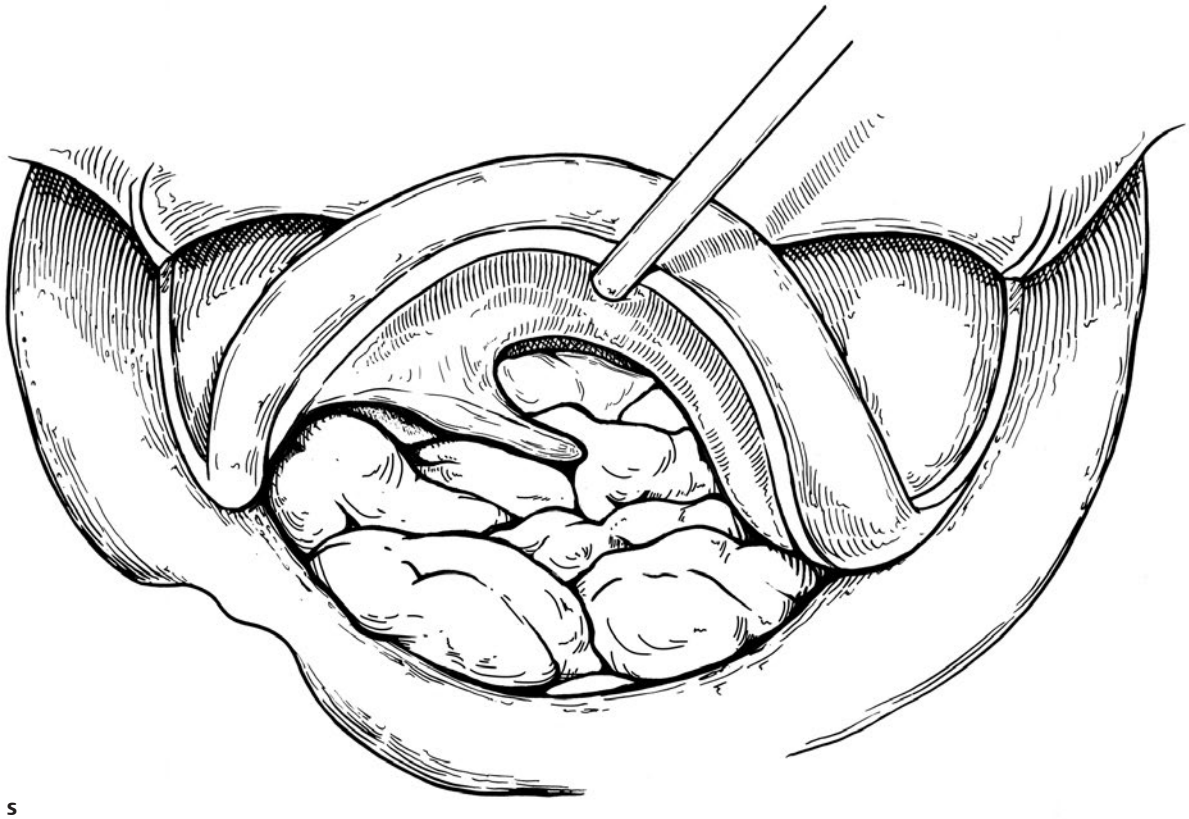


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Fig. 3.2p,q

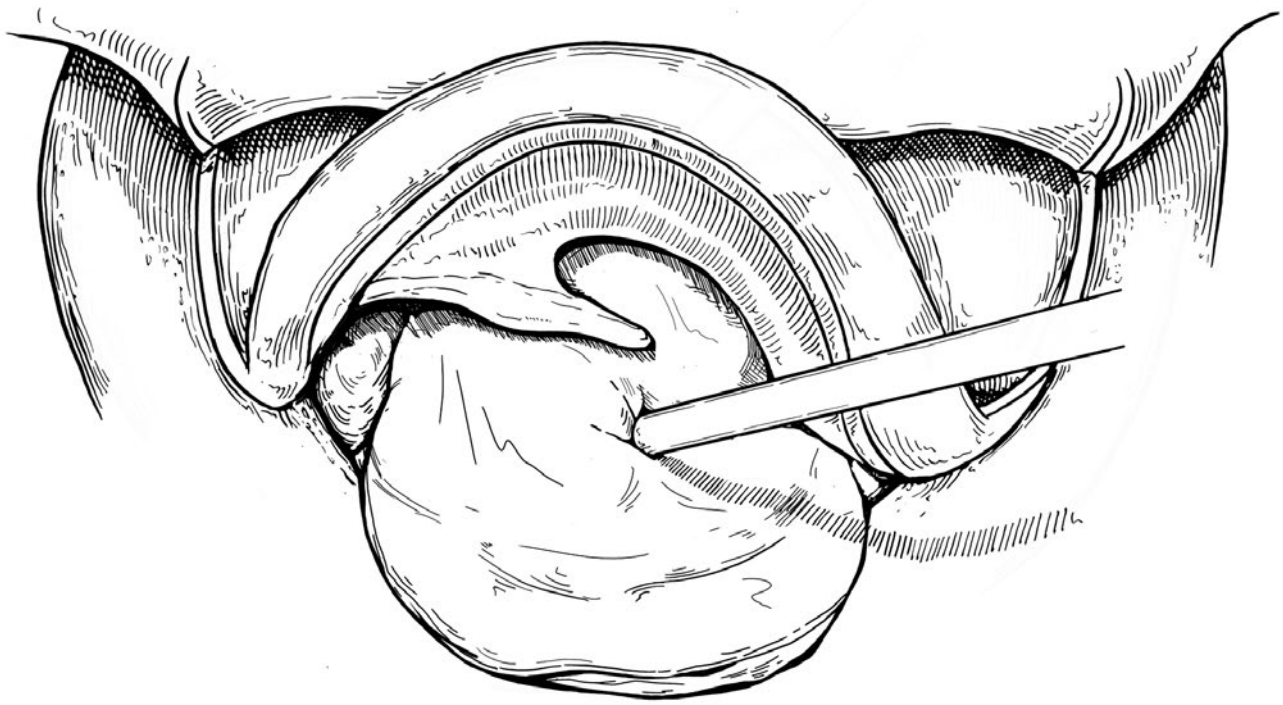


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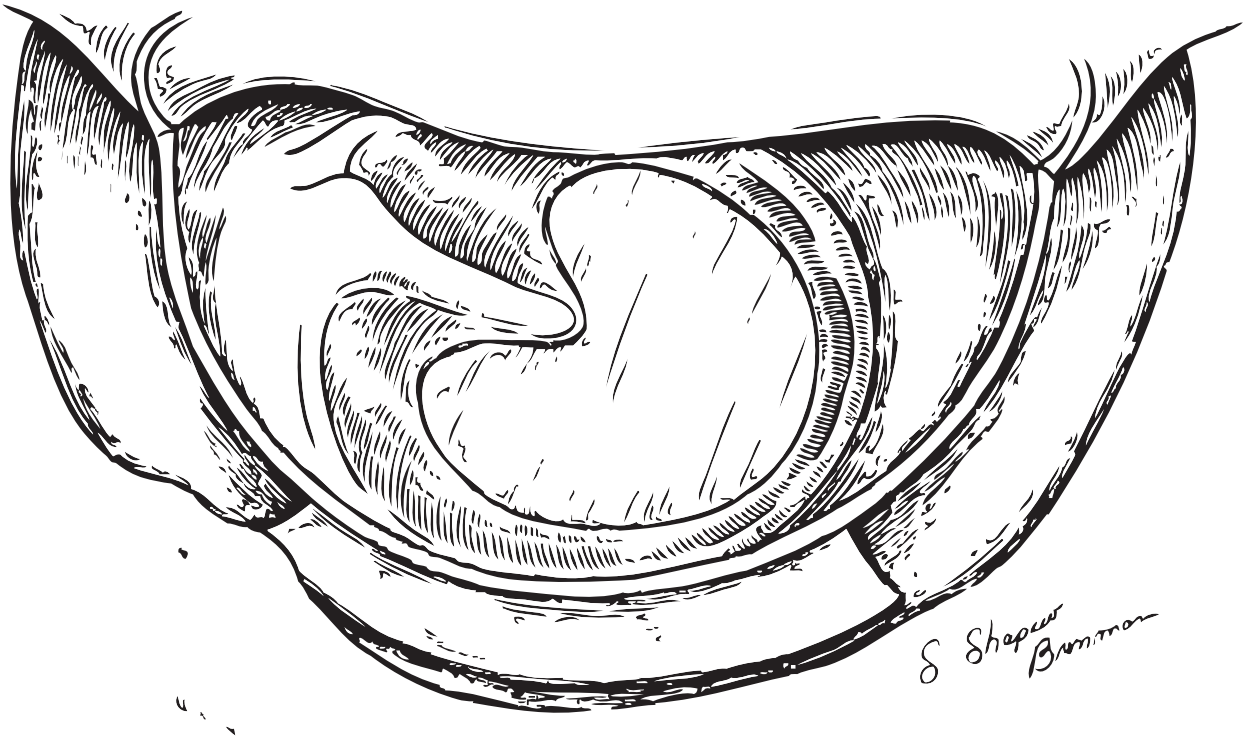


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Fig. 3.2r,s

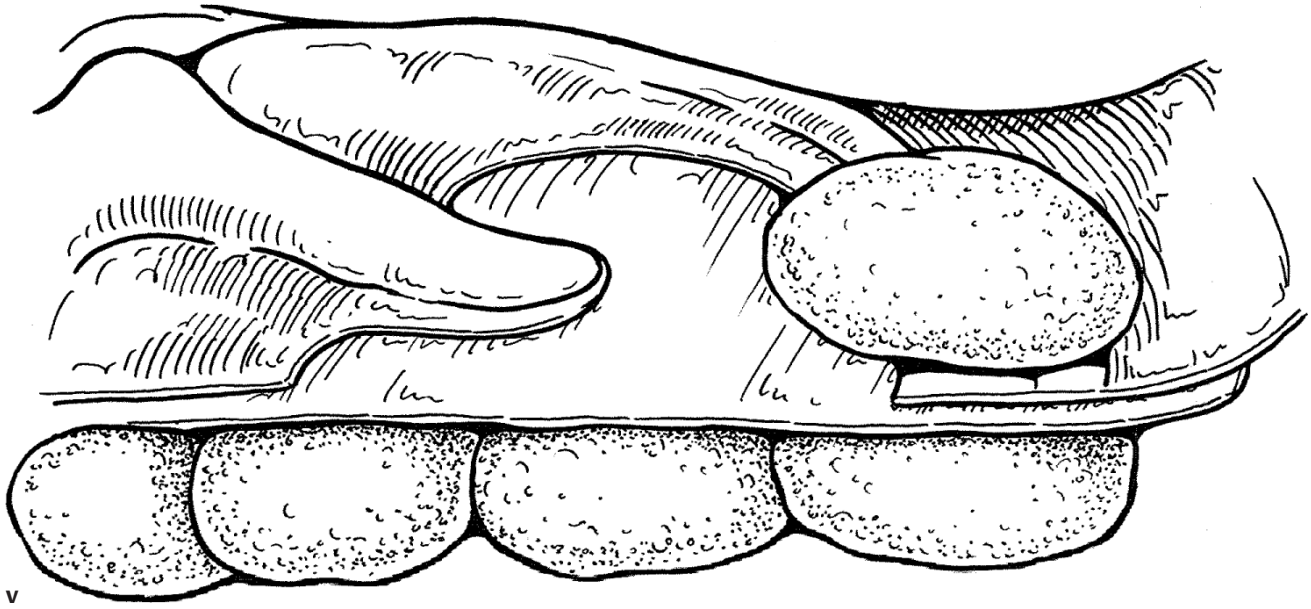


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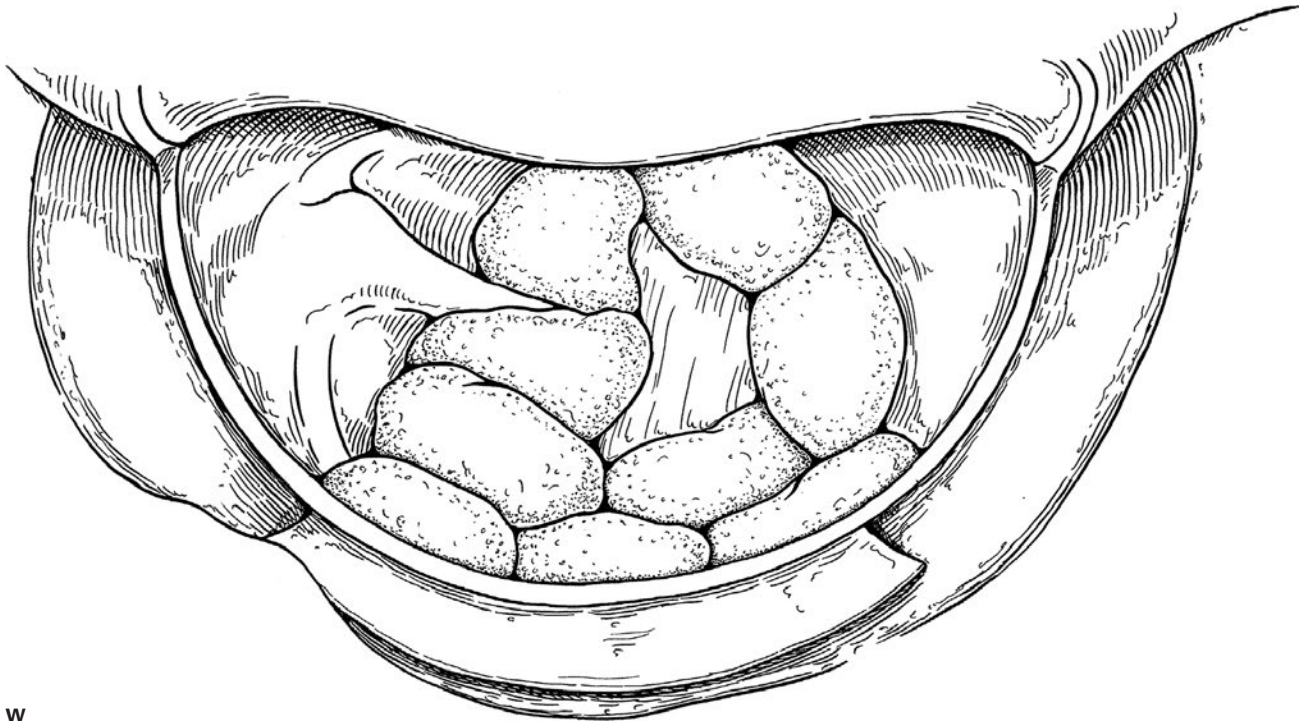


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Fig. 3.2t,u



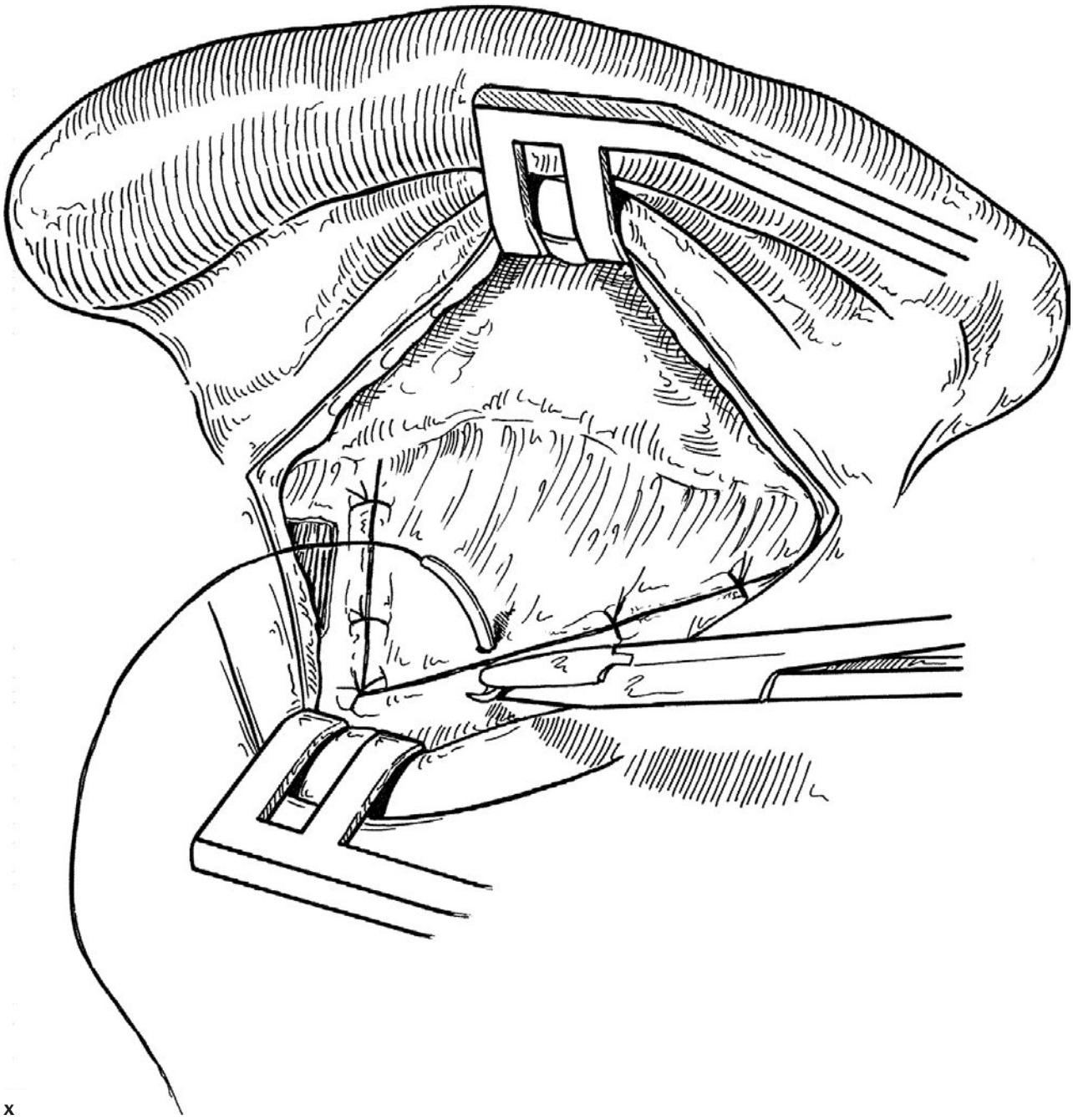
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Fig. 3.2v,w

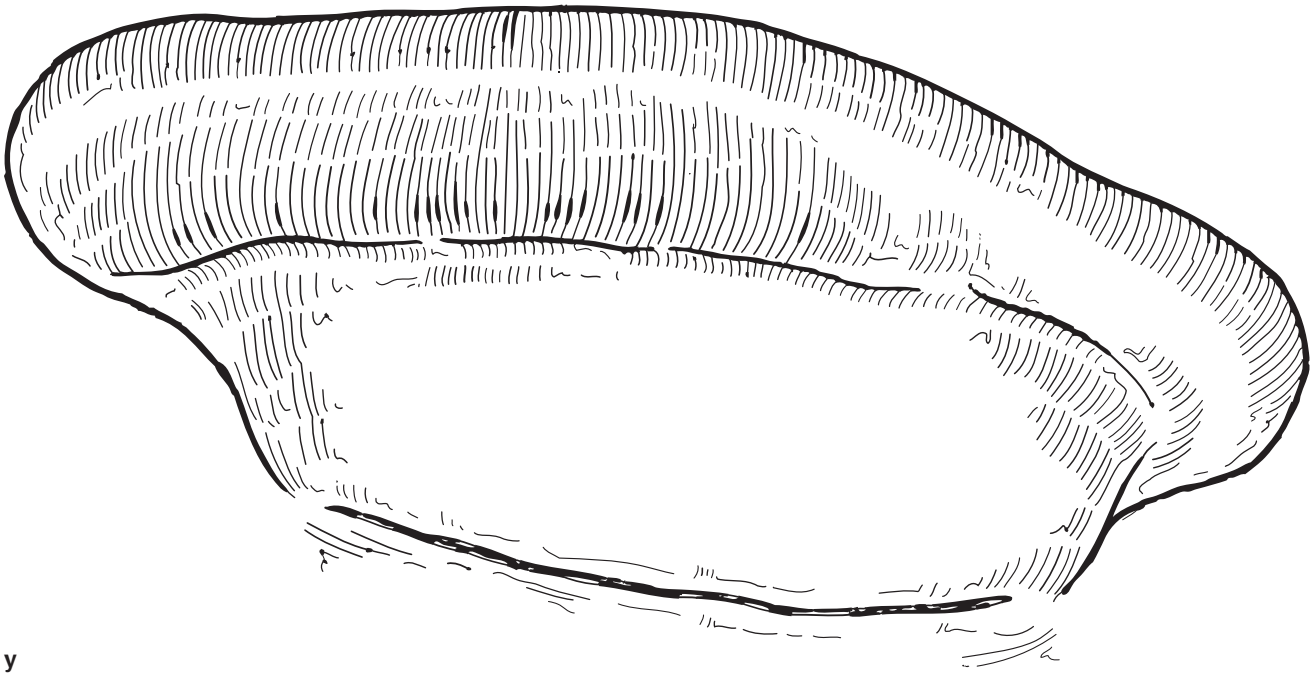
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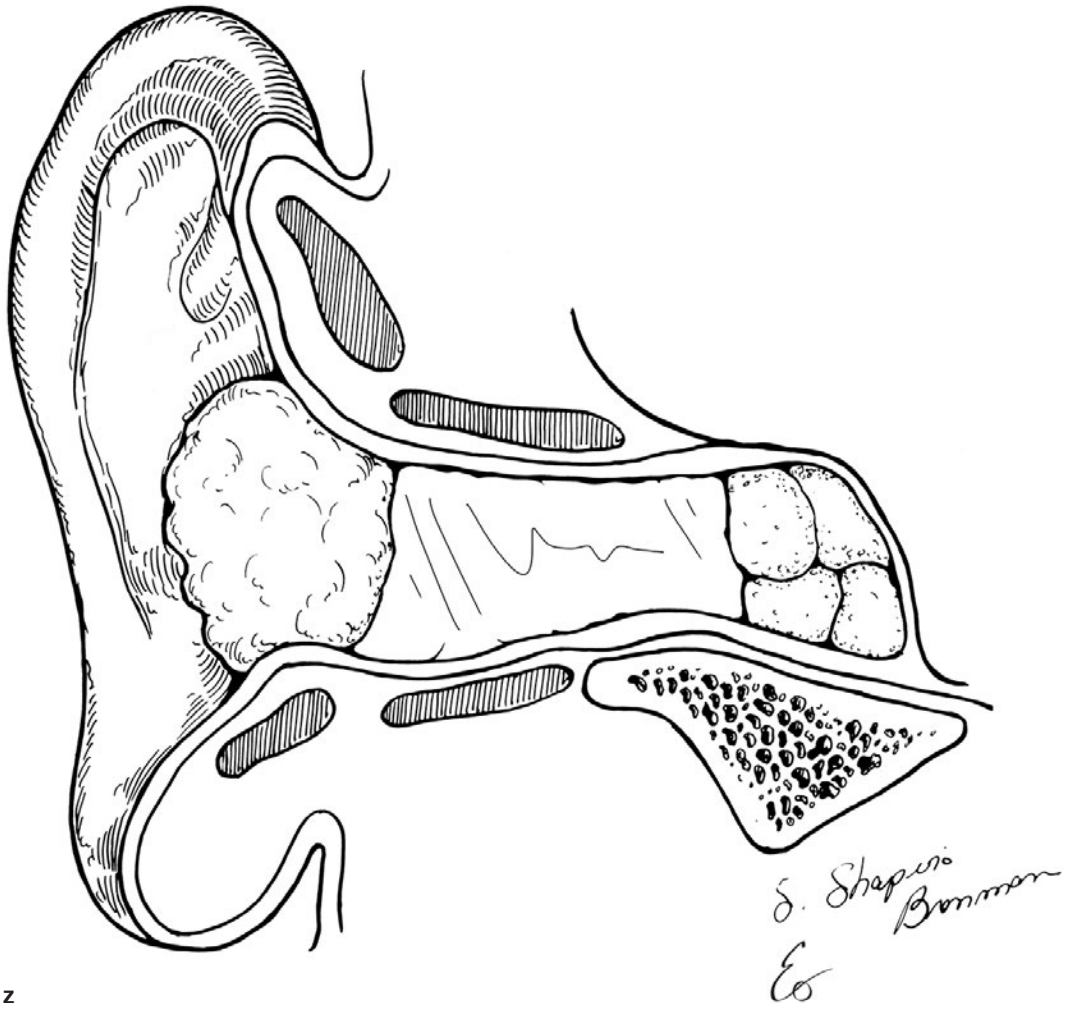
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Fig. 3.2x

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y



z

Fig. 3.2y,z

3-3 Ossicular Reconstruction

Introduction

The goal in ossicular reconstruction (OCR) is to restore the middle ear conductive machinery in order to improve hearing. Innumerable variations on the surgical techniques have been reported in the literature. Attention is often focused on the types of materials used for reconstruction of the middle ear ossicles and the technical aspects of inserting these prostheses. However, proper timing, complete eradication of underlying disease, and consideration of a patient's residual anatomy are just some of the critical factors that determine successful hearing outcomes following OCR. In addition to comprehensive audiologic testing, high-resolution computed tomography (CT) is helpful in delineating the pathology as well as surgical planning and counseling.

Indications

OCR is indicated in patients with conductive hearing losses due to defects of the malleus, incus, and/or stapes.

It is common (and prudent) practice to counsel patients with conductive losses that hearing aid amplification is a very safe and effective option that does not rule out the option of OCR at a later time.

Operative Technique

1. As described in the preceding sections, the middle ear space is widely exposed by meticulously elevating canal tympanomeatal flaps and drilling or curetting scutum or ear canal bone in order to improve visualization of the ossicles or the oval window niche (**Fig. 3.3a,b**).
2. If possible, the chorda tympani nerve is preserved, not only for taste function, but also for use in stabilizing the ossicular replacement prosthesis in some cases.
3. The incus is particularly vulnerable to damage from cholesteatomas, retraction pocket erosion, or even traumatic disruption. When the incus is partially eroded or damaged (**Fig. 3.3c**), the surgeon must determine if the residual incus is sufficient to leave in situ and to reconstruct using that remnant (e.g., an incus–stapes prosthesis or a hydroxyapatite cement) or if the residual incus is insufficient to rebuild upon and therefore requires removal of any incus remnant. Removal can be accomplished by separating the incus from the malleus using a pick or micro-Tabb knife. The remnant is grasped with an alligator forceps and gently removed (**Fig. 3.3d**). In this scenario, a malleus–incus prosthesis or partial ossicular replacement prosthesis (PORP) is used. Some of the reconstructive options include reshaping the incus remnant and interposing the remodeled incus to sit on the capitulum of the stapes with a long process that is then positioned under the manubrium of the malleus (**Fig. 3.3e**).

   Alternatively, the incus can be completely removed and a titanium or other synthetic prosthesis used to connect the stapes superstructure to the TM or from stapes to malleus and TM (**Fig. 3.3f**).

   In scenarios where the PORP is brought directly to the undersurface of the TM, the chorda tympani nerve can sometimes be used to stabilize the prosthesis by draping it over the top of the prosthesis or sometimes allowing the chorda to prevent the PORP from falling over (either inferior or superiorly, depending on how much the chorda can be mobilized in relation to the ossicular chain reconstruction).
4. For most synthetic (i.e., nonautologous) OCR prostheses, a cartilaginous "cap" is used in order to reduce the risks of the prosthesis extruding through the TM. Tragal cartilage is the most common site for harvesting such cartilage grafts. In a patient with poor eustachian tube function and a tendency to retract the TM, this is a particularly important step in OCR (**Fig. 3.3f**).
5. In instances where the stapes superstructure is compromised (e.g., eroded), it is necessary to use a total ossicular replacement prosthesis (TORP). In this case, the prosthesis is seated on the footplate of the stapes and brought up to the level of the malleus and TM (**Fig. 3.3g**). Again, a variety of techniques and prosthesis material have been proposed as being superior or preferable. Surgeon familiarity with the techniques likely outweighs the impact of specific differences in the materials or design of the prosthesis. However, as a general concept, most surgeons have migrated toward titanium or titanium-hydroxyapatite hybrid devices that seem to yield fairly consistent hearing outcomes in a variety of hands. One notable advance has been development of a two-part TORP that includes a "shoe" that is placed directly on the footplate and provides a stable position for the "foot" of the prosthesis. This design reduces the sliding and displacement of the TORP off the footplate, which is likely a common cause for some of the poor hearing results observed after ossicular reconstruction with TORPs.
6. Finally, it is requisite to emphasize the importance of attention to detail in order to obtain good hearing outcomes with OCR. Inadequate canalplasty, for example, hinders exposure and placement of the prosthesis and also increases the likelihood of the PORP or TORP contacting the ear canal and causing a persistent conductive hearing loss. Similarly, even subtle errors in trimming the length of the prosthesis or in positioning the PORP or TORP can result in the prosthesis extruding or falling over or not making adequate contact with

the remaining ossicular components—all of which would then result in poor hearing outcomes.

7. After satisfactorily placing the prosthesis (with or without a cartilage cap), the middle ear space is packed with Gelfoam and a ciprofloxacin-dexamethasone solution in order to completely surround and support the PORP or TORP. The tympanomeatal flap is then re-laid into its normal position on top of the reconstructed ossicular chain and also packed in place using the same saturated Gelfoam (refer to **Fig. 3.2z**).

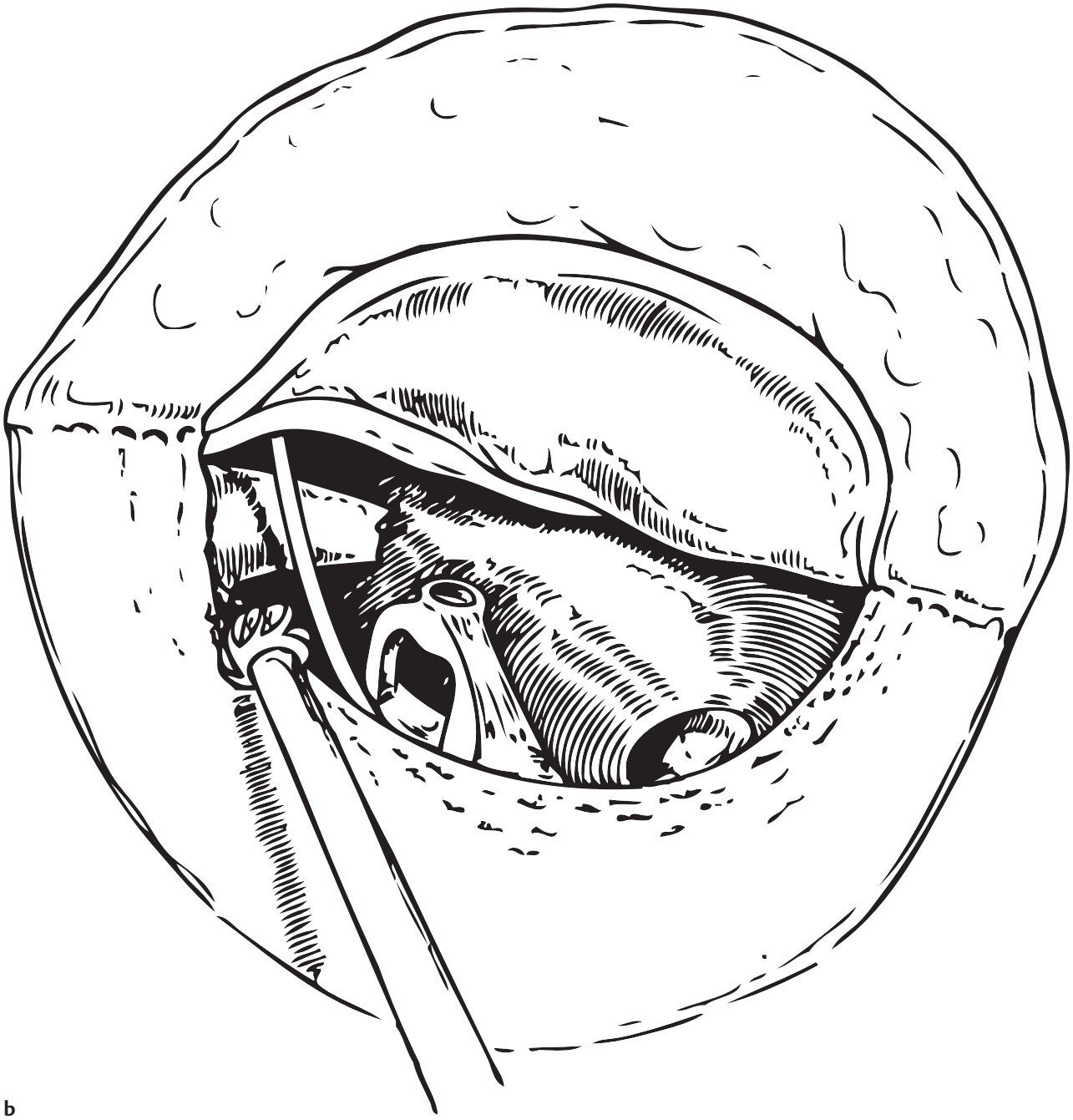
Complications

1. Tympanic membrane perforation
2. Persistent conductive hearing loss
3. Vertigo
4. Facial nerve injury
5. Chorda tympani nerve injury and dysgeusia
6. Prosthesis displacement or extrusion



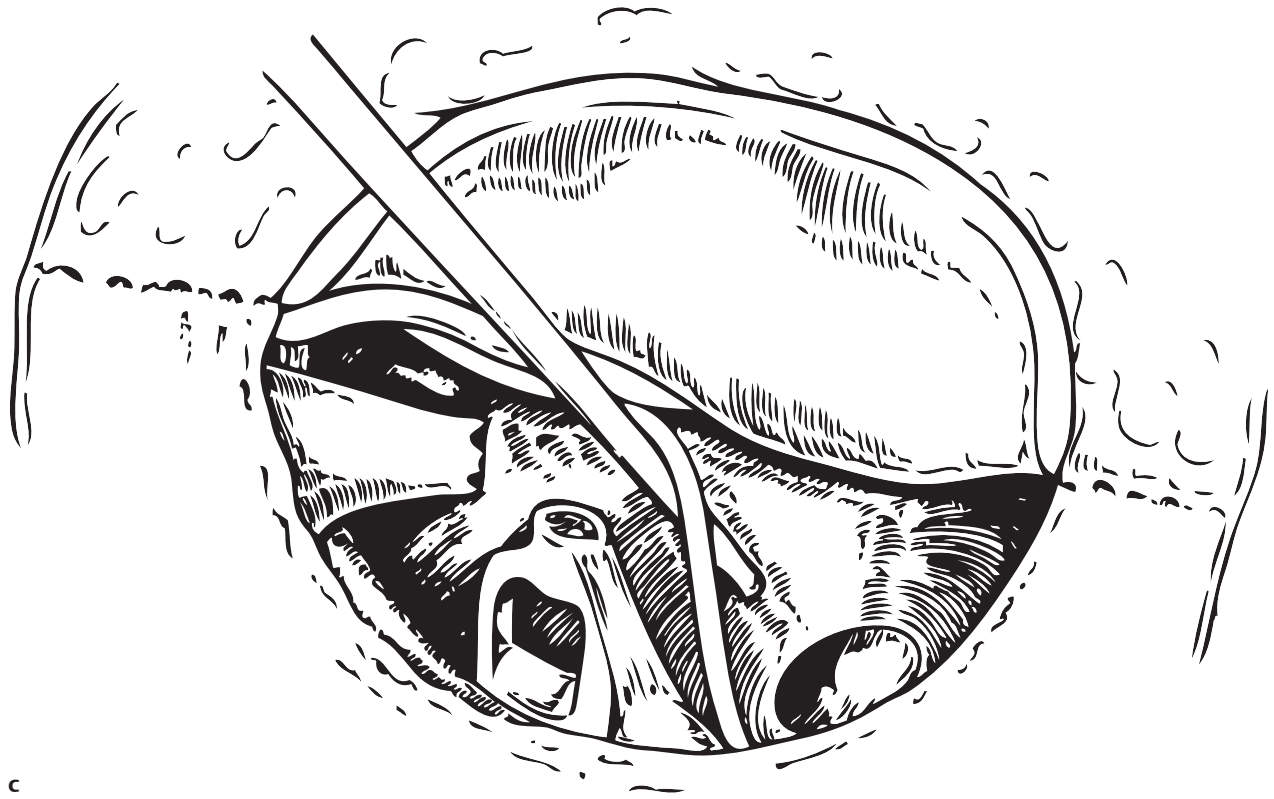
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Fig. 3.3a

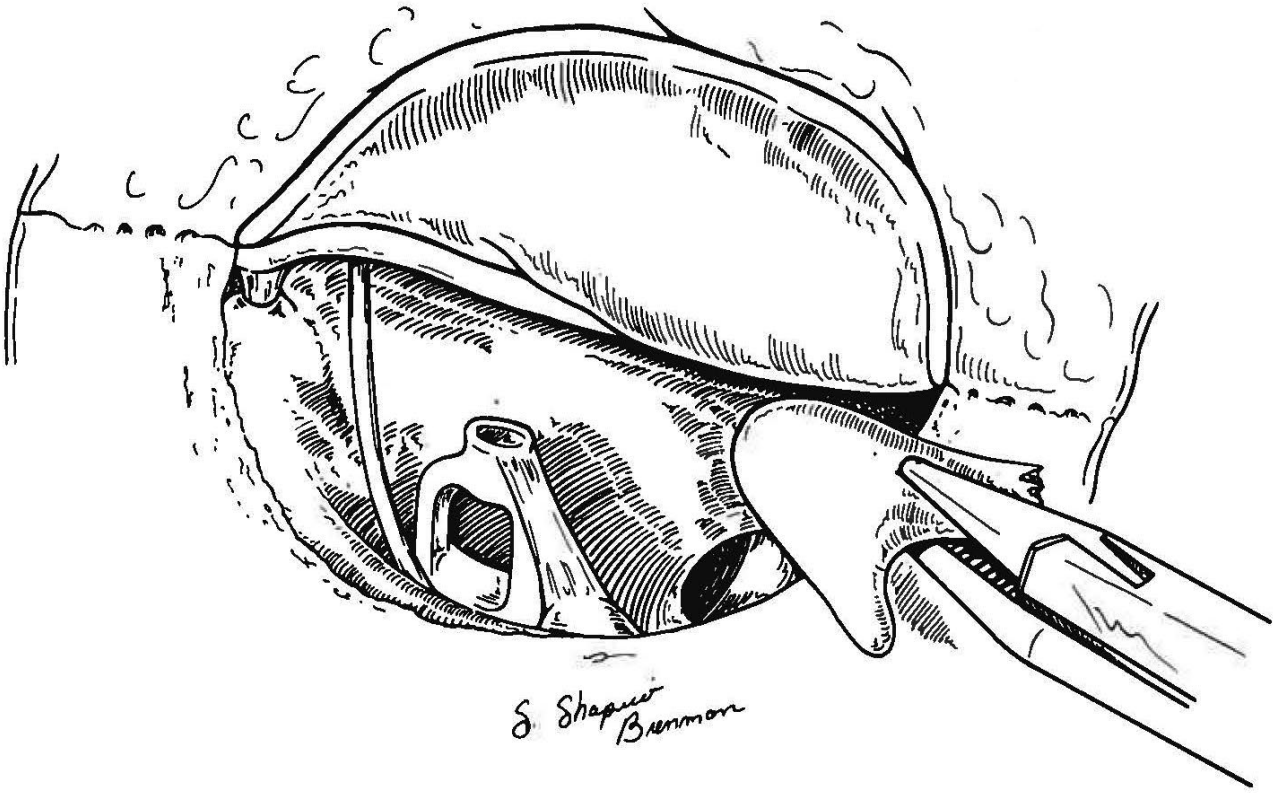


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Fig. 3.3b

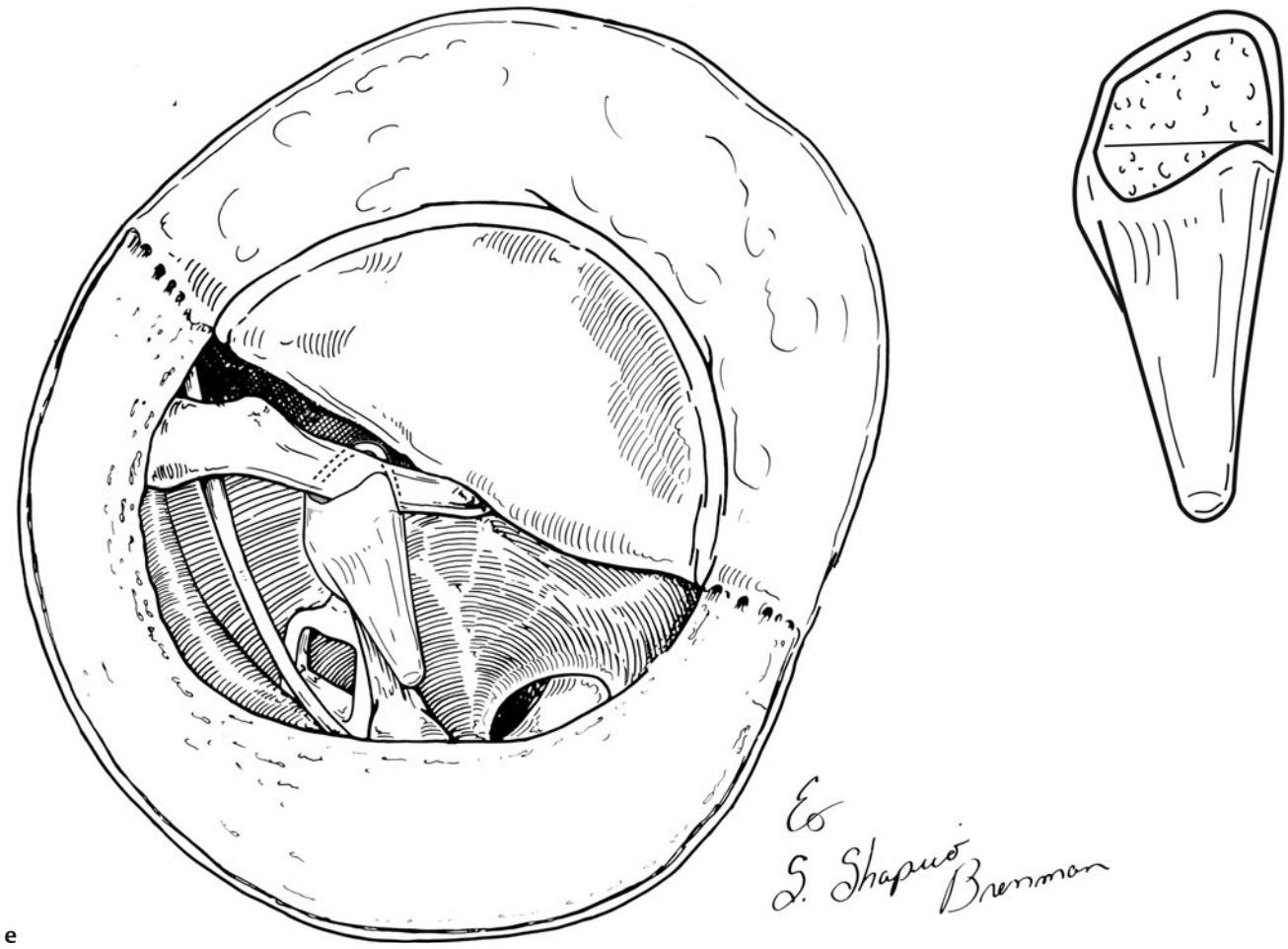


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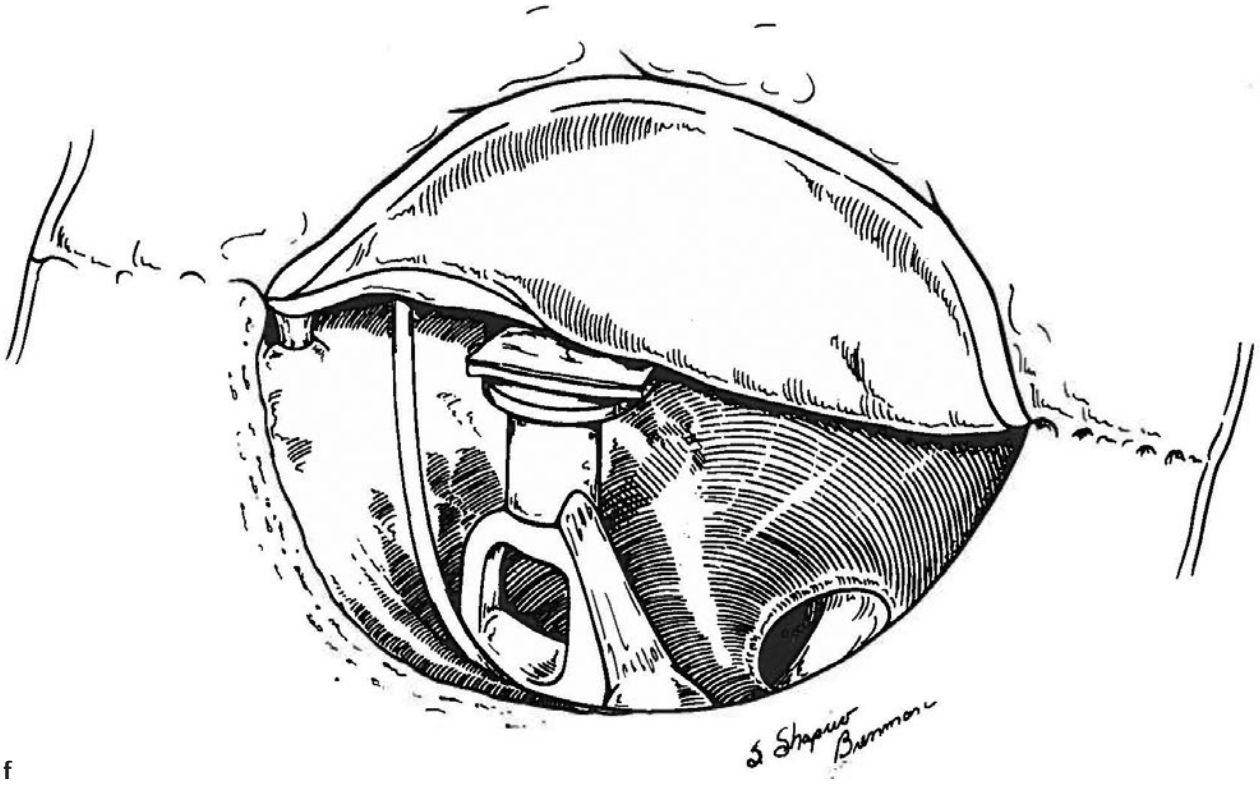
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Fig. 3.3c,d

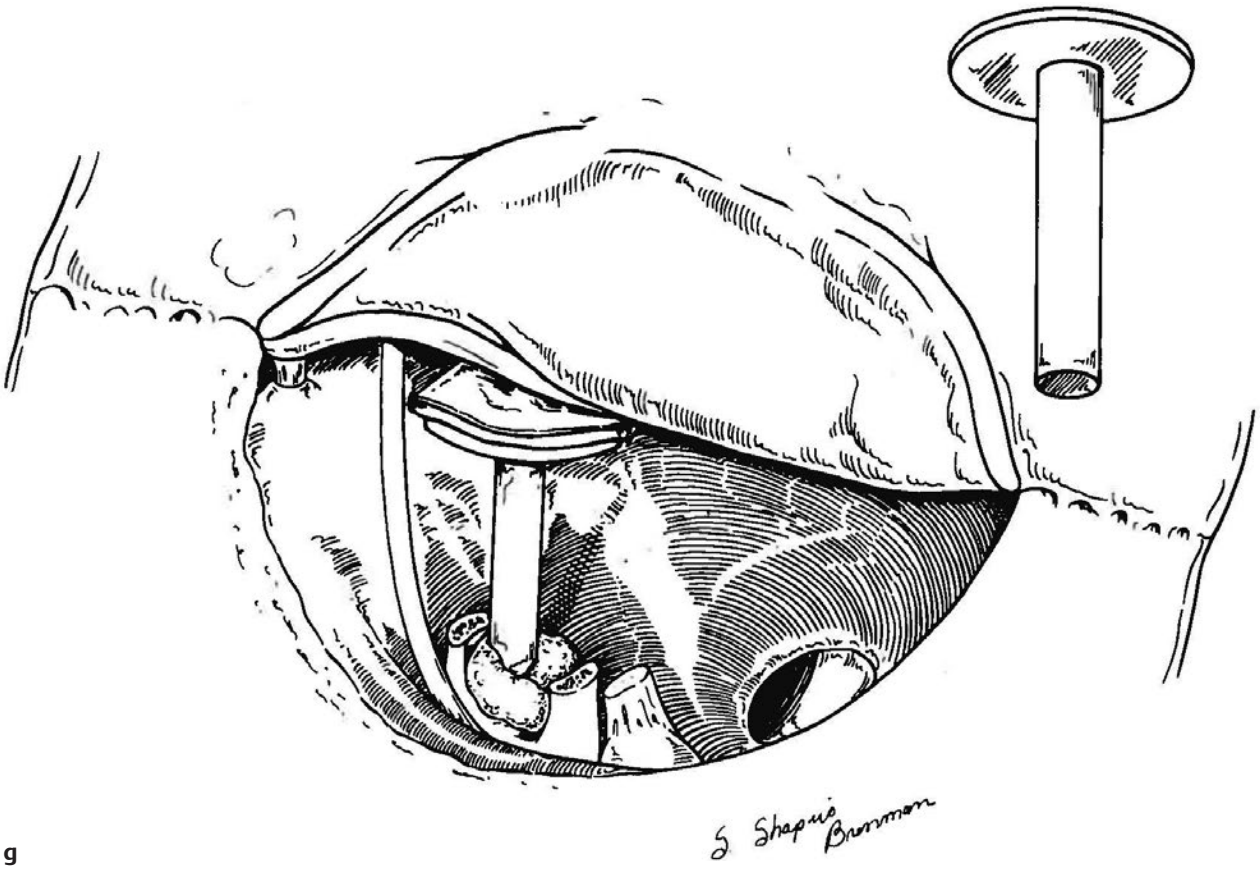


e

Fig. 3.3e



f



g

Fig. 3.3f,g

3-4 Cortical (Simple) Mastoidectomy

Introduction

The primary purposes of a cortical mastoidectomy are to provide drainage of an acute infection, remove chronic inflamed and infected disease within the mastoid air cell system, remove cholesteatoma, and improve aeration of the middle ear–mastoid air cells as a whole.

Indications

Cortical mastoidectomy is performed acutely in the setting of coalescent mastoiditis (particularly if refractory to conservative measures such as placement of a tympanostomy tube and parenteral antibiotics).

Chronic ear disease with cholesteatoma or chronic suppurative disease involving the mastoid are also clear indications for cortical mastoidectomy.

Chronic otomastoiditis complicated by facial nerve paresis/paralysis, extratemporal abscess formation, sigmoid sinus thrombophlebitis, or meningitis is also an indication for mastoidectomy.

Preoperative Evaluation

After routine history and physical examination, a careful microscopic exam of the ear is requisite. Many, if not most, cases requiring mastoidectomy will have otorrhea or other otologic findings that mandate suctioning and recognition of subtle findings (e.g., retraction pocket formation, squamous debris, granulation tissue, or bony erosions) that might not be readily discernible with a handheld otoscope.

CT scanning also remains a routine component in preoperative assessment of patients being considered for mastoidectomy. Such imaging studies are invaluable in demonstrating coalescence of air cells, erosions of the tegmen or the bony sigmoid covering, as well as thrombosis of the sigmoid or epidural abscess formation—particularly when performed with intravenous contrast.

Whenever possible, routine audiologic testing is performed for all patients prior to mastoidectomy (or any otologic surgery in general). Identification of sensorineural hearing loss, in addition to the expected conductive hearing loss, should alert the surgeon to the possibility of inner ear/labyrinthine complications from the ear disease.

Operative Technique

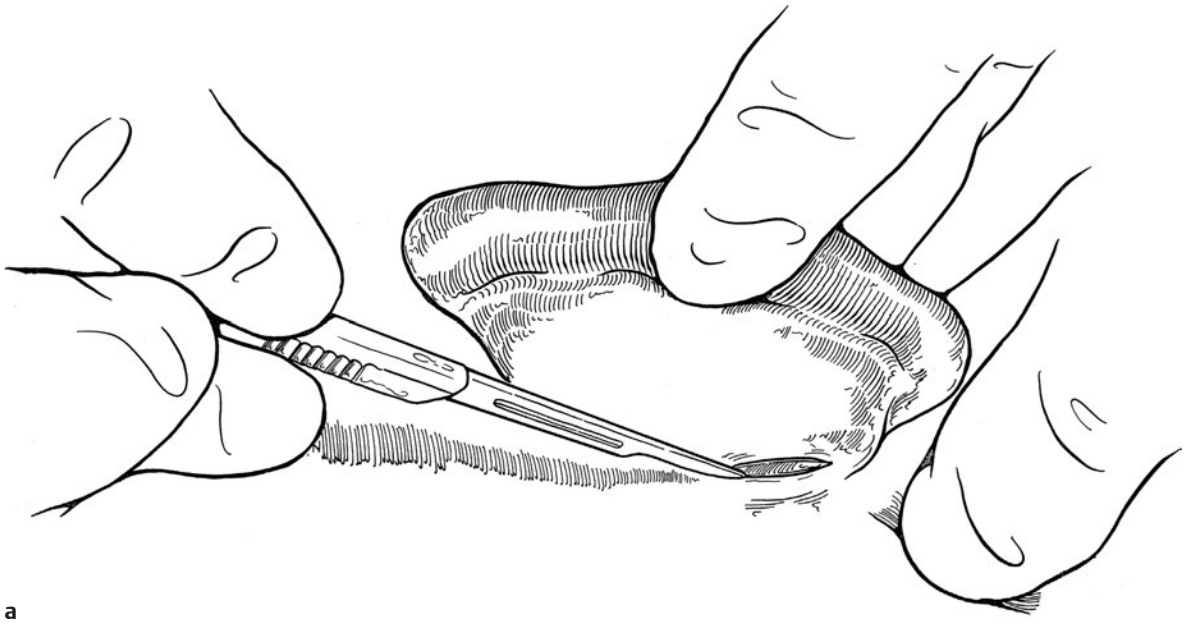
1. After induction of general anesthesia and an orotracheal intubation, the patient's ear is prepped and draped after infiltrating the ear canal and postauricular crease with a 1% lidocaine solution with a 1:100,000 concentration of epinephrine (see Section 3-2).
2. A facial nerve monitor is routinely used for most otologic surgeries as an additional layer of patient safety to prevent iatrogenic facial nerve injury. Although the likelihood of requiring the facial nerve monitor on a simple mastoidectomy may be very small, the unpredictability of those rare instances makes routine use of the monitor prudent.
3. The same skin incision used for a routine tympanoplasty can be used for mastoidectomy and similar soft tissue techniques are used to harvest areolar temporalis fascia (**Fig. 3.4a**) (see Section 3-2). The fascia is conveniently harvested at this stage in case an unexpected defect is encountered and needs to be repaired (e.g., a lateral canal fistula or dural defect in the tegmen).
4. A large C-shaped Palva flap is incised in the mastoid periosteum and reflected anteriorly in order to expose the bulk of the mastoid bone. Self-retaining retractors are placed to allow easy access to the mastoid tip, the posterior aspect of the ear canal, the bone overlying the sigmoid sinus, as well as the sinodural angle (**Fig. 3.4b,c**).
5. The dense cortical bone is removed using a large cutting bur and copious irrigation to clear away the bone dust. Drilling typically commences in the triangular area posterior to the spine of Henle (fossa mastoidea), with long strokes running parallel to the temporal line. Care should be taken to create smooth edges (saucerization) at the margins of the mastoid cavity to maximize visualization and to avoid creating overhanging ledges that might trap disease (**Fig. 3.4d**).
6. Bone is removed in the roughly triangular area delineated by the middle fossa dura superiorly (approximately at the temporal line), the sigmoid sinus posteriorly, and the bony posterior ear canal anteriorly.
7. Diseased mucosa is removed with forceps and blunt tip dissectors as drilling proceeds (**Fig. 3.4e**).
8. Once the mastoid antrum is entered, the first landmark to be recognized is the prominence of the lateral (horizontal) semicircular canal. The lateral canal provides a consistent reference point for the position of the incudal fossa as well as the facial nerve in its vertical portion.
9. With the lateral canal as a landmark, careful drilling with smaller burs allows identification of the incus head and short process. With the patient's head turned away, sighting along a more anterior vector allows the incus to be seen before inadvertently drilling into this ossicle. Often the incus can be visualized in the irrigation solution prior to be directly seen (**Fig. 3.4f**).
10. At this point, a simple mastoidectomy has been mostly accomplished. Drilling down toward the mastoid tip, into retrosigmoid air cell tracts, and back into the sinodural angle is largely determined by the extent of the disease.
11. Depending on the disease, a penrose drain can be inserted into the mastoid cavity prior to closing and brought out

through the inferior aspect of the skin incision (**Fig. 3.4g**). Copious irrigation of the wound should be performed prior to closing as well to remove the usual bone dust and debris that collects after performing a mastoidectomy.

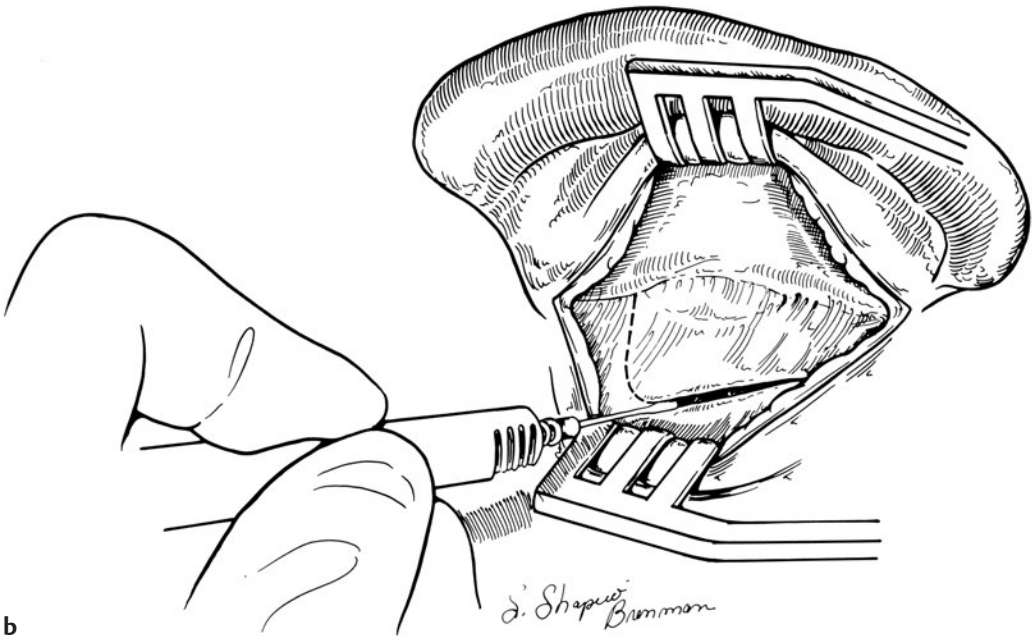
12. The soft tissue is closed in multiple layers using interrupted resorbable sutures at the Palva flap layer as well as the deep subcutaneous tissue layers. A running resorbable suture is used to reapproximate the skin edges, and a standard mastoid compression dressing is then applied (**Fig. 3.4h**).

Complications

1. Facial nerve injury
2. Labyrinthine injury (most commonly, fenestration of the lateral semicircular canal)
3. Dural laceration with cerebrospinal fluid leak
4. Sigmoid sinus laceration
5. Ossicular damage (most commonly incus drill trauma)



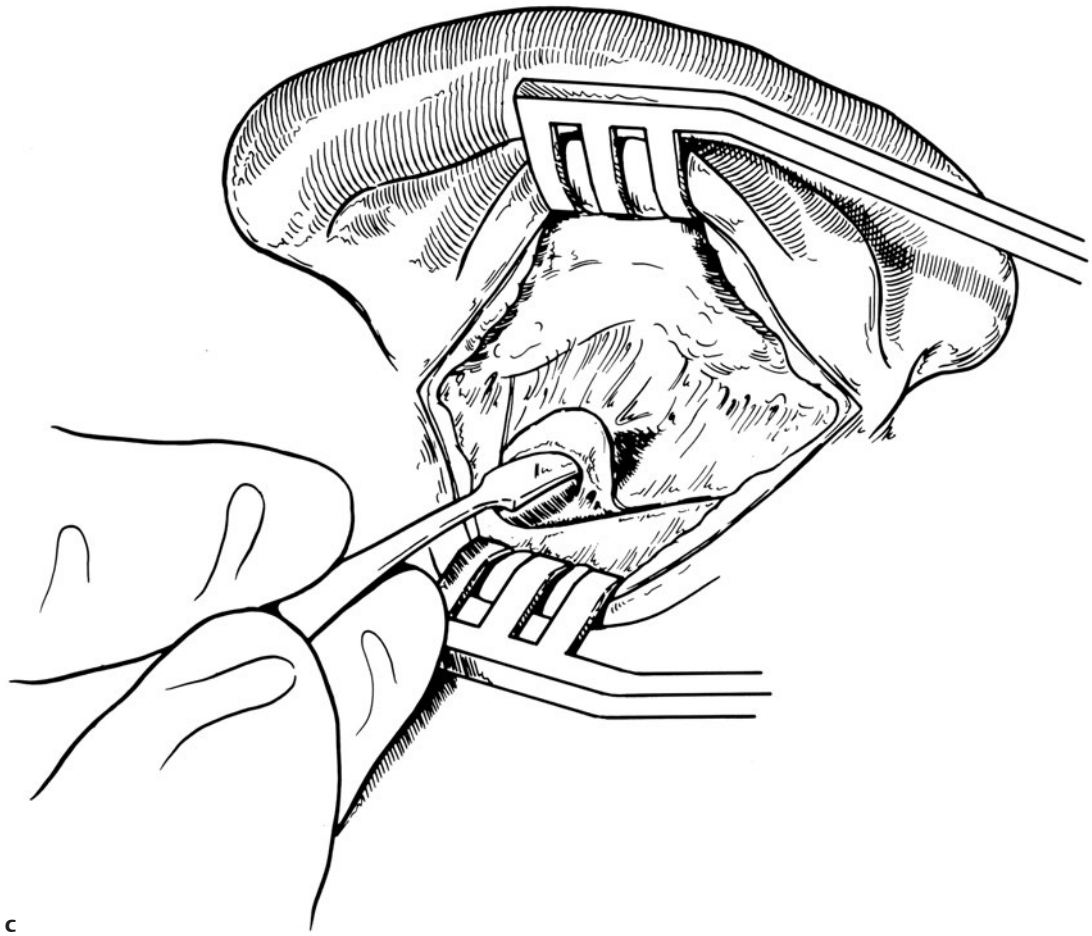
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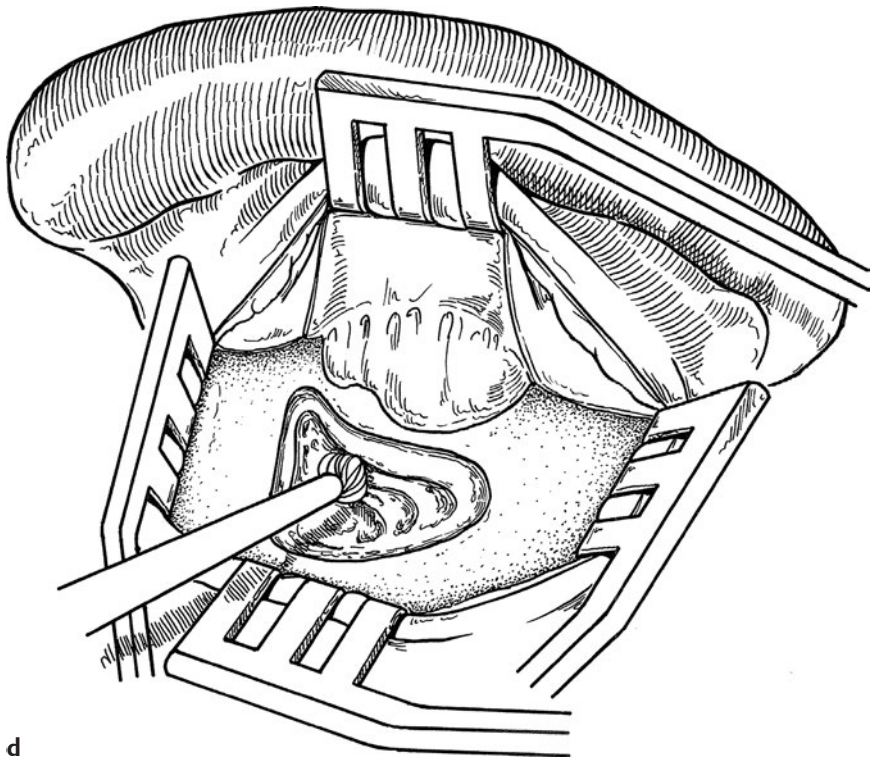
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Fig. 3.4a,b

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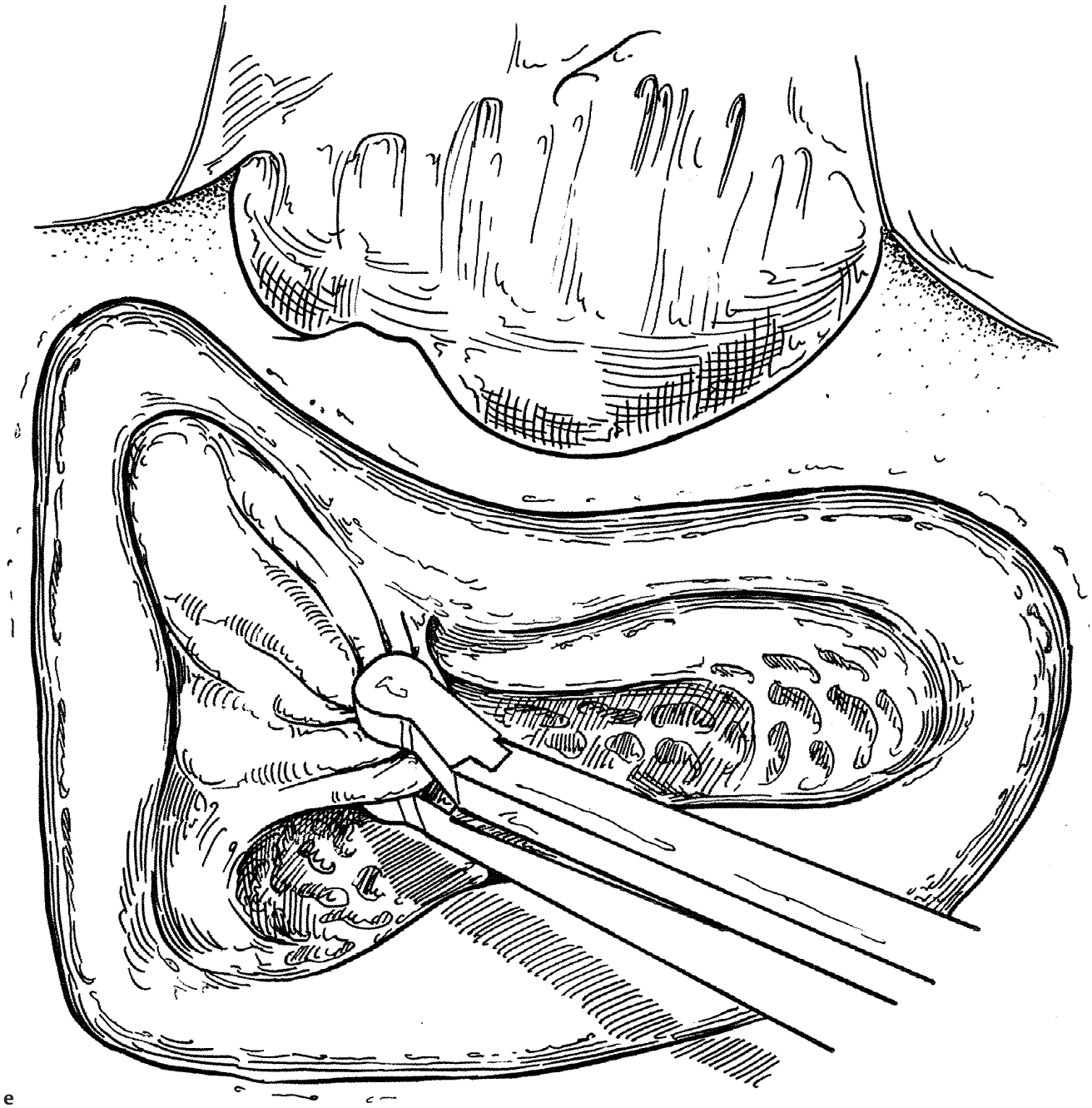
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Fig. 3.4c,d

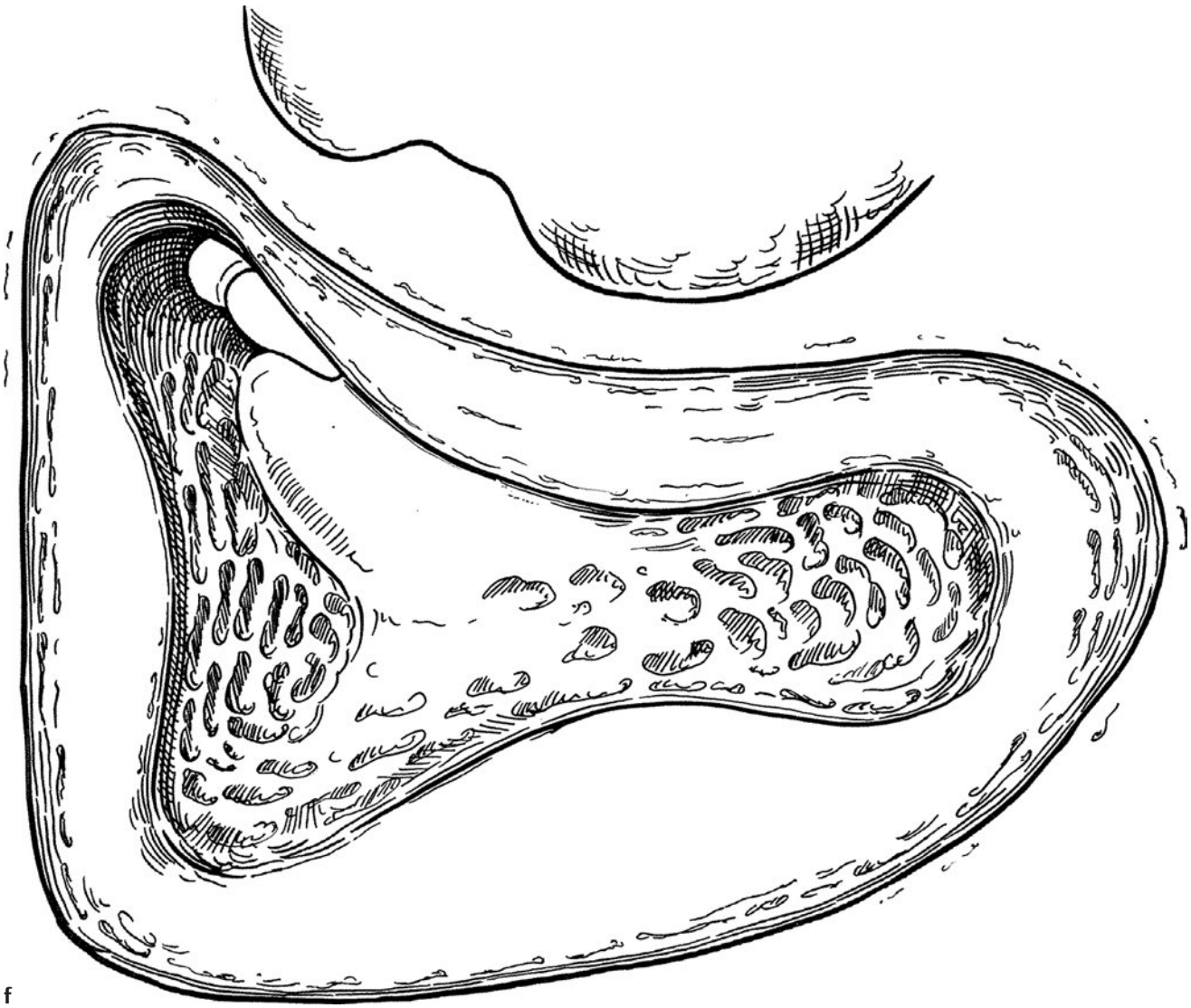
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e

Fig. 3.4e

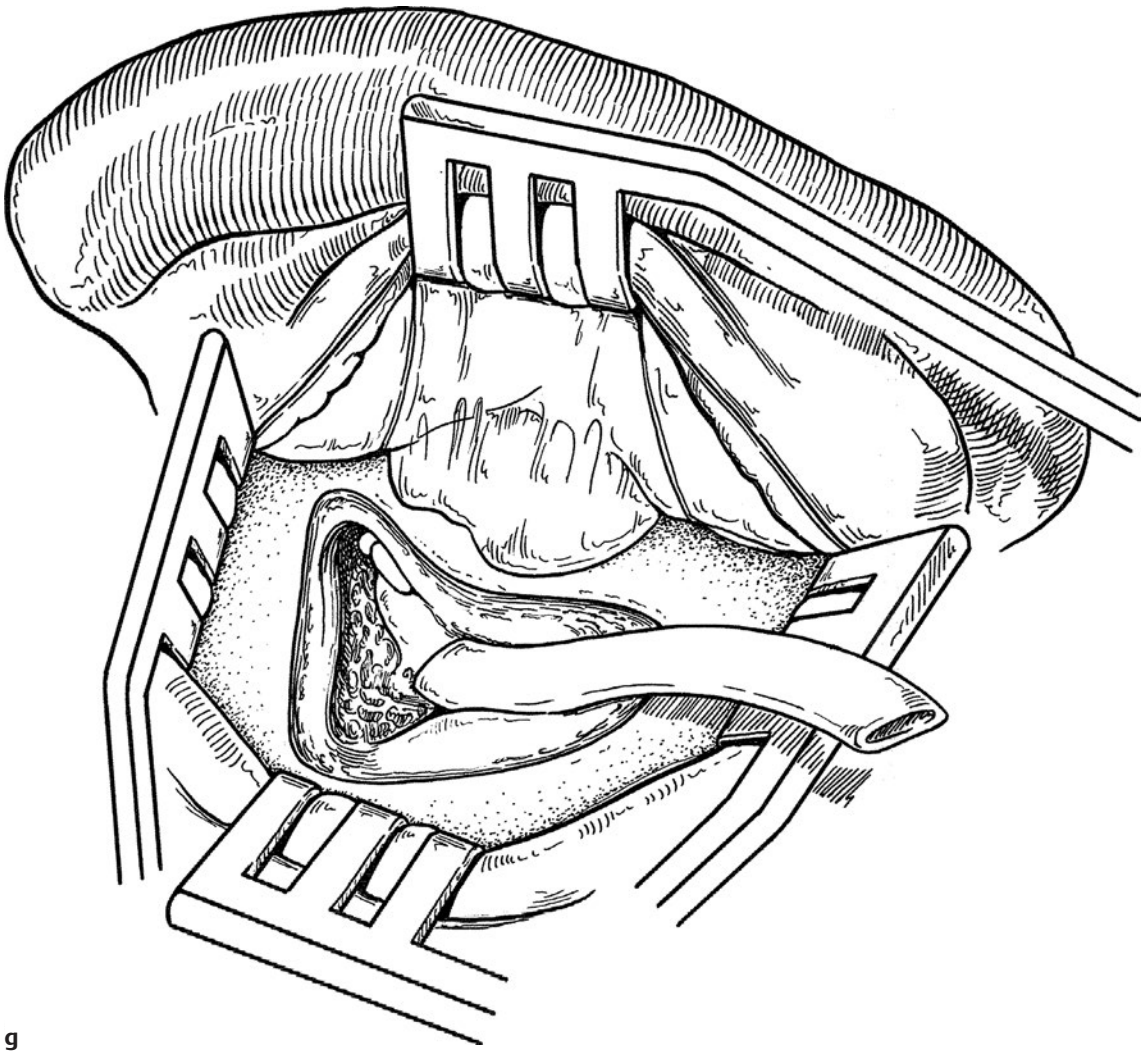
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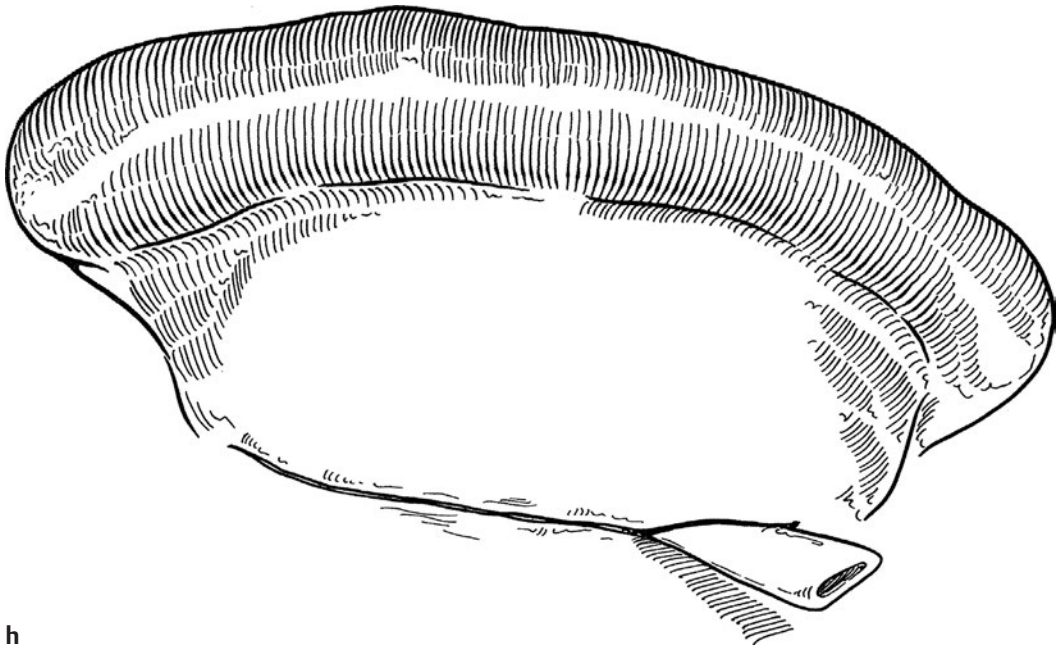
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Fig. 3.4f

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g



h

Fig. 3.4g,h

3-5 Intact Canal Wall Tympanomastoidectomy

Introduction

For several reasons, intact canal wall tympanomastoidectomy (ICW-TM) remains one of the standard surgical strategies for chronic ear disease. In this procedure, an aggressive exposure and resection of disease can be accomplished, and yet, by leaving most anatomical structures (e.g., the ear canal bone and eustachian tube) intact, it is possible to reconstruct the ear with the end goal of attaining a good hearing ear. A common criticism of the ICW-TM approach, however, is the fact that many surgeons employ a two-stage (i.e., two surgeries) approach in order to eradicate cholesteatoma, confirm that it has not recurred after several months, and then reconstruct the ossicular chain at that point. Confusingly, some studies suggest higher rates of recurrent cholesteatoma after ICW-TM, whereas others indicate rates similar to other surgical approaches.

Nonetheless, in the clinical setting of young children with chronic ear disease, it seems intuitively preferable to avoid irreversible surgical procedures (especially those that have associated hearing loss sequelae) given the long-term implications for such patients.

Indications

ICW-TM is useful in most cases of chronic otomastoiditis and cholesteatoma involving the middle ear and mastoid compartments.

Preoperative Evaluation

As discussed previously, the critical elements of the preoperative evaluation include: comprehensive history and physical exam, a detailed microscopic exam of the ear, a full audiologic test battery, and preoperative imaging (usually in the form of a CT scan).

Operative Technique

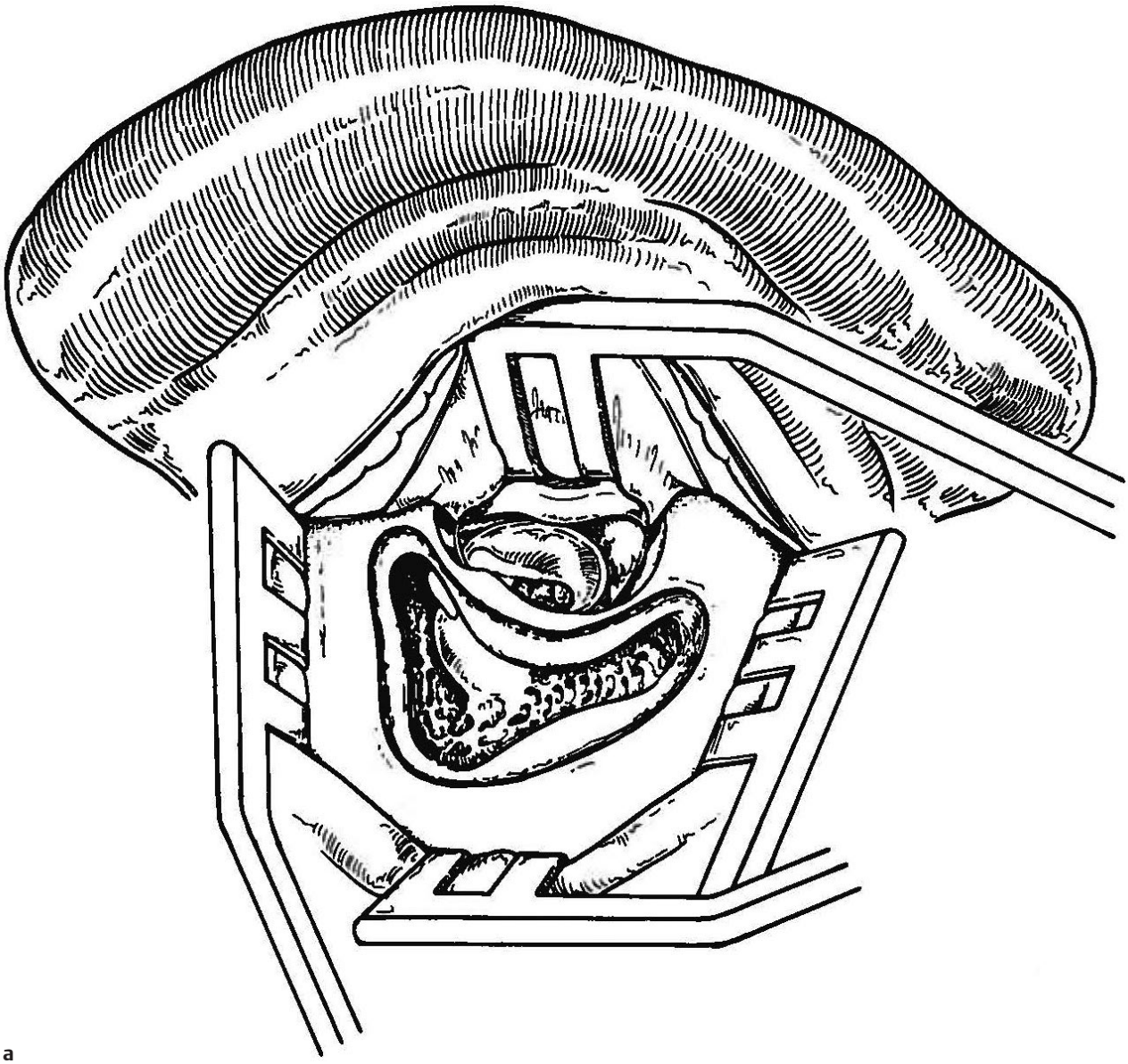
1. The standard postauricular soft tissue work and temporalis fascia grafting are initially completed as described previously (refer to **Fig. 3.2a–g**).
2. A standard tympanomeatal flap is incised and elevated in the ear canal to allow entry into the middle ear space, to determine the extent of disease in this middle ear cleft, and to assess the status of the ossicular chain (refer to **Fig. 3.2l**).
3. A cortical mastoidectomy is next performed per routine (see Section 3-4) (**Fig. 3.5a**).
4. Specific key facets of ICW-TM include a careful but aggressive thinning of the posterior ear canal bone. Thinning this bone down allows greater visualization of the attic and epitympanum as well as the incudal fossa and the superior end of the facial recess (**Fig. 3.5b**).
5. A low threshold is also maintained for performing an aggressive canalplasty in order to better visualize the facial recess and posterior mesotympanum from the middle ear side.
6. Very intentional thought should be given to performing a facial recess (or posterior tympanotomy) if significant disease is located in this cell tract or involves the stapes and oval window niche. Opening a facial recess provides an excellent view and access portal through which disease can be successfully cleaned out. In order to perform a facial recess, the facial nerve monitor should already be in place and confirmed to be functional prior to beginning the dissection. Using the lateral semicircular canal as one landmark (depth) and the short process of the incus as another landmark (a pointer), the position of the vertical facial nerve is first determined by carefully drilling with a 3-mm diamond bur along the anticipated course of the nerve. A broad field should be lowered posterior to the ear canal and down to the level of the lateral semicircular canal in order to find the nerve. A copious amount of irrigation is used to avoid thermal injury to the nerve through the bone. In most cases, small vessels running on the epineurium can be seen through the bone prior to exposing the nerve sheath. It is preferable to leave a thin layer of bone over the nerve to protect it during further dissections. The position and integrity of the facial nerve should then be confirmed with the nerve stimulator at this point. The air cells/bone immediately anterior to this vertical portion of the facial nerve then represent the facial recess. Using small diamond burs, the recess is opened superiorly where it is widest. Care is taken to look for the chorda tympani nerve, which delineates the anterior extent of the facial recess (2 mm and smaller). A small bridge of bone is also often left at the superior end of the facial recess where it comes in close proximity to the incus (the incus buttress). These structures then define a triangular shape to the facial recess bordered by the vertical facial nerve posteriorly, the chorda tympani nerve anteriorly, and the incus buttress superiorly. By opening this posterior tympanotomy, a significant access pathway as well as ventilation pathway are created that greatly enhance the ICW-TM approach without resecting any critical structures of the middle ear or mastoid (**Fig. 3.5c,d**).
7. Diseased TM and ossicles are resected at this stage and the TM repaired in standard underlay (medial graft) fashion. Although it is feasible to perform an ossicular chain reconstruction at this point, it is preferable to allow the ear drum and middle ear to heal from the aggressive first-stage resection and to plan on performing the ossicular chain reconstruction at the second stage (in approximately 6 months). By allowing the middle ear to re-epithelialize and allowing infection and inflammation to subside, the ossicular chain

reconstruction at the second stage occurs in a much healthier microenvironment with less likelihood of adhesions to the prosthesis and greater chances of good hearing outcomes.

8. The middle ear and ear canal are packed with antibiotic-impregnated Gelfoam as previously described for tympanoplasty and the incision closed in multiple layers using resorbable sutures (see Section 3-2). A standard mastoid dressing is applied and only maintained for 24 hours postoperatively.

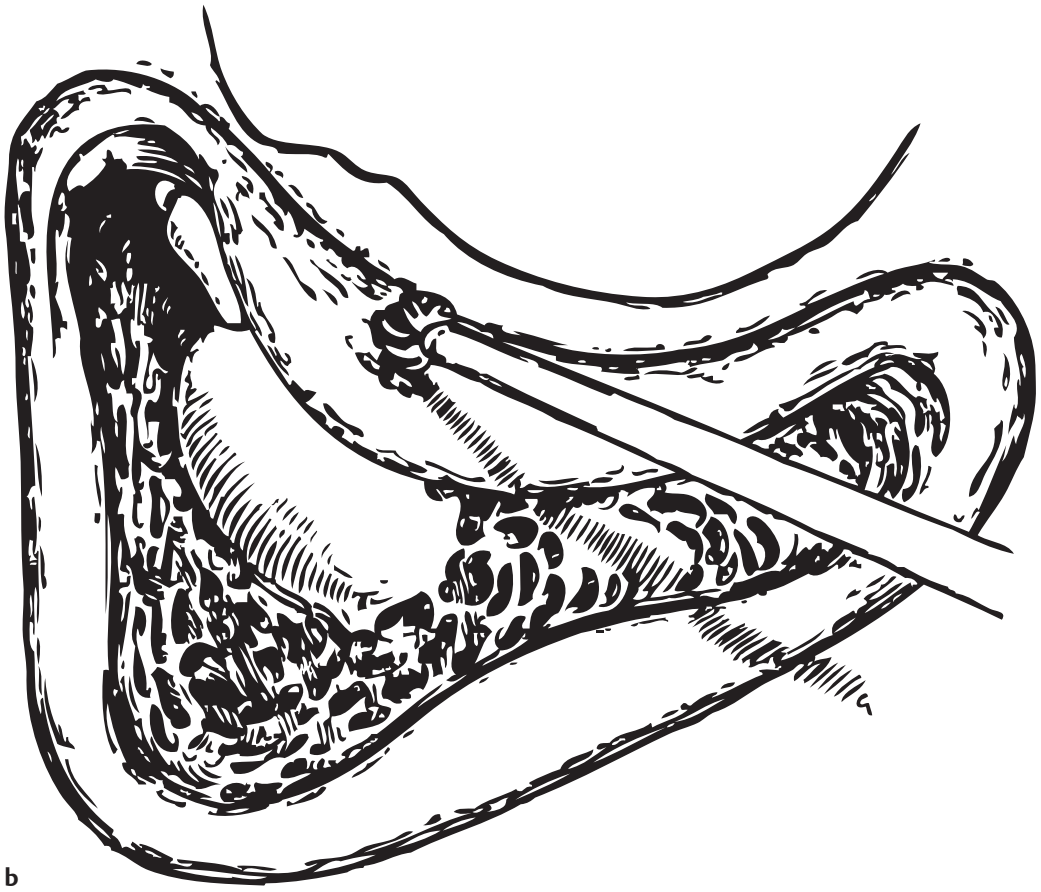
Complications

1. Recurrent cholesteatoma
2. Facial nerve injury
3. Labyrinthine trauma (semicircular injury)
4. Dural laceration with cerebrospinal fluid leak
5. Sigmoid sinus laceration
6. Ossicular chain damage

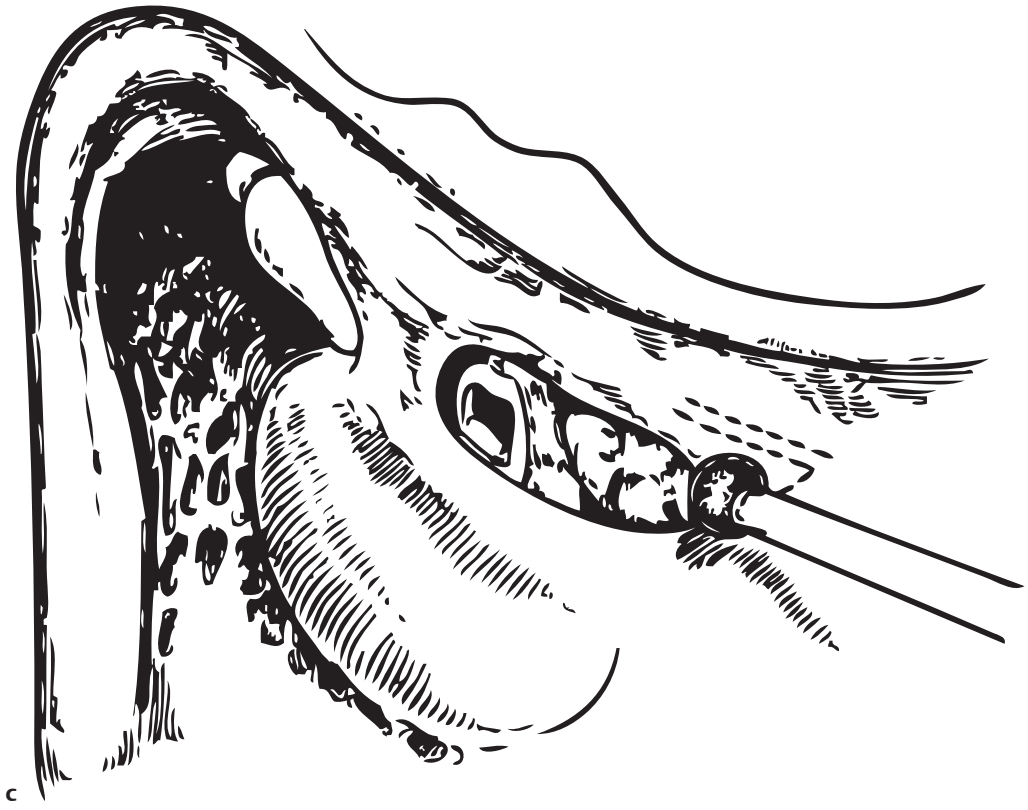


a

Fig. 3.5a

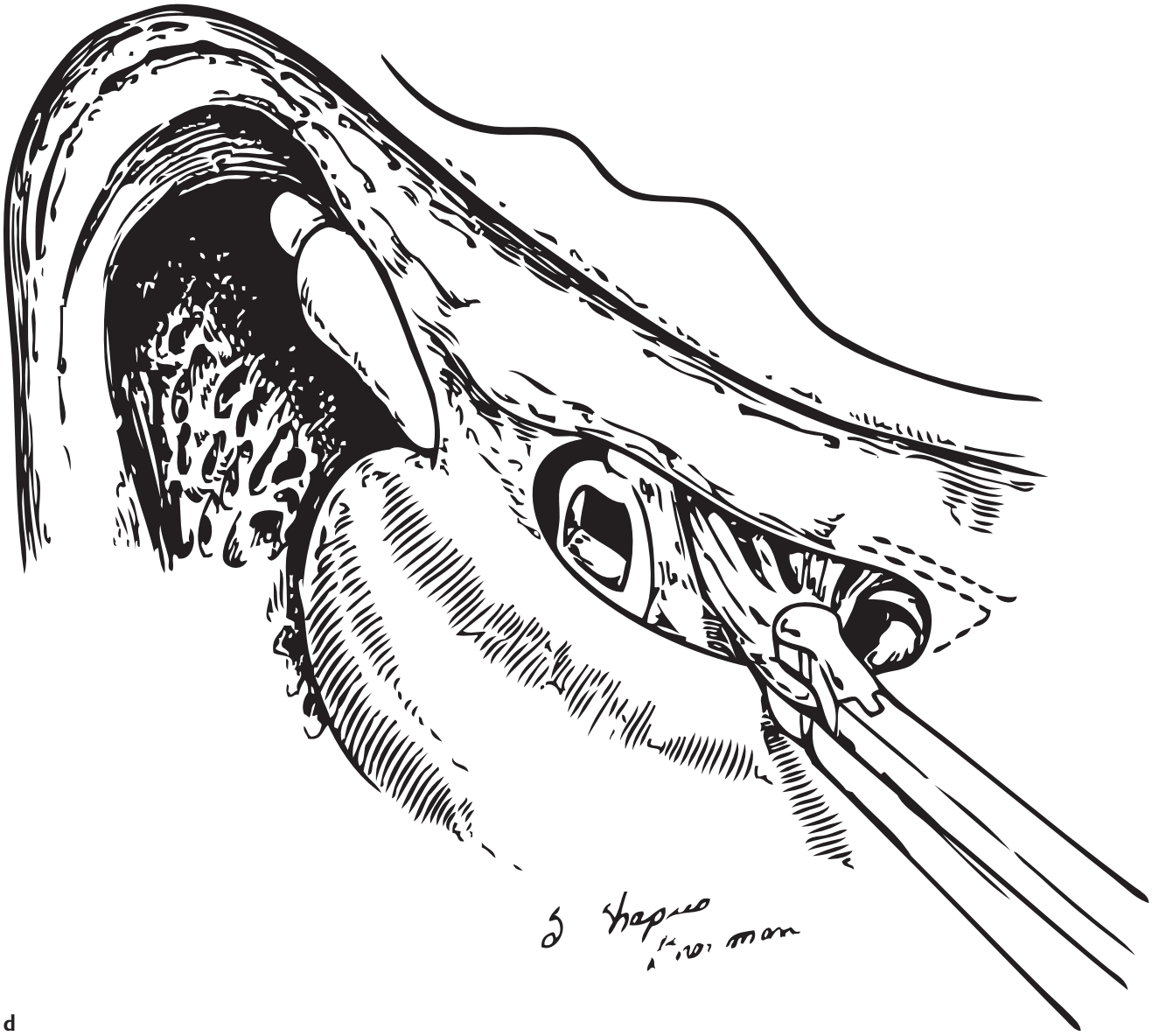


b



c

Fig. 3.5b,c



d

Fig. 3.5d

3-6 Canal Wall Down Mastoidectomy

Introduction

A key feature of a canal wall down (CWD) mastoidectomy is the removal of the posterior bony ear canal that normally separates the mastoid compartment from the external auditory canal. By doing this, disease in the mastoid (most commonly cholesteatoma) is externalized, creating a "safer" ear. In severe and/or recalcitrant disease of the middle ear and mastoid cavity, a radical mastoidectomy is performed in which the middle ear and mastoid are completely externalized with the ossicles typically being removed and the eustachian tube often being packed off and obliterated at the middle ear side.

Indications

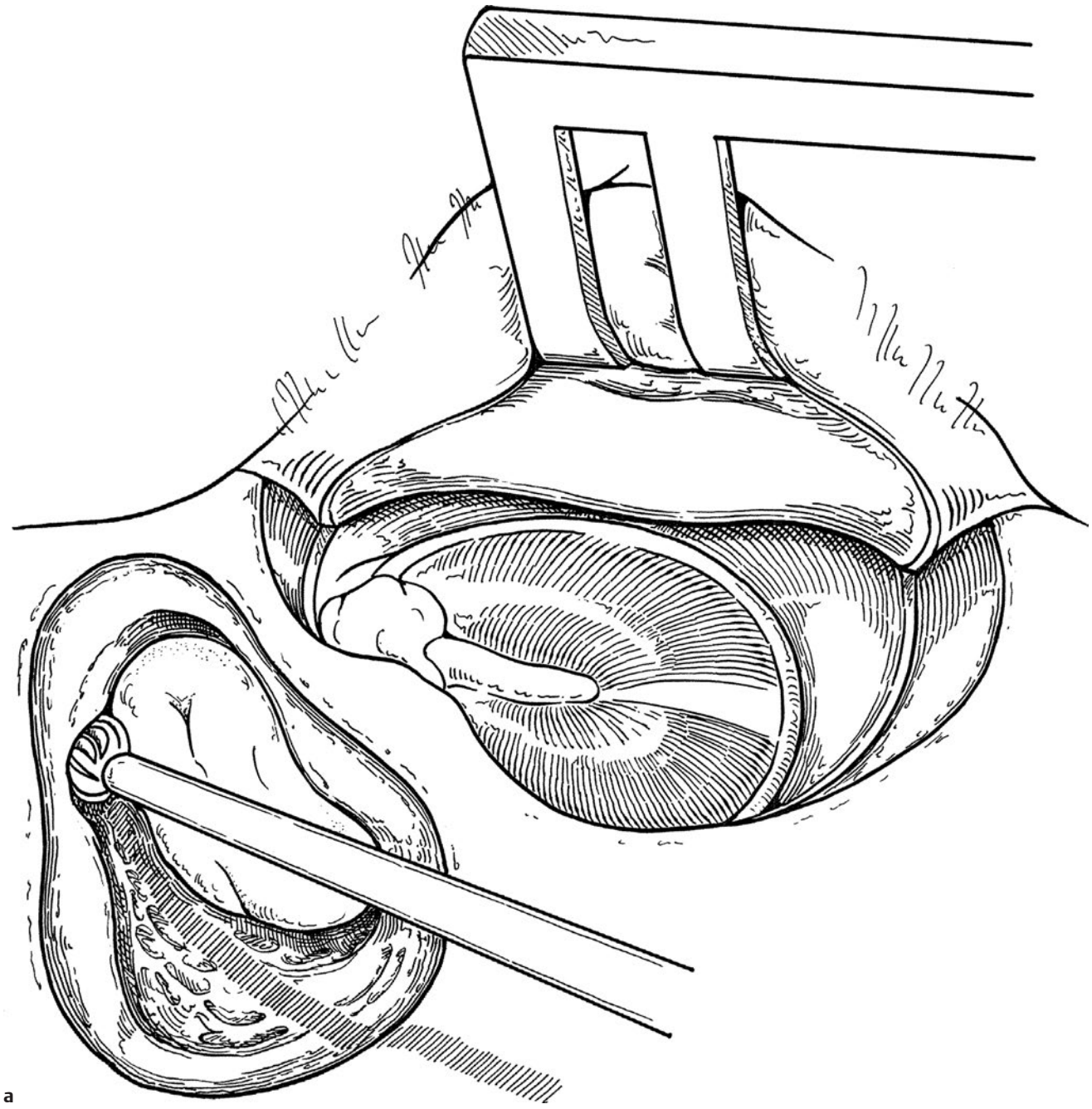
CWD is indicated when there is cholesteatoma lateral to the ossicular chain or when there is extensive cholesteatoma involving both the middle ear and mastoid that makes complete removal either extremely difficult or impossible. Other indications such as large cholesteatomatous disease with labyrinthine or cochlear complications can also be safely managed by externalizing the disease via CWD.

Operative Technique

1. The soft tissue approach prior to starting on the mastoidectomy has been described above and is identical to that for tympanoplasty or cortical mastoidectomy (see Sections 3-2 and 3-4).
2. After completing a cortical mastoidectomy (**Fig. 3.6a**) and typically after a tympanomeatal flap has been elevated in the ear canal, the bone of the posterior ear canal is carefully removed using a series of cutting and diamond burs. While cutting burs can be safely used at the lateral aspects of bone removal, diamond burs provide a greater safety margin at the medial end of the ear canal bone removal due to proximity to the facial nerve (**Fig. 3.6b,c**).
3. Careful removal of the diseased mucosa and cholesteatoma is then performed, using caution near important structures as there may be bony erosion (**Fig. 3.6d**). The surfaces of the mastoid cavity are smoothed with a diamond bur to avoid trapping of cholesteatoma. In cases where the ossicular chain is not involved by disease, it may be possible to leave flat regions of cholesteatoma matrix in the mastoid cavity.
4. If the ossicles are involved, care must be taken to avoid any trauma to the cochlea and inner ear; it is prudent at an early stage to ensure that the ossicular chain is not in continuity or to intentionally (and delicately) disarticulate the incudostapedial joint. By doing this, the incus and malleus can be manipulated aggressively without fear of traumatizing the stapes and/or the oval window and cochlea (**Fig. 3.6e**).
5. An adequate meatoplasty is requisite for any ear being managed with a CWD mastoidectomy. This is accomplished by gently elevating the skin overlying the conchal bowl (either from the endaural side or from the postauricular side) and excising a crescent of conchal cartilage that forms the posterior boundary of the external meatus (**Fig. 3.6f**). A releasing incision in the canal skin may also need to be made (at the 12 and 6 o'clock positions) in order to allow the meatus to open fully (**Fig. 3.6g**).
6. The patency of the meatoplasty is gauged by grasping the perichondrium of the remaining concha and pulling it back to the position it will have after closure of the postauricular incision.
7. If the meatus is not large enough to permit access to the entire mastoid cavity, additional soft tissue and cartilage are removed from around the meatus until adequate exposure of the mastoid is accomplished (**Fig. 3.6h**).
8. The periosteum of the remaining concha is sutured posteriorly to the periosteum of the mastoid with 3-0 chromic suture (**Fig. 3.6i**).
9. The posterior soft tissues are then closed as described above and the meatus packed using an expanding Merocel sponge (Medtronic), and a mastoid dressing is applied. The sponge is saturated with antibiotic ear drops immediately and then twice daily until the packing is removed (typically 2–3 weeks).

Complications

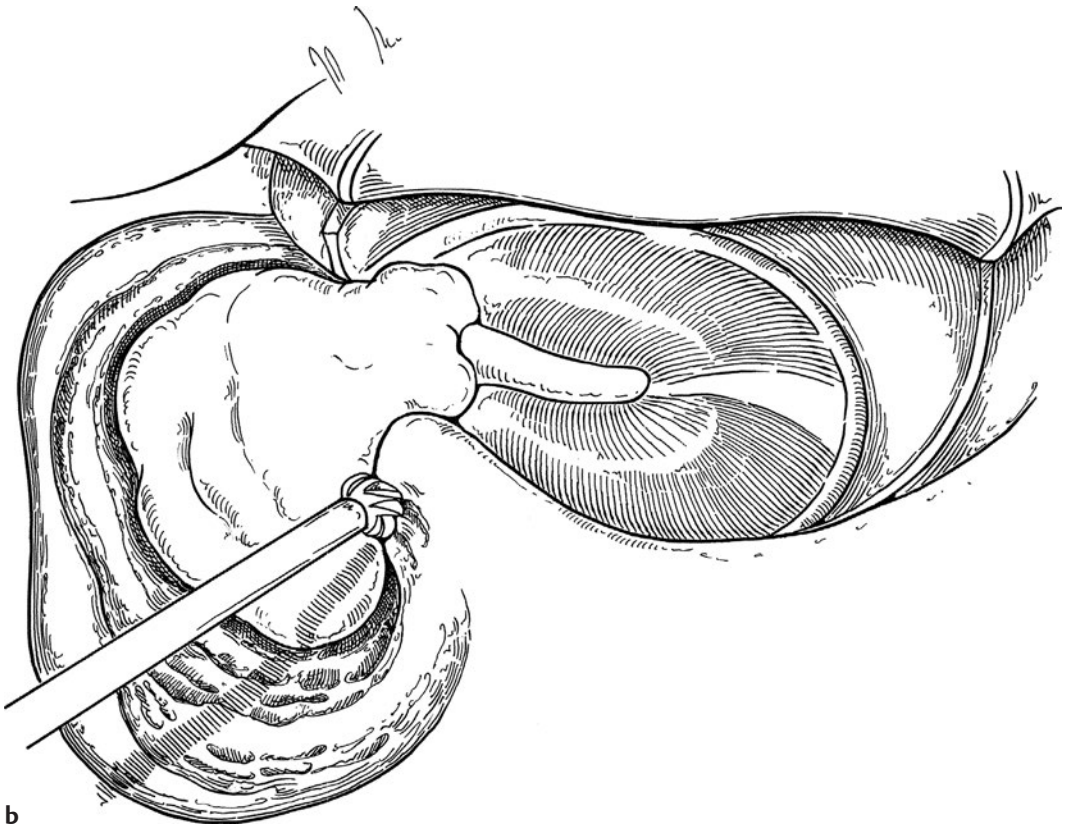
1. Recurrent cholesteatoma
2. Facial nerve injury
3. Labyrinthine injury (fistulization of semicircular canals)
4. Dural laceration with cerebrospinal fluid leak
5. Sigmoid sinus laceration
6. Ossicular chain damage
7. Meatal stenosis and recurrent infections due to inadequate meatoplasty



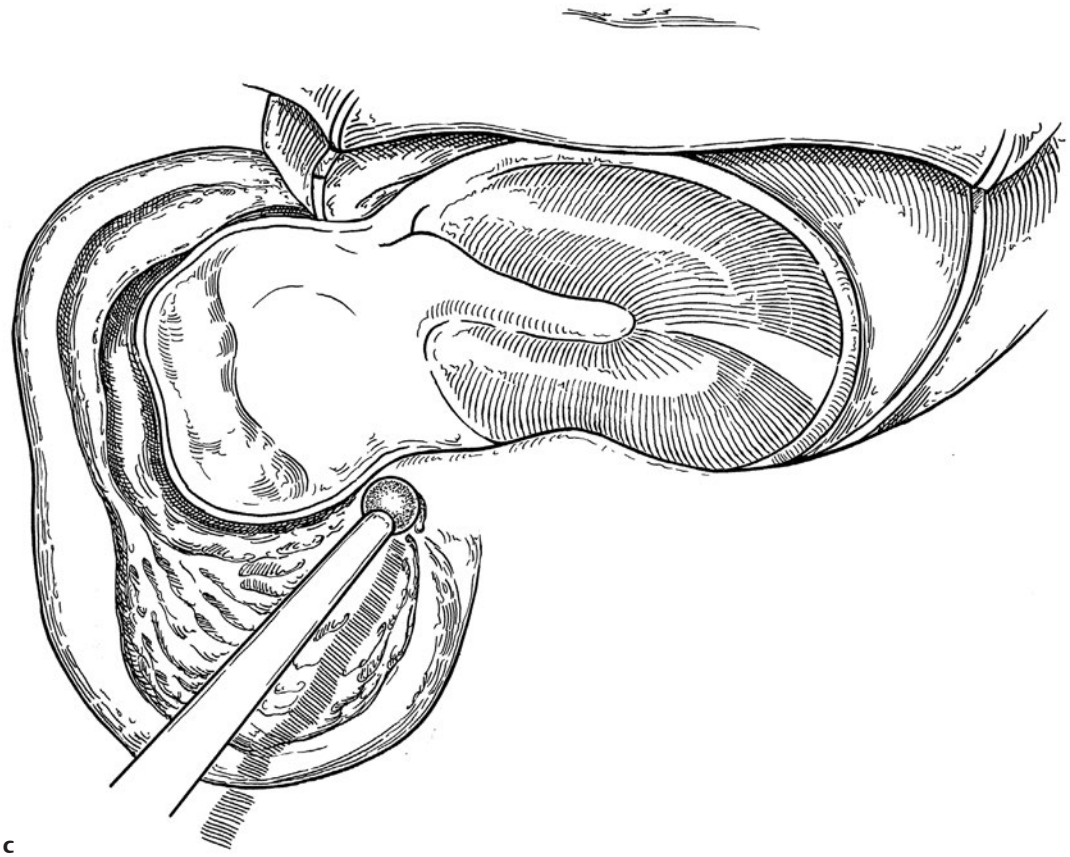
a

Fig. 3.6a

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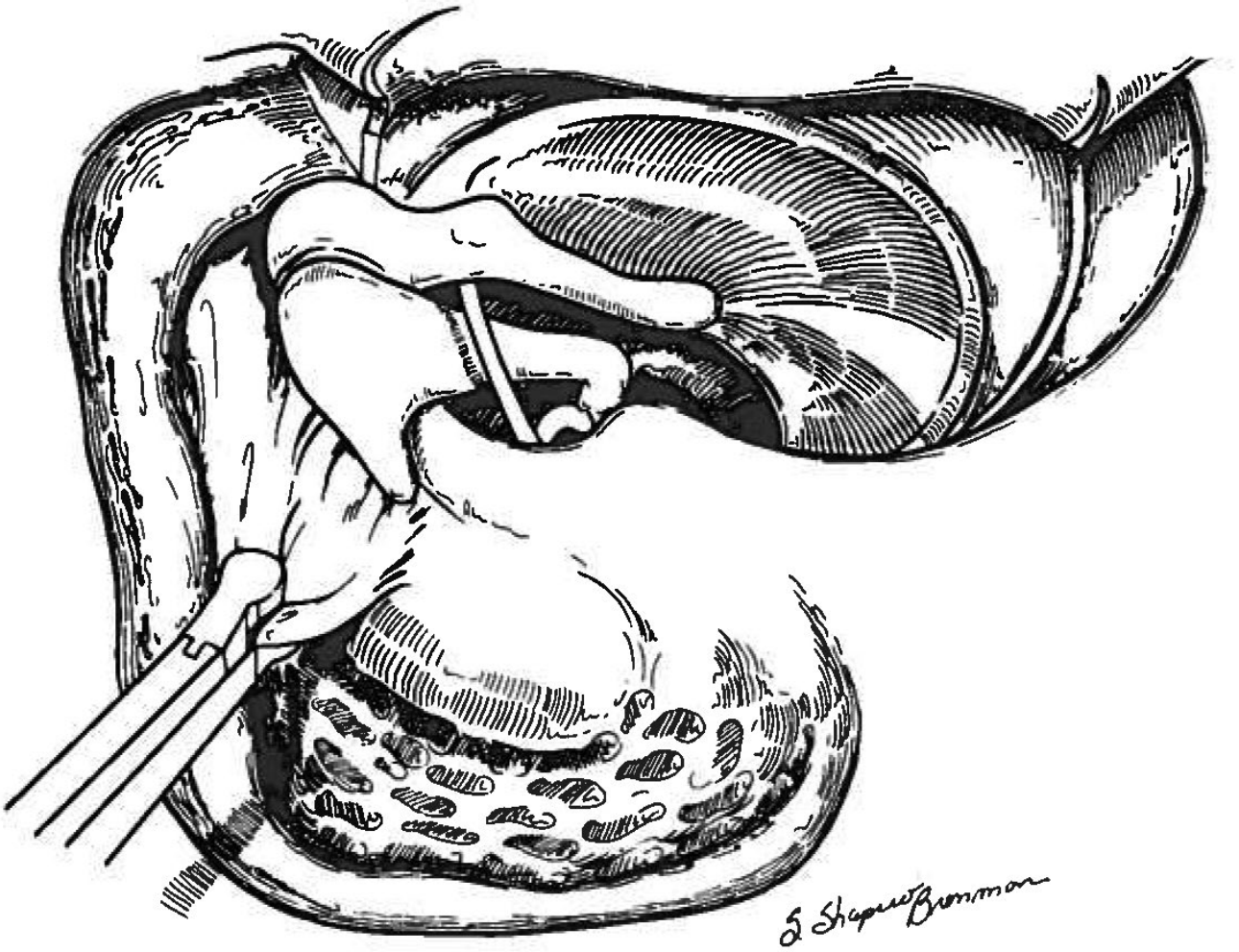
b



c

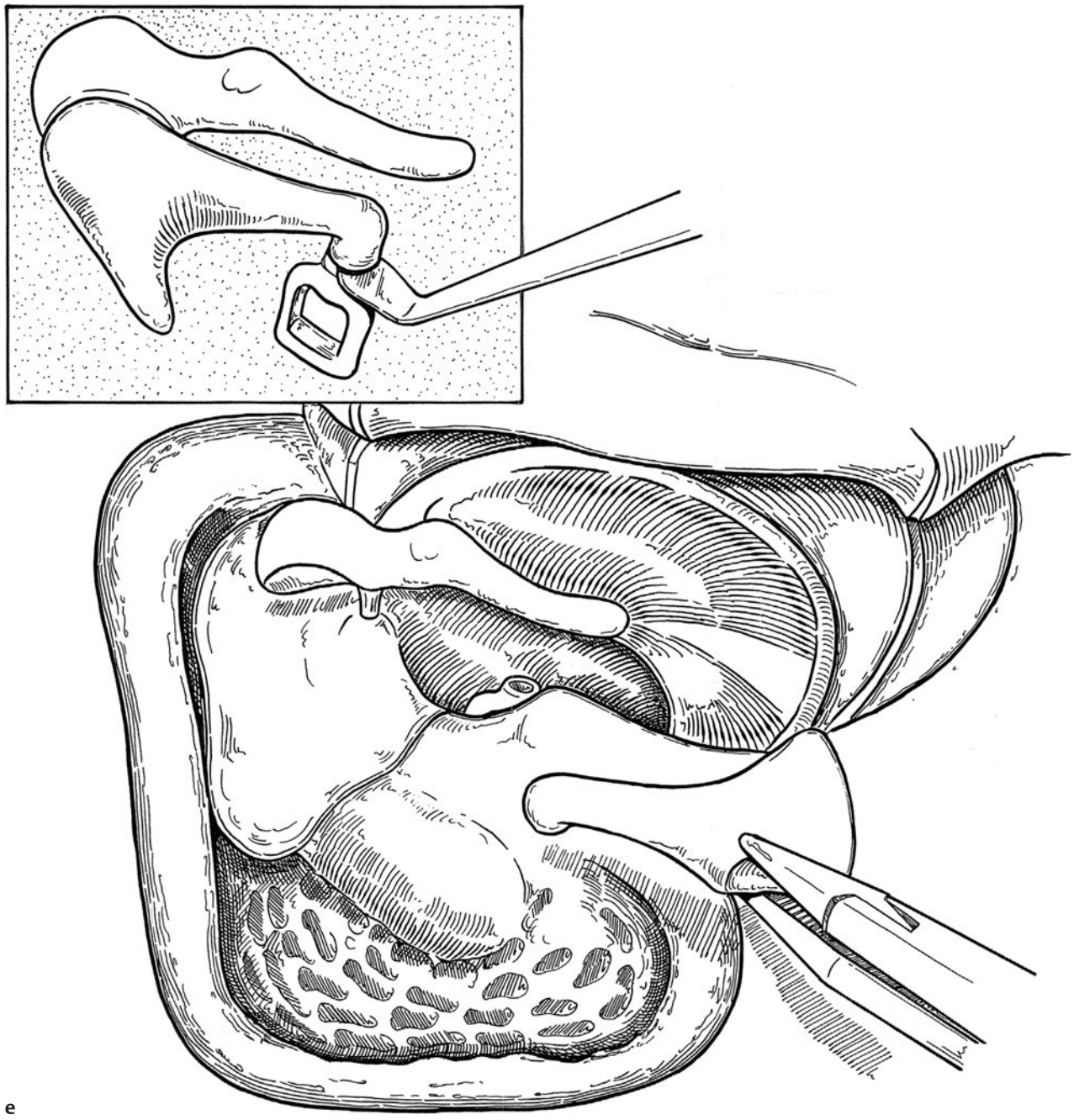
Fig. 3.6b,c

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d

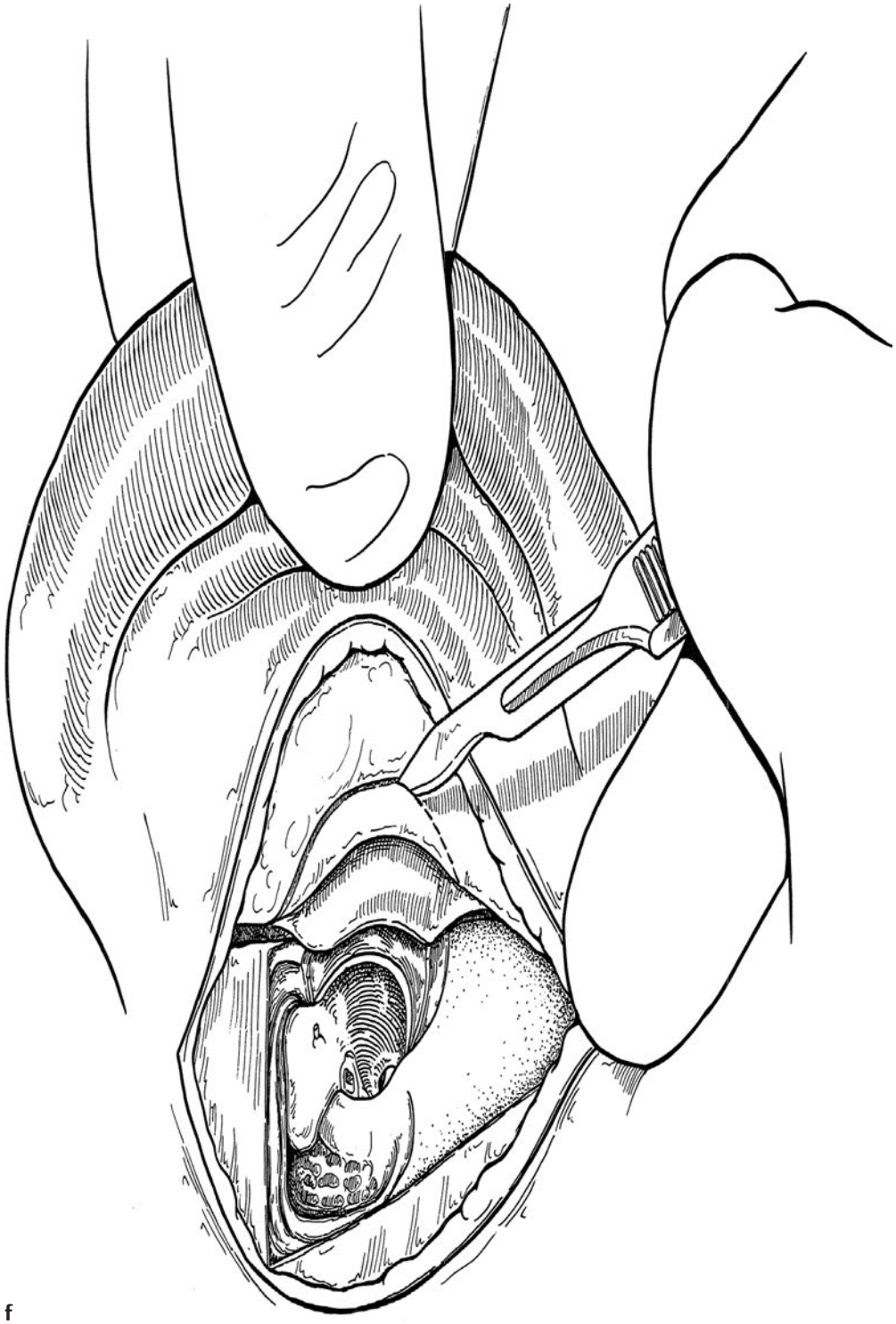
Fig. 3.6d



e

Fig. 3.6e

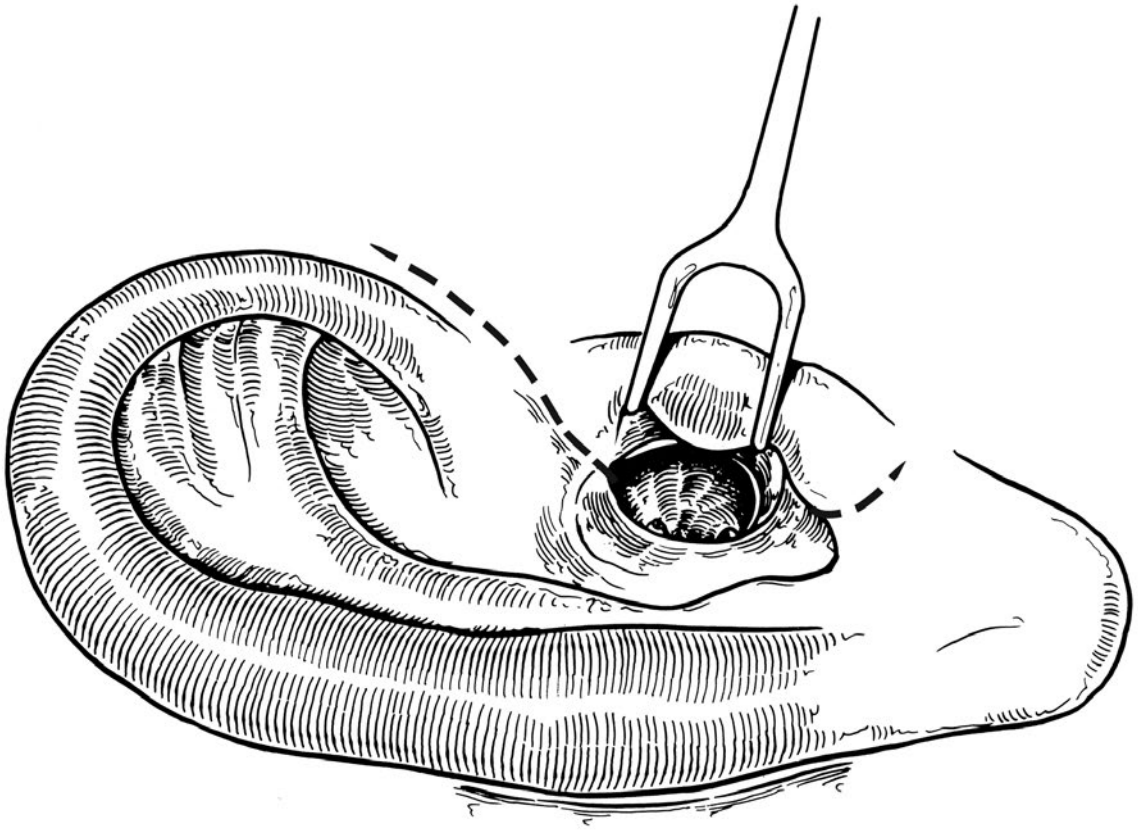
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f

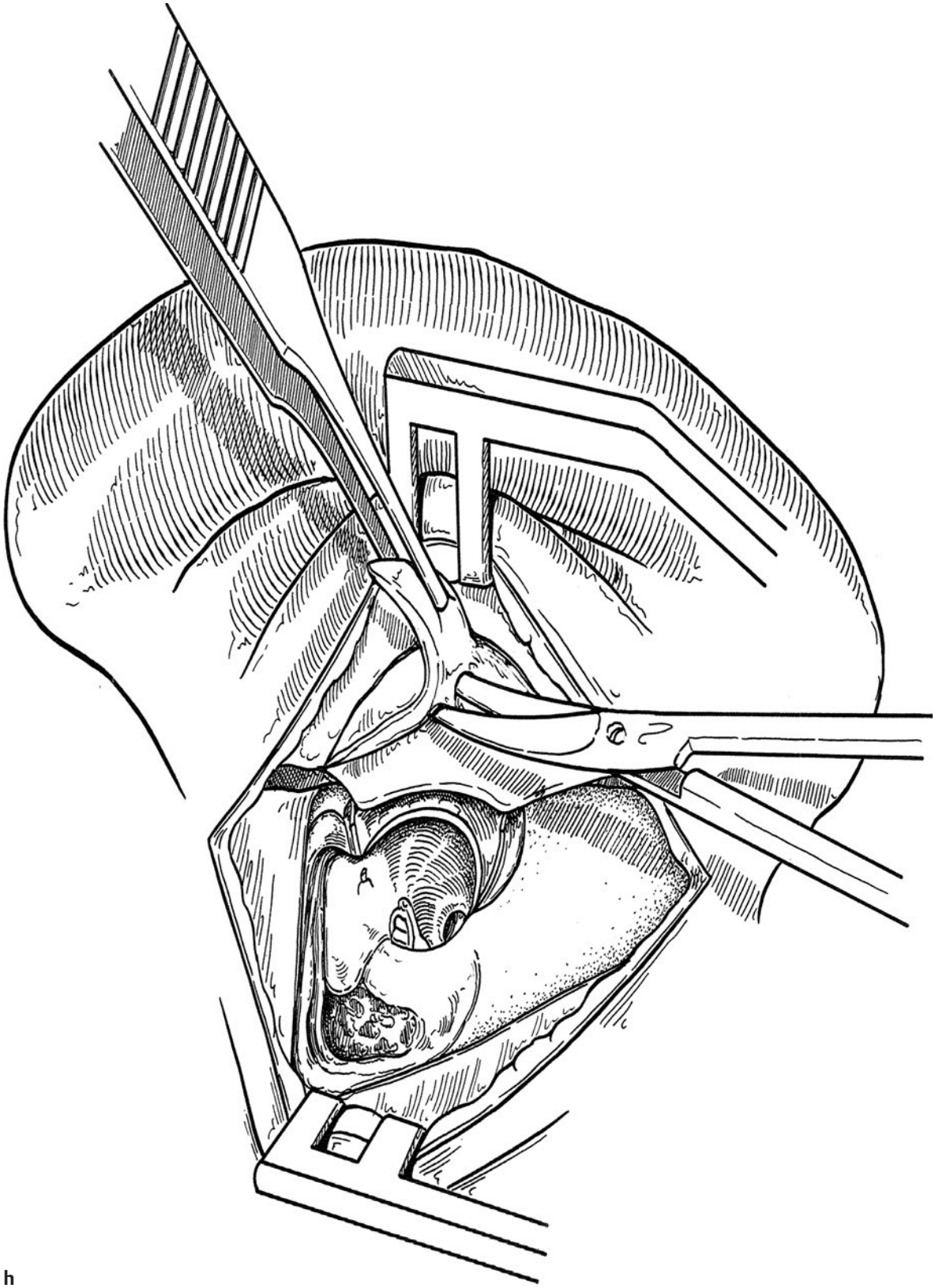
Fig. 3.6f

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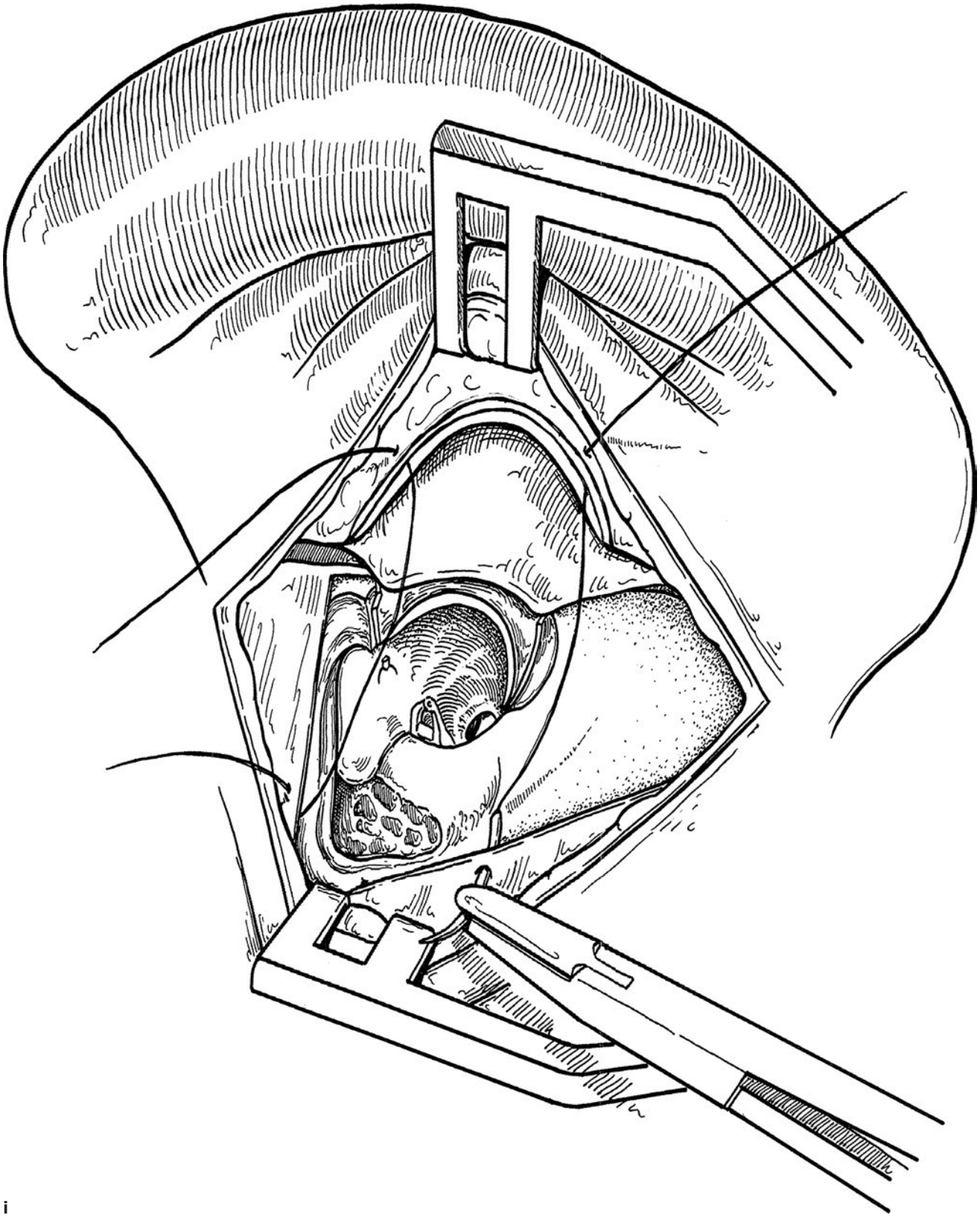
g

Fig. 3.6g



h

Fig. 3.6h



i

Fig. 3.6i

3-7 Mastoid Obliteration

Introduction

For many patients, a CWD mastoidectomy is required to fully expose and resect their cholesteatoma or chronic ear disease. And even if the primary disease is successfully managed, a problematic sequela can be a large mastoid cavity that does not self-clean and consequently builds up wax and debris with periodic bowl infections and the need for routine office appointments for uncomfortable cleanings and debridements.

For these patients who are well beyond their primary disease process, it is reasonable to obliterate their mastoid cavity using a small periosteal or muscle flap and eliminate the problem-causing dead space.

Indications

The primary indication for a mastoid obliteration would be recurrent mastoid bowl impactions or infections in someone who has undergone prior CWD mastoidectomy.

Preoperative Evaluation

After thorough microscopic debridement of the mastoid cavity, it is necessary to rule out recurrent cholesteatoma as an underlying cause for the problems. If in doubt, CT or diffusion-weighted magnetic resonance imaging is helpful in trying to identify occult cholesteatoma. Although hearing improvement or hearing changes in general are not anticipated from a mastoid obliteration, it is prudent to obtain a preoperative audiologic evaluation for any patient undergoing a major otologic procedure.

Operative Technique

1. After a standard postauricular incision, care is taken to widely elevate the tissues in a supra-temporalis fascia plane. Self-retaining retractors are then placed for good exposure of the entire field and a slightly exaggerated, posteriorly based Palva flap incised with the electrocautery (refer to **Fig. 3.4a,b**). This flap is then elevated from anterior to posterior, exposing the mastoidectomy cavity.
2. A large diamond drill is used to completely smooth out the mastoid cavity and to ensure that the mastoid cavity is completely de-epithelialized.
3. The Palva flap can now be gently laid into the mastoid compartment, filling the area overlying the sigmoid sinus, any retrosigmoid air cells, the sinodural angle, as well as the bulk of the central mastoid air cell tract.
4. A large piece of temporal fascia is then laid on top of the Palva flap and the ear sutured back into its normal anatomical position.
5. At this point, examination with a microscope through the ear canal should show what looks like a large ear canal. The posterior "ear canal" at this point will be lined by the temporalis fascia graft, which is laying on top of the Palva flap that fills the mastoid defect. Over time, the flap will fibrose in position and eliminate the issues of recurrent debris collecting in a large, nonfunctional mastoid cavity.
6. A large Merocel sponge, regularly saturated with antibiotic ear drops, is maintained in the ear canal for 2–3 weeks until removed.

Complications

1. Recurrent cholesteatoma
2. Facial nerve injury
3. Labyrinthine trauma (semicircular injury)
4. Dural laceration with cerebrospinal fluid leak
5. Sigmoid sinus laceration

4 Congenital Malformations of the Ear

John A. Germiller

Congenital malformations of the auricle, external ear canal, tympanic membrane, middle ear cleft, and ossicles may occur as isolated entities or in association with other deformities.

4-1 Preauricular Tags

Introduction

Preauricular tags are congenital malformations associated with incomplete migration and/or coalescence of the auricular hillocks. These are usually anterior to the tragus, and they may be single or multiple (**Fig. 4.1a**). They vary in shape but most often consist of skin and subcutaneous tissue. Occasionally, there is cartilage in the base of the tag.

Indications

Removal of the preauricular tags is performed to correct a congenital deformity.

Preoperative Evaluation

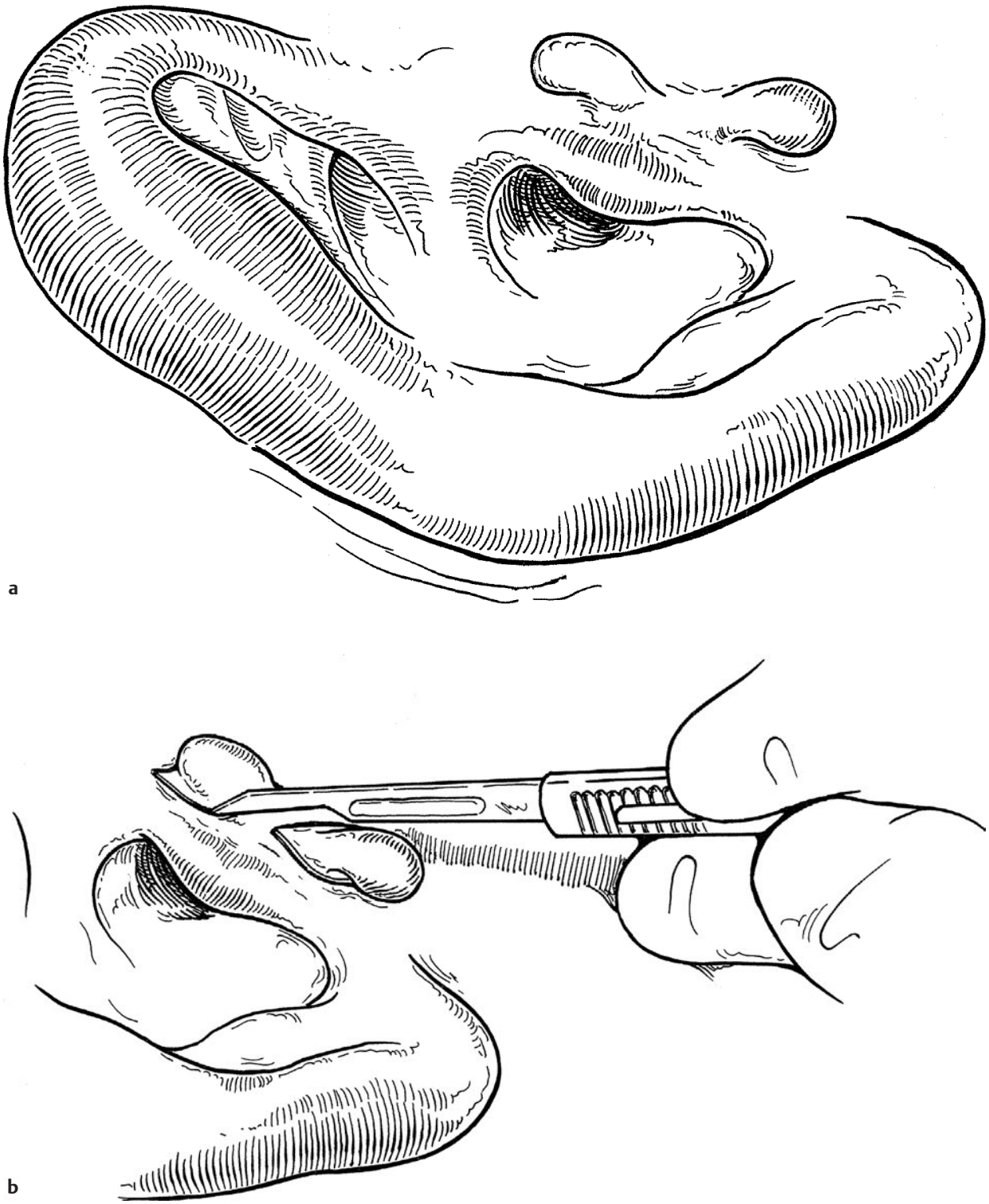
No special preoperative evaluation is required, except to recognize that any congenital outer ear anomaly may be associated with the presence of another ear (e.g., ossicular) malformation.

Operative Technique

1. A general anesthetic is usually required. Local infiltration of the base of the preauricular tag with 1% lidocaine containing 1:100,000 epinephrine will decrease bleeding.
2. An elliptical skin incision is made in the lines of the facial creases in front of the ear (**Fig. 4.1b**).
3. The tag can be grasped with a toothed forceps and placed on gentle traction while dissecting the underlying cartilage and subcutaneous tissue with sharp scissors (**Fig. 4.1c**).
4. The subcutaneous stalk and cartilage are cut free with sharp scissors (**Fig. 4.1d**).
5. Hemostasis should be obtained with needlepoint cautery.
6. The wound is closed in two layers. The skin is closed with subcuticular absorbable suture, thus avoiding the need to remove skin sutures (**Fig. 4.1e,f**).

Complications

Hematoma.

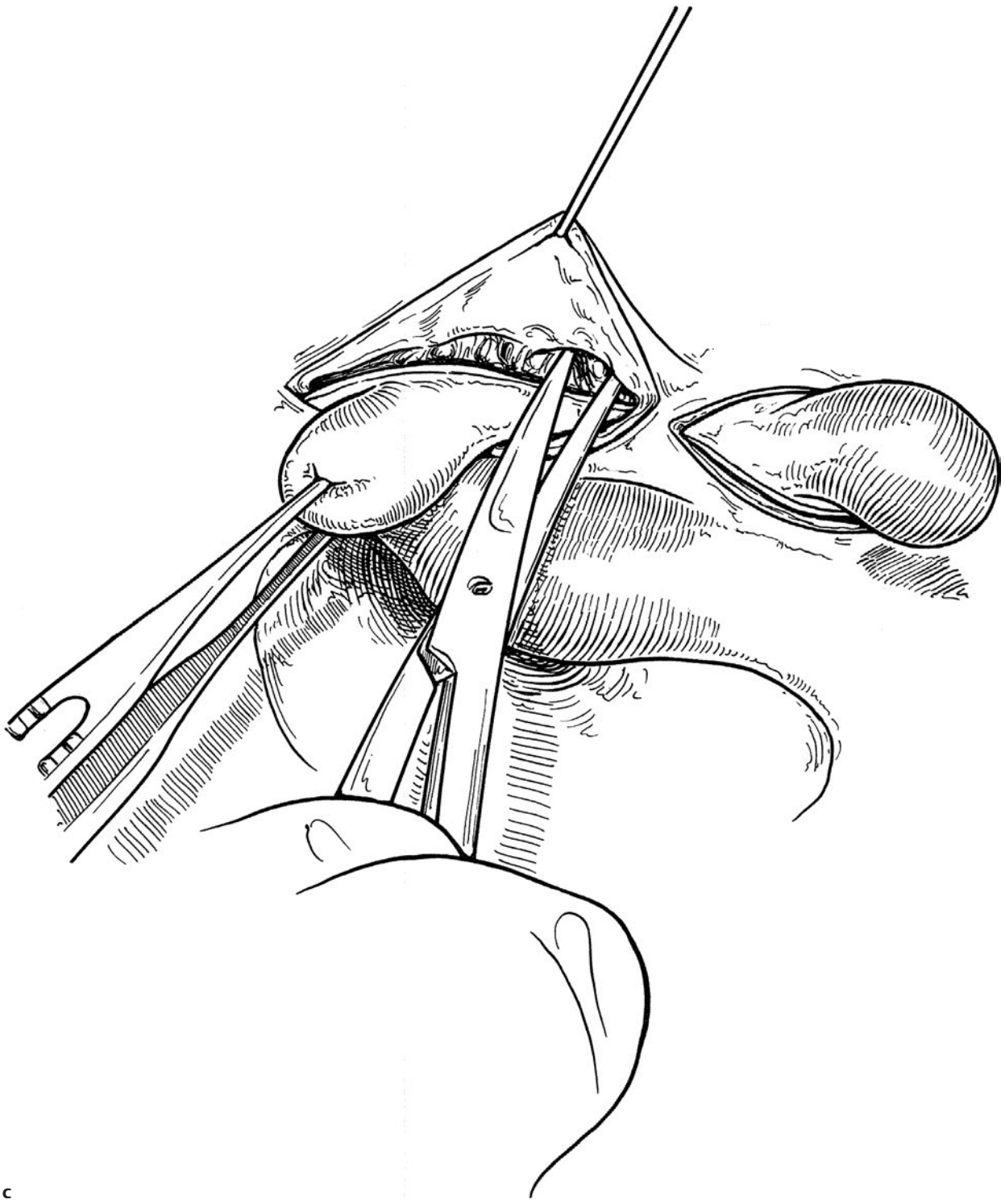


a

b

Fig. 4.1a,b

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c

Fig. 4.1c

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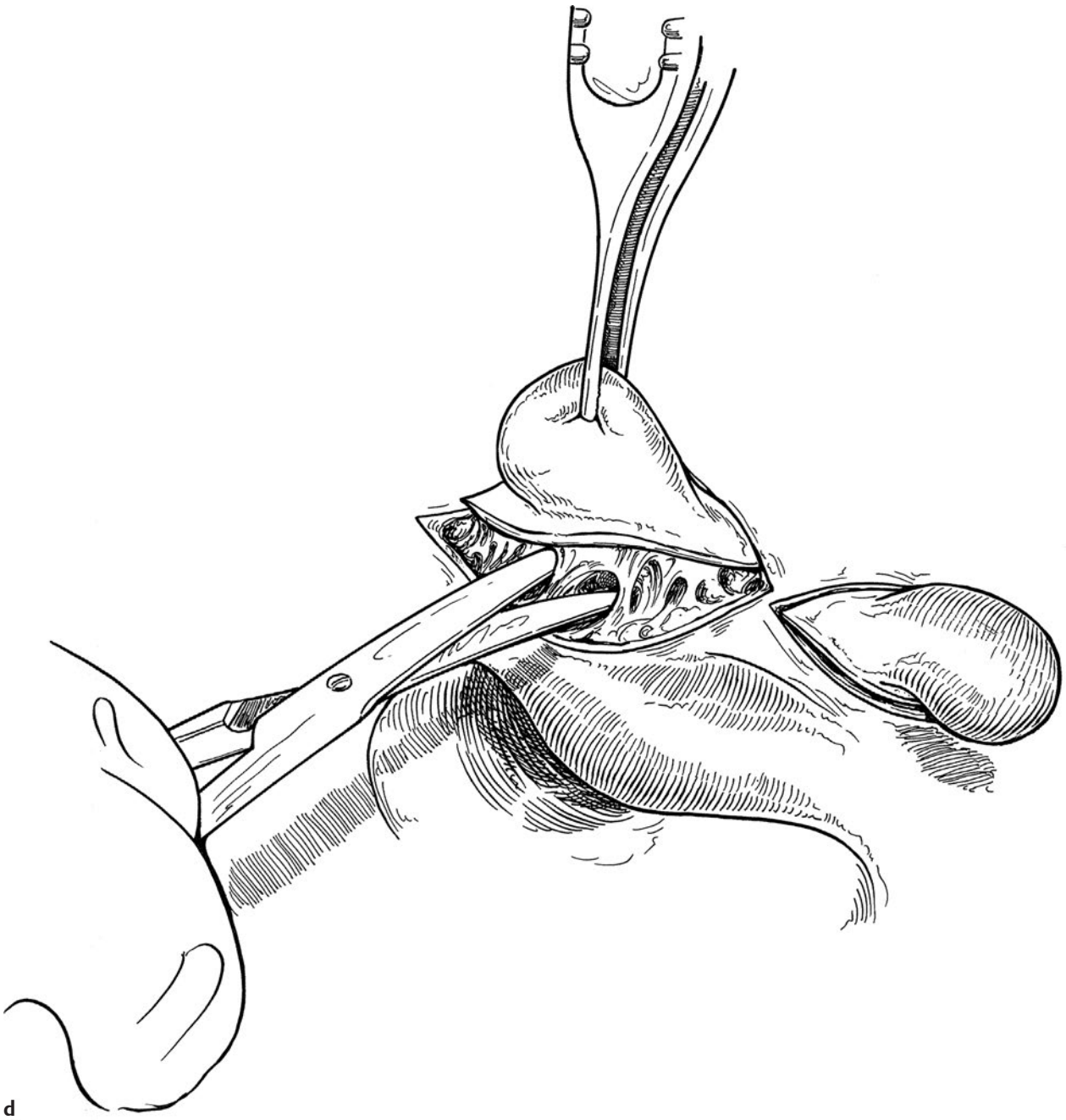
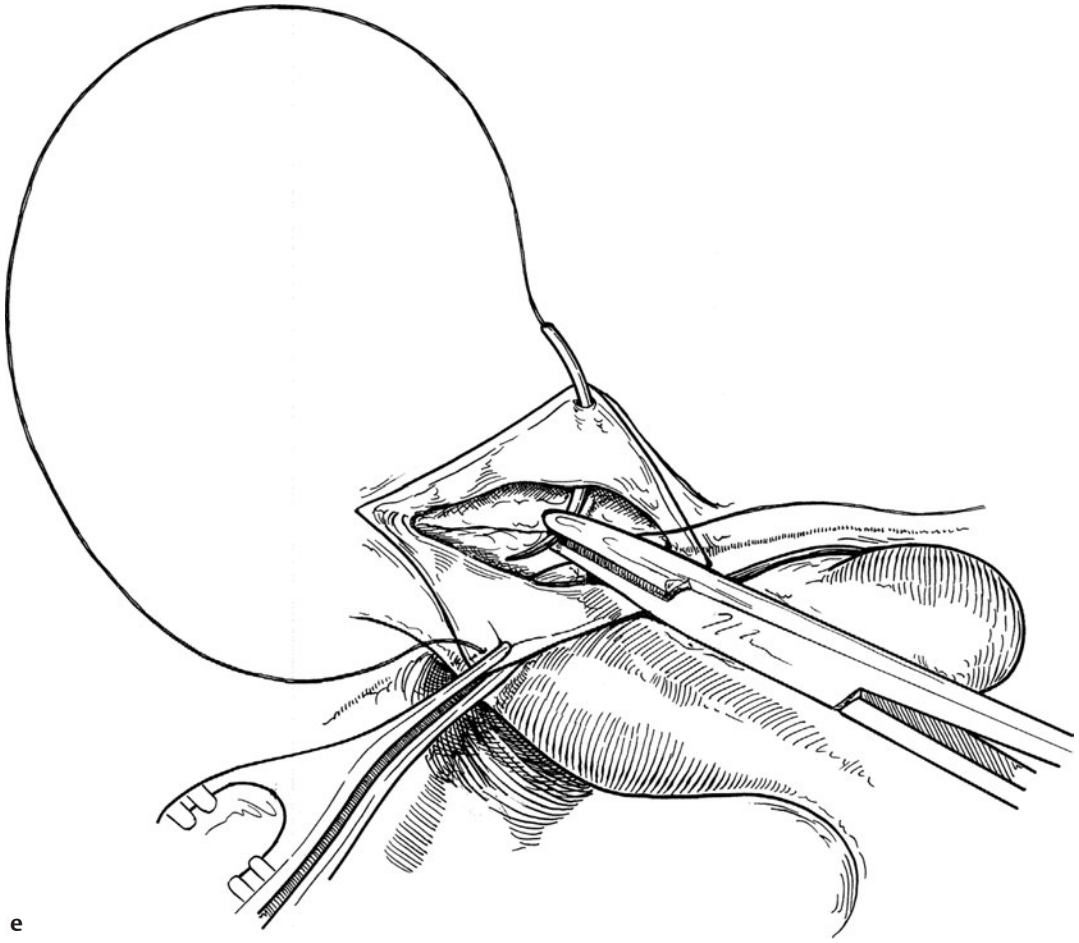


Fig. 4.1d

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e



f

Fig. 4.1e,f

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4-2 Preauricular Sinuses

Introduction

Preauricular sinuses occur as a result of the trapping of epithelium between the developing ear hillocks. They usually present as a pit in the area just superior and anterior to the tragus. The lesions sometimes arborize in the subcutaneous tissues and often attach to the helical cartilage.

Indications

Asymptomatic sinus tracts require no treatment. Excision is necessary if these skin-lined tracts become infected or form an obvious cyst.

Preoperative Evaluation

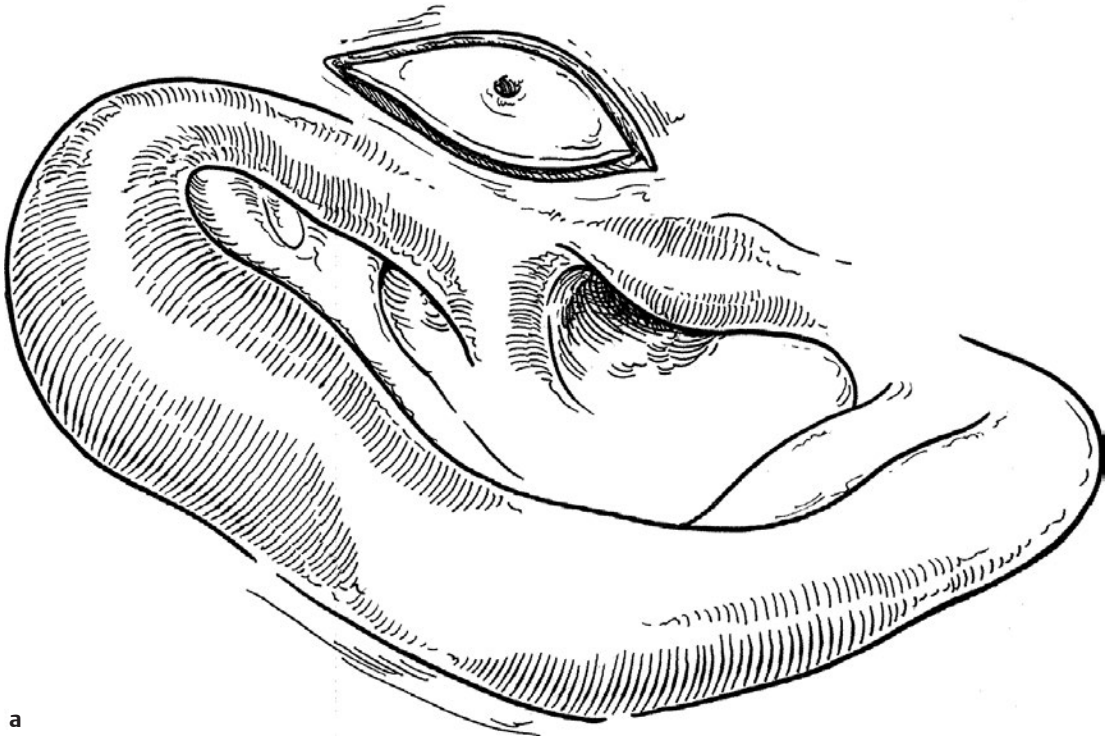
No special preoperative evaluation is required except to recognize that any congenital outer ear anomaly may be associated with the presence of another ear (e.g., ossicular) malformation.

Operative Technique

1. Preauricular sinuses are removed under a general anesthetic with local infiltration of 1% lidocaine with 1:100,000 epinephrine for hemostasis.
2. An elliptical incision is made around the skin defect in the preauricular area (**Fig. 4.2a**).
3. Skin flaps are elevated anteriorly and posteriorly (**Fig. 4.2b**).
4. Using blunt and sharp dissection, the subcutaneous tracts are followed, avoiding entry into the sinus (**Fig. 4.2c**). A lacrimal probe may be helpful to determine the direction and degree of arborization and the depth of the tract(s).
5. Preauricular sinuses usually attach to the perichondrium of the helical cartilage; thus the involved perichondrium should be excised in continuity with the cyst. Often perichondrium cannot be easily separated from the cartilage, so an ellipse of helical cartilage should also be excised (**Fig. 4.2d**).
6. The wound is closed in two layers after hemostasis is obtained. The skin is closed with subcuticular absorbable suture, avoiding the need to remove sutures (**Fig. 4.2e**).

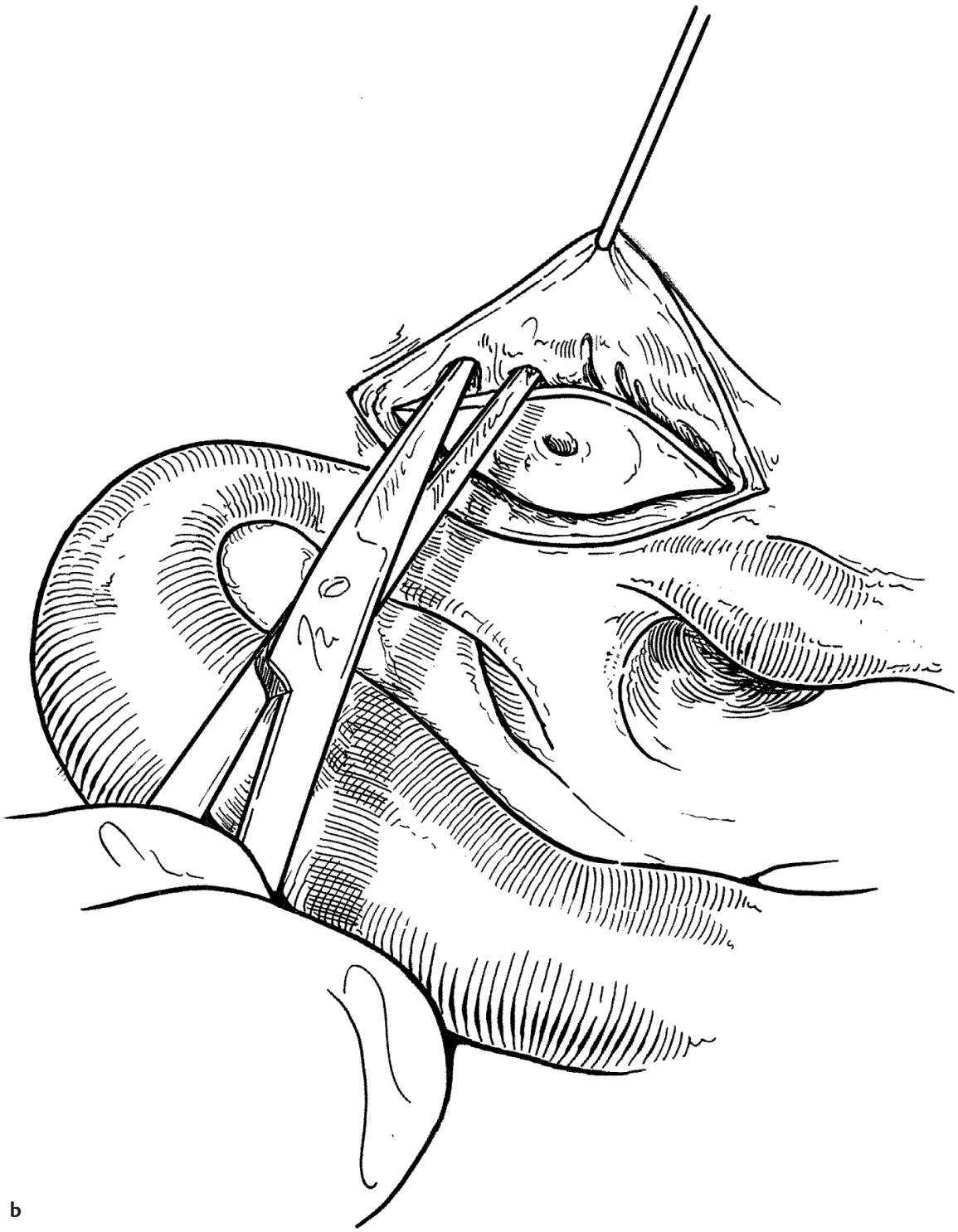
Complications

Recurrence secondary to incomplete excision.



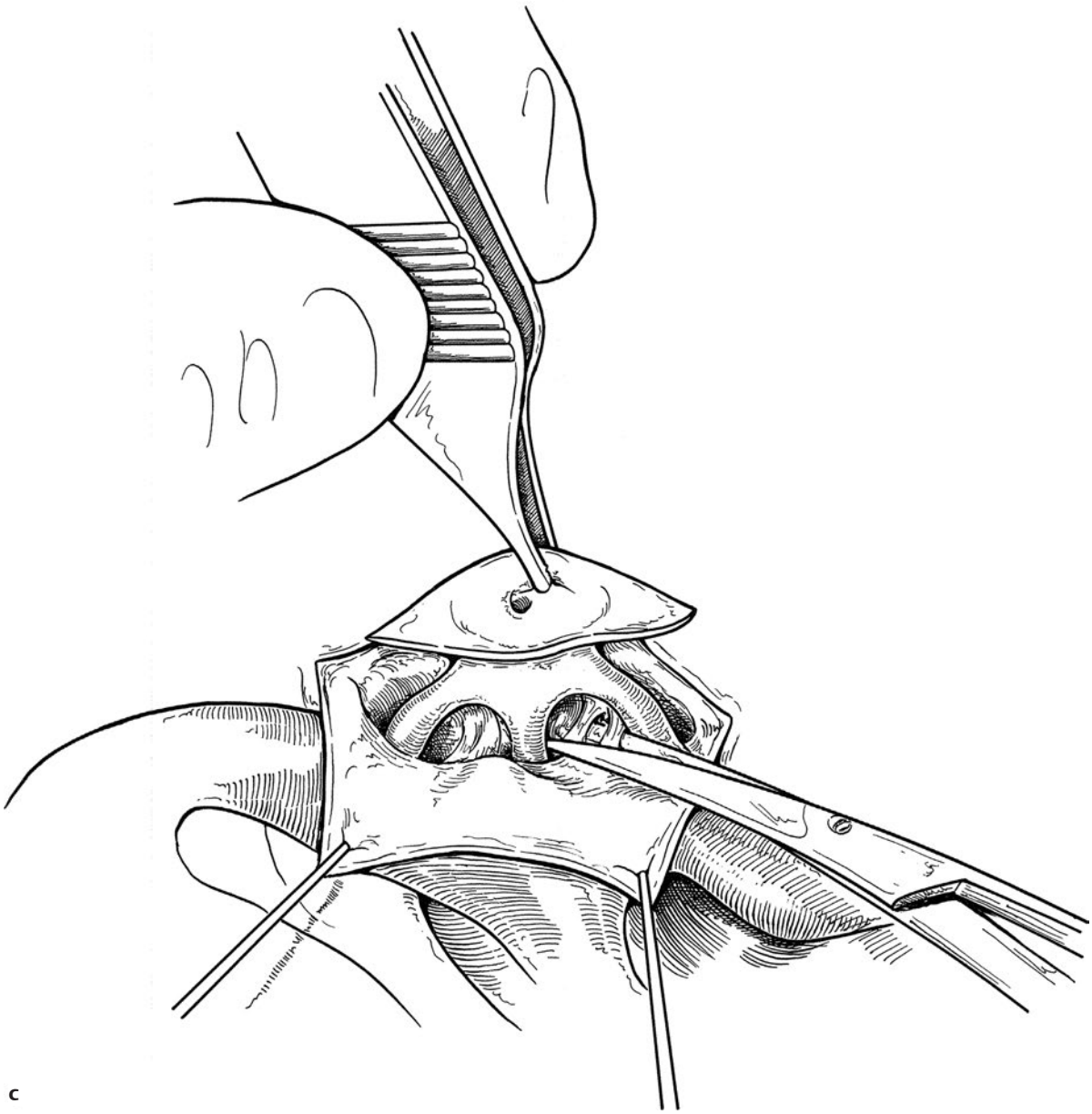
a

Fig. 4.2a



b

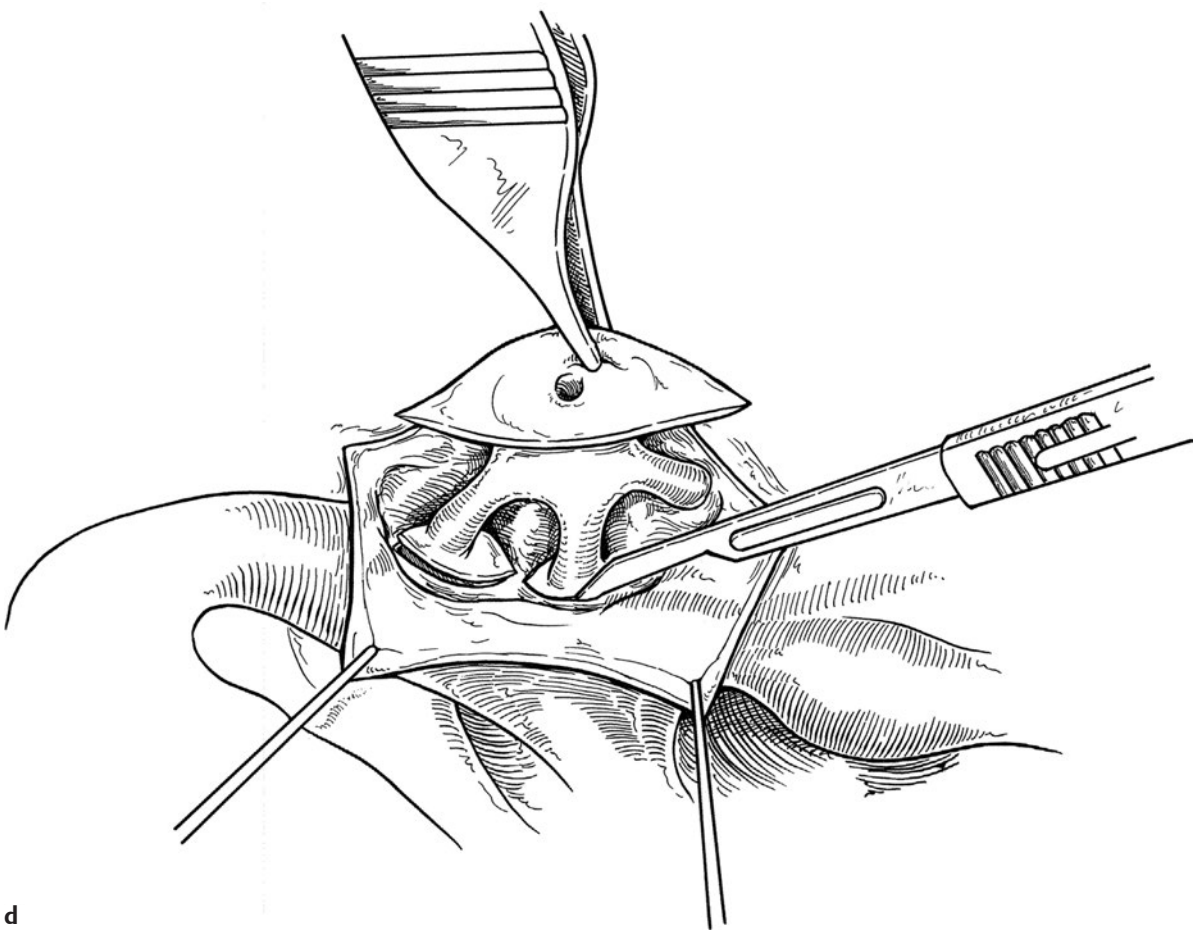
Fig. 4.2b



c

Fig. 4.2c

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d



e

Fig. 4.2d,e

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4-3 Otoplasty

Introduction

Protruding ear (prominotia) is a relatively common deformity that varies greatly in degree of severity (**Fig. 4.3a**). It is usually caused by a combination of the absence of the antihelical fold and a large conchal cartilage.

Indications

The indication for surgery is the desire of the child and parents to restore normal anatomy. The procedure is best performed between ages 4 and 5, when the child can cooperate with postoperative care and before the child is subjected to teasing by school-age peers.

Preoperative Evaluation

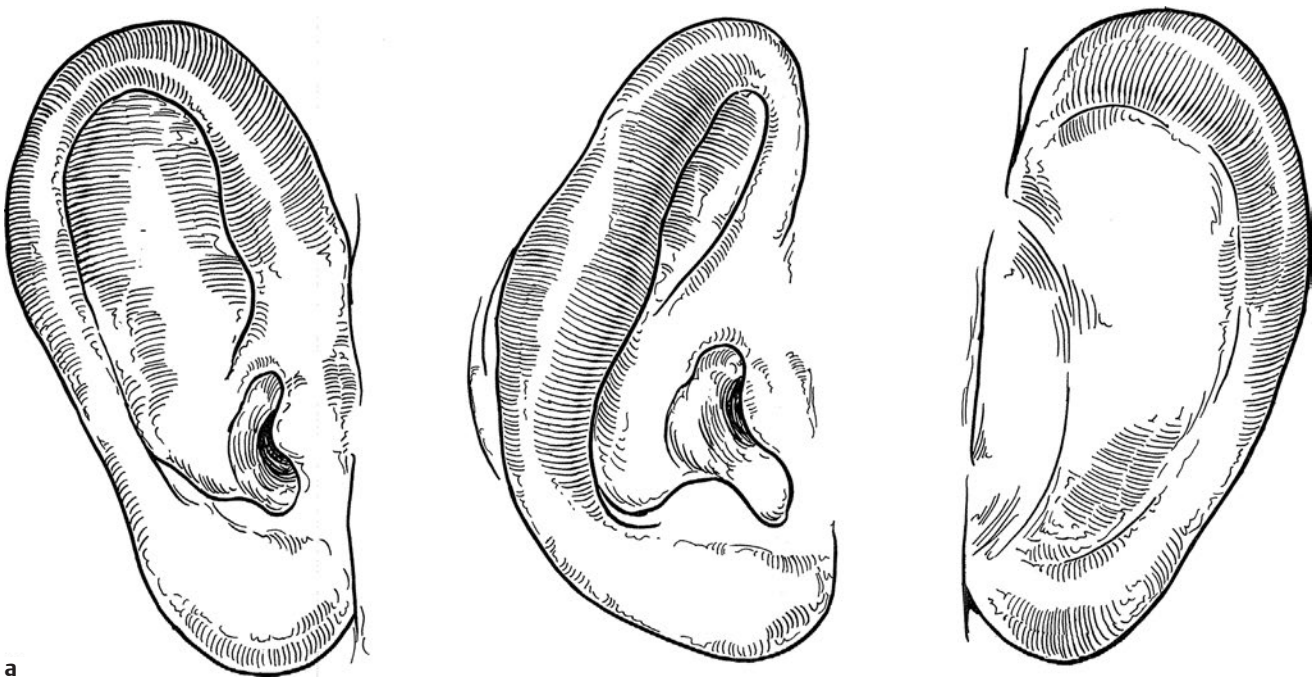
A complete examination of the ear and external canal is mandatory to determine the components of the deformity. Preoperative photographs are necessary to document the preoperative condition and to compare to the results after surgery.

Operative Technique

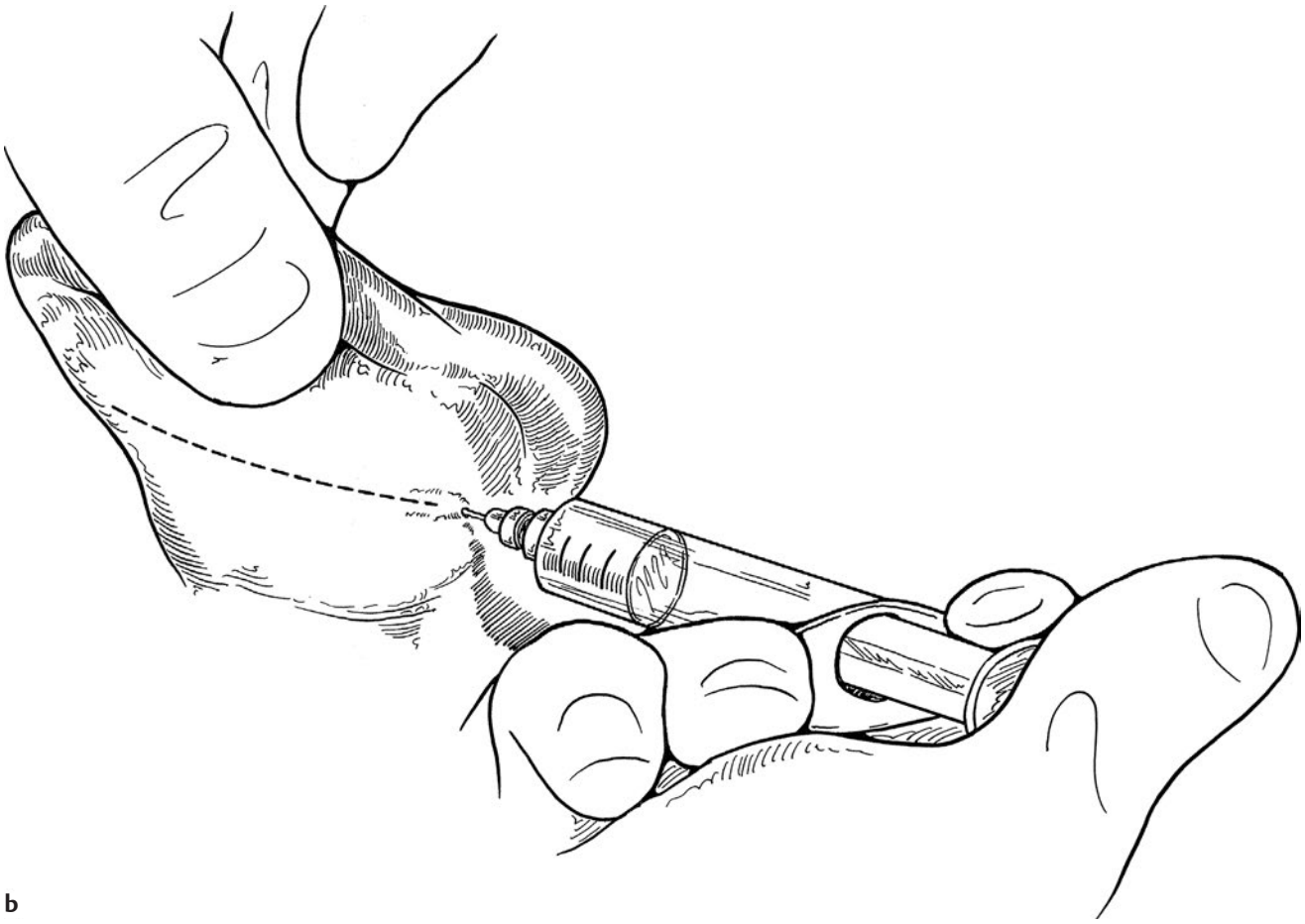
1. General anesthesia is utilized for all children having otoplasty. Both ears should be prepped into the surgical field simultaneously to allow intraoperative comparison of the two ears.
2. The desired degree of correction is determined by manipulating the auricle to create the missing fold in the antihelix and by depressing the concha against the mastoid bone. A marking pen is used to mark the line of the new fold to be created.
3. The posterior surface of the auricle is injected with 1% lidocaine with 1:100,000 epinephrine to aid in hemostasis. The line of injection is the full length of the ear and is halfway between the postauricular fold and the edge of the helix (**Fig. 4.3b**).
4. An incision is made along the line of injection down to the perichondrium.
5. Skin flaps are elevated on both sides of the incision, in a plane just superficial to the perichondrium, which is left attached to the cartilage.
6. The ear is folded along the line drawn in step 2, and three or four locations for mattress suturing are selected, close enough to produce an even contour of the new antihelical fold (**Fig. 4.3c**). These points (indicated by small circles) should be at least 5 mm from the top of the proposed antihelical fold so that the sutures will create a rounded, and not a sharp, fold.
7. At each of these points, a 25-gauge needle is passed through both skin and cartilage from the anterior surface of the ear. On the wound side, a small dab of methylene blue is then placed on the bevel of the needle, and the needle is removed, marking the cartilage (**Fig. 4.3d**).
8. Horizontal mattress sutures with 4-0 white Mersilene (Ethicon) are placed at the methylene blue marks to re-create the antihelical fold (**Fig. 4.3e**). The suture should go through the cartilage and anterior and posterior perichondrium. Care is taken to avoid perforation of the lateral (anterior) skin surface of the ear while placing the sutures.
9. The sutures are tied just tight enough to create the desired effect of a rounded fold (**Fig. 4.3f**).
10. If it is felt that the concha is prominent, a setback suture of 2-0 or 3-0 Vicryl (Ethicon) can be placed between the concha and the mastoid periosteum to rotate the ear posteriorly against the mastoid cortex (**Fig. 4.3g**). Care is taken to avoid overcorrection, which results in a "telephone ear" deformity. Degree of setback is carefully matched between left and right ears.
11. If desired, the excess postauricular skin can be removed, but this step is optional.
12. The incision is then closed with 5-0 subcuticular absorbable sutures. No drain is used.
13. The effect of the sutures to create the desired result is demonstrated in **Fig. 4.3h**.
14. Strands of cotton moistened with mineral oil are molded to the anterior surface of the auricle conforming to the auricular folds (**Fig. 4.3i**).
15. A mastoid dressing consisting of fluff gauze and elastic netting is used to apply gentle pressure. The family is instructed to lift this dressing 24 hours later, remove the oil-soaked cotton, replace the ball of gauze if needed, and wear it again for 24 additional hours of gentle pressure. After that, the dressing is removed, and an elastic terrycloth sports headband is worn for 1 week to keep the ear in place. It is used day and night for 1 week, and then just at night for another week.

Complications

1. Incomplete correction of deformity, or asymmetry of the two ears
2. Overcorrection ("telephone ear" deformity)
3. Delayed recurrence of the deformity due to relaxation or failure of the sutures
4. Unnatural appearance of auricle
5. Infection (chondritis)

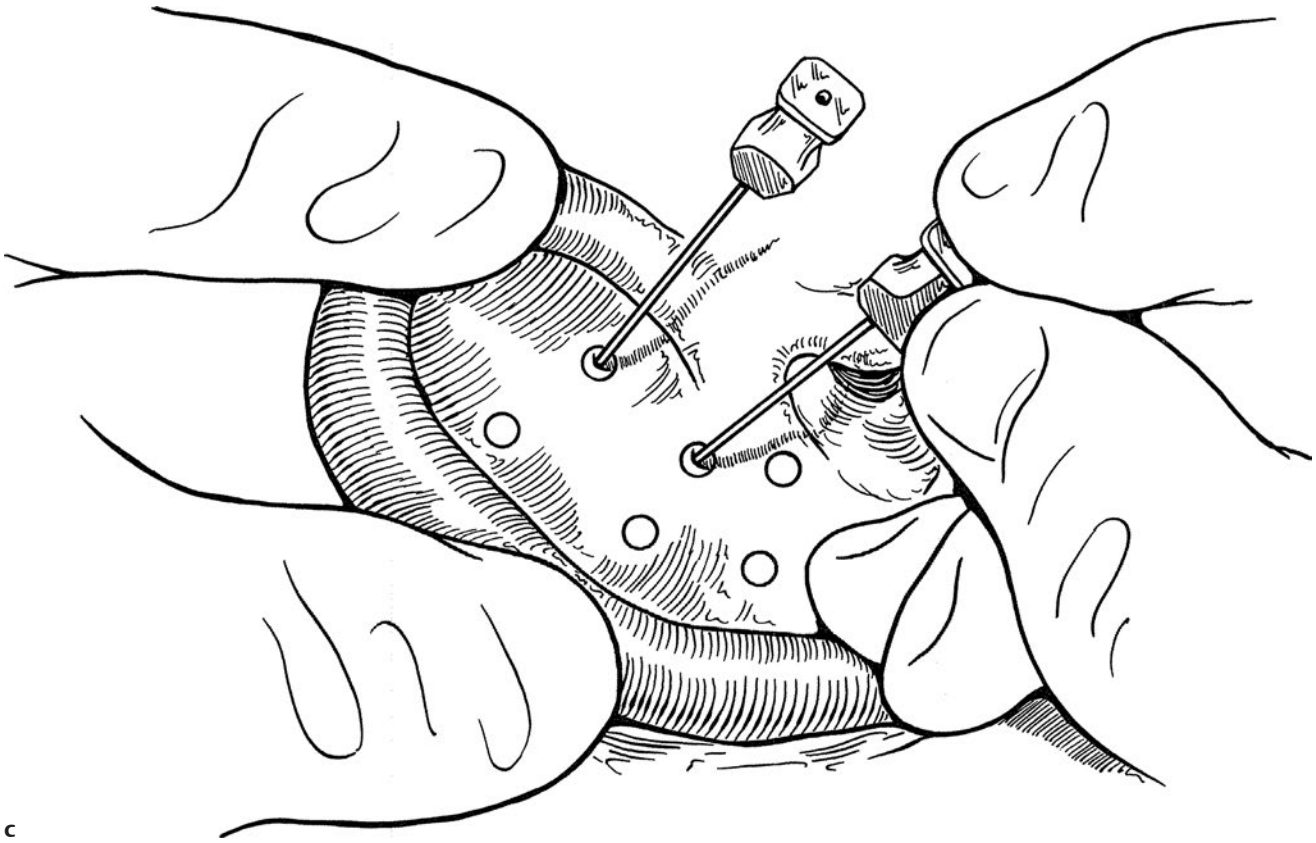


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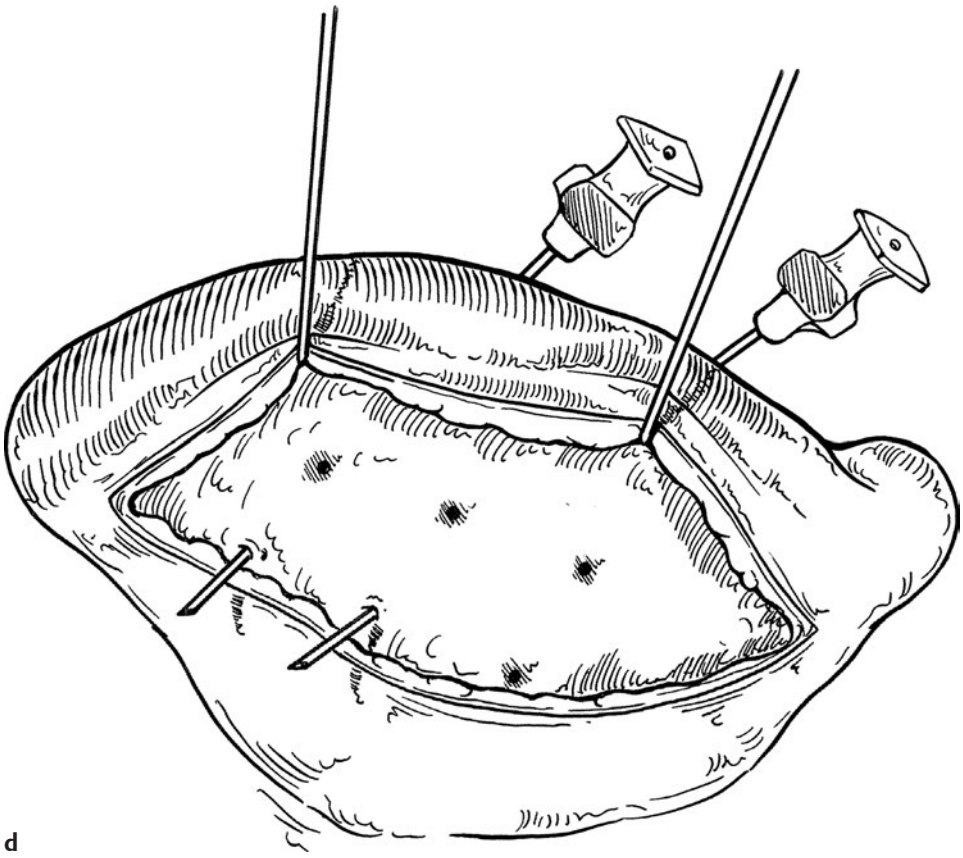


b

Fig. 4.3a,b



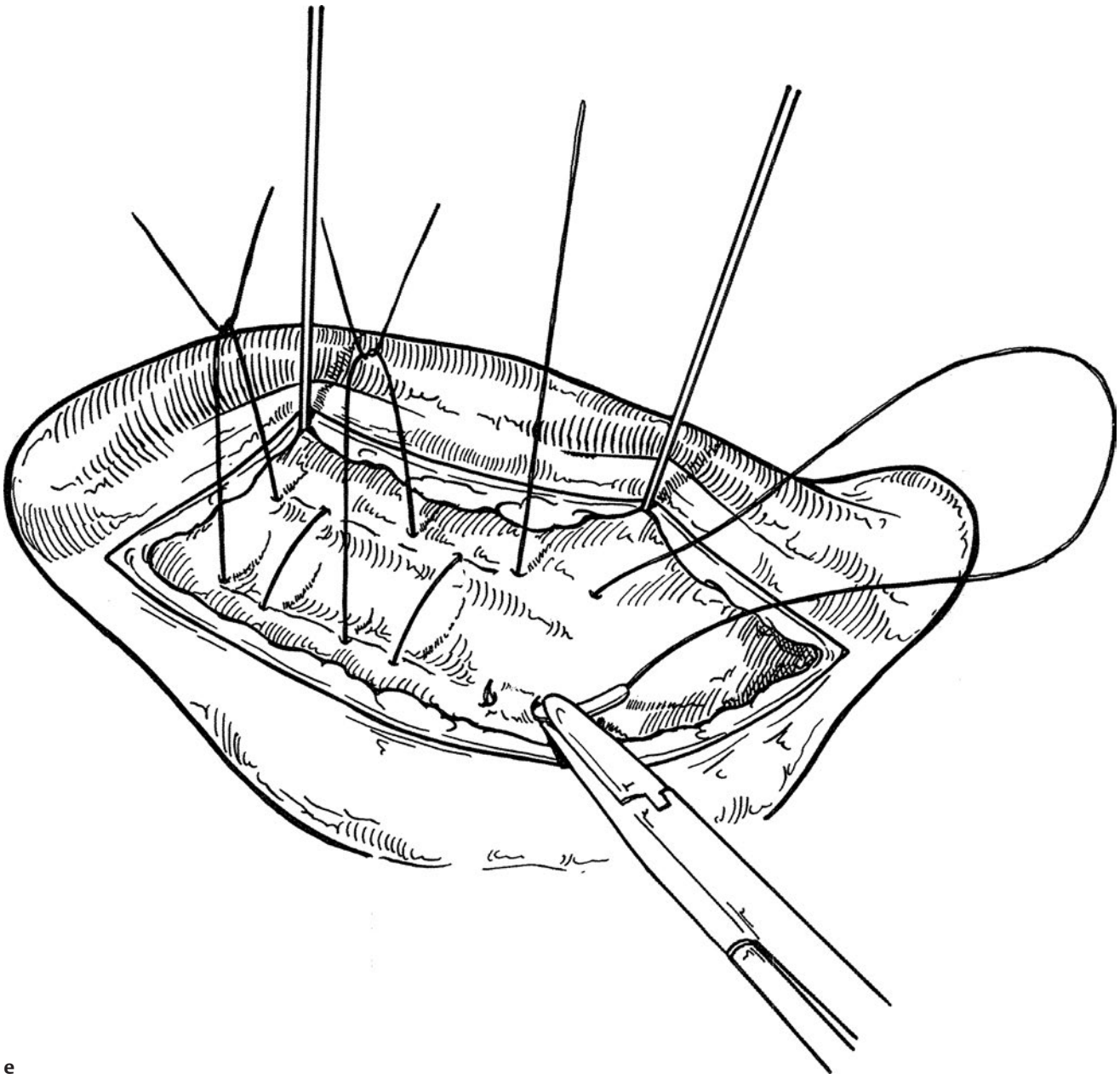
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d

Fig. 4.3c,d

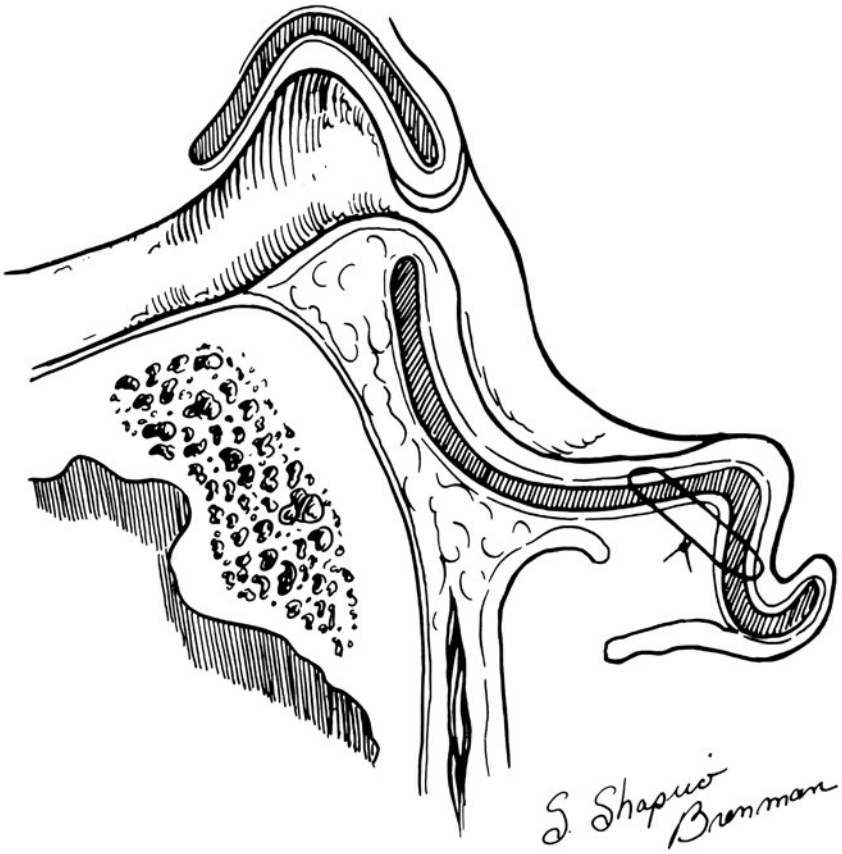
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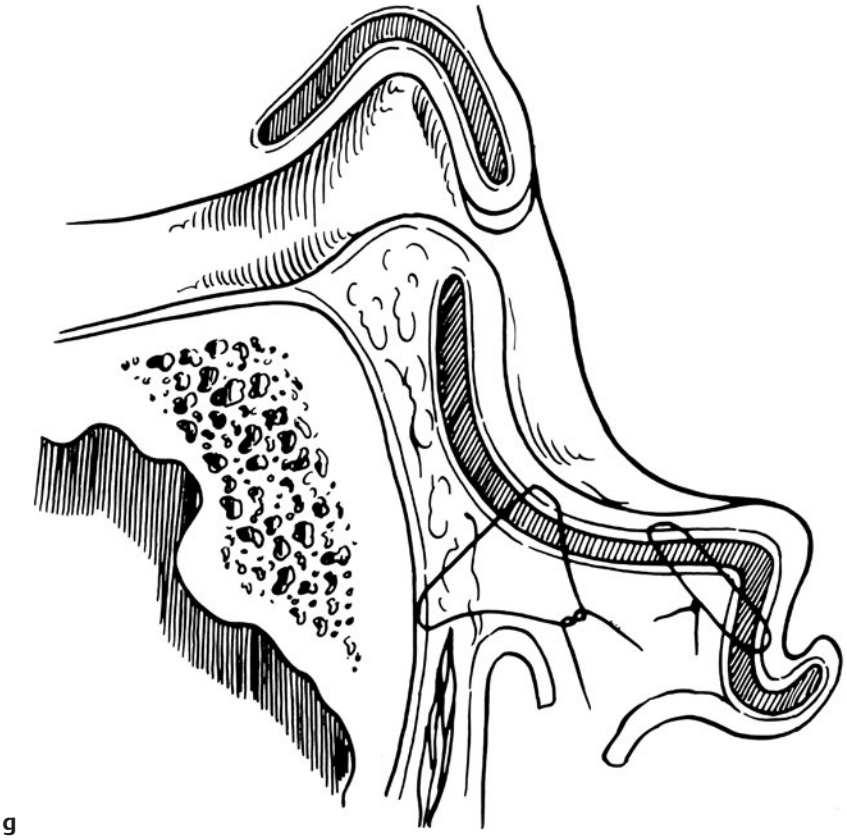
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Fig. 4.3e

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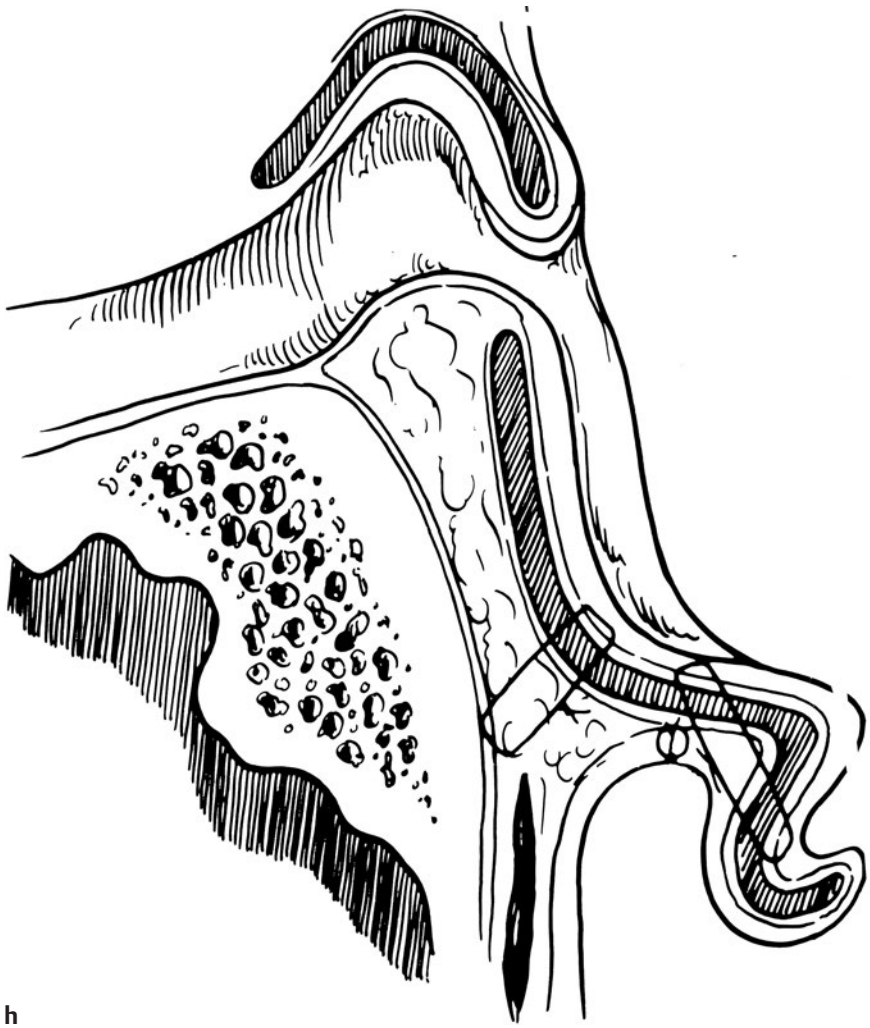
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Fig. 4.3f,g

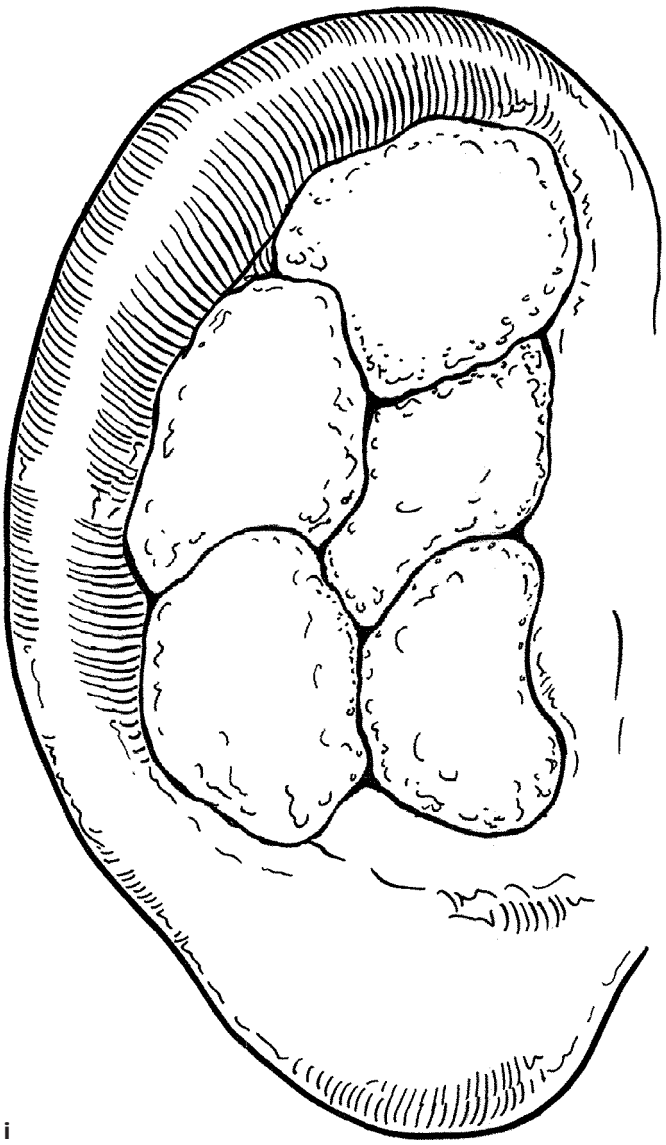
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h

Fig. 4.3h

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i

Fig. 4.3i

4-4 Middle Ear Exploration—Exploratory Tympanotomy

Introduction

Middle ear exploration is performed to examine the contents and condition of the middle ear. Middle ear exploration should permit adequate visualization of the ossicular chain to assess mobility, as well as inspection of the region of the oval and round windows. If there is suspected pathology in the epitympanum, the bone of the posterosuperior ear canal wall can be removed (atticotomy) to explore the area of the ossicular heads.

Indications

Middle ear exploration is indicated to determine the causes of and to correct a conductive hearing deficit, to biopsy or remove middle ear masses such as congenital cholesteatoma, to rule out persistent or recurrent disease following prior cholesteatoma excision, or to identify and repair a perilymph fistula.

Preoperative Evaluation

The preoperative evaluation of conditions affecting the middle ear includes pneumatic otoscopy, complete audiometry, and usually computed tomography (CT). Magnetic resonance imaging (MRI) is rarely helpful in the evaluation of the middle ear.

Binocular microscopy provides better assessment of the tympanic membrane and middle ear than simple otoscopy and is used when possible. Pneumatic insufflation while under microscopy can be helpful. Careful inspection for movement of the malleus handle during insufflation may reveal malleus fixation, which can help guide surgical planning.

Operative Technique

Middle ear exploration in children is performed under general anesthesia. Adequate exposure may be possible in older children using a transcanal approach, but most often a postauricular approach as described for tympanoplasty (see Section 3-2) provides better exposure (especially anteriorly).

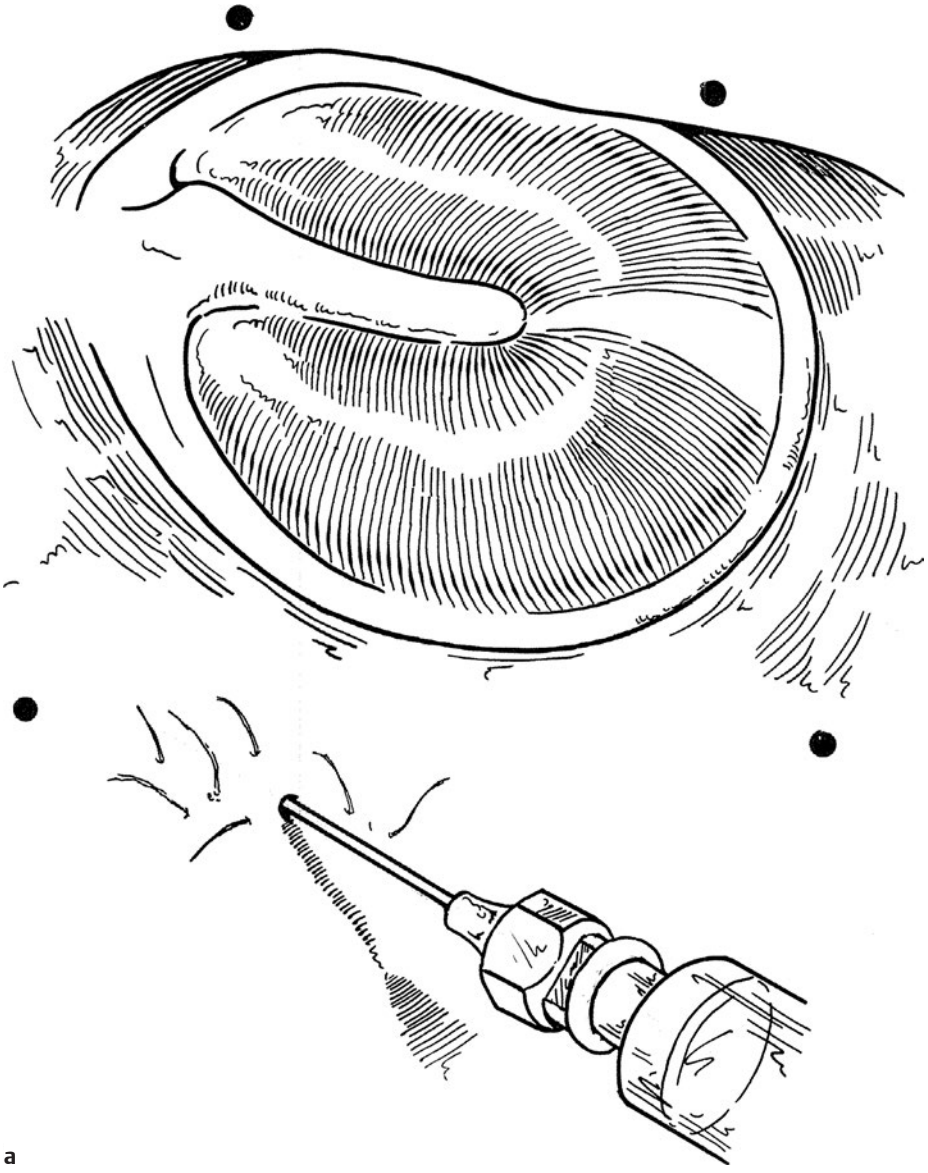
1. If the transcanal approach is selected, local anesthetic (1% lidocaine with 1:100,000 epinephrine) is injected into the skin of the ear canal (refer to *dots*, **Fig. 4.4a**) and in the posterior cartilaginous ear canal just lateral to the bony–cartilaginous junction (**Fig. 4.4a**).
2. If a postauricular incision is used, the approach is identical to that used to enter the middle ear for tympanoplasty (see Section 3-2).
3. An incision is made from a spot above the short process of the malleus to the posteroinferior portion of the ear canal, at a distance approximately 5 to 7 mm from the annulus (**Fig. 4.4b**). The superior or inferior limb of the incision can be extended to provide access to the anterosuperior or inferior quadrants, respectively. If the heads of the ossicles need to be explored via atticotomy, the incision should be carried farther anteriorly, and the flap made longer at superior pole (at least 10 mm) to allow later coverage of the atticotomy defect.
4. The ear canal skin flap is elevated until the fibrous annulus of the tympanic membrane is identified (**Fig. 4.4c**).
5. The annulus is elevated with a knife or sulcus elevator along the full extent of the incision, and the middle ear is entered (**Fig. 4.4d**).
6. The tympanomeatal flap can then be folded anteriorly to expose the contents of the middle ear (**Fig. 4.4e**).
7. Bone of the posterosuperior canal wall may be removed with a curette or drill for full exposure of the stapes footplate, if necessary. Care is taken to avoid trauma to the chorda tympani nerve (**Fig. 4.4e**).
8. If anterosuperior exposure is desired for excision of a congenital cholesteatoma, an incision is made in the periosteum along the full length of the posterior surface of the malleus with a micro-Tabb knife by scraping against the bone (**Fig. 4.4f**).
9. The mucoperiosteum is then released from the malleus by dissection with a micro-Tabb knife until the anterosuperior quadrant is visualized (**Fig. 4.4g**).
10. If needed, the tympanic membrane can be released from its attachment to the malleus at the umbo by cutting the fibrous bands with a sharp blade or microscissors. However, if possible, the flap should be left attached here to help prevent lateralization of the tympanic membrane postoperatively.
11. If pathology around the ossicular heads is suspected, an atticotomy is performed. This is done with an otologic drill and a 1.5- to 2-mm diamond bur at slow speed (**Fig. 4.4h**). Care is taken to avoid direct drilling onto the ossicular heads, especially upon removal of the innermost bone layer. A safe approach is to thin this bone with the drill until almost transparent and then remove the remainder with a curette.
12. Inspection of the round window region can help in assessment of ossicular chain mobility. Normally a brisk movement (round window reflex) is seen upon gentle ossicular palpation. If the round window cannot be directly visualized, a drop of saline can be placed in the round window niche, and movement of its meniscus/light reflection can be elicited.

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13. If an atticotomy was performed, this ear canal defect should be reconstructed with a cartilage graft, laid across the defect and supported by its bony edges, prior to replacement of the skin flap and TM (**Fig. 4.4i**).
14. When the middle ear surgery is complete, the tympanomeatal flap is replaced, and a single large piece of Gelfoam (Pfizer) is placed across the incision line (**Fig. 4.4j**).

Complications

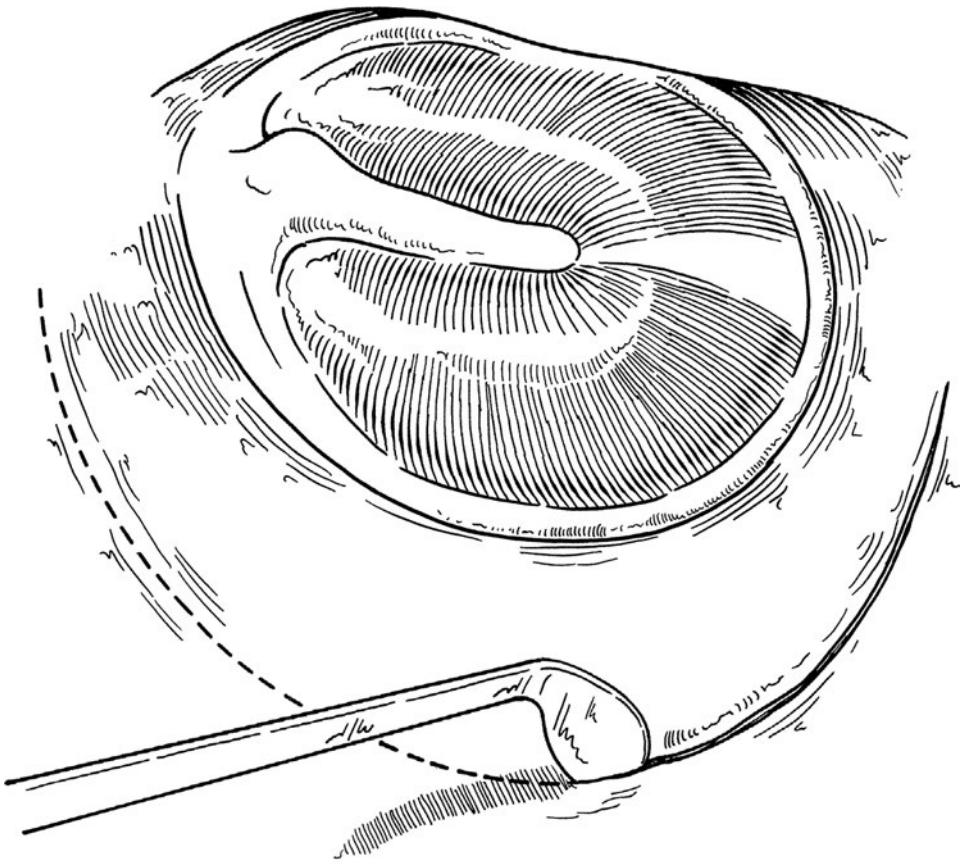
1. Failure to improve conductive hearing loss
2. Sensorineural hearing loss due to ossicular trauma
3. Ossicular disruption
4. Chorda tympani trauma
5. Perforation of the tympanic membrane



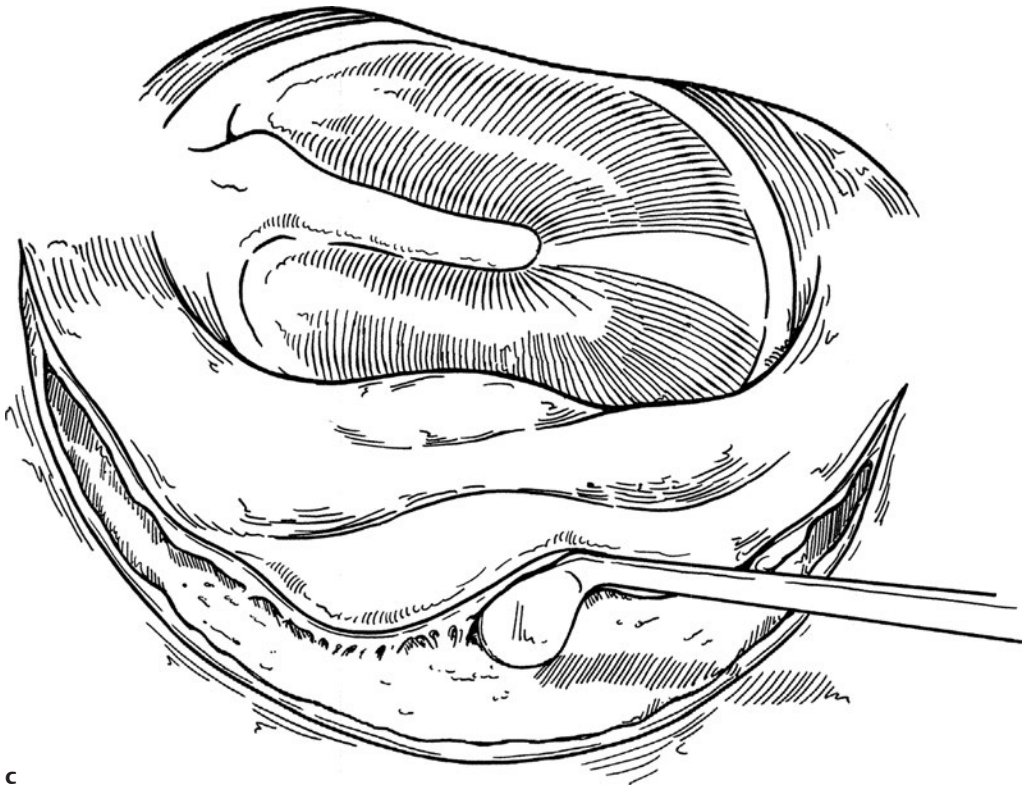
a

Fig. 4.4a

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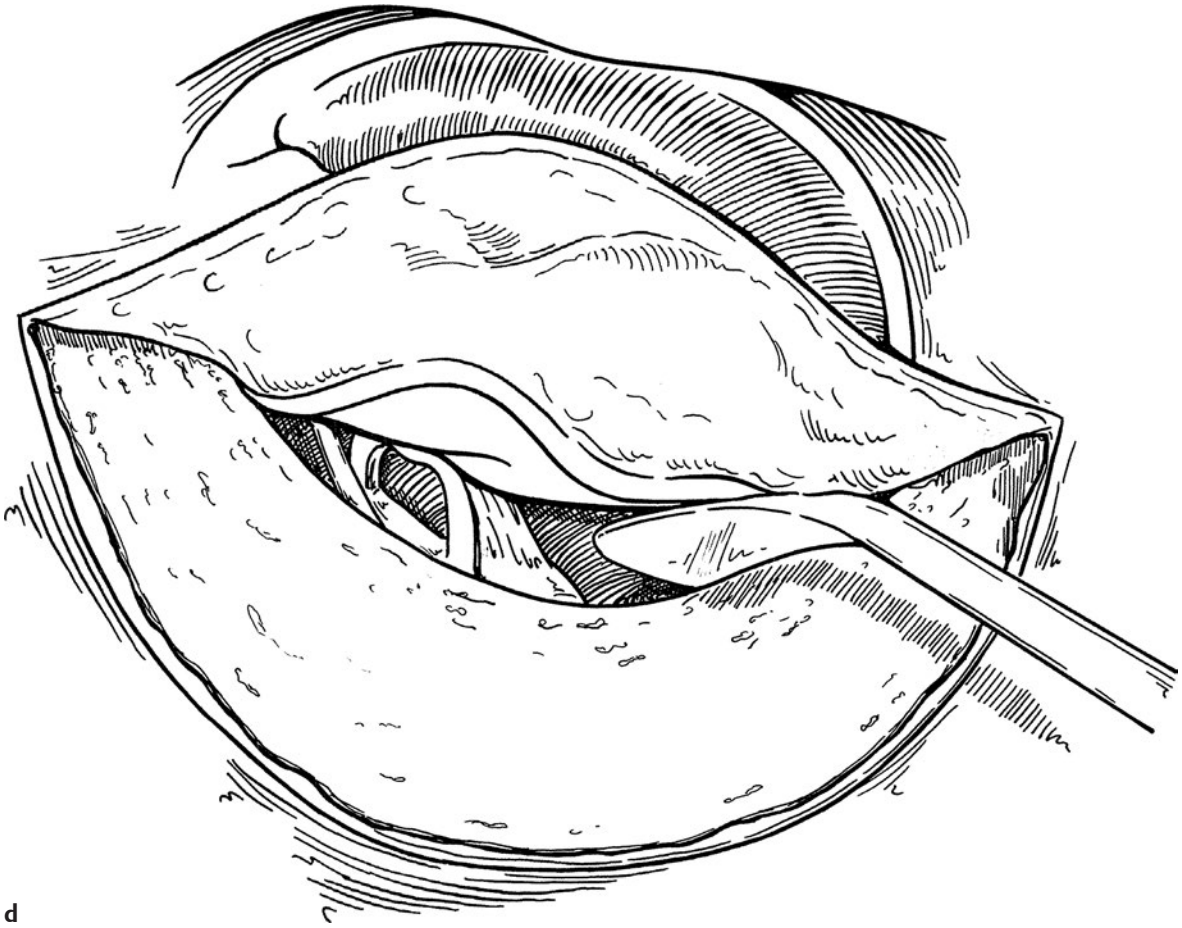


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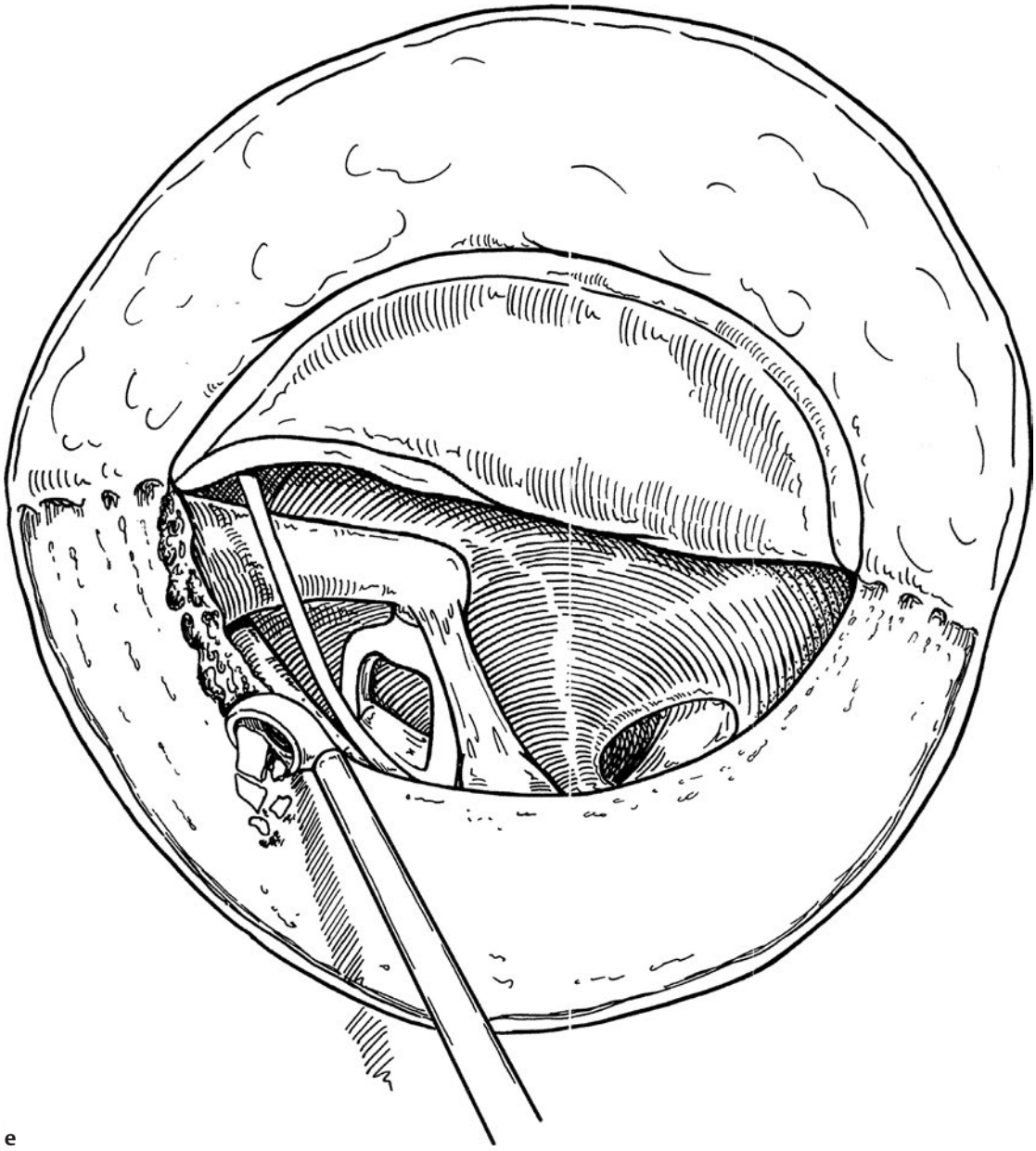
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Fig. 4.4b,c



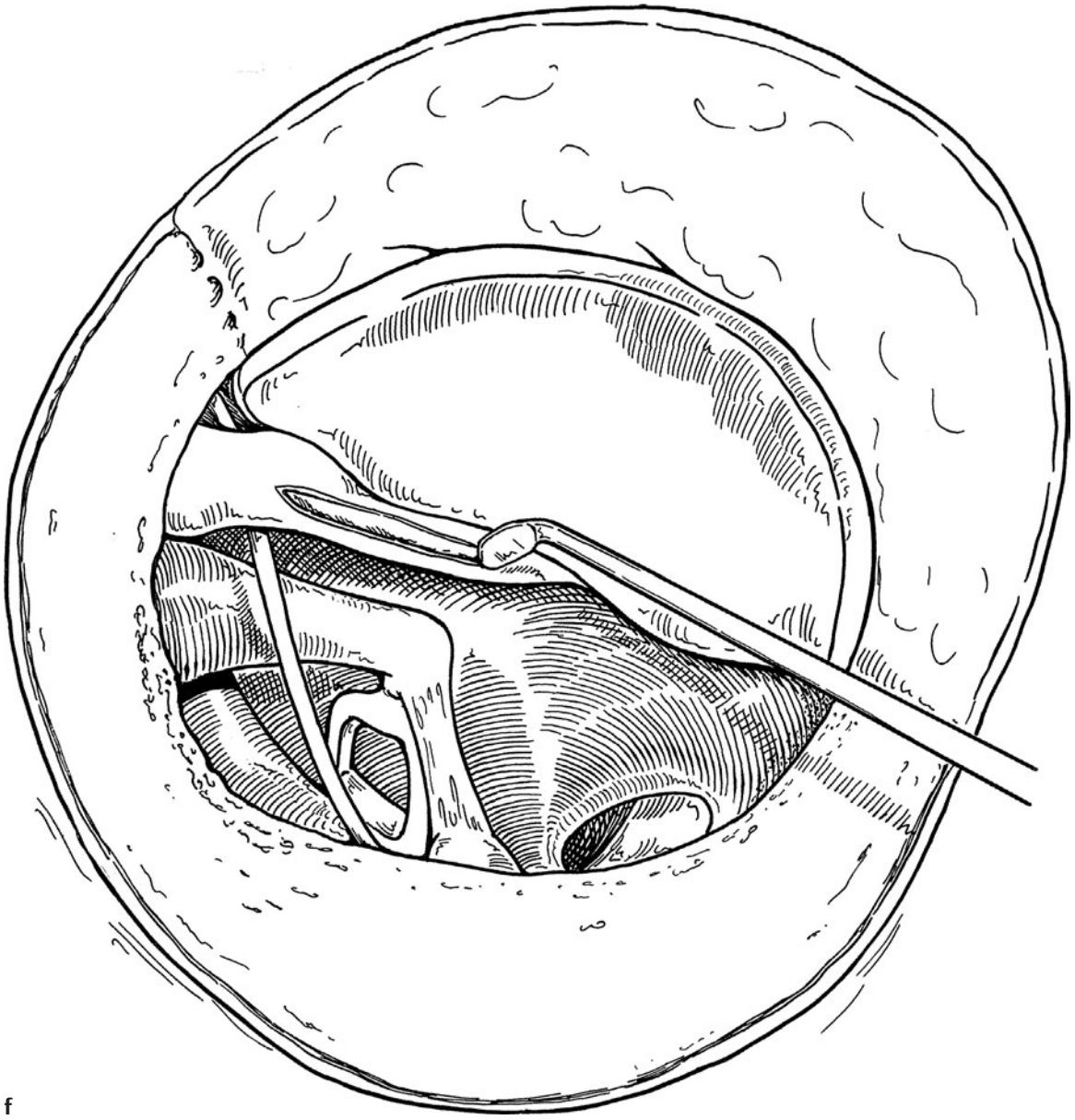
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Fig. 4.4d



e

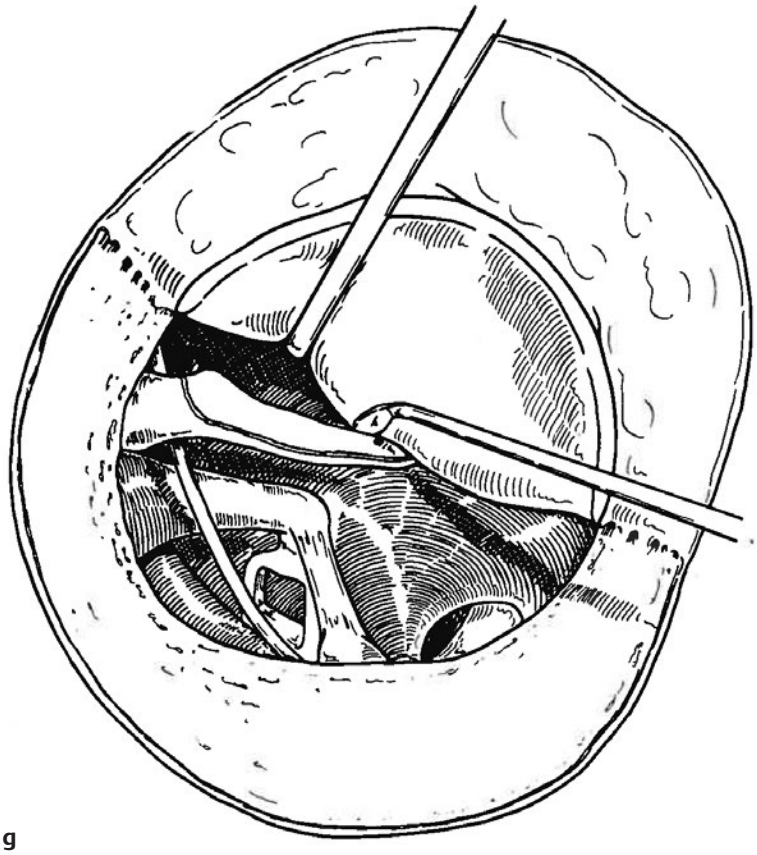
Fig. 4.4e



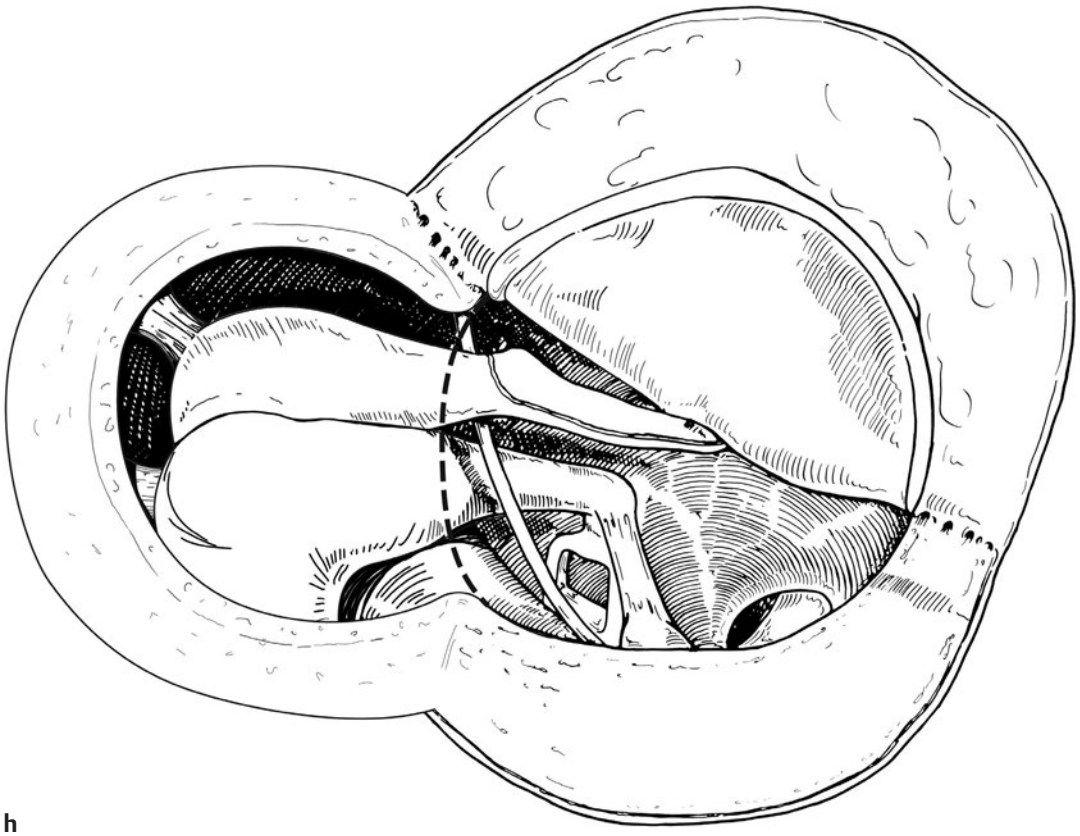
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Fig. 4.4f

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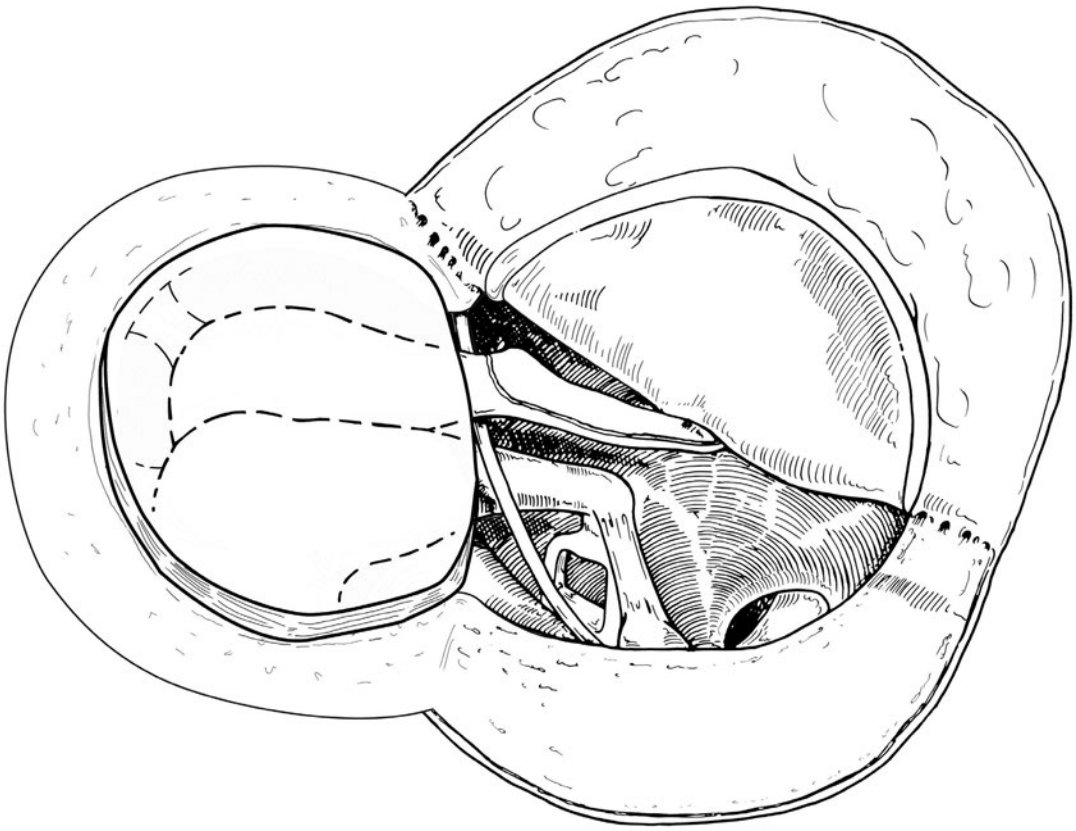
g



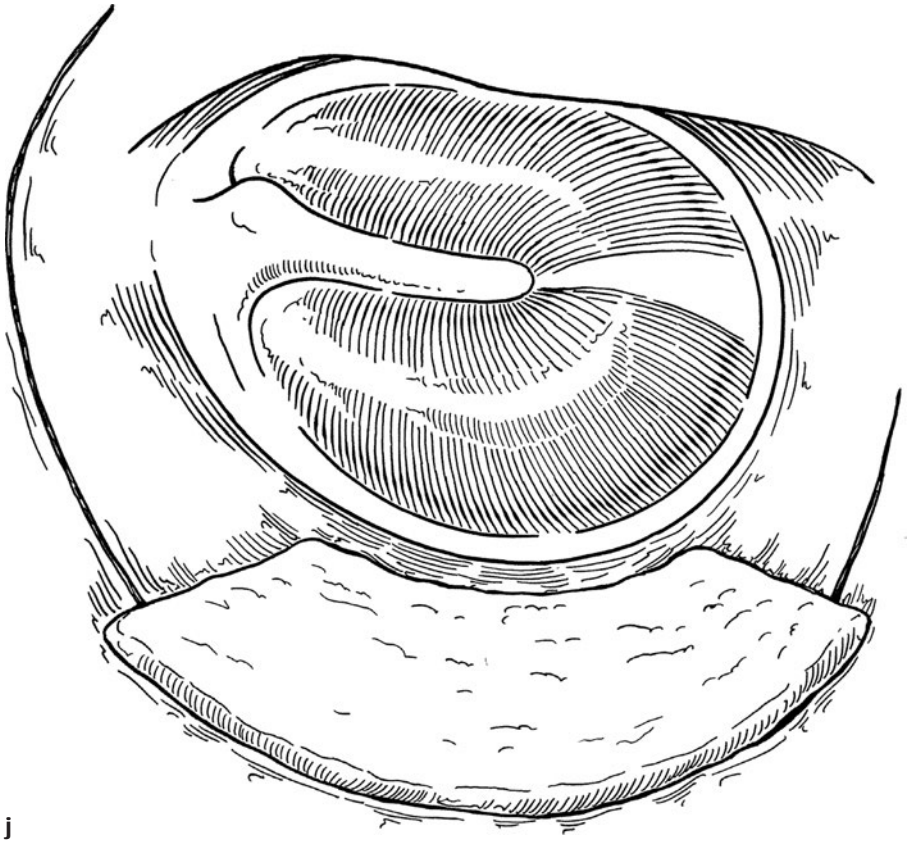
h

Fig. 4.4g,h

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i



j

Fig. 4.4i,j

4-5 Stapes Surgery

Introduction

Abnormalities of the stapes are uncommon in children.

Indications

Stapes surgery is indicated to correct a moderate-to-severe conductive hearing loss secondary to stapes fixation. Stapes fixation in children may be congenital or a result of tympanosclerosis or otosclerosis. True otosclerosis is very rare in children, but may occur in teenagers, especially when there is a family history of the disease.

Preoperative Evaluation

The preoperative evaluation includes otoscopic examination, complete audiometry, and high-resolution CT. CT demonstrates the detail of the stapes and surrounding structures in congenital middle ear malformations and can rule out other causes for the hearing loss. In particular, it can demonstrate the presence of anomalies not amenable to surgical reconstruction, including an absent oval window, mass lesions, persistent stapedial artery, an anomalous facial nerve obscuring the oval window, or an aberrant internal carotid artery.

Operative Technique: Stapes Mobilization, Stapedotomy

1. General anesthesia is used for this procedure. Local infiltration is performed, with 1% lidocaine with 1:100,000 epinephrine injected in the postauricular crease and external meatus, to decrease bleeding as described for tympanoplasty (see Section 3-2).
2. A standard postauricular exposure, as used for tympanoplasty (see Section 3-2), provides maximum exposure. Older children with a large external meatus may permit a transcanal approach as described for middle ear exploration (see Section 4-4) (**Fig. 4.5a**).
3. After the middle ear is exposed, bone is removed from the canal wall posterosuperiorly with a drill or curette to expose the stapes and surrounding area (**Fig. 4.5b**). The entire stapes footplate should be visible. Care should be taken to preserve the chorda tympani nerve, if possible (**Fig. 4.5c**).
4. If the stapes is fixed, an attempt is made to mobilize it. A small pick is placed on the head of the stapes, and the ossicle is gently rocked and pushed medially. If the stapes footplate becomes mobile, the procedure is terminated.
5. If the stapes cannot be mobilized, the distance from the long process of the incus to the footplate is measured with a measuring instrument (**Fig. 4.5d**).
6. The incudostapedial joint is divided with a micro-Tabb knife (**Fig. 4.5e**), and the stapedius tendon is cut with scissors (**Fig. 4.5f**).
7. The superstructure of the stapes is removed after fracturing the crura with a knife or by bending the superstructure against the promontory until the crura fracture (**Fig. 4.5g,h**).
8. A hole is made in the footplate with a sharp pick, microdrill, or laser and enlarged with a small oval window rasp, if necessary. The hole should be just large enough to accommodate the piston of the stapes prosthesis (**Fig. 4.5i**).
9. The stapes prosthesis is chosen, with a length that will permit minimal intrusion (0.5 mm) into the vestibule once in position. The prosthesis piston end is placed in the stapedotomy, and its hook is looped or clipped over the long process of the incus (**Fig. 4.5j**).

10. Depending on prosthesis design, the hook or loop may need to be secured by crimping it around the incus (**Fig. 4.5k**). Newer memory materials, such as nitinol, are secured by briefly heating the loop with a laser.
11. Small pieces of fascia are placed around the prosthesis to help seal the oval window (**Fig. 4.5l**).

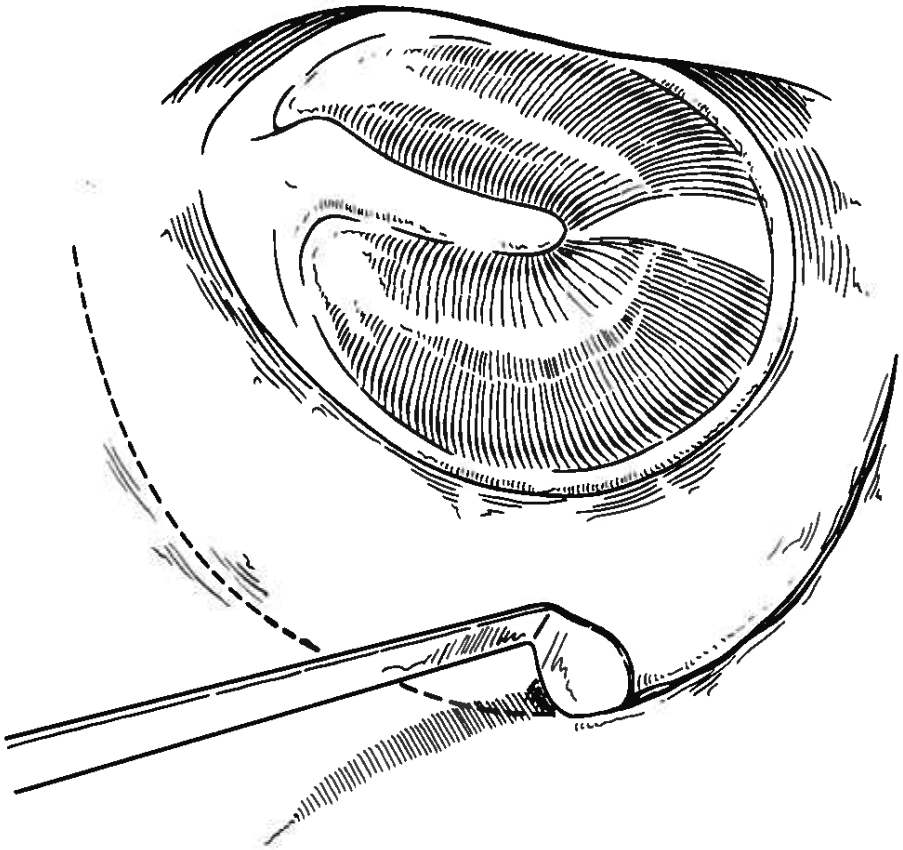
When the stapes is deformed and must be removed, or if a large piece of the footplate comes out of the oval window niche during removal of the stapes superstructure (**Fig. 4.5m**), a formal stapedectomy (see below) is performed, and a connective tissue closure of the oval window is used.

Operative Technique—Stapedectomy

1. A small perichondrial graft is taken from the tip of the tragus. The conchal cartilage perichondrium can also be used. If desired, it may be flattened with a fascia press.
2. The entire or remaining portions of the footplate are removed with a small hook (**Fig. 4.5n**).
3. The boat-shaped perichondrial tissue fits well into the oval window (**Fig. 4.5o**).
4. The prosthesis length is selected, as in step 9 above, and is then placed on the graft and positioned in the center of the oval window (**Fig. 4.5p**).
5. The prosthesis is secured to the incus as in steps 9 and 10 above. Gelfoam is placed around the prosthesis (**Fig. 4.5q**). The tympanomeatal flap is then replaced and the canal packed with Gelfoam soaked in antibiotic drops. If a postauricular incision was used, it is closed with subcutaneous absorbable suture.

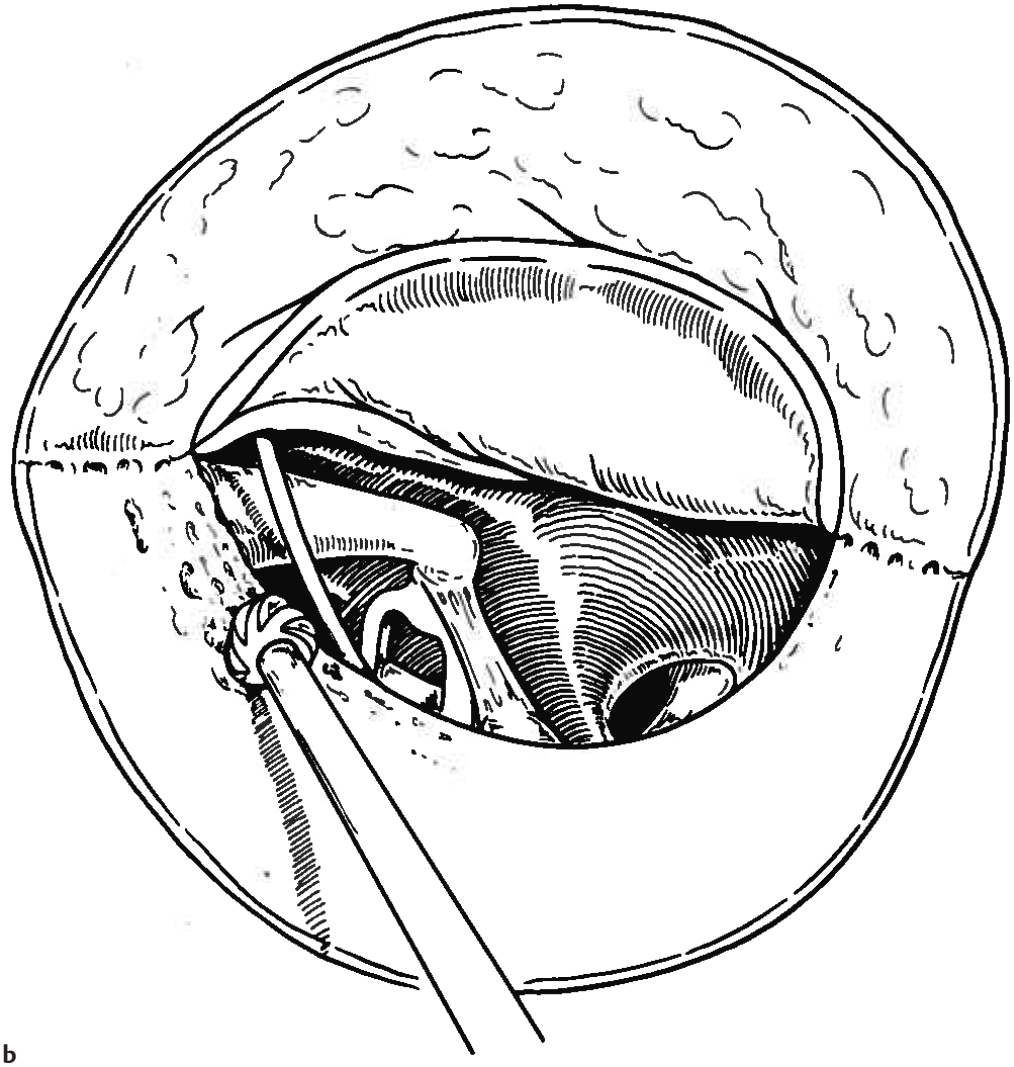
Complications

1. Prosthesis malposition with persistent conductive hearing loss
2. Erosion of incus long process or prosthesis dislocation, causing delayed conductive hearing loss
3. Unilateral sensorineural hearing loss or deafness
4. Chorda tympani injury
5. Vertigo from prosthesis intrusion or from perilymph fistula

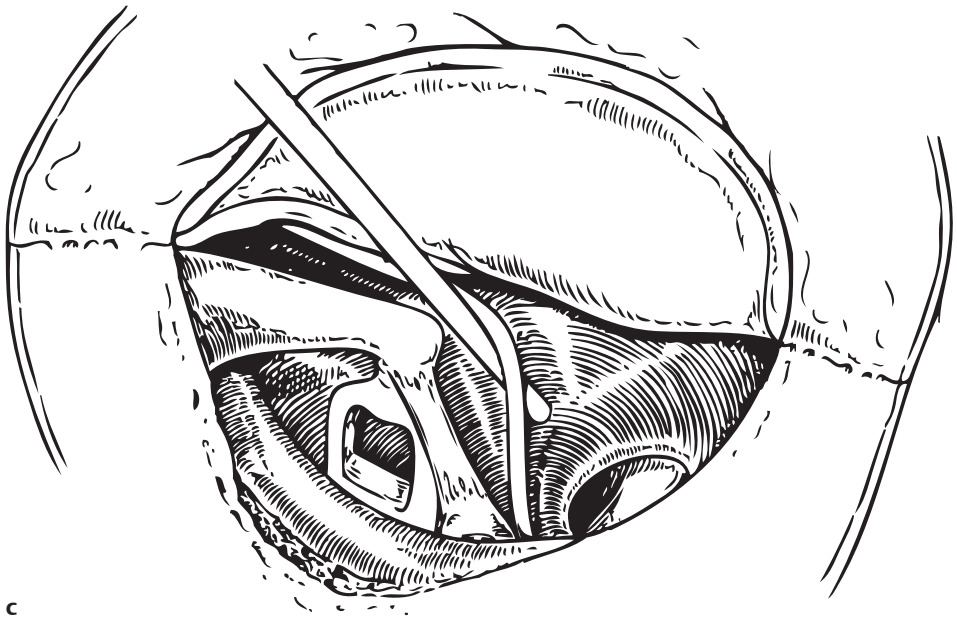


a

Fig. 4.5a

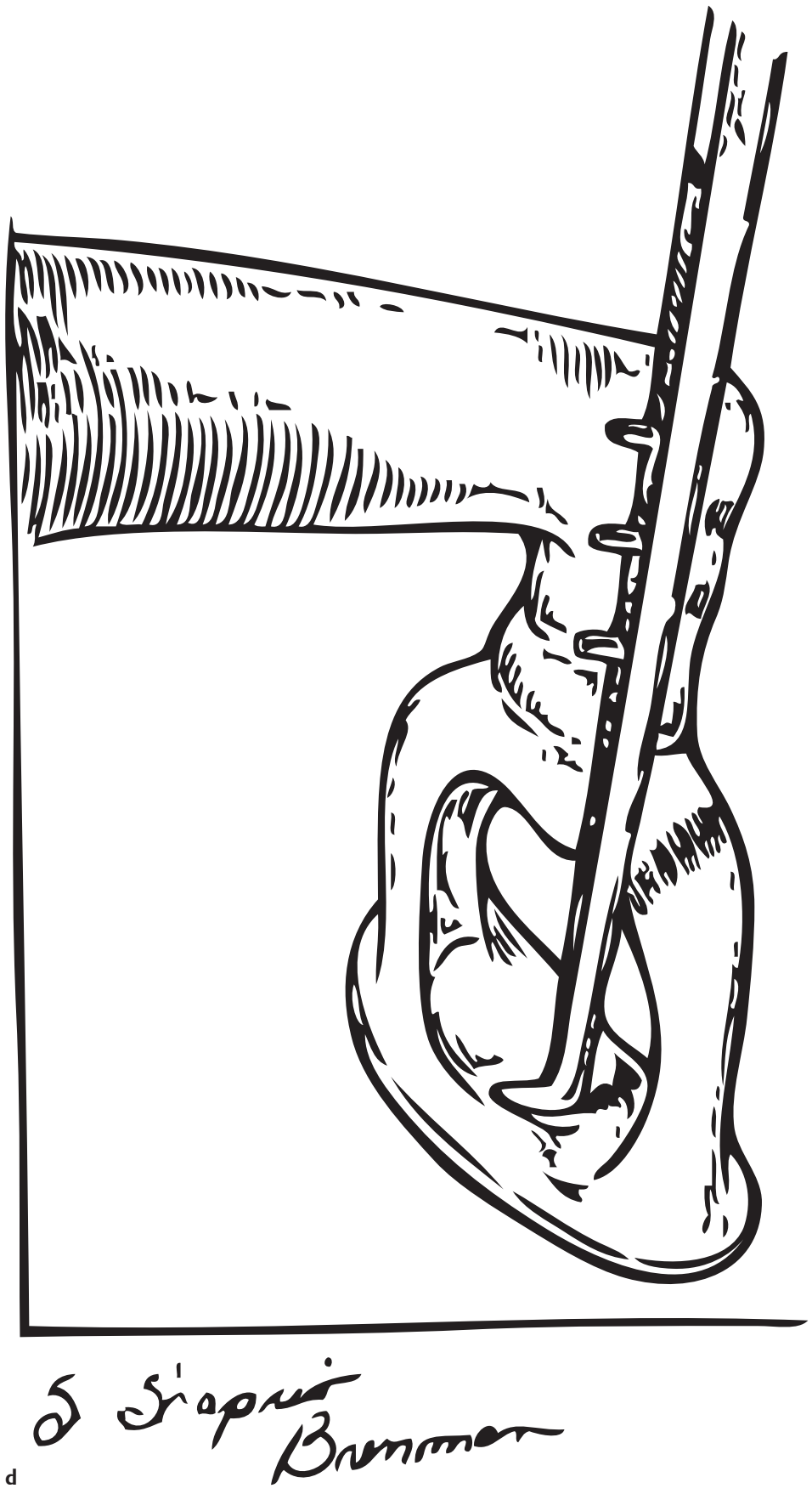


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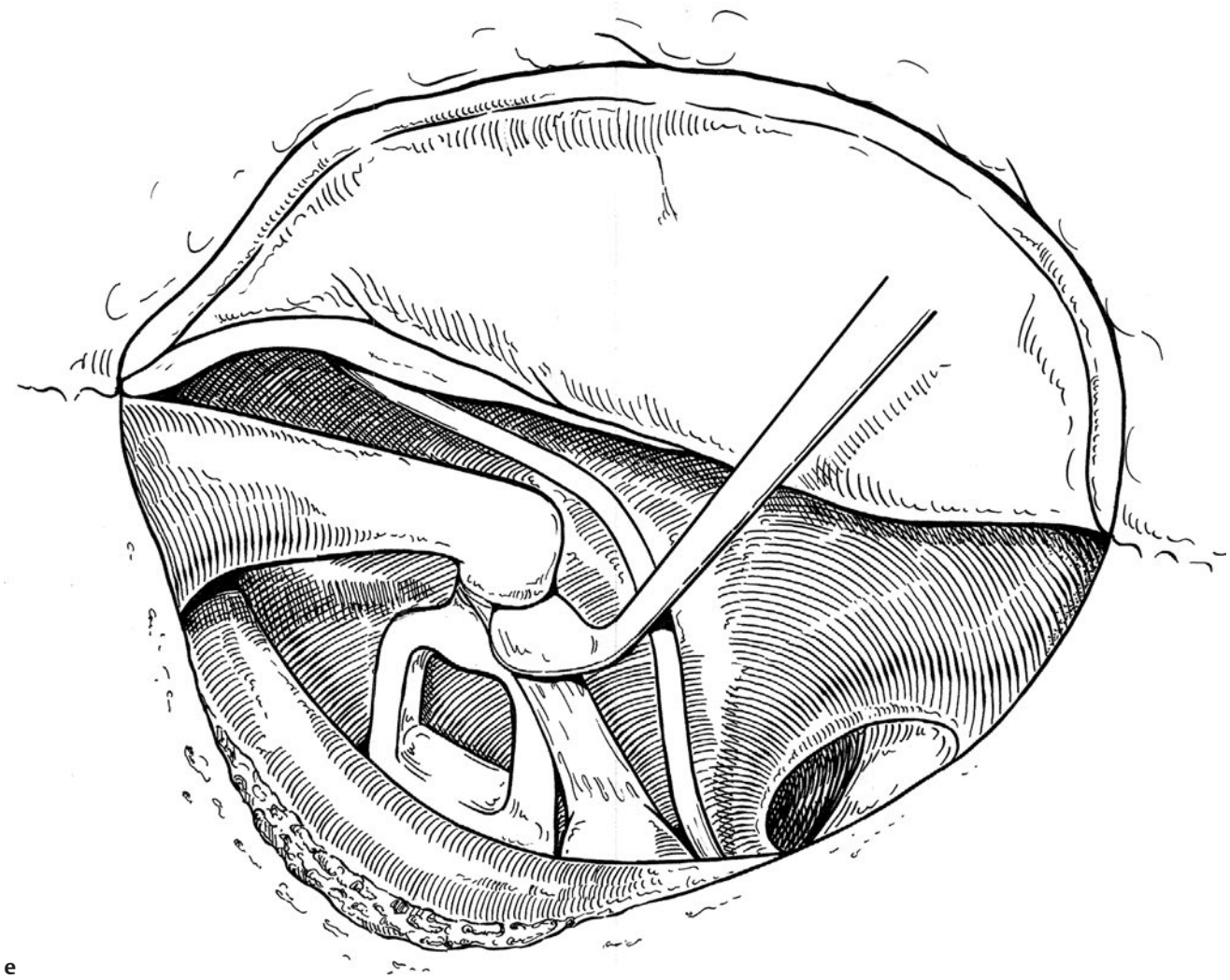
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Fig. 4.5b,c



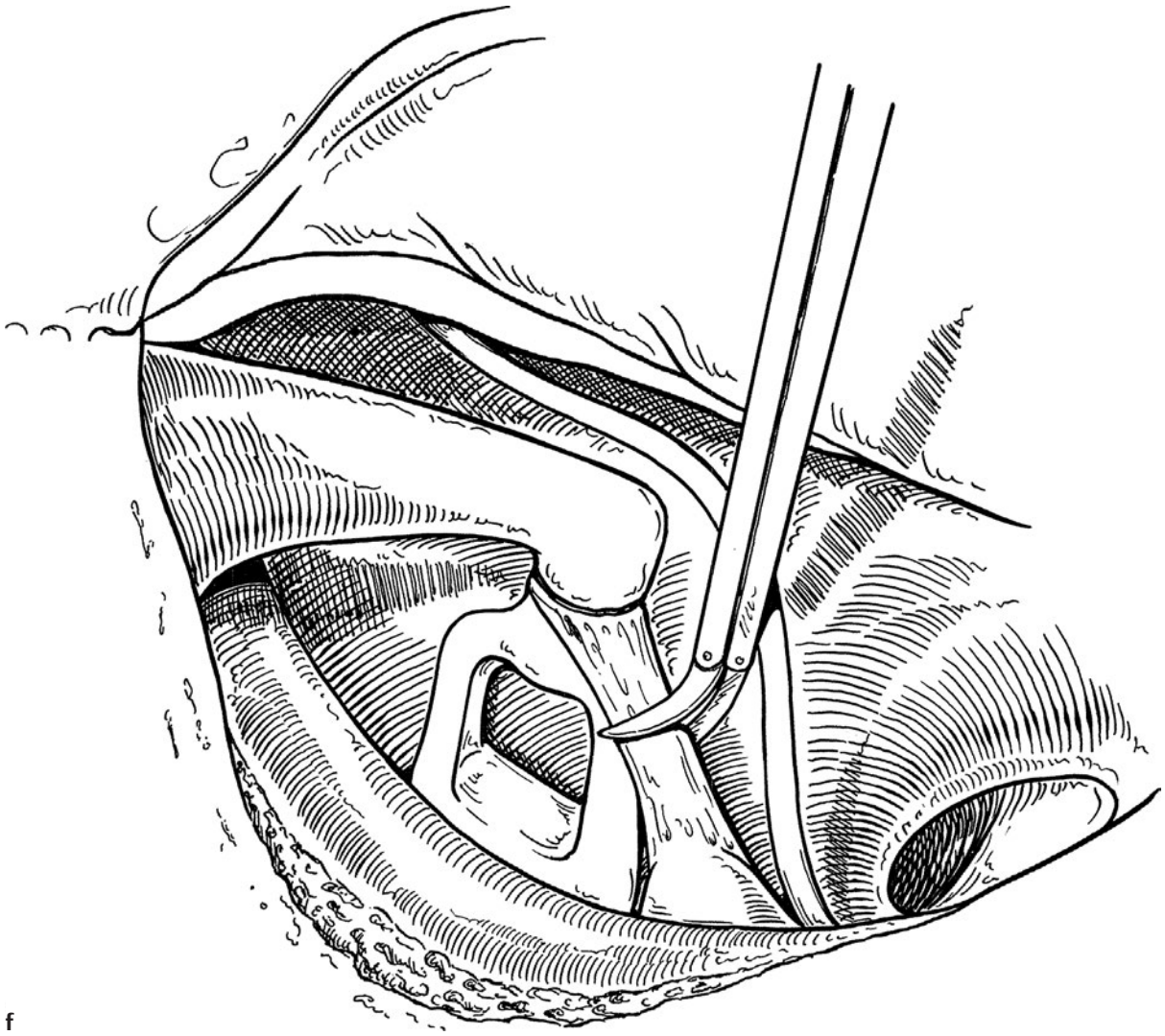
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Fig. 4.5d



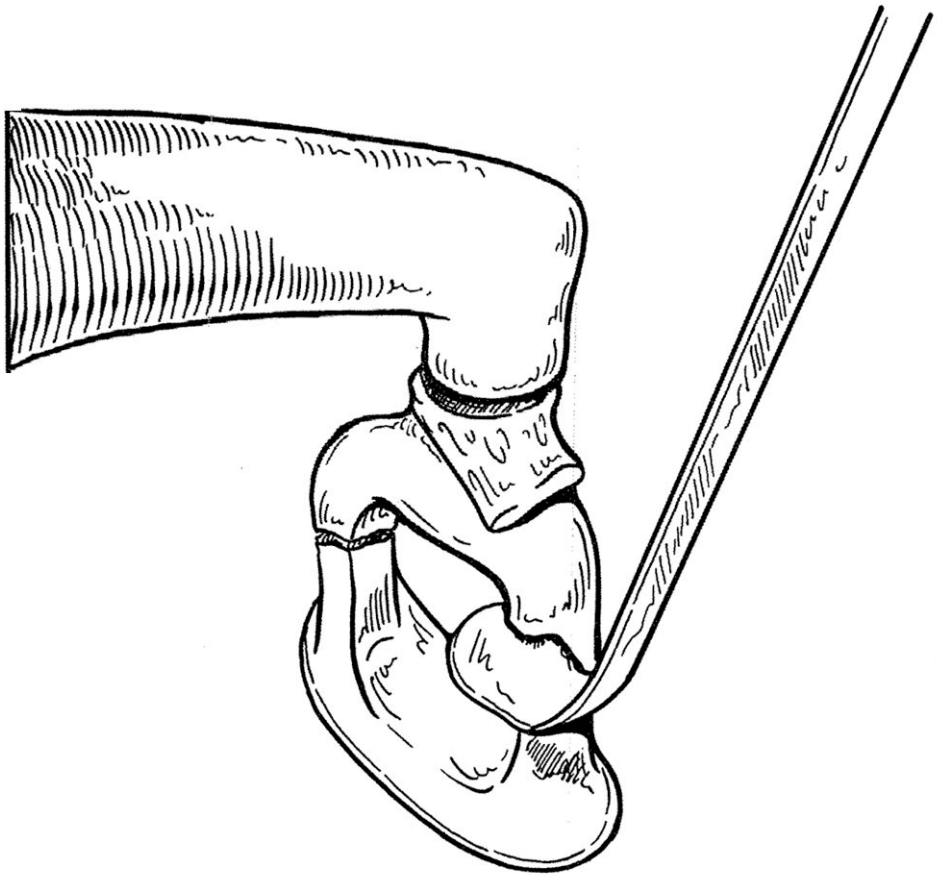
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Fig. 4.5e



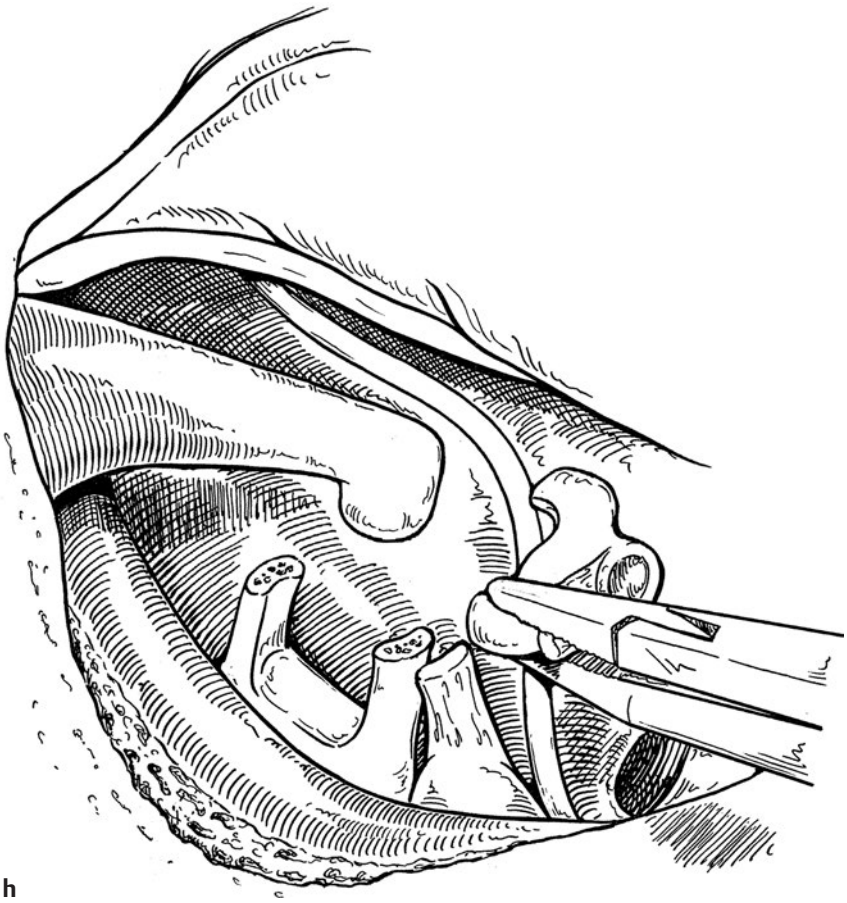
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Fig. 4.5f

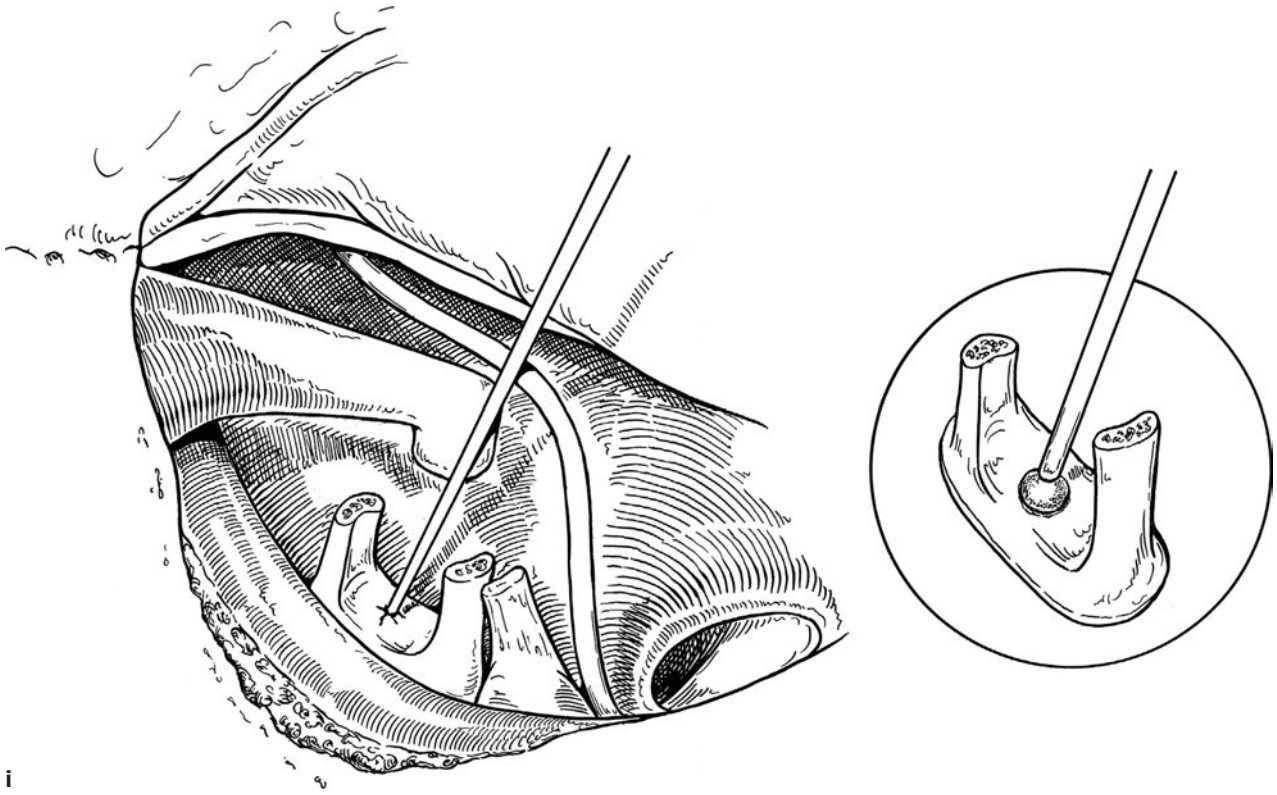


g

Fig. 4.5g

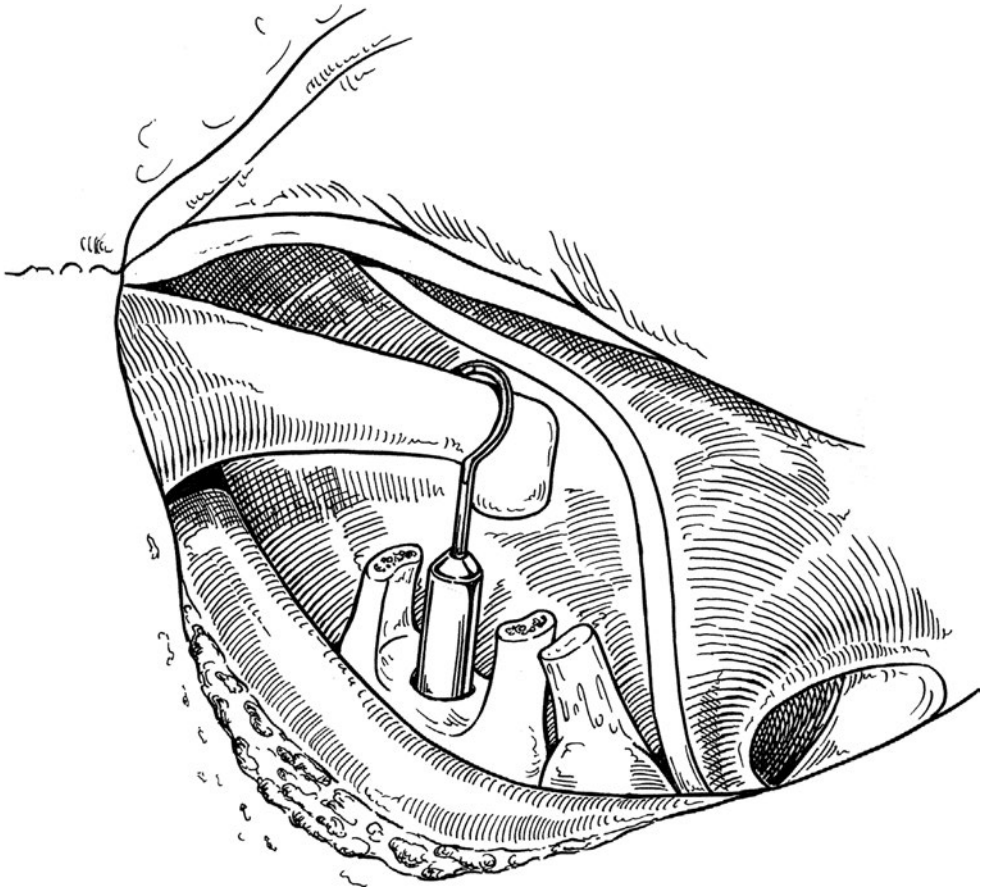


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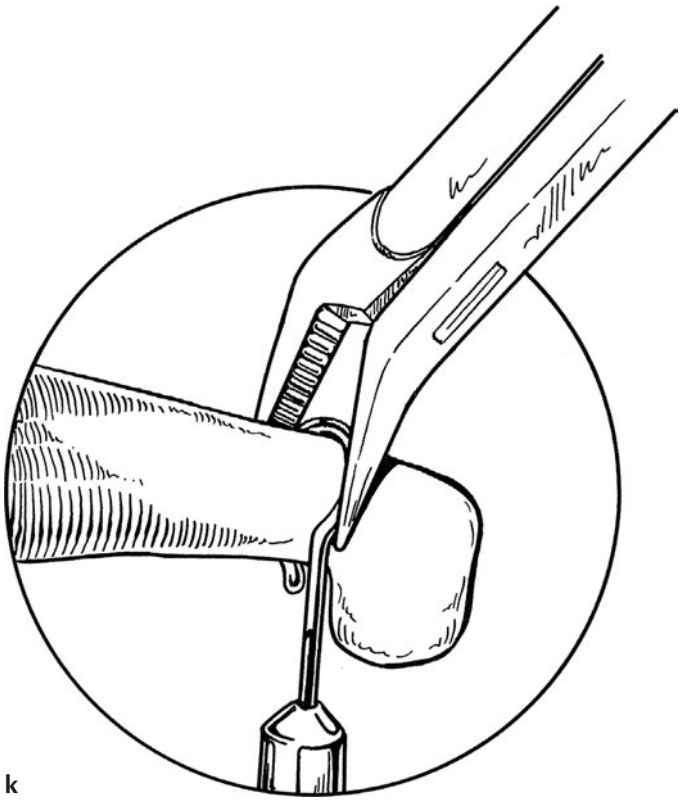


i

Fig. 4.5h,i

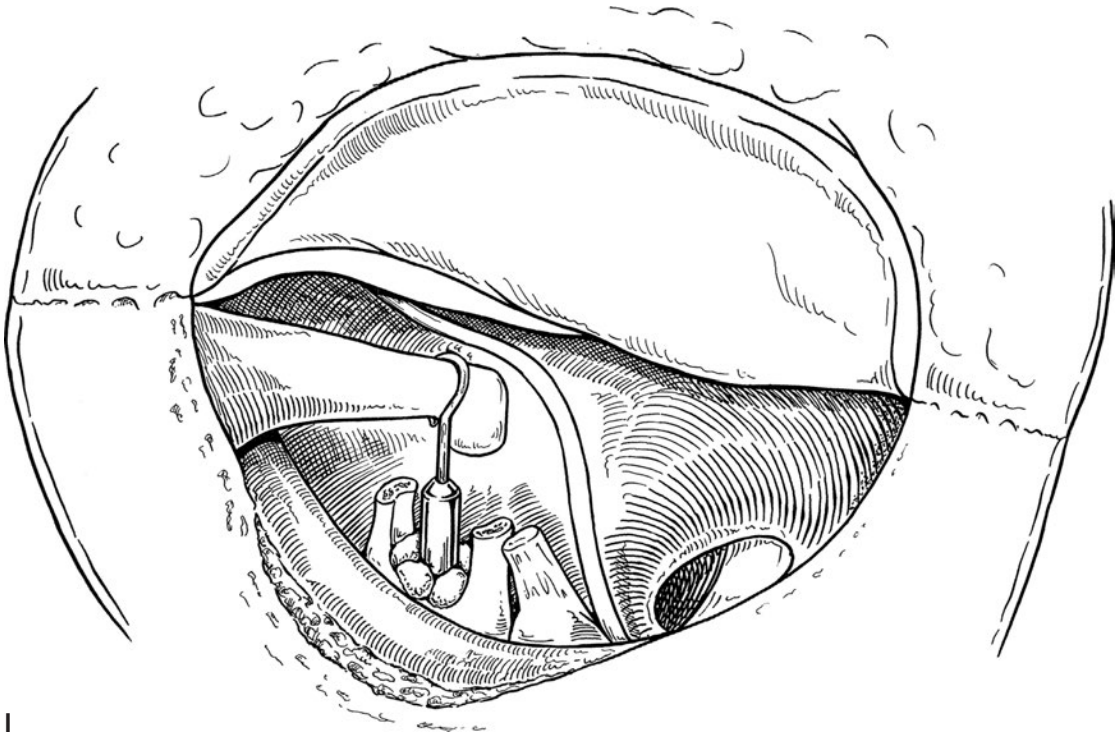


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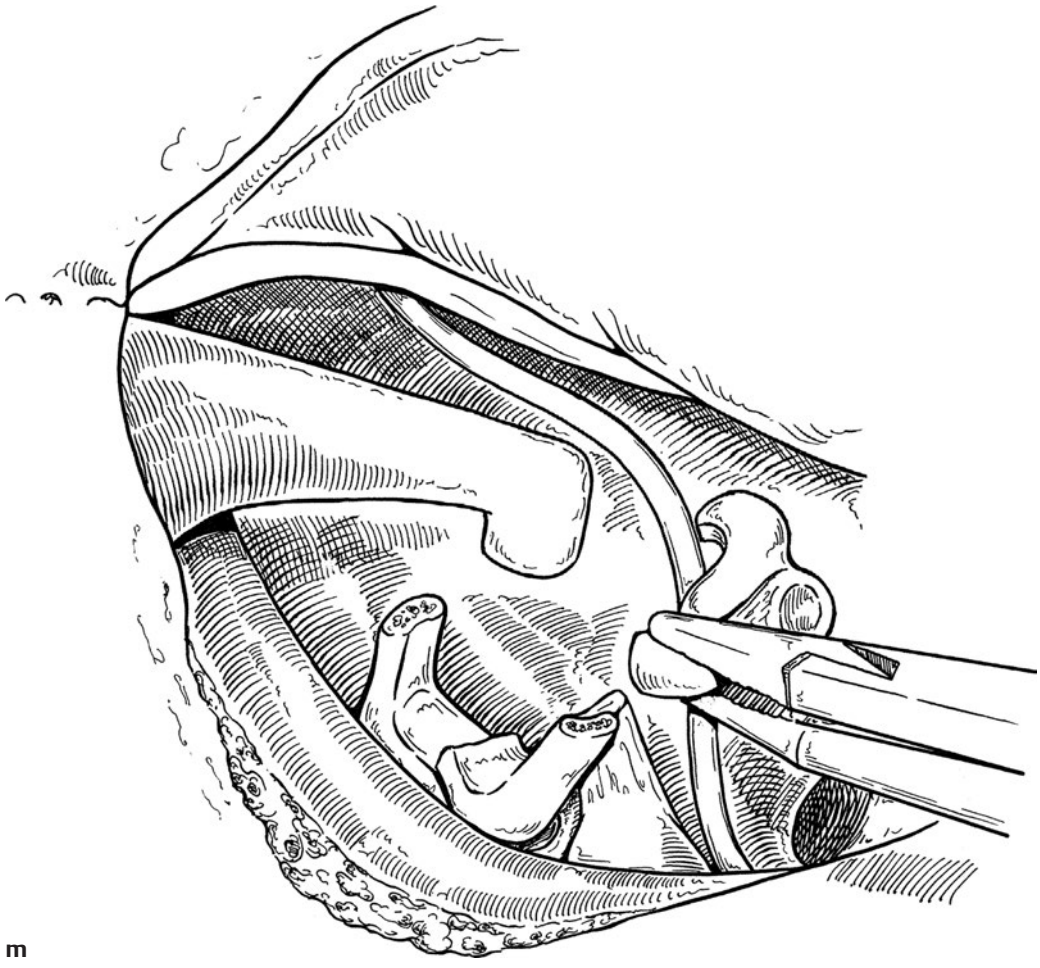


k

Fig. 4.5j,k

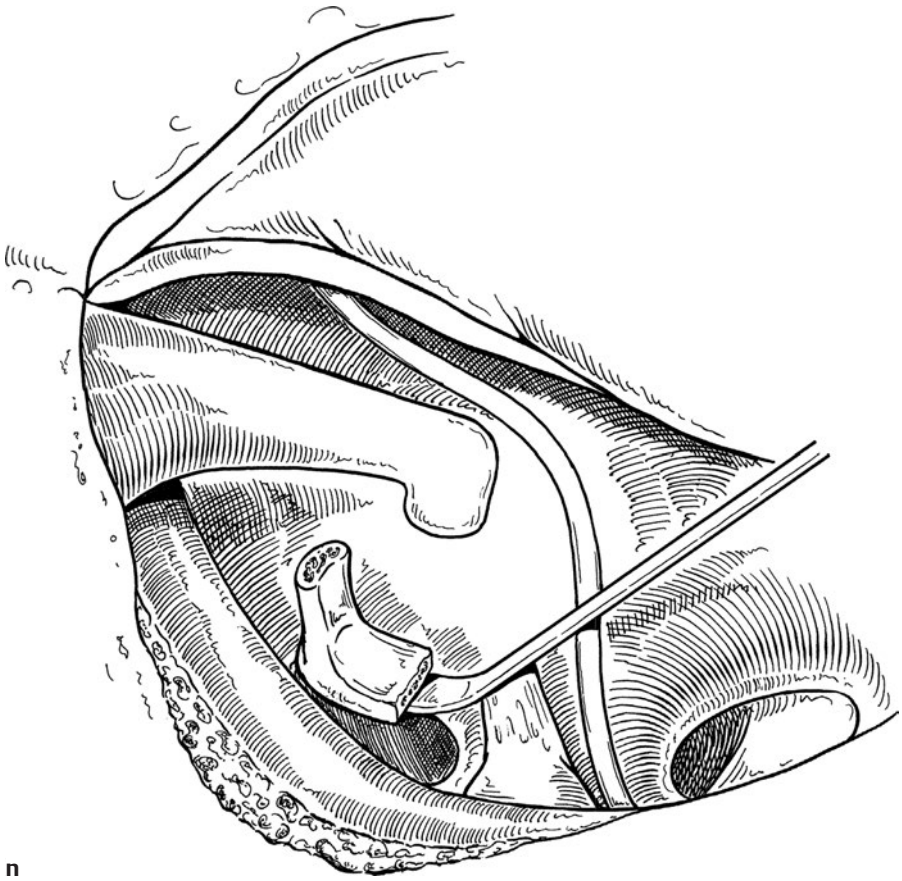


l

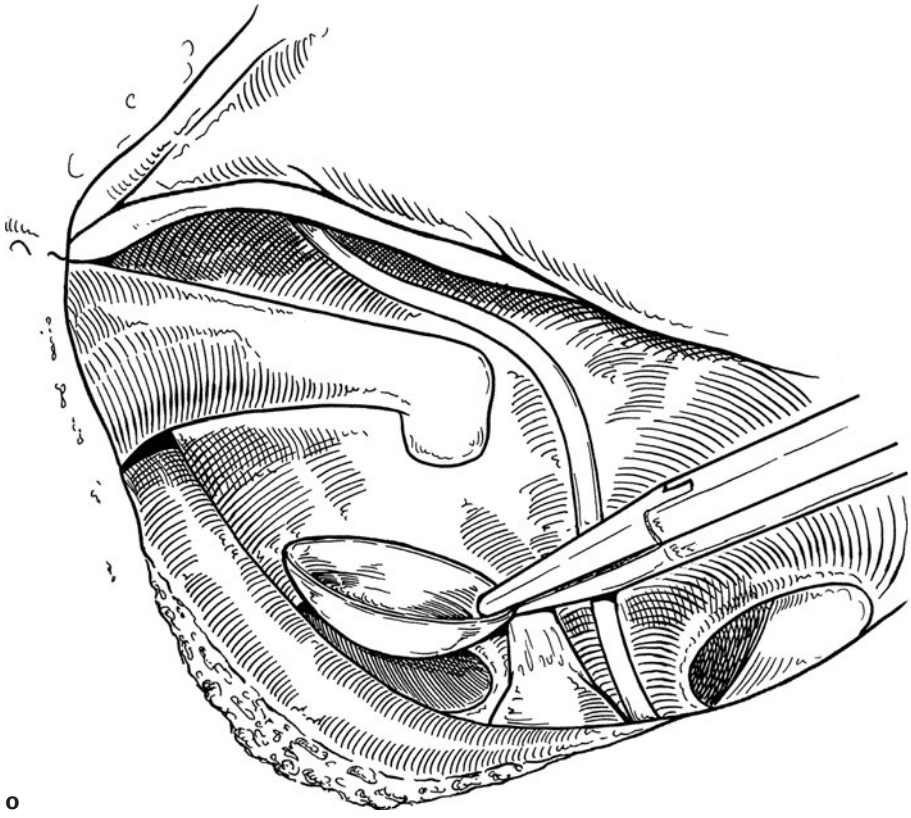


m

Fig. 4.5l,m

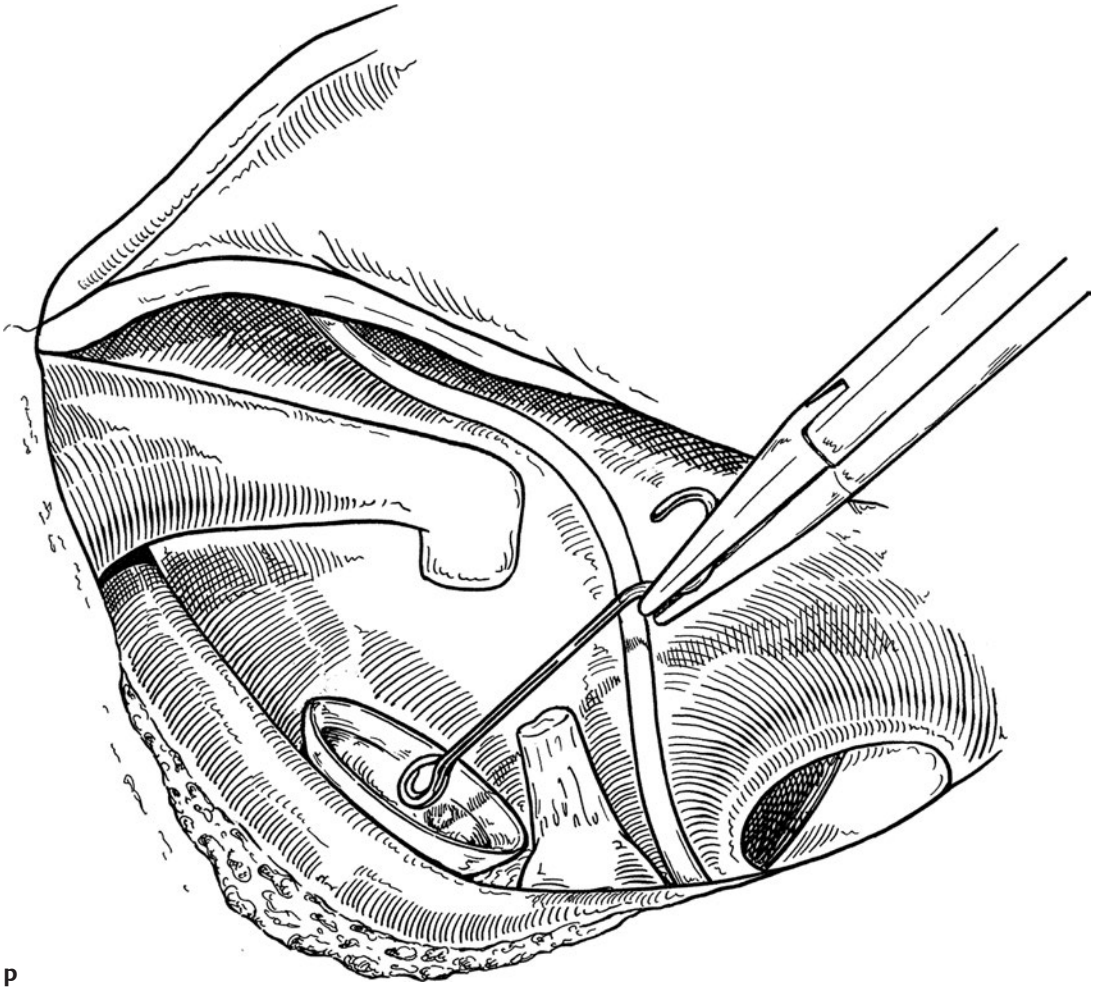


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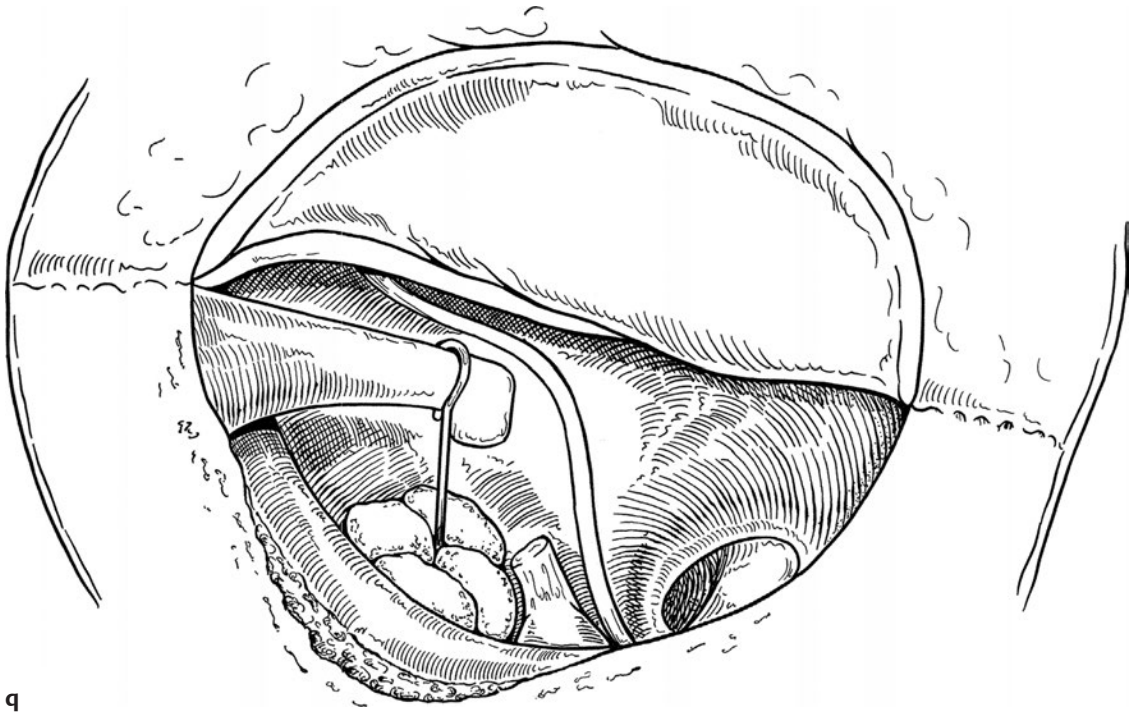


o

Fig. 4.5n,o



p



q

Fig. 4.5p,q

4-6 Atresia and Associated Anomalies

Introduction

Congenital aural atresia is a spectrum of anomalies of the external and middle ear. At one extreme are milder anomalies consisting of a stenotic ear canal, accompanied by either a normal or hypoplastic tympanic membrane. These patients may have normal hearing or only mild conductive hearing loss. At the other extreme are severe anomalies with complete bony ear canal atresia, absence of the tympanic membrane, hypoplastic temporal bone, and severely malformed or absent ossicles. Atresia can occur in isolation or accompany many craniofacial syndromes.

Indications

Surgery to enlarge a severely stenotic canal (simple canaloplasty) may be needed if skin debris or cerumen accumulates deep to a stenosis. The appropriateness of reconstructing more severe cases of aural atresia depends on degree of hearing loss, absence of large sensorineural component to the loss, degree of deformity of the ossicular chain, abnormal course of the facial nerve, and extent of temporal bone and middle ear development and pneumatization. Families should consider the alternatives, including bone conduction hearing aids and bone-anchored amplification implants. For candidates with favorable anatomy, atresia reconstruction can be considered. If there is also deformity of the auricle (microtia), reconstruction of the latter must usually be done first. If there is minimal or no microtia, atresiaplasty is best performed between the ages of 3 and 5 years when the child can cooperate with postoperative care.

Preoperative Evaluation

The preoperative evaluation requires high-resolution CT of the temporal bone to define the status of the ossicular chain, the development of the middle ear space and inner ear, and the extent of mastoid pneumatization. Most importantly, CT defines the course of the facial nerve, which may be more anterior than normal. Complete audiometry is also required to be certain that there is no sensorineural hearing loss. This may require auditory brainstem testing.

Successful surgical reconstruction to improve hearing depends on adequate development of the mastoid bone to allow sufficient space to create an external meatus and sufficient space in the middle ear cavity in which to reconstruct the sound conduction mechanism (**Fig. 4.6a**). The ear with the best anatomy for reconstruction is operated upon first. The decision to operate on the second ear must take into account the functional and anatomic result obtained on the first ear.

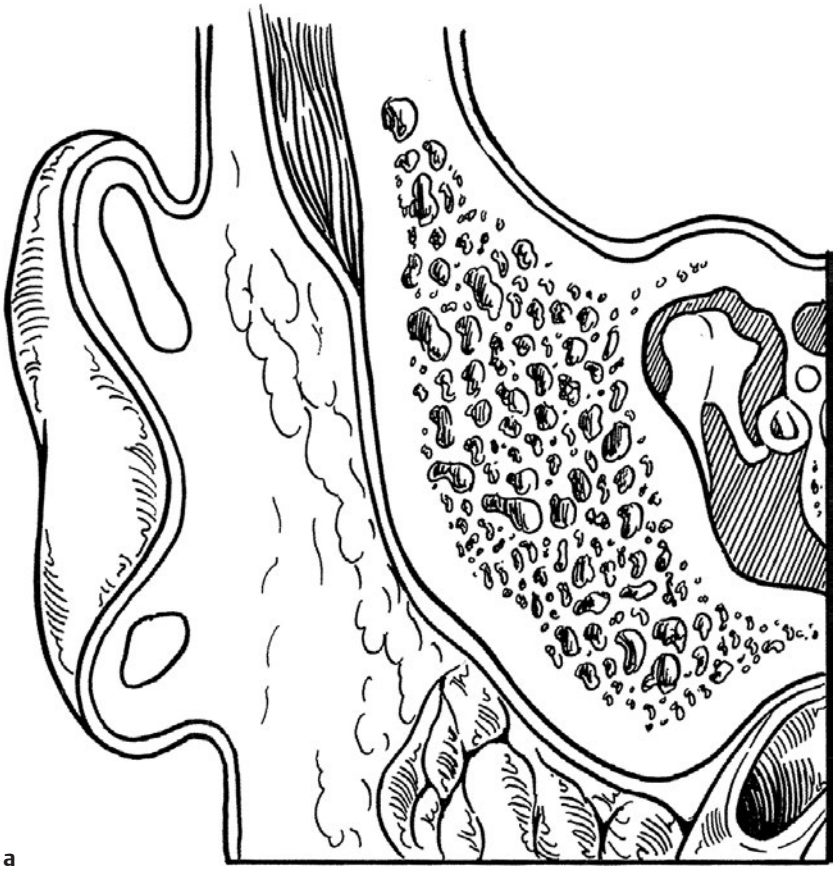
Operative Technique

1. General anesthesia is required to correct aural atresia. The postauricular area and the region where the external meatus is to be created are injected with 1% lidocaine containing 1:100,000 epinephrine. Intraoperative facial nerve monitoring should be employed.
2. A standard postauricular incision, as for tympanoplasty, is performed (see Section 3-2).
3. The periosteum of the mastoid is incised and reflected with a self-retaining retractor, exposing the mastoid and temporal line (**Fig. 4.6b**).
4. A cutting bur is used to create a new bony external meatus that is at least 10 mm, but not more than 15 mm, in diameter. The dissection is directed toward the attic region, closely following two landmarks: the tegmen superiorly, and the convexity of the glenoid fossa anteriorly. Staying anterior and superior in this fashion protects the region of the facial nerve and permits limited mastoid dissection. More medially, diamond burs are used, and the air-containing space of the epitympanum is identified through the bone (the “atresia plate”) before entering. The head of the malleus and body of the incus are the first middle ear structures usually seen (**Fig. 4.6c**).
5. Bone of the atresia plate is then removed with diamond burs to expose the epitympanum and middle ear. During this dissection, the ossicular heads are left fixed to the atresia plate anteriorly as long as possible, to avoid acoustic trauma to the inner ear.
6. The final release of the thinned bony plate is done with a curette to avoid sensorineural hearing loss from drilling on the ossicles (**Fig. 4.6d**). The ossicular reconstruction will depend on the condition of the ossicular chain. Often, only release of the fused malleus–incus complex from its bony attachment is required.
7. A ledge of bone (pseudoannulus) is created with a small drill around the rim of the bony external meatus at the level of the middle ear (**Fig. 4.6e**).
8. A temporalis fascia graft is taken as described for tympanoplasty (see Section 3-2). The anterior edge is cut to create a flap that will be tucked under the anterior ledge of the canal to reduce lateralization (**Fig. 4.6f**). The graft is then draped over the ossicles and onto the new bony ear canal posteriorly (**Fig. 4.6g**).
9. Using a dermatome, a split-thickness skin graft (8–12 1,000ths of an inch thick and about 5 cm square) is taken from the buttock region or inner aspect of the upper arm.
10. The skin graft is notched to allow the edges to overlap the fascia when the graft is placed in the canal (**Fig. 4.6h**).
11. The skin graft is placed in the canal with the cut edges slightly overlapping each other on the surface of the fascial graft. Any exposed areas of bone or soft tissue should be covered with additional strips of split-thickness skin graft (**Fig. 4.6i**).

12. A thin Silastic (Dow) disk is placed on the skin overlying the site of the new tympanic membrane to hold it in place, and the medial part of the canal is packed with Gelfoam. The remainder of the bony ear canal is packed with an expanding 12-mm Merocel (Medtronic) ear pack or several Pope ear wicks, which are expanded with ofloxacin solution (**Fig. 4.6j**).
13. A meatoplasty is now performed; its location is chosen to line up with the new bony ear canal. If the external ear is well developed, the external meatus is simply widened by removing the plug of skin and soft tissue overlying the proposed site of the external meatus. In the case of a reconstructed auricle, the existing skin overlying the site is fashioned into an anteriorly based flap, attached near the tragus, which will ultimately be rotated inward to line the anterior third of the new meatus (**Fig. 4.6k**). A large core of cartilage and soft tissue (minimum 1.5 cm diameter) is excised. If the new meatus and the bony canal are not perfectly aligned, this can be corrected during closure (below) by adjusting the position of the external ear with strong suture fixation (e.g., 2-0 Vicryl).
14. The periosteum and skin incisions are closed. The anteriorly based auricular skin flap is then turned inward to line the anterior third of the meatus. Through the meatus, the free edges of the previously placed skin graft are retrieved and laid upon the remaining walls of the meatus. Its lateral edges are trimmed and tacked to the edge of the meatus with 6-0 mild chromic suture. Any exposed areas of soft tissue are covered separately with free pieces of skin graft. A large 15-mm Ambrus (Medtronic) pack is placed and expanded with ofloxacin solution to press the skin flaps and grafts outward against the walls of the meatus (**Fig. 4.6j**). A mastoid dressing is applied.
15. The child is kept on oral antibiotics and antibiotic-containing otic drops twice a day for the entire time the packing is in place or longer, as judged by the surgeon.
16. The packing is removed at 2 to 3 weeks under general anesthesia or in the office for cooperative teenagers. Granulation tissue is removed, and overlapping nonviable skin is trimmed with Bellucci scissors.

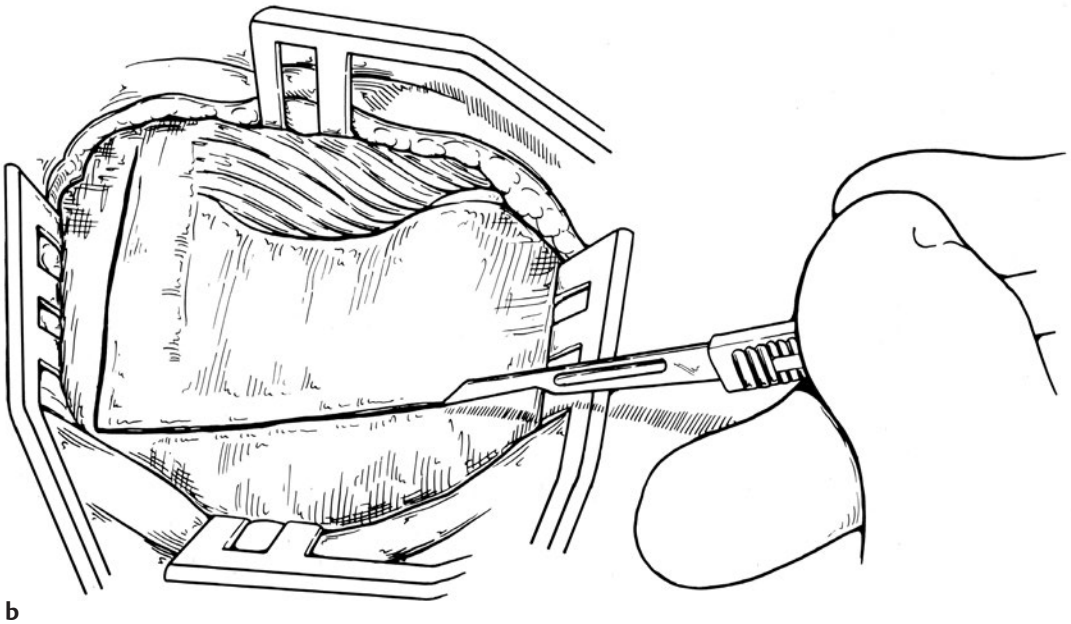
Complications

1. Incomplete take of skin graft, with granulation
2. Lateralization of the tympanic membrane
3. External canal restenosis
4. Poor hearing result
5. Facial nerve injury
6. Sensorineural hearing loss

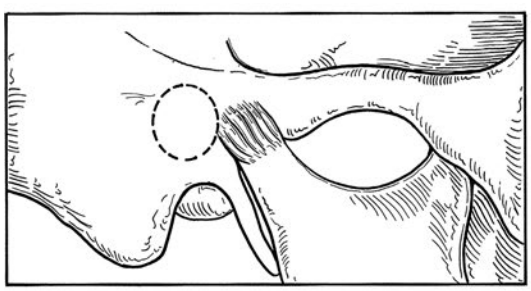


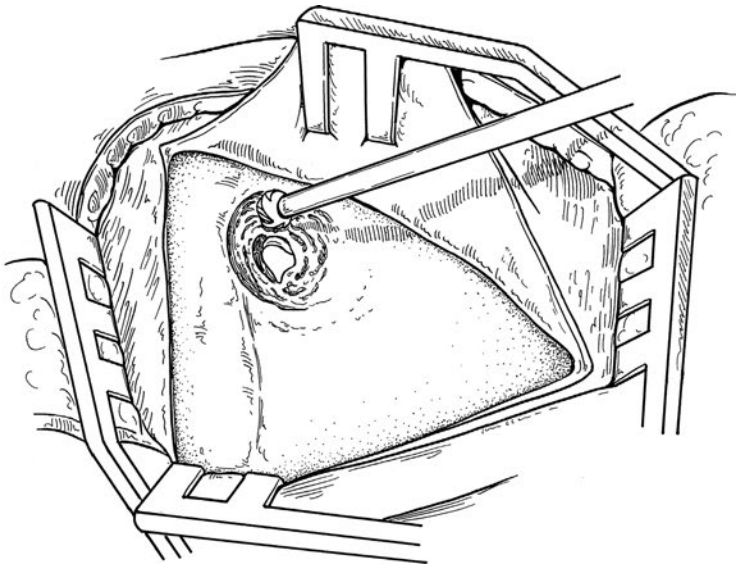
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Fig. 4.6a



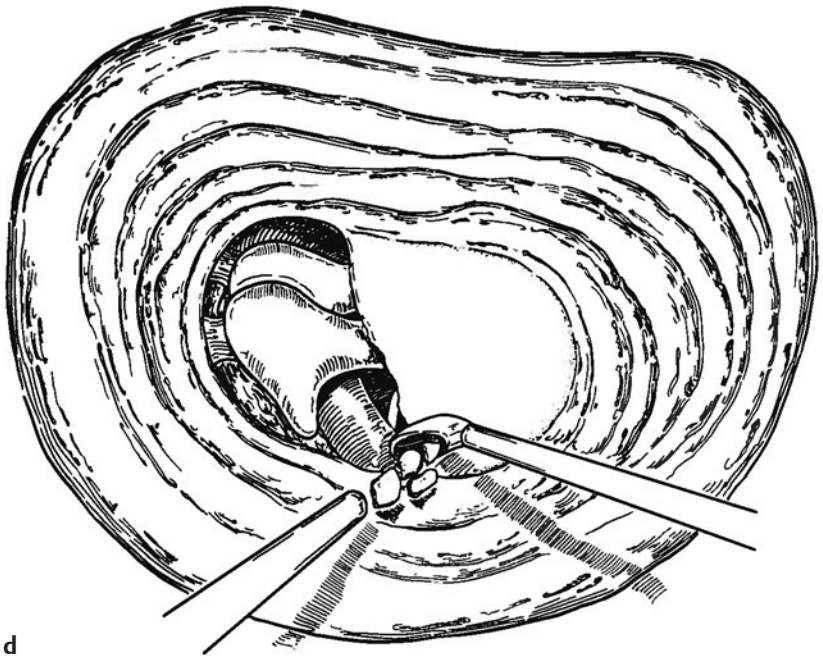
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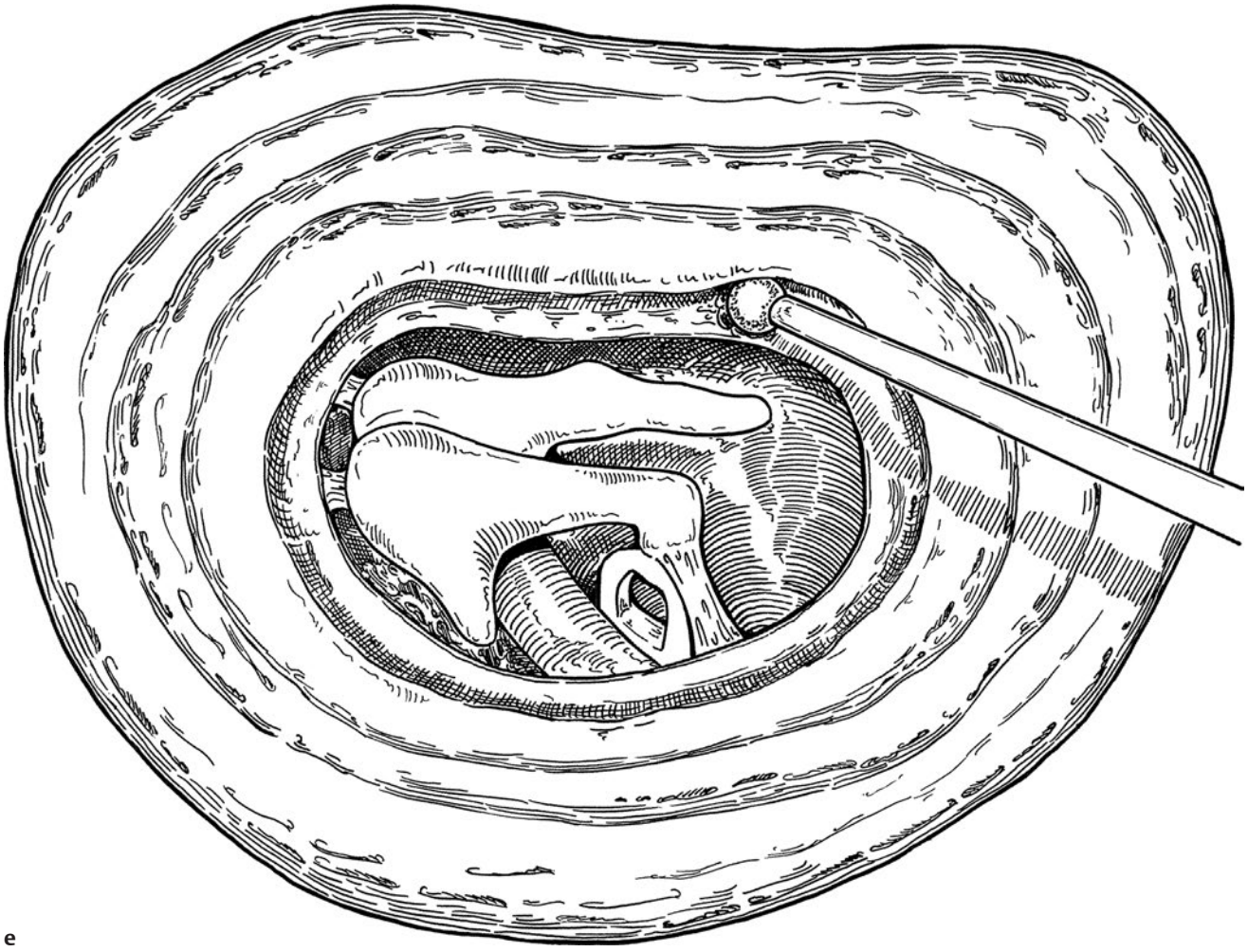


c

Fig. 4.6b,c

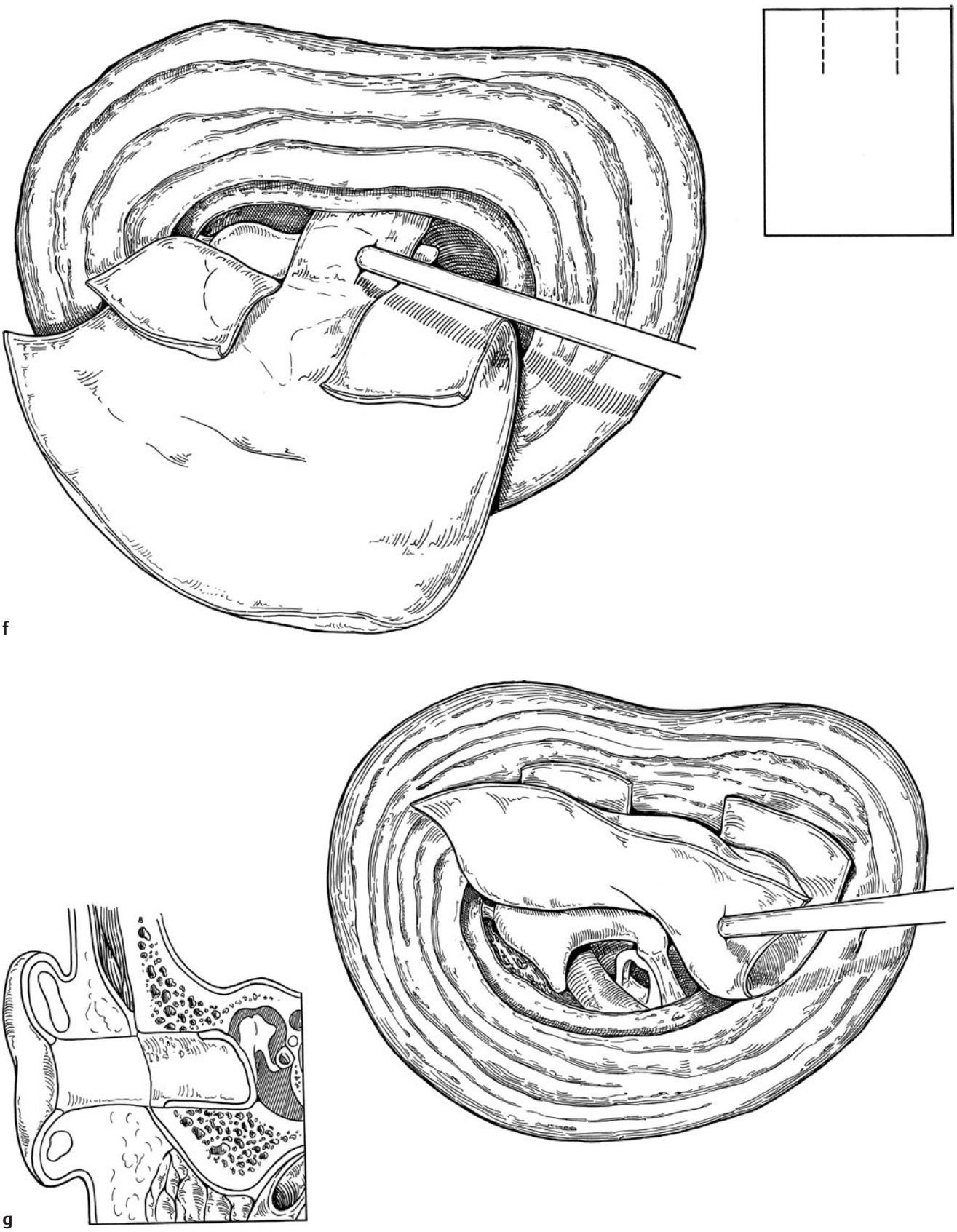


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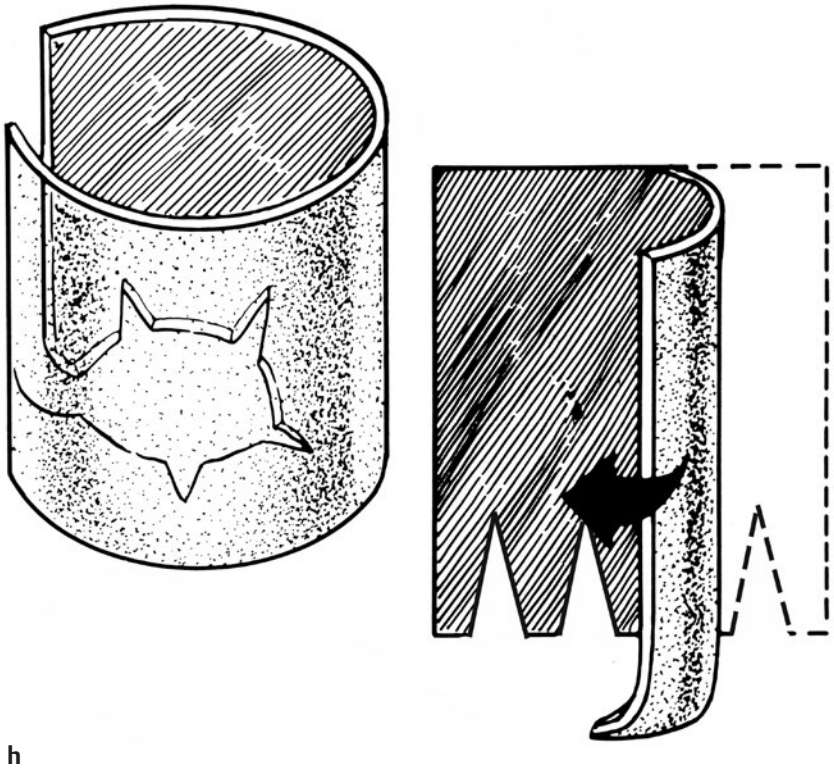
Fig. 4.6d,e



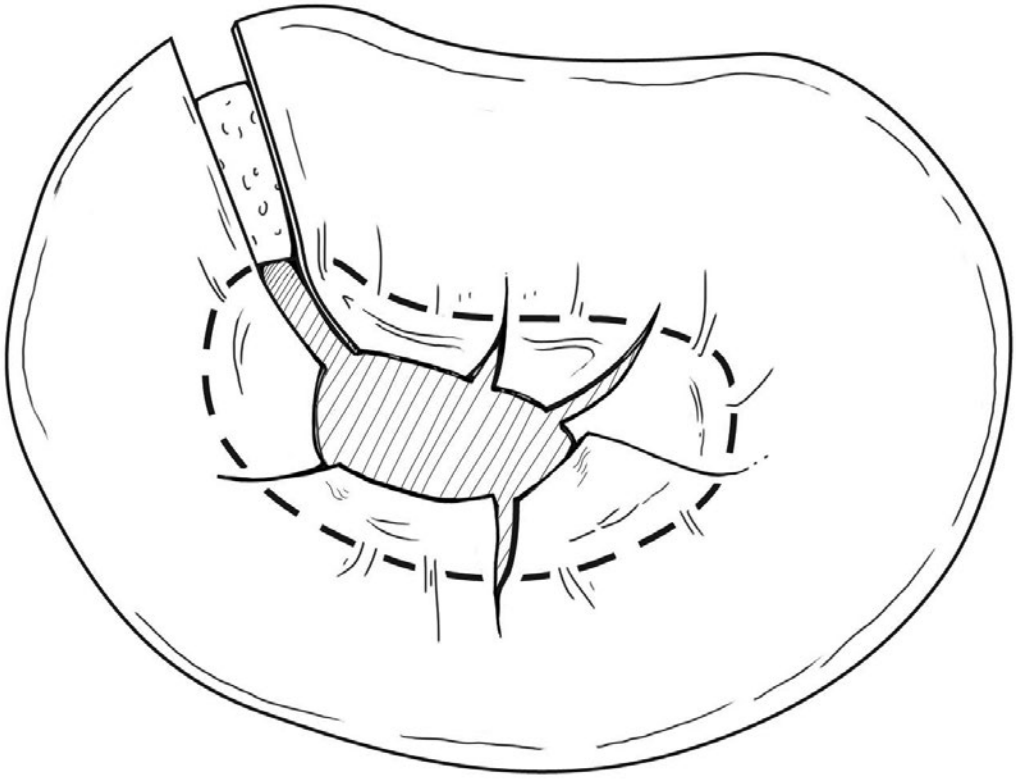
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g

Fig. 4.6f,g

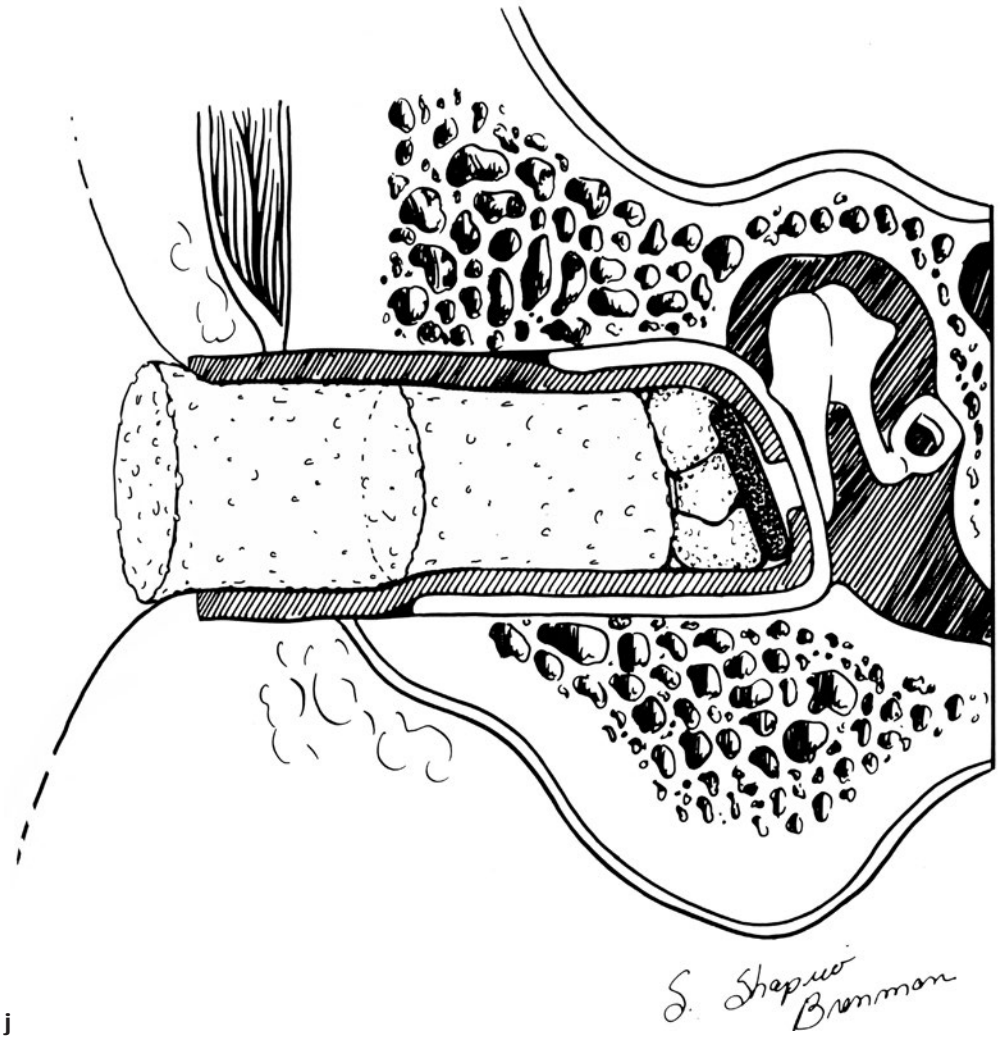


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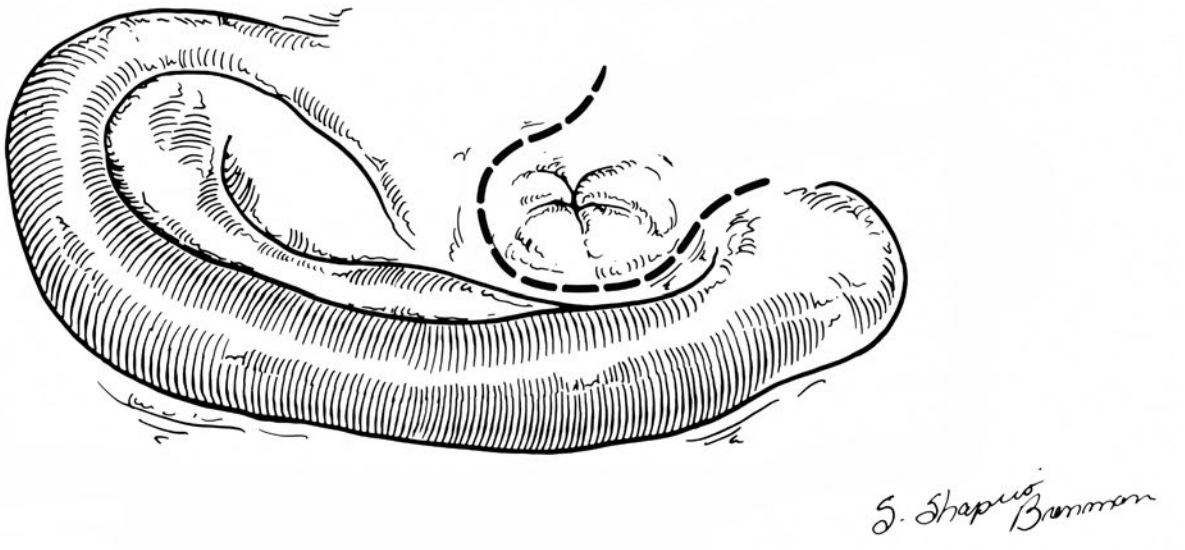


i

Fig. 4.6h,i



j



k

Fig. 4.6j,k

5 Ear Trauma

Mark D. Rizzi

External ear trauma occurs frequently in children because of the ear's prominent and unprotected position as well as the reflex tendency of head turning to avoid direct facial injury. Blunt trauma may occur during contact sports, most frequently wrestling, or during falls.

5-1 Incisional Evacuation of Hematoma

Introduction

Blunt or shearing trauma may lead to separation of the perichondrium, which, on the lateral surface of the auricle, is tightly adherent to the skin. A hematoma may then form between the two layers. This collection typically forms in either the conchal bowl or the scaphoid fossa (**Fig. 5.1a**). The consequent devascularization of the underlying cartilage may lead to permanent ear deformity.

Indications

Evacuation of seroma or hematoma is indicated to avoid permanent auricular deformity.

Preoperative Evaluation

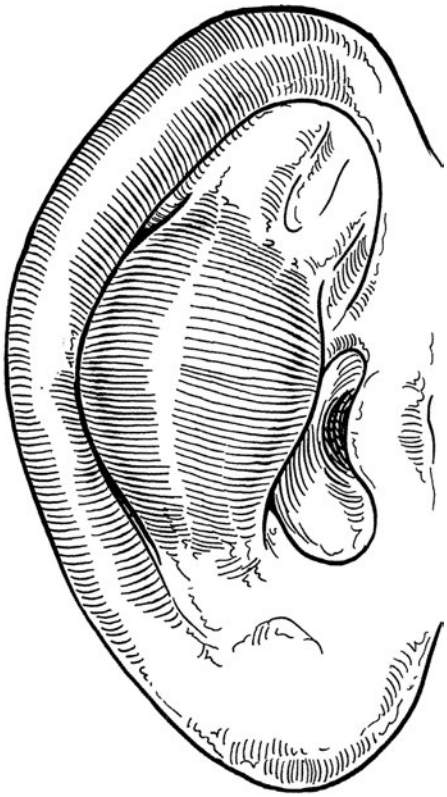
Preoperative evaluation consists of noting the presence of a seroma or hematoma. Associated injuries to the inner and middle ear and the rest of the head must be ruled out.

Operative Technique

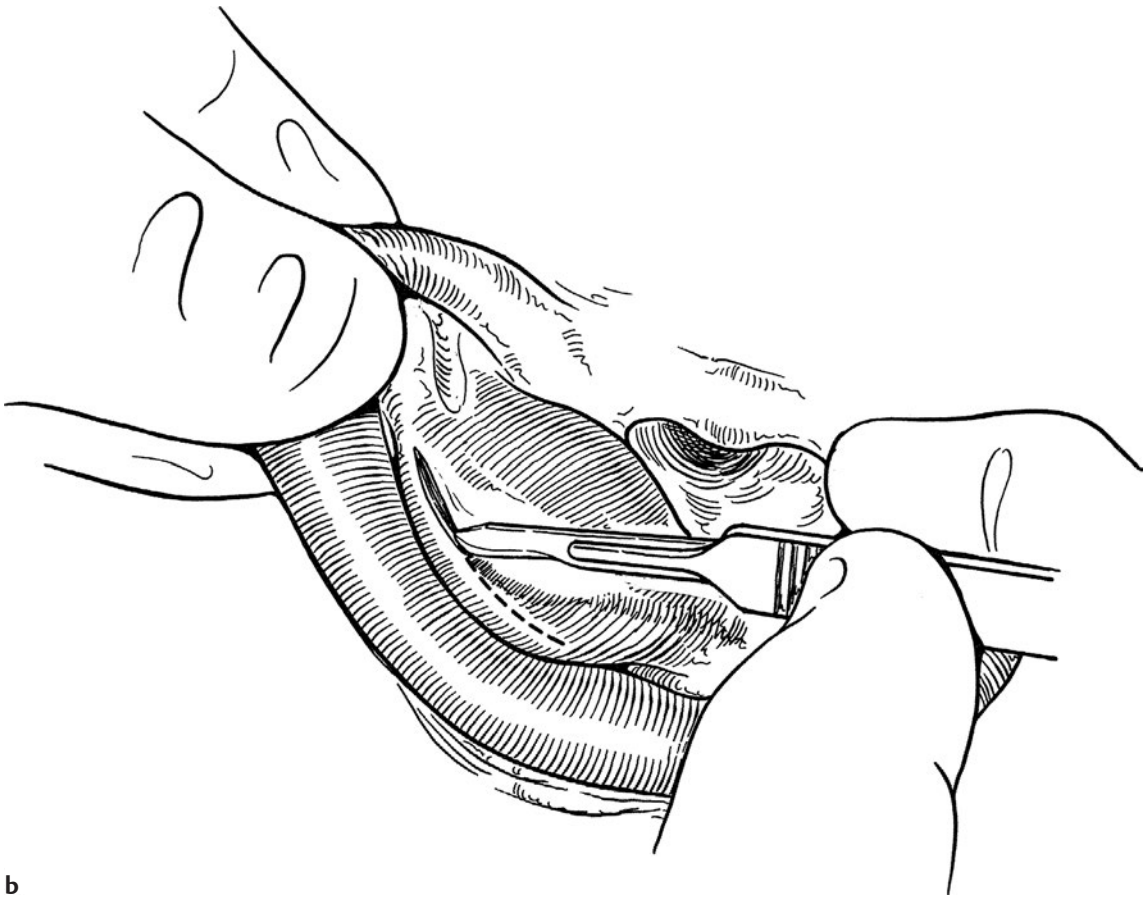
1. This procedure can often be performed under local anesthesia in older children but may require a general anesthetic in young, uncooperative children.
2. The ear is thoroughly cleansed with an iodine-containing solution. A small amount of local anesthetic can then be instilled at the site of the planned incision.
3. An incision is made along the lateral margin of the hematoma in parallel with the natural curve of either the helical or antihelilcal folds (**Fig. 5.1b**).
4. The perichondrium and skin are gently separated from the cartilage, and the hematoma is thoroughly evacuated with a suction device (**Fig. 5.1c**). Gentle curettage with a small sharp mastoid curette can be performed to remove any fibrogranulomatous material that may have formed. The pocket is gently irrigated with sterile saline using an 18-gauge angiocatheter.
5. The incision can then be loosely reapproximated with interrupted 5-0 or 6-0 fast absorbing chromic sutures that do not need to be removed (**Fig. 5.1d**). Leaving the incision partly open allows a pathway for drainage of any additional fluid.
6. The perichondrial flap is held in position with 4-0 nylon sutures that are tied over dental rolls or petroleum gauze dressings that are precisely contoured to apply pressure, which immobilizes the flap and eliminates all dead space (**Fig. 5.1e**). This bolster can be removed in 7 to 10 days.
7. Antistaphylococcal antibiotics are prescribed for 10 days to prevent chondritis.

Complications

1. Reaccumulation of hematoma/seroma
2. Chondritis
3. Perichondritis
4. Scar formation, cauliflower ear

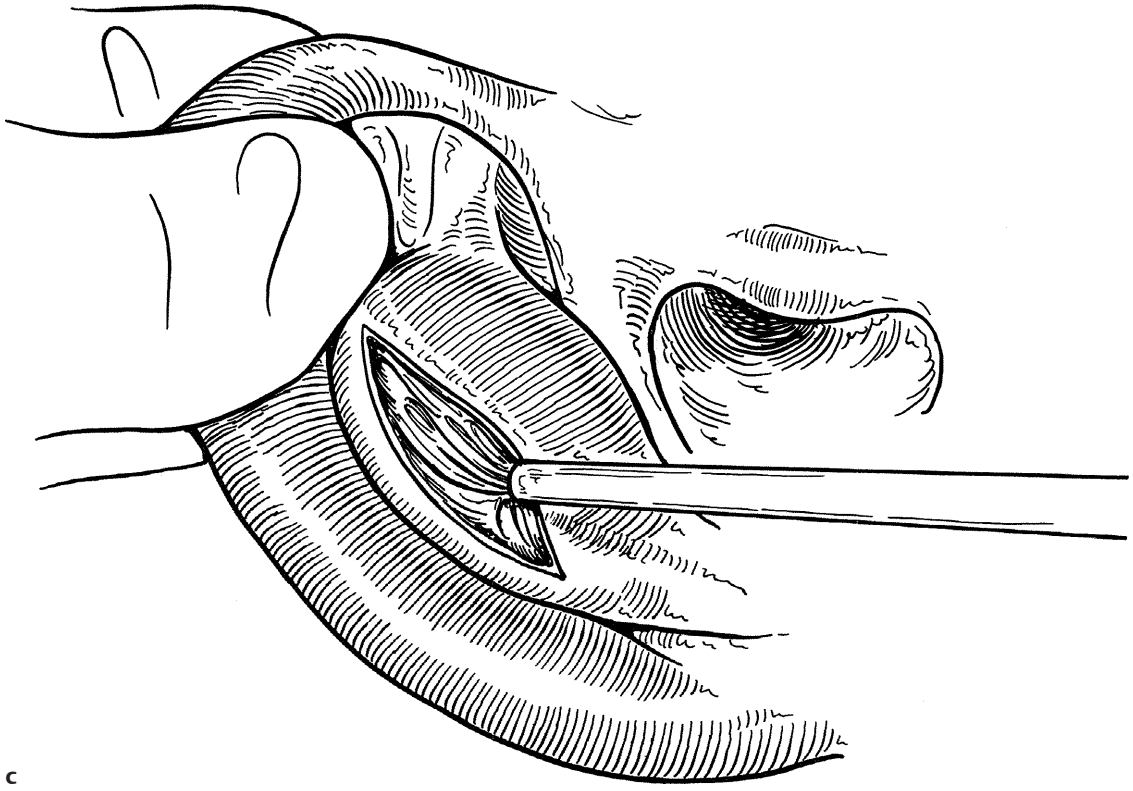


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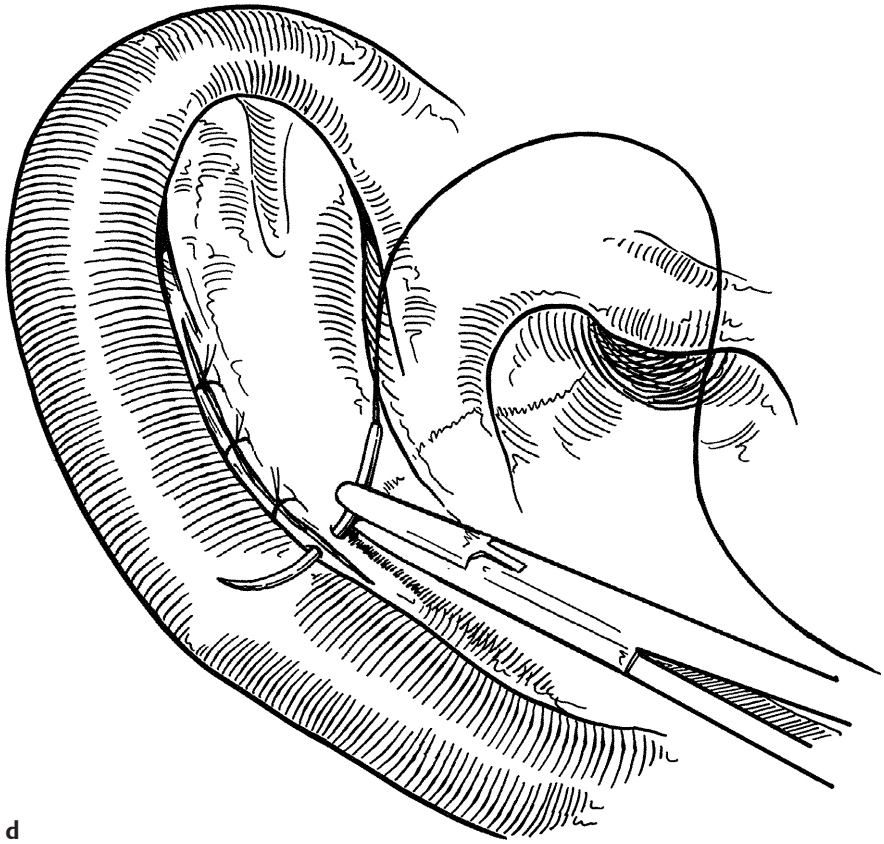


b

Fig. 5.1a,b

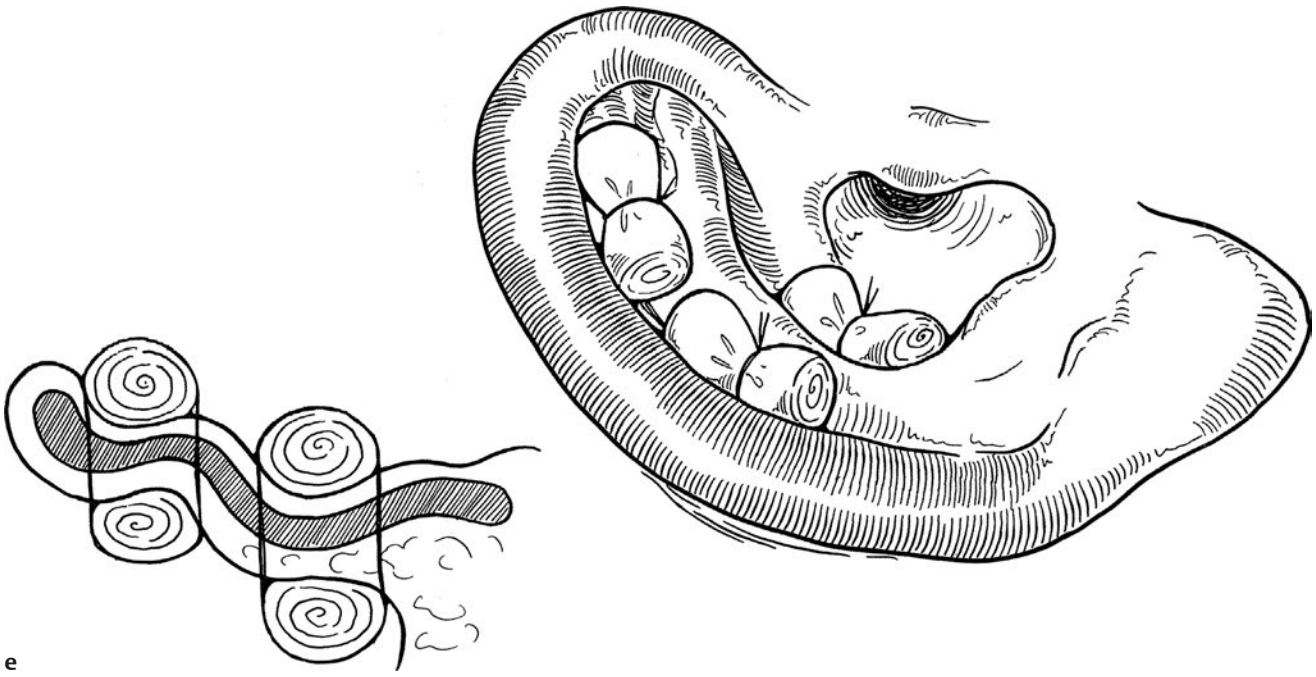


c



d

Fig. 5.1c,d



e

Fig. 5.1e

6 Foreign Bodies in the Ear Canal

Mark D. Rizzi

Foreign bodies in the ear canal are common in children. There is no limit to the variety of items that may require removal, which should be carried out as soon as possible to avoid infection. No anesthesia is required if the child is cooperative or can be completely and safely restrained. General anesthesia is indicated in uncooperative children and when the foreign body cannot be removed without pain or damage to the tympanic membrane or ear canal.

6-1 Removal of Foreign Bodies from the Ear Canal

Indications

Presence of foreign body in the ear canal.

Preoperative Evaluation

An attempt is made to visualize the tympanic membrane distal to the foreign body. This is especially important if one wishes to flush the foreign body out with water. An audiogram may be obtained to determine if there has been damage to the tympanic membrane, ossicles, or inner ear as a result of the foreign body.

Operative Technique

A large speculum is placed in the outer aspect of the ear canal to visualize the foreign body.

Smooth Objects

1. Smooth foreign bodies in the ear canal that do not completely occlude the lumen should be removed with a curette, loop, or blunt ear hook.
2. The loop or hook is gently passed along the ear canal. When possible, during extraction, the object should be lifted gently from the thin-skinned (and more highly sensate) bony ear canal to the thick-skinned and more tolerant vascular strip posteriorly as the object is rolled outward (**Fig. 6.1a**).

Soft Objects

Soft objects such as cotton or paper are most easily removed with a small, otologic forceps (**Fig. 6.1b**).

Sharp-Edged Objects

1. Sharp-edged foreign bodies are most easily and comfortably removed with a small, otologic forceps.
2. Rapid removal is important because the sharp edges may scratch the ear canal and make continued patient cooperation impossible.
3. The leading edge should be grasped firmly with a small, otologic forceps and withdrawn rapidly (**Fig. 6.1c**).

Occluding Foreign Bodies

1. Foreign bodies occluding or nearly occluding the ear canal can be irrigated out. It is not advisable to employ irrigation for tightly impacted organic objects, such as dried beans, as these will only swell and become more occlusive with hydration.
2. The most effective instrument is a 20-mL syringe with a flexible intravenous catheter tip that can be directed to produce a thin, powerful stream of water.
3. Body temperature water is injected along the posterior wall of the ear canal providing a pressure head of water against the drum that forces the foreign body out of the meatus (**Fig. 6.1d**).

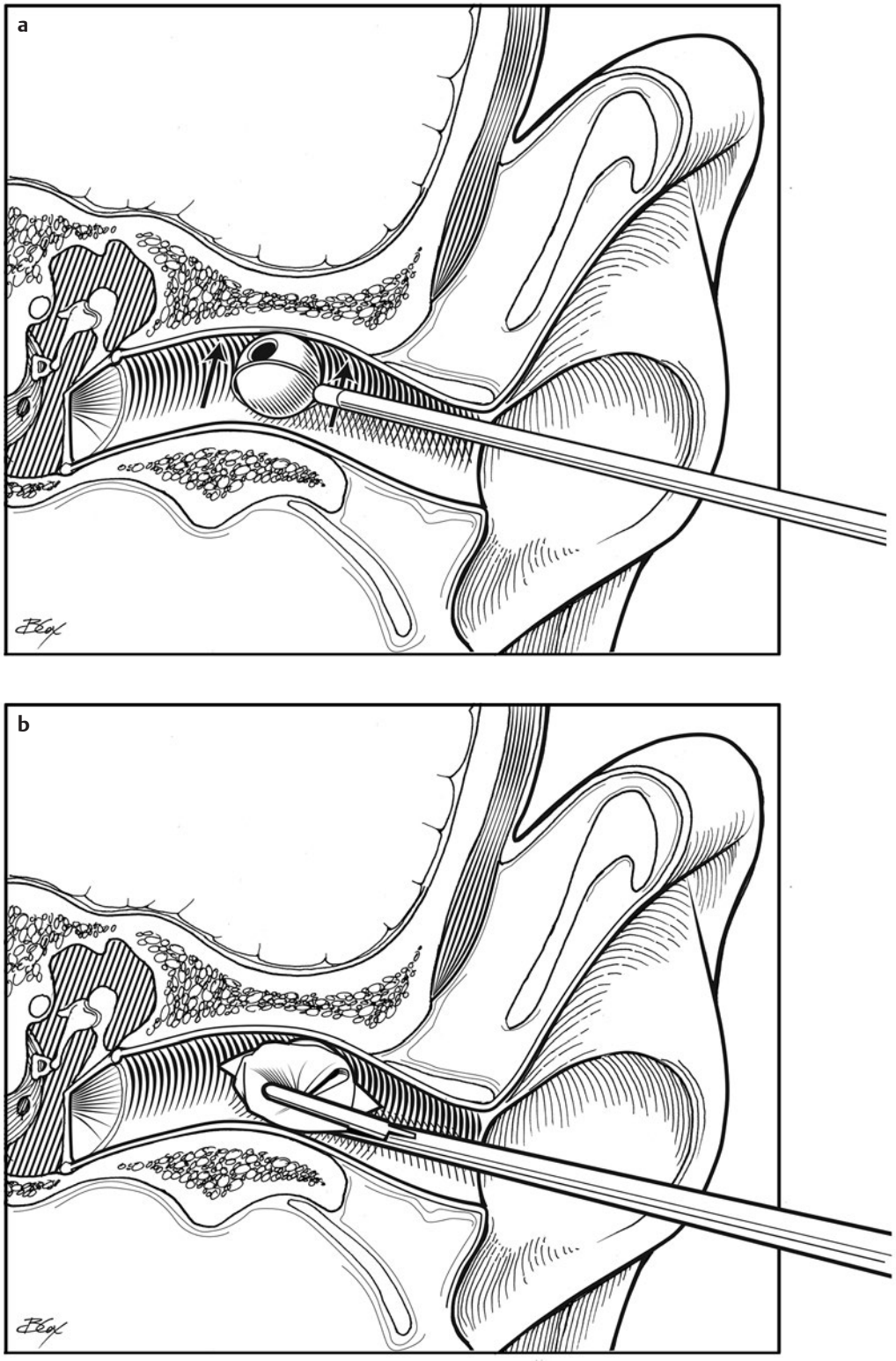


Fig. 6.1a,b

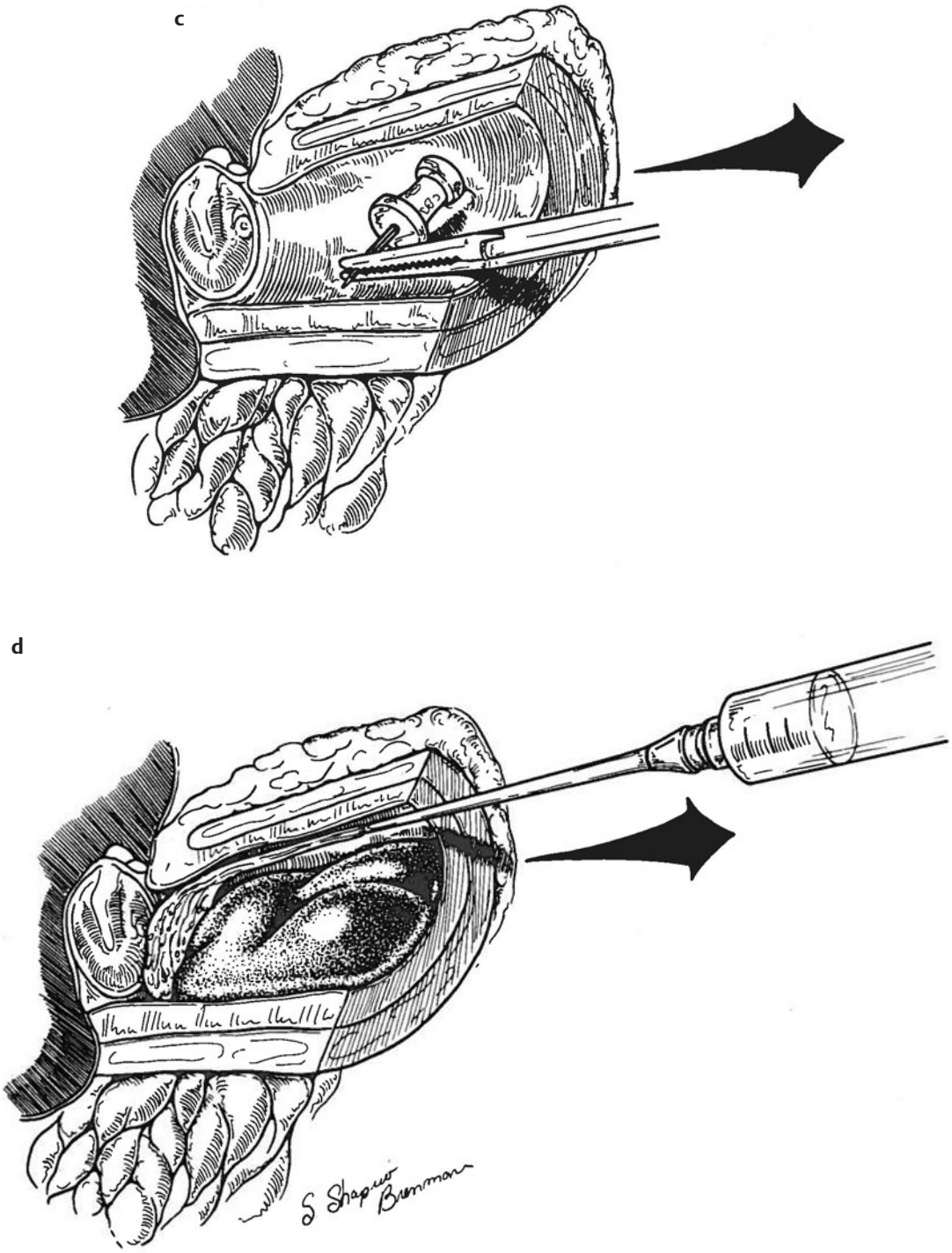


Fig. 6.1c,d

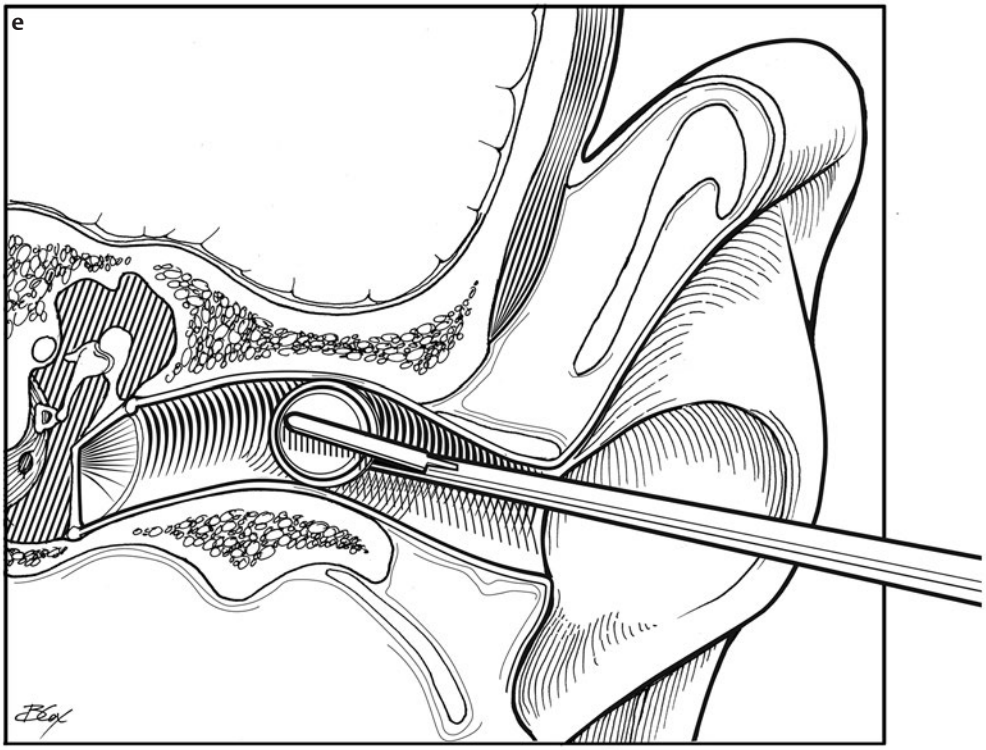


Fig. 6.1e

Disk Batteries

The incidence of foreign body impaction with highly corrosive disk or "button" batteries is rising as these products increase in their ubiquity in our environment. Upon exposure to the warmth and moisture of the ear canal, these batteries can leak their contained corrosive electrolyte solution, resulting in liquefaction necrosis of the underlying skin, cartilage, and bone of the ear. A high index of suspicion is required on the part of the physician as these objects must be removed urgently. When suspected, these objects should be urgently extracted. Their removal is best accomplished by gently grasping the battery with a forceps and lifting it away from the tympanic membrane (**Fig. 6.1e**). General anesthesia is usually required, and the ear canal should be irrigated with sterile water after extraction to dilute and remove any residual alkaline solution.

Complications

1. Tympanic membrane perforation
2. Laceration of the ear canal
3. Ear canal stenosis may result from alkaline induced tissue injury if disk battery is not removed promptly

7 Perilymph Fistula Repair

Brian P. Dunham

Perilymph fistula is a leak of fluid from the inner ear into the aerated middle ear. It is important to stress that this is a rare condition that typically requires great clinical suspicion to make the diagnosis; this is especially true when there is no antecedent trauma. In children, it usually occurs following severe head trauma or barotrauma. Spontaneous fistulas do occur and most often happen suddenly during physical stress.

Intermittent vertigo and fluctuating hearing loss are characteristics of perilymph fistulas, but both are not always present. Recurrent meningitis may result from a perilymph fistula that allows cerebrospinal fluid (CSF) to enter the middle ear space. The two structurally weakest points implicated in a perilymph fistula are the round window and oval window. The oval window leaks typically occur on the anterior edge of the footplate. However, congenital fissures or traumatic injuries may also be the site of the leak. What makes intraoperative identification challenging is the low volume of the perilymphatic space; these are typically very subtle leaks if they are seen intraoperatively. Topical anesthetics from canal injection will often dissect into the middle ear and confuse the picture; it is essential to be patient during this operation and observe for an active leak to confirm the diagnosis.

The diagnosis of a perilymphatic fistula is often controversial, even intraoperatively. The leaks, if present, are typically very subtle. It is not uncommon to have a negative middle ear exploration. Some surgeons in this instance advocate placing grafts over both oval and round windows; others do not, citing the risk of creating a conductive hearing loss or possibly injuring the inner ear.

7-1 Perilymph Fistula Repair

Indications

Given how controversial this operation currently is, it is wise to recommend that patients obtain a second opinion before considering surgical intervention, unless the diagnosis is imminently clear or strongly suspected.

Most fistulas respond to conservative treatment, which includes a week or more of bed rest and stool softeners with avoidance of barotrauma for several months, provided that hearing is stable or improving. Some surgeons advocate for the placement of tubes stating that they mollify external barotrauma and may allow the fistula to repair itself (but will not help avoid pressure variation from internal pressure/Valsalva maneuvers). Given that the middle ear already communicates with the nasopharynx through the eustachian tube, it is unlikely that it would result in a labyrinthitis.

Middle ear exploration and repair of perilymph fistula are indicated if a perilymph fistula is suggested as the cause of vertigo and/or hearing loss, or recurrent meningitis, especially if it has not responded to conservative treatment and there is evidence of progressive hearing loss.

Preoperative Evaluation

The preoperative evaluation of a child with suspected perilymph fistula includes an audiogram to assess for hearing loss. A fistula test, the application of positive tympanic pressure and observing for nystagmus, can be very subtle, producing little or no nystagmus; however, a frankly positive test is a solid indication to consider operative intervention. Computed tomography (CT) may demonstrate inner ear pathology, such as Mondini's deformity, or middle ear pathology, such as dislocated incus, especially following severe trauma. A CT may demonstrate a dehiscent superior semicircular canal in an older child, which would be a relative contraindication to a middle ear exploration. However, imaging studies are rarely positive. Electronystagmography may be helpful to document the nystagmus that

may accompany the perilymph fistula and can generally be done under the age of 4 in the hands of an experienced tester.

Operative Technique

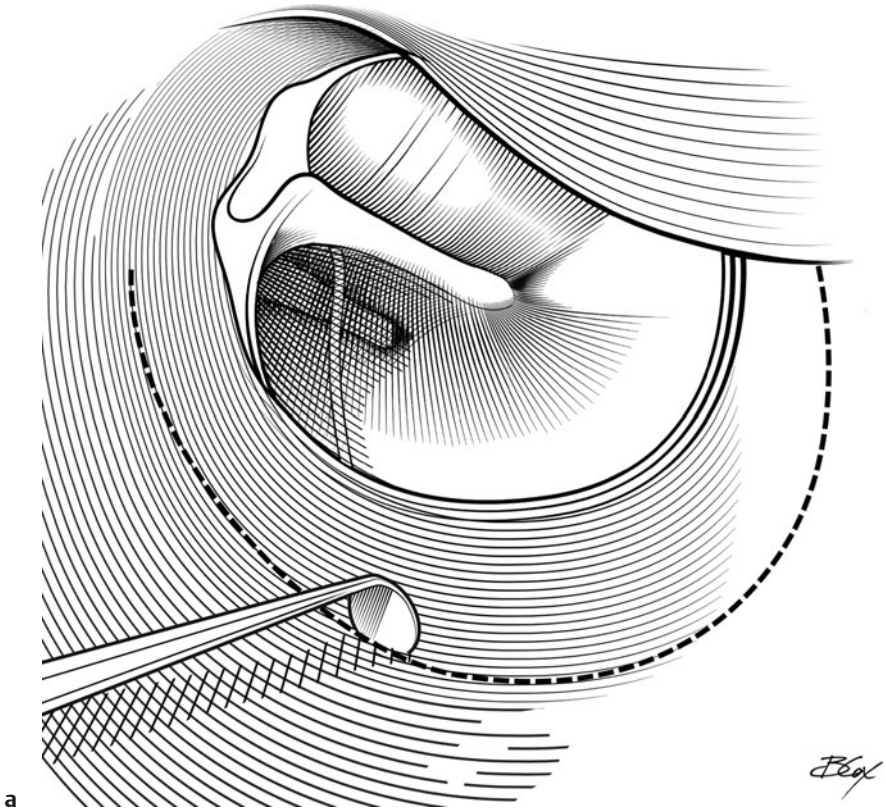
1. General anesthesia and local infiltration with 1% lidocaine with 1:100,000 epinephrine are used as described for tympanoplasty. A standard postauricular incision for maximum exposure is also employed. In older children with a large external auditory canal, a transcanal approach can be used as described for middle ear exploration.
2. The middle ear space is exposed by incision and elevating the tympanomeatal flap (**Fig. 7.1a**).
3. Bone is removed with a curette or drill in the posterosuperior portion of the ear canal to provide visualization of the entire stapes footplate. Care is taken to avoid traumatizing the chorda tympani nerve (**Fig. 7.1b,c**).
4. Sufficient bone is removed to permit complete visualization of the oval and round window areas. The middle ear is examined, and the fistula, if present, is located. The region of the oval window and round window should be dried with gentle suction and watched for accumulation of fluid for up to 20 minutes (**Fig. 7.1d**). Having the anesthesiologist maintain a full inhalation for several seconds may increase the pressure in the subarachnoid space and increase the flow of fluid out of the fistula. If no obvious leaks are noted, the round window should be carefully assessed for a leak or the absence of a reflex while the ossicular chain is gently mobilized.
5. If the fistula is small, the mucosa surrounding the edges of the fistula of the round and/or oval window is removed with a pick and small hook (**Fig. 7.1e**).
6. The defect and surrounding denuded bone are covered with connective tissue (**Fig. 7.1f**) (e.g., fascia or perichondrium). Fascia may be obtained from the temporalis muscle, and the perichondrium is easily obtained from the tragus or conchal cartilage. The connective tissue graft can be overlaid with a small muscle graft. The grafts are then held firmly in place with Gelfoam (Pfizer) pledgets. Fibrin glue (**Fig. 7.1g**) can also be considered. Fat should be avoided as a graft because it is associated with a higher recurrence rate of fistulas.
7. The tympanomeatal flap is then replaced and is held in place with Gelfoam.

Typically the removal of the stapes should not be considered during the first two to three attempts to seal a perilymphatic leak as there is an increased risk of high-frequency sensorineural hearing loss with stapedectomy. However, if a large or complex defect occurs in the stapes footplate, removal of the mucosal edge of the fistula may be difficult, and covering the defect with connective tissue may not be sufficient to close the leak (**Fig. 7.1h**). Stapedectomy is then required. A piece of "boat-shaped" perichondrium is obtained from the tip of the tragus.

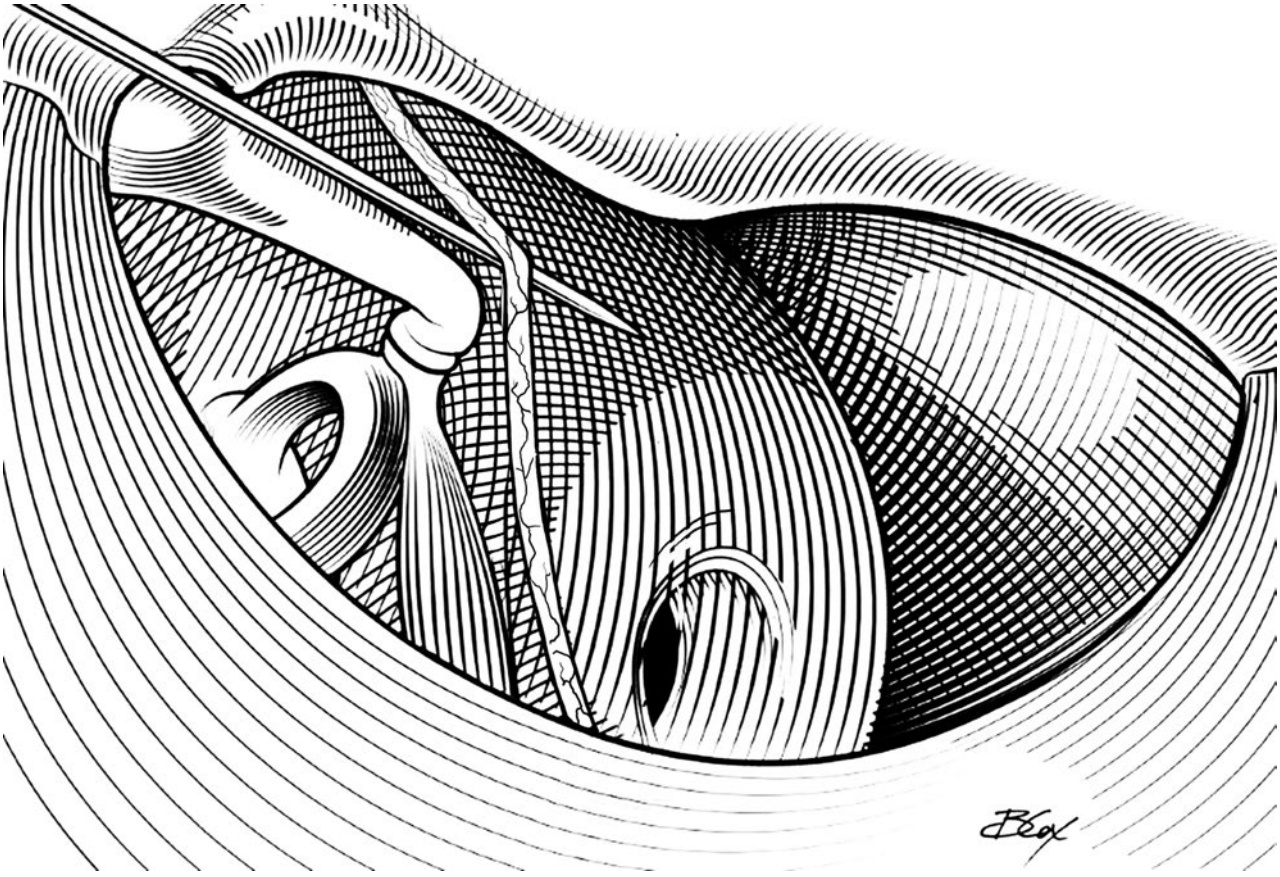
8. The suprastructure of the stapes should be removed by disarticulating the incudostapedial joint and cutting the stapedius tendon (**Fig. 7.1i,j**).
9. The crura should be removed with a forceps or hook exposing the remaining footplate (**Fig. 7.1k**).
10. The footplate fragments and mucosal adhesions are removed with a hook (**Fig. 7.1l**).
11. The previously obtained perichondrial "boat" graft is placed over the open oval window (**Fig. 7.1m**).
12. A stapes prosthesis is then positioned between the incus and the connective tissue graft overlying the oval window if the ear has auditory function (**Fig. 7.1n**).
13. The prosthesis is secured by securing it to the lenticular process of the incus with a crimper, alligator forceps, laser, or heat source (depending on the type of prosthesis). Several small pieces of connective tissue can then be placed around the wire to hold it in place if a wire prosthesis is selected.
14. The tympanomeatal flap is then replaced and the postauricular incision is closed as described for tympanoplasty.

Complications

1. Recurrent fistula
2. Trauma to the chorda tympani nerve
3. Facial nerve injury
4. Tympanic membrane perforation
5. Sensorineural hearing loss
6. Vertigo

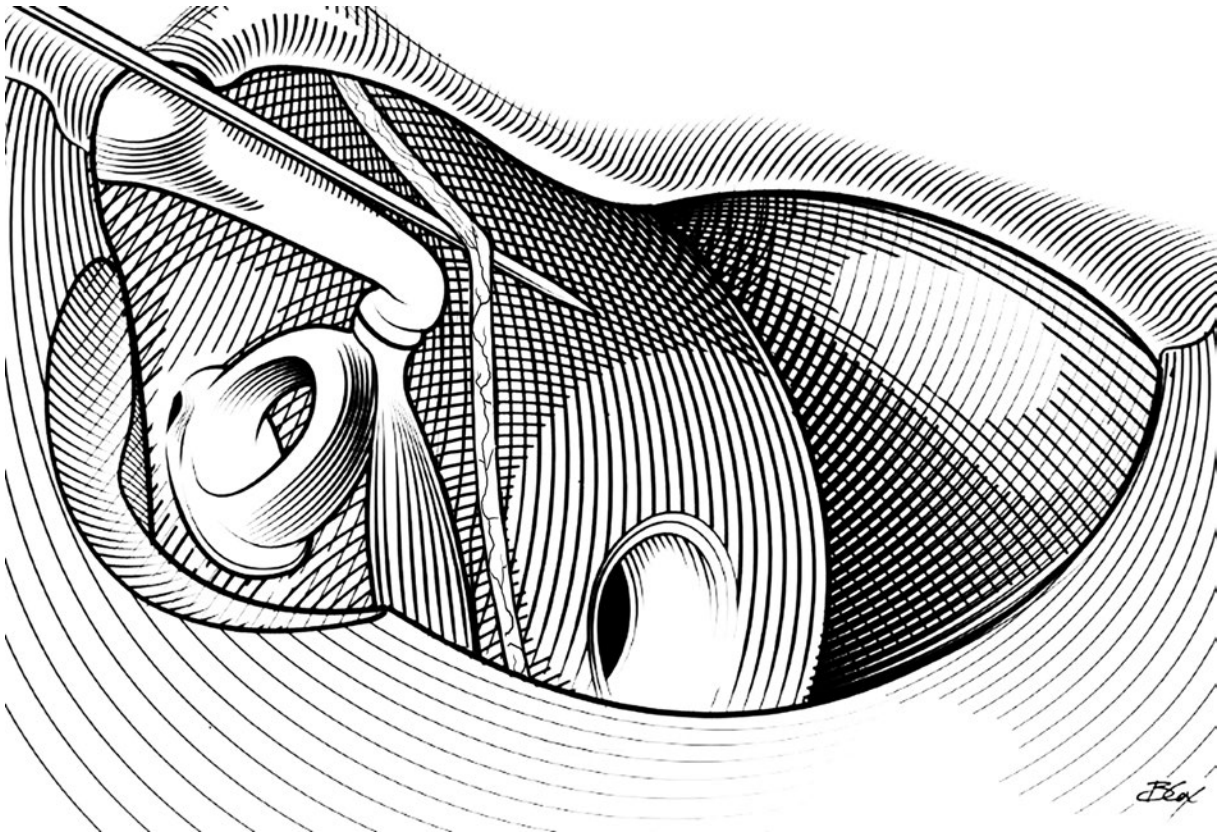


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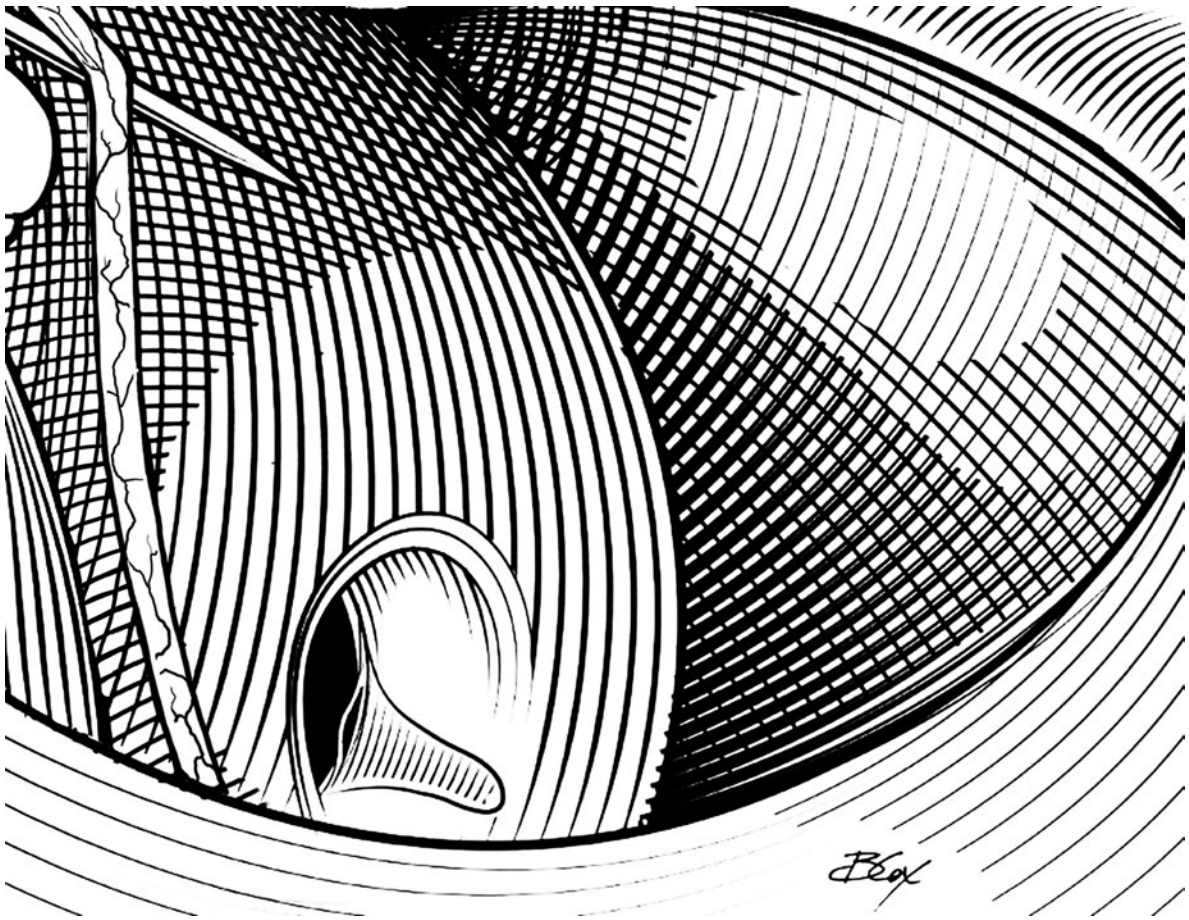


b

Fig. 7.1a,b

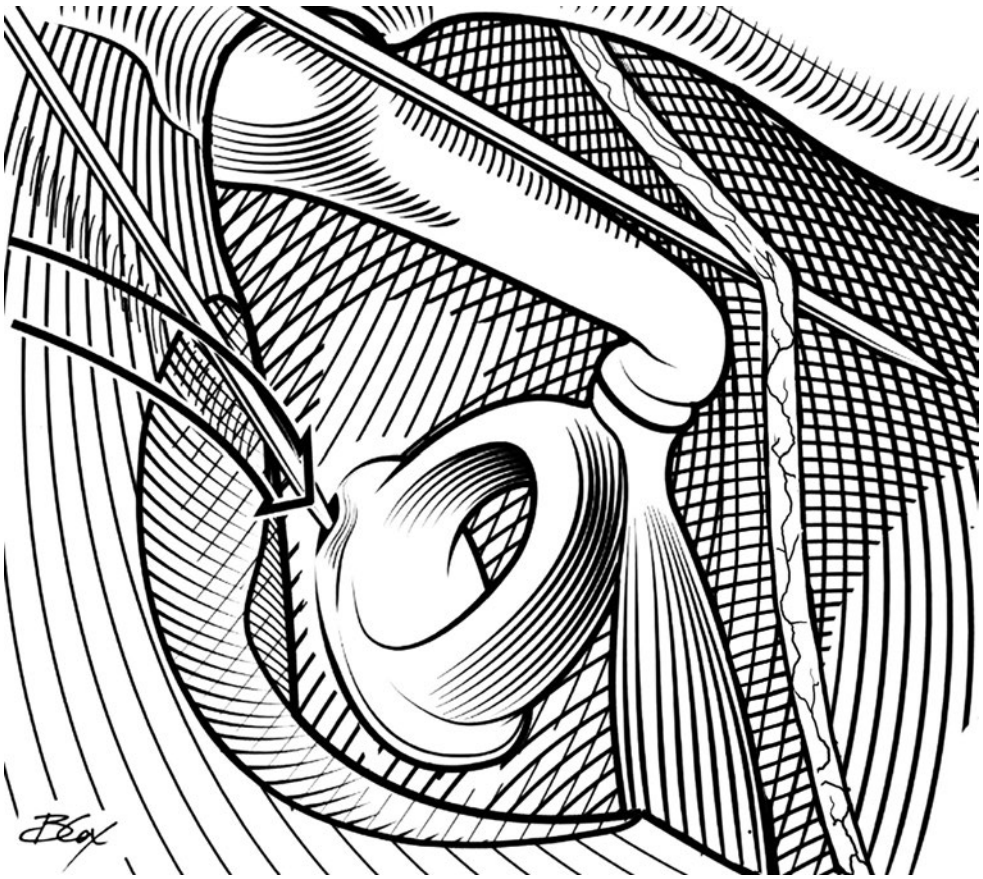


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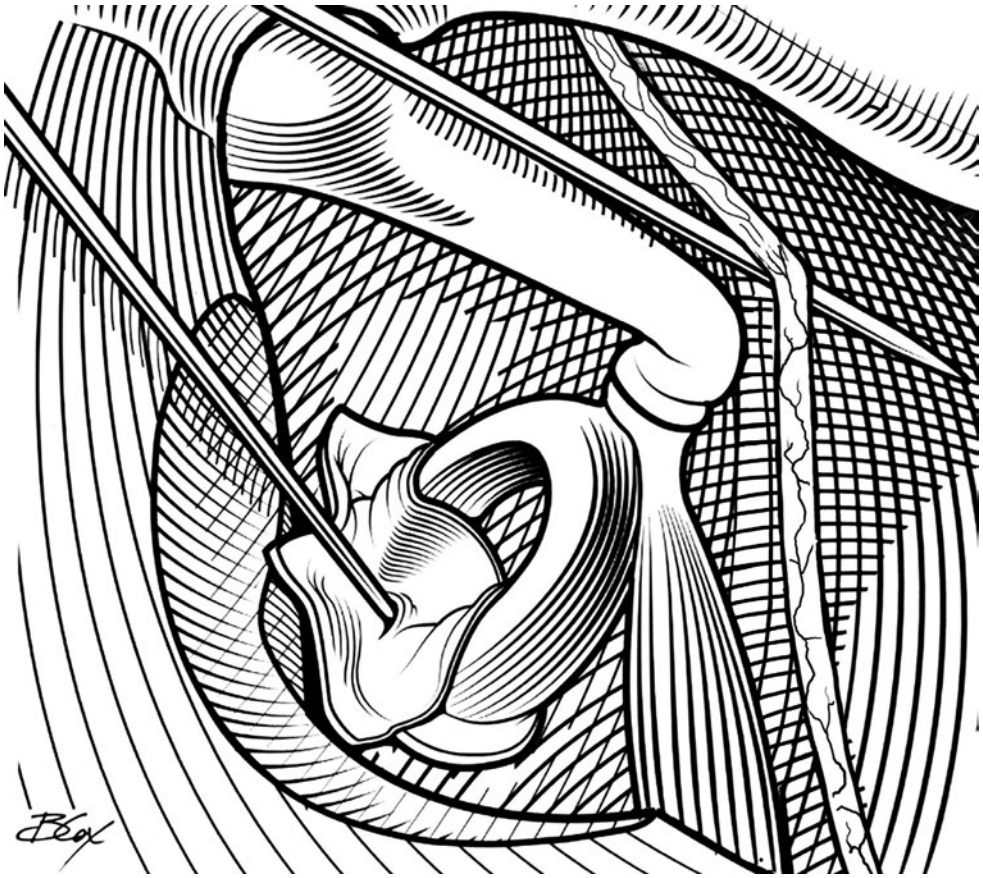


d

Fig. 7.1c,d

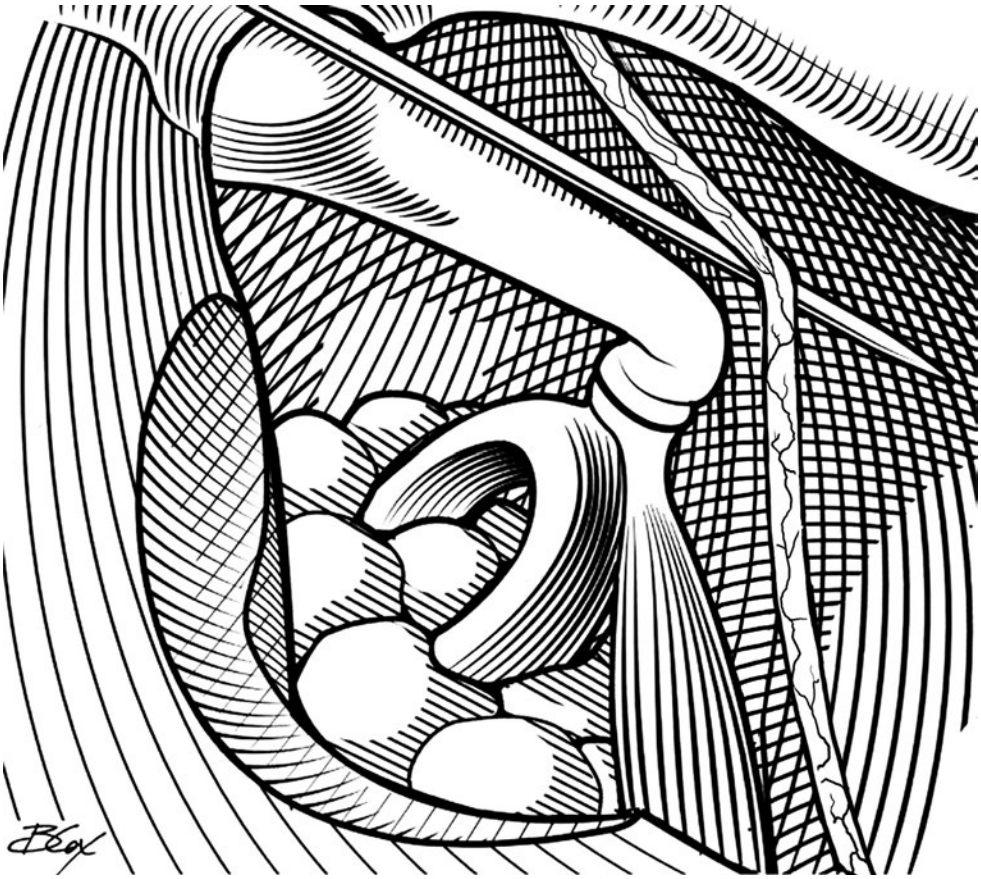


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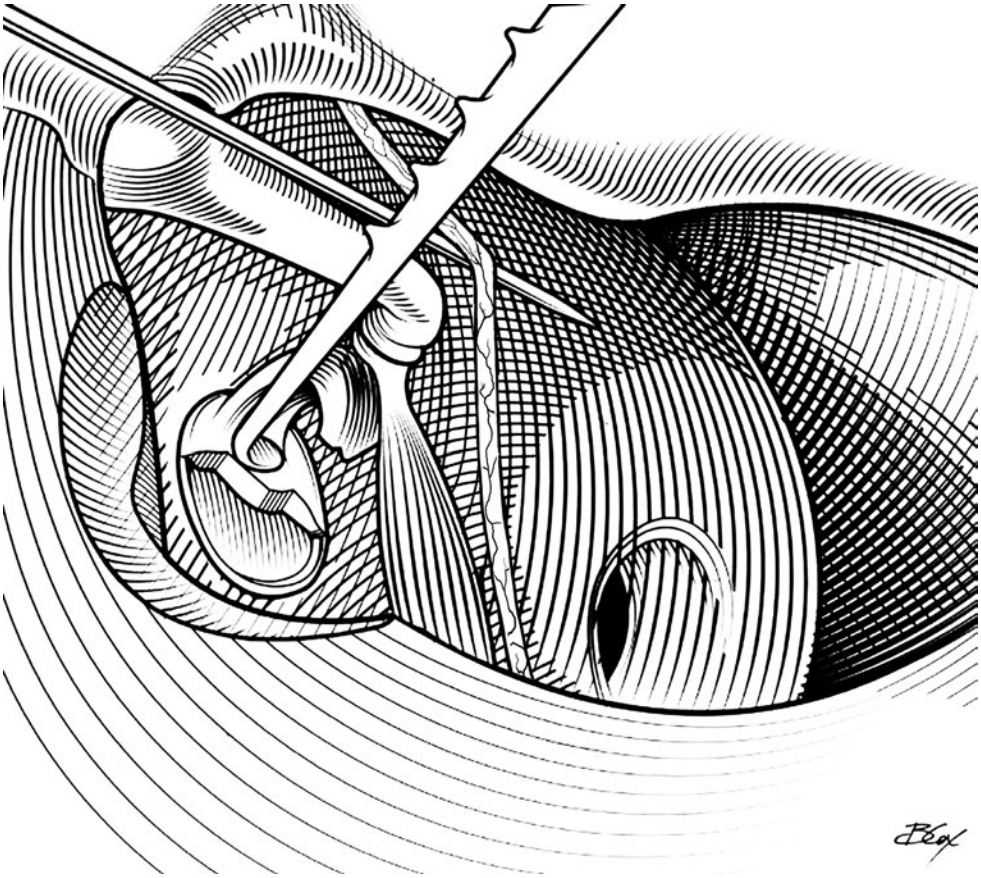


f

Fig. 7.1e,f

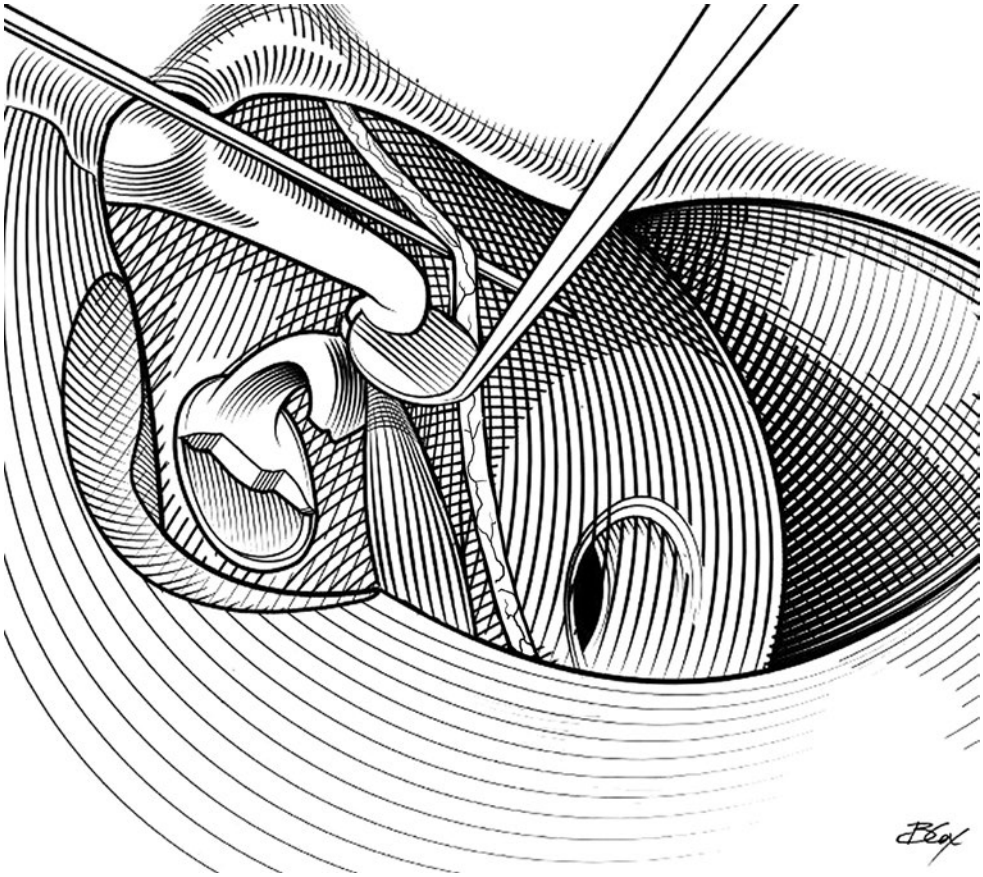


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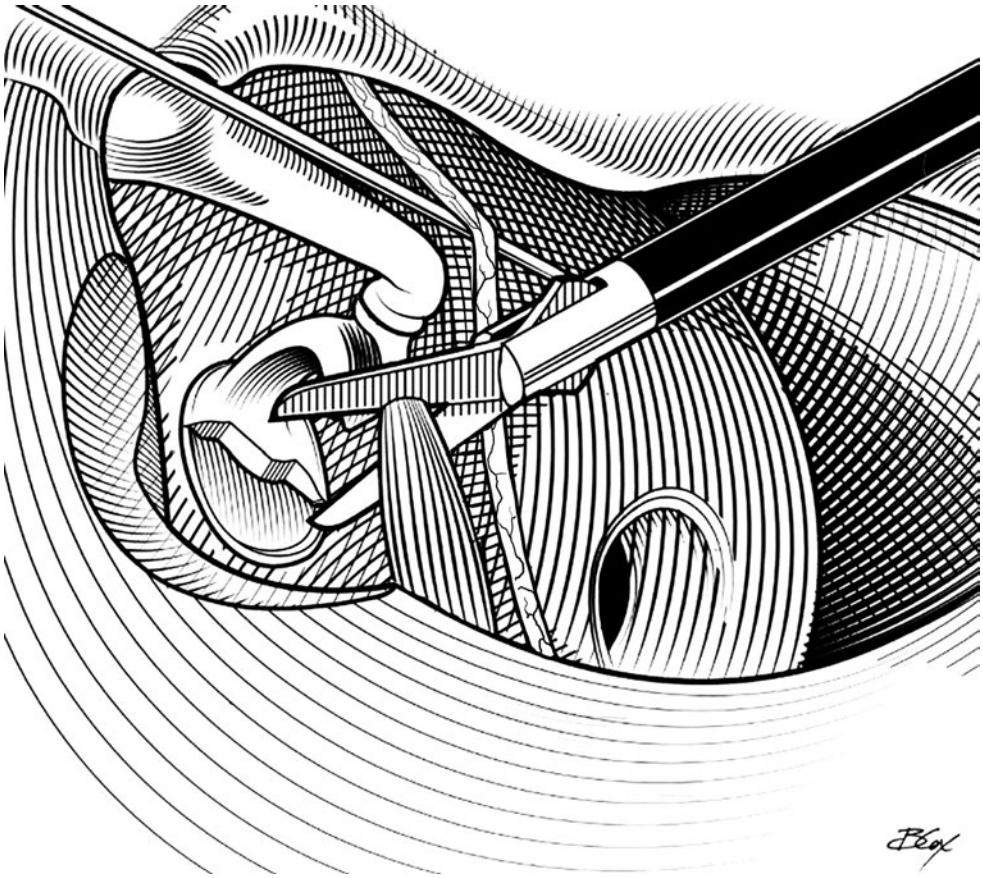


h

Fig. 7.1g,h

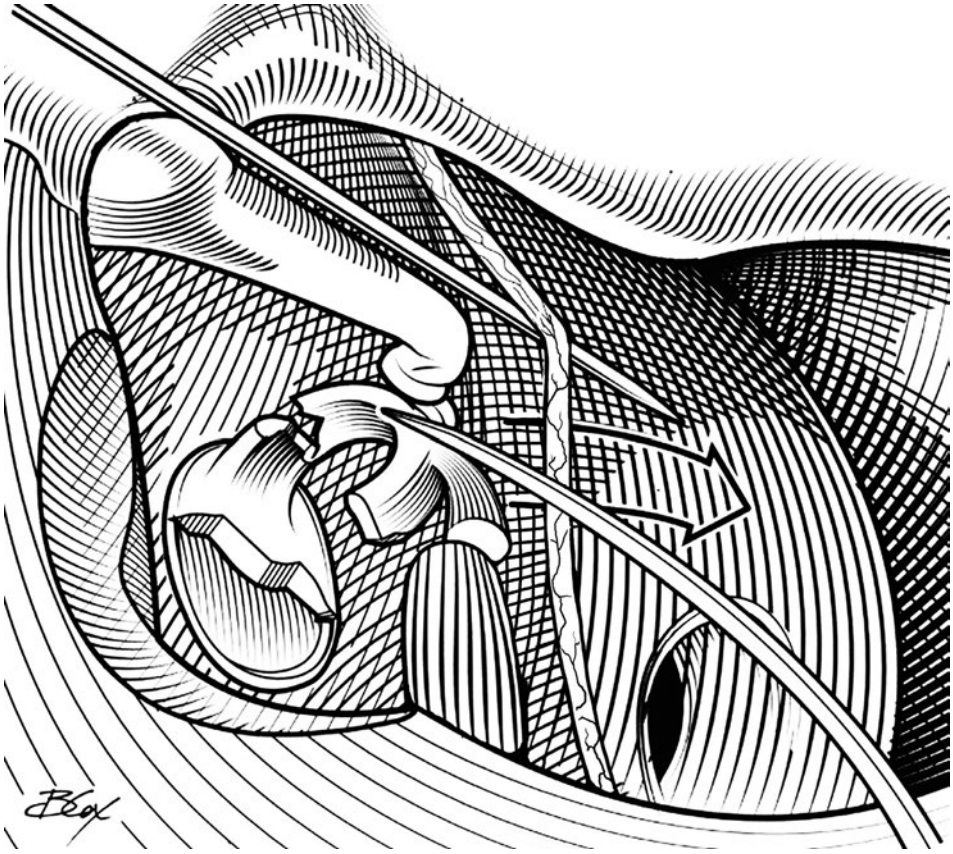


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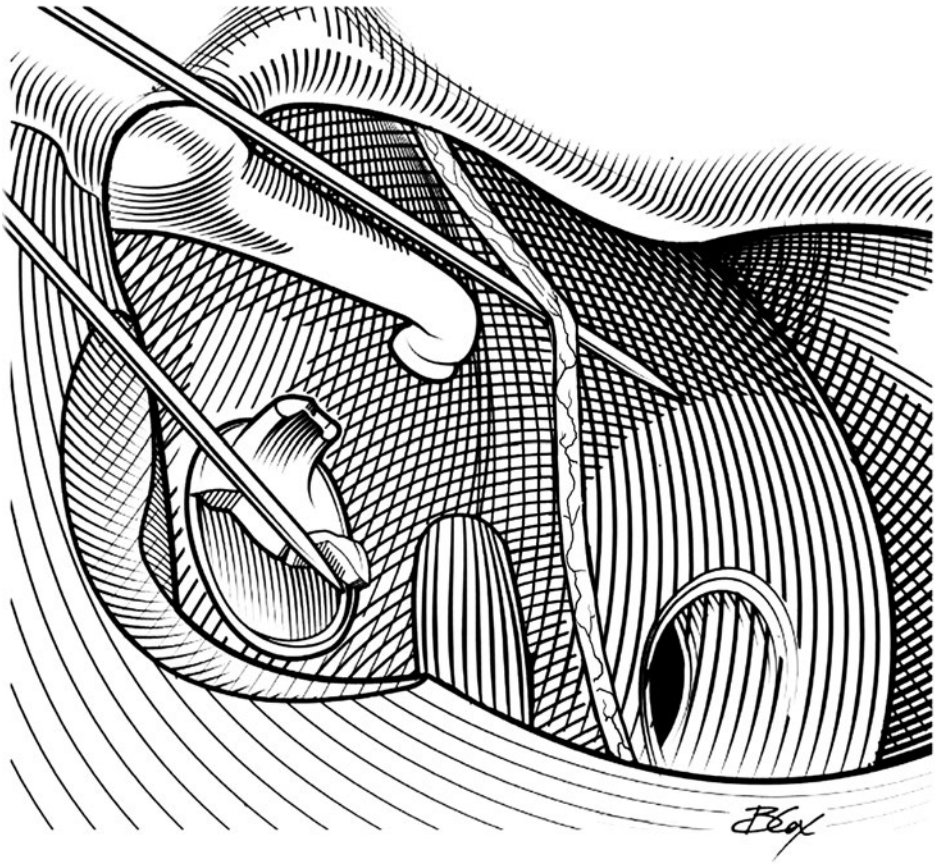


j

Fig. 7.1i,j

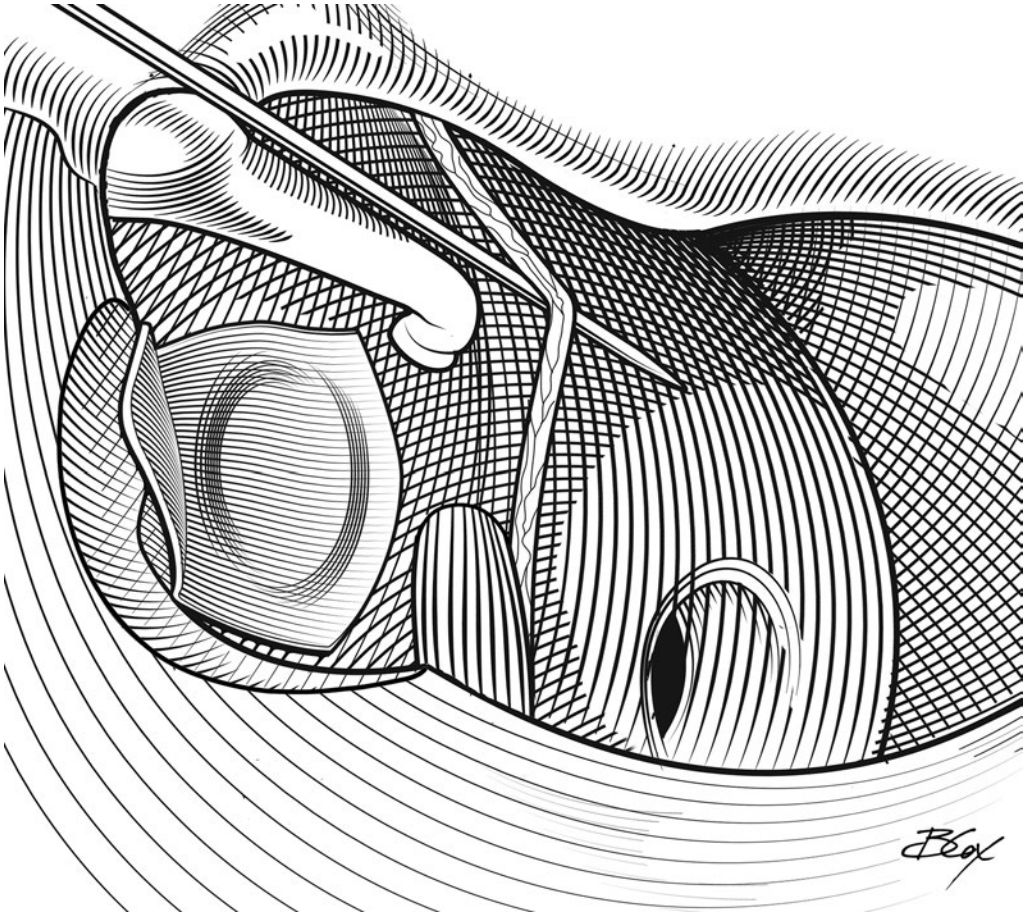


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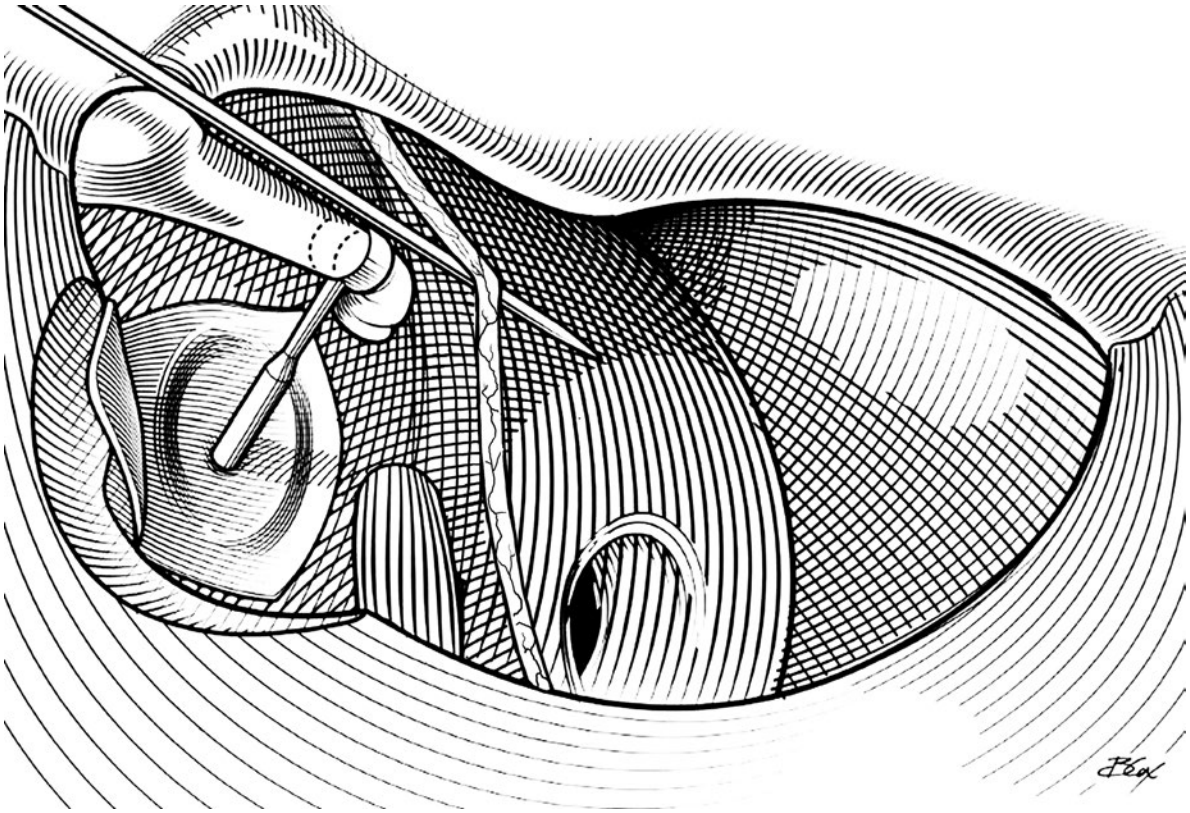


l

Fig. 7.1k,l



m



n

Fig. 7.1m,n

8 Cochlear Implantation

John H. Greinwald Jr., Douglas R. Sidell, and Aliza P. Cohen

Over the past two decades, cochlear implantation (CI) has been shown to be a safe and effective treatment for children with bilateral severe to profound sensorineural hearing loss (SNHL). To date, CI has been performed in approximately 28,000 children in the United States, yielding successful outcomes and low morbidity. Early implantation provides the potential for affected children to develop language skills similar to those in normal-hearing children. In recent years, the clinical focus has shifted to performing minimally invasive procedures that minimize postoperative morbidity and speed recovery.

8-1 Cochlear Implantation

Indications

Cochlear implantation is currently approved by the U.S. Food and Drug Administration for patients 1 year of age or older. Specific audiologic criteria for implantation vary with age. Patients younger than 24 months of age require a bilateral pure tone average (PTA) ≥ 90 dB, whereas children 24 months or older require a bilateral PTA ≥ 75 dB. Because of the risk of cochlear ossification in children with postmeningitic SNHL, many centers offer cochlear implantation to these children as early as 6 months of age.

Preoperative Evaluation

Preoperative evaluation is best performed by an interdisciplinary cochlear implant team. This team evaluates each patient's anatomy, auditory status, psychosocial characteristics, developmental milestones, and educational setting prior to developing an individually tailored management plan. Computed tomography (CT) scans are obtained to evaluate the temporal bone anatomy, including the osseous labyrinth and internal auditory canal. Magnetic resonance imaging (MRI) scans may be obtained to provide additional information about the nonosseous components of the labyrinth, the cochlear nerve, and the brainstem.

Patients should receive age-appropriate vaccinations against *Streptococcus pneumoniae* at least 2 weeks prior to implantation. Currently, children ≤ 24 months of age receive the 7-valent conjugated pneumococcal vaccine (PCV-7). Children ≥ 24 months of age receive PCV-7 as well as the 23-valent pneumococcal polysaccharide vaccine (PPV-23). Children ≥ 5 years of age receive the PPV-23 vaccine alone.

Operative Technique

1. Cochlear implantation is performed under general anesthesia without muscle paralysis to permit facial nerve monitoring. The patient is positioned supine. Intravenous antibiotics are given within 1 hour preoperatively. Monopolar cautery is not necessary.
2. The procedure begins by placing facial nerve monitor electrodes and testing the facial nerve monitoring device. An incision site is then marked approximately 0.5 cm posterior to the postauricular crease. The incision extends approximately 1.5 to 2 cm superiorly from its origin at a line perpendicular to the inferior margin of the external auditory canal. The site of placement for the receiver/stimulator (R/S) is then marked using a mock implant for reference. The head is not shaved (**Fig. 8.1a**).
3. The patient is prepped and draped in a sterile fashion and the occlusive component of a mastoid drape is used to deflect the pinna anteriorly. The incision site is then infiltrated with 1% lidocaine with 1:100,000 units of epinephrine for hemostasis. If the patient is undergoing bilateral implantation, both ears are incorporated into a single sterile field and marked for symmetry prior to draping.
4. The skin is incised, and the incision is carried down to the level of the periosteum (**Fig. 8.1b**). Exposure is maintained using skin hooks. The periosteum is incised 0.5 cm anterior to the skin incision site. The periosteal incision is carried 0.75 to 1 cm beyond the superior margin of the skin incision in a curvilinear fashion. This allows for improved access to the temporal-parietal scalp, while maintaining a small skin incision site and minimizing unnecessary soft tissue elevation. Periosteum is elevated anteriorly using a Lempert elevator.
5. A Joseph elevator is then used to back-elevate a subperiosteal flap extending approximately 1.5 cm posterior to the skin

incision site. The posterior elevation of adherent periosteum allows for the precise creation of an R/S pocket in the desired vector (**Fig. 8.1c**).

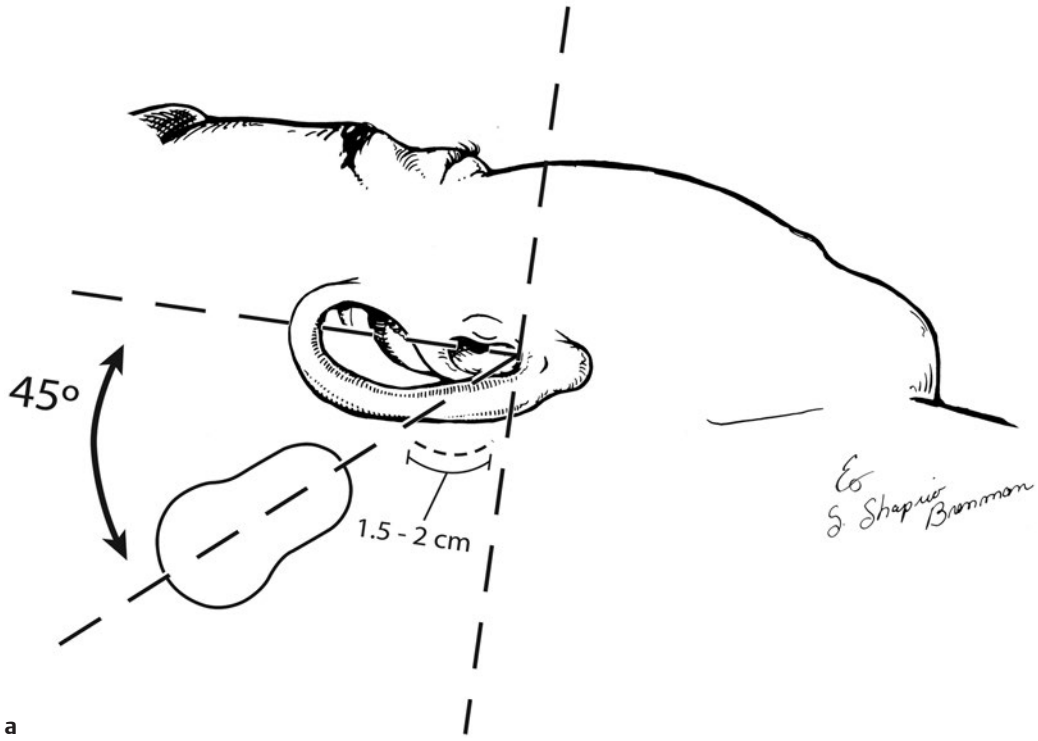
6. Creation of the R/S pocket is performed using a Freer elevator to undermine the periosteum. Approximately two-thirds of the desired pocket width is elevated. The remaining dissection is performed by inserting the mock implant into the undersized pocket, thereby allowing for a tight R/S fit and reducing the potential for migration. The requirement for securing the implant is obviated if the implant pocket is appropriately created. If a cochlear implant with a grounding electrode is used, another small pocket is created anteriorly, parallel to the temporal line (**Fig. 8.1d**).
7. Next, a self-retaining retractor or blunt retention hooks are placed, maintaining exposure of the mastoid cortex. With the mastoid cortex and posterior canal exposed, a standard cortical mastoidectomy is performed using a cutting bur (**Fig. 8.1e**).
8. With this exposure, it is possible to identify the tegmen, sigmoid sinus, and lateral semicircular canal. The facial recess is drilled with a small diamond bur, beginning adjacent to the buttress and extending inferiorly, leaving a layer of bone over the facial nerve (**Fig. 8.1f**). The location of the round window niche is visually confirmed, and the bony overhang of the niche can be removed with a diamond bur if necessary (**Fig. 8.1g**).
9. The surgical field is then copiously irrigated, removing all bone dust from the surrounding area. Fibrofatty tissue is harvested for use later in the procedure to bolster the electrode in the cochleostomy. Sterile gloves are then changed and the surgical field is over-draped with fresh sterile towels.
10. A cochleostomy is performed with a tapered 1-mm diamond bur, and the scala tympani is entered just anteroinferior to the round window membrane (**Fig. 8.1g**).
11. The implant is soaked in bacitracin-instilled saline and then placed within the previously created subperiosteal R/S pocket (**Fig. 8.1h**). If a grounding electrode is present, it is placed in the previously created anterior pocket parallel to the temporal line.
12. The electrode array is then completely inserted into the cochleostomy utilizing a gold-plated electrode guide and jeweler forceps (**Fig. 8.1i**).
13. Next, previously harvested fibrofatty tissue is cut into three pieces and placed circumferentially around the base of the electrode. The remaining slack of the electrode lead is coiled in the mastoid cavity.
14. Neural response telemetry can be performed during closure. The periosteum and muscle over the mastoid defect and cochlear implant are closed using 3-0 Vicryl (Ethicon) suture in an interrupted fashion. The periosteum is closed from a superior to inferior direction extending away from the array, thus preventing inadvertent damage (**Fig. 8.1j**). A subcuticular layer is approximated using 4-0 Vicryl suture in an interrupted fashion. The skin is closed using a 5-0 plain gut suture in a running fashion (**Fig. 8.1k**). A mastoid dressing is then placed.
15. A 7-day course of antibiotics is administered during the postoperative period. A neoprene mastoid band is worn for 10 days following implantation.

Pearls and Pitfalls

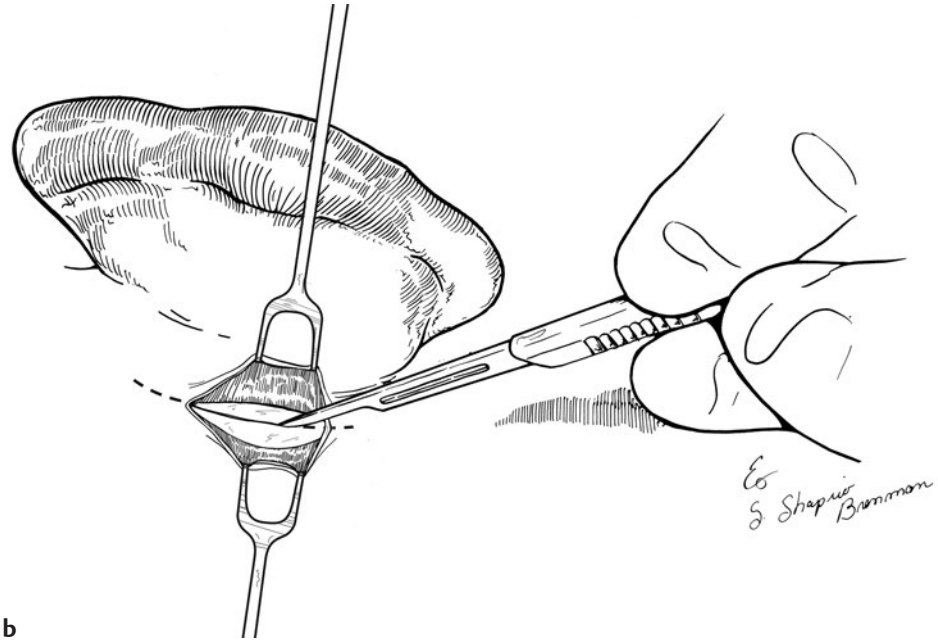
1. Monopolar cautery is not required in this procedure and is therefore not included on the instrument tray. This prevents inadvertent injury to the implant and is an important consideration in bilateral implant procedures.
2. Marking of the proper implant location is performed prior to placing a clear mastoid drape. This allows for the marking to be seen throughout the procedure without being smudged or wiped clean prior to implant placement.
3. When creating the implant R/S pocket, it is important to bolster against unwanted dissection superior or anterior to the desired pocket location. This is achieved by holding one hand firmly against the patient at the margin of the desired pocket, resisting the natural tendency for the mock implant to migrate anterosuperiorly along the path of least resistance. Failure to perform this maneuver will result in an oversized pocket and risk excessive mobility or migration of the R/S unit.
4. Drilling of the cochleostomy should be performed immediately adjacent to the round window membrane in an anteroinferior location. This allows for rapid entrance into the proximal scala tympani. In addition, it prevents inadvertent entry into the scala vestibuli, particularly when drilling a right-sided cochleostomy.

Complications

1. Implant migration or exposure
2. Soft tissue infection or necrosis
3. Implant malfunction or damage
4. Vertigo
5. Facial nerve injury
6. Facial nerve stimulation with implant

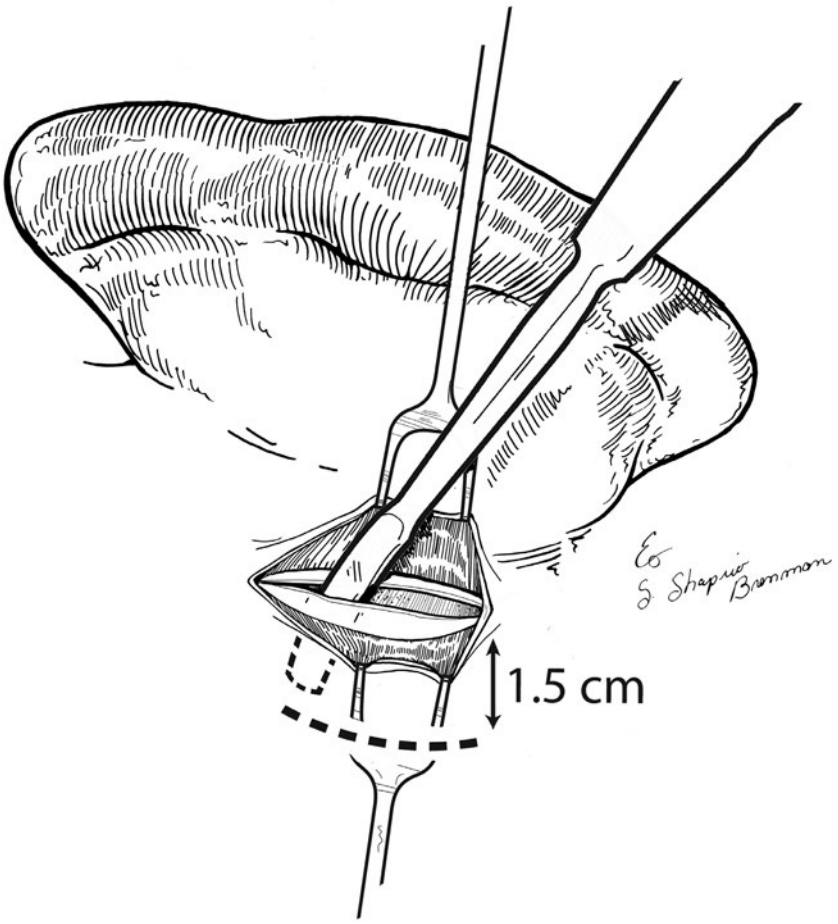


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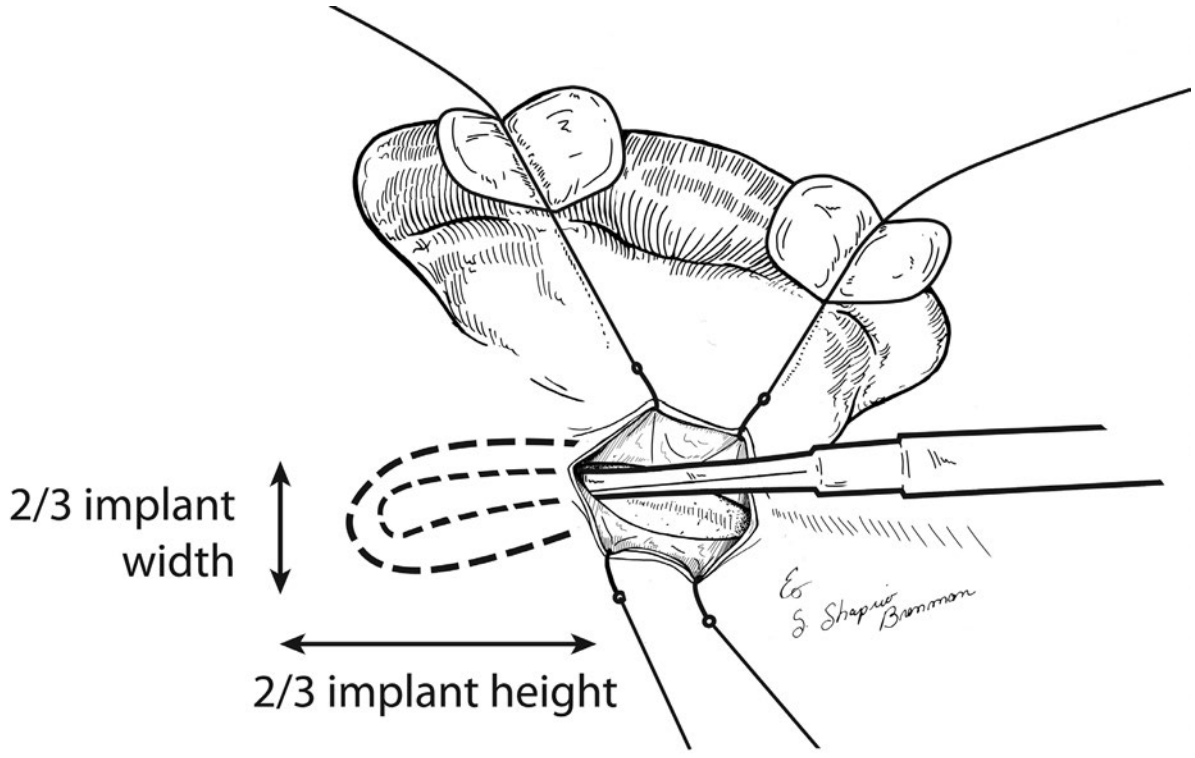


b

Fig. 8.1a,b

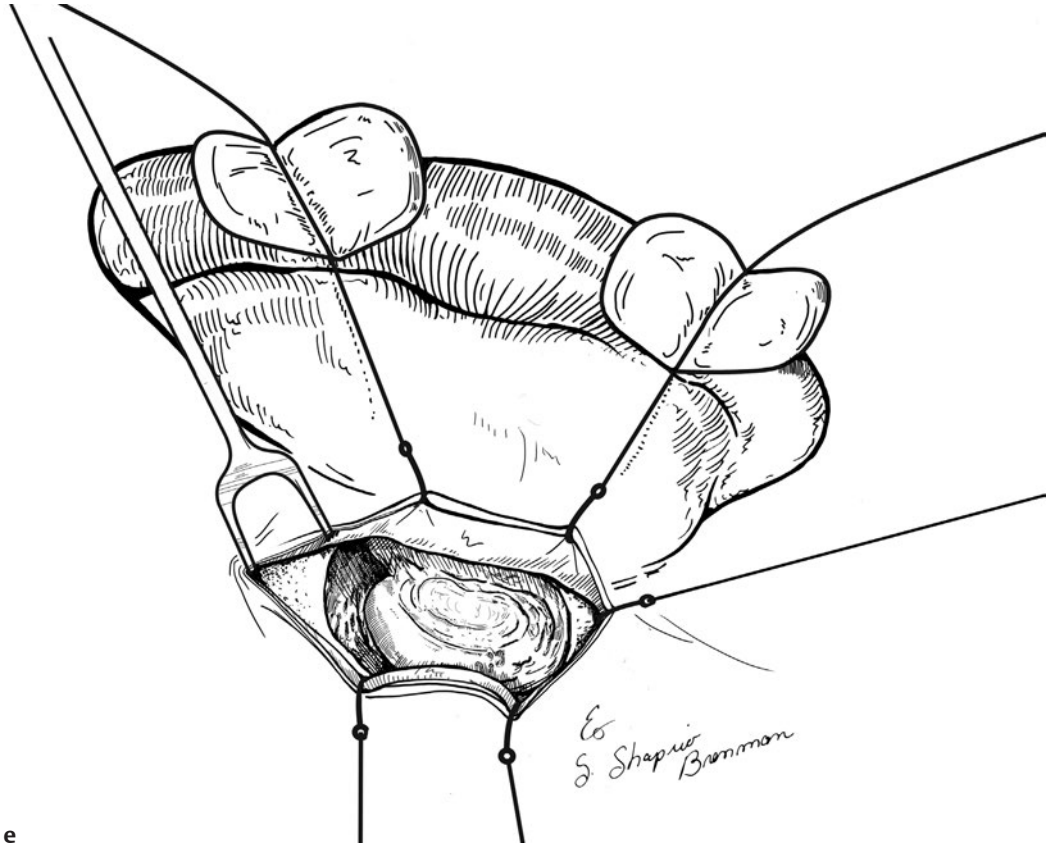


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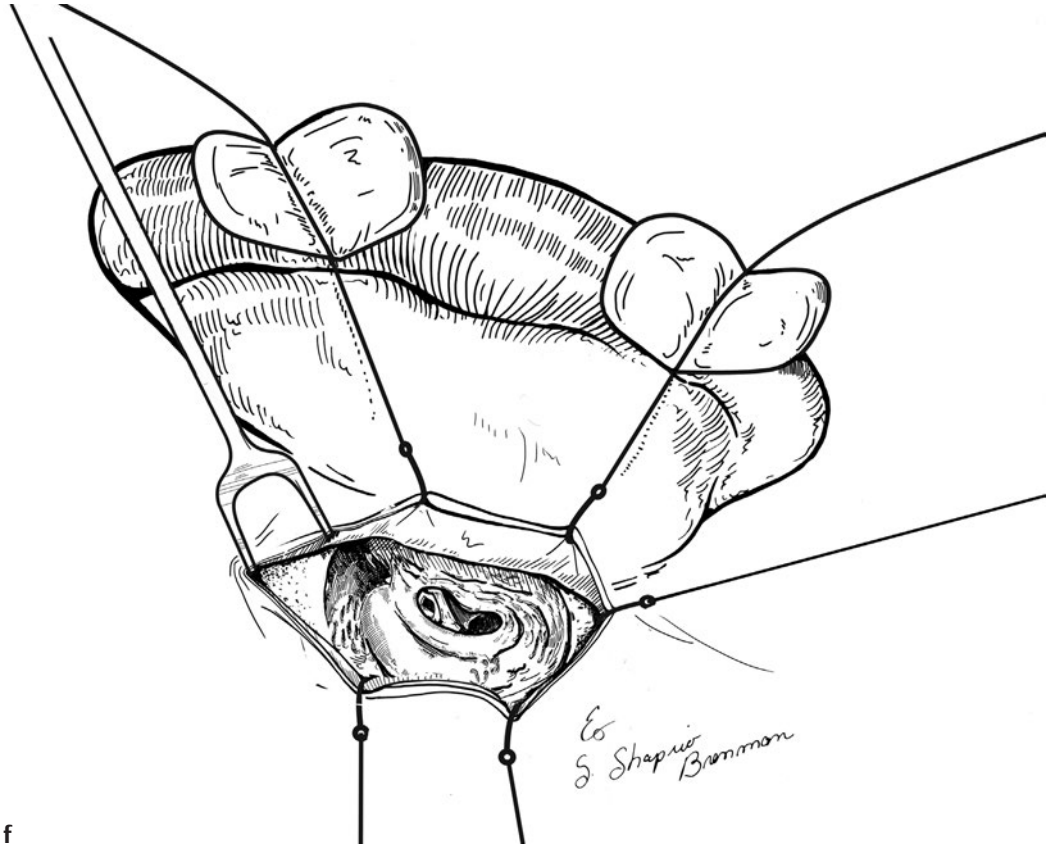


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Fig. 8.1c,d

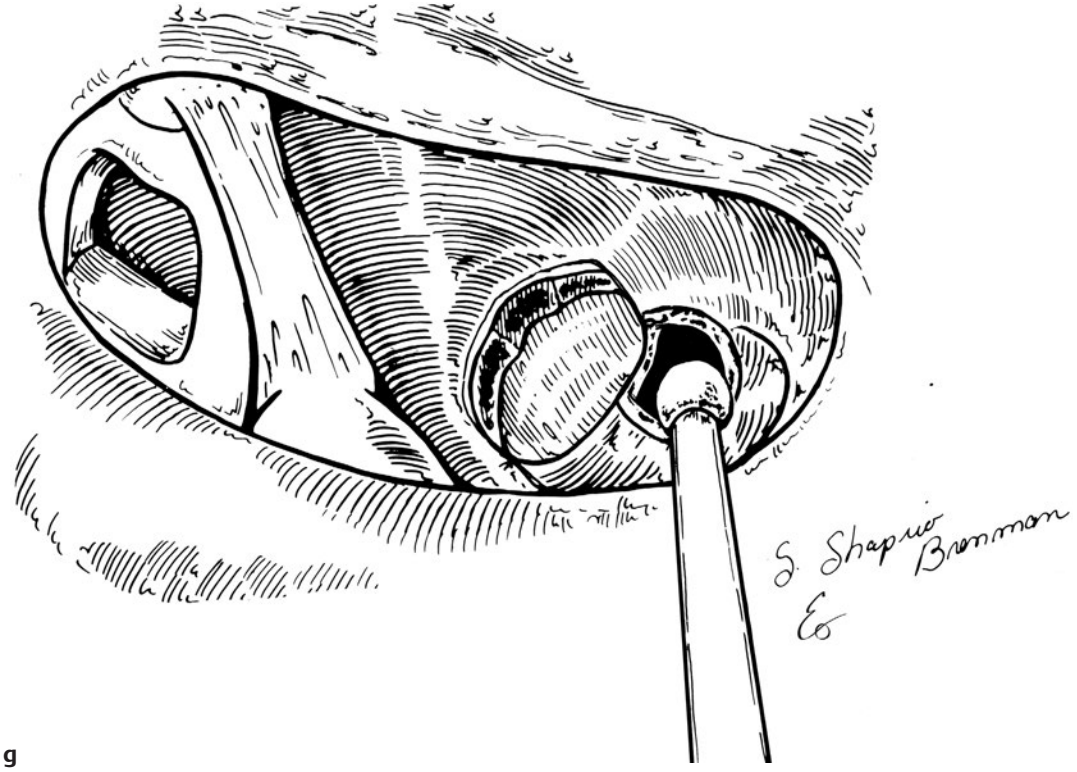


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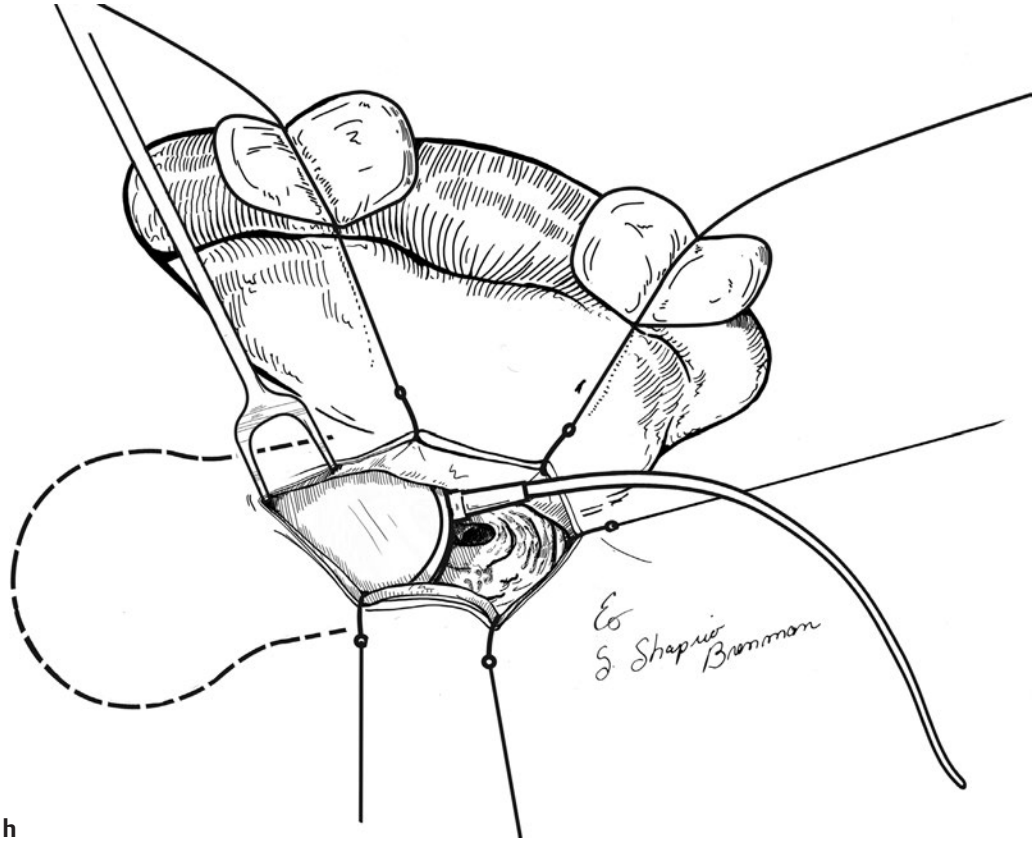


f

Fig. 8.1e,f

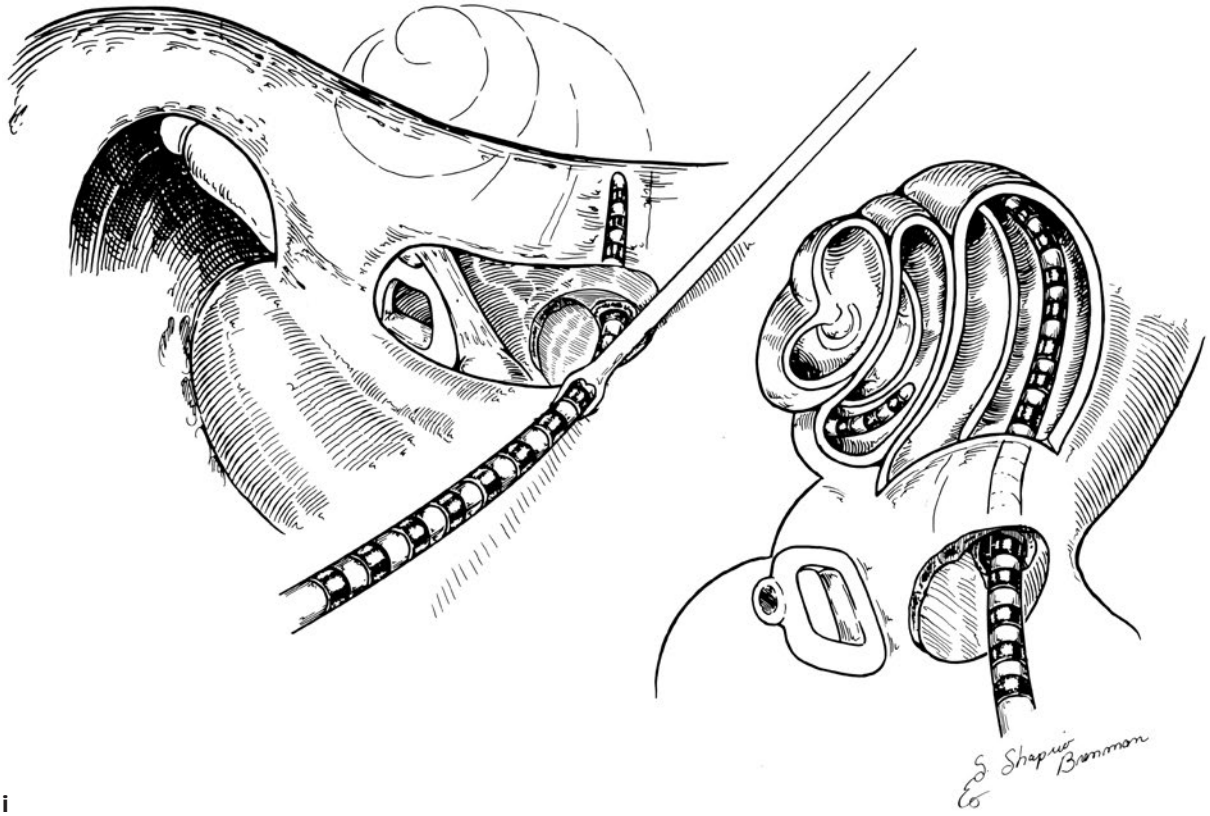


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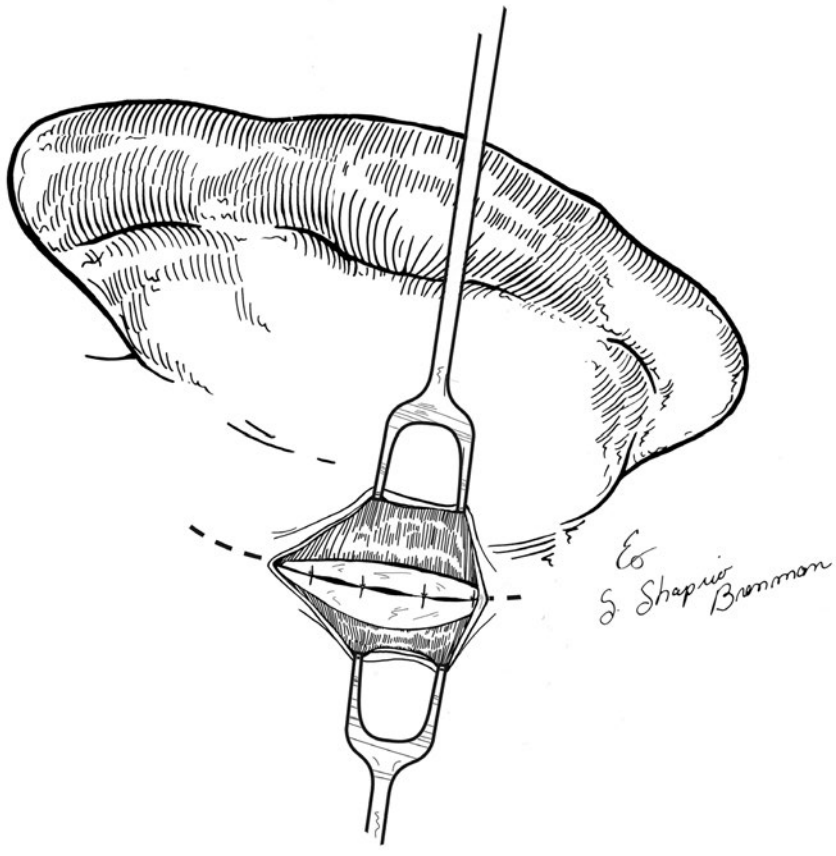


h

Fig. 8.1g,h

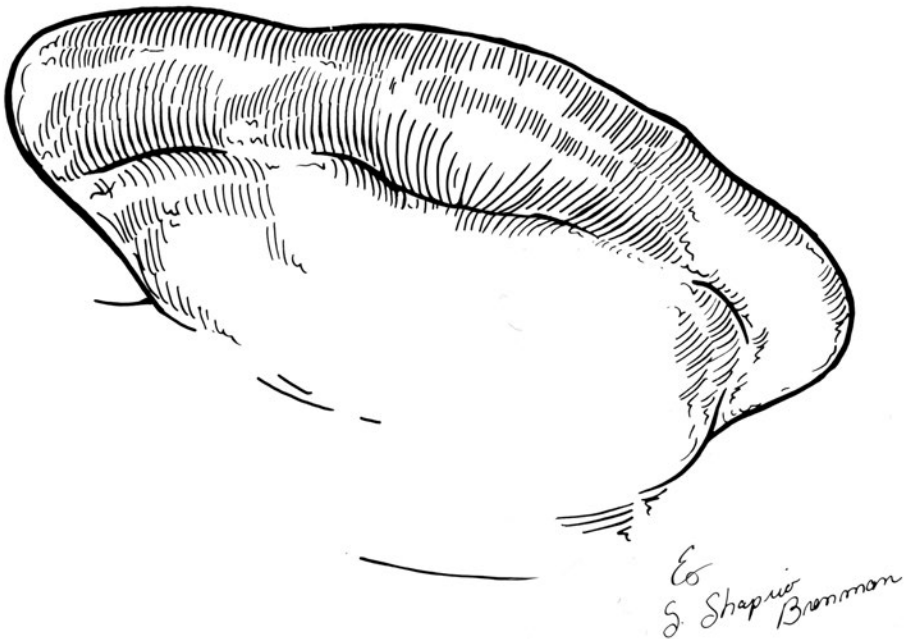


i



j

Fig. 8.1i,j



k

Fig. 8.1k

9 Bone-Anchored Cochlear Stimulator

John H. Greinwald Jr., Douglas R. Sidell, and Aliza P. Cohen

Bone-anchored cochlear stimulators rely on bone vibration to transmit environmental sound stimuli to the cochlea. They provide an alternative for patients who cannot take advantage of conventional hearing aids, such as those with canal atresia, a chronically draining ear, or single-sided deafness. Currently, percutaneous and nonpercutaneous implant systems exist, and both are used in the pediatric population. Multiple percutaneous systems are available and have been approved by the U.S. Food and Drug Administration for more than a decade. These systems require the placement of an abutment post that traverses the skin, extending from the mastoid cortex. The nonpercutaneous system is relatively new (2010), and only one such device is currently available. This device uses a bone-anchored magnetic plate that is coupled with an external bone oscillator and a sound processor. Both devices provide substantial improvement in hearing.

9-1 Bone-Anchored Cochlear Stimulator

Indications

Surgically implanted bone conduction hearing devices are indicated for patients 5 years of age or older who meet either of the following criteria: (1) a conductive or mixed hearing loss with bone conduction thresholds ≤ 45 dB (nonpercutaneous) or ≤ 65 dB (percutaneous); or (2) unilateral severe to profound sensorineural hearing loss with bone conduction thresholds ≤ 20 dB in the normal hearing ear.

Preoperative Evaluation

A complete medical history, a thorough physical examination, and a comprehensive audiologic assessment are required. For patients who have undergone previous mastoid surgery, imaging studies may be indicated.

Percutaneous Bone-Anchored Cochlear Stimulator

Linear Incision Technique

A percutaneous bone conduction stimulator may be surgically implanted using a variety of surgical approaches. The decision as to which approach to use is based on patient age, skin thickness, bone density, and surgical history. In general, the pediatric patient has comparatively thinner skin overlying the mastoid bone. In the absence of anatomic abnormalities involving the postauricular skin or underlying mastoid, the linear-incision technique is an excellent surgical approach.

Operative Technique

1. Implantation of a percutaneous bone conduction device is performed with the child under general anesthesia. Intravenous antibiotics are administered within 1 hour preoperatively. The patient is placed in a supine position so that the postauricular skin of the ear to be operated on is readily visible.
2. A vertical incision site is then marked approximately 5 cm from the external auditory canal and at a 45-degree angle from the vertical axis. Hair located at the proposed incision site and transcutaneous abutment site is shaved (**Fig. 9.1a**).
3. The patient is then prepped and draped in a sterile fashion and the area previously marked is infiltrated with 1% lidocaine with 1:100,000 units of epinephrine.
4. A tangential incision is made in the area previously marked to transect hair follicles at the incision site and simultaneously undermine soft tissue overlying the mastoid cortex (**Fig. 9.1b**).
5. Tissue reduction is performed by removing a bulk of underlying soft tissue from the proposed abutment site. A 1-cm diameter circle of underlying periosteum is excised (**Fig. 9.1c**).
6. A pilot hole is drilled with a supplied guide drill and spacer. This is performed with the drill set at a high-speed setting (approximately 2,000 rpm). The depth of the drill hole is checked intermittently (visually or by palpation with an

instrument) to assure that the inner cortex of the mastoid has not been violated. The spacer may be removed to assure adequate depth if necessary (**Fig. 9.1d**).

7. A countersink is created using a widening drill at 2,000 rpm. This is 3 to 4 mm in diameter. The tip of the widening drill is blunt; however, over-drilling risks inadvertent dural injury, and caution must be exercised despite this safety mechanism.
8. The implant and abutment are then placed using a supplied abutment inserter. Drill settings are reduced to a torque limit of approximately 20 to 25 newton cm (N cm). The implant is placed without irrigation until multiple threads of the abutment have engaged the cortical bone (**Fig. 9.1e**).
9. After the implant is seated and maximal torque settings have been achieved, the drill handpiece is removed from the abutment. A supplied abutment wrench can then be used to tighten the abutment an additional one-quarter turn.
10. A second "sleeper" implant abutment is placed in an identical fashion. The location of the implant should be approximately 15 mm inferior and posterior to the first abutment. Inadvertent risk of transverse sinus injury can be avoided by avoiding the placement of the second implant directly posterior to the first.
11. A flat cover screw is placed in the second implant at the abutment insertion site. This will inhibit tissue accumulation within the internal threads of the sleeper implant.
12. The wound is copiously irrigated with antibiotic irrigation prior to closure. The skin incision is then closed superficially with a 3-0 running chromic suture.
13. Following skin closure, a 4-mm biopsy punch is used to create a skin defect directly over the abutment site. This allows for the abutment to breach the skin surface adjacent to the previously closed incision (**Fig. 9.1f**).
14. A healing cap is placed over the abutment (**Fig. 9.1g**).
15. A 7-day course of antibiotics is administered during the postoperative period, and a neoprene mastoid band is worn for 2 days following implantation. The audio processor is placed 2 months postoperatively.

Alternative Percutaneous Surgical Techniques

Dermatome/Skin Flap Technique

This technique is frequently used for older patients or patients with thicker skin. It involves the creation of a medially based, U-shaped soft tissue flap. The skin flap can be elevated separately from the underlying soft tissue by first using a dermatome. The underlying soft tissue is ultimately excised from the area surrounding the abutment site prior to placement of the implant.

Two-Stage Technique

The two-stage technique is used primarily in patients with poor bone density or with very thin cortical bone. The first stage of this method involves the placement of the implant and the removal of the buttress from the implant site prior to closure. A flat screw is placed in the implant to inhibit tissue accumulation within the internal threads prior to the second stage. The second stage is performed only after the implant has undergone osseointegration over a predetermined period of time. This stage involves exposing the implant site and placing the abutment. A defect is created in the skin overlying the abutment in a fashion similar to that used in single-stage procedures.

Pearls and Pitfalls

1. Because of an increased rate of failed osseointegration in children, the simultaneous placement of a second sleeper implant is an important consideration.
2. Improper drill settings may result in over-torque of the implant post. If the implant continues to rotate despite the flange being flush with the cortex of the mastoid, a new implant site should be created.
3. Appropriate subcutaneous tissue removal is extremely important, as it decreases the likelihood of wound complications.

Complications

1. Cerebrospinal fluid leak
2. Intraoperative soft tissue injury with skin flap technique
3. Failure of osseointegration
4. Pain at abutment site
5. Skin or bone overgrowth at abutment site
6. Surgical site infection
7. Skin flap necrosis

Nonpercutaneous Bone-Anchored Cochlear Stimulator

The benefits of the nonpercutaneous cochlear stimulator include the lack of hair follicle sacrifice intraoperatively, a shorter postoperative recovery time prior to placement of the sound processor, and a decreased potential for soft tissue complications.

Operative Technique

1. Implantation of a nonpercutaneous bone conduction device is performed with the child under general anesthesia. Intravenous antibiotics are administered within 1 hour preoperatively. The patient is placed in a supine position so that the postauricular skin of the ear to be operated on is readily visible.
2. The incision site and implant location are marked using a template. The location of the implant should be approximately 5 to 6 cm from the external auditory canal and oriented at a 45-degree angle from the vertical axis. To facilitate skin closure, hair at the proposed incision site may be shaved preoperatively; however, extensive shaving is not necessary (**Fig. 9.1h**).

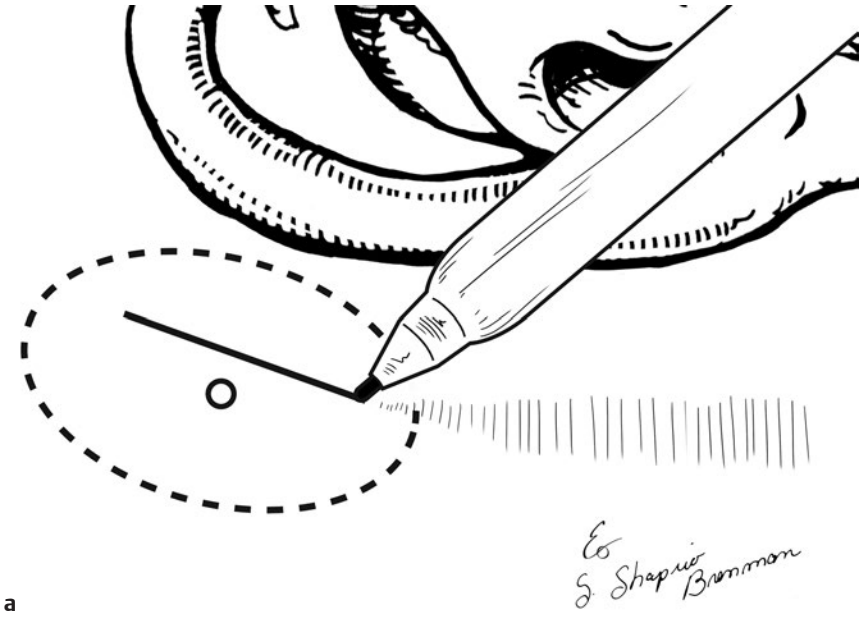
3. The patient is prepped and draped in a sterile fashion, and the area previously marked is infiltrated with 1% lidocaine with 1:100,000 units of epinephrine. An incision is made through the skin and carried deep to the periosteum of the mastoid cortex (**Fig. 9.1i**).
4. A subperiosteal flap is elevated in a posterior to anterior direction, exposing the mastoid cortex. The implant is outlined with a sterile marking pen directly on the mastoid cortex by using the marks created with the template as a reference (**Fig. 9.1j**).
5. Two circular bony wells are created to allow for the titanium magnet housing to be secured flush to the underlying mastoid cortex. A cutting bur is used to drill each well to a depth of 2 mm. The superior well is drilled first (**Fig. 9.1k**).
6. Prior to drilling the second bony well, the implant is placed within the first drill site and the second well is re-marked on the mastoid cortex using a sterile marking pen. This maneuver assures that the previously marked position for the second well remains in the appropriate position.
7. The magnetic implant is seated appropriately within the superior and inferior bony wells. There are five brackets located around the margin of the implant used to secure the device to the mastoid. Each of the five brackets is then marked with a marking pen. After removal of the implant, the previously marked bracket sites are each drilled to a depth of 0.5 mm allowing the implant to lie flush with the mastoid cortex after it is secured.
8. The titanium implant is then secured to the mastoid cortex by placing five monocortical screws in a stepwise fashion. The center screw is secured first, followed by four additional screws that are placed around the implant (**Fig. 9.1l**).
9. The implant is checked to assure that it is seated flush with the mastoid cortex, and the surgical site is closed in three layers. The periosteum and muscle over the implant are closed using 3-0 Vicryl (Ethicon) suture in an interrupted fashion. A deep dermal layer is then approximated using interrupted 4-0 Vicryl suture. The skin is closed using a 5-0 plain gut suture (**Fig. 9.1m**). A mastoid dressing is placed.
10. A 7-day course of antibiotics is administered during the postoperative period, and a neoprene mastoid band is worn for 2 days following implantation. The processor is placed approximately 1 month postoperatively.

Pearls and Pitfalls

1. A history of prior mastoidectomy is not uncommon in patients undergoing implantation of bone conduction devices. The presence of a potential mastoidectomy defect must be taken into account when marking the proposed incision and implant site.
2. The inner cortex of the mastoid must not be violated during drilling. Because the implant relies on contact with bone to function, violation of the inner cortex and exposure of the dura will temporarily inhibit the effective bone-conducting ability of the implant; this will prolong the postoperative healing time prior to use of the stimulator. This is an important consideration in the pediatric patient, as the cortical depth is frequently shallow when compared to that of the adult.
3. To assure that the implant is seated flush against the mastoid cortex, it is often necessary to create a shallow well for the narrow portion of the implant connecting the superior and inferior magnet.

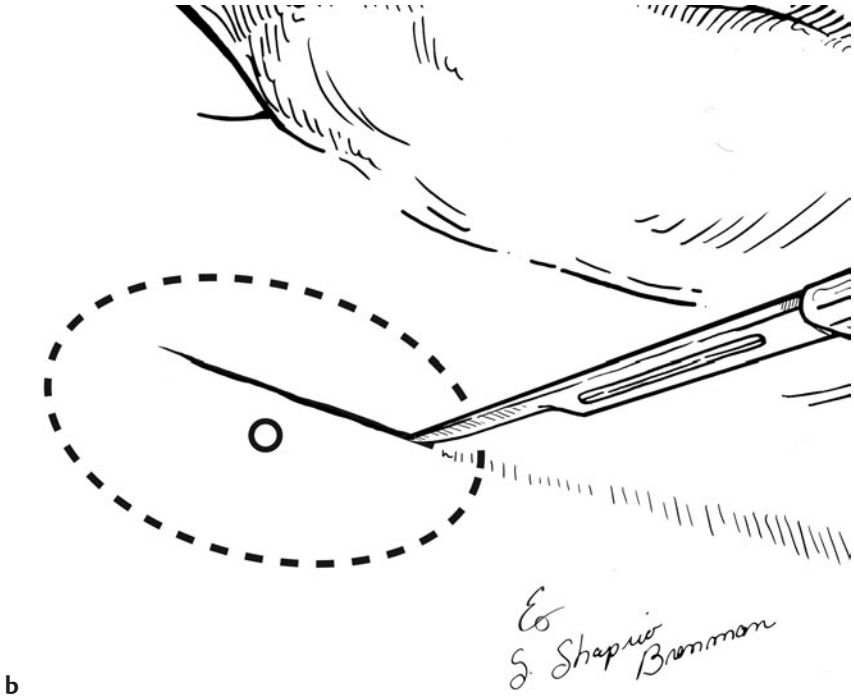
Complications

1. Cerebrospinal fluid leak
2. Mobile implant
3. Pain at implant site
4. Soft tissue infection

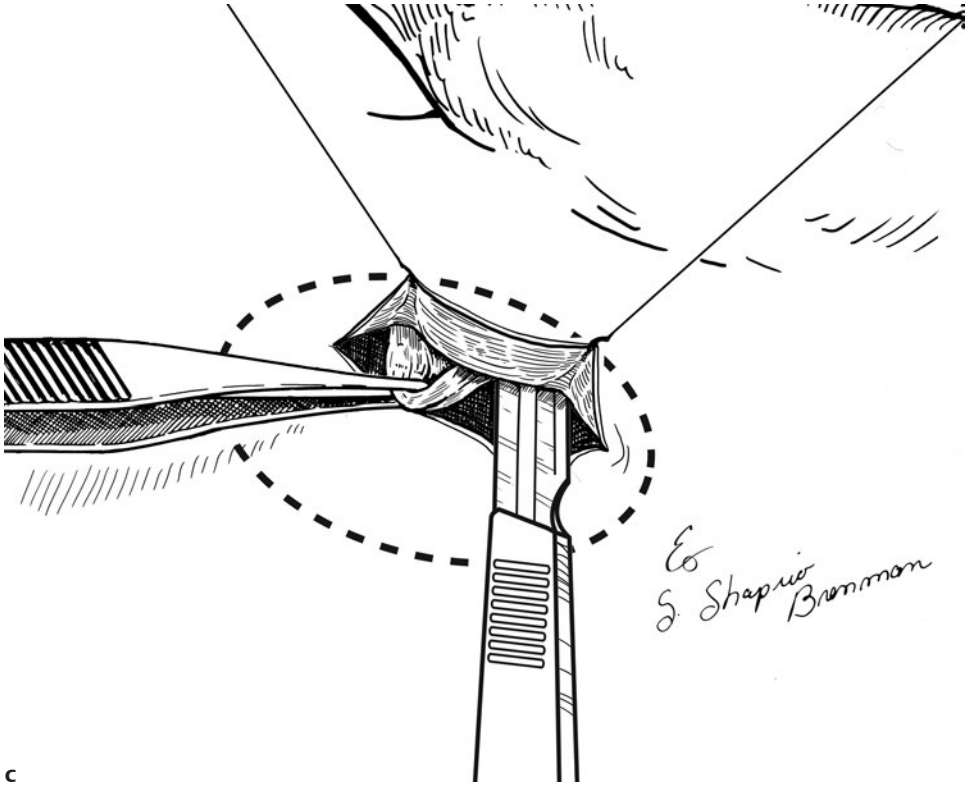


a

Fig. 9.1a



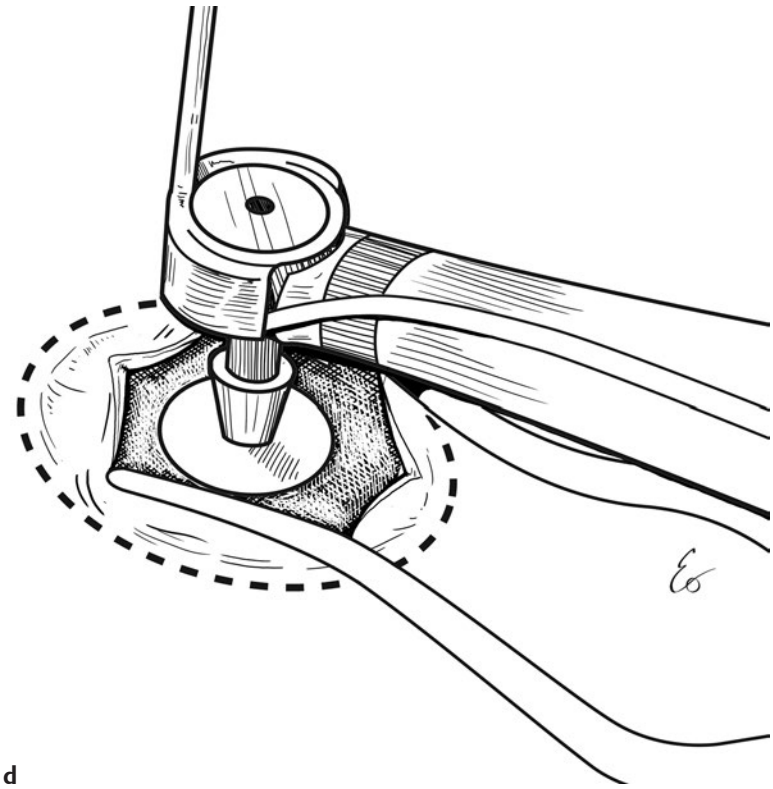
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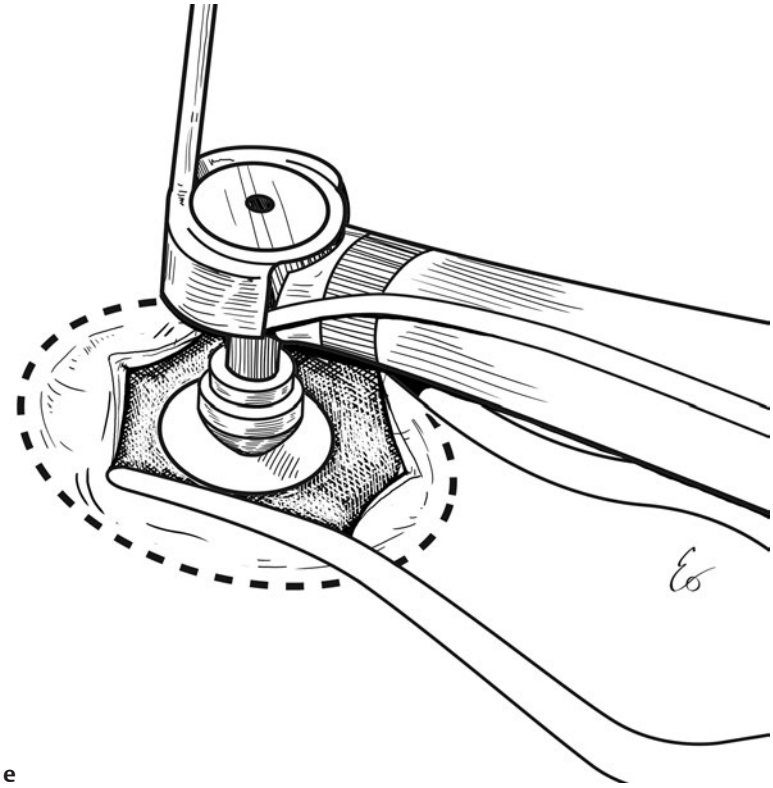
c

Fig. 9.1b,c

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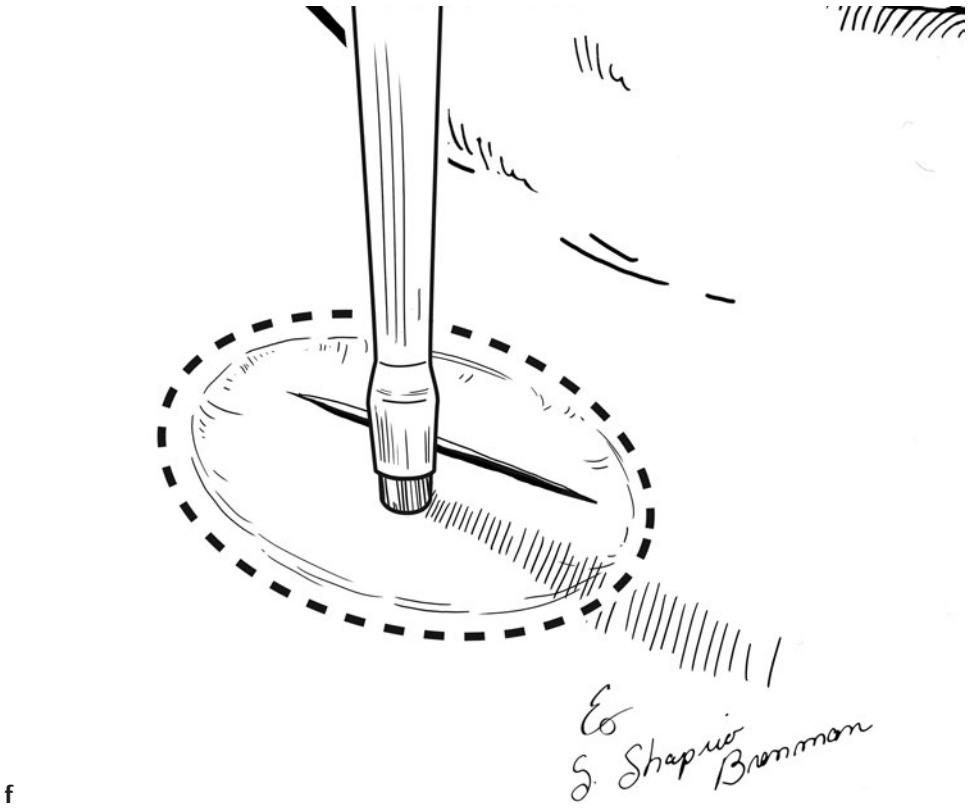
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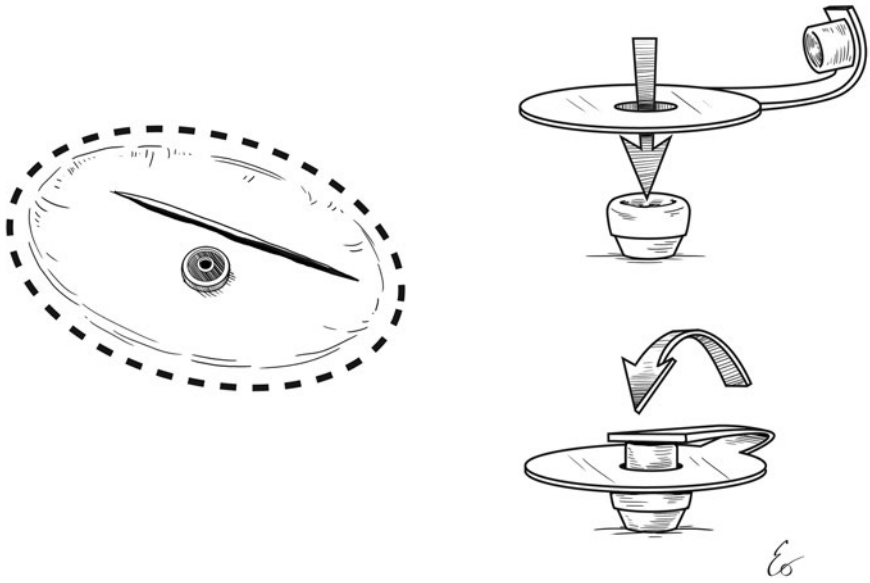
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Fig. 9.1d,e

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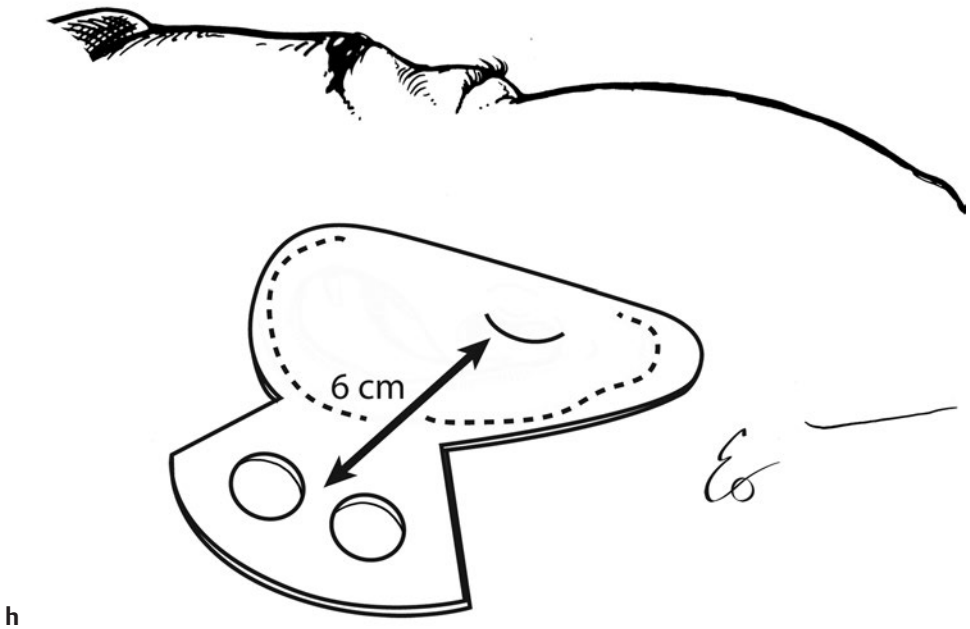


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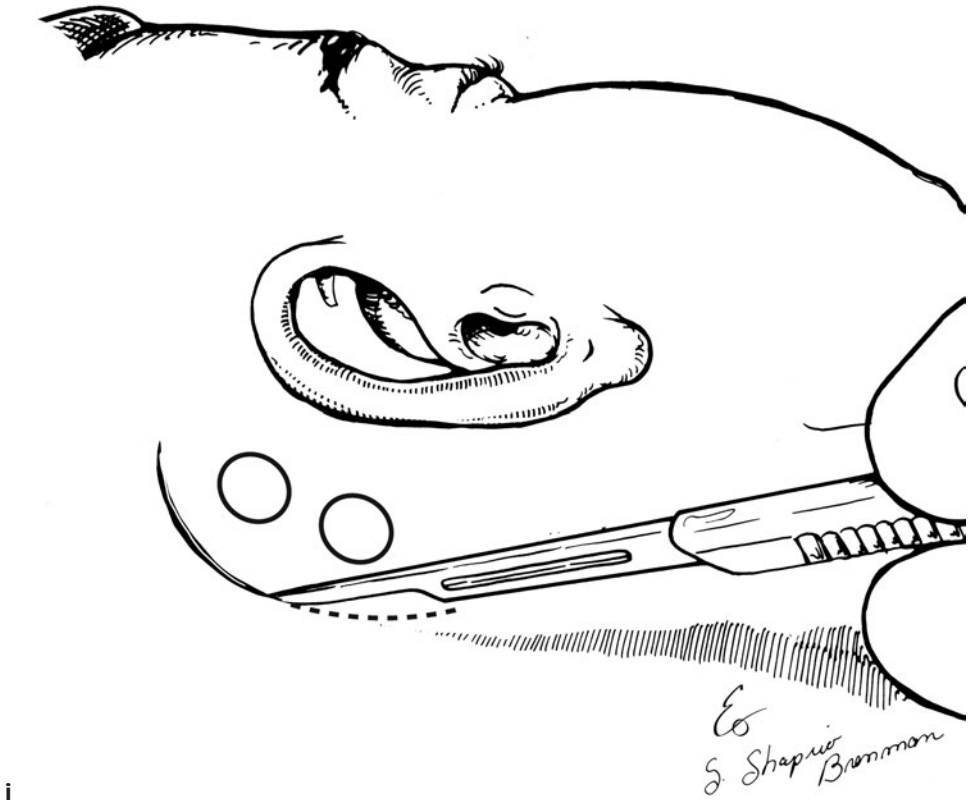


g

Fig. 9.1f,g

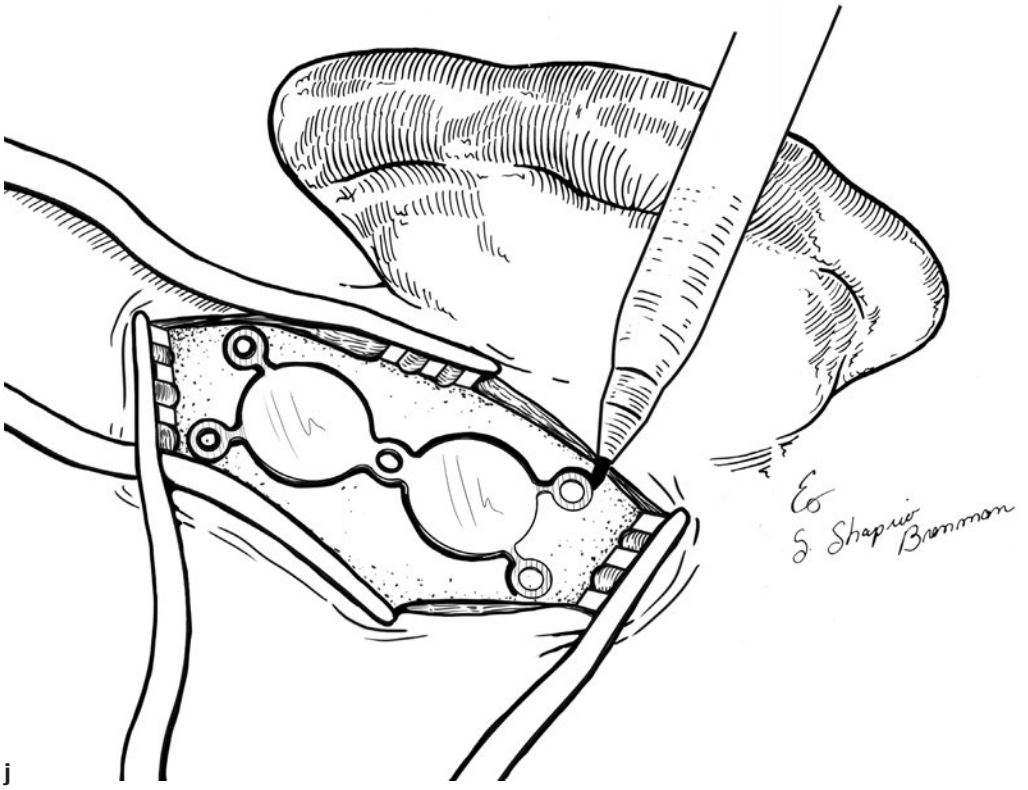


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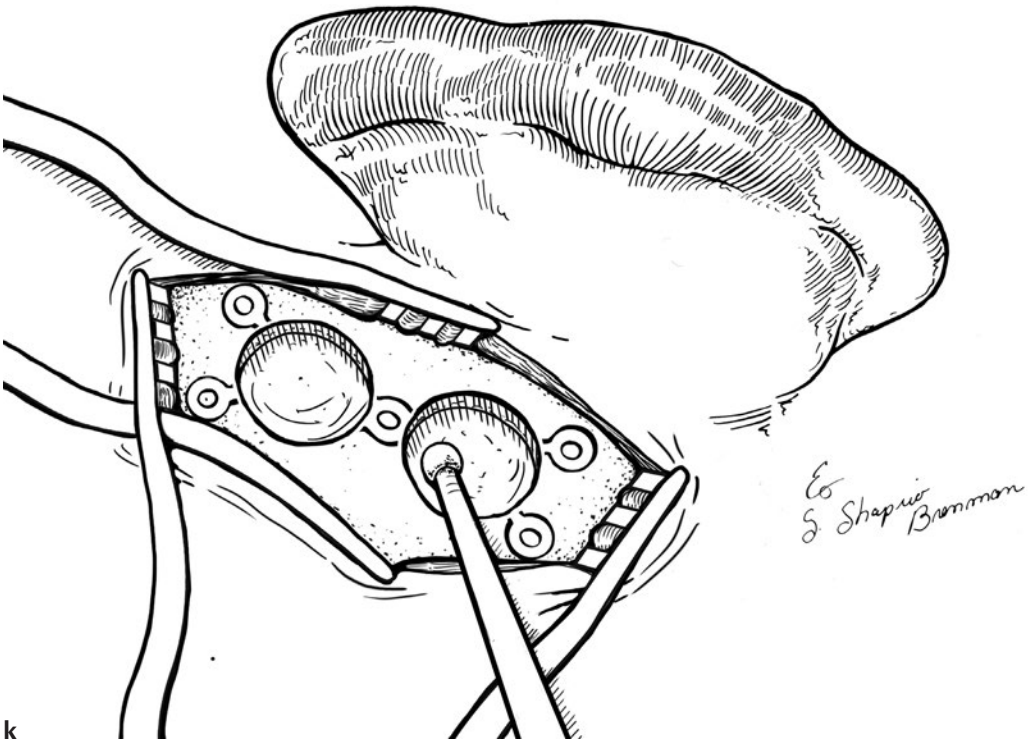


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Fig. 9.1h,i

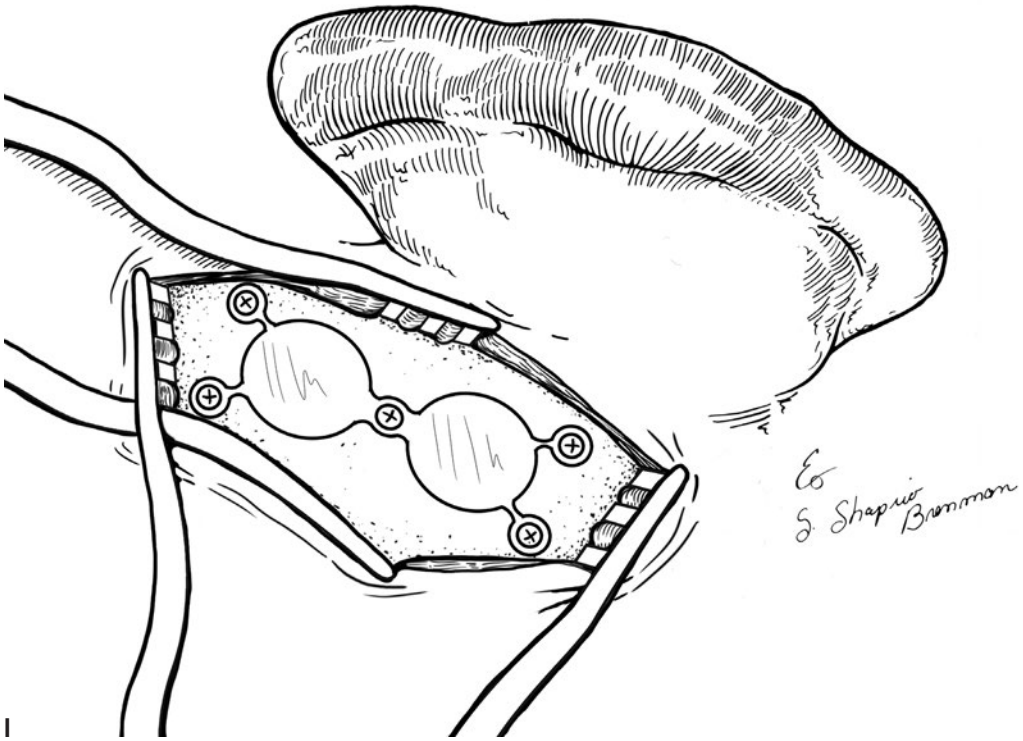


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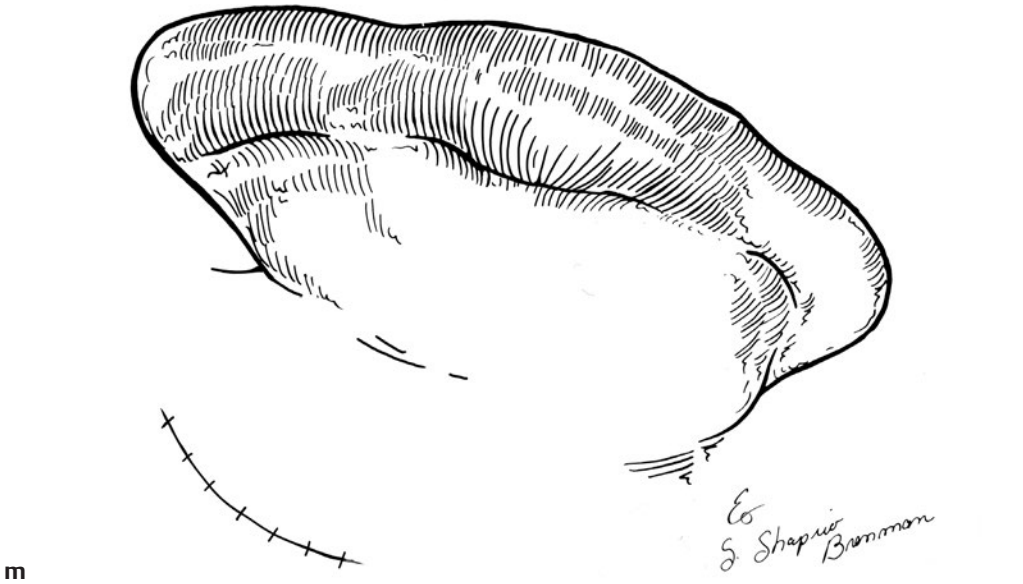


k

Fig. 9.1j,k



l



m

Fig. 9.1l,m

Section II

The Nose

II

10 Intranasal Trauma and Epistaxis

Lisa M. Elden

The majority of children who present to the clinician with epistaxis can be treated medically with ointments and saline. This chapter demonstrates surgical techniques for those who have ongoing recurrent or severe epistaxis despite medical management.

10-1 Evacuation of Septal Hematoma and Abscess

Introduction

Septal hematomas may develop following blunt nasal trauma. The septum is often fractured, but not displaced. Blood collects between the perichondrium and cartilage on one or both sides of the nose. A septal abscess can result from a hematoma that is not promptly drained.

Indications

Hematomas and abscesses must be drained expeditiously to prevent septal cartilage necrosis with loss of nasal support and a resultant saddle nose deformity.

Preoperative Evaluation

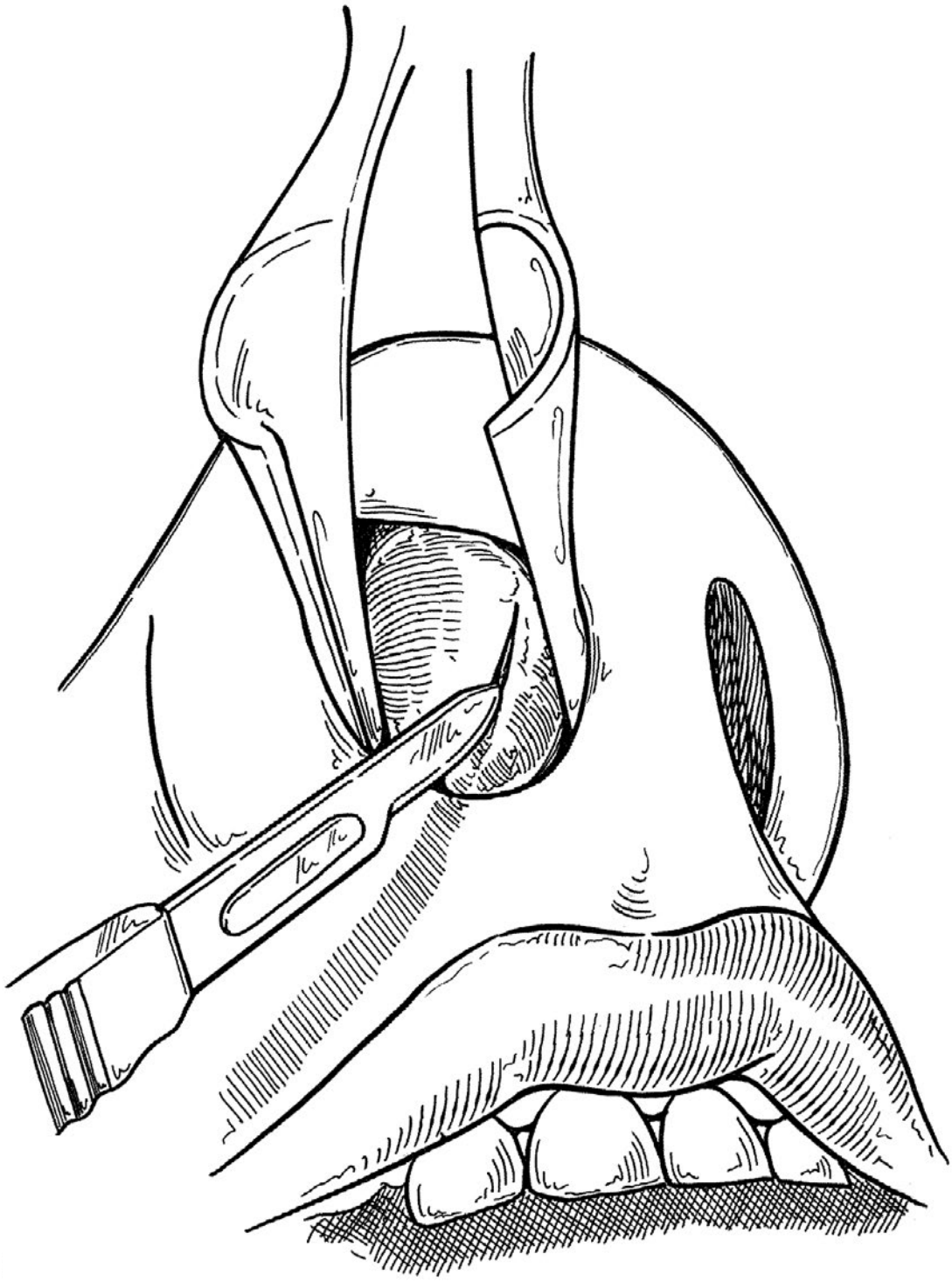
Preoperative evaluation consists of a thorough intranasal examination, recognition of the abscess or hematoma, and evaluation for associated facial and cranial trauma.

Operative Technique

1. General anesthesia is recommended in children in order to accomplish complete evacuation of the hematoma.
2. An incision is made at the caudal edge of the fluctuance (**Fig. 10.1a**).
3. The contents of the hematoma or abscess are removed by suction and, if necessary, gentle curettage (**Fig. 10.1b**).
4. A cut rubber band drain is placed in the cavity and brought out of the bottom of the incision. The incision is closed loosely with one 5-0 chromic suture (**Fig. 10.1c**).
5. The nose is then packed with Gelfoam (Pfizer), Surgicel (Ethicon), or gauze to approximate the perichondrial flap to the cartilage. Antibiotic-impregnated gauze may be used in older children, but biodegradable material is easier to remove in the young child (**Fig. 10.1d**). Both the drain and the packing are removed in 2 days.
6. Ten days of oral antistaphylococcal antimicrobial treatment are indicated when treating a child with septal abscess or hematoma.

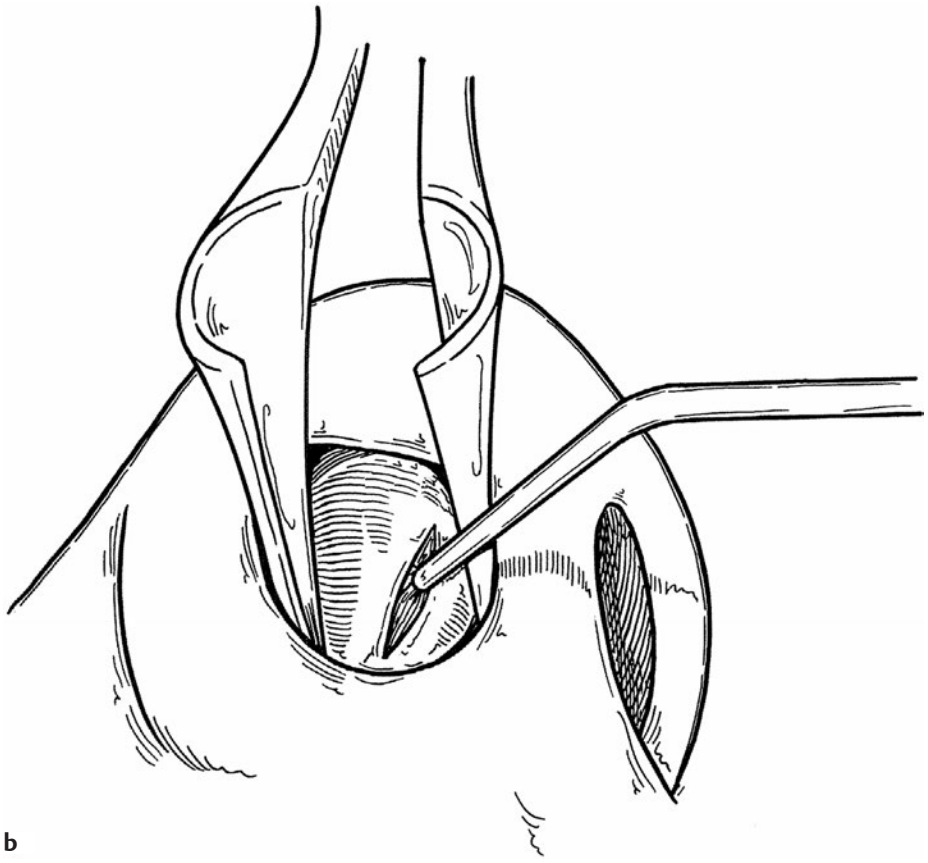
Complications

1. Saddle nose deformity
2. Septal perforation
3. Reaccumulation of hematoma/abscess

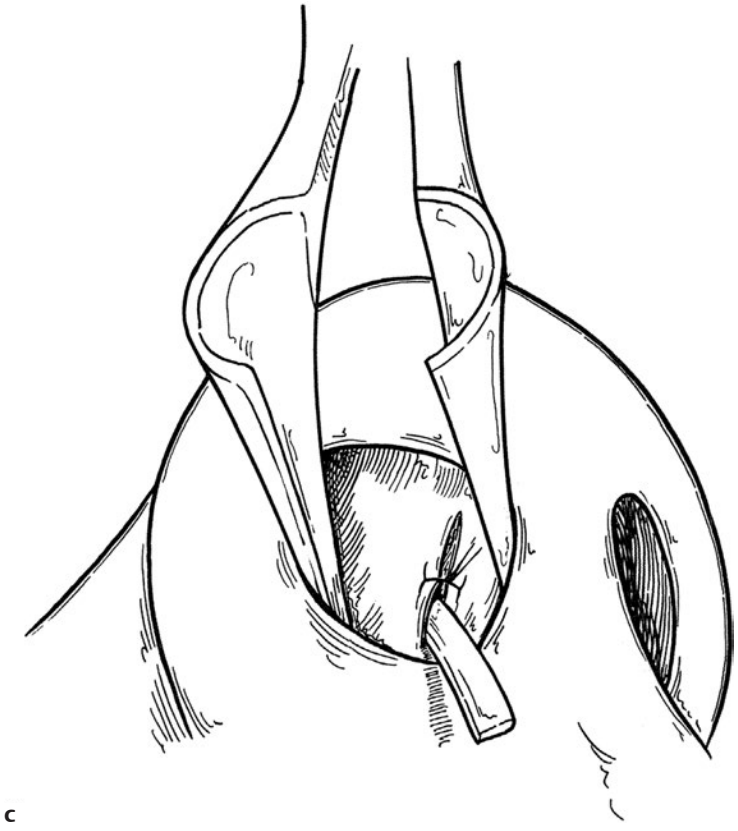


a

Fig. 10.1a



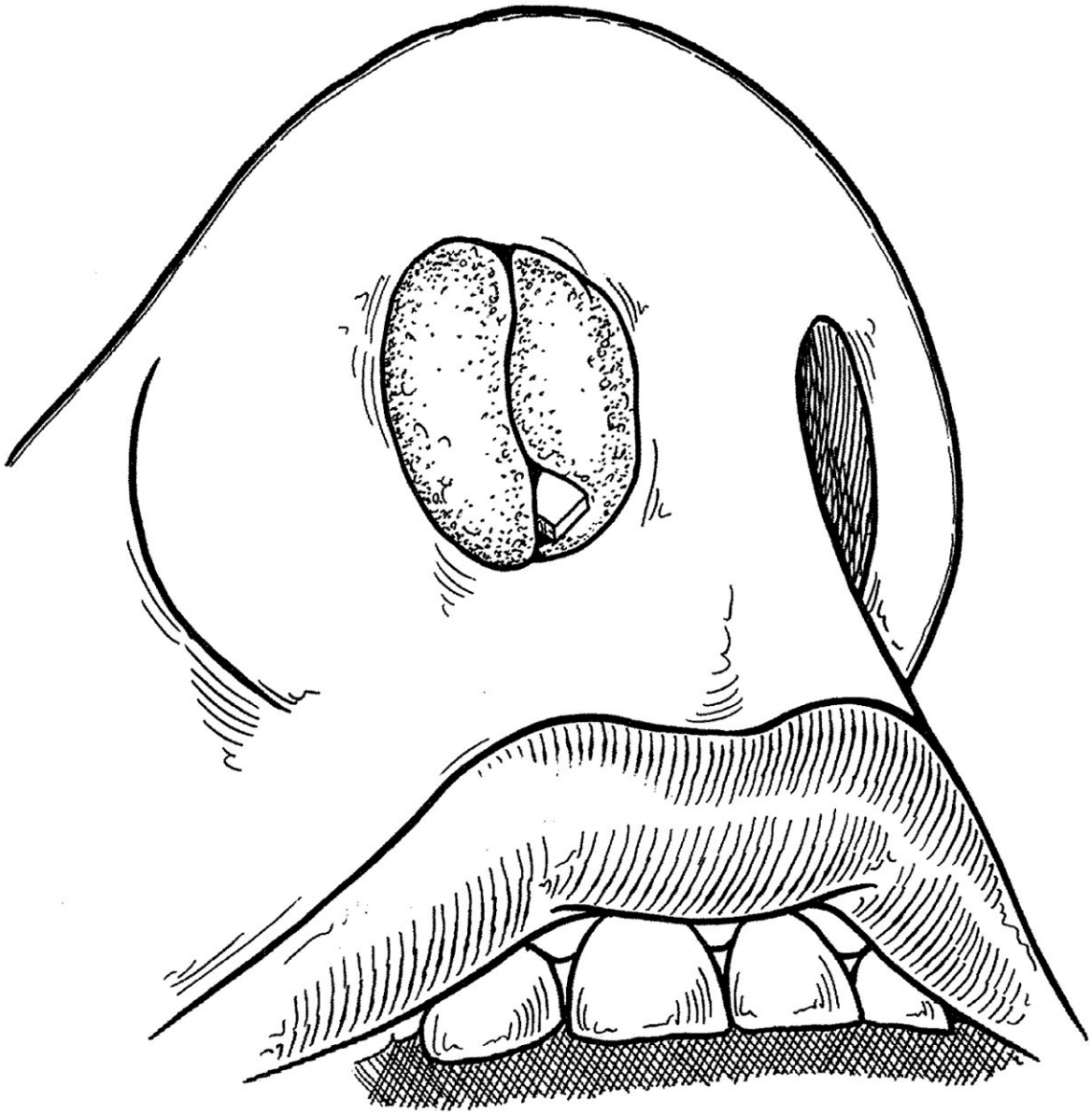
b



c

Fig. 10.1b,c

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d

Fig. 10.1d

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10-2 Nasal Cautery

Introduction

Epistaxis is a common problem of childhood and adolescence. Most episodes stop spontaneously or with gentle pressure. However, recurrent epistaxis can be debilitating because of its frequency and/or severity. In those instances, surgical intervention is required.

Indications

Cauterization is indicated in those cases of recurrent epistaxis that do not respond to conservative methods of humidification and topical ointments.

Preoperative Evaluation

The preoperative evaluation of a patient with recurrent epistaxis must include a thorough examination of the nose and nasopharynx. This is essential to identify hemangiomas, neoplasms (e.g., juvenile angiofibromas), septal deflections, or foreign bodies that may be the cause of the epistaxis. If there is a strong family history of bleeding, then a referral to Hematology is necessary preoperatively. A complete coagulation profile does not rule out the more common causes of mild bleeding disorders, such as von Willebrand's disease. Radiographic examination of the sinuses and pharynx may be done. While plain films can demonstrate large masses, computed tomography (CT) affords the best radiographic view of the nose and sinuses.

Operative Technique

1. Nasal septal cauterization in children is most effectively accomplished utilizing general anesthesia.
2. The nose should be cleared of all debris and clots before cotton pledgets soaked in 4% cocaine are applied to the bleeding area (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used). This provides a dry field for cautery. If there is no active bleeding, this step may be unnecessary.
3. The septal blood vessels feeding the bleeding area are cauterized individually with a protected suction or needle-point cautery or hyfrecator (**Fig. 10.2**).
4. Cauterization of only the feeding vessels provides the best control of epistaxis, allows rapid healing, and avoids a large mucosal burn that may result in atrophic mucosa or a septal perforation.
5. Antibiotic ointment should be applied to the cauterized area twice daily until the site has healed, usually 7–10 days.

Complications

1. Continuing epistaxis
2. Septal perforation

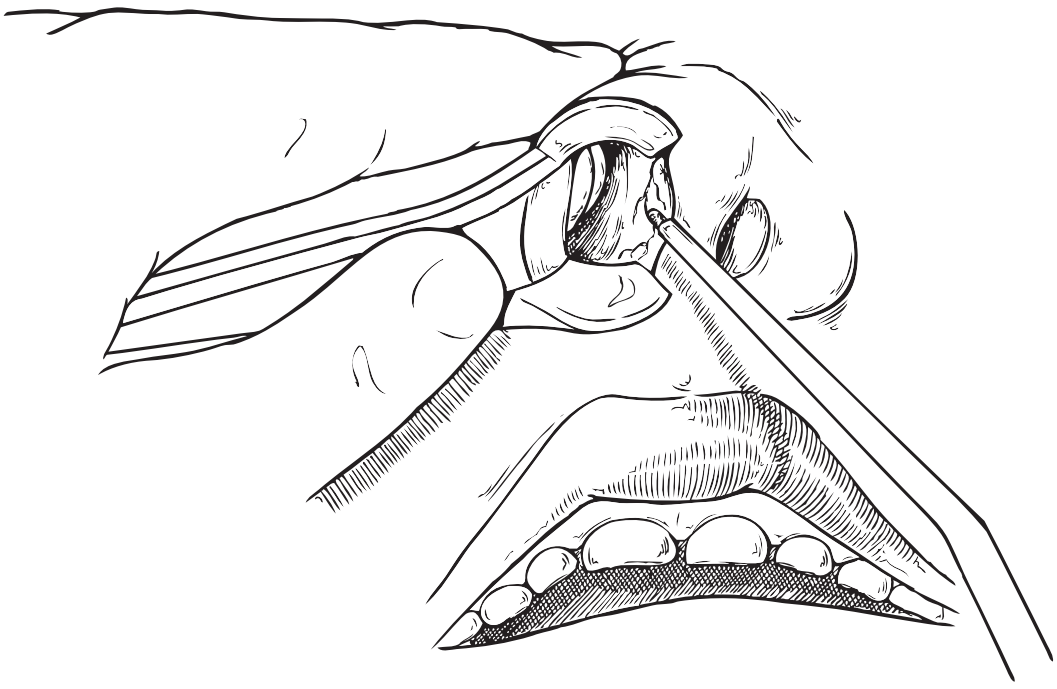


Fig. 10.2

10-3 Anterior Nasal Packing

Indications

When active epistaxis is not controlled by measures such as gentle pressure or silver nitrate cautery, nasal packing may be required. The source of the bleeding is usually from the superior septal vessels or the lateral wall of the nose. Both sides of the nose should be packed for maximum control and stabilization of nasal structures.

Preoperative Evaluation

No further preoperative evaluation is needed (see Section 10-2).

Operative Technique

1. Because bleeding is uncontrolled, packing the nose is urgent and performed utilizing a topical anesthetic.
2. Mucoid debris and blood clots should be cleared from both sides of the nose with a suction.
3. The nasal mucosa should be anesthetized and vasoconstricted with 4% cocaine-soaked neurosurgical pledgets (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used). Three 1/2″ × 3″ pledgets on each side of the nose are usually sufficient.

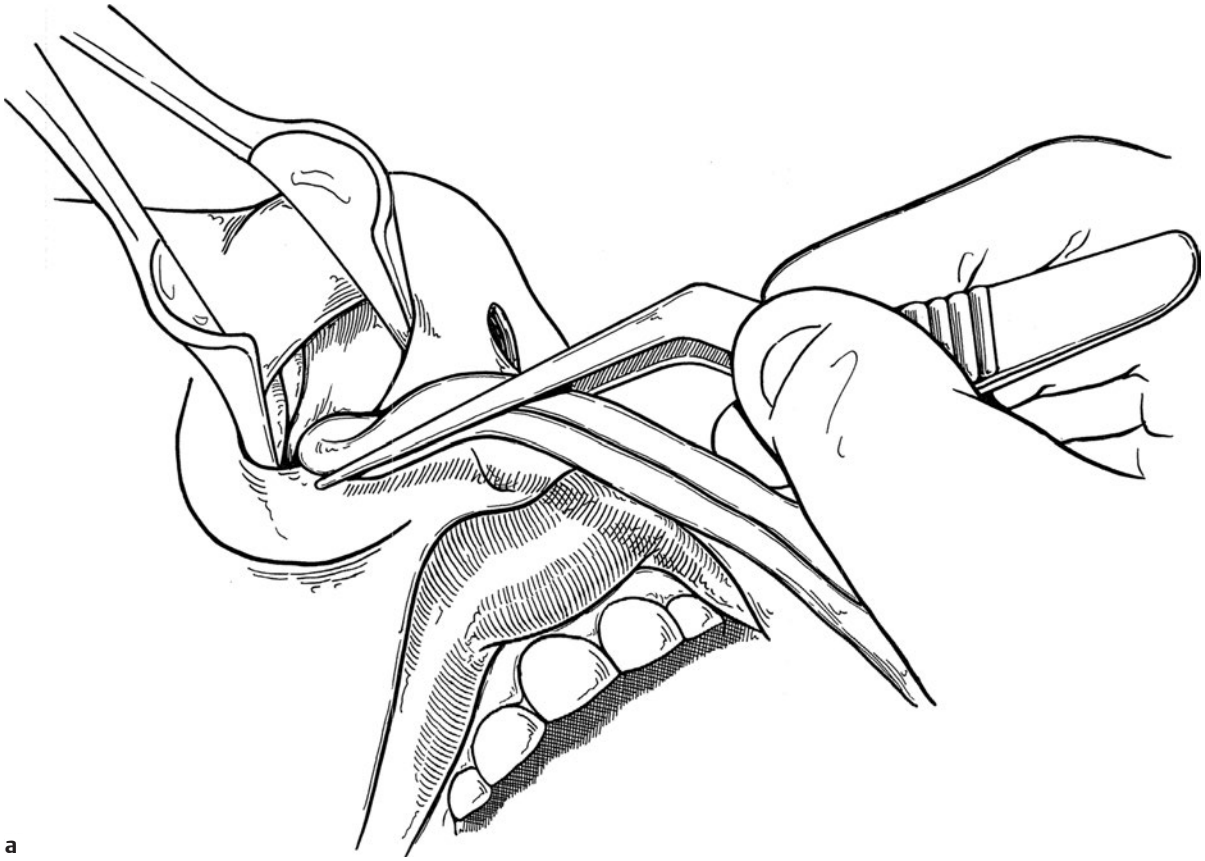
4a. In some cases, bleeding can be controlled with absorbable packs and may be the preferred treatment in children with bleeding disorders. These commercially available agents include oxidized cellulose (Surgicel), absorbable gelatin sponge (Gelfoam), or agents with a combination of gelatin matrix and thrombin (FloSeal; Baxter).

4b. A 1/4″ × 72″ gauze strip is impregnated with antibiotic ointment by rubbing the ointment into the gauze.

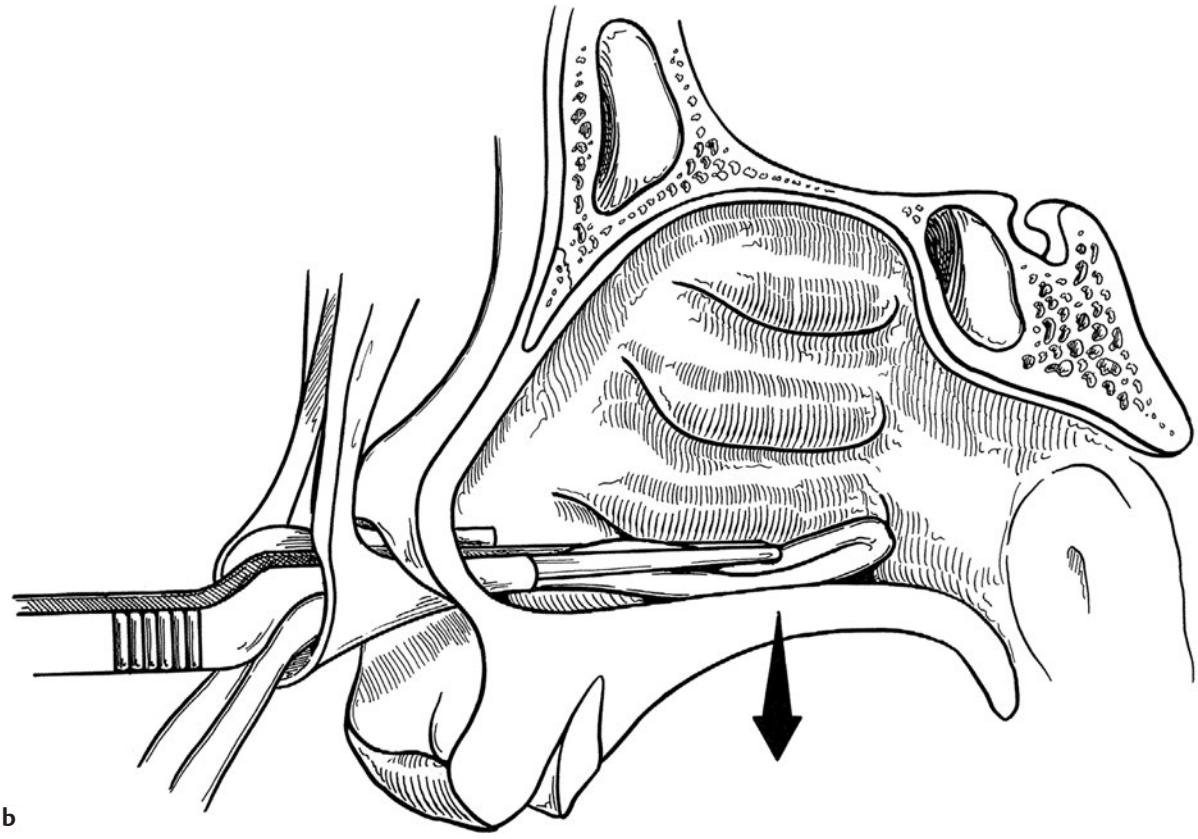
5. The nasal cavity is then packed by grasping the gauze with a bayonet forceps and placing it deep in the nose (**Fig. 10.3a**).
6. The packing is pushed down against the floor of the nose (**Fig. 10.3b**).
7. Each side of the nose is packed in a similar fashion: layering the packing from the floor of the nose toward the top of the nasal cavity. The final portion of packing is placed anteriorly (**Fig. 10.3c**).
8. Alternately, commercially available expanding sponge packs may be used instead of gauze packing to control anterior hemorrhage, including Merocel packs (Medtronic). Some prefabricated packs also have balloons that can be inflated to control anterior bleeding.
9. The packing is kept in place by taping the nose across the nostrils. It is removed after 72 hours (**Fig. 10.3d**).
10. Antistaphylococcal antibiotics are administered for 7–10 days to prevent the occurrence of toxic shock syndrome that has been associated with nasal packing.

Complications

1. Continuation of bleeding
2. Mucosal abrasion

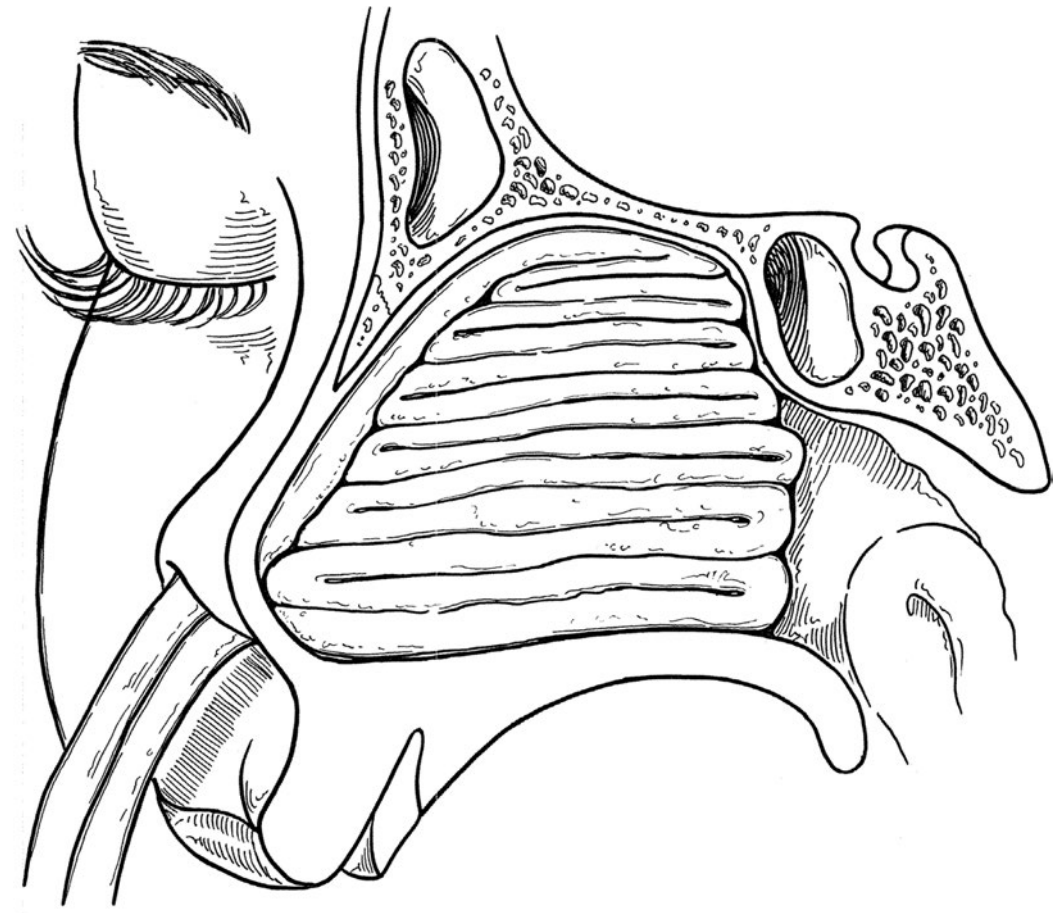


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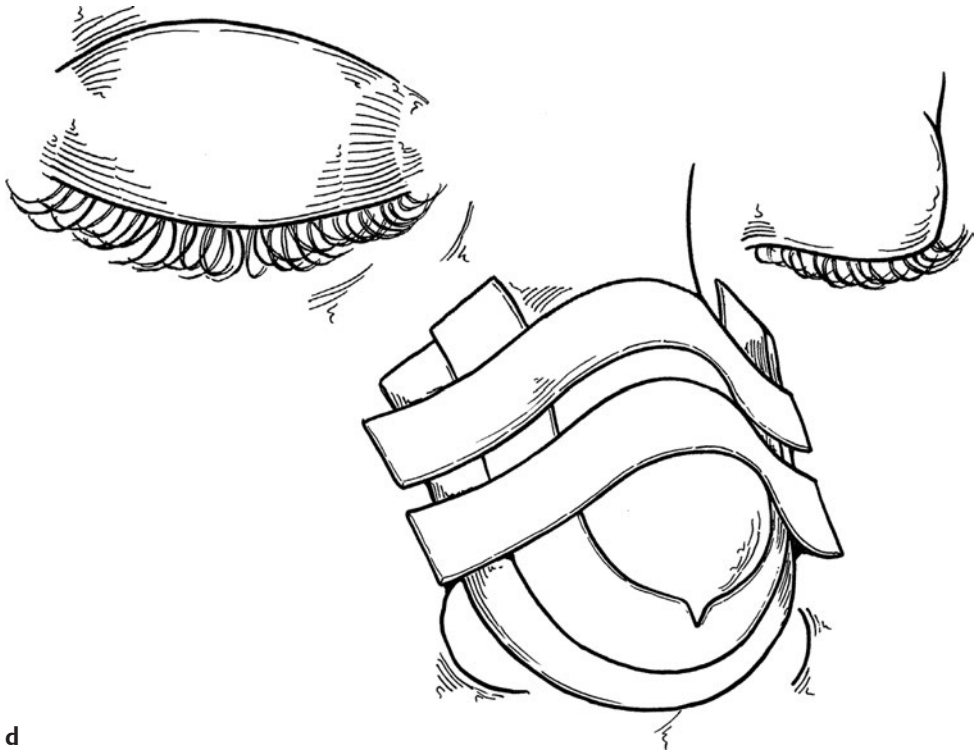


b

Fig. 10.3a,b



c



d

Fig. 10.3c,d

10-4 Posterior Nasal Packing

Introduction

The purpose of a posterior pack is to provide a wall at the posterior choana against which packing can be placed. It also provides some pressure at the choana, posterior nasal cavity, and nasopharynx.

Indications

When an anterior pack is insufficient to control bleeding, a posterior pack should be used. Posterior packs are rarely required in children.

Preoperative Evaluation

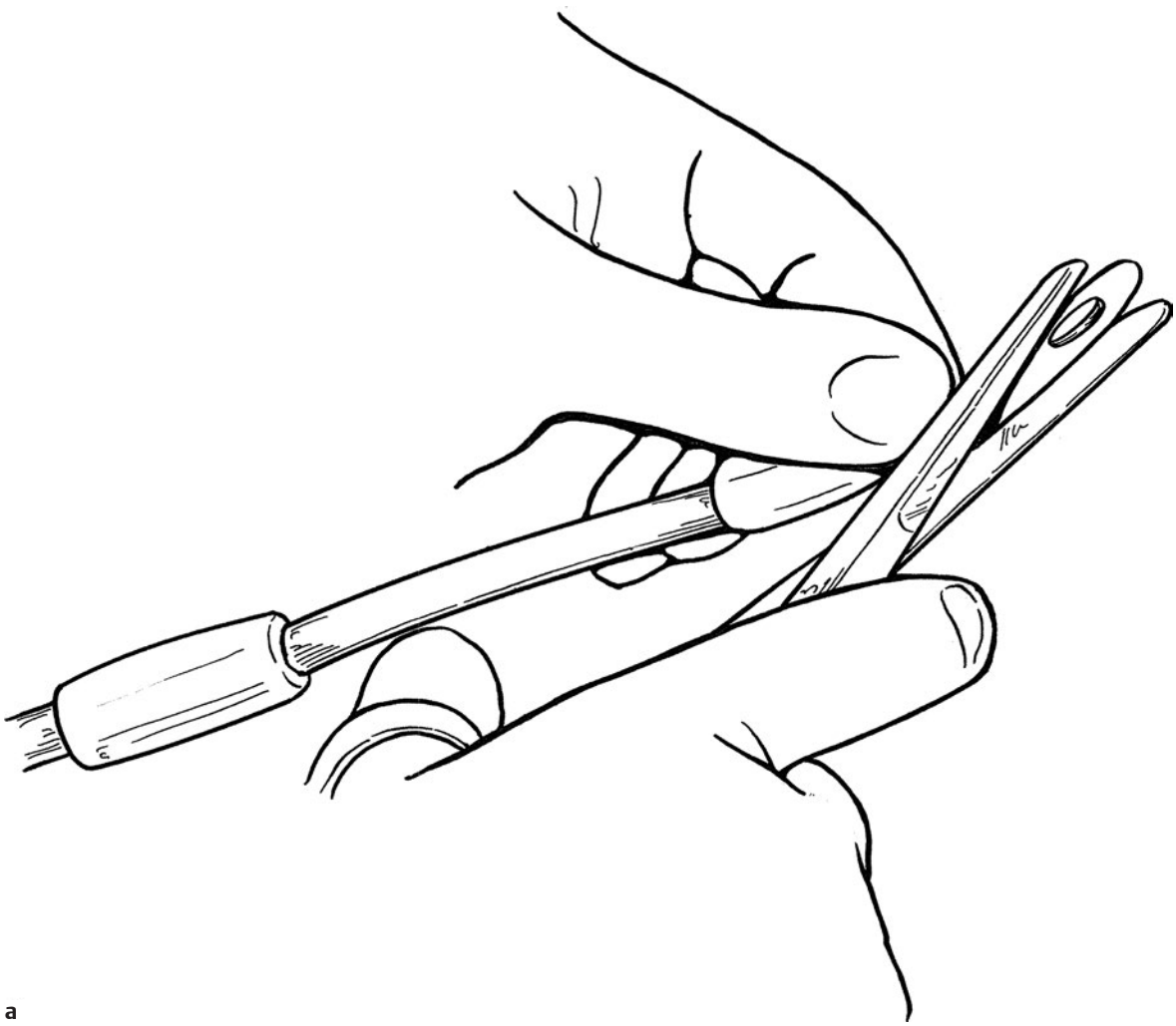
No further preoperative evaluation is needed (see Section 10-2).

Operative Technique

1. Placement of a posterior pack in a child may require a general anesthetic. However, teenagers may be able to tolerate the procedure using only topical intranasal 4% cocaine (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used).
2. The nose is cleared of mucus and blood with a Frazier suction.
3. The nasal mucosa is anesthetized and vasoconstricted with 4% cocaine-soaked neurosurgical pledgets (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used). Three 1/2″ × 3″ pledgets on each side are usually sufficient.
4. A 2- to 3-cm length of clear plastic suction tubing is passed over a 12- or 14-gauge Foley catheter that has a 30-mL balloon (**Fig. 10.4a**) or a prefabricated epistaxis catheter with posterior balloon.
5. The tip of the Foley extending beyond the balloon should be cut off to minimize gagging when the catheter is in position (**Fig. 10.4a**).
6. The integrity of the balloon should be tested by filling it with 30 mL of water.
7. With the balloon deflated, the catheter should be advanced into the side of the nose that is bleeding until the tip is visible in the oropharynx (**Fig. 10.4b**). Only one catheter is needed because one balloon will occlude the entire nasopharynx.
8. After 15–20 mL of water are introduced into the balloon, the catheter is withdrawn until it is seated in the posterior choana (**Fig. 10.4c**).
9. A bilateral anterior pack is then applied as previously described with gauze impregnated with antibiotic ointment (see Section 10-3).
10. The piece of suction tubing is positioned against the pack inside the nostril and clamped in place while gentle traction is applied to the Foley (**Fig. 10.4d**). This is done to avoid alar necrosis.
11. The pack is left in place 3–5 days. The patient is placed on a broad-spectrum antistaphylococcal antimicrobial given intravenously. Intravenous hydration may be necessary since oral intake is difficult with a posterior pack in place.
12. The child should be monitored in an intensive care unit because a posterior pack may cause hypoxia and hypercapnia. Supplemental oxygen should be administered.
13. If the nose continues to bleed, then a referral to Interventional Radiology should be considered for embolization of branches of the internal maxillary arteries or facial arteries.

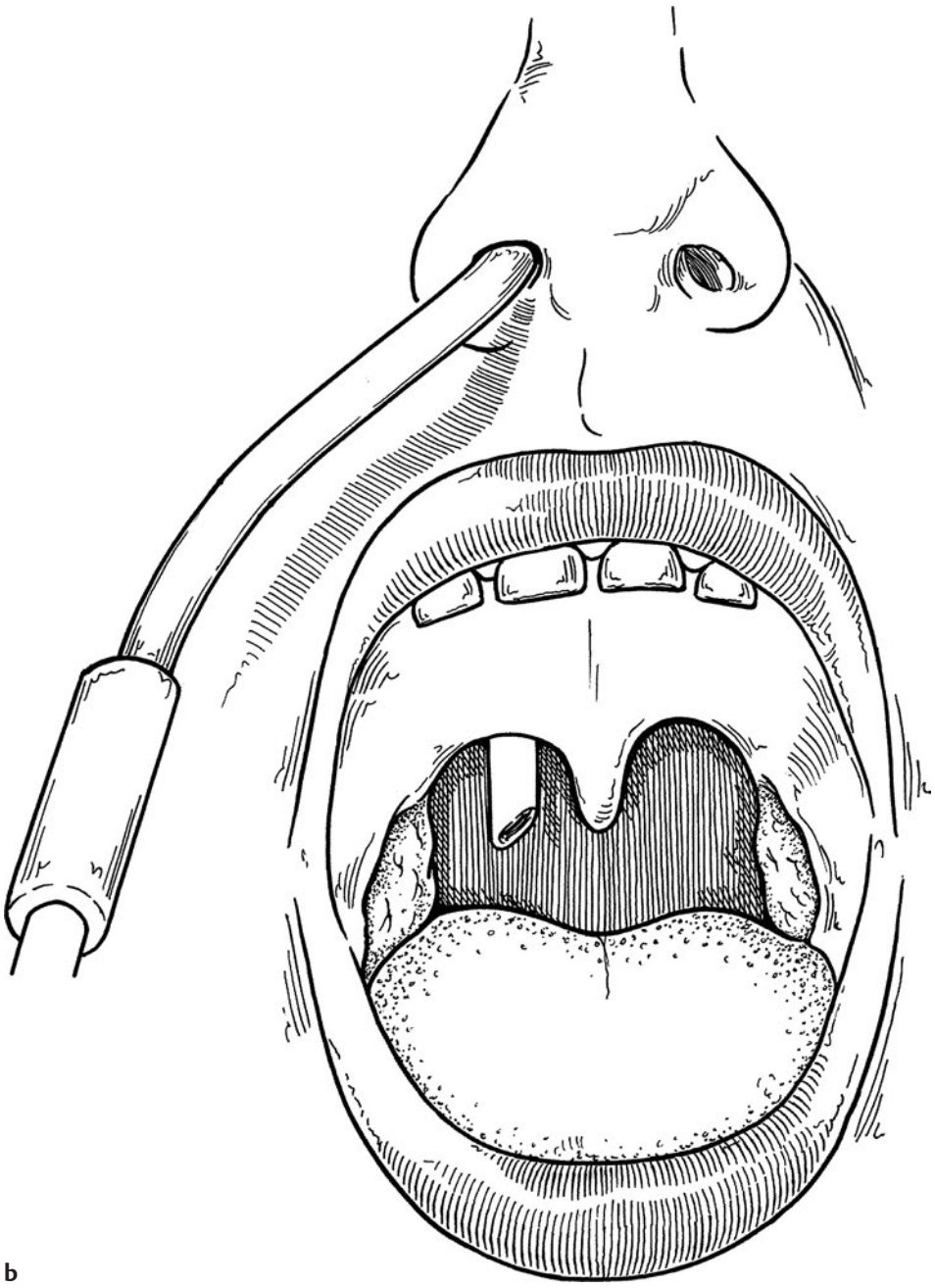
Complications

1. Hypoxia/hypercapnia
2. Altered mental state
3. Cardiac arrhythmia
4. Continued bleeding



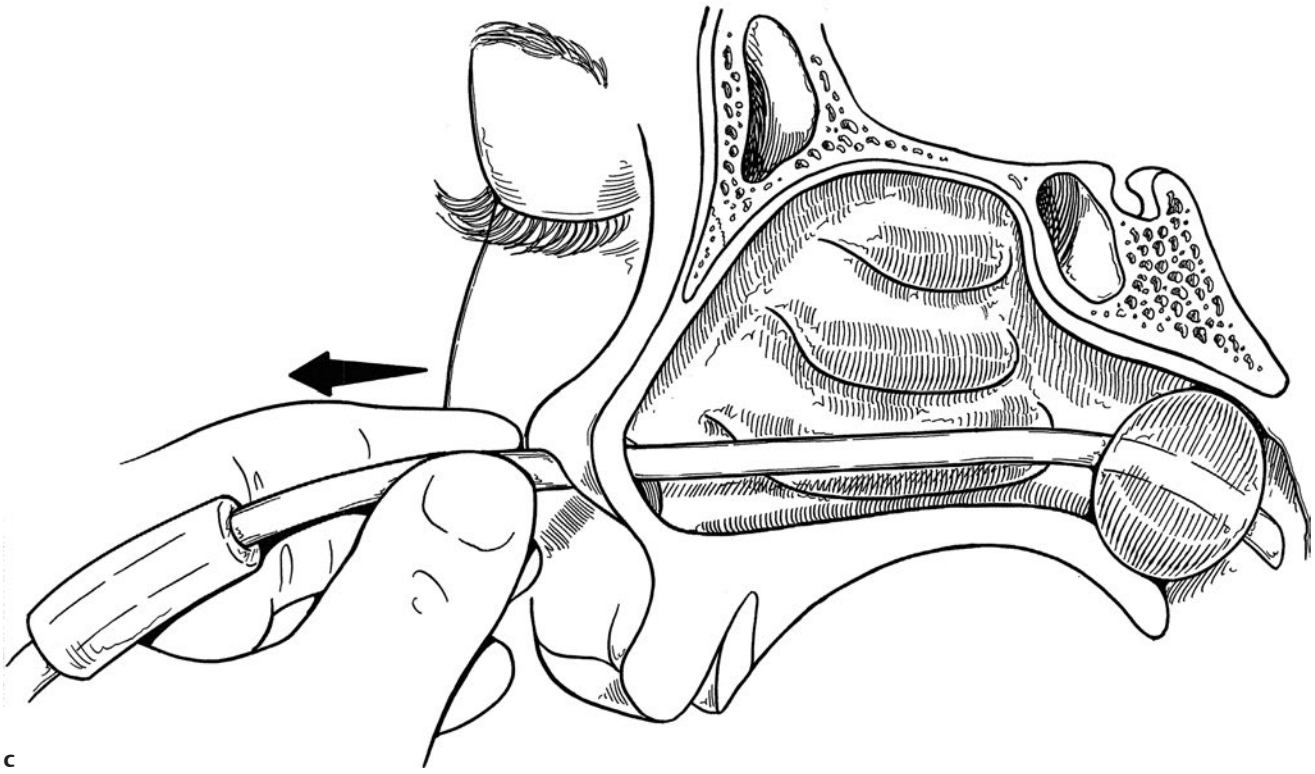
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Fig. 10.4a

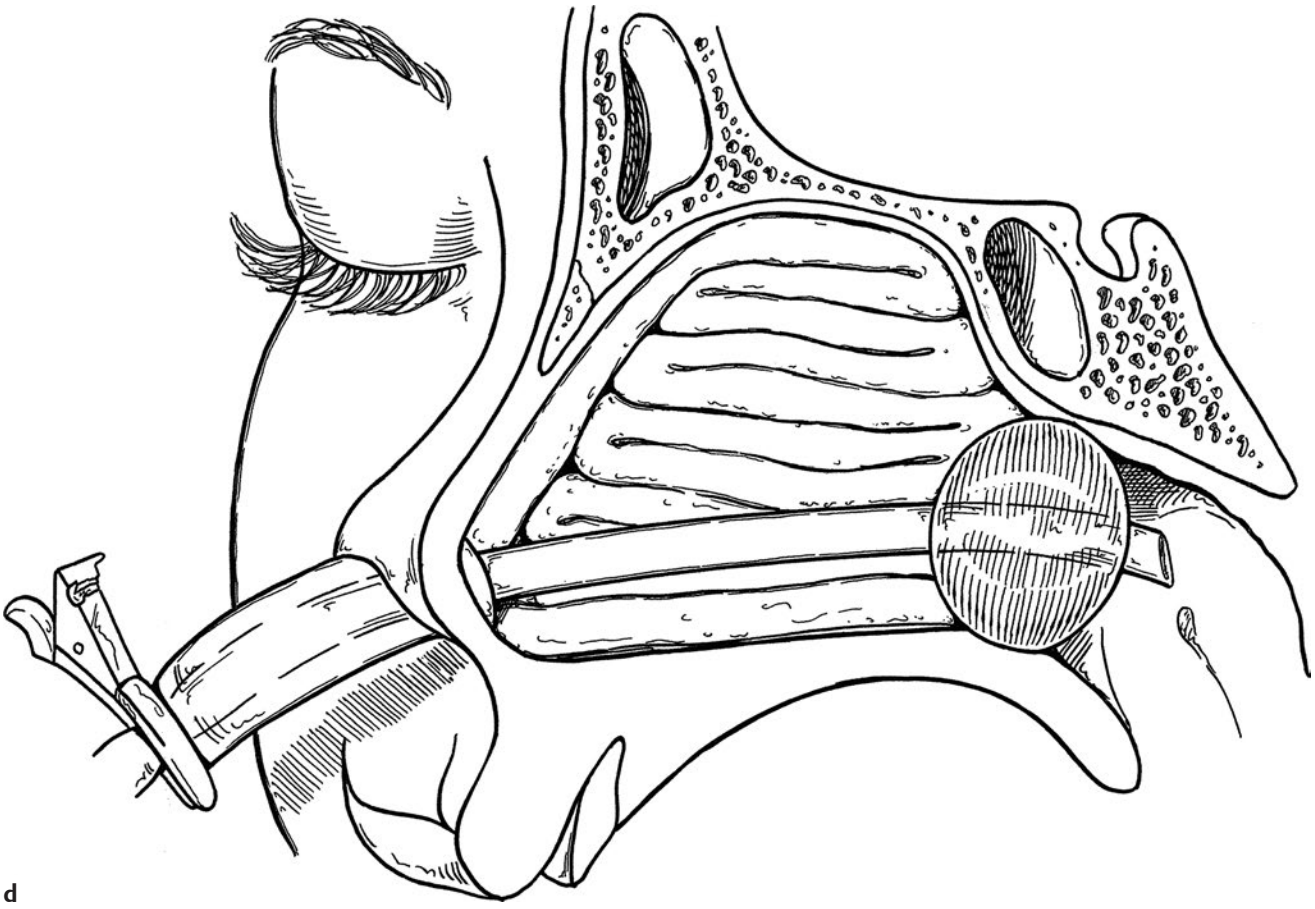


b

Fig. 10.4b



c



d

Fig. 10.4c,d

10-5 Ligation of the Internal Maxillary Artery

Indications

Ligation of the internal maxillary artery is an option in patients with posterior epistaxis who have not responded to, or will not tolerate, anterior/posterior packing or embolization. Access to the internal maxillary artery is obtained through the maxillary sinus. Ligation of the internal maxillary artery is often done in conjunction with ligation of the ethmoid arteries.

Preoperative Evaluation

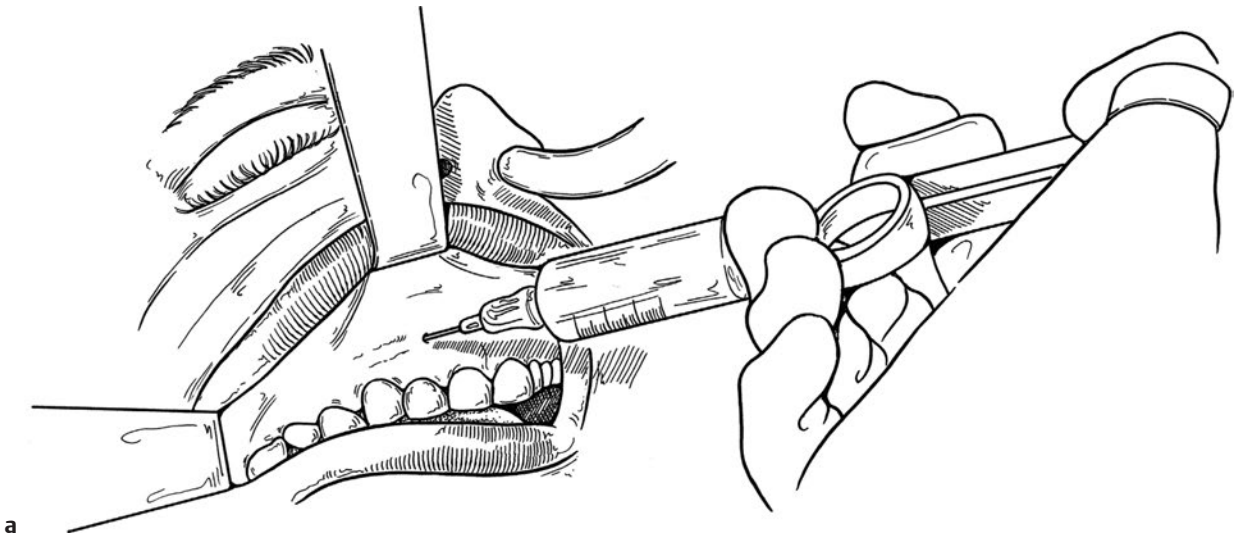
Bilateral carotid angiography should be performed prior to the procedure. This is to ensure that the source of the bleeding is from the external carotid system. Sinus radiography (especially CT) should be obtained to define the maxillary sinus anatomy.

Operative Technique

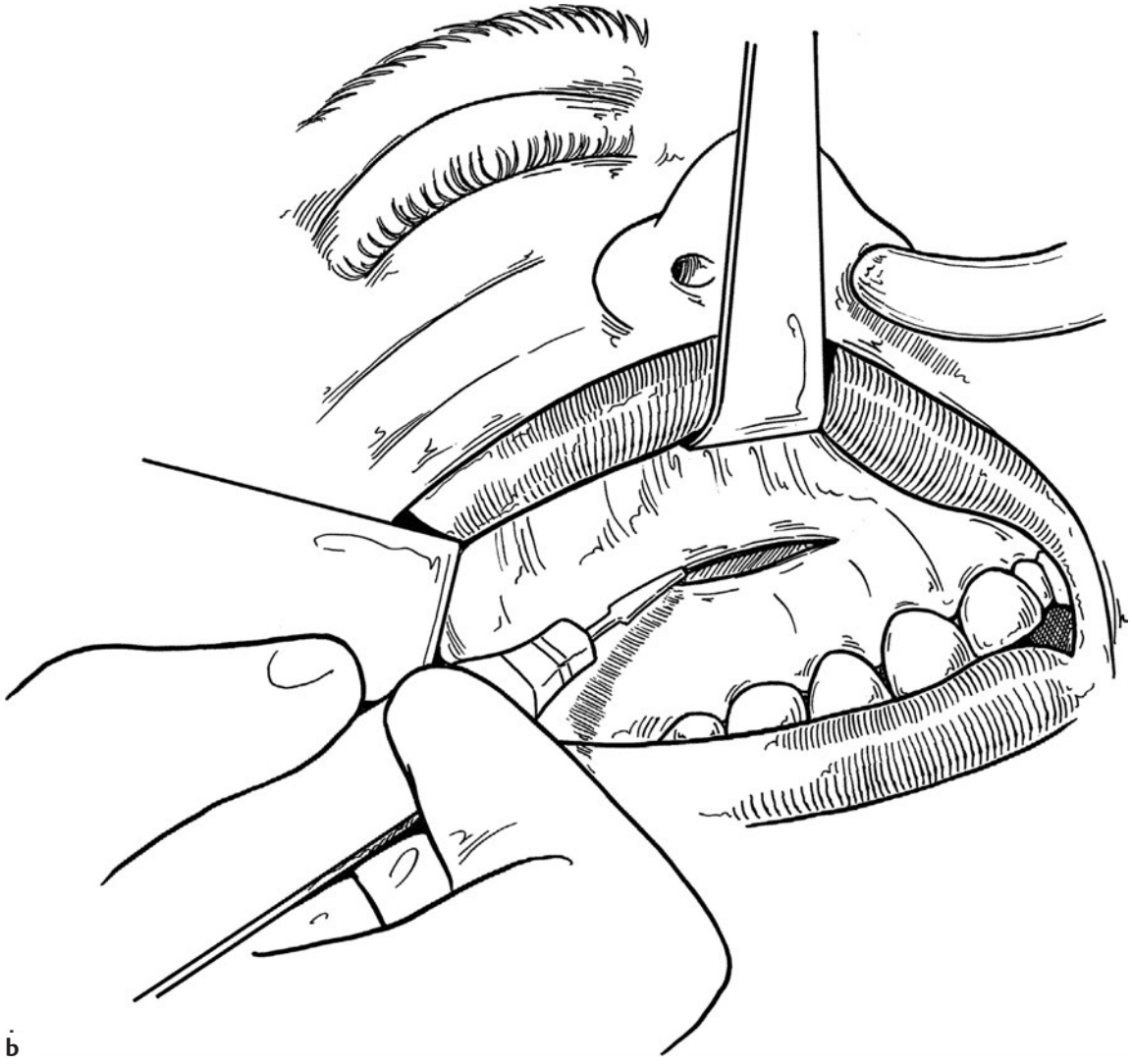
1. The procedure is performed utilizing a general anesthetic.
2. The gingival buccal groove is injected with 1% lidocaine with 1:100,000 epinephrine for hemostasis (**Fig. 10.5a**).
3. An incision is made with a cutting cautery through the mucosa and the periosteum of the anterior wall of the maxilla from the lateral incisor tooth back to the lateral wall of the maxillary sinus (**Fig. 10.5b**).
4. The periosteum is elevated superiorly to the level of the infra-orbital nerve (**Fig. 10.5c,d**).
5. The maxillary sinus is opened in the canine fossa with a chisel (**Fig. 10.5d**).
6. The anterior and lateral wall of the maxillary sinus is removed with a bone rongeur. The mucosa is removed with a forceps to open the sinus widely (**Fig. 10.5e**).
7. Self-retaining retractors are placed, and an operating microscope is used to visualize the posterior wall of the sinus.
8. The mucosa of the posterior wall is cauterized with a suction cautery to minimize bleeding (**Fig. 10.5f**). The mucosa is peeled aside with an elevator and removed with a cup forceps (**Fig. 10.5g**).
9. The posterior wall of the maxillary sinus is then cracked with the elevator and the bone pieces removed with the elevator and cup forceps. The posterior periosteum is kept intact (**Fig. 10.5h**).
10. The periosteum is cauterized in a cruciate fashion with a suction cautery to minimize bleeding and cut along the line of cauterization with a sickle knife (**Fig. 10.5i**). This permits direct access to the pterygomaxillary space (**Fig. 10.5j**).
11. The periosteal flaps are laid aside. The internal maxillary artery can then be seen pulsating in the fat (**Fig. 10.5j,k**). The artery is exposed and cleansed of fat with a small forceps and a blunt hook (**Fig. 10.5l**).
12. The main trunk and branches are clipped with vascular clips (**Fig. 10.5m**).
13. The gingival buccal incision is closed loosely with three or four interrupted chromic sutures (**Fig. 10.5n**).
14. The nasal cavity is usually left unpacked or very lightly packed with antibiotic-impregnated gauze.
15. Antibiotics are administered for 7–10 days, especially if nasal packing is used.

Complications

1. Numbness of the lip
2. Laceration of the internal maxillary artery

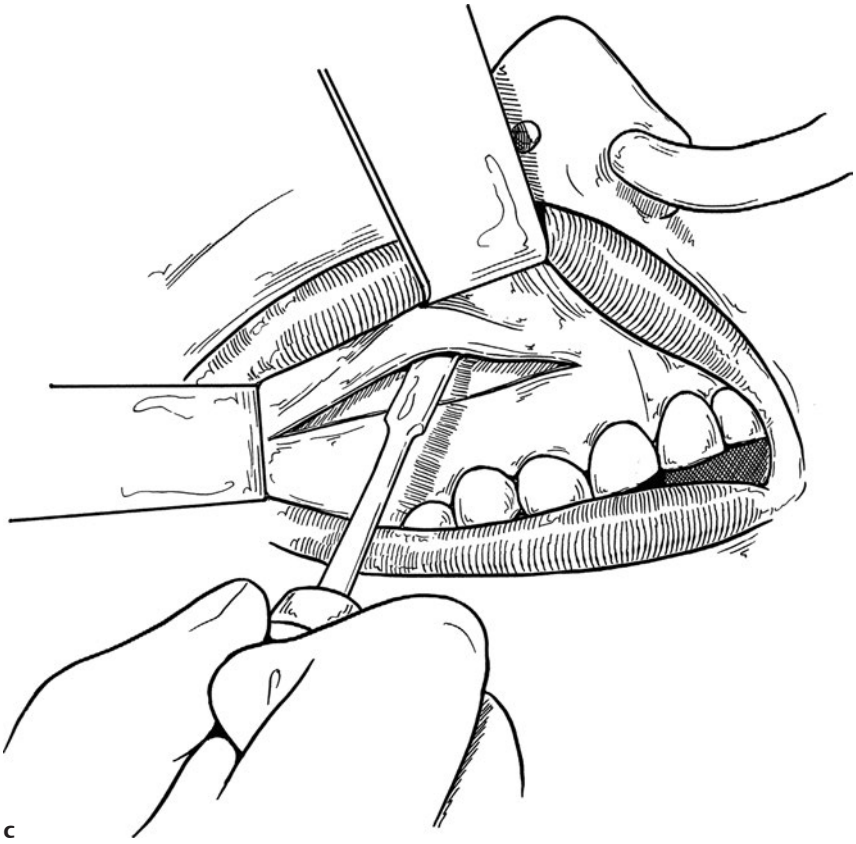


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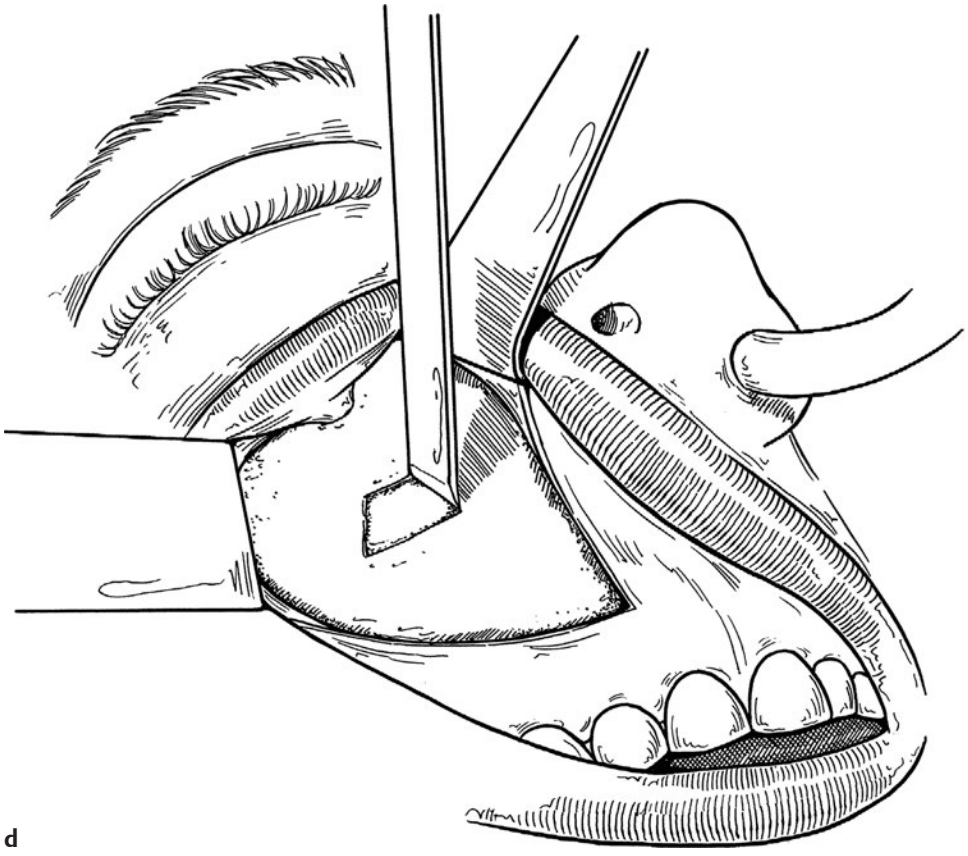


b

Fig. 10.5a,b

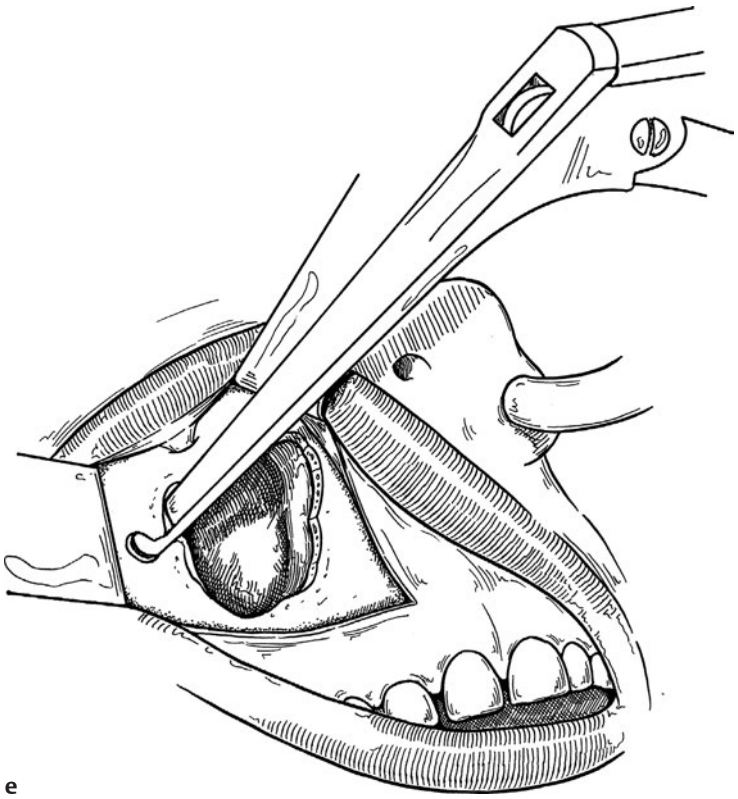


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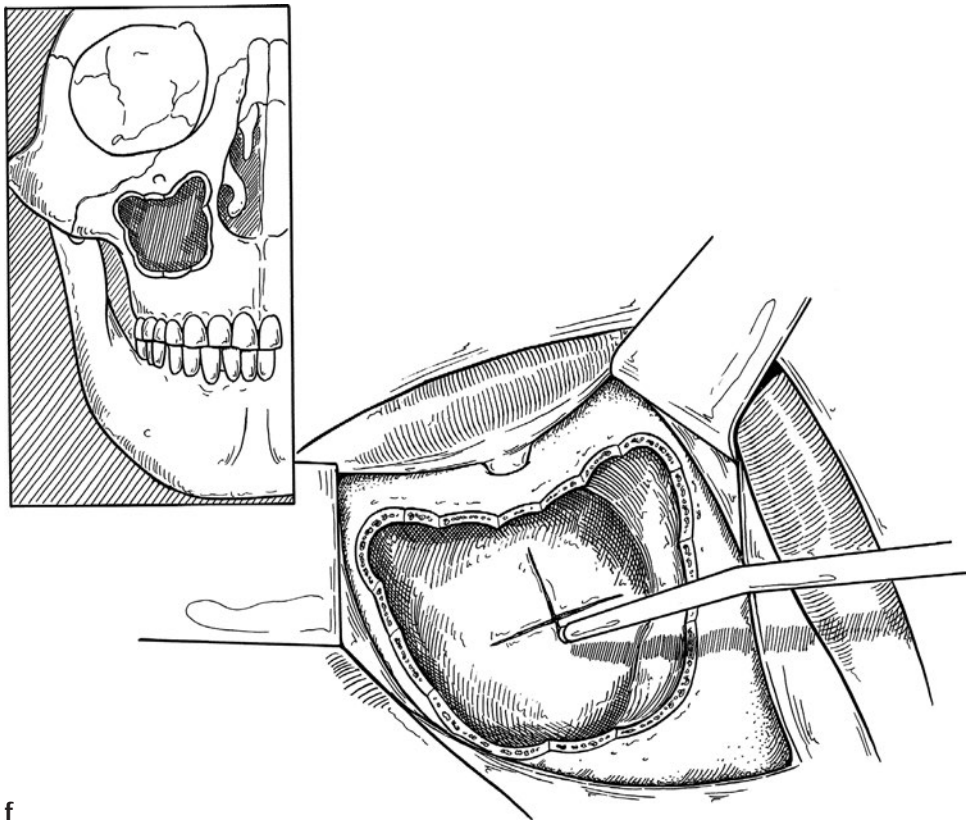


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Fig. 10.5c,d

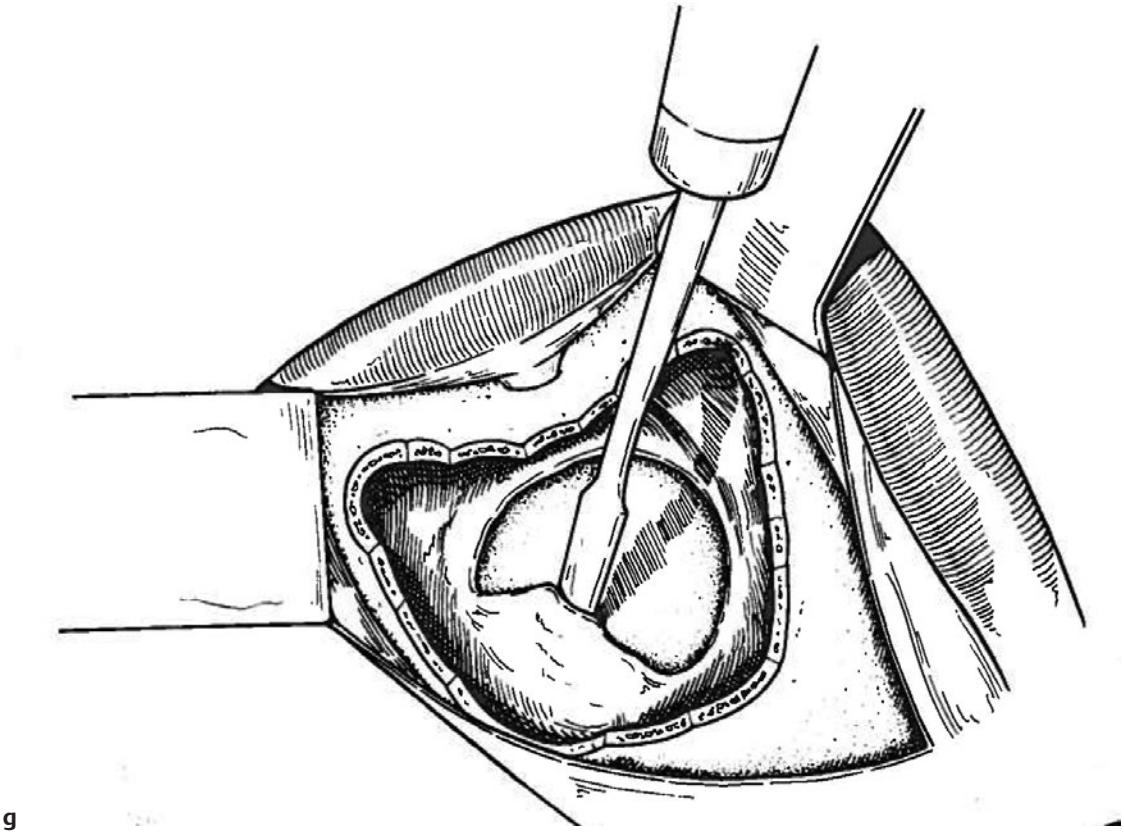


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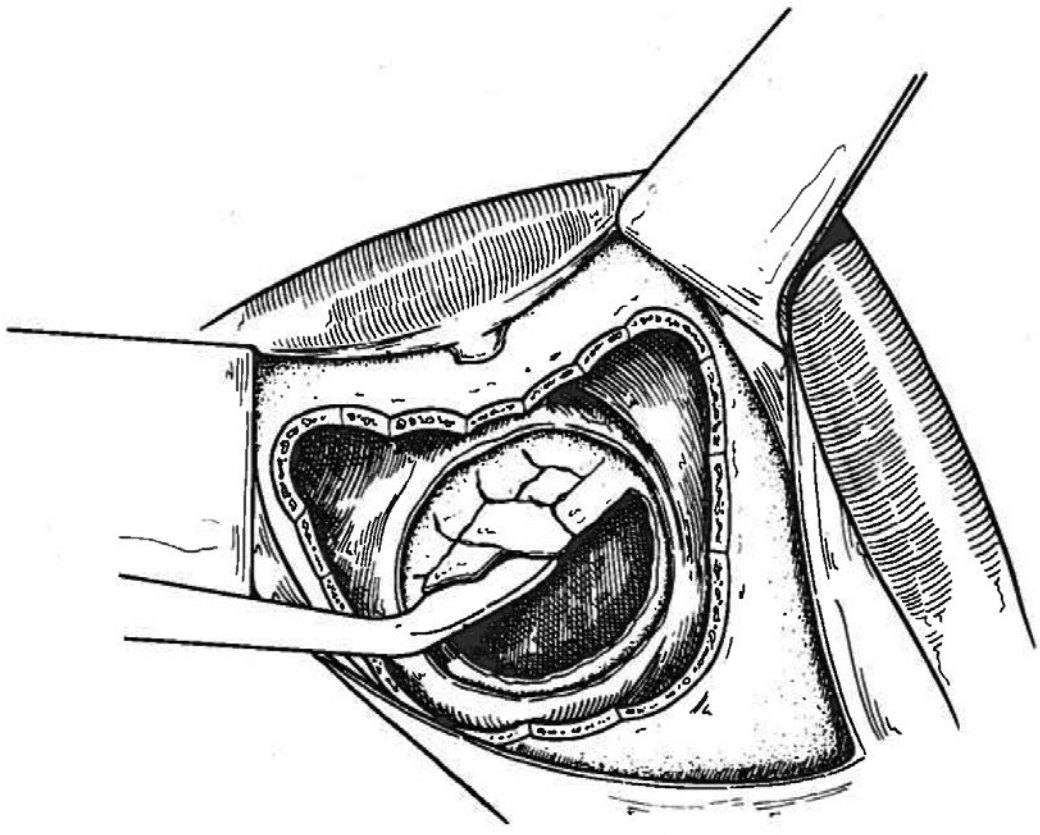


f

Fig. 10.5e,f



g

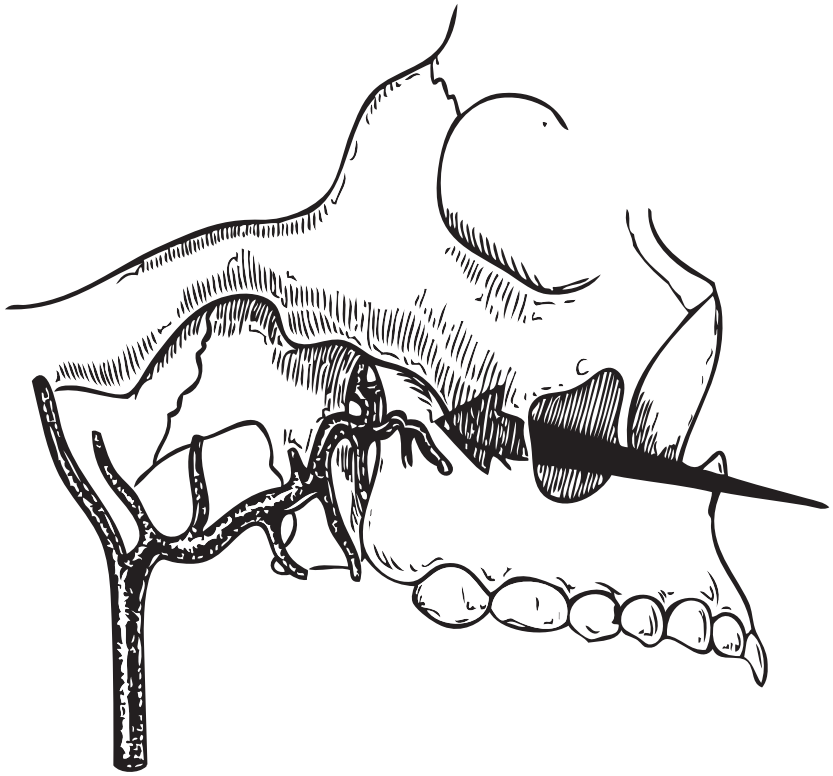


h

Fig. 10.5g,h

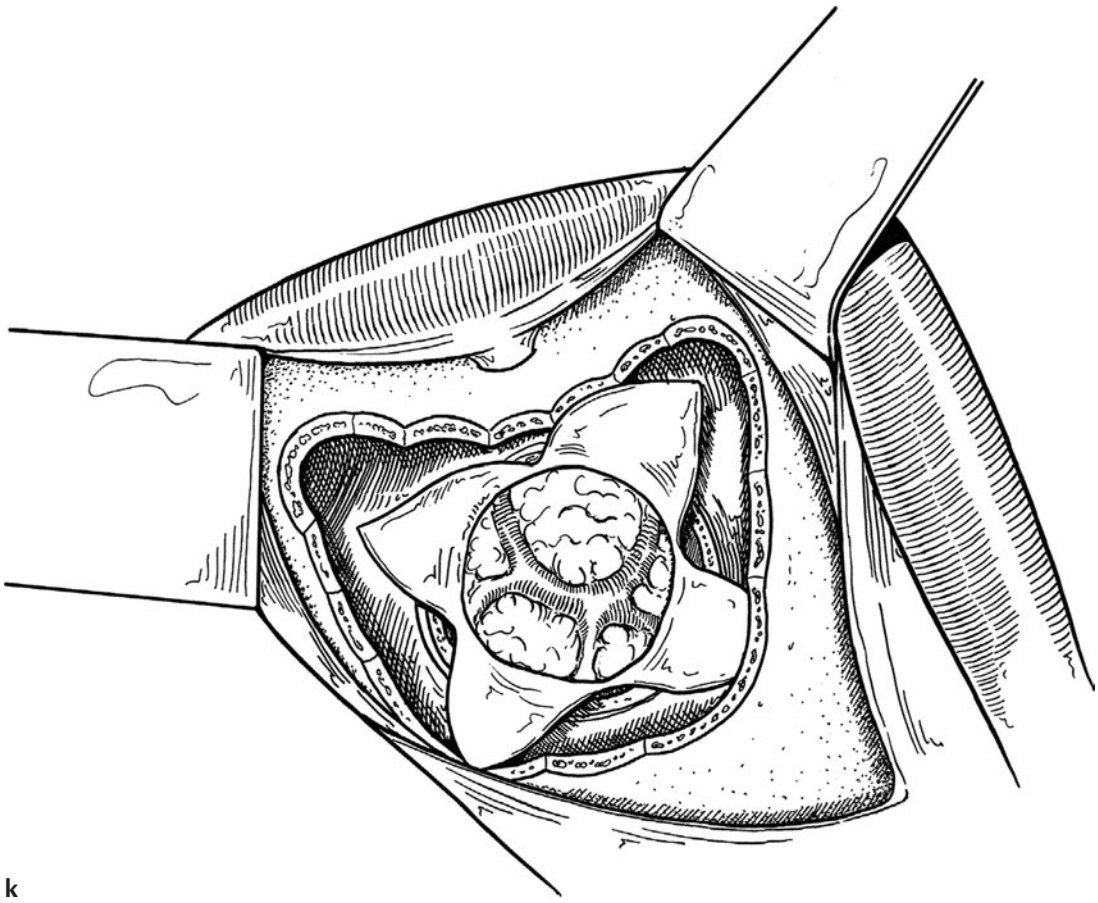


i

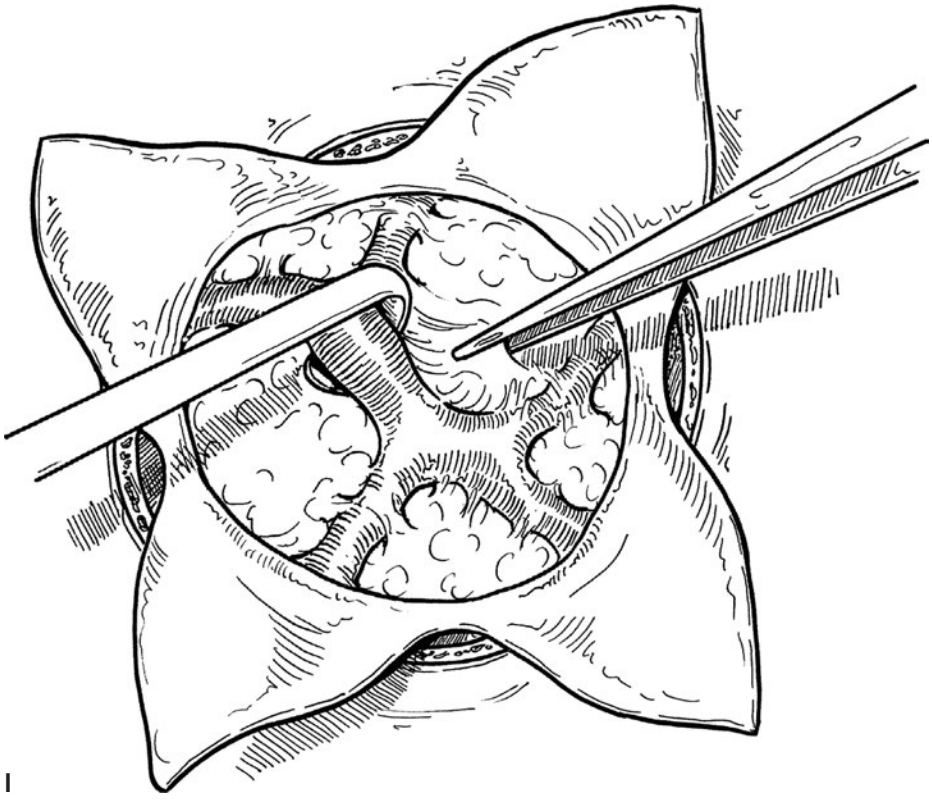


j

Fig. 10.5i,j

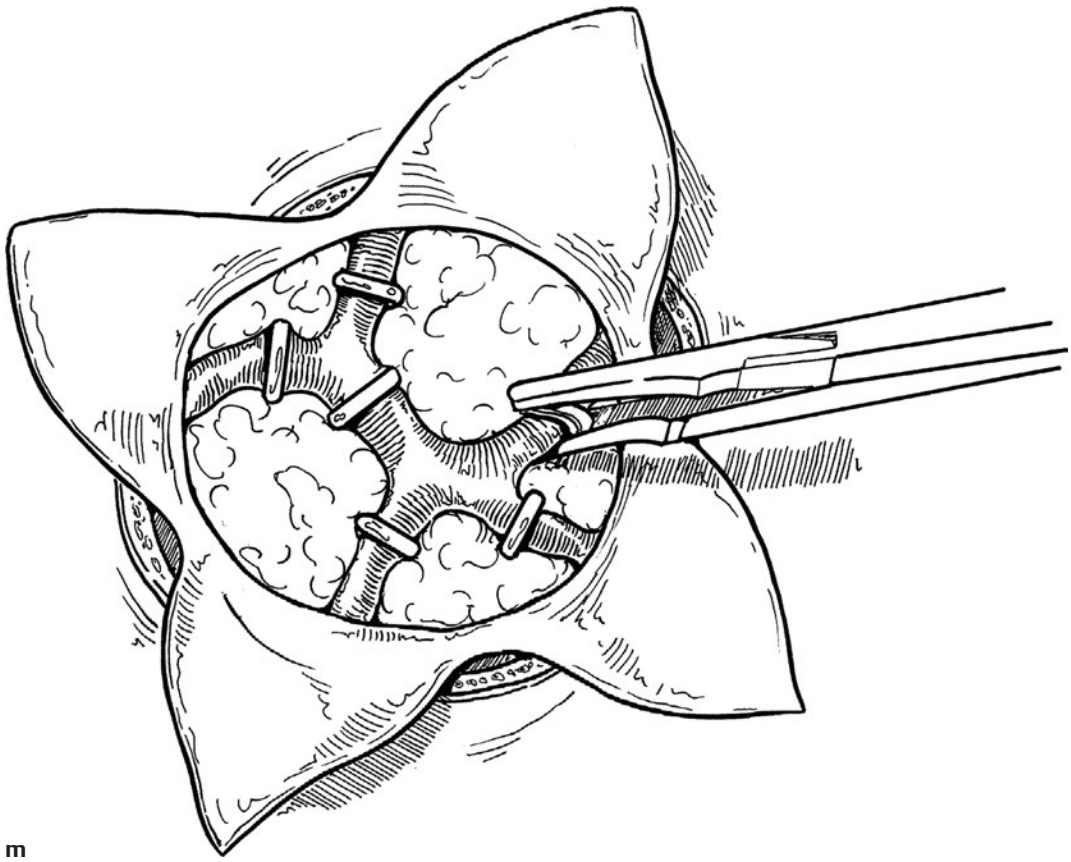


k

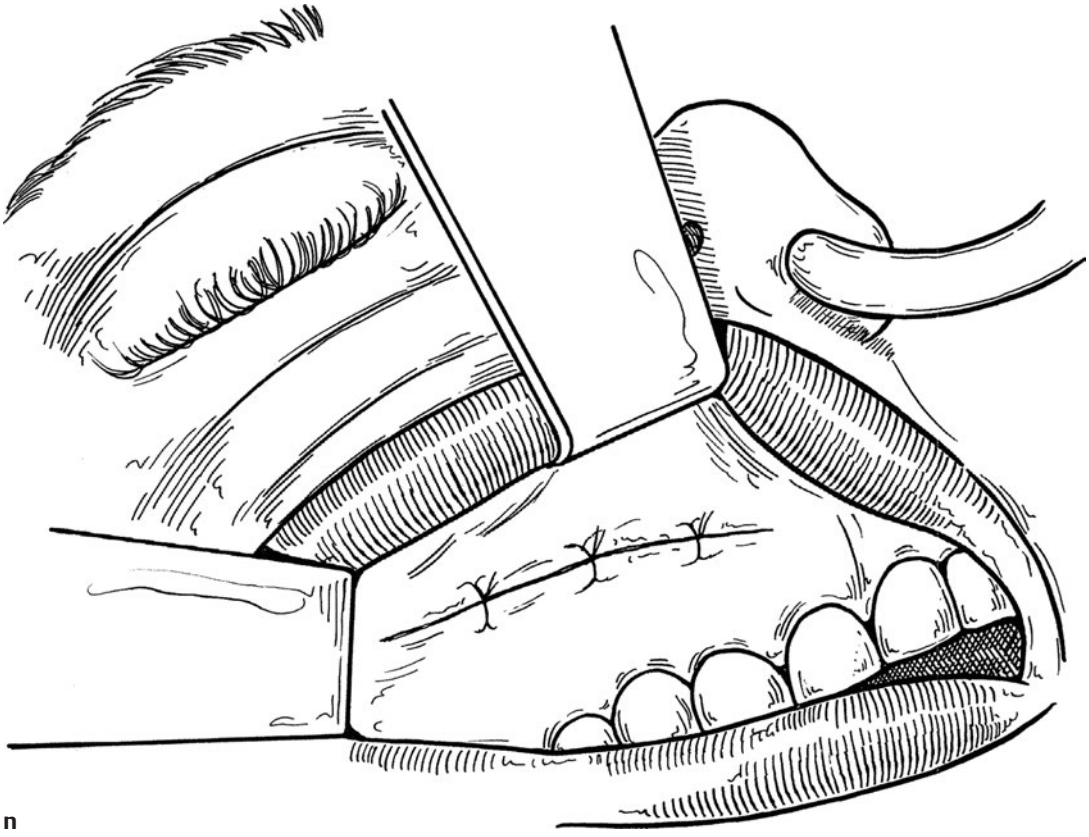


l

Fig. 10.5k,l



m



n

Fig. 10.5m,n

10-6 Ligation of the Ethmoid Arteries

Introduction

On rare occasions (especially in children and teenagers), nasal bleeding may not be controlled with anterior and posterior packing or with embolization. This can become a life-threatening problem. In this case, ligation of the blood vessels supplying the nasal cavity on the bleeding side should be carried out. Ligation of the anterior and posterior ethmoid arteries is most often performed in conjunction with ligation of the internal maxillary artery (see Section 10-5).

Indications

Ligation of the ethmoid arteries is required in cases of epistaxis that do not cease with nasal packing.

Preoperative Evaluation

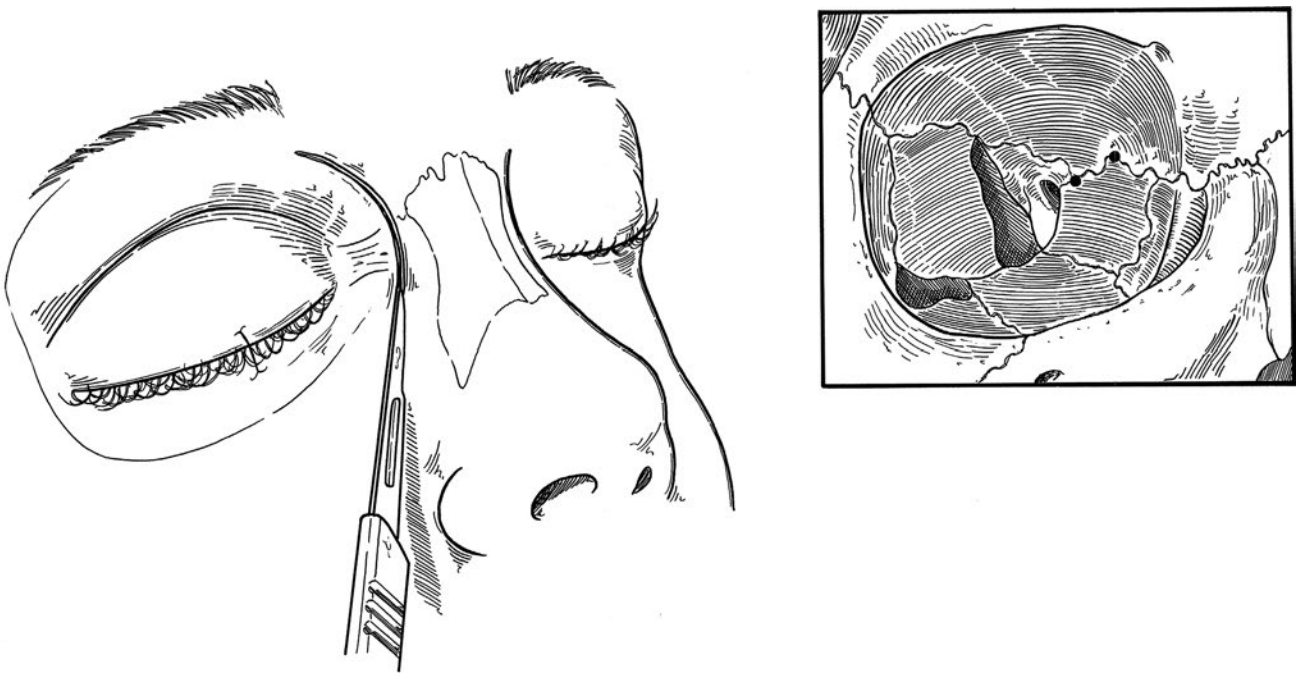
Bilateral carotid angiography should be performed prior to the procedure. This is to ensure that the source of the bleeding is from the external carotid system. Sinus radiography (especially CT) should be obtained to define the nasal and sinus anatomy.

Operative Technique

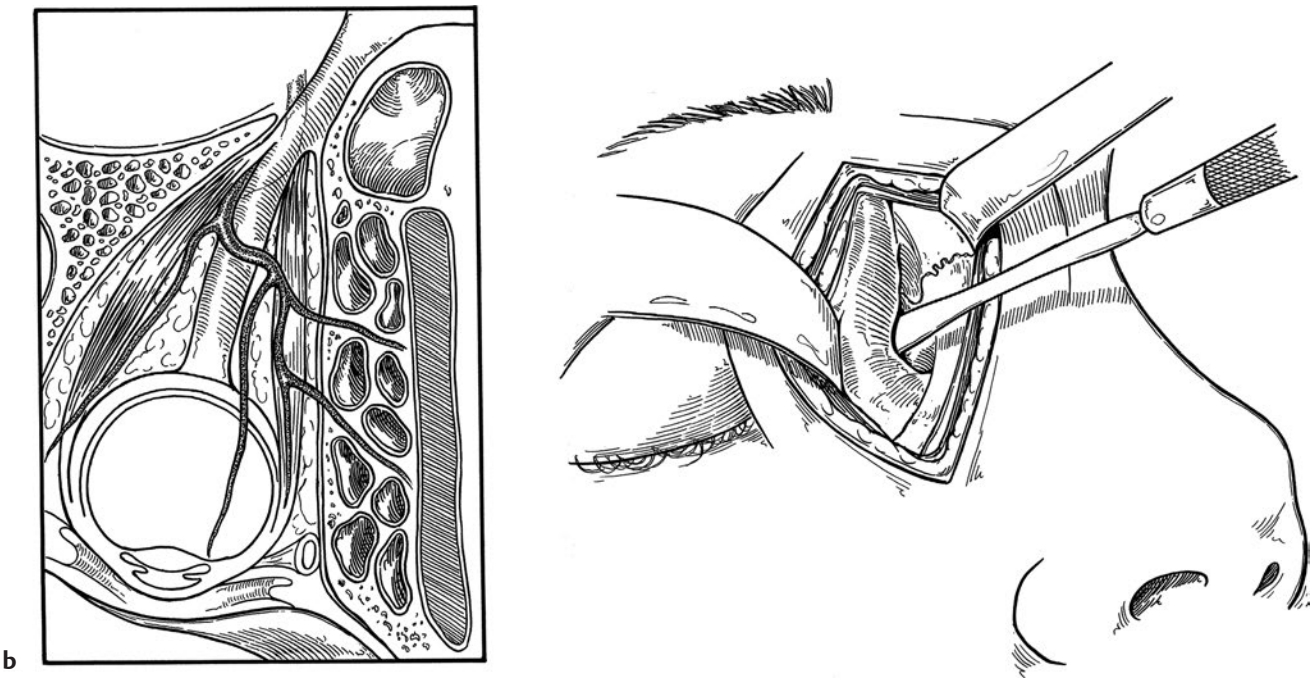
1. Anterior and posterior ethmoid artery ligation is carried out under general anesthesia. The area of the proposed incision is injected with 1% lidocaine with 1:100,000 epinephrine.
2. A curvilinear incision is made one-half of the distance between the medial canthus and the dorsum of the nose. The incision is carried down through the lateral nasal periosteum to bone (**Fig. 10.6a**).
3. The periosteum is elevated medially with a Freer elevator until the frontoethmoidal suture is identified. The ethmoidal vessels pass from the orbit to the nose through this suture line (**Fig. 10.6b**).
4. The frontoethmoidal suture line is followed until the anterior ethmoid artery is identified (**Fig. 10.6c**).
5. The artery is then ligated with two small vascular clips (**Fig. 10.6d**). The vessel is divided between the clips.
6. The frontoethmoidal suture is then followed farther back until the posterior ethmoid artery is identified and clipped in a similar fashion (**Fig. 10.6e**). Care is taken to avoid the optic nerve, which lies approximately 1 cm posterior to the posterior ethmoid artery.
7. The incision is closed with 3-0 interrupted chromic suture in the periosteum and 4-0 interrupted subcuticular chromic suture in the skin. No drain is required.

Complications

1. Continued bleeding
2. Intraorbital hemorrhage
3. Optic nerve damage

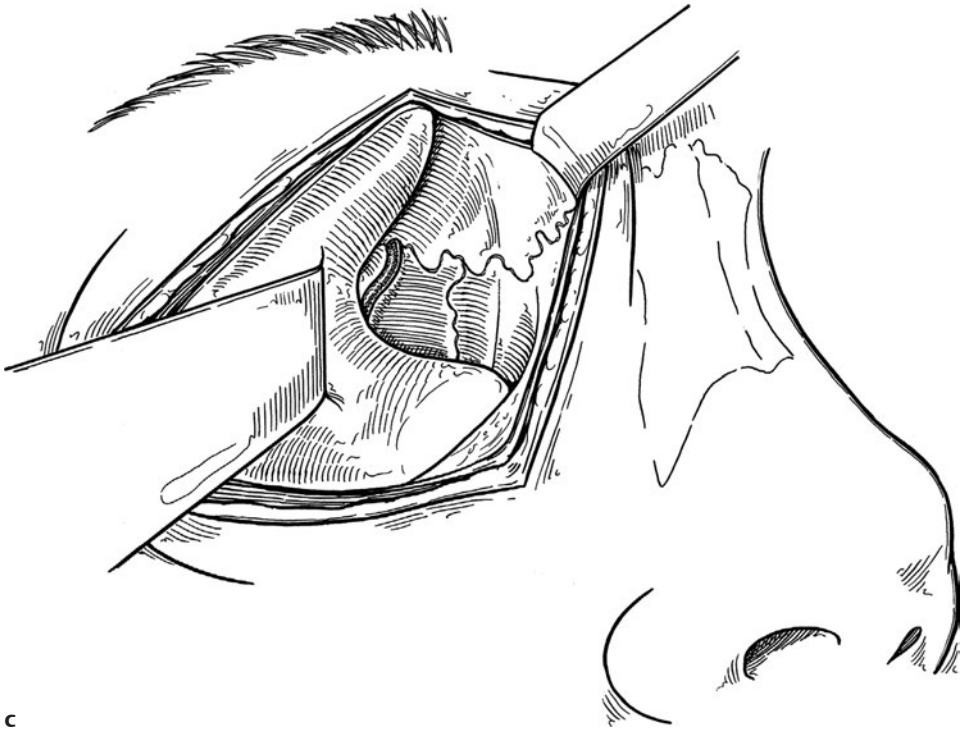


a

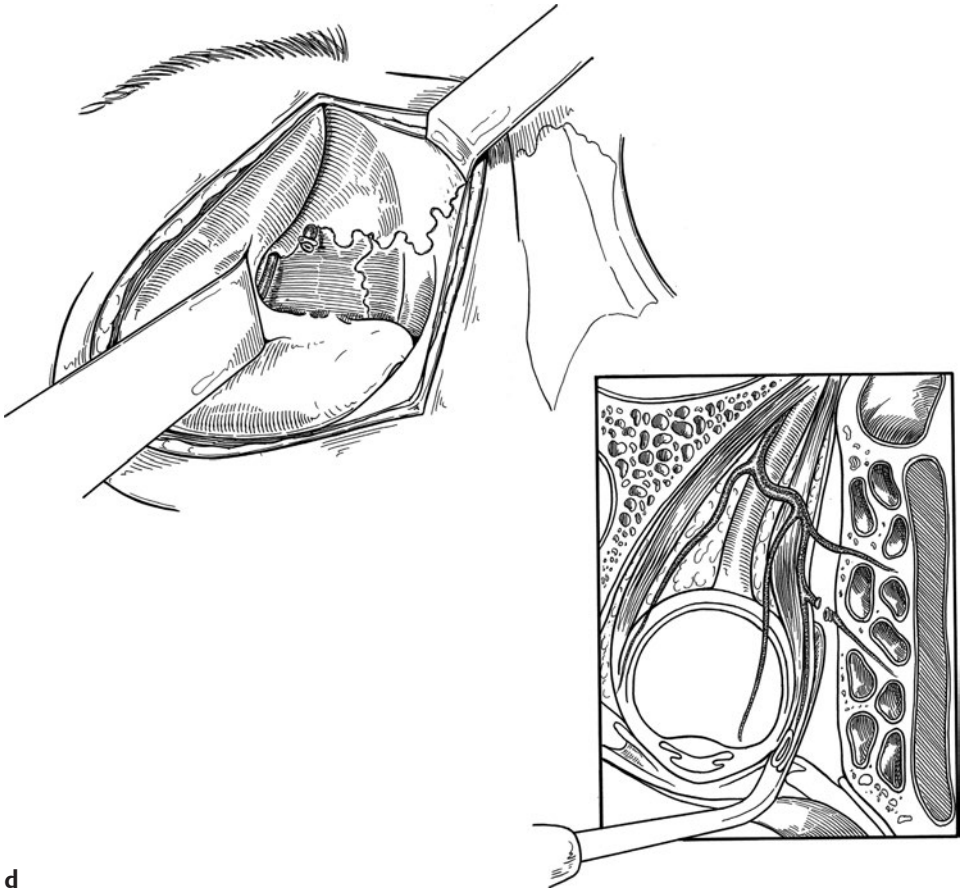


b

Fig. 10.6a,b



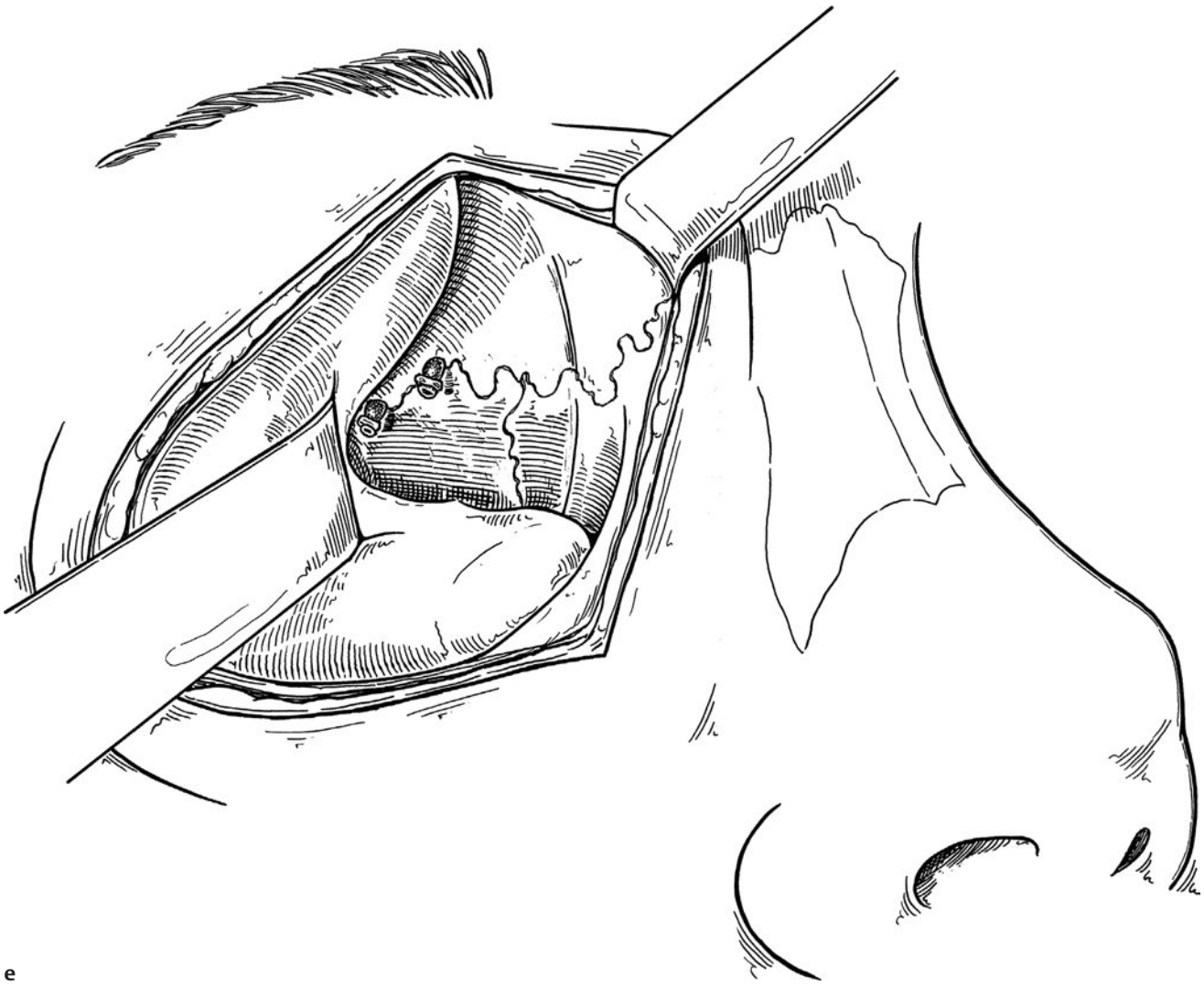
c



d

Fig. 10.6c,d

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e

Fig. 10.6e

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10-7 Septal Graft for Telangiectasia

Introduction

Hereditary telangiectasia with a single hemangioma or multiple hemangiomas of the nasal septum can be a cause of recurrent and debilitating epistaxis.

Indications

Removal of septal mucosa with skin grafting is indicated in the case of recurrent epistaxis secondary to hereditary telangiectasia that has not responded to packing, cautery, or KTP laser (potassium titanyl phosphate).

Preoperative Evaluation

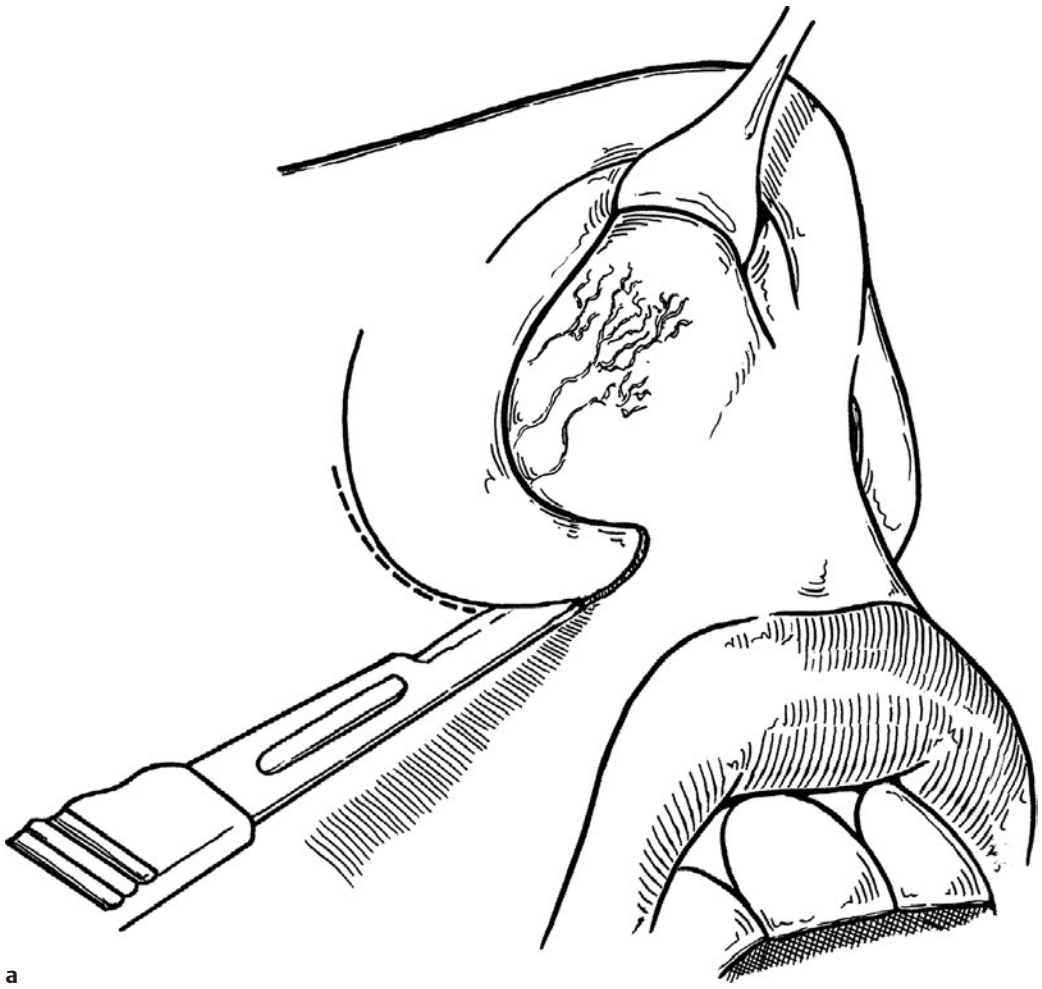
Preoperative evaluation includes a complete endoscopic examination of the nasal cavities. Angiography may be performed to localize the hemangiomas and also to evaluate the suitability for embolization of the malformation.

Operative Technique

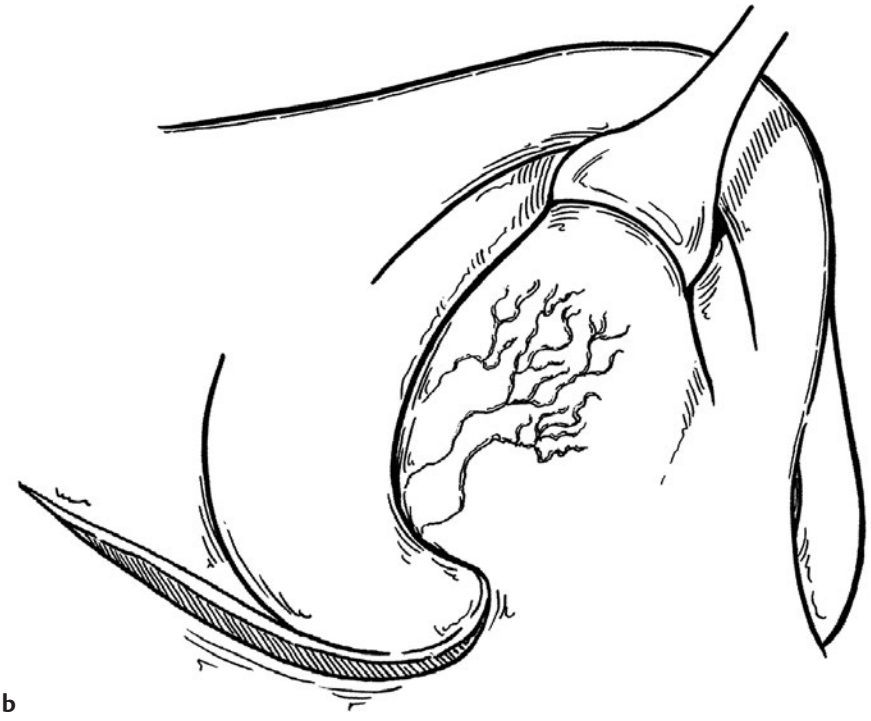
1. Septal grafting is best performed utilizing general anesthesia and topical vasoconstriction with 4% cocaine (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used).
2. One percent lidocaine with 1:100,000 epinephrine is injected in the subcutaneous tissue of the alar rim and the anterior septum. The septum is exposed by an alar incision in the nasolabial crease from its attachment at the septum to the inferior edge of the nasal bone. This exposes the anterior septum (**Fig. 10.7a**).
3. Additional exposure can be obtained by extending the incision along the lateral border of the nose (**Fig. 10.7b**).
4. The septal mucosa is incised down to, but not through, the nasal septal perichondrium surrounding the area to be removed (**Fig. 10.7c**).
5. The mucosa is elevated and removed with a sharp elevator taking care to keep the perichondrium intact over the septum (**Fig. 10.7d**).
6. A split-thickness skin graft of 0.012″ to 0.015″ is taken from a relatively hairless area of the body (e.g., lateral hip above the bathing suit line) and secured in place with 5-0 Vicryl suture (Ethicon) (**Fig. 10.7e**).
7. The alar incision is closed with interrupted chromic subcutaneous sutures and 5-0 interrupted subcuticular absorbable sutures in the skin (**Fig. 10.7f**).
8. The nose is then packed with Gelfoam moistened with an antibiotic-containing otic suspension. The Gelfoam usually becomes soggy and falls out in a few days.
9. Antibiotic ointment should be applied twice daily to the nostril for 2 weeks following removal of the pack.
10. Antibiotics are administered for 7–10 days.

Complications

1. Partial necrosis of graft
2. Continued epistaxis

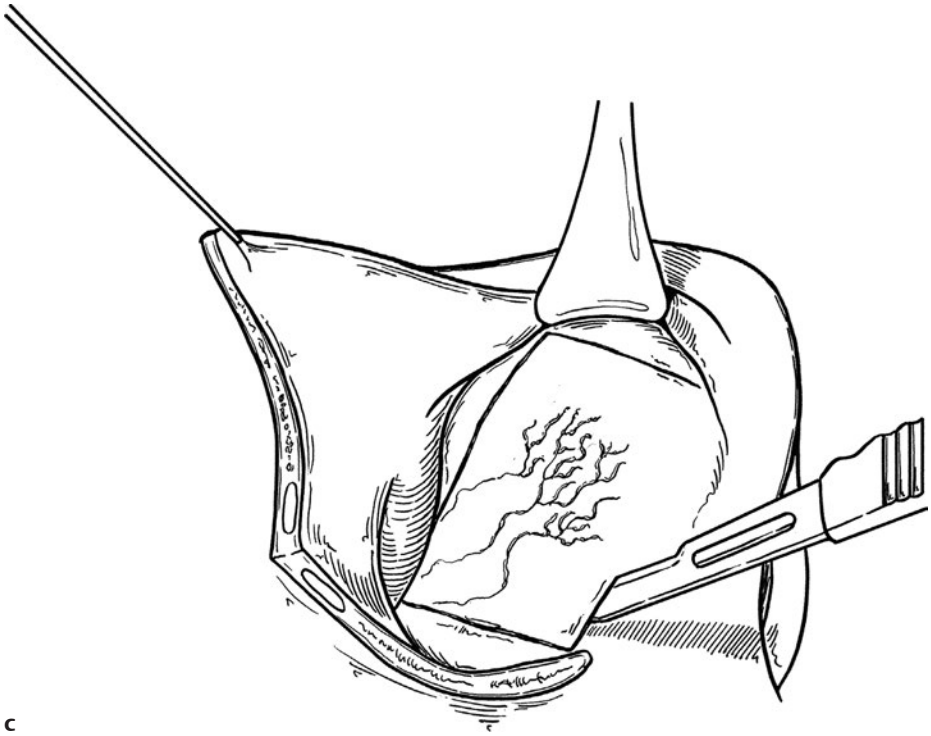


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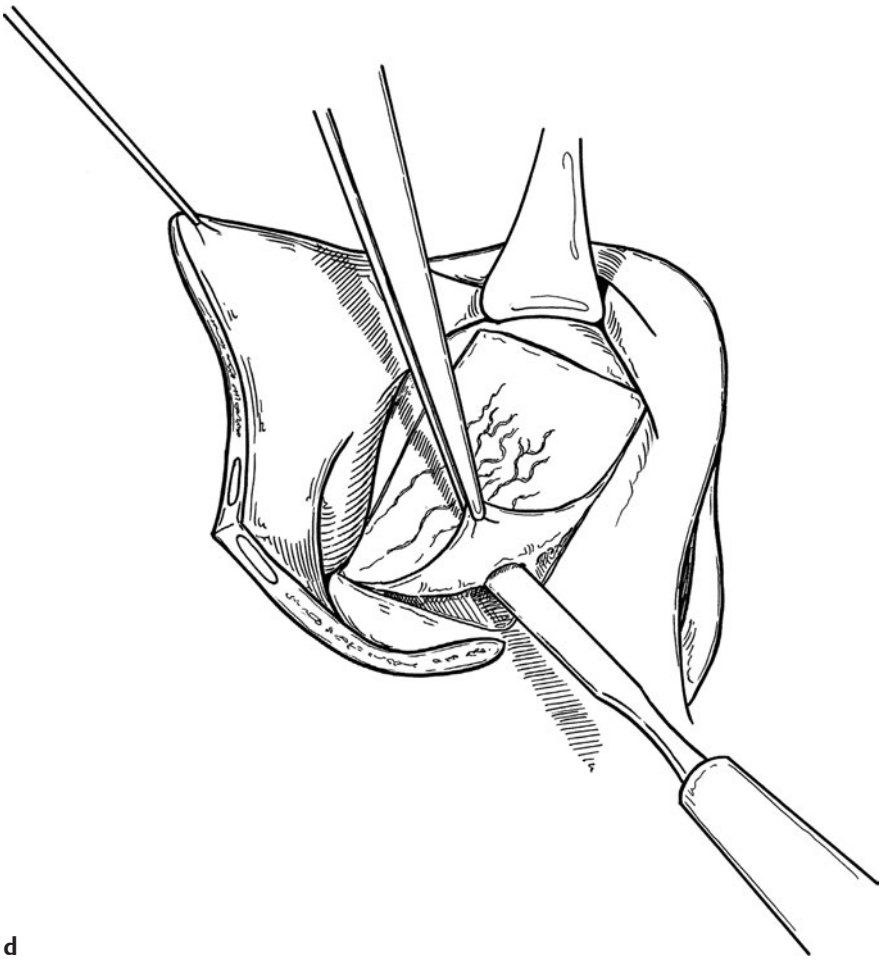


b

Fig. 10.7a,b

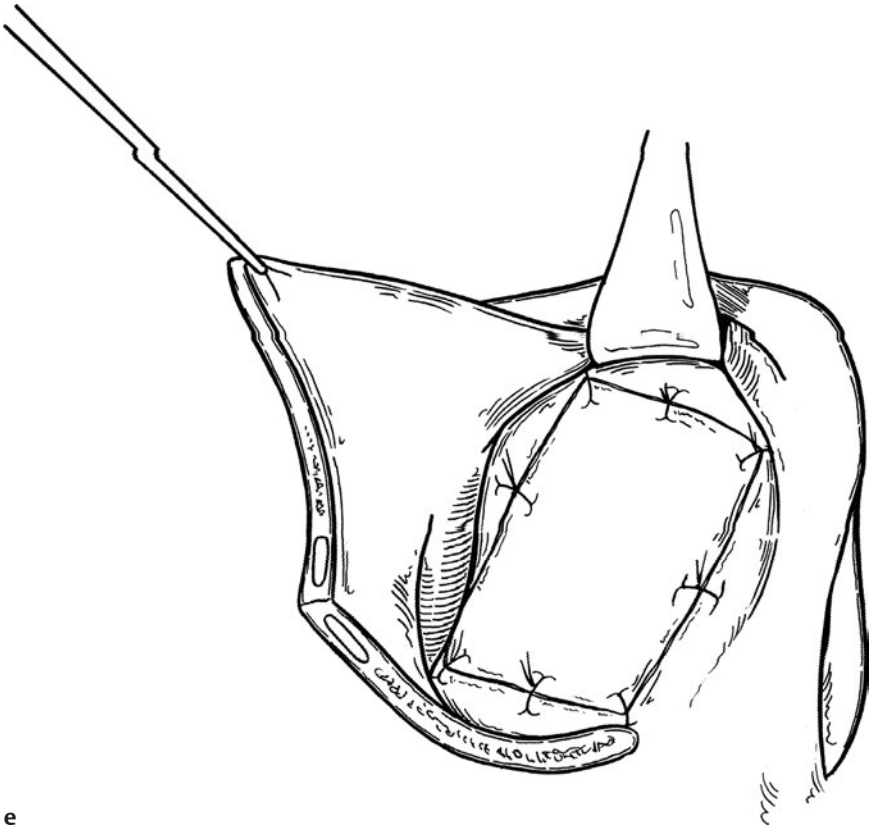


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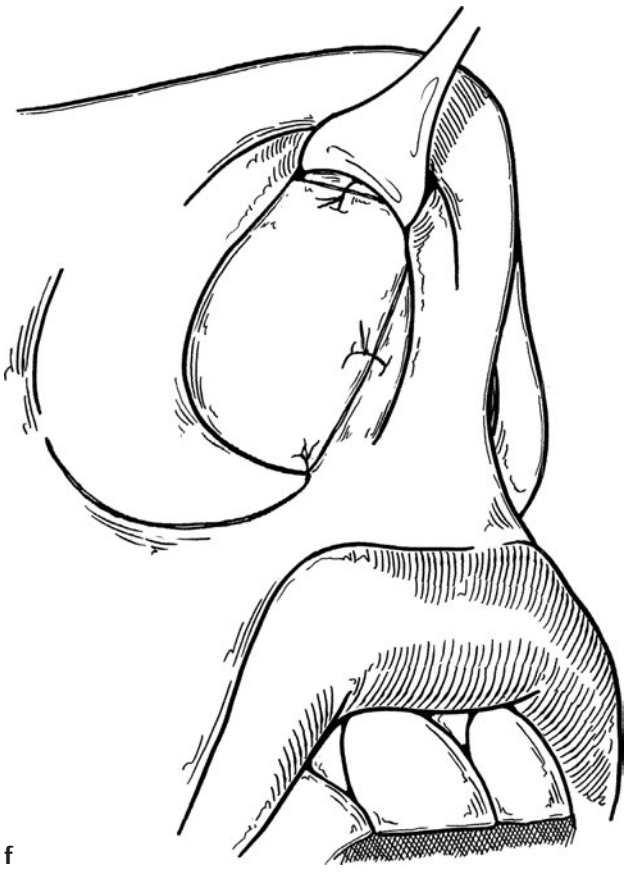


d

Fig. 10.7c,d



e



f

Fig. 10.7e,f

11 Nasal Foreign Bodies

Lisa M. Elden

Children frequently put foreign bodies into their noses. Paper, vegetables (beans), and stones are common examples. A nasal foreign body is suspected in a child with a foul-smelling unilateral nasal discharge.

11-1 Removal of Nasal Foreign Bodies

Indications

Nasal foreign bodies should be removed expeditiously to avoid nasal and sinus infections.

Preoperative Evaluation

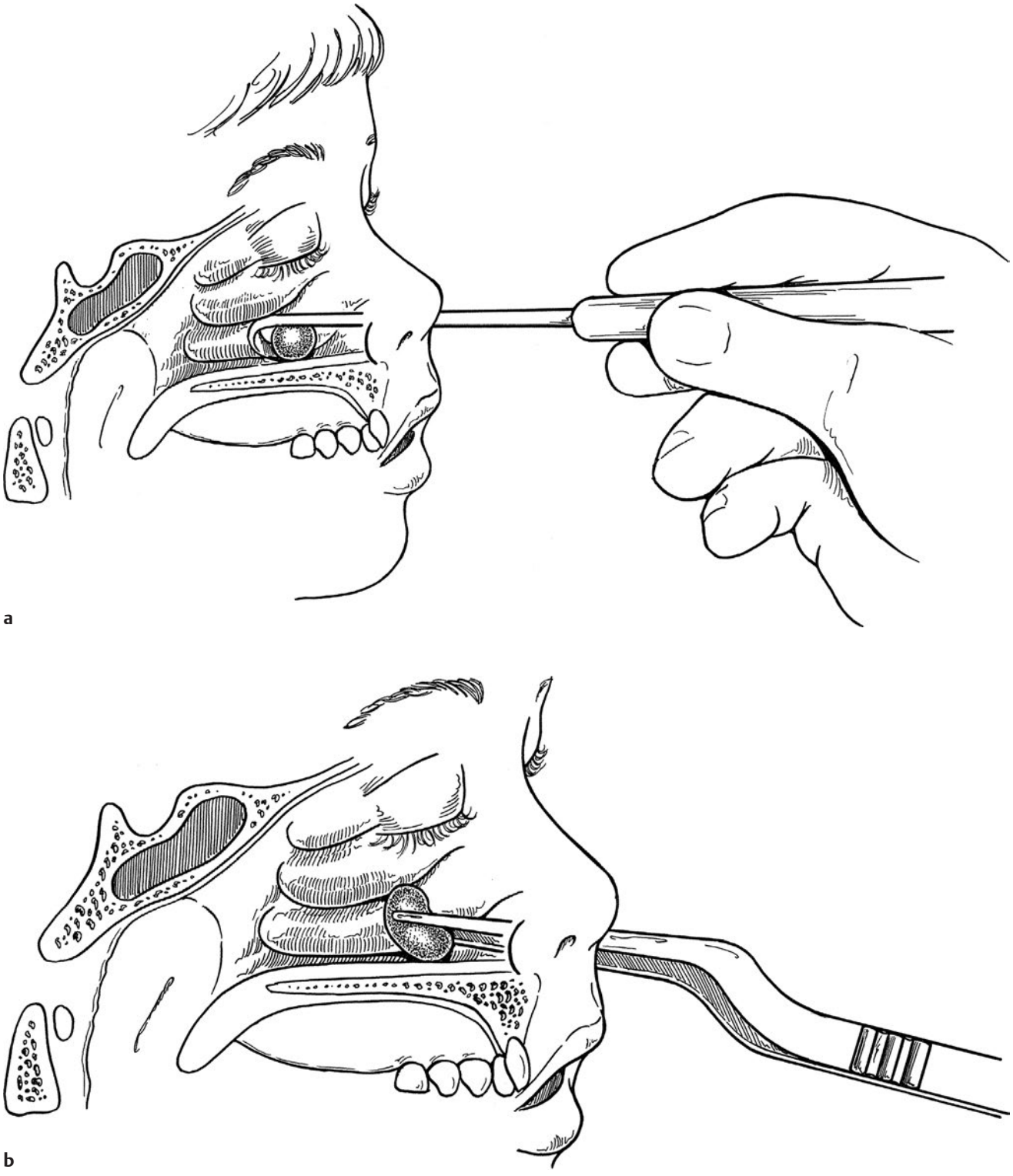
The foreign body is usually seen on anterior rhinoscopy. Endoscopic examination may be helpful in locating a nasal foreign body. This is most easily done if the nasal cavity is suctioned and decongested with 4% cocaine (alternately, any combination of a topical vasoconstrictor and local anesthesia may be used). If a foreign body is not seen but is highly suspected, the examination should be performed under general anesthesia. Most nasal foreign bodies are radiolucent, so radiographs are rarely helpful.

Operative Technique

1. Removal of nasal foreign bodies in small children usually requires immobilization with a papoose board. Older children may cooperate for removal of the foreign body utilizing topical anesthesia. Occasionally, general anesthesia may be required.
2. The nasal mucosa is decongested with 4% cocaine dropped or sprayed into the nose (alternately, any combination of a topical vasoconstrictor and local anesthesia may be used).
3. After the nasal cavity is suctioned clear of mucus, the foreign body is removed under direct vision or endoscopically.
4. Rounded foreign bodies should be rolled to the anterior nare with a blunt hook (**Fig. 11.1a**).
5. Foreign bodies that can be grasped with a forceps can be removed in this fashion (**Fig. 11.1b**).
6. Foreign bodies in the posterior nasal cavity or partially in the nasopharynx are always removed under general anesthesia to prevent aspiration. They can be grasped with forceps while placing a finger in the nasopharynx to prevent posterior displacement (**Fig. 11.1c**).
7. Identification of button batteries that are located in the nasal cavity or other parts of the upper airway should be removed on an urgent basis. Direct current and acid discharging can cause local tissue damage within minutes to hours. In most instances, foreign body hooks, forceps, or suctions may be used to successfully remove these items (**Fig. 11.1d**).

Complications

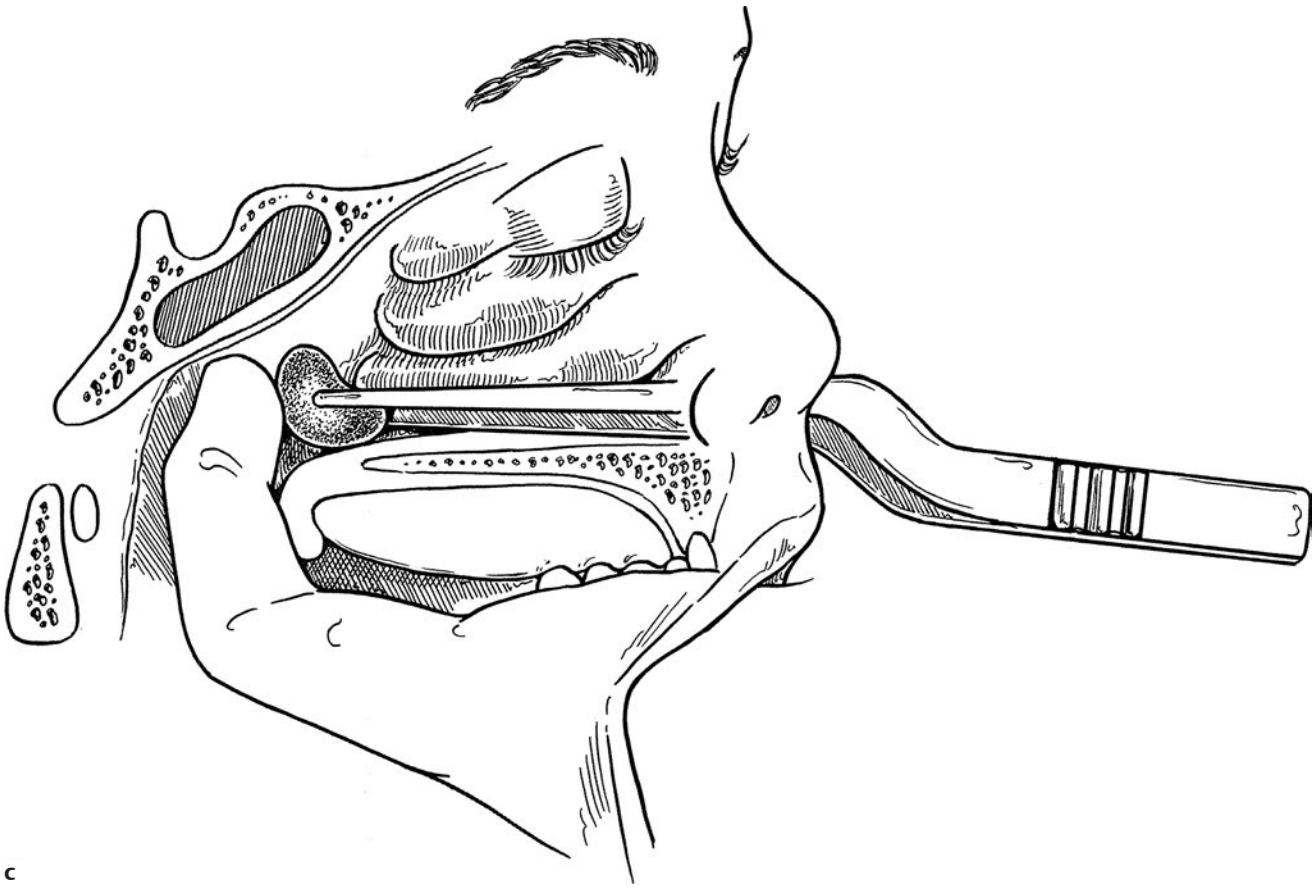
Mucosal abrasion.



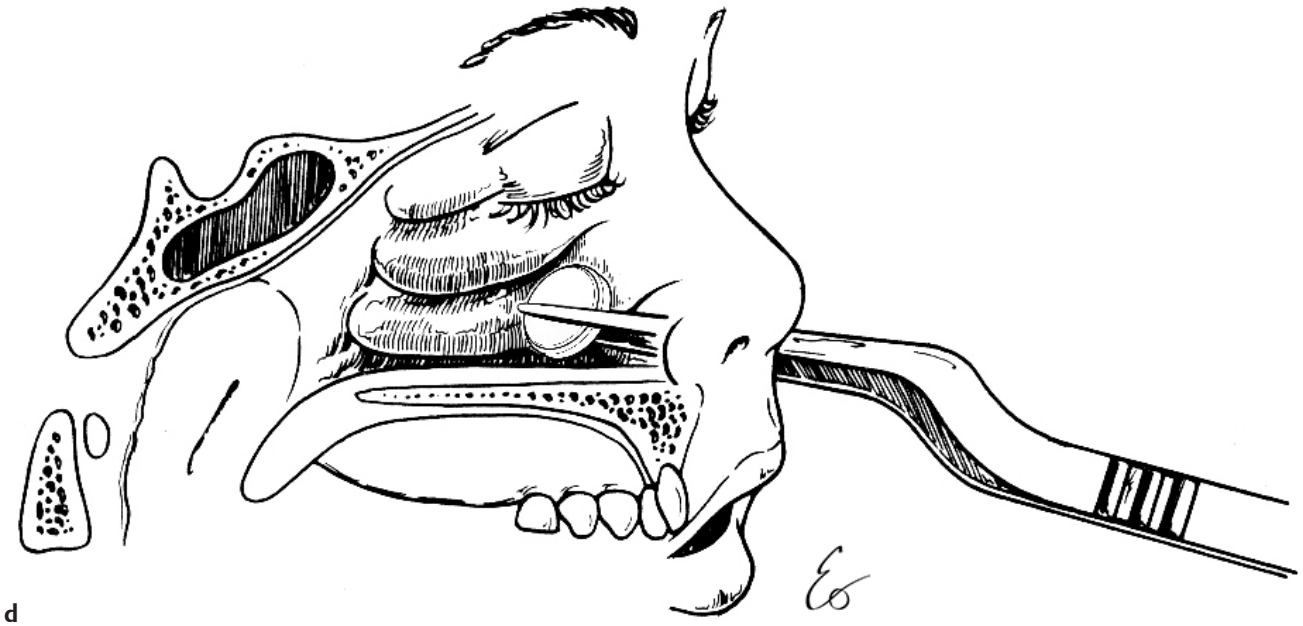
a

b

Fig. 11.1a,b



c



d

Fig. 11.1c,d

12 Nasal Deformity

Ken Kazahaya

Children frequently sustain nasal trauma from falls or sports. Nasal trauma may cause a deviated septum or displaced nasal bones.

12-1 Conservative Septoplasty

Introduction

Septoplasty should be carefully considered in the pediatric population for risk of disturbing the growth centers in the septum. However, if a child has severe nasal obstruction secondary to septal deviation or recurrent sinus infections as a result of the septal deviation, then a conservative septoplasty may be considered. Removal of a septal spur or minimal resection of cartilage to remove the septal deformity and to improve nasal patency should be the goal of surgery, rather than attempting to achieve a perfectly straight septum.

Indications

Septoplasty may be indicated when there is sufficient septal deformity or deviation to cause nasal obstruction. Septoplasty may also be performed to manage refractory epistaxis.

Preoperative Evaluation

Careful visual inspection of the nasal cavity before and after topical vasoconstriction of the nasal mucosa should be performed. Patients should be evaluated and treated for allergic rhinitis as a potential etiology for nasal congestion/obstruction. Additionally, gastroesophageal reflux may also contribute to posterior nasal mucosal edema and inflammation, contributing to nasal congestion. Radiographic examination is usually not necessary or helpful.

Operative Technique

1. General anesthesia is typically required to perform septoplasty in children and teenagers. Additionally, the nasal mucosa is injected with 1% lidocaine with 1:100,000 epinephrine. The injection is placed ideally under the mucoperichondrium to provide hydrodissection and hemostasis (**Fig. 12.1a**). Additional intranasal decongestion is provided with 4% topical cocaine solution applied with neurosurgical Cottonoid (Codman) pledgets.
2. If there is an isolated septal spur or deformity, a small mucoperichondrial flap may be created directly over the lesion.
   a. An incision is made just anterior to the defect through the mucosa and perichondrium, but not through the cartilage (**Fig. 12.1b**).
   b. The mucoperichondrium is elevated off of the spur or deformity (**Fig. 12.1c**). This can be performed utilizing a headlight or a nasal endoscope. The endoscope may provide better illumination and a magnified view; however, it will limit a surgeon to a single hand to operate or necessitate an assistant to manipulate the scope to allow the surgeon the freedom to use both hands. There are many surgical instruments that have been developed for use in endoscopic surgery; one convenient instrument is a suction elevator.
   c. After elevating the flap, the spur or septal deformity can be shaved off using a sharp instrument like a scalpel or Cottle or Freer elevator (**Fig. 12.1d**).
3. If there is a large deflection or deviation that needs to be addressed, a larger mucoperichondrial flap may be elevated.
   a. The mucoperichondrial incision can be made approximately 5 mm cephalad to the caudal edge of the cartilaginous septum. Care is taken not to cut through the cartilage.
   b. The mucoperichondrium is elevated using a flat elevator such as a Cottle or Freer elevator or a suction elevator. Once again, this may be performed utilizing a headlight or nasal endoscope.
   c. The mucoperichondrial flap is elevated over the septum and, if there is deflection of the bony septum, the mucoperiosteal flap is elevated over the bony septum also.
   d. If necessary, a mucoperichondrial flap may be elevated on the contralateral side of the septum by either dissecting around the caudal end of the septum or by making an incision though the cartilage, about 5 mm cephalad to

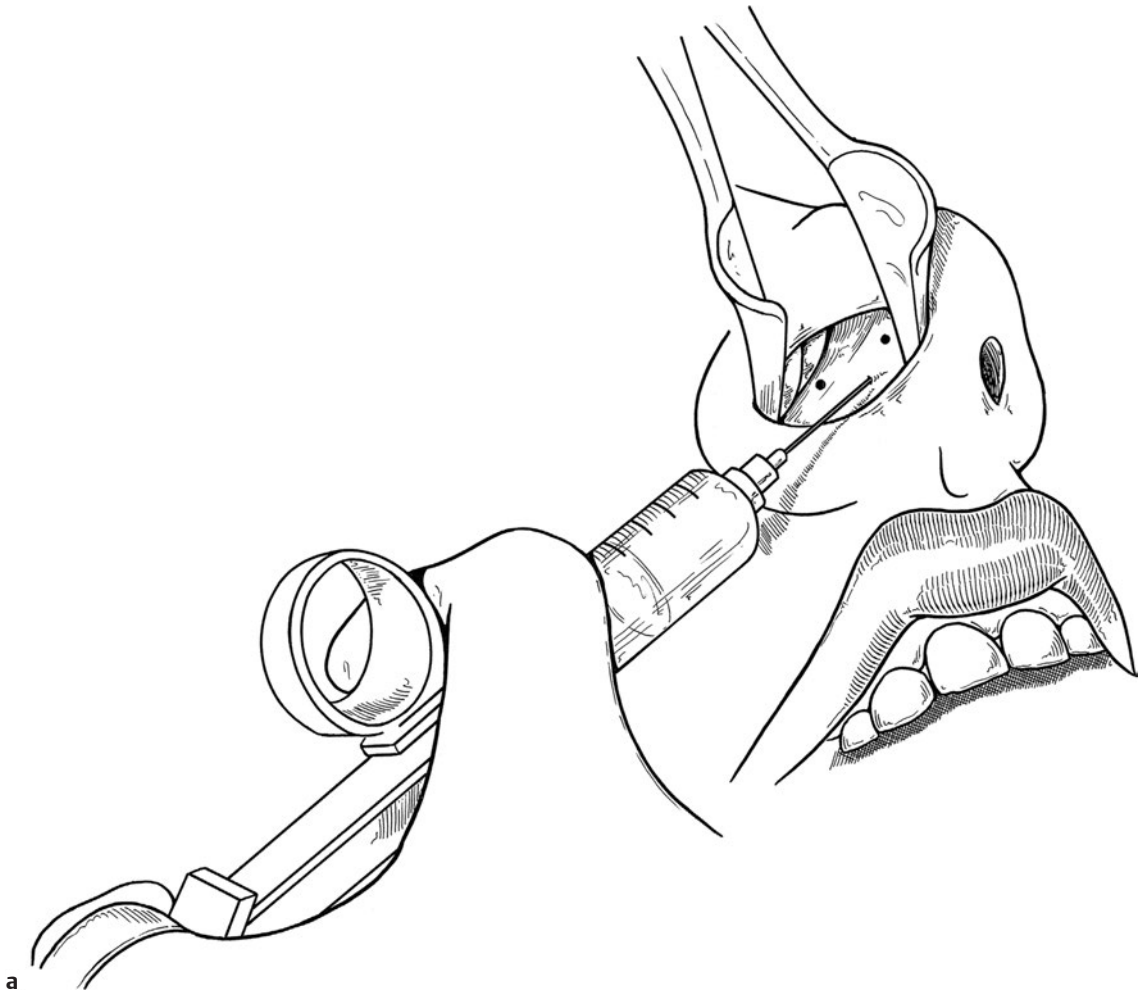
the mucoperichondrial incision, taking care not to cut through the mucoperichondrium on the contralateral side (**Fig. 12.1e,f**). Care must be taken if dissection is made around the caudal end of the septum so as not to disrupt the support of the nasal tip; otherwise, this will need to be addressed at the time of closure.

e. A small strip of cartilage may be cut or removed to allow for repositioning of the cartilaginous septum. The dorsal and caudal margins of the quadrilateral cartilage need to be preserved to maintain support of the nose (**Fig. 12.1g,h**).
f. Resection and cutting of the cartilage should be minimized to reduce the potential risk of disturbance of nasal growth.
g. Deviations of the bony septum as well as thick areas and duplications of bone or cartilage may be resected or shaved.
h. Prominent edges of the maxillary crest may also be reduced with a narrow osteotome or ronguer, taking care to avoid cutting through or tearing the overlying mucoperiosteal flap (**Fig. 12.1i**).

4. Once the deviation/spur/deflection has been addressed, the mucoperichondrial flaps need to be reapproximated to the septum to reduce dead space and to prevent collections between the flaps and the septal cartilage. Various techniques are available to reapproximate the flaps. A simple technique involves using an absorbable suture (e.g., 5-0 Chromic gut [Ethicon]) through and through the septum. There are also endonasal staplers designed to quickly reapproximate the septal flaps (**Fig. 12.1j**).
5. If a caudal incision was made, it is closed with absorbable suture (e.g., 5-0 Chromic gut).
6. Telfa (Covidien) or Merocel (Medtronic) packs with silk retrieval sutures may be placed on each side of the septum to apply gentle pressure to the septum. These packs may be removed 12–24 hours after surgery. Some surgeons have used reinforced Silastic sheeting (Dow) on each side of the septum to apply pressure and also to reduce the risk of intranasal synechiae (**Fig. 12.1k**).

Complications

1. Septal perforation
2. Epistaxis
3. Recurrence of septal deviation and persistence of symptoms
4. Saddle nose deformity (loss of dorsal support)
5. Loss of tip projection (loss of tip support from caudal septum)
6. Intranasal synechiae



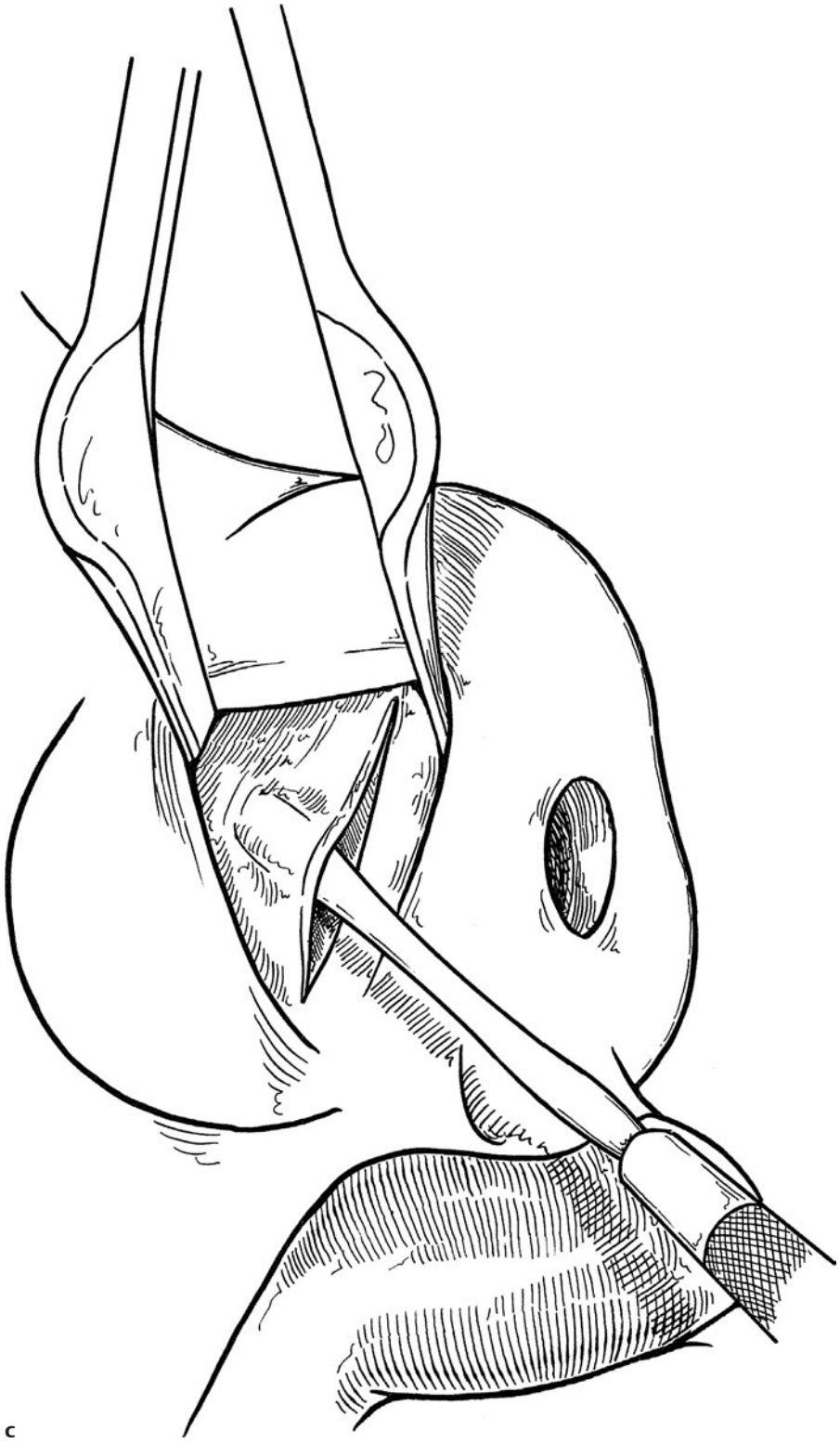
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Fig. 12.1a



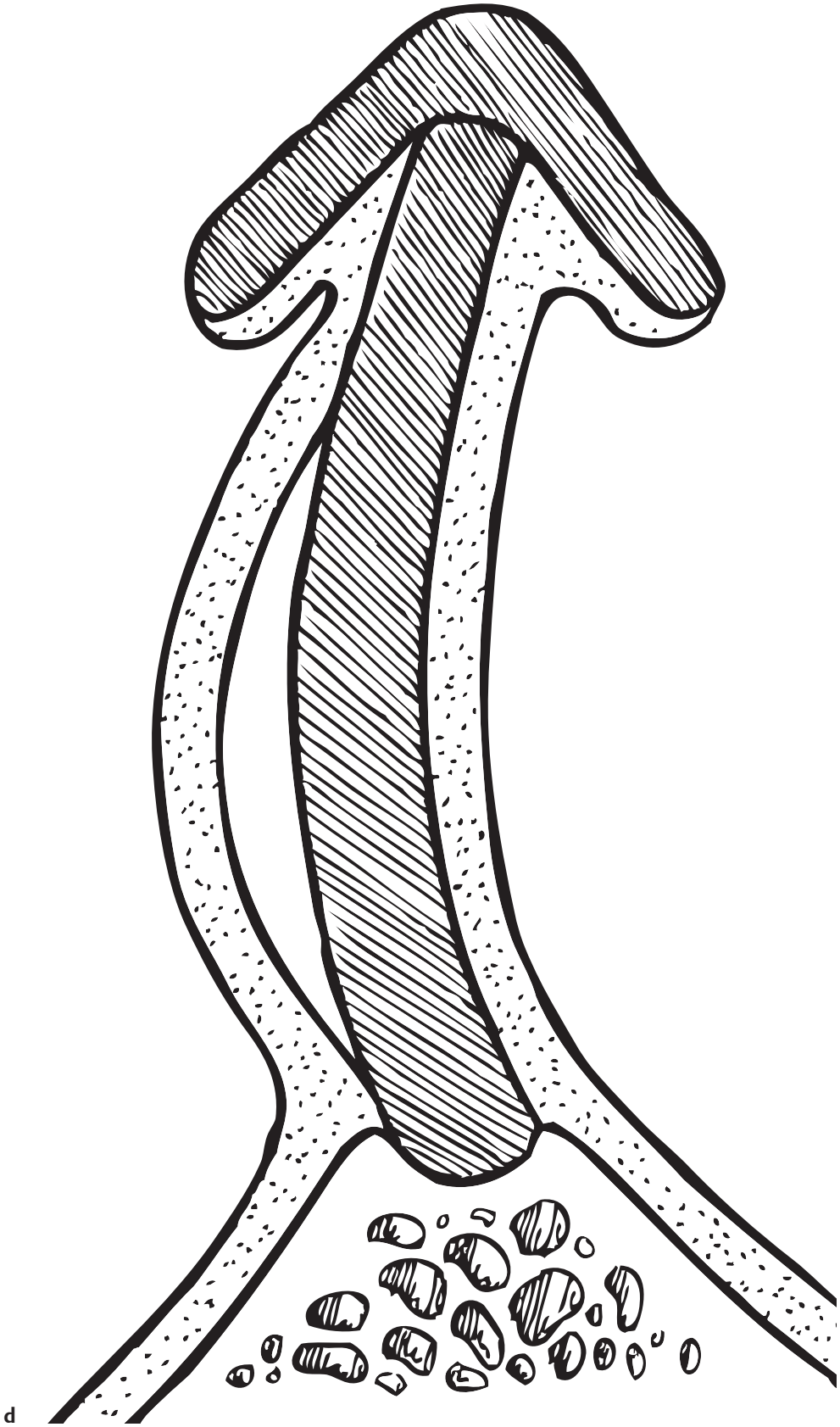
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Fig. 12.1b



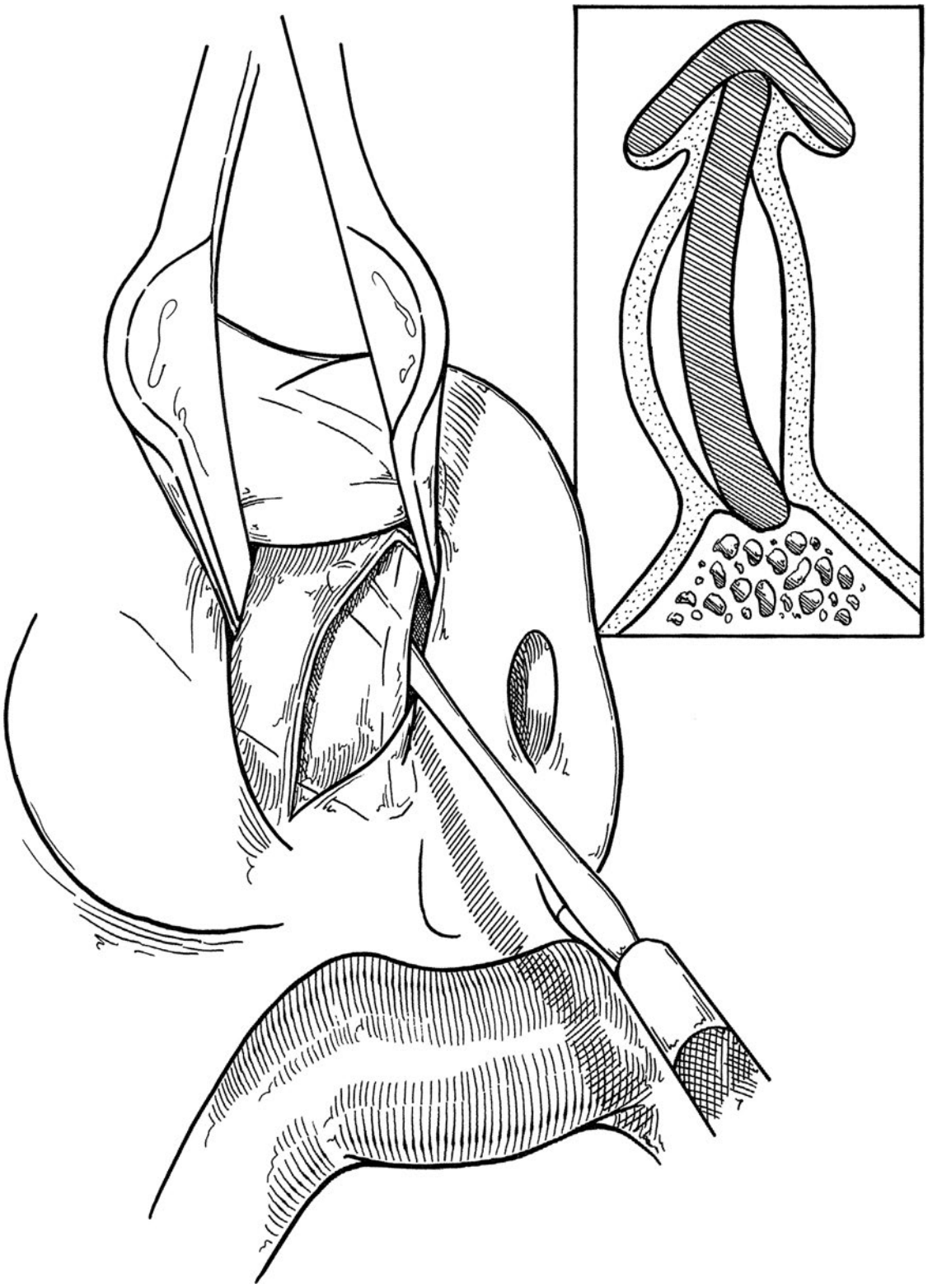
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Fig. 12.1c



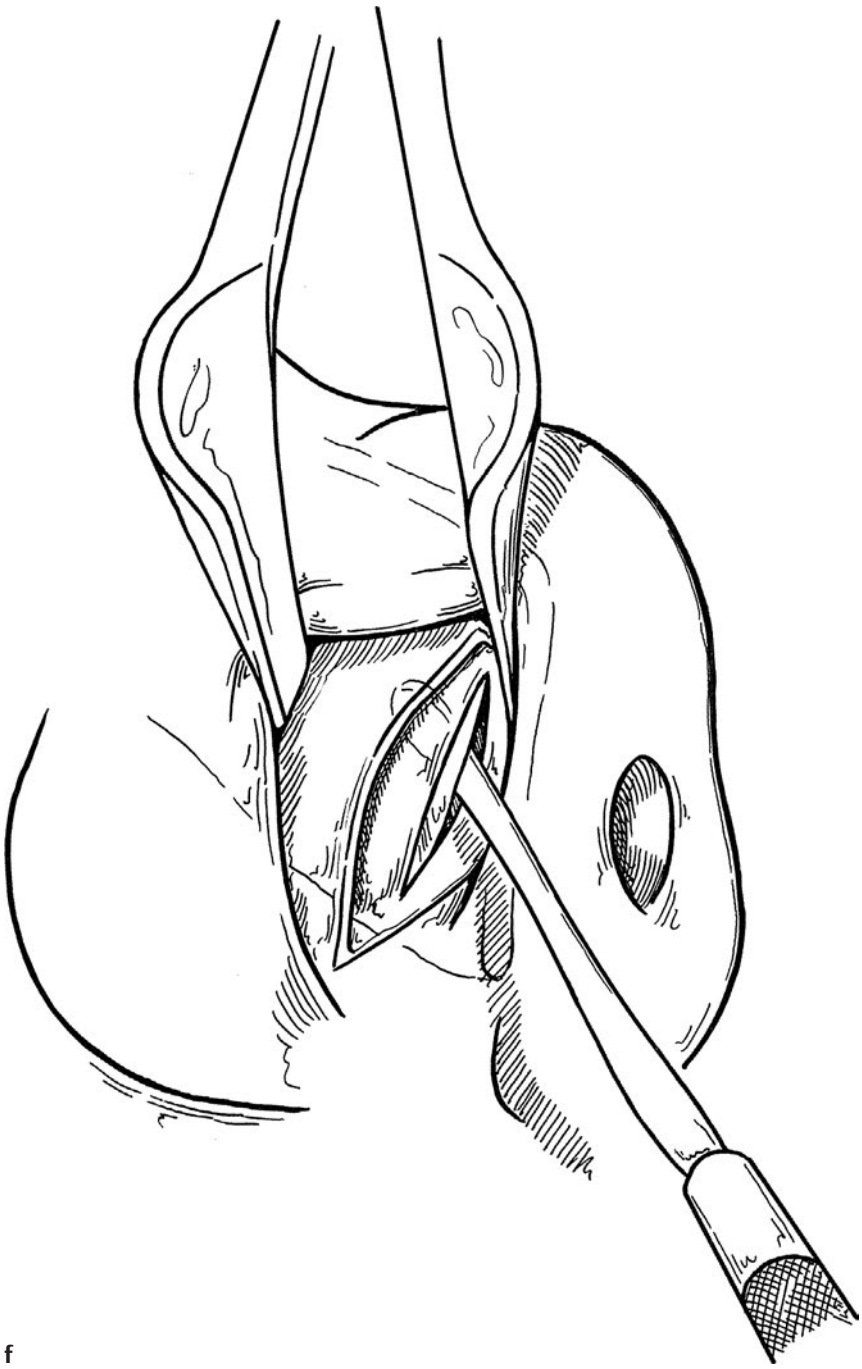
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Fig. 12.1d



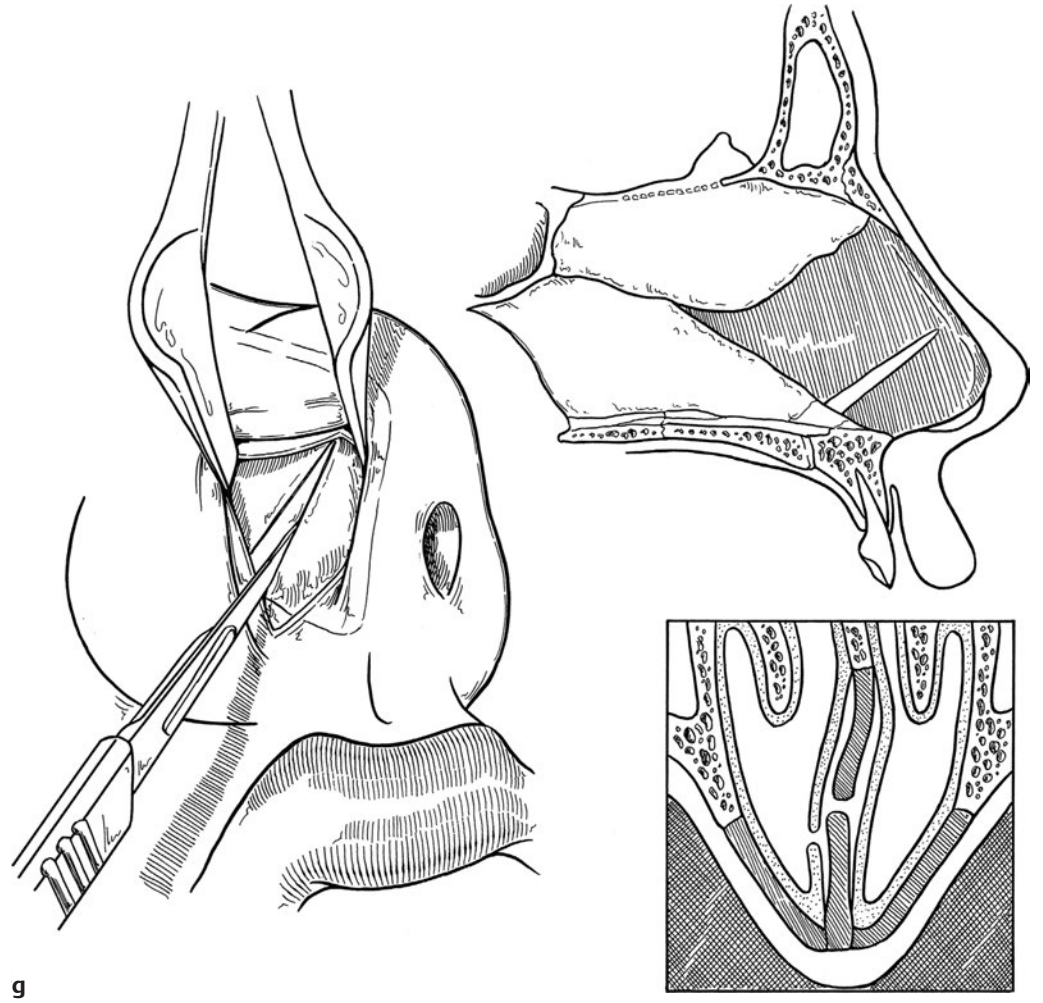
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Fig. 12.1e

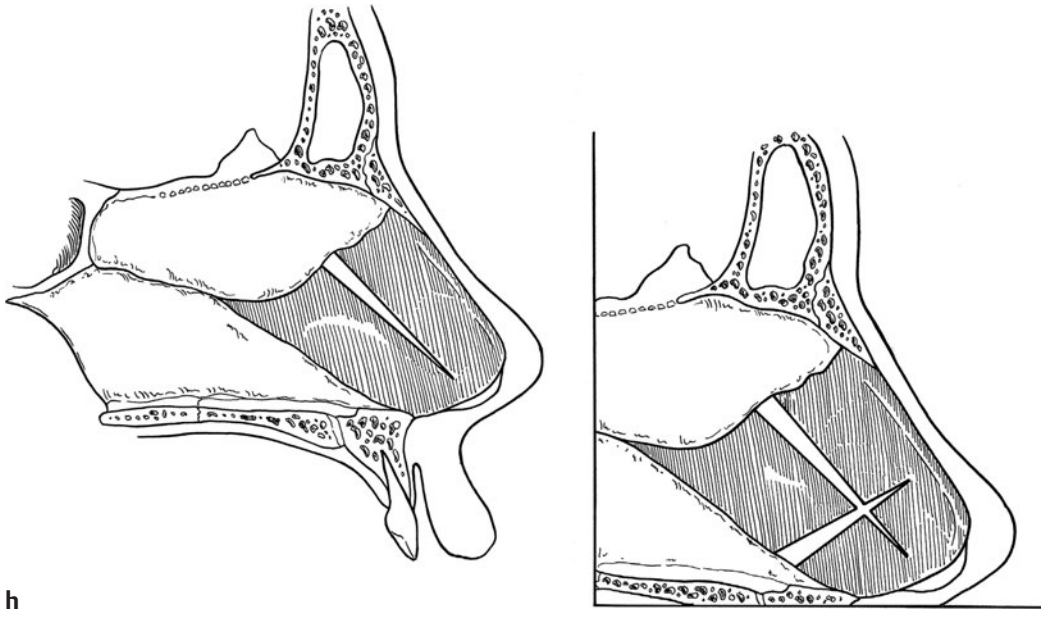


f

Fig. 12.1f

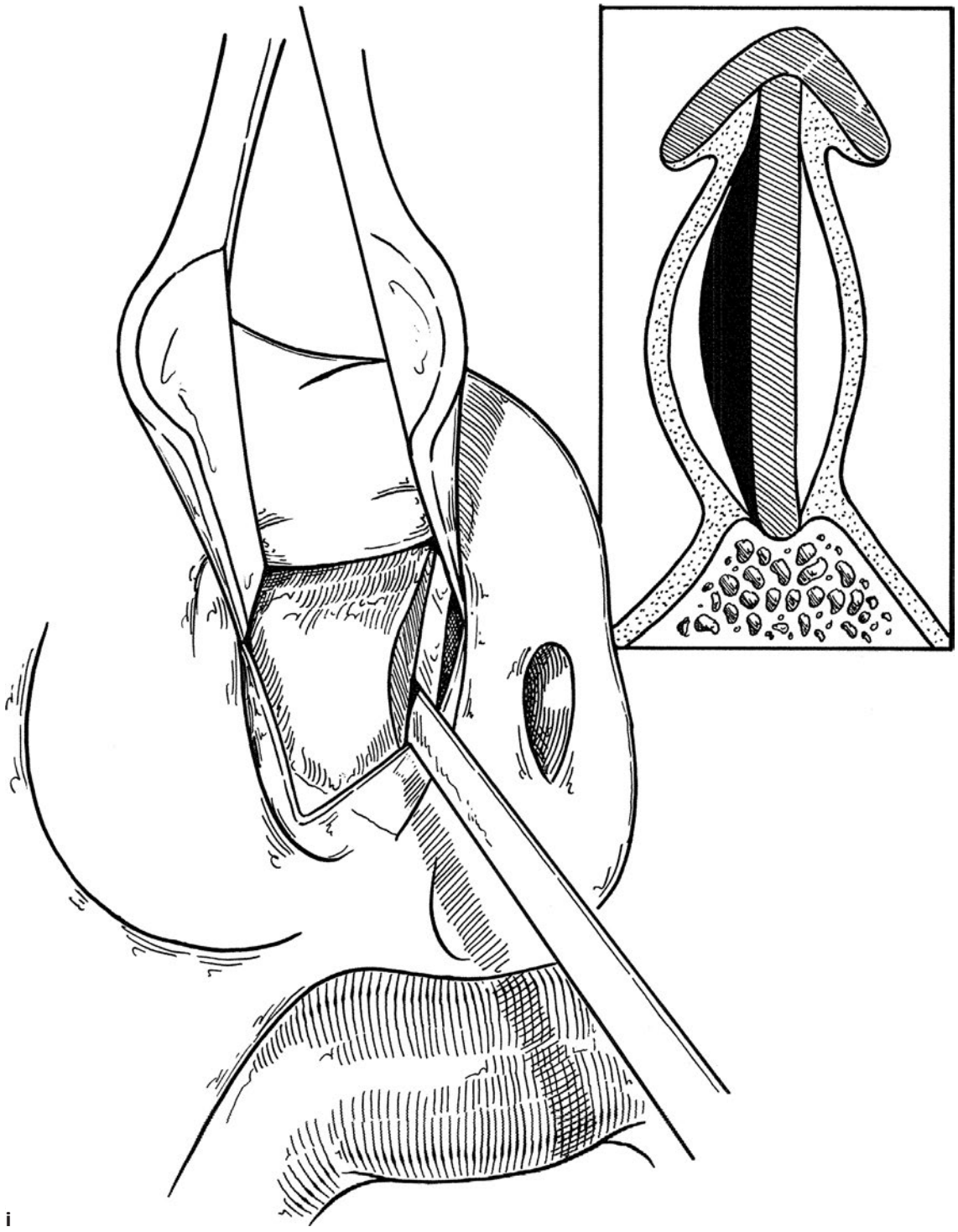


g



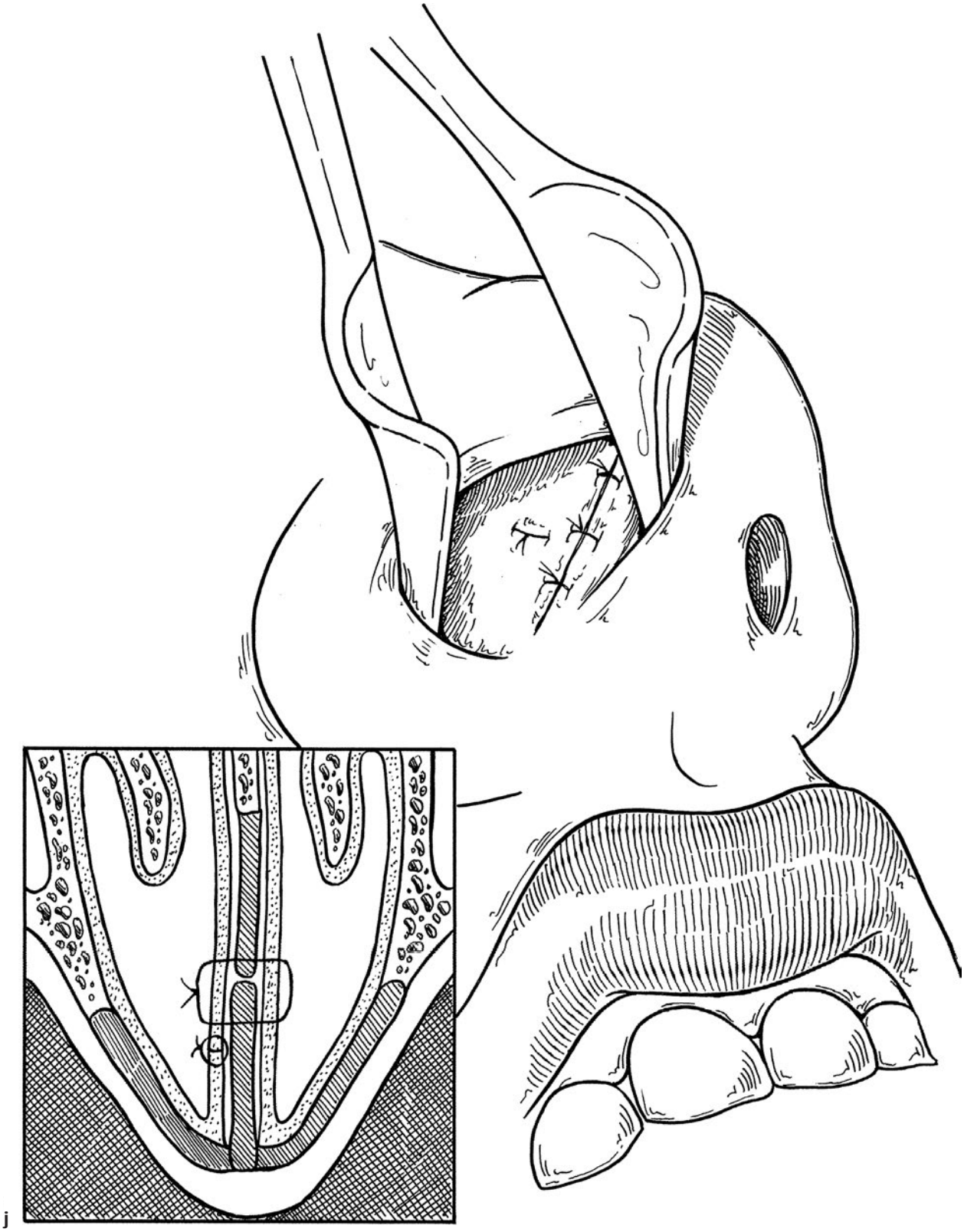
h

Fig. 12.1g,h



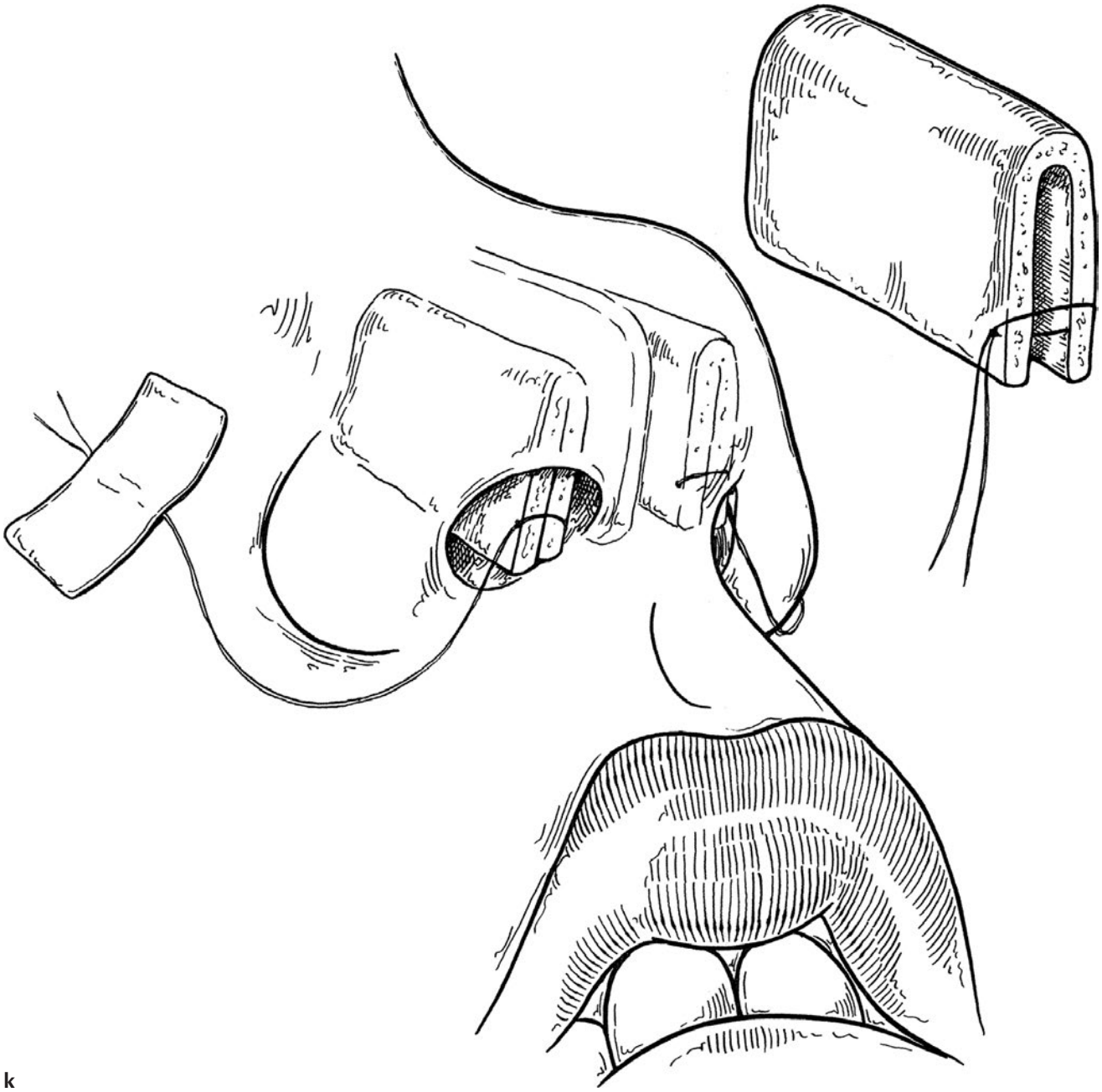
i

Fig. 12.1i



j

Fig. 12.1j



k

Fig. 12.1k

12-2 Conservative Rhinoplasty

Introduction

Conservative rhinoplasty is a procedure to straighten a congenitally or traumatically deviated nose and septum. Rhinoplasty in children is best deferred until the middle-to-late teenage years when resection of bone or cartilage is unlikely to alter growth of the nose and the nasal soft tissue and overlying skin have attained the adult/mature characteristics.

Correction of the deviated nose in a child should be done cautiously and conservatively taking into account the anatomy, severity of the deformity, and psychosocial circumstances.

Indications

Rhinoplasty is indicated to straighten a congenitally or traumatically deformed nose.

Preoperative Evaluation

Visual inspection of the nasal pyramid and nasal septum is essential because the external nasal deformity is often accompanied by a septal deviation. Both deformities must be corrected to obtain an adequate result. Radiographs are rarely helpful in this evaluation.

Operative Technique

1. Rhinoplasty in the pediatric population is best done utilizing general anesthesia and local injection of the nasal tissues with 1% lidocaine with 1:100,000 epinephrine. Intranasal vasoconstriction is accomplished with 4% cocaine applied with neurosurgical Cottonoid patties (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used).
2. The nasal septum is injected as described for septoplasty (see Section 12-1).
3. A line of local anesthesia is placed on each side of the nose by injection of 1% lidocaine with 1;100,000 epinephrine in the subcutaneous tissues halfway between the nasal dorsum and the lateral border of the nose (**Fig. 12.2a**).
4. The mucosa at the lower edge of the upper lateral cartilage is injected at multiple sites with just enough solution to blanch the tissues, but not enough to deform the nose (**Fig. 12.2b**).
5. The septum is corrected as described in septoplasty (see Section 12-1).
6. An intercartilaginous incision is made at the lower edge of the upper lateral cartilage (**Fig. 12.2c**).
7. The skin over the dorsum of the nose is elevated by sharp dissection with a blunt scissors (**Fig. 12.2d,e**).
8. If the nasal septal deviation is high and the septum is adherent to the upper lateral cartilages, it is released by cutting the attachments with a knife or septal scissors while protecting the overlying skin of the nasal dorsum (**Fig. 12.2f,g**). Otherwise, no release of the upper lateral cartilages needs to be done.
9. The medial osteotomy is performed by placing a small osteotome at the caudal edge of the nasal bones along the septum. The osteotome is directed posterosuperiorly along the septum with gentle taps from a small mallet. The osteotomy is curved laterally to meet the point of return fracture expected from the lateral osteotomy (**Fig. 12.2h**).
10. For the lateral osteotomy, a small, intransal transverse incision is made with a knife down to the edge of the pyriform aperture just above the attachment of the inferior turbinate. Scissors are used to clean off remaining soft tissue attachments from the bony edge (**Fig. 12.2i**).
11. An small osteotome is placed in the incision. A lateral osteotomy is carried out with gentle taps from a small mallet as the osteotome advances along the lateral base of the nose (**Fig. 12.2j**).
12. The nasal pyramid is then mobilized manually and positioned in the midline (**Fig. 12.2k**).
13. A 2 × 4 cm piece of Telfa is folded and placed in each side of the nose to help reapproximate mucosal flaps and to stabilize the nasal structures (alternately, Merocel packing may be used). A long 3-0 silk suture is placed at the anterior edge of the packing to facilitate its removal in 12–24 hours (**Fig. 12.2l**).
14. A splint made of plaster or a prefabricated material is placed on the nose to protect the nasal pyramid. This can removed in 7 days.
15. Antibiotics are administered for 7–10 days.

Special Considerations

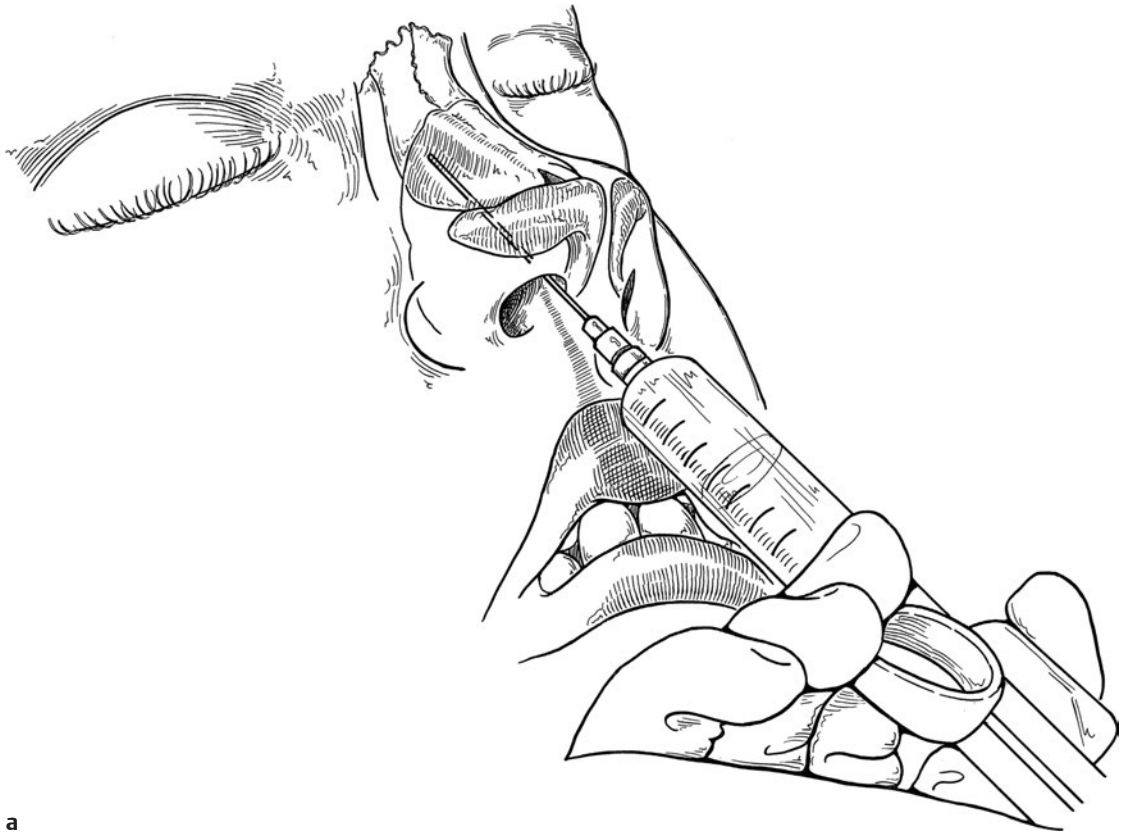
In the Neonate

1. The neonate may have a severely deviated nose secondary to birth trauma. The nose should be replaced by firm digital pressure.
2. If the deviation has been present for days to weeks, it may not be amenable to manual reduction.
3. Long-standing deviation (> 2 weeks) may be left alone. The deformity may correct itself in 1–3 months. The resulting position may not be perfect, but is usually quite acceptable.
4. If the nose remains severely deviated, it may be corrected after 4 years of age. Correction of lesser deformities should be delayed until the teenage years.

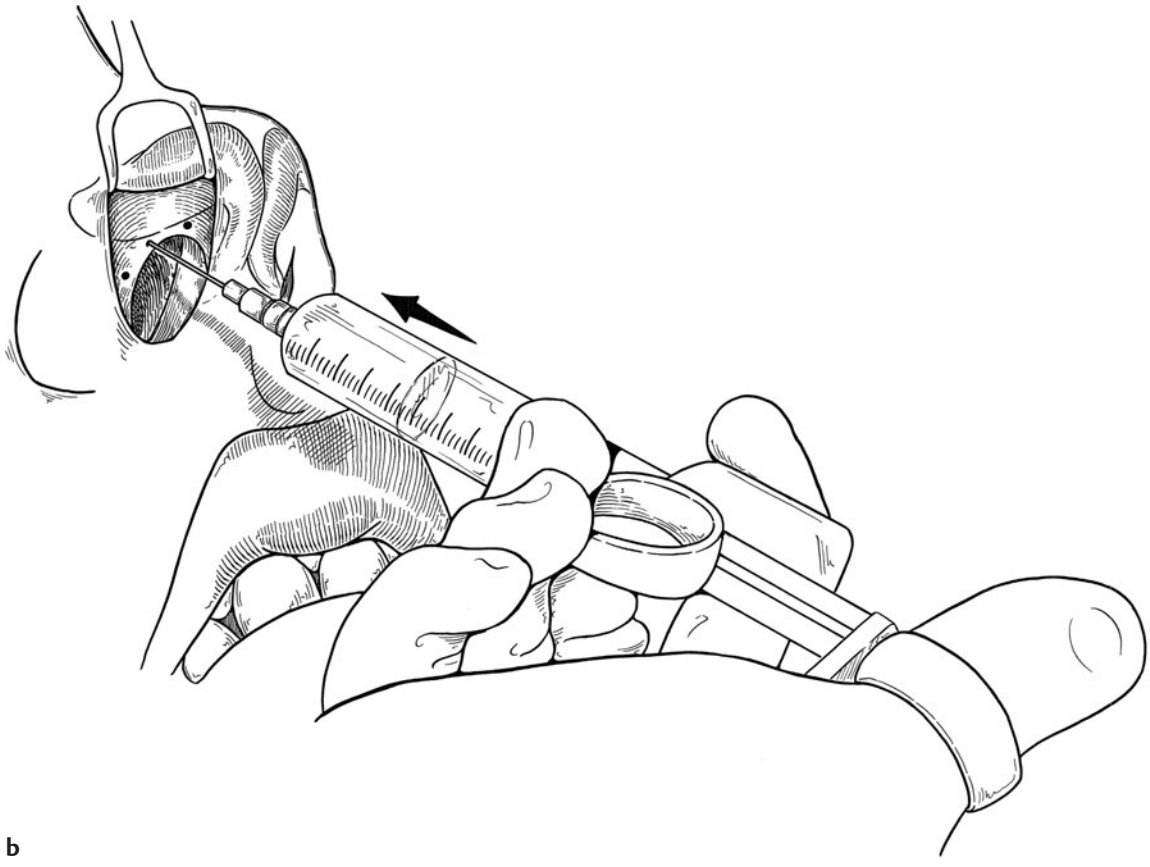
Complications

1. Poor cosmetic/functional result
2. Septal perforation
3. Orbital hemorrhage

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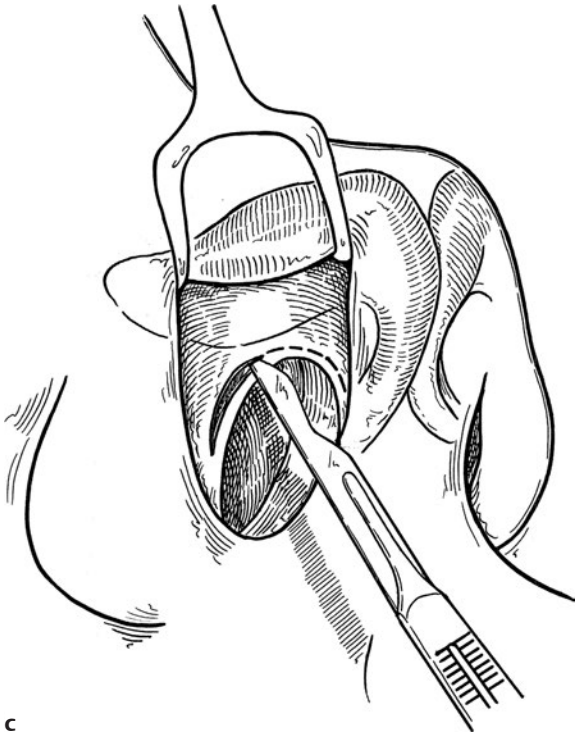
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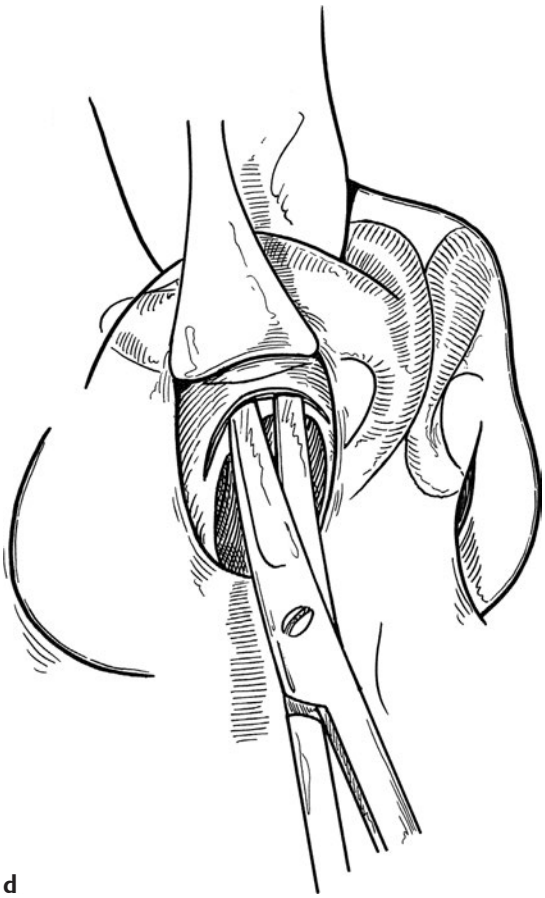
b

Fig. 12.2a,b

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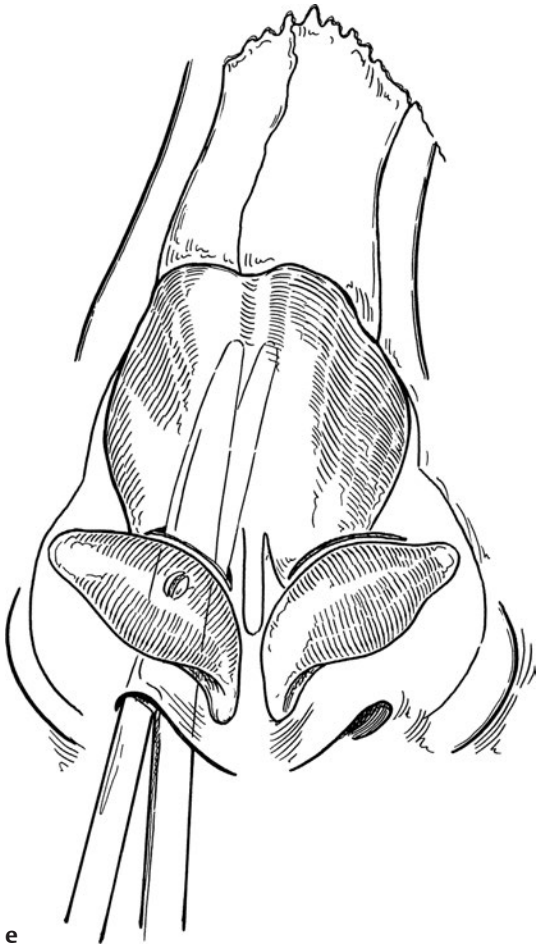


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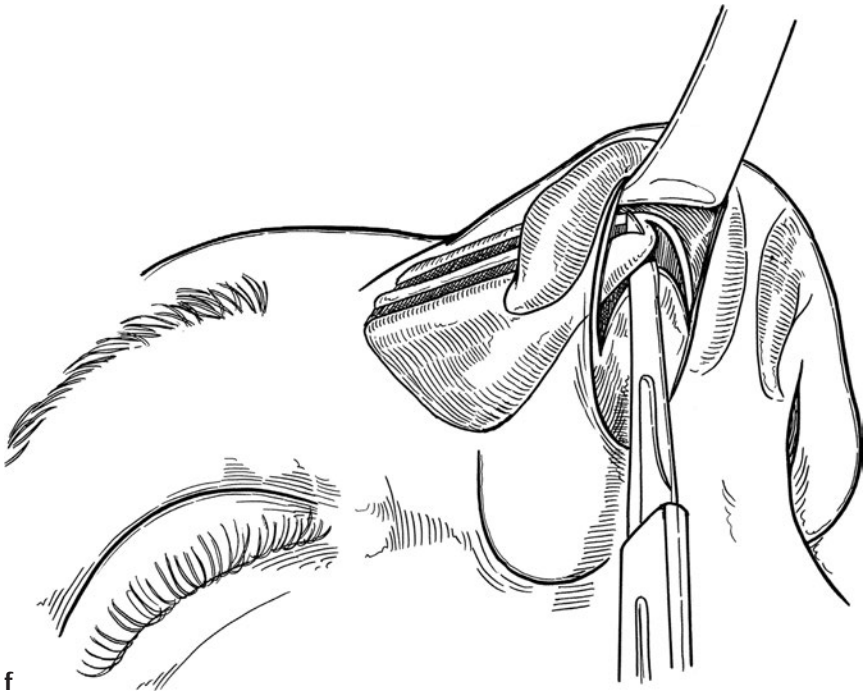


d

Fig. 12.2c,d

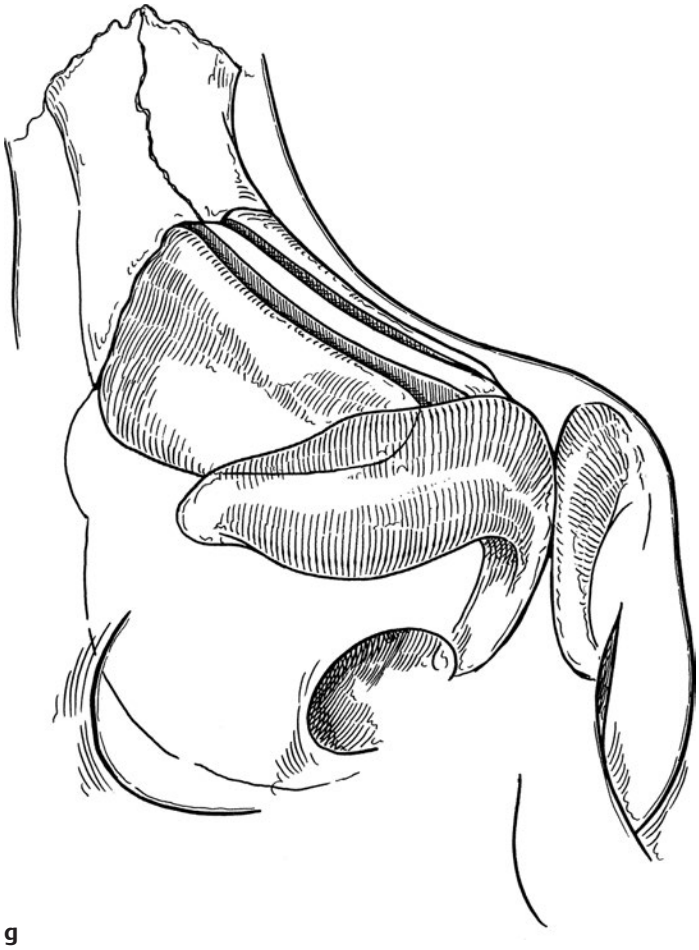


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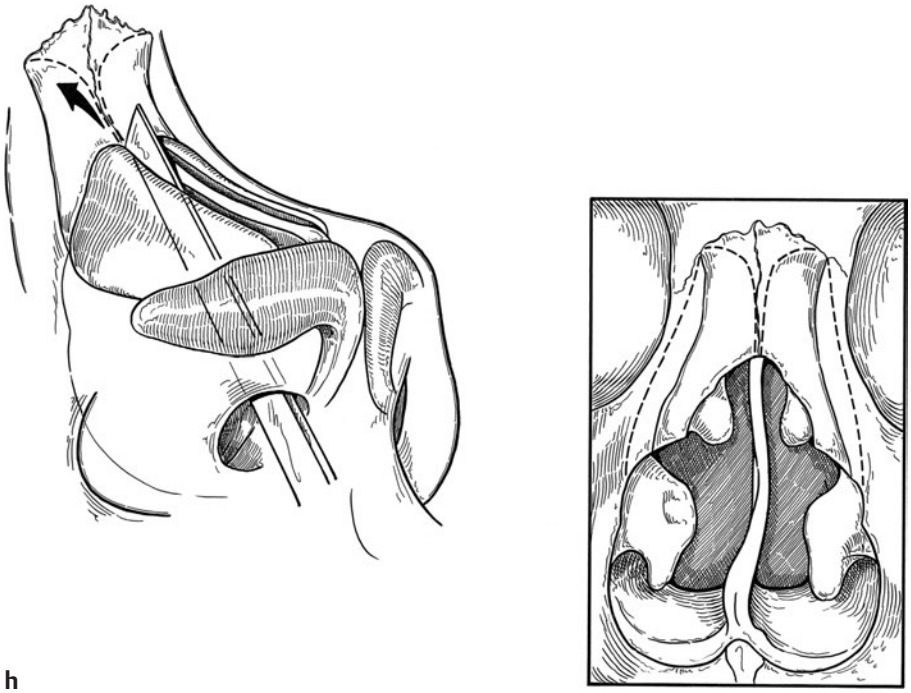


f

Fig. 12.2e,f

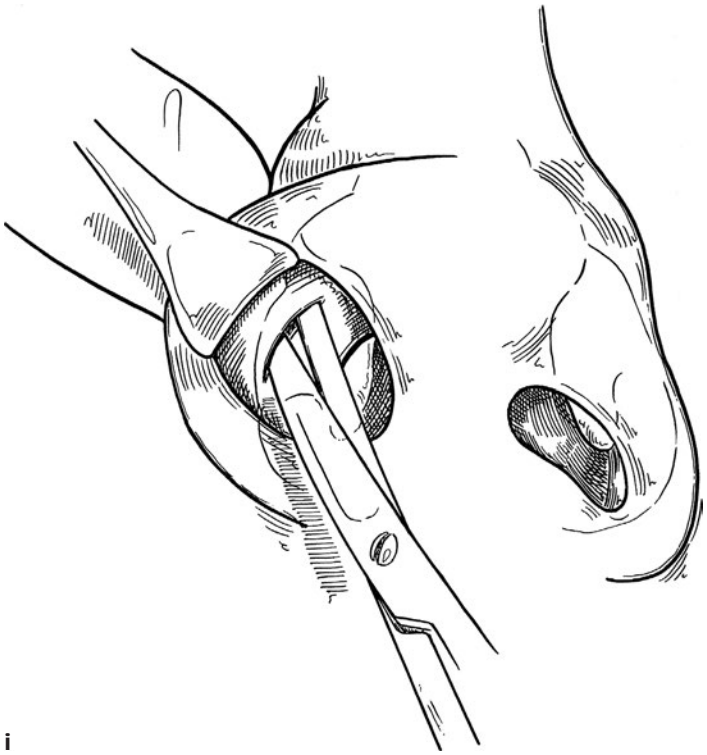


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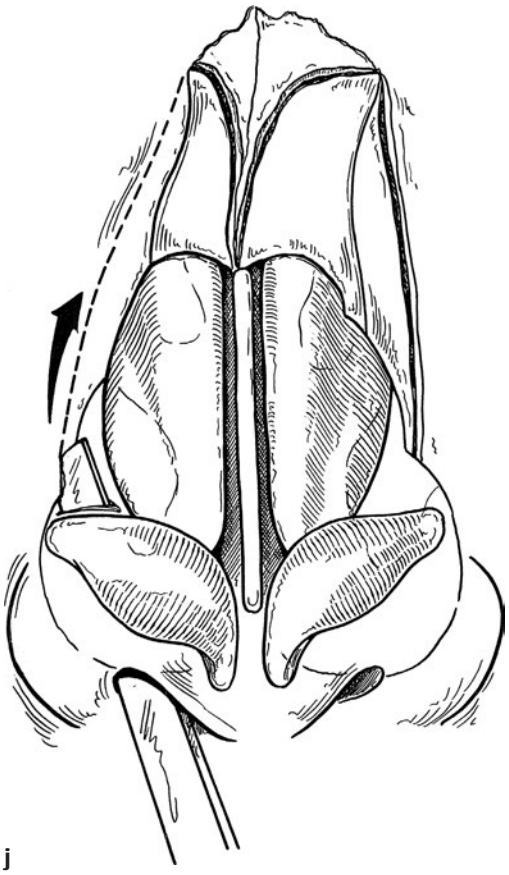


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Fig. 12.2g,h

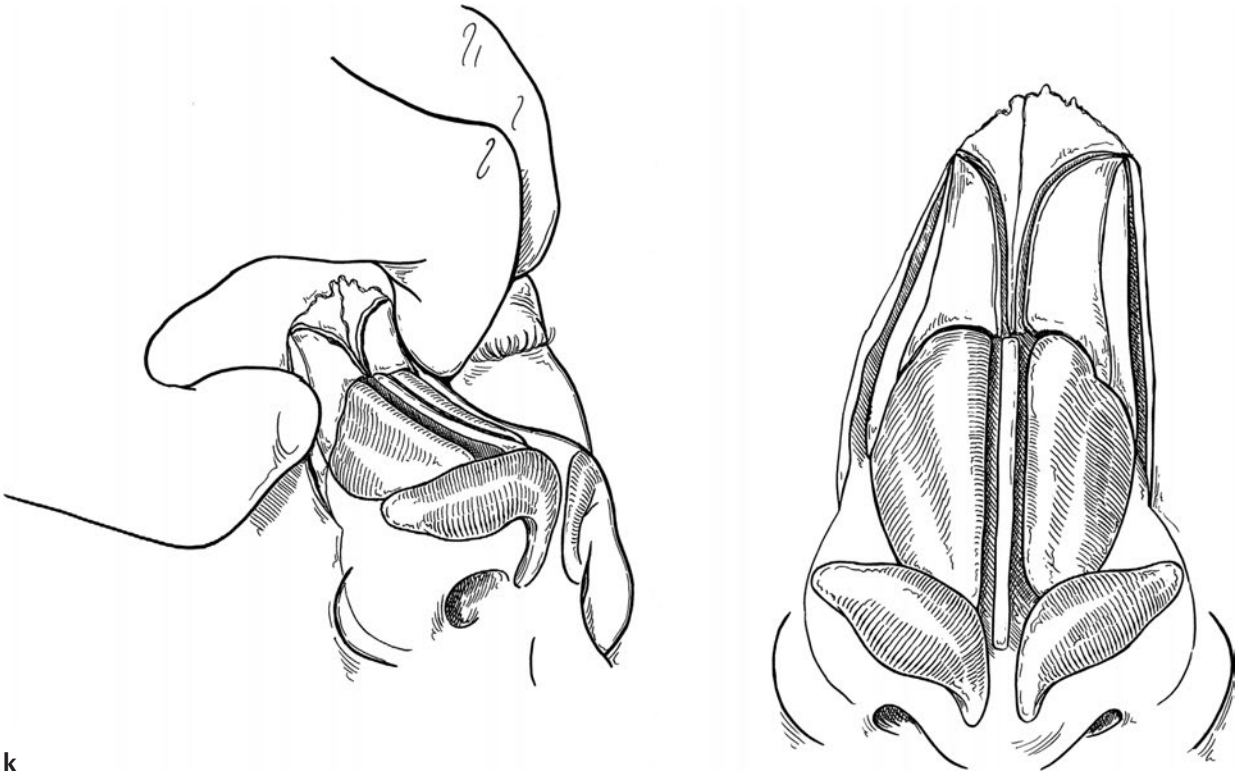


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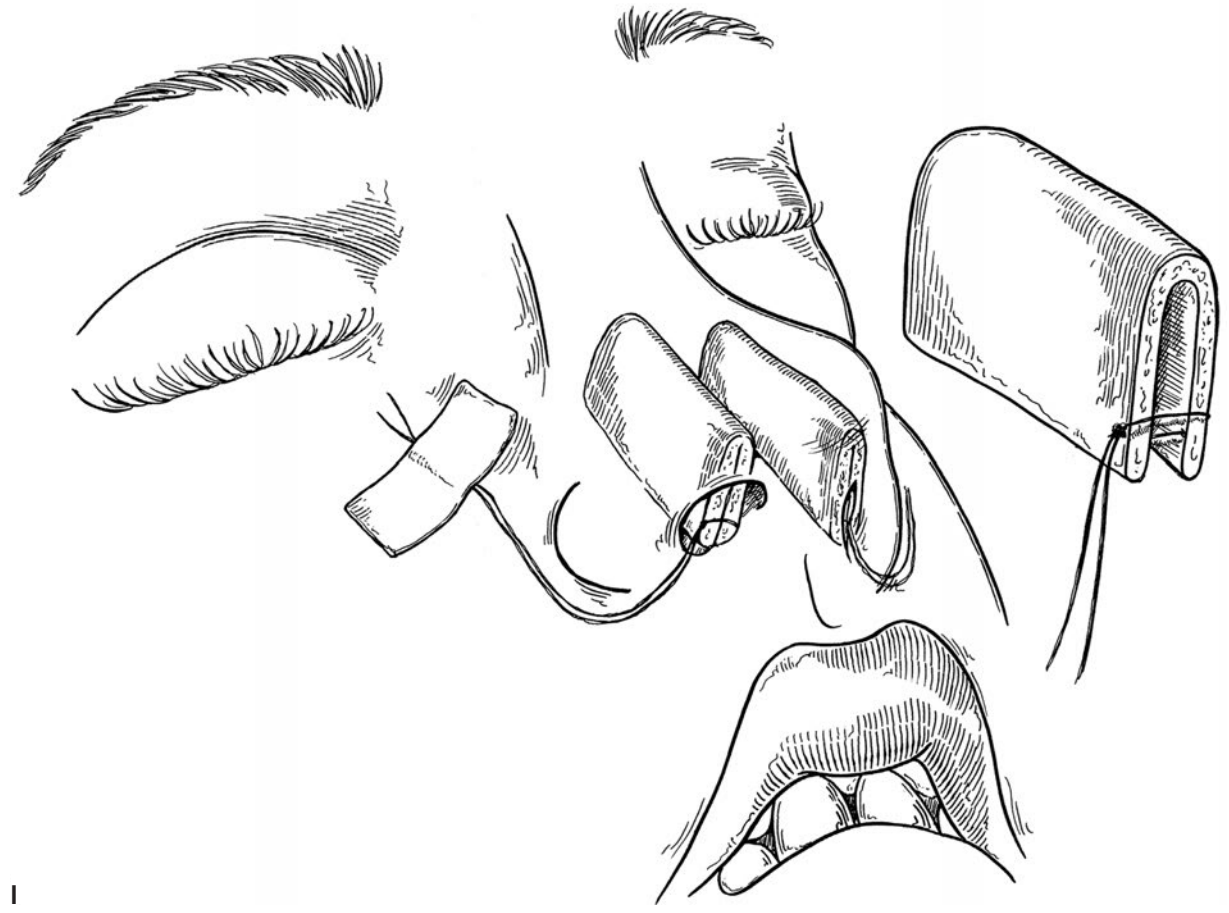


j

Fig. 12.i,j



k



l

Fig. 12.2k,l

13 Nasal Tumors

Ken Kazahaya

Nasal tumors span the full range of intranasal pathology, but the vast majority of intranasal tumors in children are benign.

13-1 Lateral Rhinotomy

Introduction

This is an open approach to provide exposure inside the nasal cavity. It may be combined with a medial maxillectomy to give excellent exposure to the lateral aspect of the nasal cavity and maxillary sinus, and even out laterally into the infratemporal fossa. Lateral nasal wall tumors and nasal septal masses can be approached via this method. However, with the advancement of endoscopic techniques and technology, the need for a lateral rhinotomy to manage intranasal lesions has decreased.

Indications

Lateral rhinotomy is indicated for a mass of the lateral wall of the nasal cavity or septum that may not be able to be managed or accessible by endoscopic techniques.

Preoperative Evaluation

Direct examination of the nasal cavity should be performed. A headlight with a nasal speculum and/or anterior rhinoscopy with an otoscope is useful in evaluating the anterior nasal cavity. The remainder of the nasal cavity and posterior nasal cavity may be examined using flexible or rigid endoscopy. Radiologic imaging is useful to delineate the anatomy and extent of the lesion. Computed tomography (CT) is useful to determine bony anatomy and can show signs of bony remodeling and/or erosion. Magnetic resonance imaging can help determine extent of the lesion and involvement of surrounding soft tissues.

Operative Technique

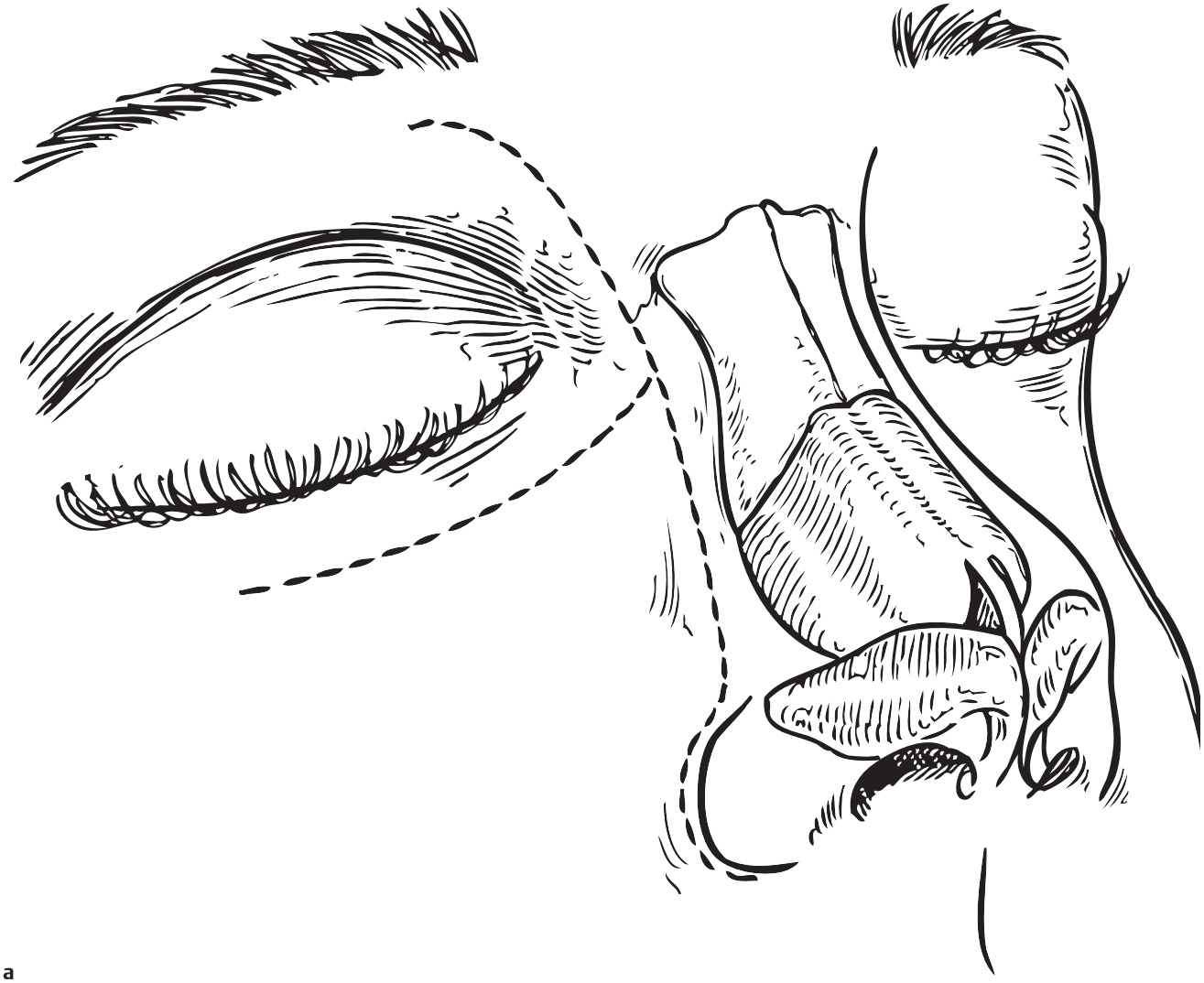
1. General anesthesia with an oral RAE tube.
2. An incision line is drawn along the edge of the aesthetic unit between the cheek and the lateral aspect of the nasal dorsum. This is then extended down around the base of the nasal alae (**Fig. 13.1a**).
3. Injection of 1% lidocaine with 1:100,000 epinephrine is made along the planned incision line to aid in hemostasis.
4. An incision is made around the base of the nasal alae down to the edge of the pyriform aperture. The incision can be extended up along the lateral edge of the nose between the cheek and the lateral aspect of the dorsum of the nose (along the aesthetic unit). The incision can even extend up to the level of the medial canthus along a line one-half the distance between the medial canthus and the dorsum of the nose. Then the incision can be extended laterally through the medial canthus and along the inferior orbital rim. This will allow access to the ethmoid and the maxillary sinuses. A medial maxillectomy can also be performed through this incision (**Fig. 13.1a**).
5. From the edge of the pyriform aperture, a small osteotome can be used to cut along its lateral edge and then brought medially toward the dorsum at the junction of the nasal bone and the bony nasal septum. This will allow this piece of bone to be flapped medially allowing exposure to the nasal cavity (**Fig. 13.1b,c**).
6. The maxillary and ethmoid sinuses may be opened to provide lateral and posterior exposure, respectively. Bone can be removed with a drill or rongeurs (**Fig. 13.1d**).
7. If further exposure is required after opening the face of the maxilla, the medial aspect of the maxilla may be removed by creating osteotomies between the antral window and the opening created in step 5. This anterior medial buttress of

the maxilla can be replaced at the completion of the case using plates or wire (**Fig. 13.1e**).

8. After the tumor is resected by sharp dissection with scissors or knife, the nasal bone can be returned to its normal position; it can be secured with a suture or small absorbable plate or supported intranasally with packing.
9. The incision is closed with 4-0 absorbable sutures in the subcutaneous layers and the skin closed with 5-0 interrupted subcuticular absorbable suture (e.g., Chromic gut [Ethicon] or Monocryl [Ethicon]) (**Fig. 13.1f**).

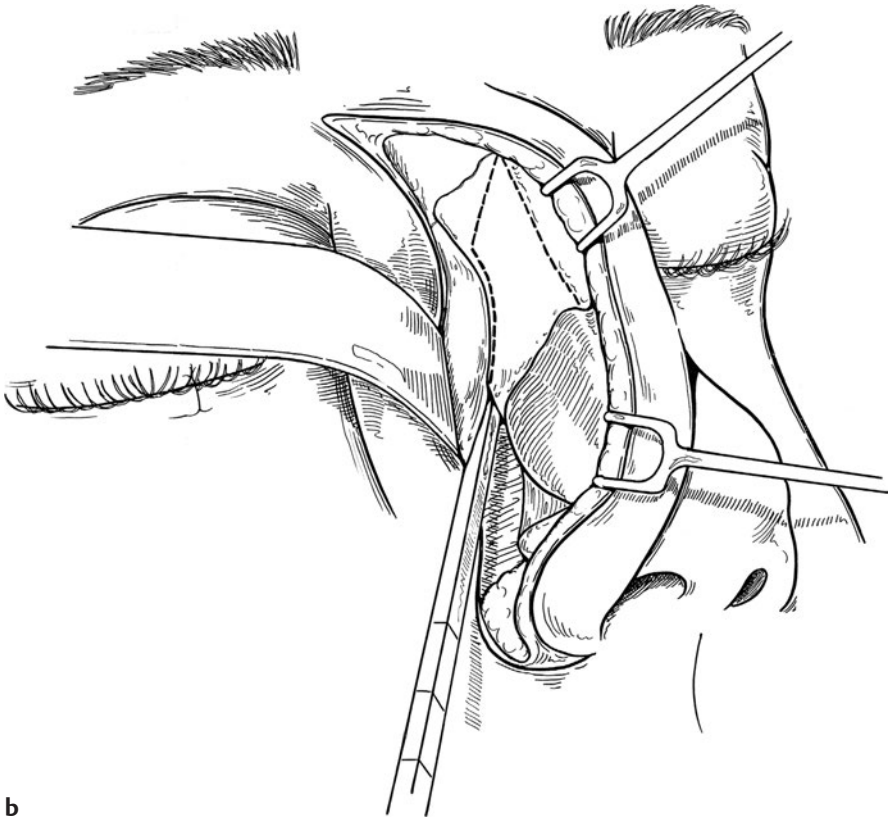
Complications

1. Nasal dorsal deformity
2. Nasal alar scarring/deformity
3. Incisional scar
4. Infraorbital nerve injury
5. Orbital hemorrhage/loss of vision/ophthalmoplegia
6. Cerebrospinal fluid leak

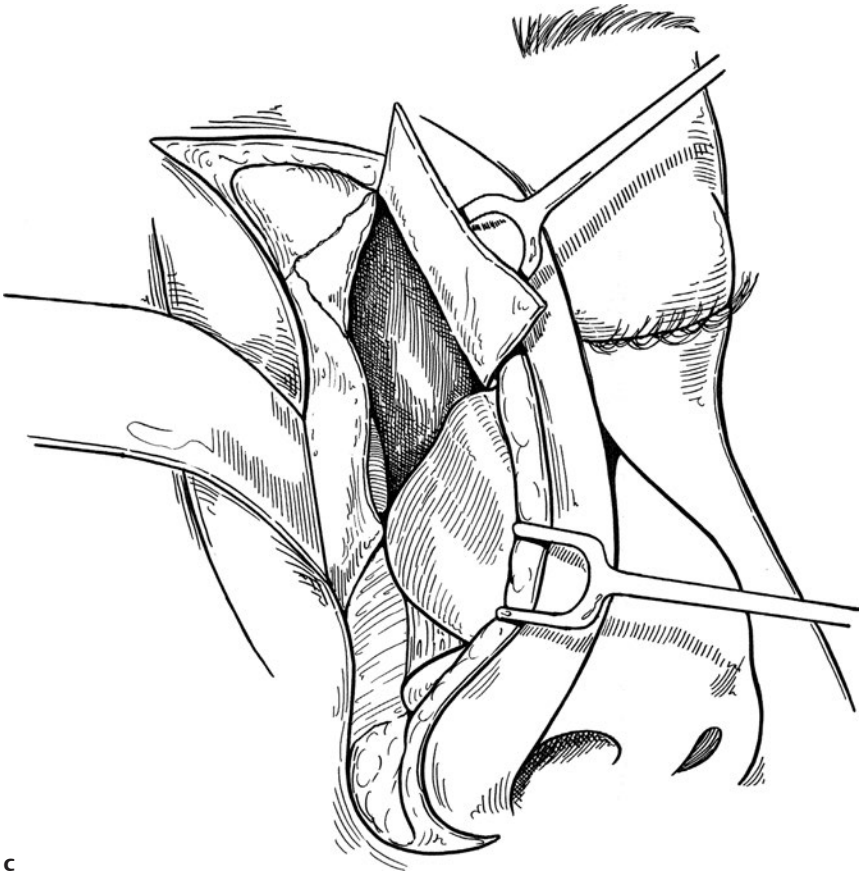


a

Fig. 13.1a

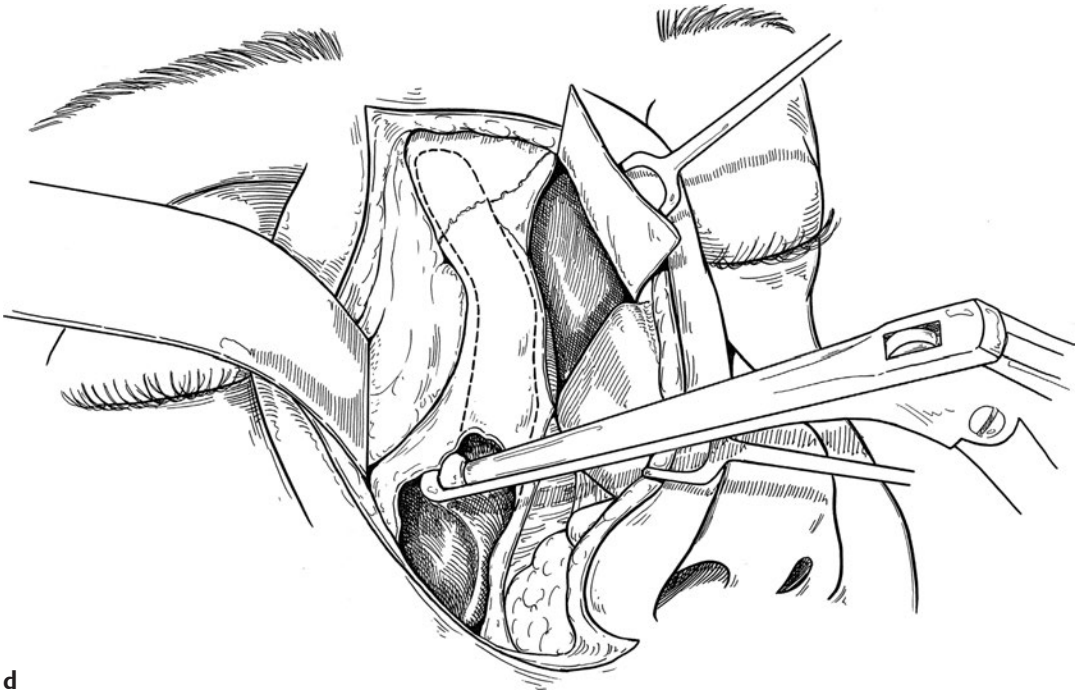


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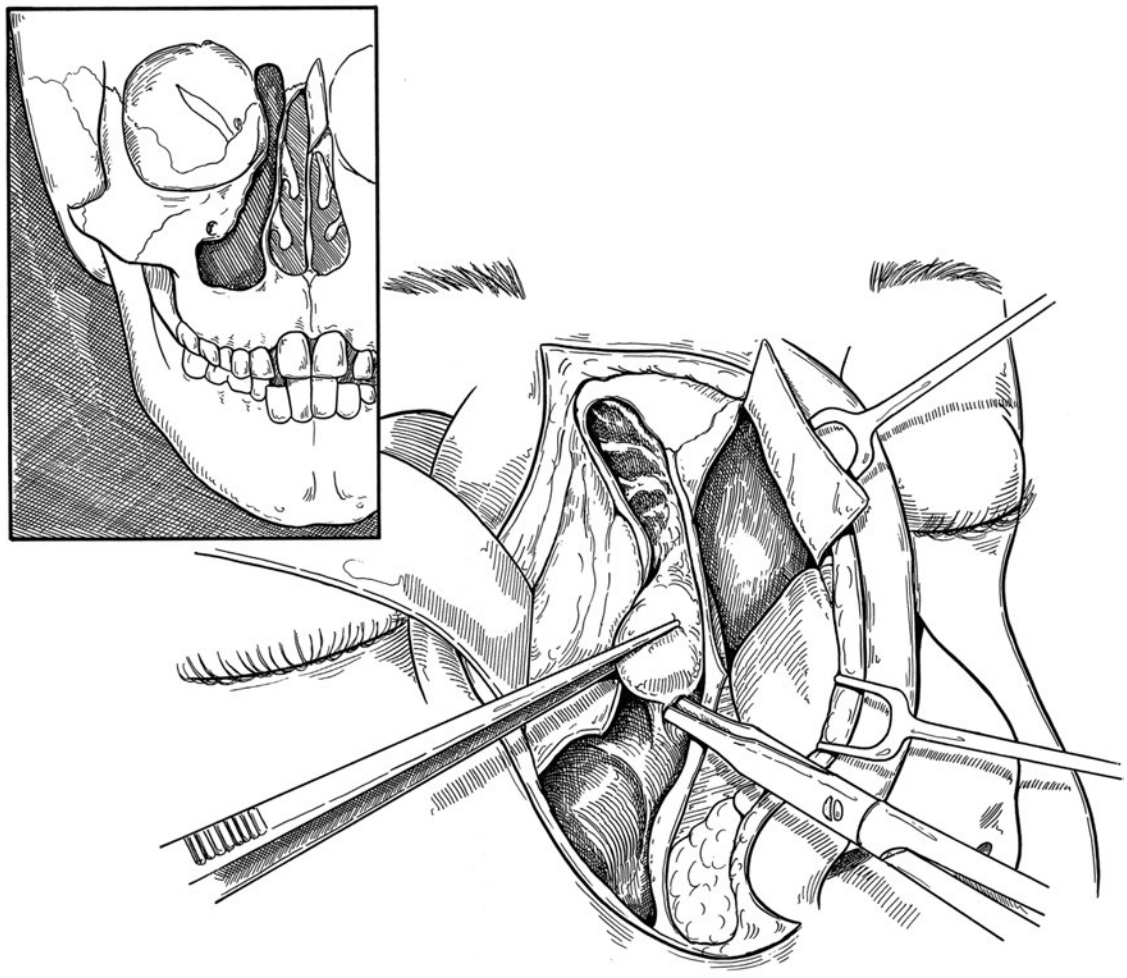


c

Fig. 13.1b,c



d



e

Fig. 13.1d,e

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f

Fig. 13.1f

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13-2 Nasal Polypectomy

Introduction

Nasal polyps are relatively uncommon in children and adolescents. They may occur unilaterally or bilaterally. Common etiologies of nasal polyps in children include chronic infection, allergy, and cystic fibrosis. Some children may have nasal polyposis associated with Sampter's triad: (1) aspirin sensitivity, (2) asthma, and (3) nasal polyps. If a child is diagnosed with nasal polyposis, he or she should be tested for cystic fibrosis.

Antrochoanal polyps are isolated polyps that typically arise from within the maxillary sinus and are commonly attached along the anterior or lateral aspect of the maxillary sinus. They typically present with unilateral nasal obstruction and can sometimes be visualized behind the palate or coming out of the nostril. Antrochoanal polyps need to be completely excised, including the site of attachment, to minimize the risk of recurrence.

Indication

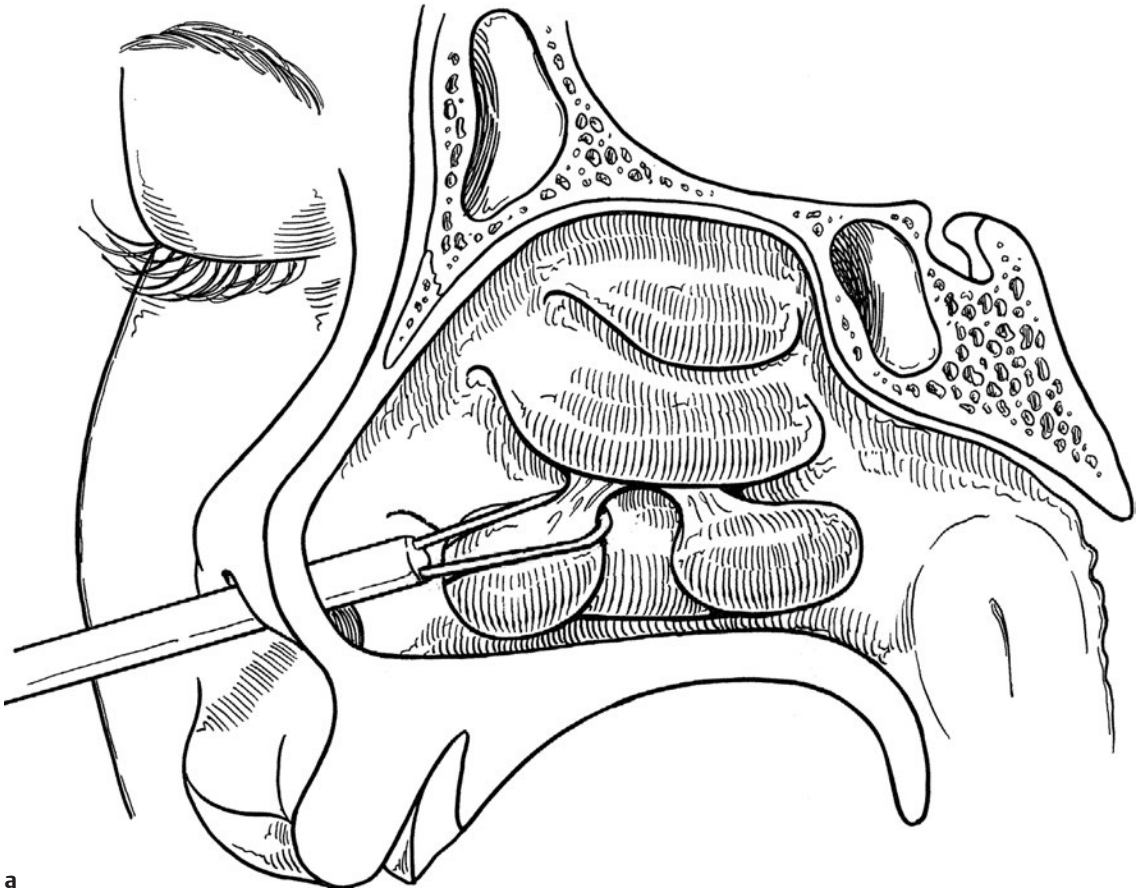
Nasal polypectomy should be considered if there is chronic nasal obstruction and/or recurrent infections that cannot be managed by medical therapy. Also polypectomy should be considered if there is evidence of bony remodeling or sinonasal expansion due to the polyps.

Operative Techniques

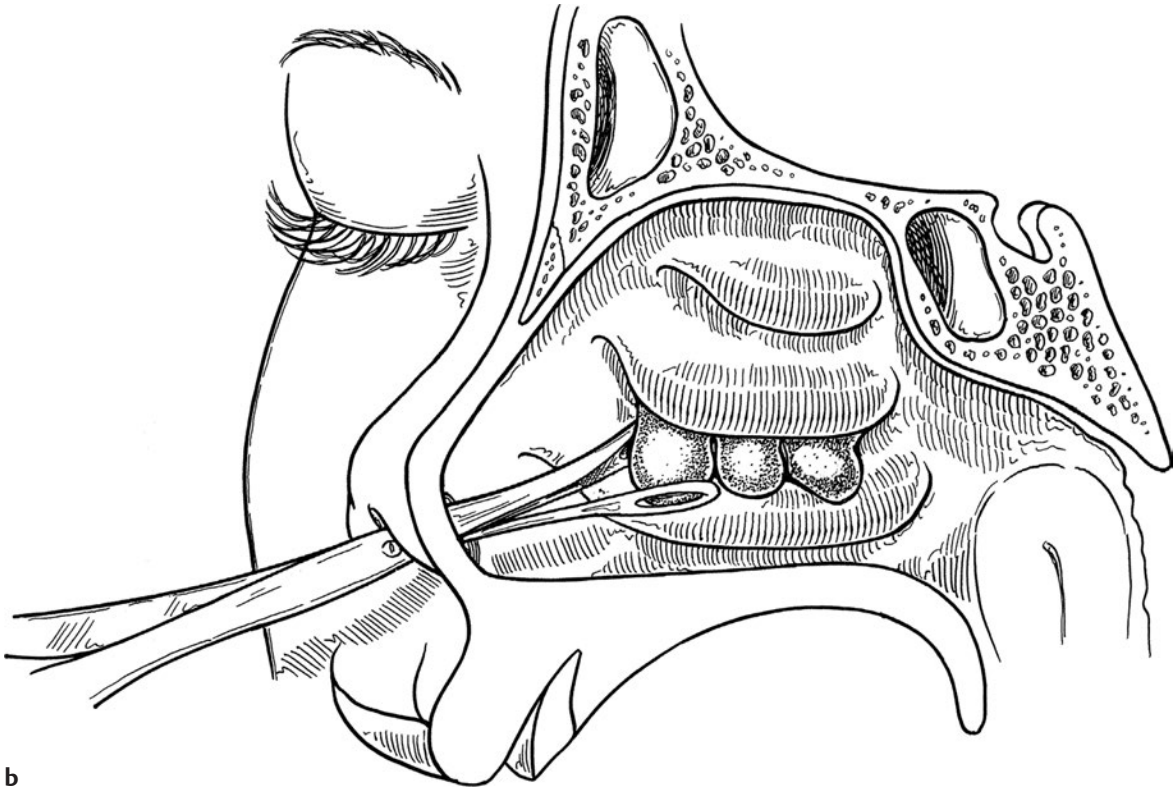
1. Polypectomy in children should be performed under general anesthesia with an oral RAE tube.
2. In selected primary resection cases and revision procedures, computer-assisted image guidance may be utilized.
3. The nasal cavity is decongested with 4% cocaine solution on neurosurgical Cottonoid patties (Codman). Oxymetazoline or other topical decongestants may also be utilized.
4. A rigid nasal endoscope can be used to provide illumination and visualization during the procedure. Depending on the age of the patient and the size of the nasal cavity, a 2.7-mm or 4.0-mm endoscope may be utilized. Typically, the 0-degree endoscope is utilized for as much of the procedure as possible to help maintain orientation. There are various angled endoscopes that may be useful (e.g., 30-, 45-, 70-degree).
5. Polyps can be pedunculated and should be removed at their base **(Fig. 13.2a,b)**. Removal can be performed using endonasal forceps, nasal snare, endonasal shaver/microdebrider, or coblation. Often the polyps may need to be reduced or debrided to be able to visualize the base. In the case of antrochoanal polyps, the maxillary sinus ostium has typically been widened or dilated by the polyp. If the base of the antrochoanal polyp is visible, the stalk can be grasped and the polyp can be delivered from the nose by pushing the polyp forward from the nasopharynx; sometimes the polyp needs to be delivered posteriorly into the nasopharynx and out through the mouth **(Fig. 13.2c)**. If the base of an antrochoanal polyp is not visible, the polyp may be debulked and then the opening into the maxillary sinus may need to be further widened using through-cutting forceps commonly used in sinus surgery. Angled endoscopes and long-necked forceps may be required to visualize the base and complete its removal. If the origin of the antrochoanal polyp is in the maxillary sinus and cannot be removed with long-necked forceps and angled endoscopes, a Caldwell-Luc approach may be used to open the maxillary sinus and then visualize and address the base of the polyp. The area of the base may be drilled with diamond burs to smooth the bone and remove the base of the polyp completely. Monopolar and bipolar cautery may be used for hemostasis. Both monopolar and bipolar suction cautery are useful within the sinuses for hemostasis. Other technologies are also useful to debride polyps and provide hemostasis as well, such as coblation, and there are also some shavers that have cautery capabilities in their blades.
6. Smaller polyps may be excised using the microdebrider, through-cutting forceps, or coblation.
7. The other sinuses may need to be opened and debrided. Functional endoscopic sinus surgery techniques can be utilized to open the affected sinuses and provide exposure for debridement of the polyps.
8. After removal of the polyps, hemostasis may be obtained using a suction monopolar or bipolar cautery, bipolar forceps, plasma technology (coblation), or topical hemostatic agents. There are also some shavers that have cautery capabilities in their blades.

Complications

1. Recurrence of polyps
2. Requirement for further interventions or recurrence of symptoms
3. Nasal synechiae
4. Injury to orbital contents/blindness/ophthalmoplegia/diplopia
5. Cerebrospinal fluid leak
6. Change/loss of sense of smell
7. Injury to the infraorbital nerve

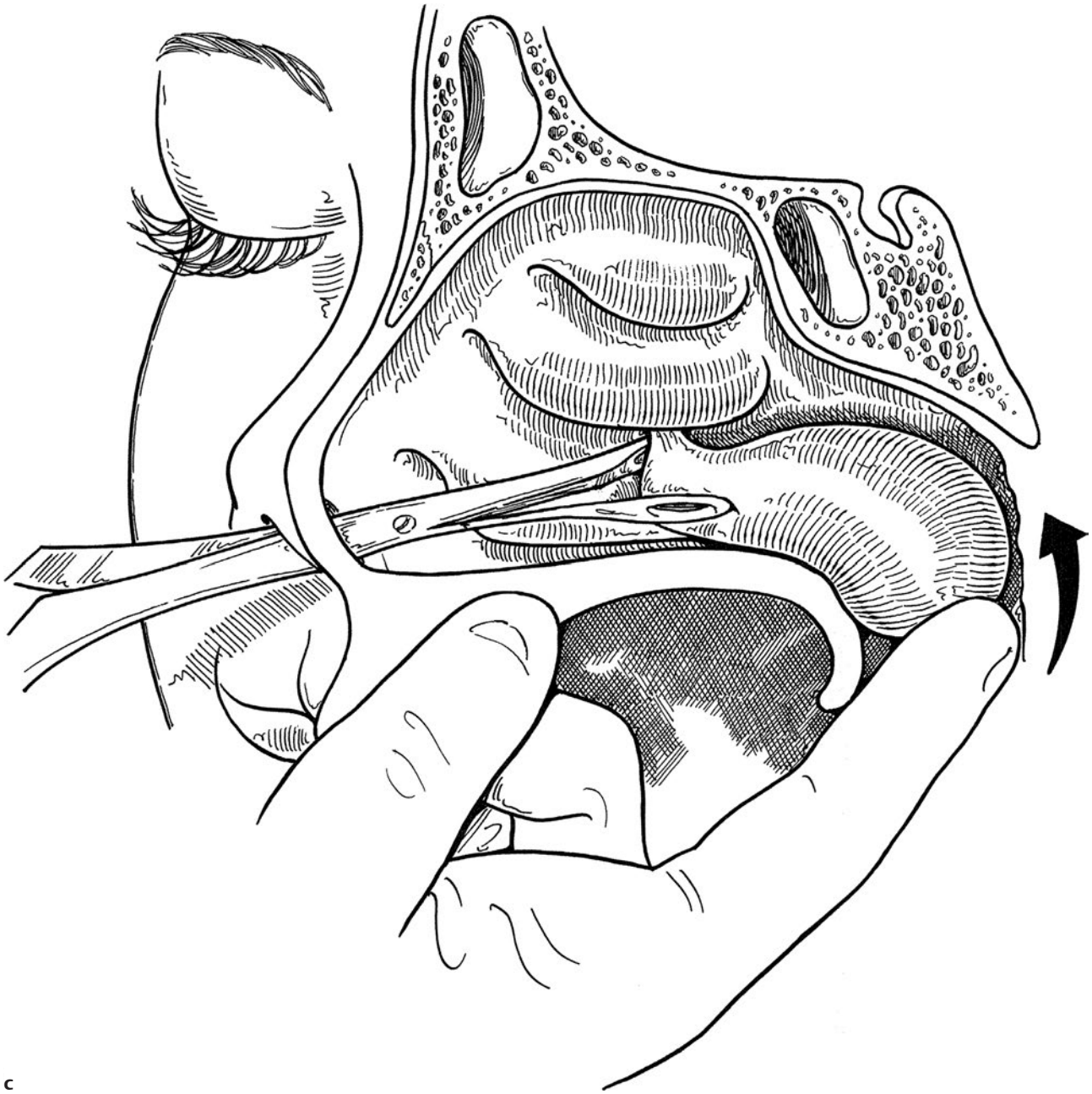


a



b

Fig. 13.2a,b



c

Fig. 13.2c

14 Choanal Atresia and Anterior Nasal Stenosis

J. Paul Willging

Choanal atresia is an incomplete opening between the posterior nasal cavity and the nasopharynx. This condition may be unilateral or bilateral. Unilateral choanal atresia usually presents with chronic unilateral rhinorrhea; however, it causes little or no respiratory distress.

Because neonates are obligate nasal breathers, bilateral atresia causes severe respiratory distress (**Fig. 14.1a,b**). When neonates cry, they open their mouths to breathe and the distress subsides. The initial distress can be managed with a McGovern nipple (large nipple with cross-cuts in the end) to open the mouth and displace the tongue inferiorly to permit oral breathing. An orogastric tube is often necessary to supply adequate nutrition until the repair is completed.

14-1 Transnasal Repair of Choanal Atresia

Indications

Repair of choanal atresia is necessary to provide an adequate airway.

Preoperative Evaluation

A computed tomography (CT) scan is essential to define the shape of the nasal chambers and to determine both the level of the skull base and whether the atresia is membranous or bony. The scan must be perpendicular to the plane of the hard palate. Bony atretic plates less than 3 mm in thickness are amenable to a transnasal approach.

Operative Technique

1. Transnasal repair is performed under general anesthesia. Orotracheal intubation with an oral RAE tube facilitates access to the nasopharynx.
2. Afrin-soaked neurosurgical patties are placed into the nasal vault for vasoconstriction.
3. A Crowe-Davis mouth gag is used to expose the oropharynx and provide access to the nasopharynx (**Fig. 14.1c**). The choanae can be visualized with a 120-degree telescope, retracting the soft palate and viewing the posterior choanae from behind. A 0-degree telescope is passed transnasally to view the posterior choanae and other nasal anatomy.
4. Under continual visualization with a 120-degree telescope in the nasopharynx, a urethral sound can be passed along the floor of the nose and used to puncture the atretic plate. This works well for stenoses that contain a membranous component (**Fig. 14.1d**).

For thick atretic plates, an endoscopic drill is used with visualization provided by a 0-degree telescope. The atretic plate can be visualized, and the drill is used to open the atretic plate medially along the floor of the nose. Direct visualization is required to remain oriented (**Fig. 14.1e**).

5. After the atretic plate is opened, visualization is maintained with the 120-degree endoscope. A backbiting instrument is used to remove a portion of the posterior septum (**Fig. 14.1f**). Drills can be used to open the choanae laterally, taking care not to violate the sphenopalatine artery (**Fig. 14.1g**).
6. Nasal stenting is controversial. If used, it should be for less than 3 weeks. Suction catheters are passed through the nose on each side and pulled out of the mouth (**Fig. 14.1h**). A size-appropriate endotracheal tube stent is chosen and the stent is folded in half at the area of flexion (**Fig. 14.1i**). Three-quarters of the endotracheal tube is removed to create two patent tubes connected to each other by the remnant of the endotracheal tube wall (**Fig. 14.1i**). Next, the suction catheters are sutured to the ends of the newly fashioned stent to allow it to be pulled retrograde into position in the choanae,

exiting the nasal vestibule (**Fig. 14.1j**). The endotracheal tube stents are then cut in such a way that they extend beyond the columella. A section of the discarded endotracheal tube is fashioned as a connecting strut that will be sutured between the two stents coming through the nasal vestibule (**Fig. 14.1k**). This creates a complete loop of the stent, preventing it from being pulled out of and pushed into the nasopharynx. Suction catheters are then measured to determine the length needed to keep the stents open. The suction catheter should extend beyond the tip of the stent into the nasopharynx by 5 mm. Suctioning should occur every 8 hours and as needed.

Complications

Restenosis

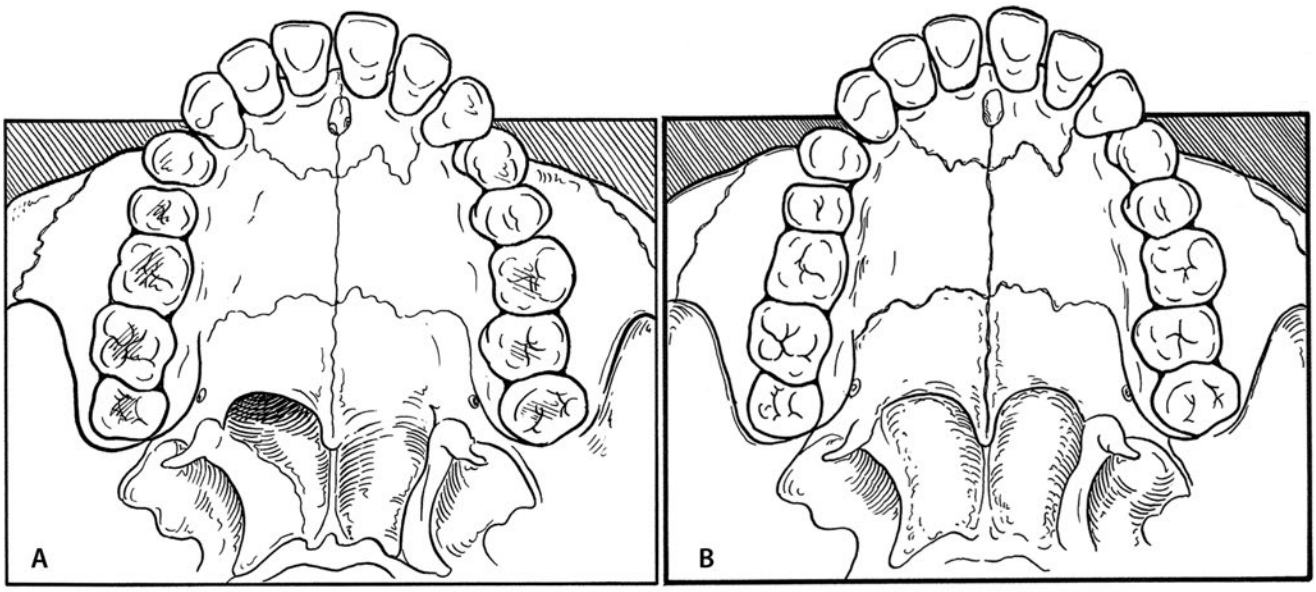
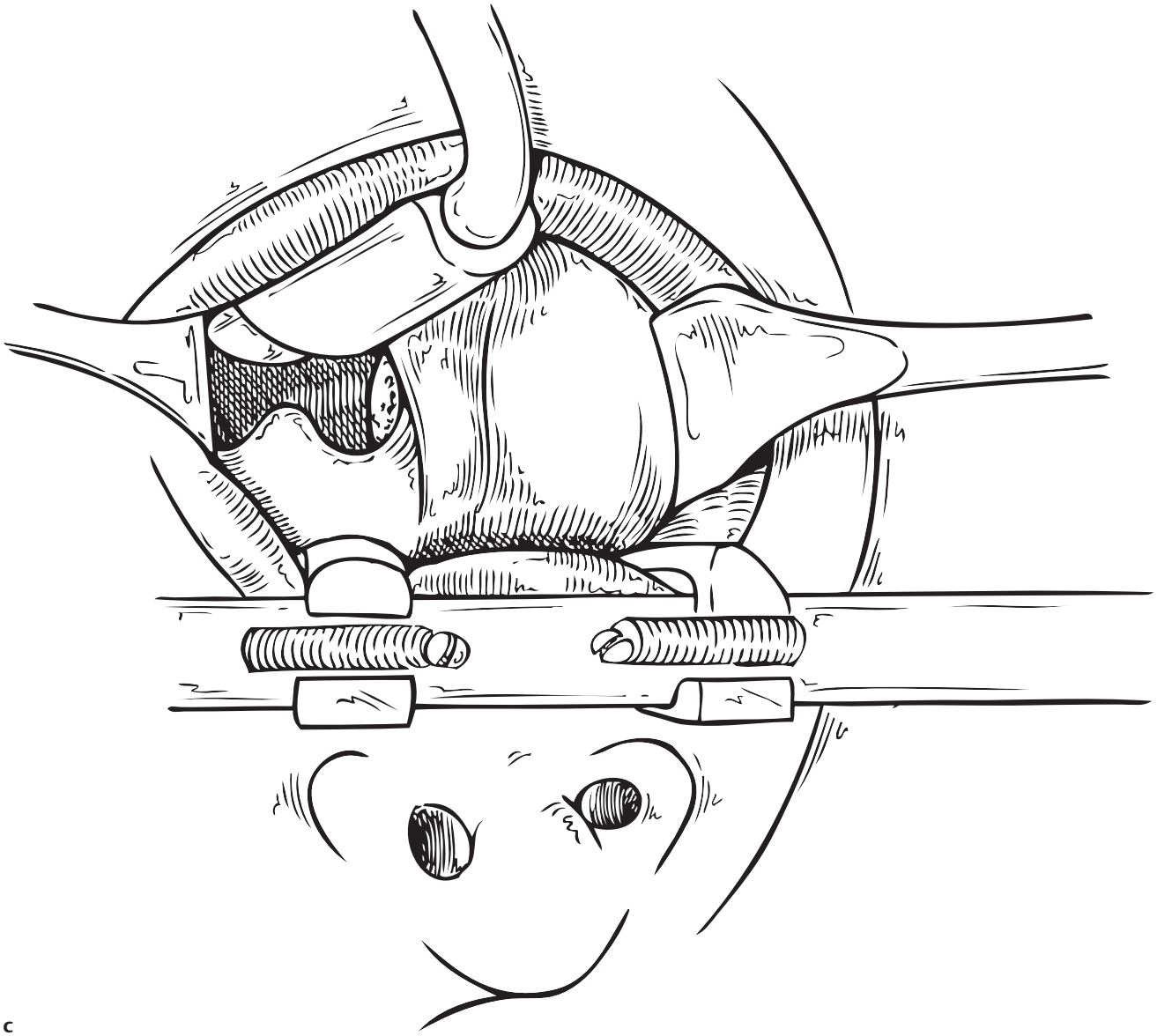
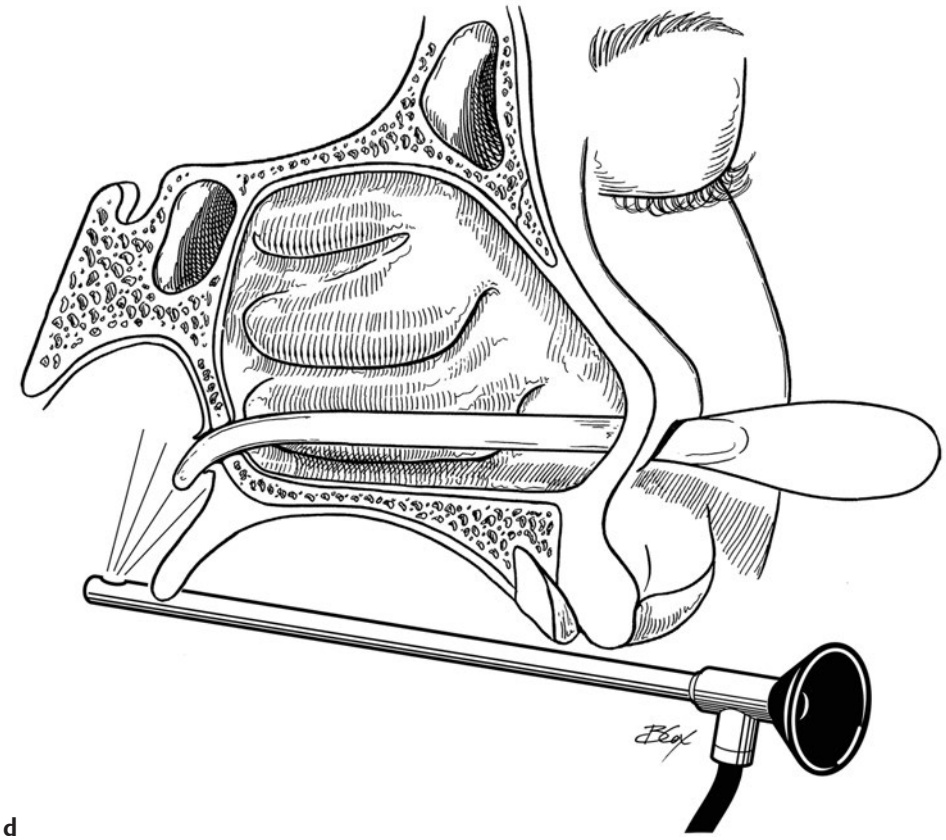


Fig. 14.1a,b

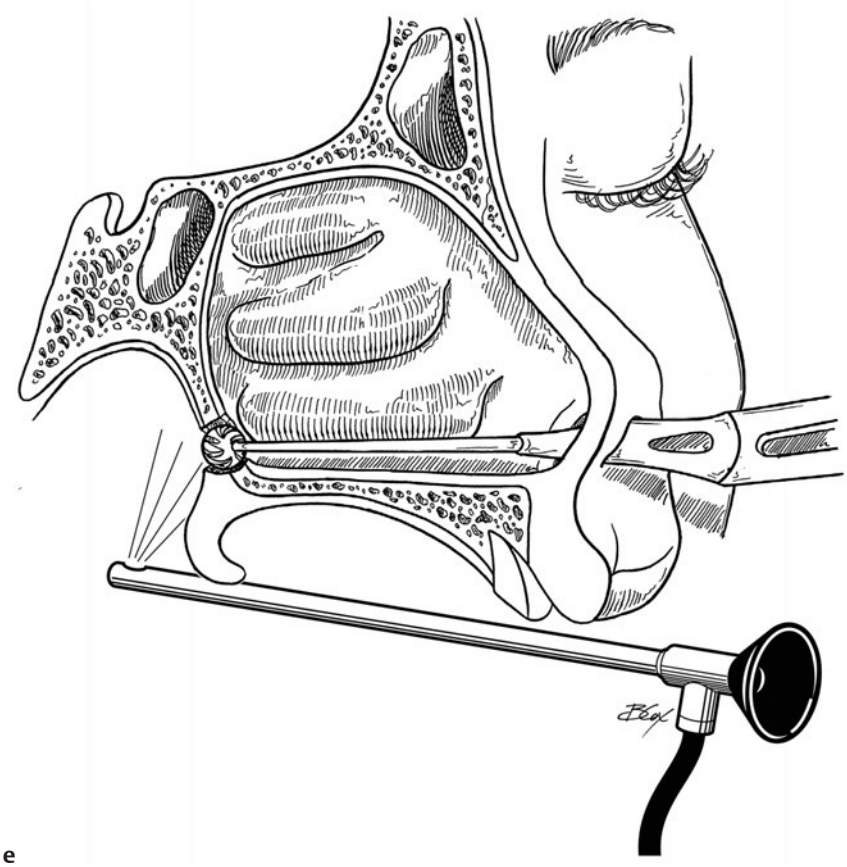


c

Fig. 14.1c

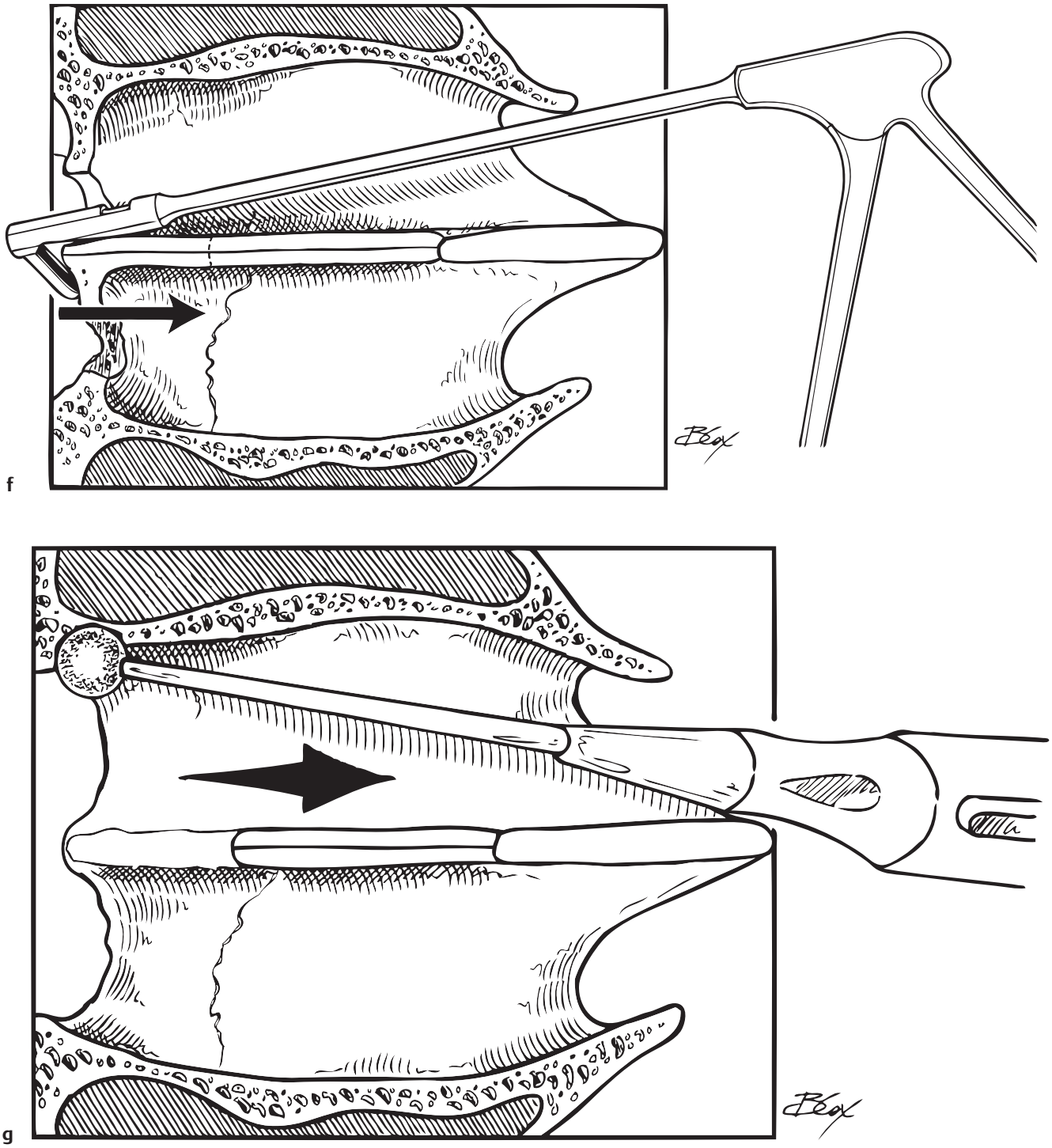


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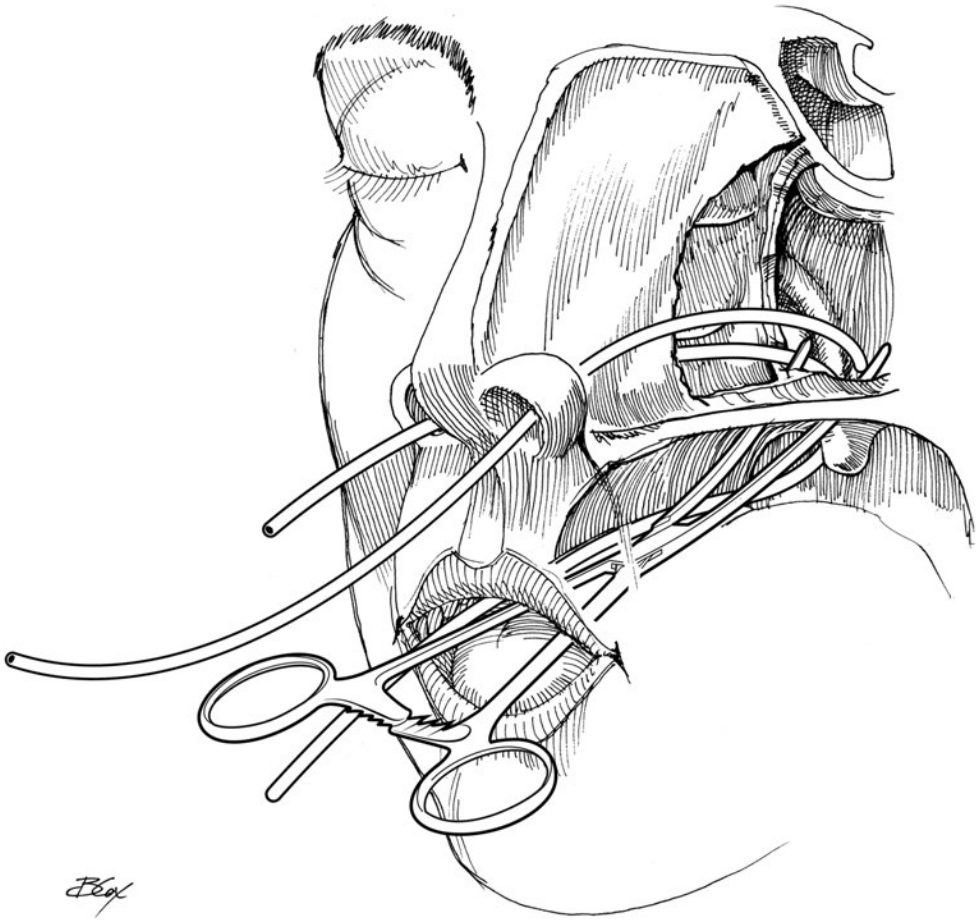
Fig. 14.1d,e



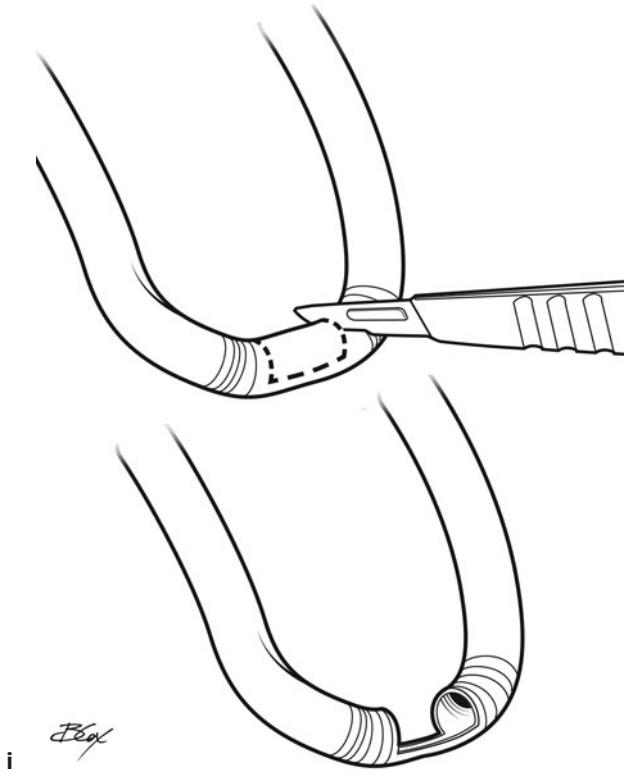
f

g

Fig. 14.1f,g



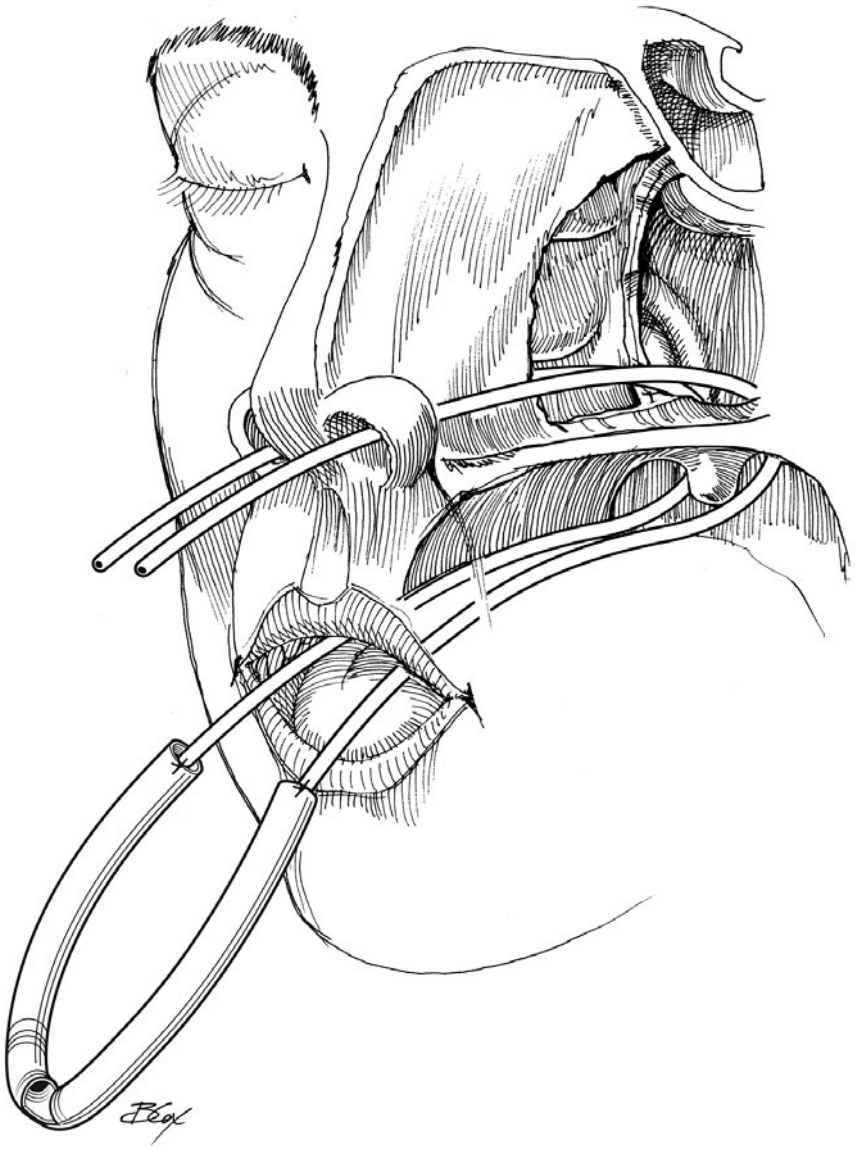
h



i

Fig. 14.1h,i

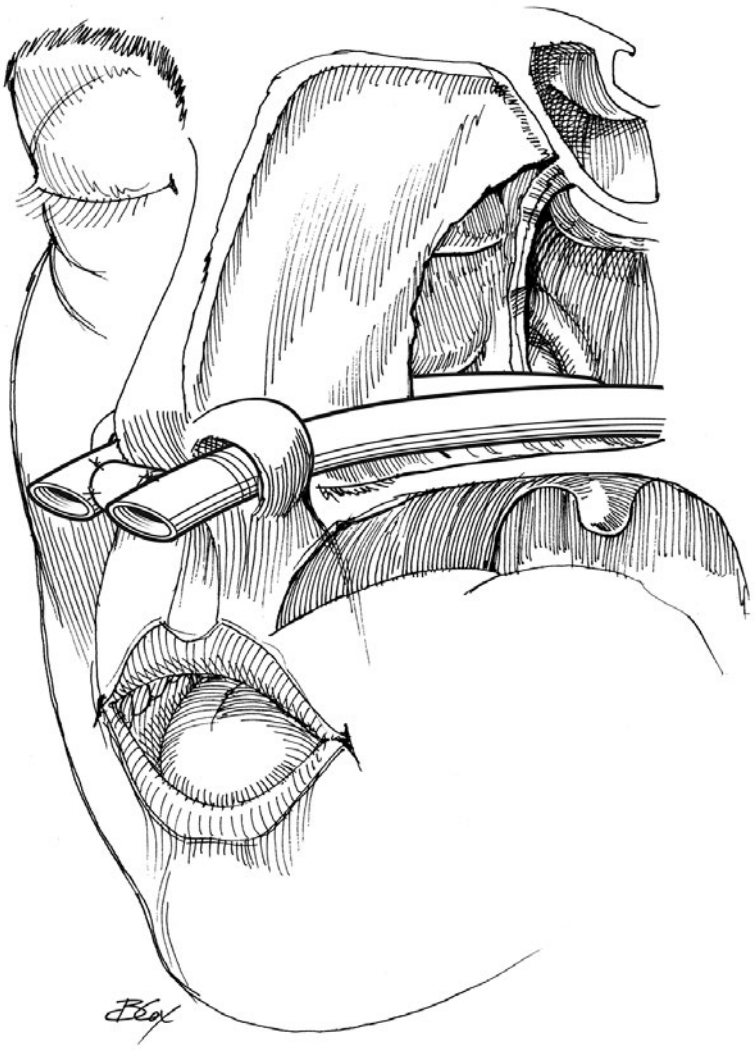
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j

Fig. 14.1j

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k

Fig. 14.1k

14-2 Transpalatal Repair of Choanal Atresia

Indications

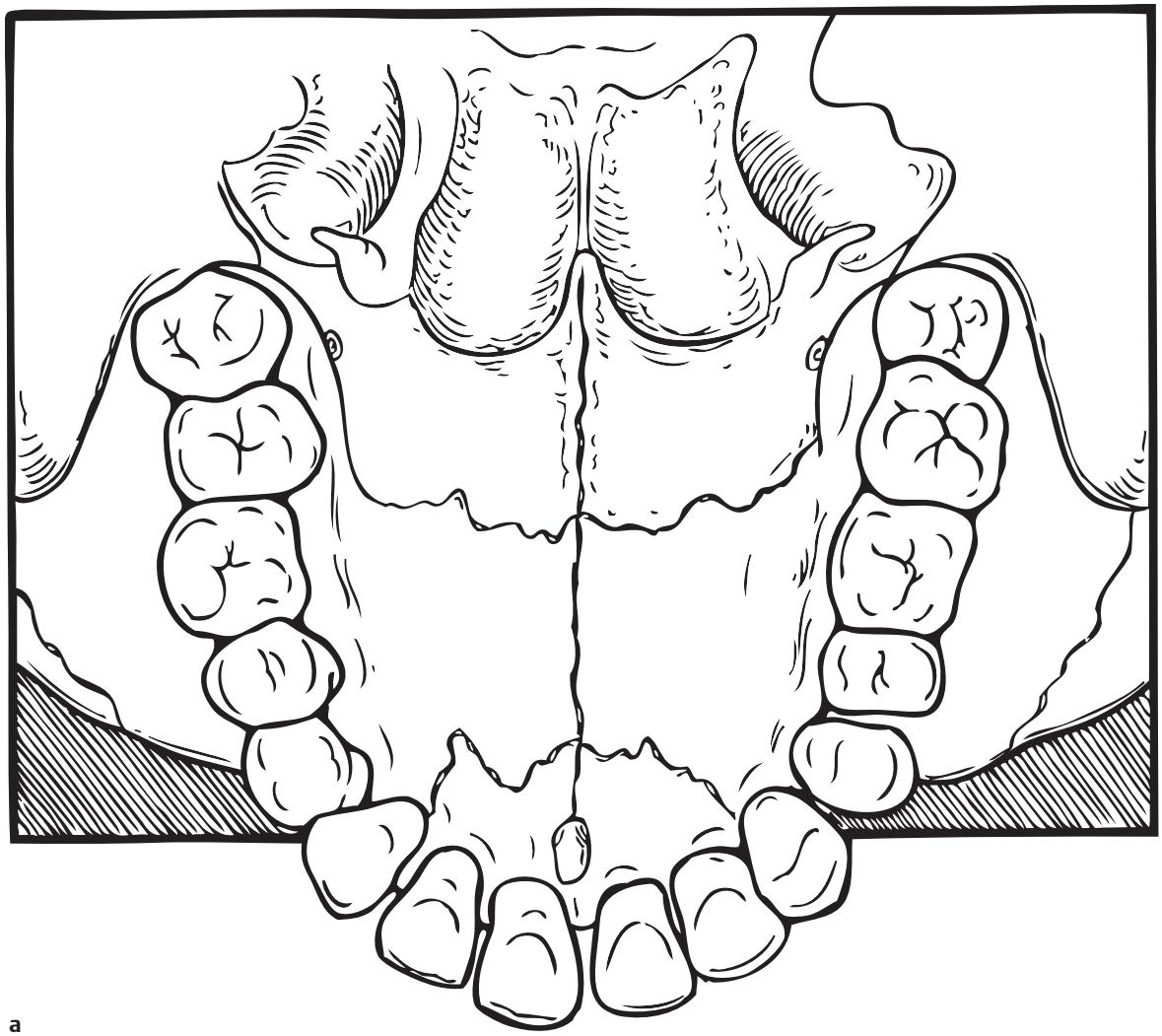
The transpalatal approach may be used for primary repair of choanal atresia or for revision of failed transnasal repairs.

Operative Technique

1. Transpalatal repair is performed under general anesthesia. Orotracheal intubation with an oral RAE tube facilitates access to the nasopharynx (**Fig. 14.2a,b**).
2. The hard palate is injected near the greater palatine arteries with 1% lidocaine with 1:100,000 units of epinephrine for hemostasis (**Fig. 14.2c**).
3. A W-shaped palatal flap is created (**Fig. 14.2d**).
4. The aponeurosis connecting the soft palate to the hard palate is divided. The soft palate need not be violated (**Fig. 14.2e**).
5. A drill is used to open the nasal passages, starting slightly off the midline at the posterior edge of the hard palate. The bone is removed until the floor of the nose is identified (**Fig. 14.2f,g**).
6. Once both posterior choanae are open, the posterior septum separating the two nasal passages posteriorly is removed (**Fig. 14.2h**).
7. Stenting is performed. The palatal incisions are closed with 4-0 Vicryl sutures (Ethicon) (**Fig. 14.2i,j**).

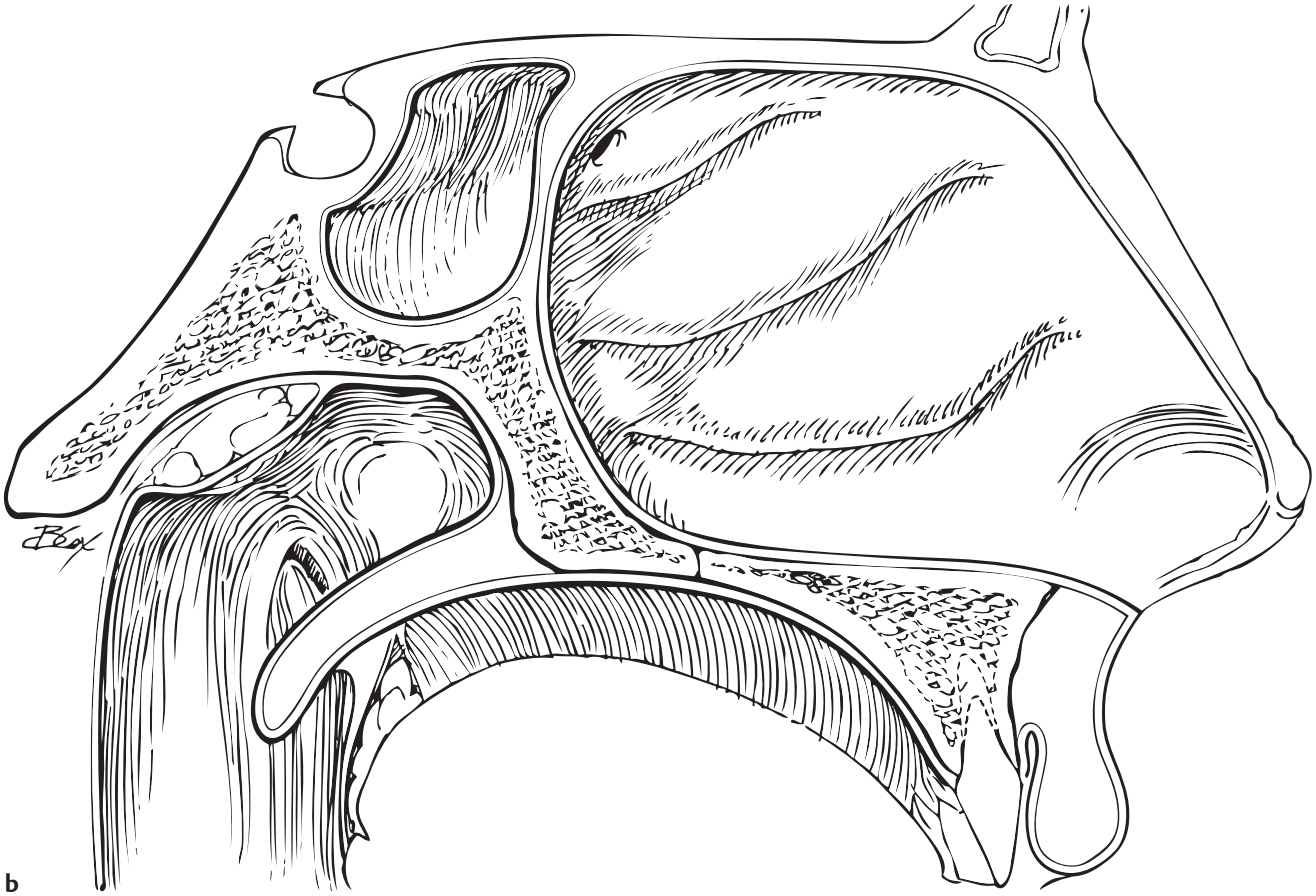
Complications

1. Restenosis
2. Palatal fistula



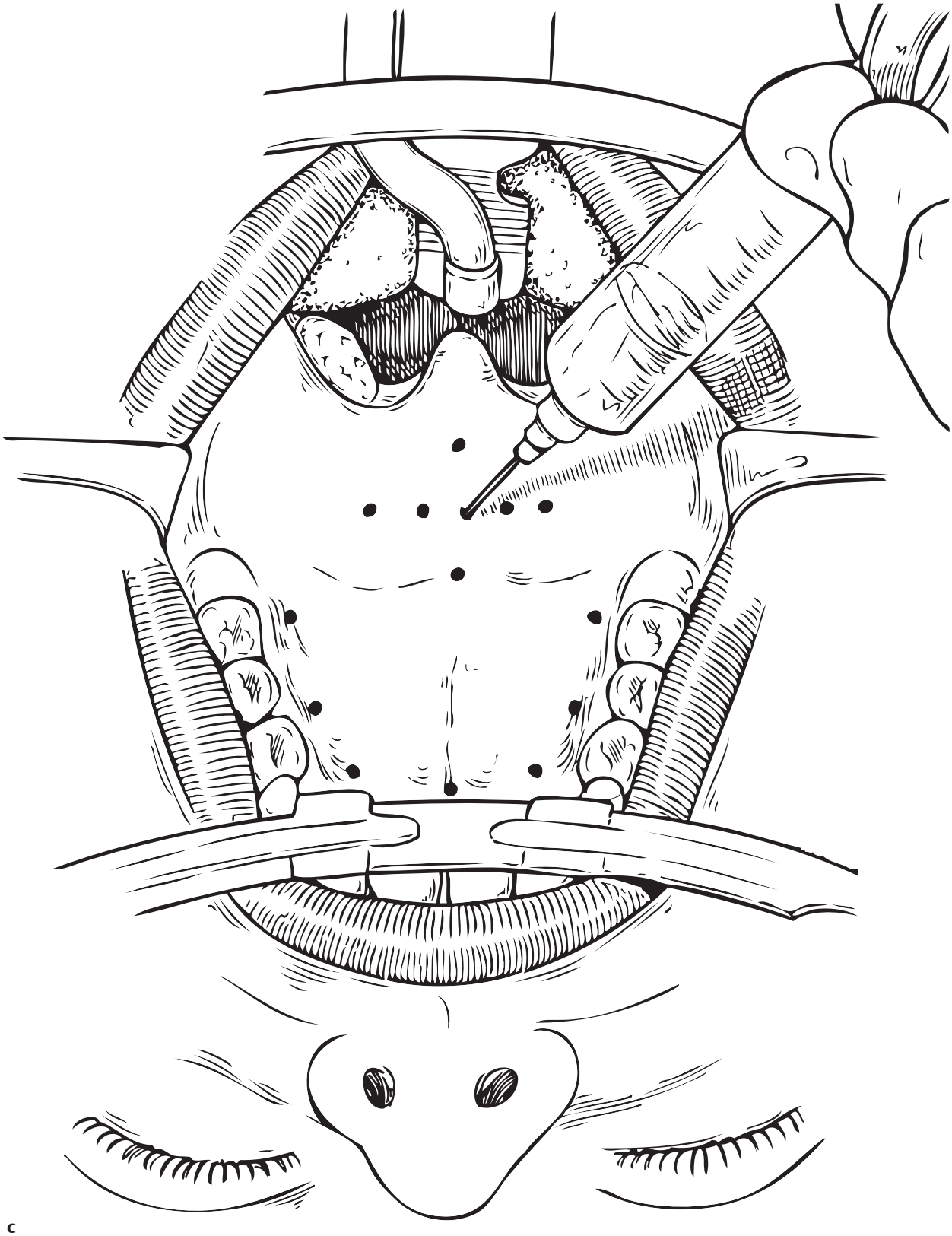
a

Fig. 14.2a



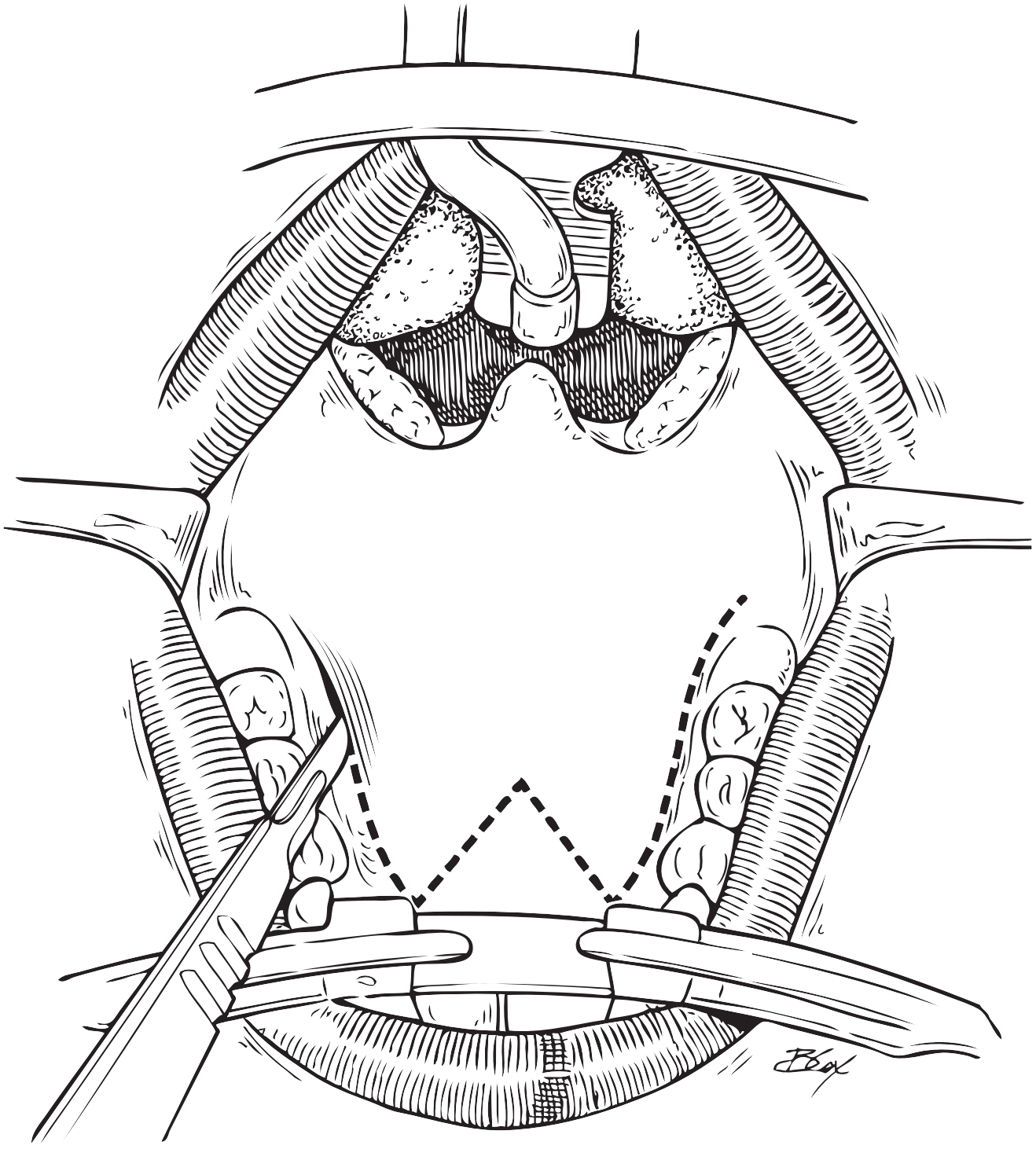
b

Fig. 14.2b



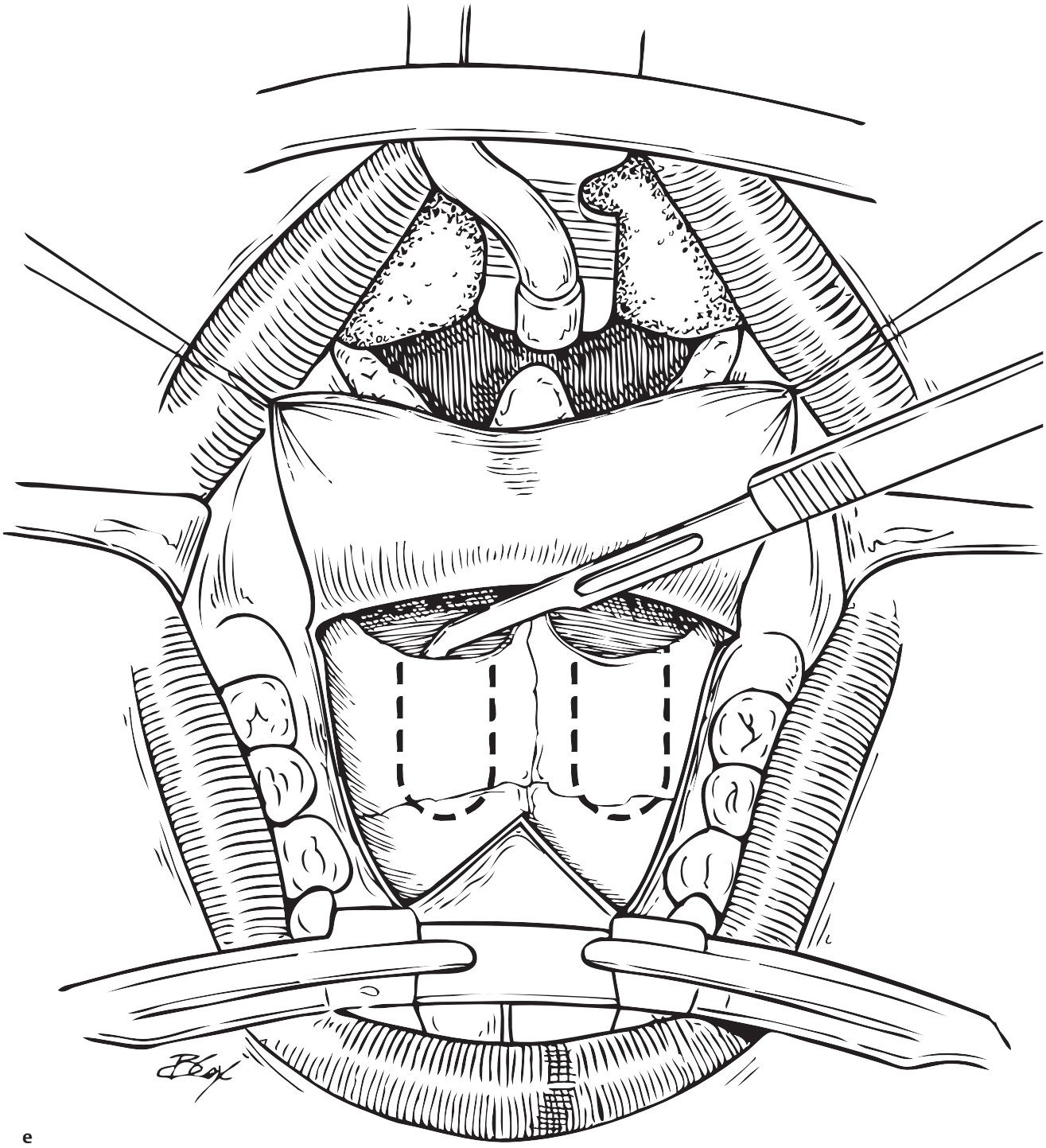
c

Fig. 14.2c



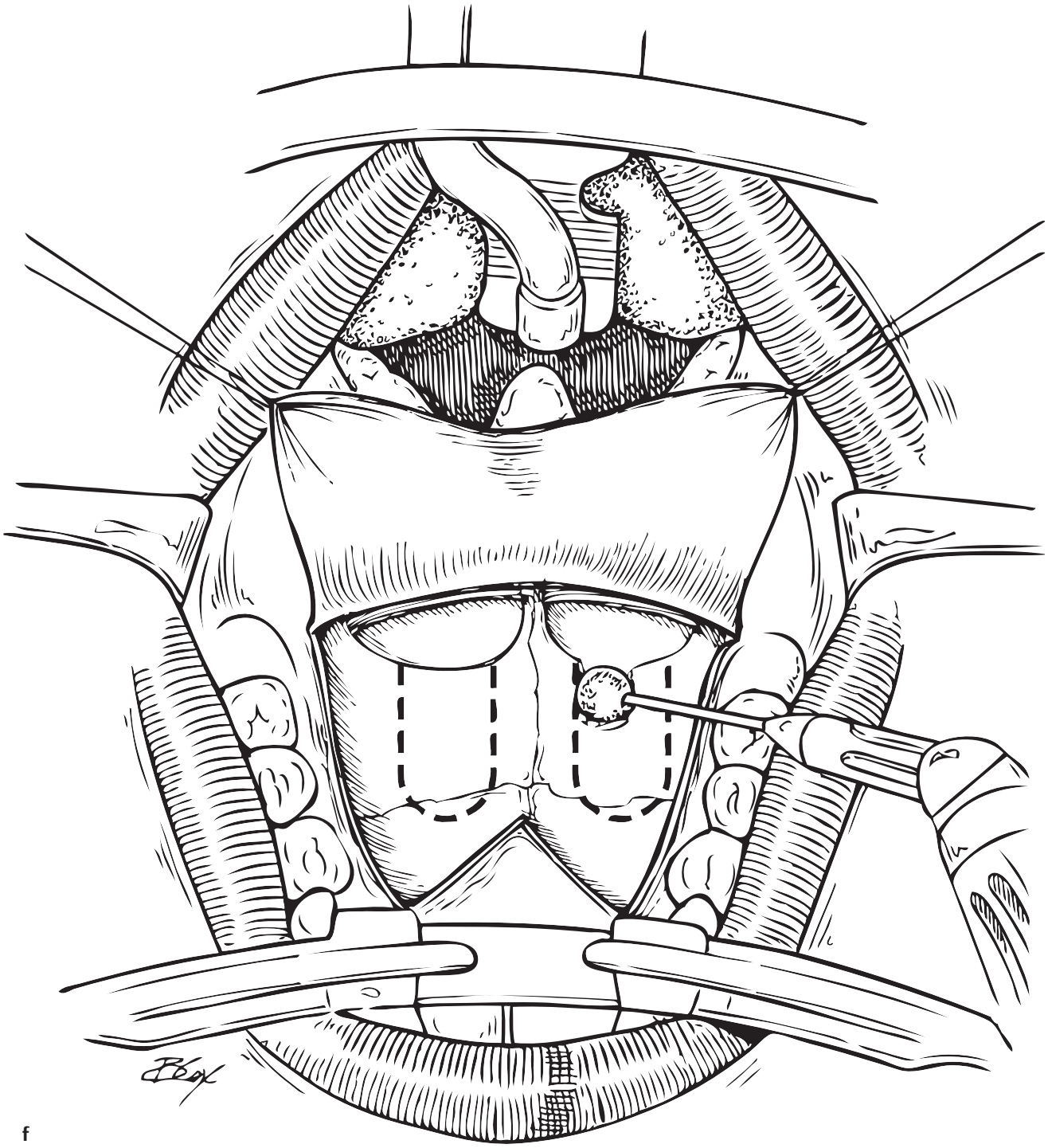
d

Fig. 14.2d



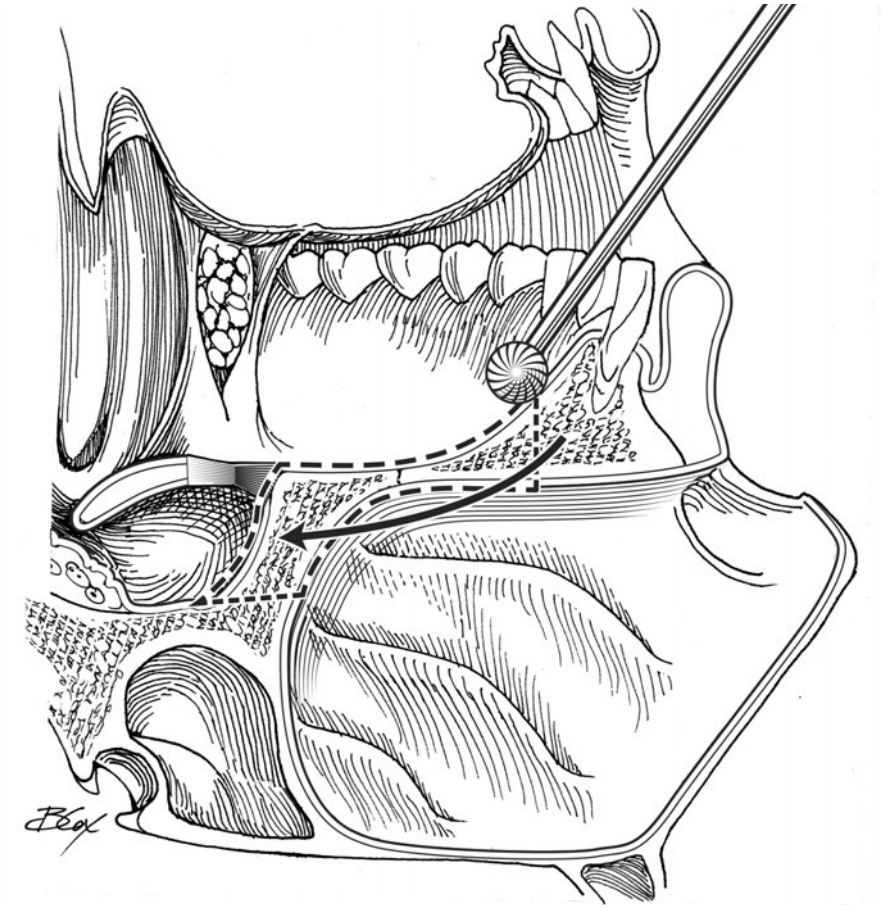
e

Fig. 14.2e

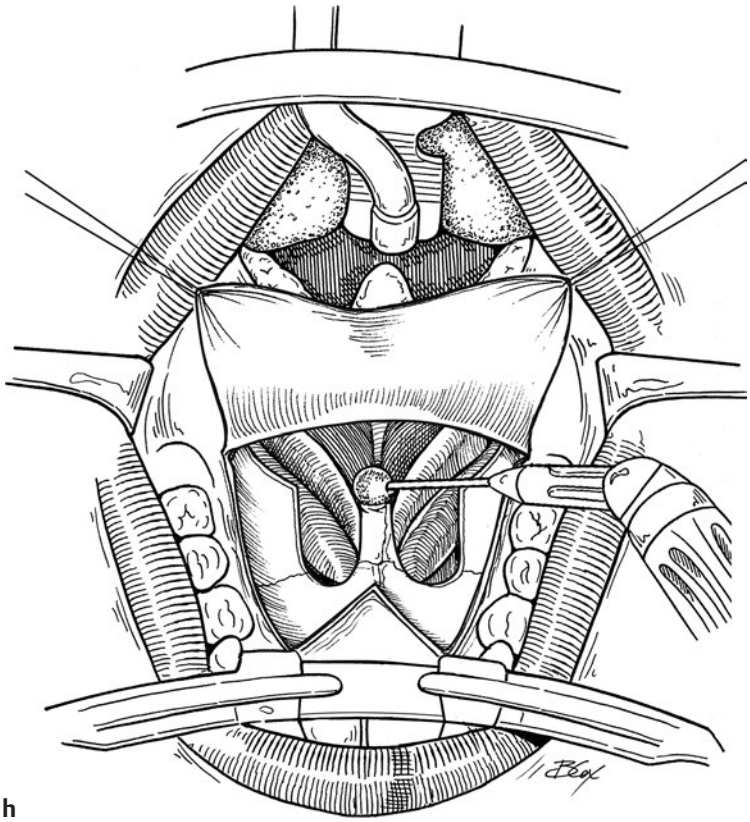


f

Fig. 14.2f

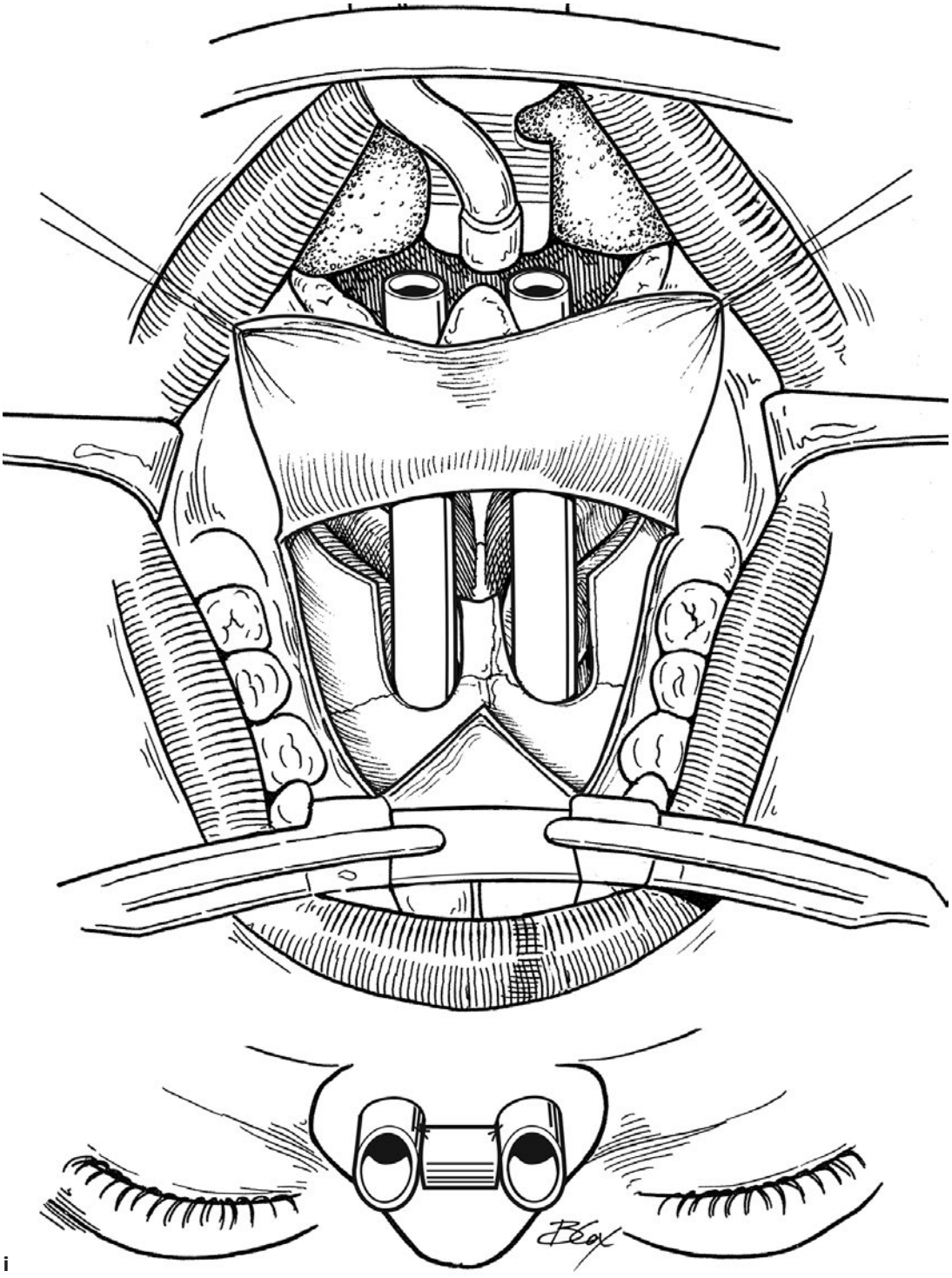


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h

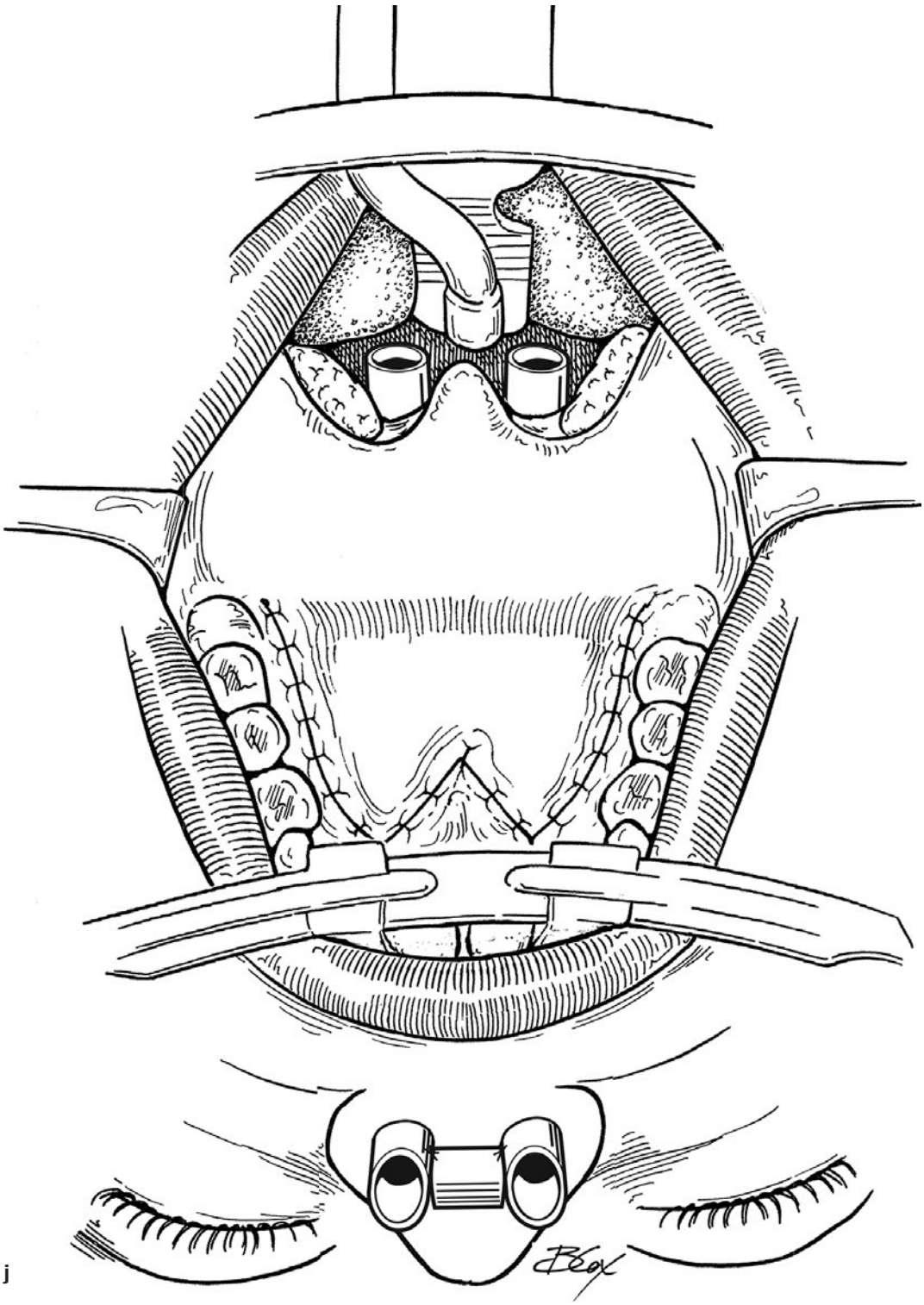
Fig. 14.2g,h



i

Fig. 14.2i

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j

Fig. 14.2j

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14-3 Repair of Anterior Nasal Stenosis

Introduction

Anterior nasal stenosis, also referred to as pyriform aperture stenosis, is a narrowing of the nasal passages caused by overgrowth of the nasal processes of the maxilla.

Indications

Repair of anterior nasal stenosis is necessary to provide an adequate airway.

Preoperative Evaluation

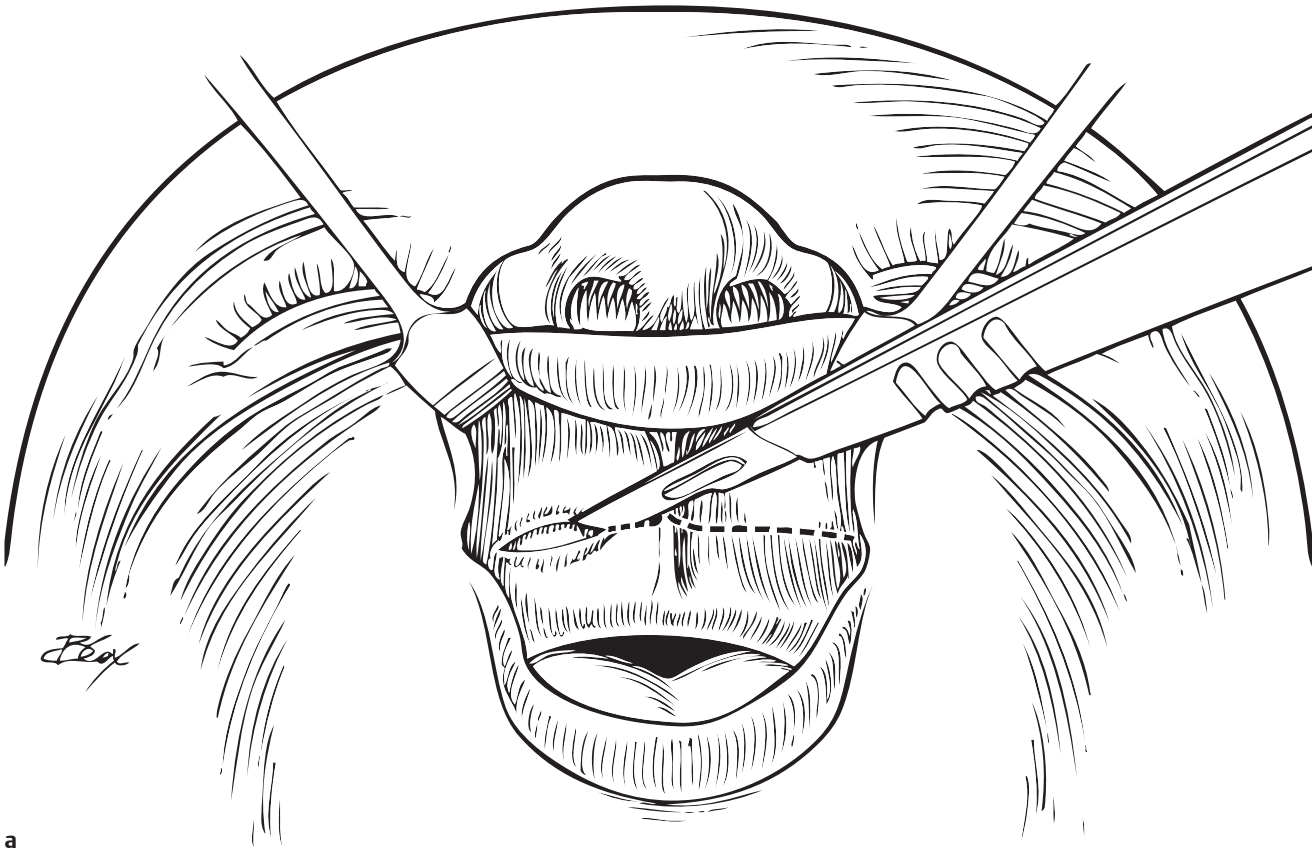
A CT scan demonstrates the anterior narrowing with patent posterior choanae.

Operative Technique

1. Repair of anterior nasal stenosis is performed under general anesthesia with orotracheal intubation.
2. Afrin-soaked neurosurgical patties are placed into the nasal vault for vasoconstriction.
3. The proposed sublabial incision is injected with 1% lidocaine with 1:100,000 units of epinephrine.
4. The sublabial incision is made, carrying it through the underlying periosteum. The incision should extend from one canine area to the opposite canine area (**Fig. 14.3a**).
5. The soft tissues are elevated, exposing the face of the maxilla and the pyriform apertures bilaterally (**Fig. 14.3b**).
6. The tissue is elevated from the floor of the nose, the lateral nasal wall, and the septum to expose the pyriform aperture (**Fig. 14.3c**).
7. A drill is used to enlarge the pyriform aperture. The nasal process of the maxilla is taken down to enlarge the nasal opening. The floor of the nose is also drilled down, taking care not to injure the underlying tooth buds; this limits the inferior extent of the opening (**Fig. 14.3d**).
8. If the nasal crest is impinging into the nasal airway, it can be drilled away.
9. The nasal mucosa has been preserved to this point. An incision is made laterally to allow the mucosa to reline the floor of the nose. Bone will be exposed laterally on the nasal floor (**Fig. 14.3e**).
10. The head of the inferior turbinate often contributes to the nasal obstruction. With a telescope providing visualization, a shaver is used to trim away excess tissue from the turbinate to improve the potential for nasal respiration.
11. Nasal stents are fashioned similar to those used for posterior choanal stenosis (refer to Section 14-1).
12. The sublabial incision is closed with interrupted 4-0 Vicryl sutures, with the knots buried. To ease with the closure, the gingival mucosa is reflected inferiorly to create a cuff of mucosa with which to close the incision (**Fig. 14.3f**).
13. Stents are placed as in posterior choanal atresia stenosis and sutured to the sublabial area to prevent extrusion (**Fig. 14.3g**).
14. Stents are suctioned every 8 hours, using saline to keep secretions thin. Stents are kept in place for 2 to 6 weeks.

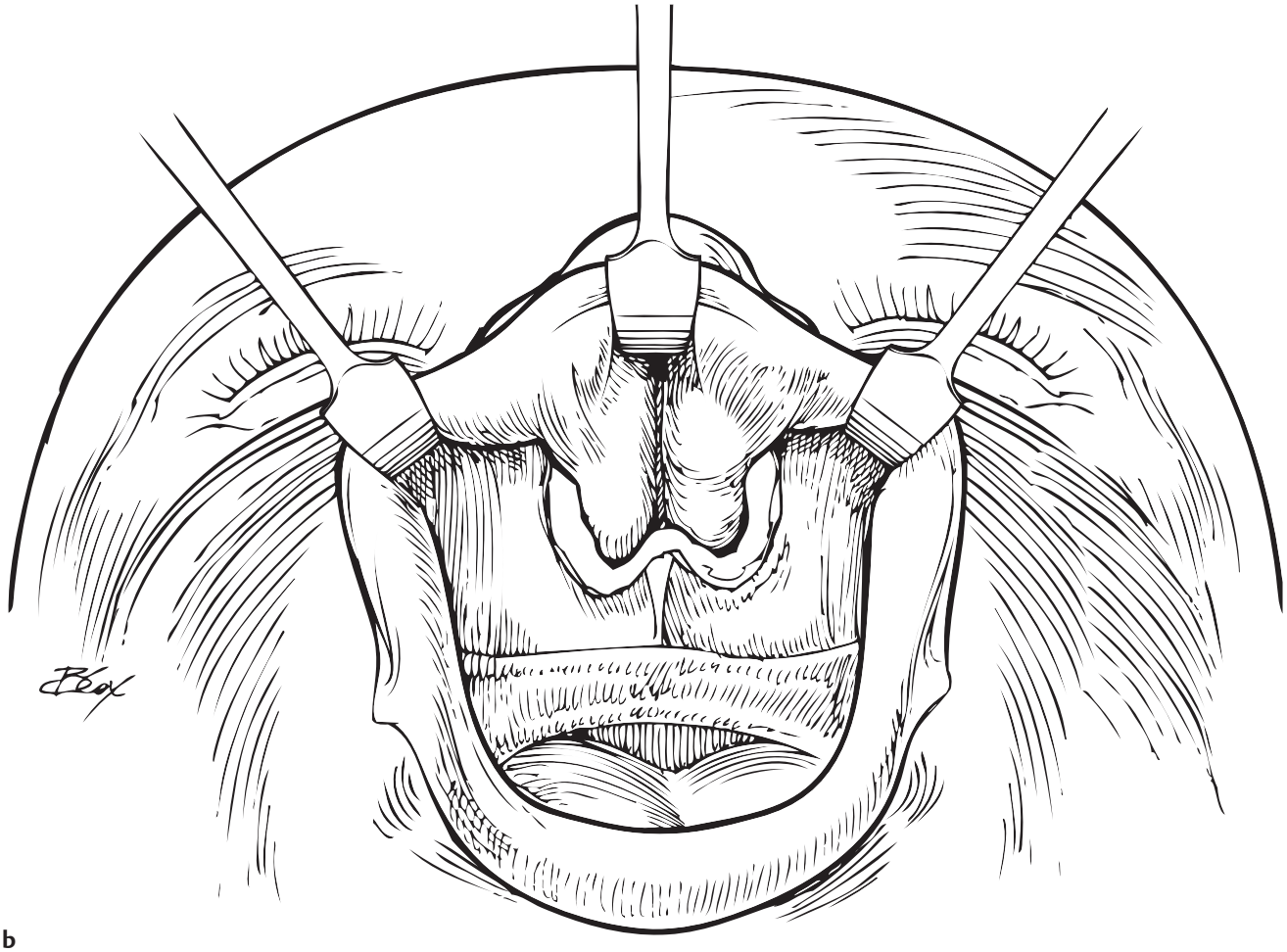
Complications

Stenosis of the anterior nasal vault



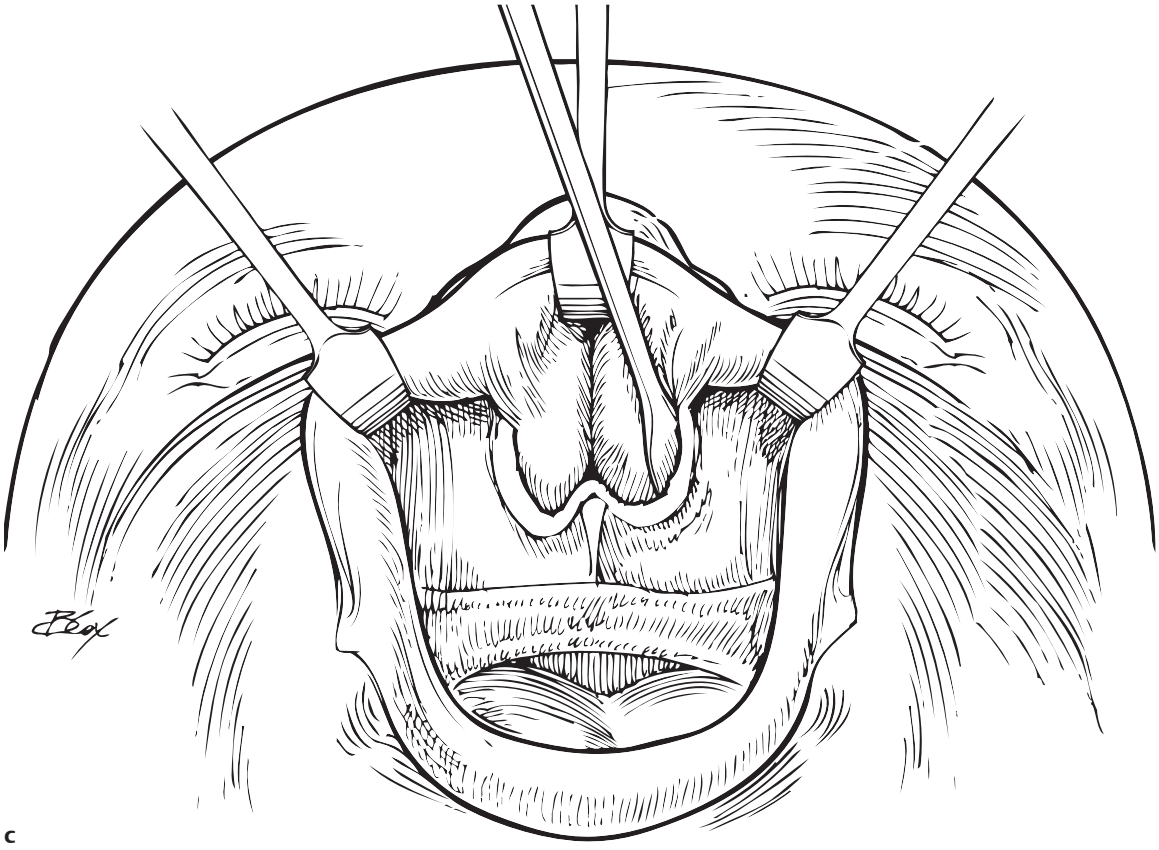
a

Fig. 14.3a

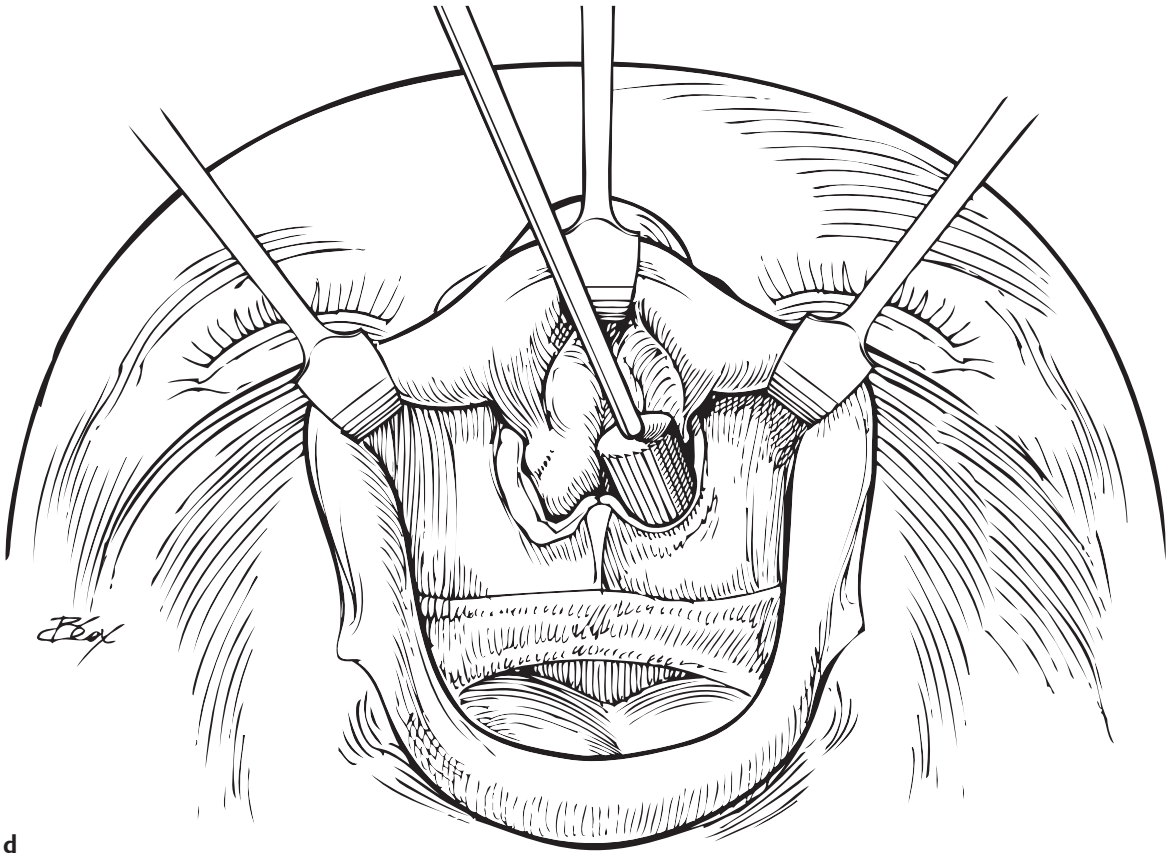


b

Fig. 14.3b

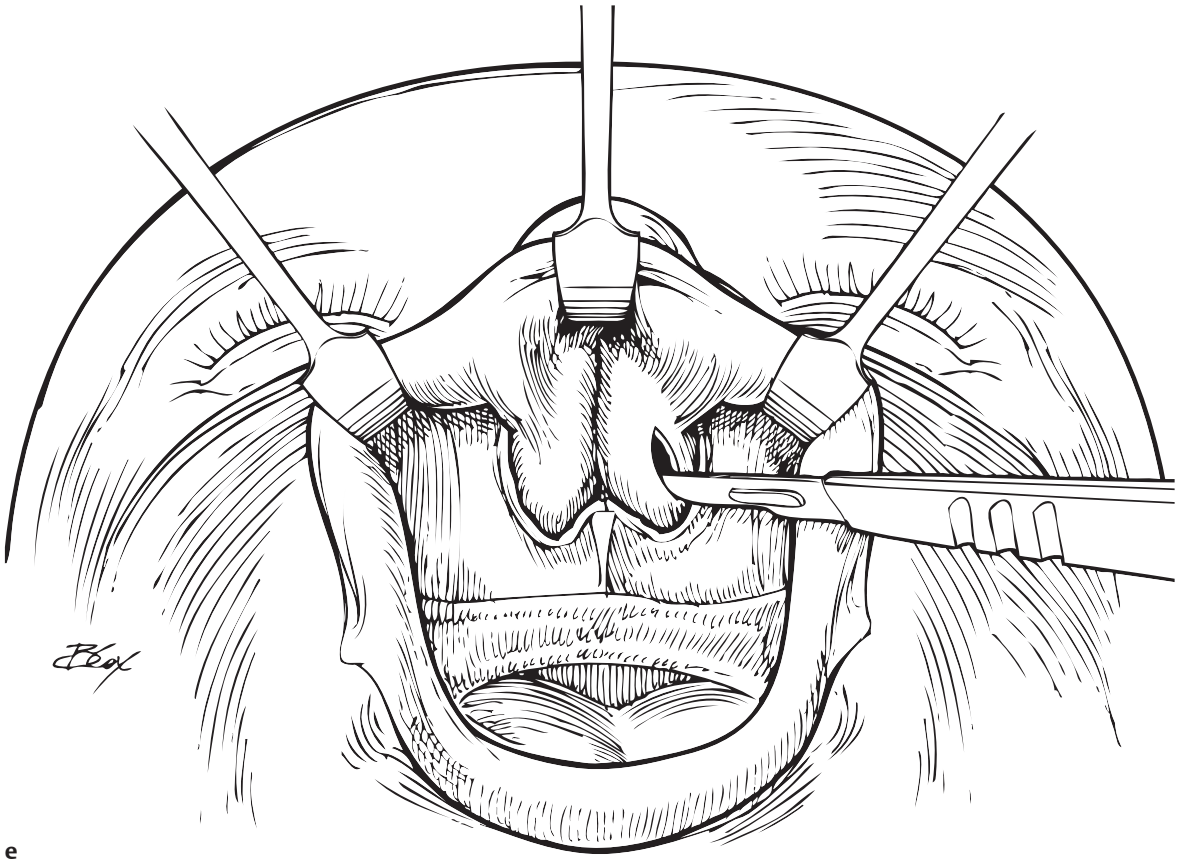


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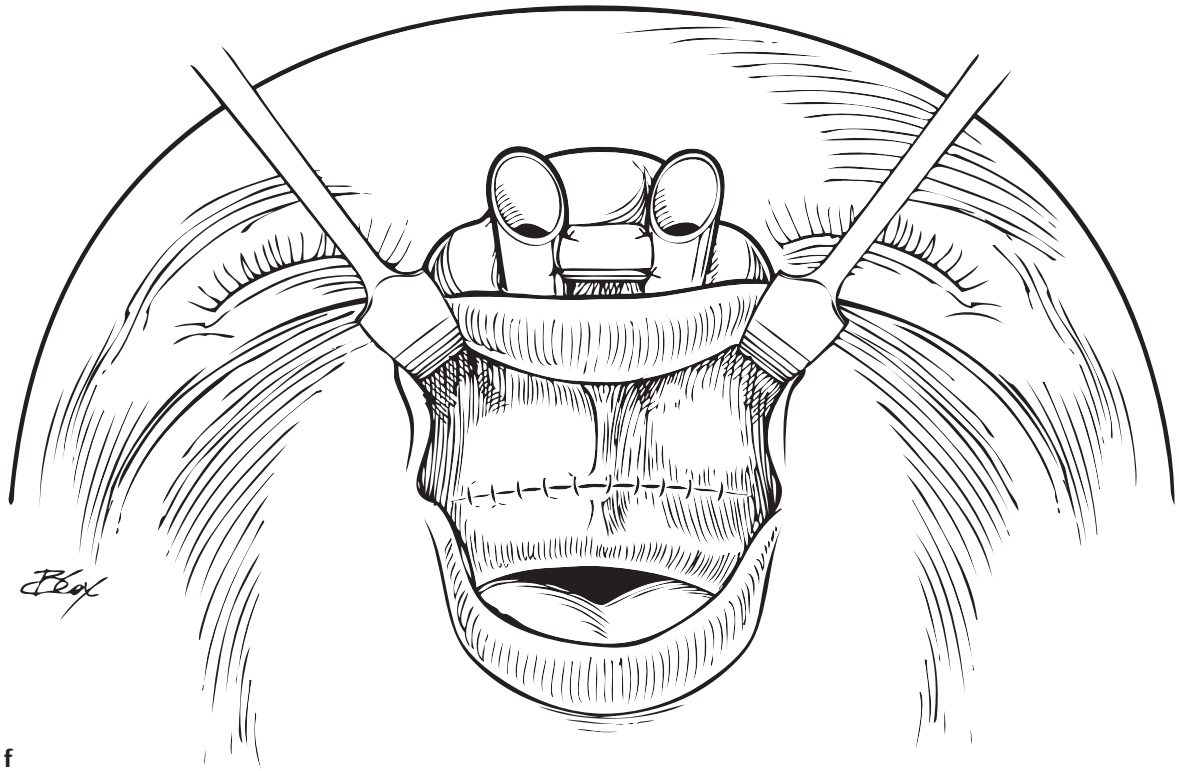


d

Fig. 14.3c,d

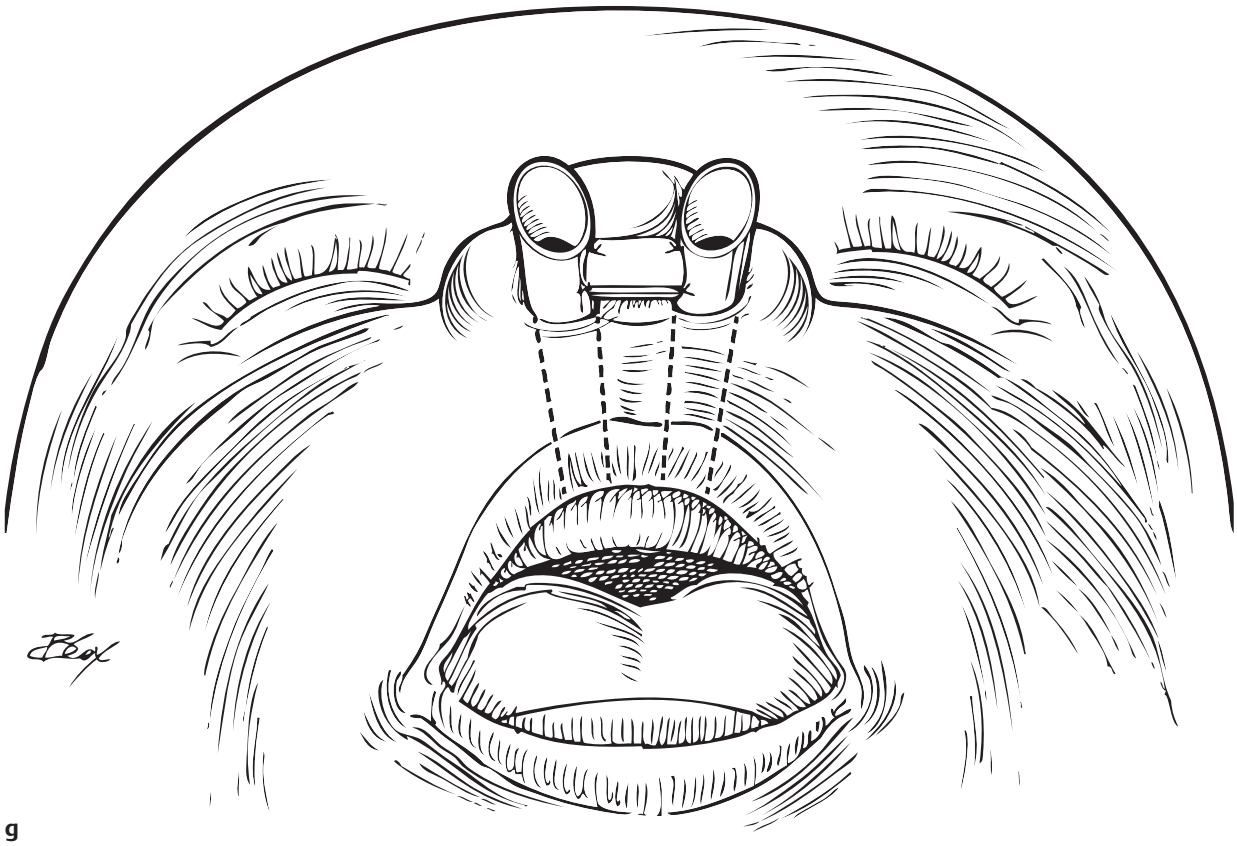


e



f

Fig. 14.3e, f



g

Fig. 14.3g

Section III

The Nasopharynx, Oral Cavity, and Oropharynx

III

15 Nasopharyngeal Angiofibroma

Ken Kazahaya

Nasopharyngeal angiofibromas, or juvenile nasopharyngeal angiofibromas (JNAs), are the most common benign neoplasms of the nasopharynx. They comprise approximately 0.5% of all head and neck neoplasms. They are unencapsulated vascular tumors composed of an irregular network of blood vessels in a fibroblastic stroma. These tumors are usually locally aggressive and destructive. JNAs also have the tendency to spread submucosally along lines of least resistance making assessment of their extent more challenging. Expansion of these tumors can occur anteriorly into the nasal cavity, posteriorly into the nasopharynx and sphenoid sinus, superiorly extending intracranially and into the cavernous sinus, and laterally into the pterygopalatine and infratemporal fossa. As they are extremely vascular tumors, patients with these tumors can have life-threatening epistaxis and massive hemorrhage intraoperatively.

JNAs present almost exclusively in adolescent males usually 10 to 17 years of age with a mean age at presentation of about 13 to 14 years. Nasal congestion and spontaneous epistaxis are the most common symptoms. Other less common symptoms include headache, facial pain, facial or cheek swelling, eustachian tube dysfunction and conductive hearing loss, trismus and jaw dysfunction, hyponasal speech, vision changes, proptosis, diplopia, and eyelid edema. Symptoms commonly present for 6 to 12 months prior to diagnosis.

Diagnosis is confirmed by imaging, most commonly computed tomography (CT) with contrast. JNAs have a classic appearance of a mass widening the space between the posterior maxillary wall and the pterygoids. Also, the mass demonstrates a rapid blush and enhancement after contrast administration. CT is useful in revealing the anatomic extent of the mass and its relationship to the bony anatomy of the nasopharynx and skull base. Magnetic resonance imaging (MRI) with contrast is also useful in determining the extent of the tumor. MRI can help delineate between soft tissue and fluid and assess the extent of tumor into the orbit and cavernous sinus as well as intracranially; vascular structural integrity and anatomy can also be assessed by MRI.

The author uses the Snyderman Classification System, described in 2010, which takes into account changes that arise as a result of the development of endonasal techniques.

Snyderman noted that tumor size and extent are less important in predicting complete tumor removal with endonasal surgical approaches. Using his classification system, sinus involvement is not considered an impediment to compete surgical resection. However, he did note two important prognostic factors predicting complete tumor removal and risk of recurrence: (1) route of cranial base extension; and (2) vascularity, in particular, residual vascularity after embolization. This system also provides better prediction of the immediate morbidity of blood loss during surgery, the need for multiple procedures, and risk of tumor recurrence.

In the new Snyderman Classification System, tumors are divided into five stages. Stage I is confined to the nasal cavity without extension lateral to the midpoint of the pterygopalatine fossa; stage II extends into the paranasal sinuses and/or lateral to the midpoint of the pterygopalatine fossa, without residual vascularity after embolization; stage III tumors exhibit skull base erosion or extension into extracranial spaces such as the orbit or infratemporal fossa, without residual vascularity after embolization; stage IV tumors exhibit skull base erosion and/or extension into the orbit and/or infratemporal fossa, *with* residual vascularity after embolization; and, lastly, stage V tumors exhibit intracranial extension and residual vascularity. Stage V lesions are also separated into M type tumors with medial routes of extension (cavernous sinus and medial to the paraclival and cavernous segments of the internal carotid artery) and L type tumors with lateral routes of extension (middle fossa superior to the petrous portion of the internal carotid artery and lateral to the paraclival and cavernous segments of the internal carotid artery).

Surgery is the primary treatment modality and performed completely endonasal, endoscopically assisted, or via an open approach. Other treatment modalities that have been utilized include radiotherapy,

hormonal therapy, and chemotherapy. Traditionally, large or extensive JNAs were considered to require open approach for resection, while endonasal approaches were reserved for smaller of more limited JNAs. Open approaches include lateral rhinotomy, transpalatal, transmaxillary, midfacial degloving, Lefort I, Weber-Fergusson, and cranio-zygomatico-facial.

15-1 Excision of Nasopharyngeal Angiofibroma

Indications

Nasopharyngeal angiofibromas are excised to prevent recurrent epistaxis, nasopharyngeal obstruction, and intracranial extension.

Preoperative Evaluation

The preoperative evaluation of a nasopharyngeal angiofibroma includes CT scan, MRI with MR angiogram, and arteriography with arterial embolization. Embolization is usually performed 24 to 72 hours prior to resection to reduce intraoperative blood loss.

Operative Technique

With the development of endonasal techniques and technologies, the endonasal approach has expanded to include resection of larger lesions. Often, lesions that were once considered to be only amenable to open resection can be managed either completely endonasally or by an endoscopic-assisted approach (see Section 13-1).

Endonasal approaches have been made possible in part by the preoperative embolization of these tumors to reduce their vascularity. Preoperative embolization may reduce intraoperative blood loss and improve visualization during endonasal procedures. Angiography with embolization is typically utilized prior to surgery; however, there have been descriptions of use of direct injection of materials into the JNA, during surgery, to embolize the tumor. One such material is an ethylene vinyl alcohol copolymer, Onyx, which can be directly injected into a lesion under fluoroscopy to see its extension into the tumor.

Endoscopic resection of JNAs has the benefits of better illumination, magnified and panoramic views, ability to visualize around corners and edges, less morbidity, no cutaneous incisions, and reduced hospitalization. However, some of the disadvantages of the endoscopic approach include: visualization through the scope is easily obscured by blood in the field, may require an additional skilled assistant, and limited access in the case of massive bleeding. A surgeon can consider converting a completely endonasal technique to an endoscopically assisted one and widen access by combining the open approach, such as a Caldwell-Luc, to access some of the lateral extent of the tumor or gain an additional tunnel of approach to a deep lesion. One should be cautioned that, if an endonasal or endoscopically assisted approach is planned, the surgeon should be prepared and able to convert to an open approach, as well as having craniofacial and neurosurgical backup.

Endonasal approaches have essentially replaced lateral rhinotomy and transpalatal approaches especially for small to mid-sized tumors performed by endoscopically experienced surgeons. Even large, more extensive tumors are often able to be addressed using endonasal techniques.

Endonasal approaches have been made practical and an excellent choice for the management of JNAs because of preoperative embolization and technologies such as microdebriders, extended length drill burs, skull base burs, lasers, endoscopic bipolar forceps, and radiofrequency and plasma technology. Given that endonasal techniques have replaced open approaches for management of most JNAs, this approach is described here.

Endonasal Technique

1. Preoperative embolization within 24 to 72 hours prior to surgical resection.
2. Consider the use of an intraoperative computer-assisted guidance (IGS) system. Verify accuracy and review plan.
3. Begin in the nasopharynx.
   a. Introduce a tonsil mouth gag (Dingman or Crowe-Davis) and suspend in the typical fashion as for an adenoidectomy.
   b. Carefully introduce a 10-French catheter through the contralateral nostril and deliver it through the oral cavity. Approximate the two ends and apply a slight amount of tension to retract and elevate the palate. Then clamp the two ends of the catheter as to maintain this traction.
   c. Using a dental mirror or angled endoscope, visualize the nasopharynx from the posterior/inferior aspect.
   d. The posterior aspect of the JNA can be visualized and demarcated using a plasma wand, bipolar cautery, or a monopolar suction cautery, taking care to avoid injury to the tori. Sometimes the JNA can be submucosally attached to the septum and may need to be addressed there as well. Some debulking of the JNA may be performed from this direction. This will define the posterior extent of the resection of the JNA.
4. Debulk the nasal cavity component of the JNA. Protect normal mucosa and the nares as injury may be caused during the repetitive insertion and removal of the endoscope and instruments into the nasal cavity. By debulking the

intranasal component, this will make further dissection easier and provide room to displace the tumor. Dissection around the tumor mass can be performed with a suction elevator and neurodissectors. Removal of tissue can be performed with a multitude of different methods such as bipolar and suction cautery, laser, or coblation.

5. Consider posterior septectomy. This will allow for exposure to the posterior aspect of the tumor through the contralateral nostril. Also if the septectomy is made large enough, visualization into the pterygoid fissure and lateral aspect of the sphenoid recess may be made easier from the more obtuse angle provided through the contralateral nasal cavity.
6. Clip and ligate the sphenopalatine artery.
7. An extensive maxillary antrostomy and removal of the posterior wall of the maxillary sinus provides additional exposure of the tumor. This can be performed using diamond burs and neurodissectors/elevators. The extended length and skull base burs are particularly useful to drill this bone. A wide maxillary antrostomy will allow better exposure to the posterior wall of the maxillary sinus and pterygomaxillary fissure and, in some cases, out into the medial aspect of the infratemporal fossa. This may allow adequate exposure to deliver a JNA that extends into the infratemporal fossa, maxillary sinus, and nasal cavity. The internal maxillary artery may also be visualized and ligated with endoscopic clip appliers and cut with endoscopic scissors.
8. Debulking the tumor will provide space into which the tumor may be displaced to allow it to be dissected out of various areas, such as the paranasal sinuses, the infratemporal fossa, the orbit, intracranially, and the cavernous sinus.
9. If more lateral access and exposure are required, one may consider a sublabial incision and create an opening in the face of the maxilla.
10. Control of posterior vascular supply.
    a. If the mass goes posteriorly into the sphenoid sinus, the surgeon must pursue the lesion posteriorly. The extended length or skull base burs are helpful to remove the face of the sphenoid.
    b. Care must be taken posteriorly as there is typically vascular supply from the Vidian artery. Drilling the sphenoid bone may allow this artery to be identified and managed.
    c. Often there is vascular contribution that comes through the cancellous bone of the clivus and sphenoid bone. Drilling of the bone may be necessary to completely remove tumor extending into the bone, and then this may require hemostatic agents to be applied, such as bone wax, to control bleeding.
11. Superior extent
    a. Cavernous sinus: If there is extension into the cavernous sinus, sometimes a plane may be created between the cavernous sinus and the JNA. Careful dissection may allow delivery of tumor that extends into the region of the cavernous sinus. Care should be taken to avoid penetrating or tearing the sinus. One needs to remember that this is a benign process and leaving a small amount of tumor adjacent to delicate structures may be better than causing significant morbidity.
    b. Intracranial extension may often be brought inferiorly into the nasal cavity. The dura often provides a barrier to the JNA. Sometimes there is a thin rind of attenuated bone still remaining between the JNA and the dura, which can provide a plane of dissection. If there is a large skull base defect, a portion of septal bone or a split calvarial bone graft may be required to reconstruct the skull base.
12. At the completion of the procedure, the defect can be packed with hemostatic agents and antibiotic-coated gauze strip packing or Xeroform strips (Covidien). To help with breathing, a nasopharyngeal airway may be placed through the nose and have the packing around the airway, thereby allowing air to pass through the nose after surgery. Typically, the nasopharyngeal airway and packing are removed 2–3 days postoperatively.
13. The patient may require temporary placement of a ventilation tube in the ipsilateral ear if there is persistent fluid and conductive hearing loss.

Hemostatic Agents to Be Considered

1. Ephedrine: 1:1,000 topical application of Gelfoam (Pfizer) or Cottonoid neuropledgets (Codman). May consider coloring the liquid to help identify it and prevent inadvertent injection; can use methylene blue or fluorescein.
2. Gelfoam with thrombin
3. Surgicel (Ethicon)
4. FloSeal (Baxter)
5. Avitene (Davol Inc.)
6. Bone wax

Endoscopically Assisted Techniques

The surgeon may combine open exposures such as a Caldwell-Luc approach or midface degloving and translocation to gain more extended exposure and utilize endoscopic techniques to resect tumor that may otherwise have required a much more extensive approach in order to have direct line of sight exposure (see Section 13-1).

Open Approaches

Lateral Rhinotomy

Refer to Section 13-1, Lateral Rhinotomy.

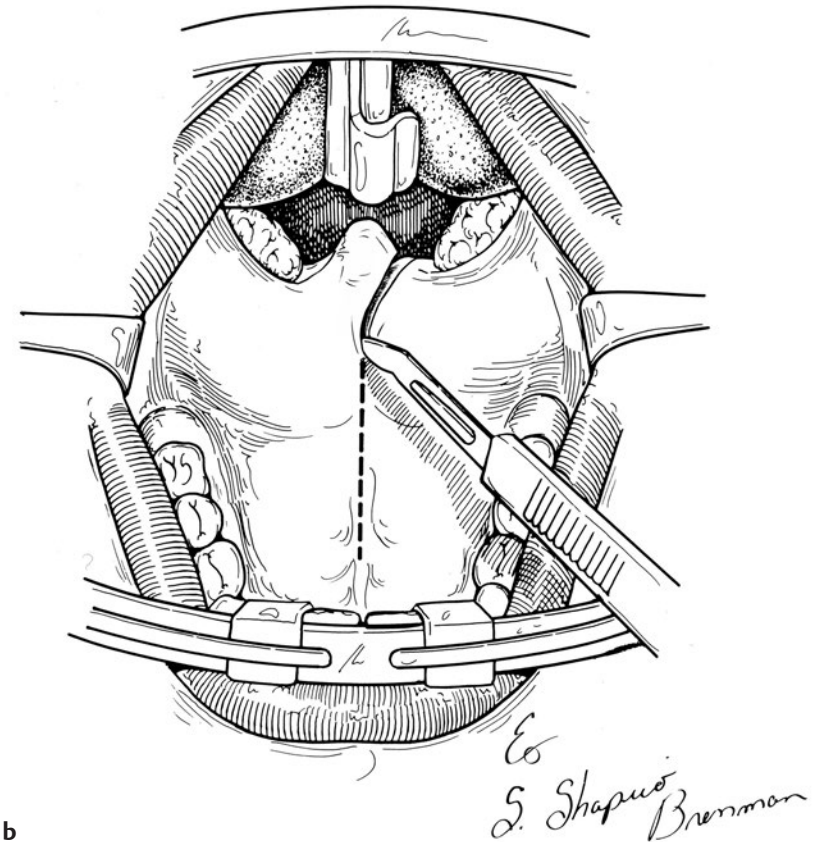
Transpalatal Operative Technique

1. Transpalatal excision of an angiofibroma is performed utilizing general anesthesia administered through an oral RAE tube. A Dingman mouth gag is placed for exposure of the palate (**Fig. 15.1a**).
2. The midline of the palate is injected with 1% lidocaine with 1:100,000 epinephrine for hemostasis (**Fig. 15.1a**).
3. A midline palatal splitting incision is made with a knife through the soft palate and through the soft tissue overlying the hard palate (**Fig. 15.1b**). Incision can be made to one side of the uvula, rather than through the middle of the uvula.



a

Fig. 15.1a



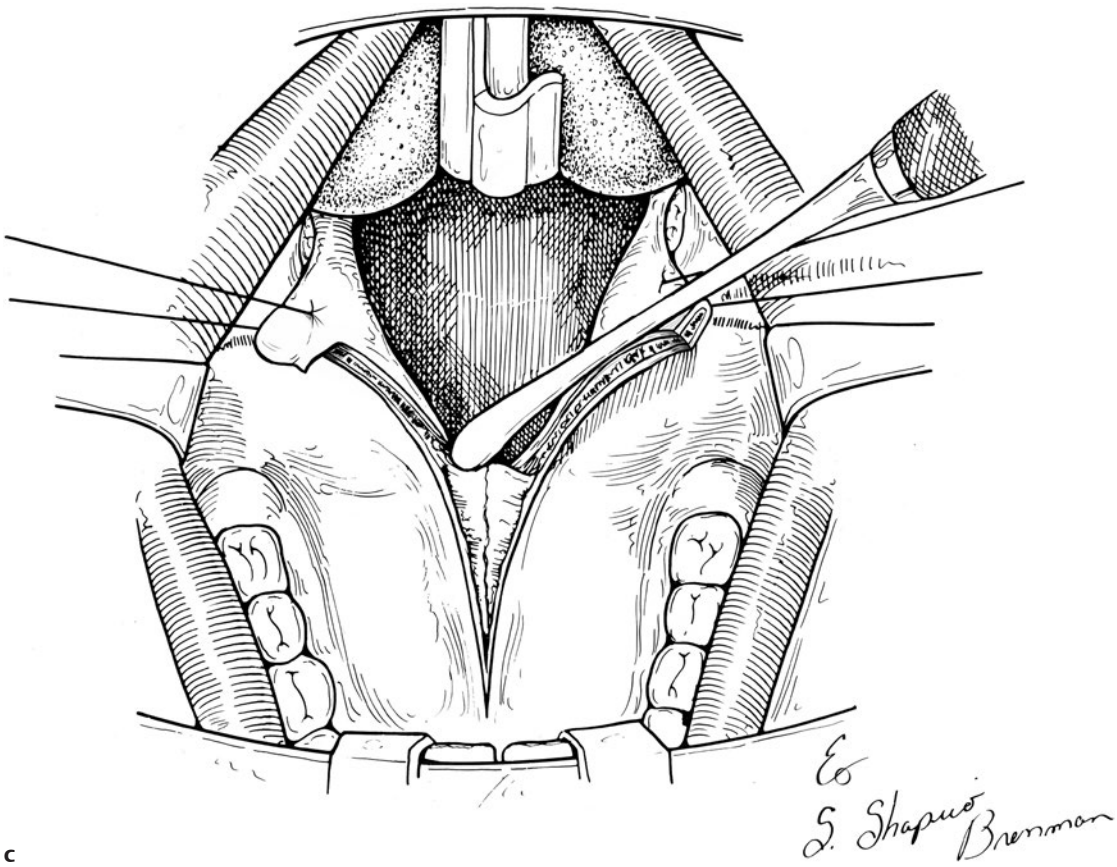
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Fig. 15.1b

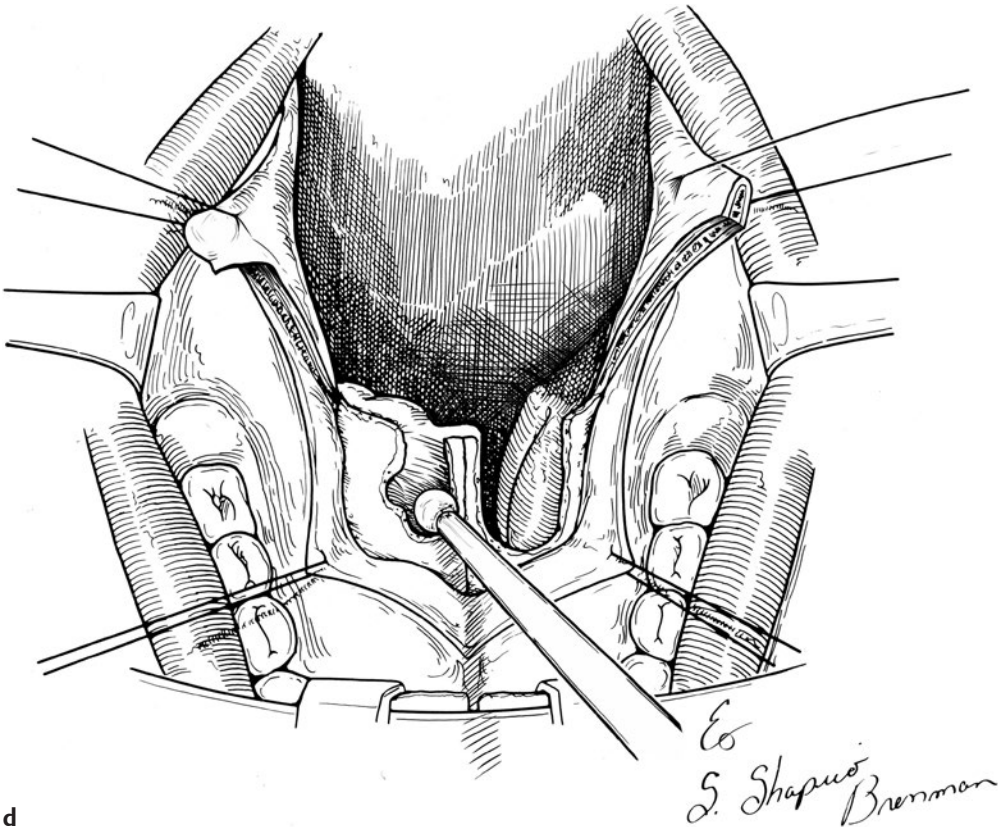
4. The muscular attachments and soft tissue flaps are reflected laterally exposing the hard palate (**Fig. 15.1c**).
5. The bone of the hard palate is removed with a drill or bone rongeurs exposing the angiofibroma. A portion of the posterior nasal septum may also be removed (**Fig. 15.1d**).
6. The angiofibroma is excised by dissection from its surrounding attachments (**Fig. 15.1e,f**).
7. Hemostasis is obtained by suction cautery, bipolar cautery, or other methods such as coblation.
8. The palate incision is closed in two layers. The mucosa on the nasal side is closed with 4-0 interrupted Chromic suture (Ethicon). The oral mucosa and muscle are closed with deep 3-0 interrupted Vicryl suture (Ethicon) (**Fig. 15.1g**).
9. Very large extracranial lesions may be additionally approached through a lateral rhinotomy incision (see Section 13-1), midfacial degloving, Weber-Fergusson, or cranio-zygomatico-facial approaches.

Complications

1. General complications
   a. Nasal crusting is one of the most common postoperative problems. Nasal irrigations may reduce crusting; however, periodic debridements may be necessary.
   b. Internal maxillary artery laceration
   c. Carotid artery injury
   d. Cavernous sinus hemorrhage and injury to cavernous sinus contents
   e. Orbital injury/optic nerve injury
   f. Nasolacrimal duct injury/obstruction
   g. Cheek numbness
   h. Cerebrospinal fluid leak
   i. Meningocele/encephalocele formation
   j. Enophthalmos
   k. Diplopia/alteration in extraocular muscle function
   l. Recurrence
2. Endonasal complication
   a. Injury to nares
   b. Intranasal synechiae
   c. Incomplete resection
      i. Exposure issues
      ii. Excessive intraoperative bleeding
   d. Extended operative times
      i. Increase risk of pressure ulcers
      ii. Alopecia from pressure on back of head during case
3. Open approach complications
   a. Cutaneous facial scarring
   b. Malunion of osteotomies
   c. Retardation of facial growth
   d. Facial asymmetry
   e. Oronasal/oroantral fistula
   f. Palatal fistula
   g. Extended hospitalization/recovery
   h. Laceration of internal maxillary artery
   i. Cerebral spinal fluid leak

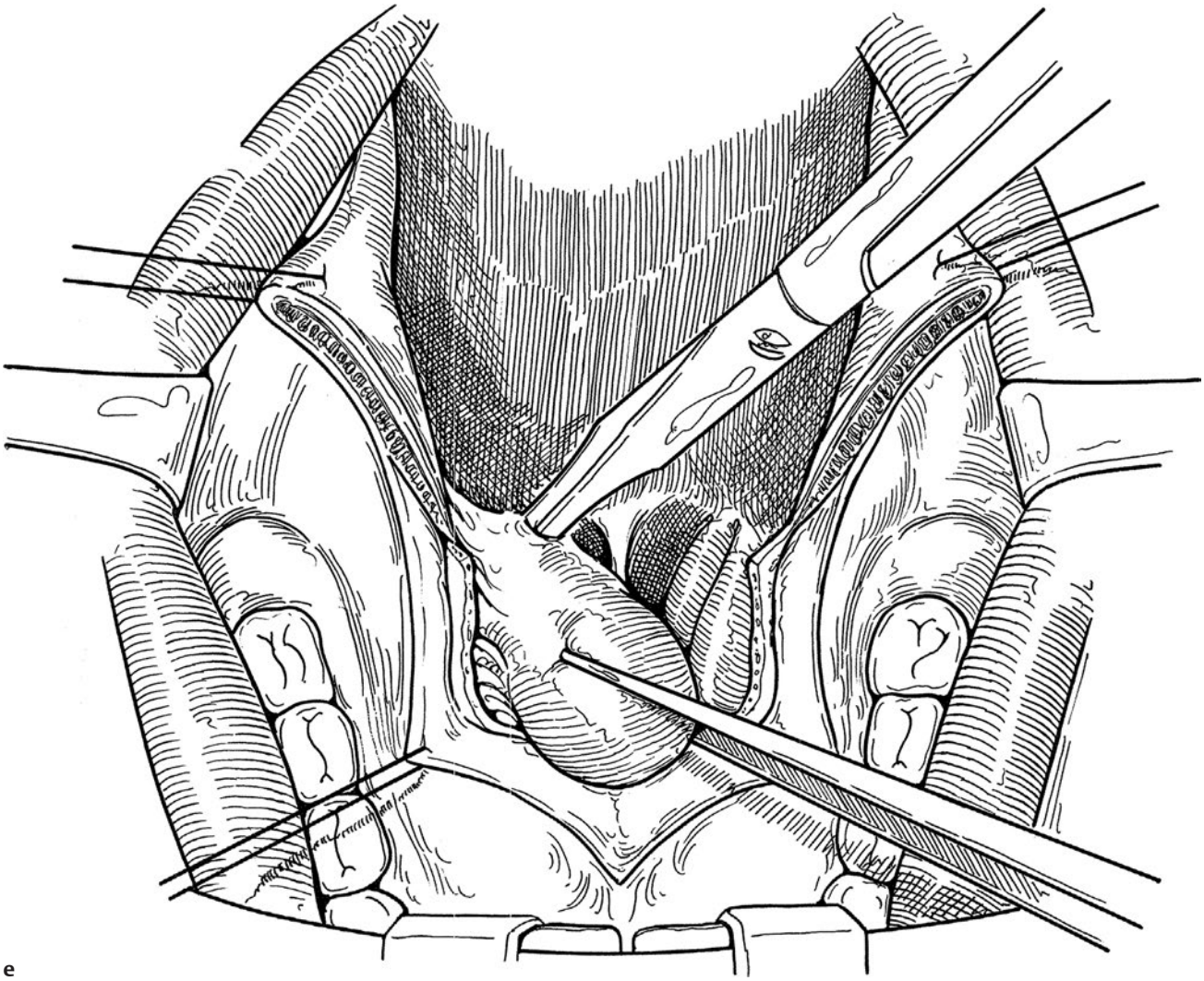


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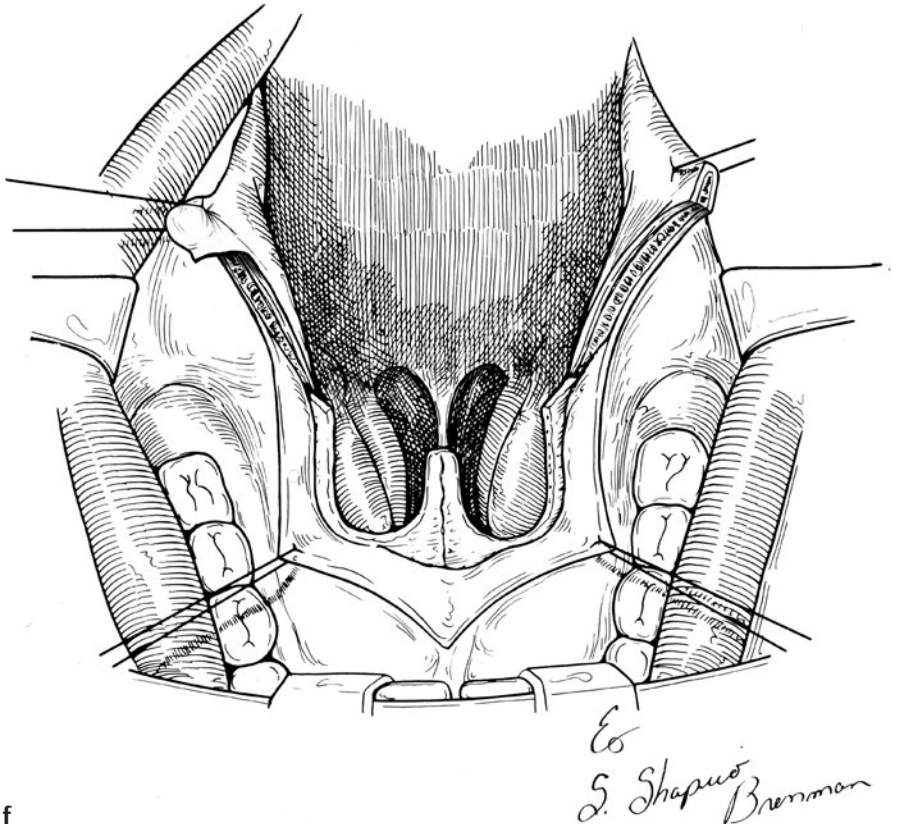
d

Fig. 15.1c,d

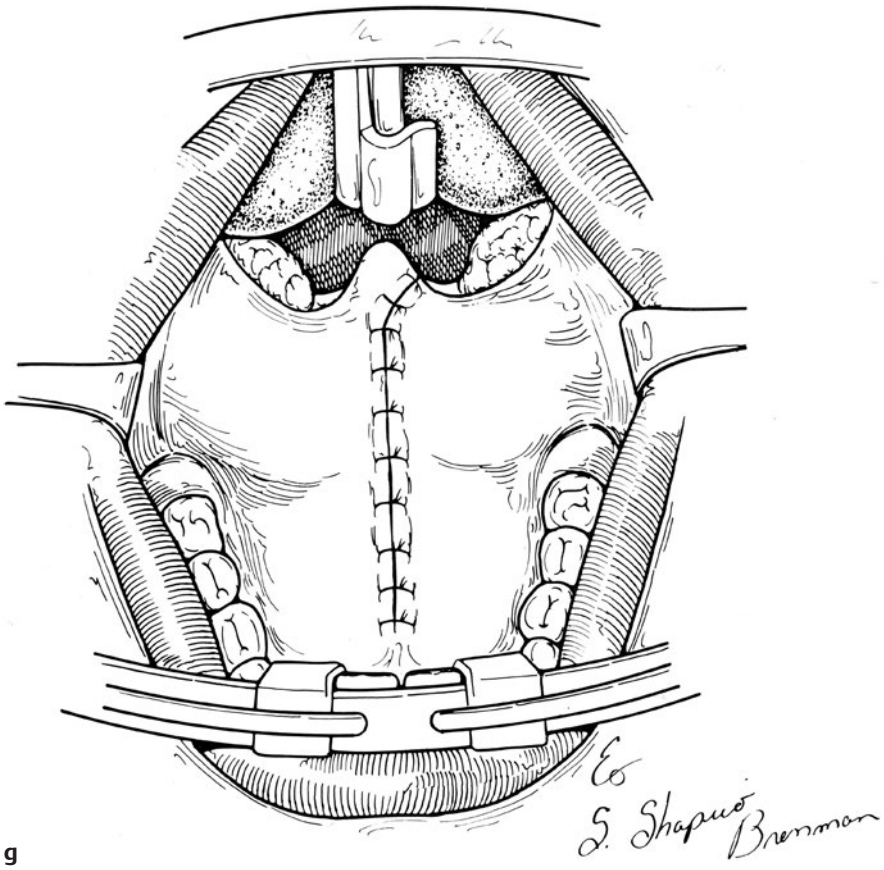


e

Fig. 15.1e



f



g

Fig. 15.1f,g

16 Nasopharyngeal Stenosis

J. Paul Willging

Nasopharyngeal stenosis usually occurs when there is extensive scarring following an adenoidectomy or adenotonsillectomy.

16-1 Repair of Nasopharyngeal Stenosis

Indications

Repair of nasopharyngeal stenosis is required to restore function of the upper airway impacted by obstruction at the junction of the nasopharynx and oropharynx.

Preoperative Evaluation

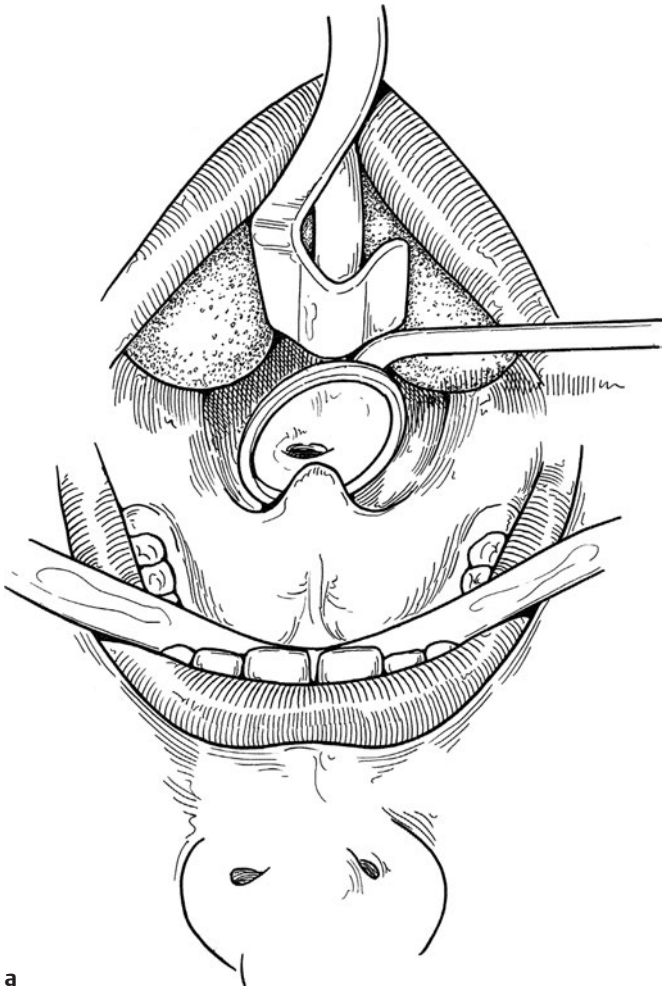
Flexible nasopharyngoscopy or indirect mirror nasopharyngoscopy is used to define the extent of the stenosis. In selected patients, computed tomography scans and magnetic resonance imaging are used to more thoroughly visualize the stenosis.

Operative Technique

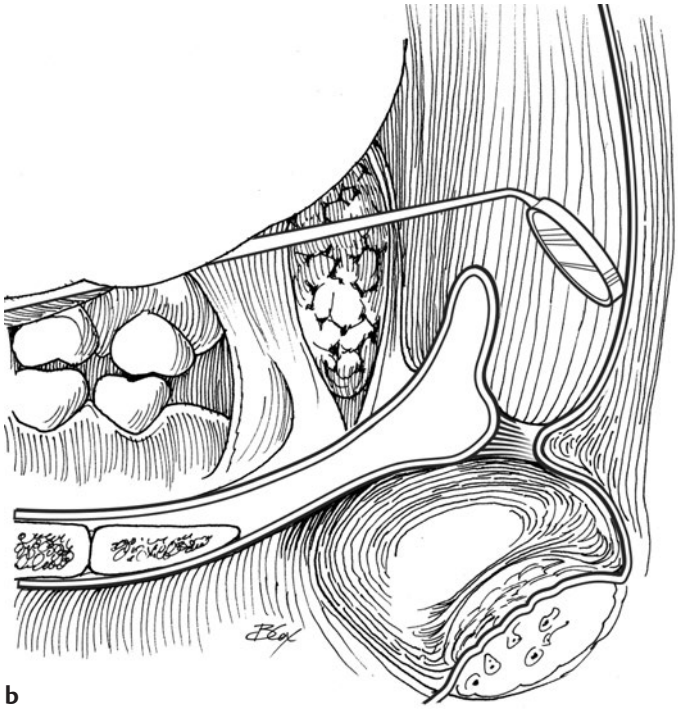
1. Repair of nasopharyngeal stenosis is carried out under general endotracheal anesthesia through an oral RAE tube with a mouth gag in place to expose the pharynx (**Fig. 16.1a**).
2. The nasopharyngeal lumen is visualized with a nasopharyngeal mirror (**Fig. 16.1b**).
3. If a lumen is present, nasal catheters are passed through the nasopharyngeal stenosis into the hypopharynx. They are then pulled out of the mouth to exert tension on the stenosis (**Fig. 16.1c**).
4. One percent lidocaine with 1:100,000 epinephrine is injected into the proposed incision lines (**Fig. 16.1d**).
5. Scar bands are divided to free the soft palate from the posterior and lateral pharyngeal walls (**Fig. 16.1e**).
6. Local mucosal flaps are rotated into the surgical defect (**Fig. 16.1f**).
7. Donor sites are closed as much as possible. Raw surfaces on the soft palate may be oversewn (**Fig. 16.1g,h**).
8. Kenalog-40 injections (Bristol-Myers Squibb) should be considered to control scar formation and restenosis.
9. A nasal endotracheal tube may be used to stent the nasopharynx open (**Fig. 16.1i**).

Complications

Restenosis of nasopharynx

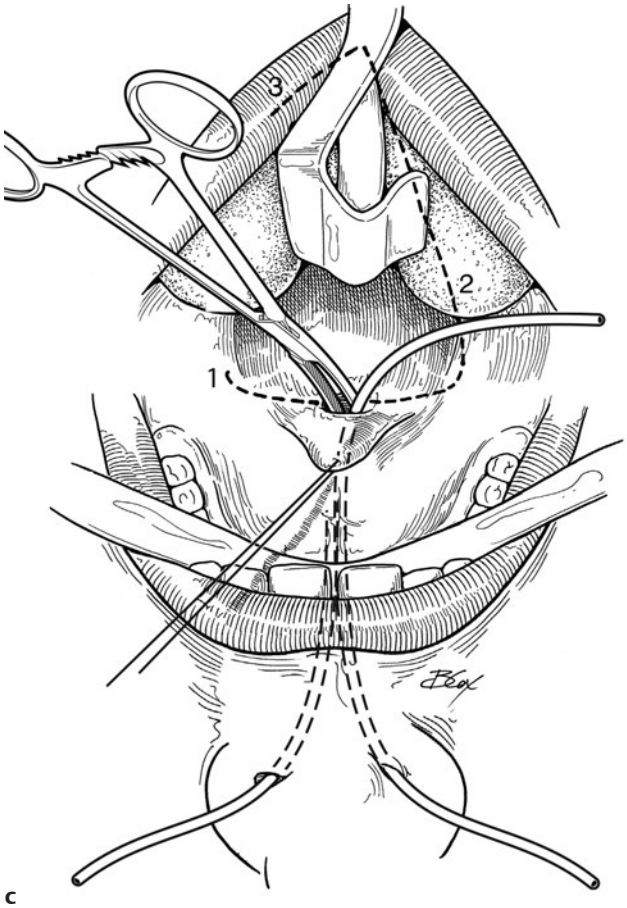


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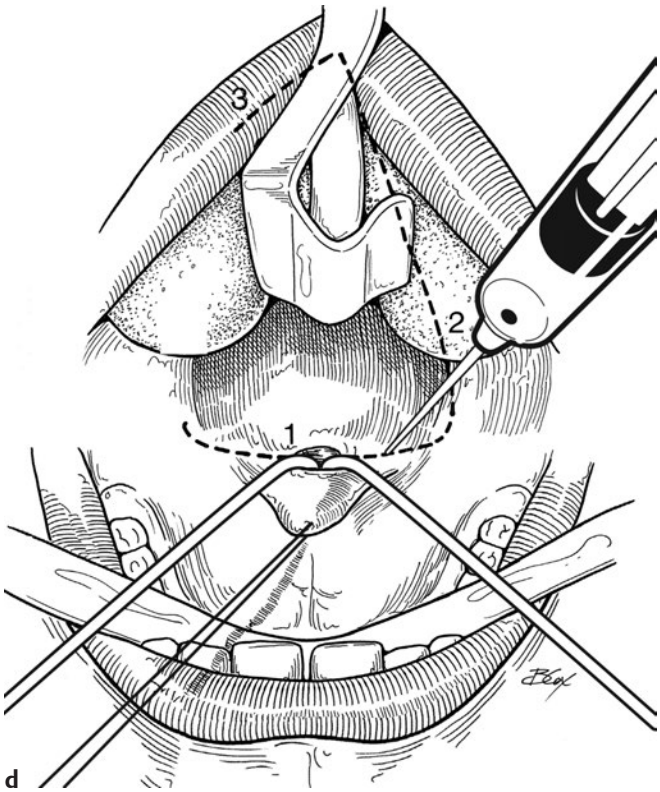


b

Fig. 16.1a,b



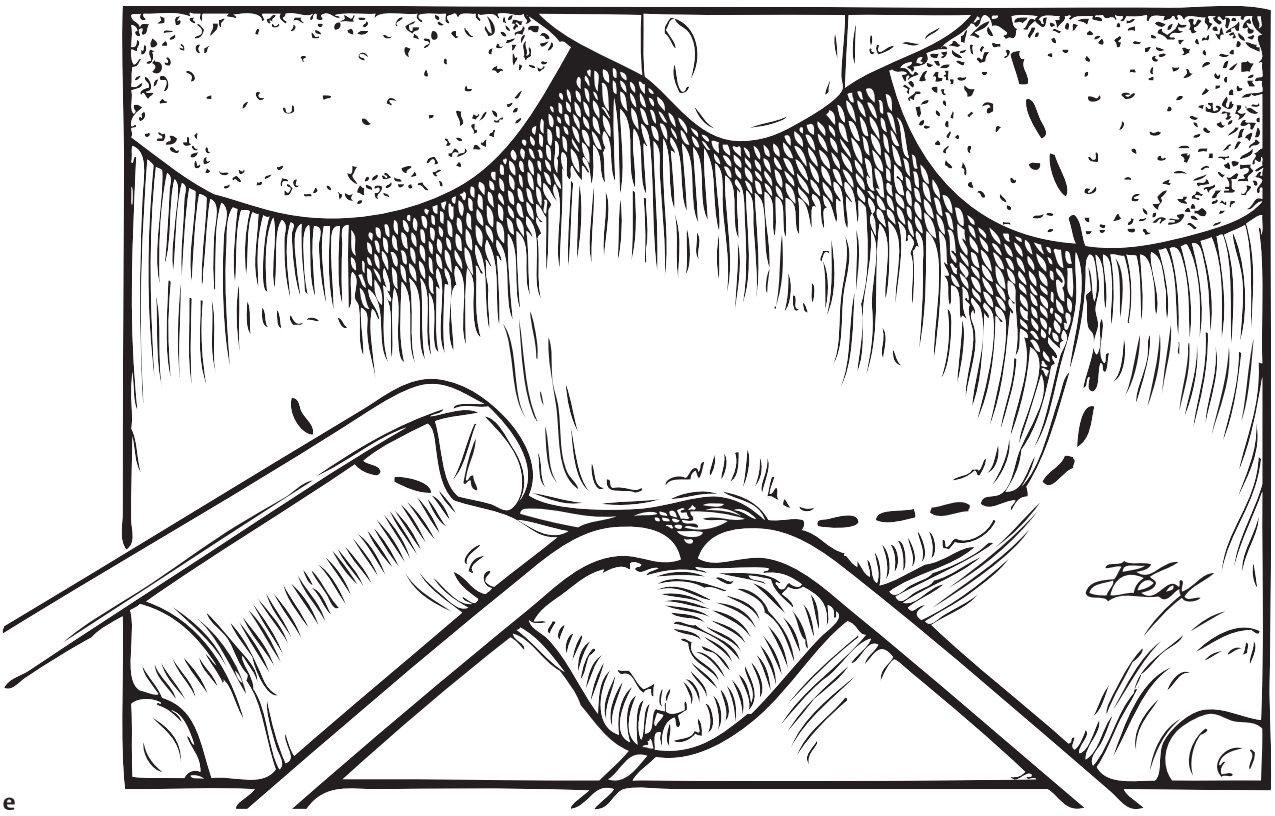
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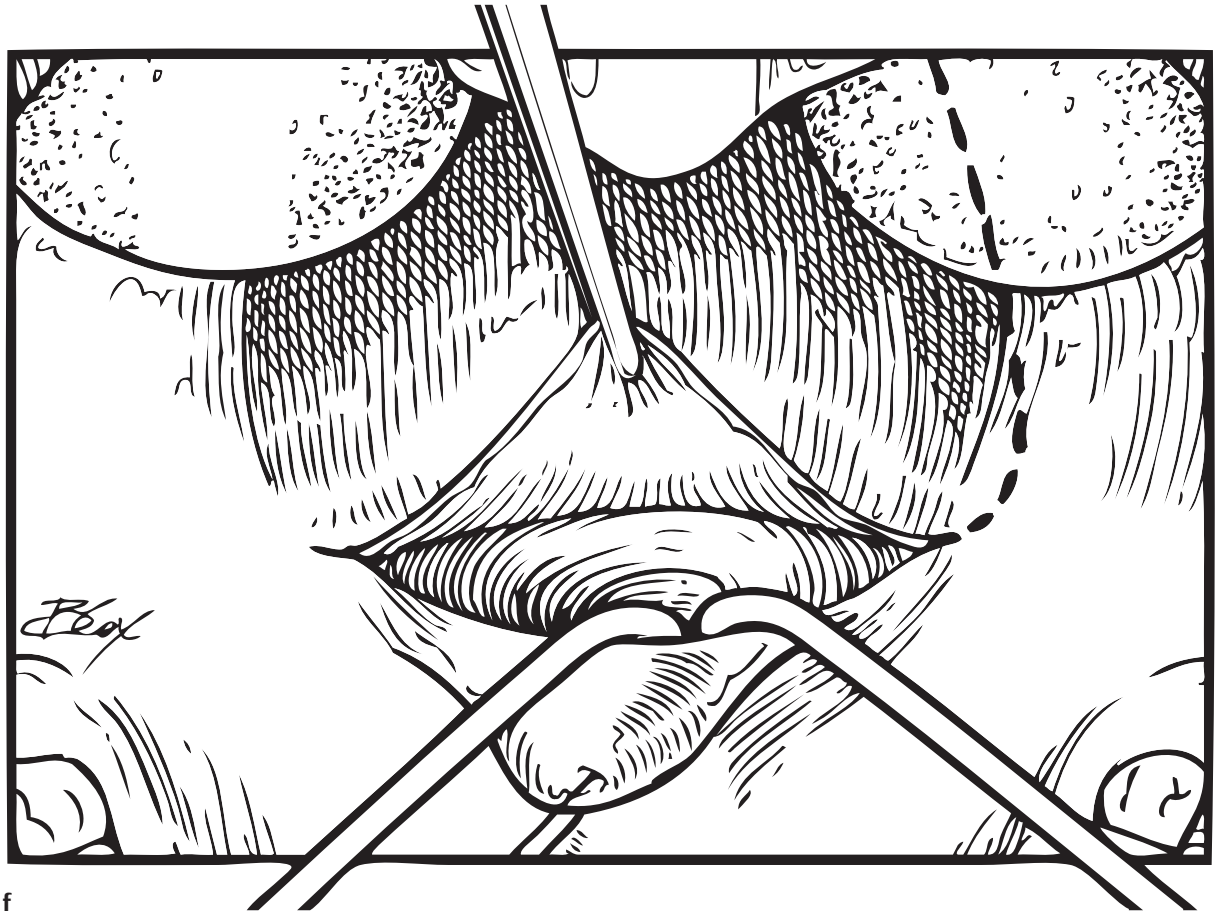
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Fig. 16.1c,d

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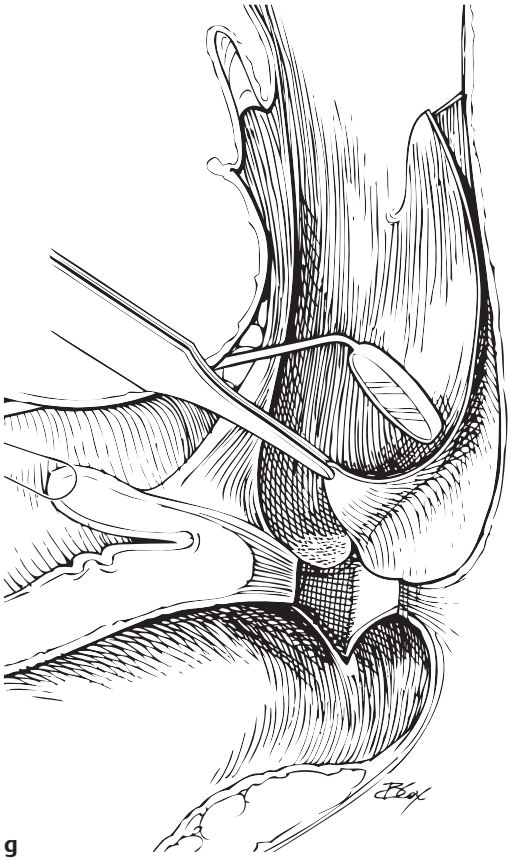
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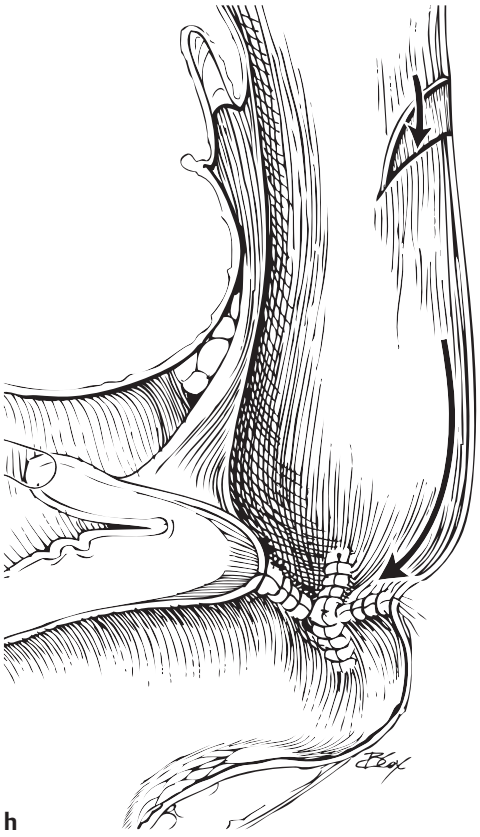
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Fig. 16.1e,f

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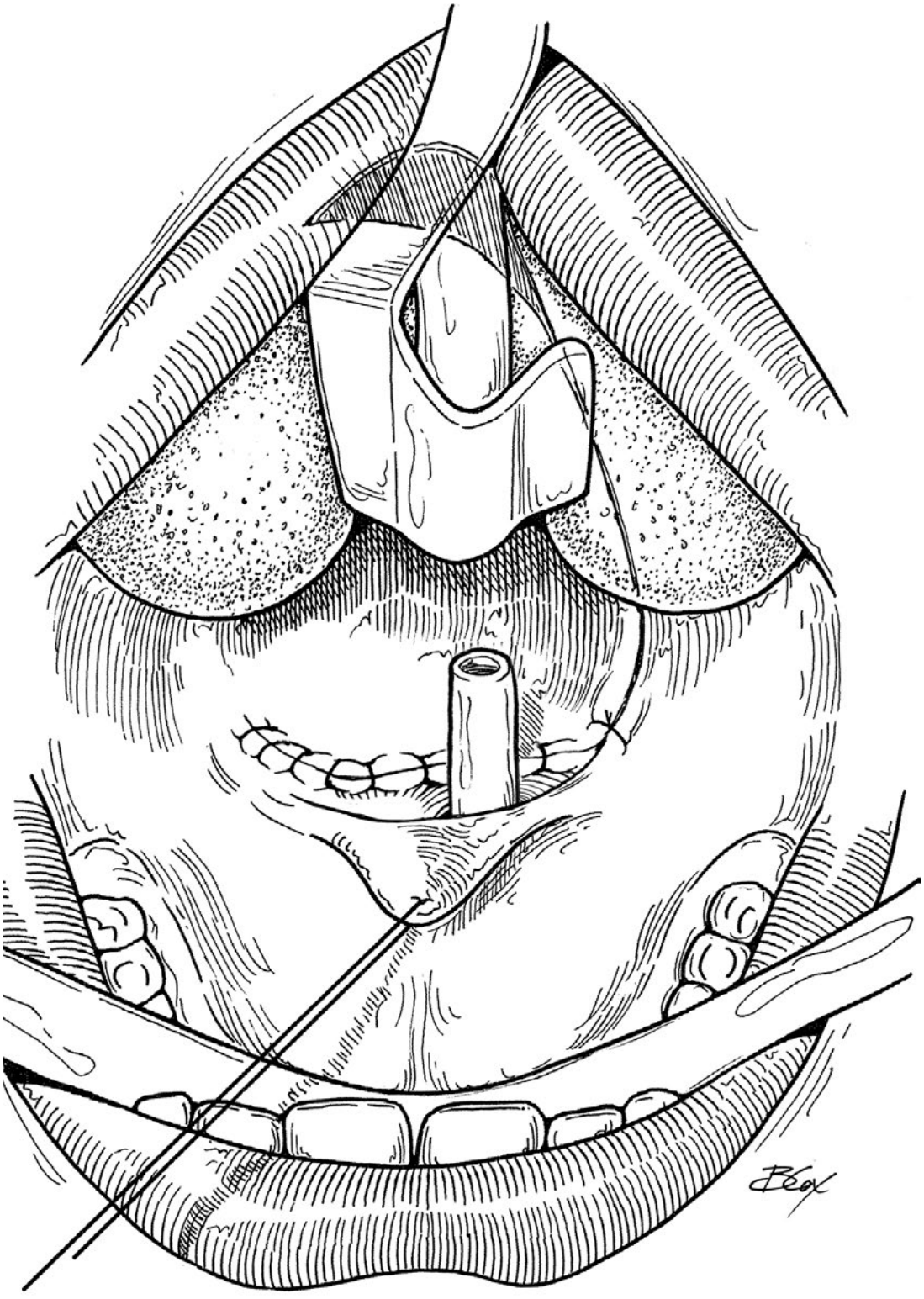


g



h

Fig. 16.1g,h



i

Fig. 16.1i

17 Velopharyngeal Insufficiency

J. Paul Willging

Velopharyngeal insufficiency (VPI) refers to the abnormal sound resulting from the inability to separate the nasopharynx from the oropharynx during speech. It may be caused by a structural abnormality or neuromuscular condition. Both structural and neuromuscular causes may be congenital or acquired.

17-1 Pharyngeal Flap (Palatopharyngoplasty)

Introduction

Pharyngeal flap is an operation designed to correct velopharyngeal insufficiency (VPI) thereby creating a new structure that enables the patient to develop normal speech and resonance.

Indications

A pharyngeal flap is indicated when VPI significantly affects speech intelligibility and nasopharyngoscopy illustrates a consistent central defect in velopharyngeal sphincter closure.

Preoperative Evaluation

Optimally, a thorough assessment of a child with suspected VPI involves the collaborative efforts of a speech-language pathologist, an otolaryngologist, and a geneticist. Geneticists offer expertise in the identification of syndromes associated with VPI and frequently conduct DNA testing. They also screen for developmental delays, special educational needs, general pediatric problems, and problems with social development. The perceptual evaluation of speech remains the gold standard for determining the need for intervention. Nasopharyngoscopy is a minimally invasive endoscopic procedure that allows direct assessment of the velopharyngeal mechanism during speech; it is therefore performed with the patient awake and not sedated. Because the pharyngeal flap creates a partial obstruction of the upper airway, care must be taken to identify patients with other sources of airway obstruction so as not to cause postoperative obstructive sleep apnea (OSA).

Operative Technique

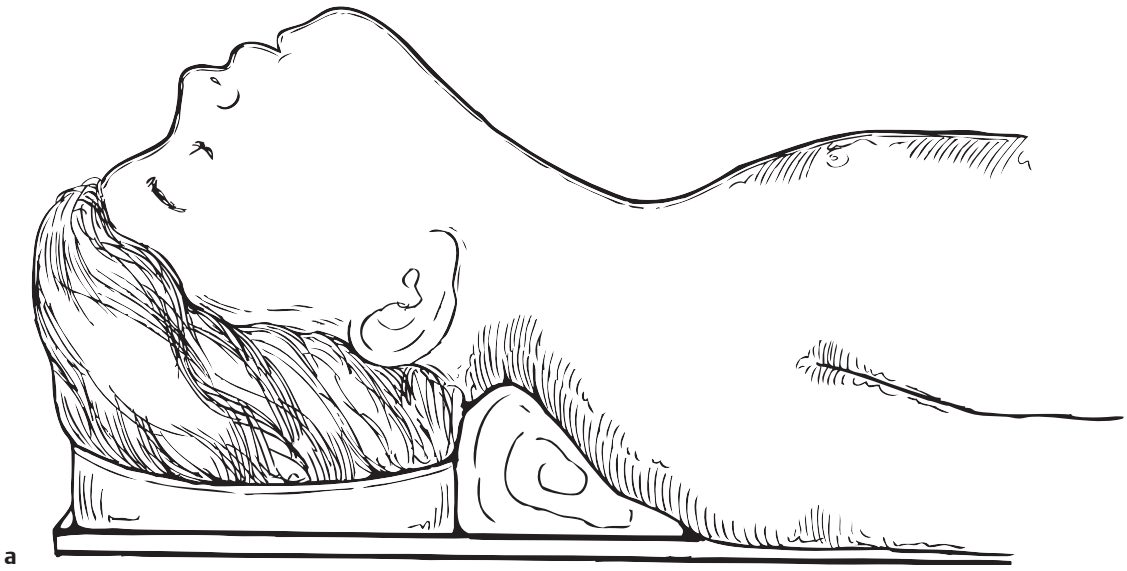
1. The pharyngeal flap is performed under general endotracheal anesthesia, utilizing an oral RAE tube. The patient is placed in the Rose position (**Fig. 17.1a**).
2. Palpation and visual inspection of the posterior pharyngeal wall are undertaken, looking for medialized carotid arteries.
3. The incisions are planned on the posterior pharyngeal wall. The lateral limbs of the incision are at the level of the posterior tonsillar pillars. If a wide flap is needed, the tonsillar pillars can be reflected laterally and the incisions can be placed in a more lateral position. The inferior aspect of the flap is generally at the level of the mid-tonsil (**Fig. 17.1b**).
4. The soft palate incision is made on the nasopharyngeal surface of the soft palate, ideally at the level of the velopharyngeal closure, which is generally 3 to 5 mm cephalad from the soft palate margin (**Fig. 17.1c**).
5. Proposed pharyngeal incision lines and the posterior aspect of the soft palate are infiltrated with 1% lidocaine with 1:100,000 units of epinephrine. Distortion of the tissue should be avoided.
6. The lateral incisions are carried down to the prevertebral fascia bilaterally. The inferior transverse incision is then made. The flap is elevated in this relatively avascular plane. The superior limit of elevation of the flap is high in the nasopharynx, at the level of velopharyngeal closure. This level is generally at the inferior edge of the adenoid remnant (**Fig. 17.1d,e**).
7. Closure of the donor site is undertaken. The inferior two-thirds of the donor site is closed with 3.0 Vicryl sutures (Ethicon). Extending the closure too far superiorly creates a stenosis of the nasal/oropharyngeal inlet. To minimize dead space beneath the repair, the superior suture should incorporate the prevertebral fascia when closing the mucosa (**Fig. 17.1f**).
8. A pocket is created on the posterior aspect of the soft palate (**Fig. 17.1g,h**). The incision must be at the level of velopharyngeal closure. The central aspect of the incision is made

with a right angle Beaver blade. The palate is everted anteriorly with forceps. The incision is made into the substance of the palate. Care must be taken not to extend the incision inferiorly along the tonsillar pillars. The lateral aspect of the incision is made with palate scissors, again everting the palate for adequate visualization. One tine of the scissors is placed within the previously created pocket in the midline, and the tine is slid laterally along the plane of velopharyngeal closure. The scissors is turned such that the blades are perpendicular to the plane of the soft palate.

9. Endotracheal tube stents are placed transnasally into the hypopharynx; 3.5 endotracheal tubes are used for children age 6 years and younger and 4.0 tubes are used for those 8 years and older. For children from 6 to 8 years of age, endotracheal tube size is determined by the size and weight of the child. The stents define the size of the lateral ports (**Fig. 17.1h,i,j**).
10. Starting with the lateral sutures, the pharyngeal flap is positioned into the soft palate. A 3.0 Vicryl suture is placed laterally, going through the oral surface of the soft palate and exiting the previously created fishmouth incision in the soft palate (**Fig. 17.1j**).
11. The suture is placed in the pharyngeal flap at the junction of the proximal and middle thirds of the flap. The suture is placed in the muscle and submucosa only; the squamous mucosa is not included in this suture.
12. The suture then passes through the fishmouth incision of the soft palate and exits into the oral cavity within 2 mm of its initial pass, completing the horizontal mattress suture (**Fig. 17.1k**).
13. The suture is pulled (not tied) to position the flap into the palate. A mirror is used to check the size of the lateral port created when the flap is inset into the soft palate. The flap should touch the endotracheal tube, leaving space anterior and posterior to the endotracheal tube stent. The flap should not wrap tightly around the stent, as nasopharyngeal obstruction will likely develop. The suture is then loosened, and the opposite lateral suture is placed in similar fashion and checked (**Fig. 17.1l**).
14. Two paramedian sutures are similarly placed to finish the insetting of the flap.
15. The sutures are tied, starting with the lateral sutures. Care must be taken to approximate the flap into the pocket without strangulating the tissue. Care also must be taken to ensure that the free end of the flap is positioned such that the muscle of the flap is in contact with the raw surface of the soft palate. The squamous mucosa of the flap cannot reside within the soft palate pocket.
16. A final check of the position of the flap and size of the ports is undertaken. The flap should not be visible from the oral cavity, as it needs to be high in the nasopharynx.
17. The endotracheal tube stents are positioned in the oropharynx, with the tips at the level of the mid-tonsil (**Fig. 17.1l**).
18. The endotracheal tubes are secured to the upper lip with tape and then trimmed.
19. A number 6-8 Fr suction catheter is measured to direct the suctioning of the stents postoperatively. The catheter should extend 5 mm beyond the tip of the stent to ensure continued patency of the tube.
20. Elbow cuffs are used to protect the nasal stents.
21. Stents are removed the following morning. The child is discharged after demonstrating an adequate airway and adequate oral intake; this usually occurs 48 hours postoperatively.
22. Steroids should be avoided, as they may increase the risk of dehiscence of the flap from the soft palate pocket.
23. Speech therapy should begin 3 weeks postoperatively to obtain maximal functional use of the pharyngeal flap.

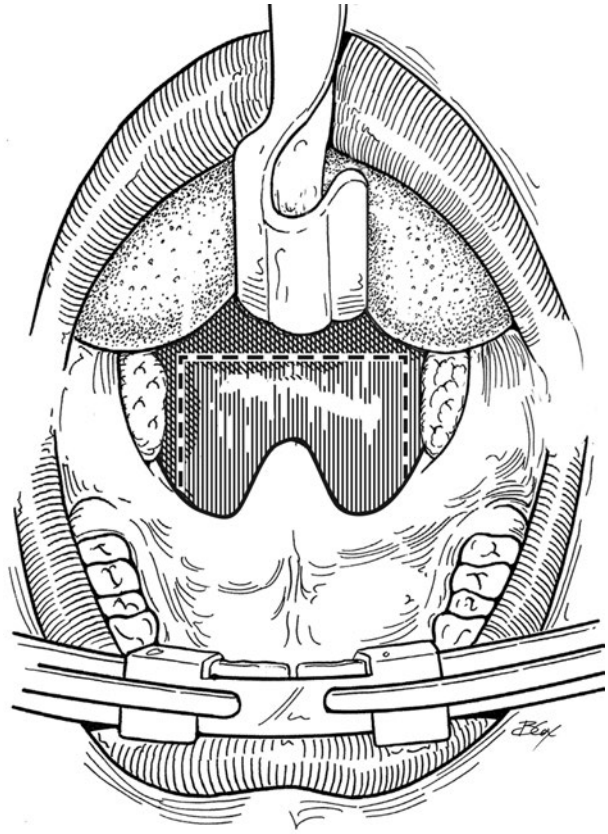
Complications

1. Flap breakdown
2. Persistent VPI
3. Inadequate nasal airway

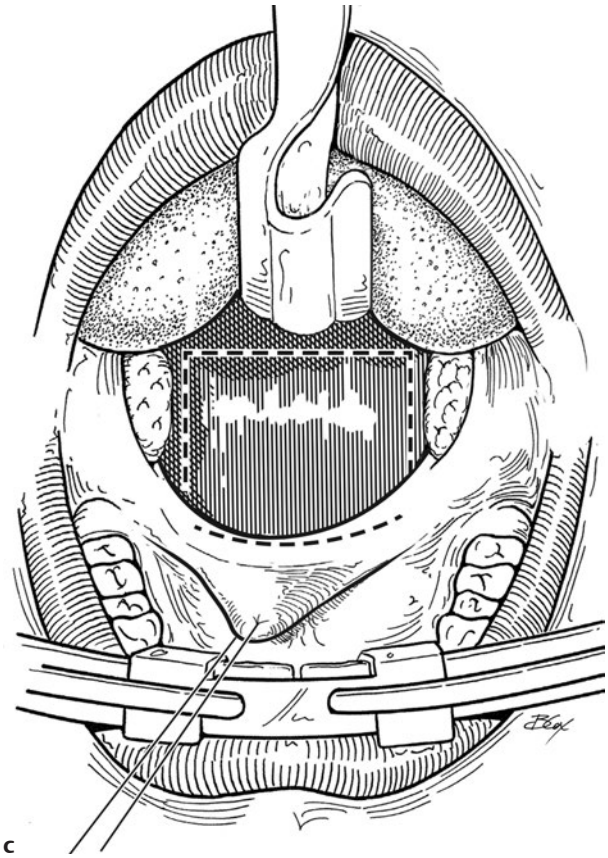


a

Fig. 17.1a

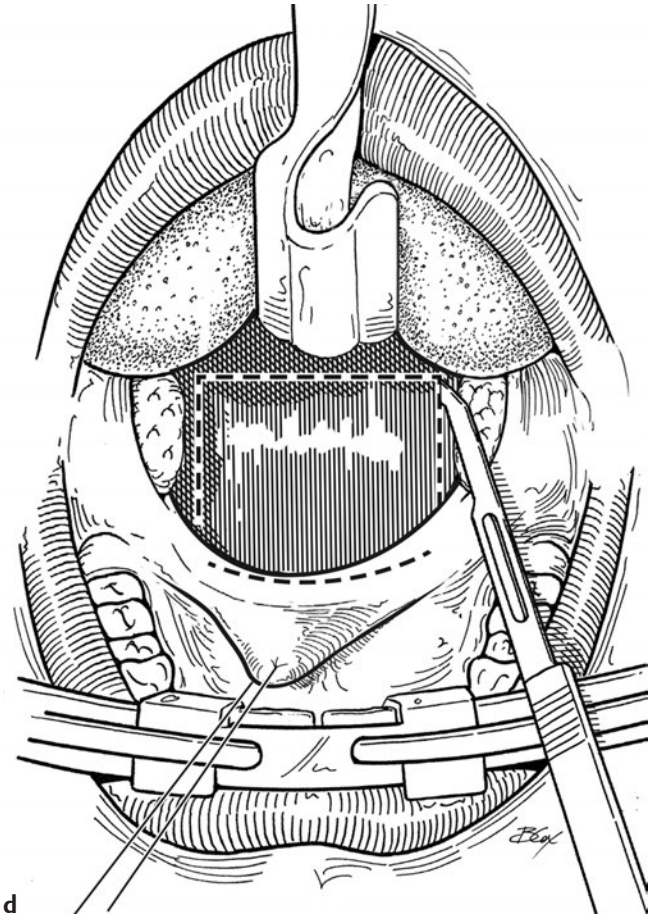


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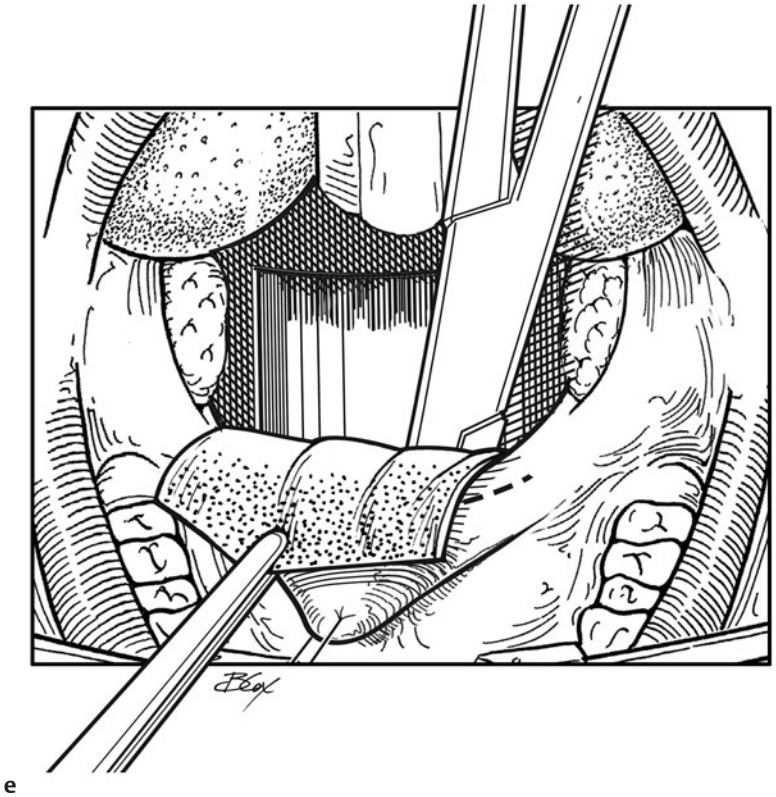


c

Fig. 17.1b,c

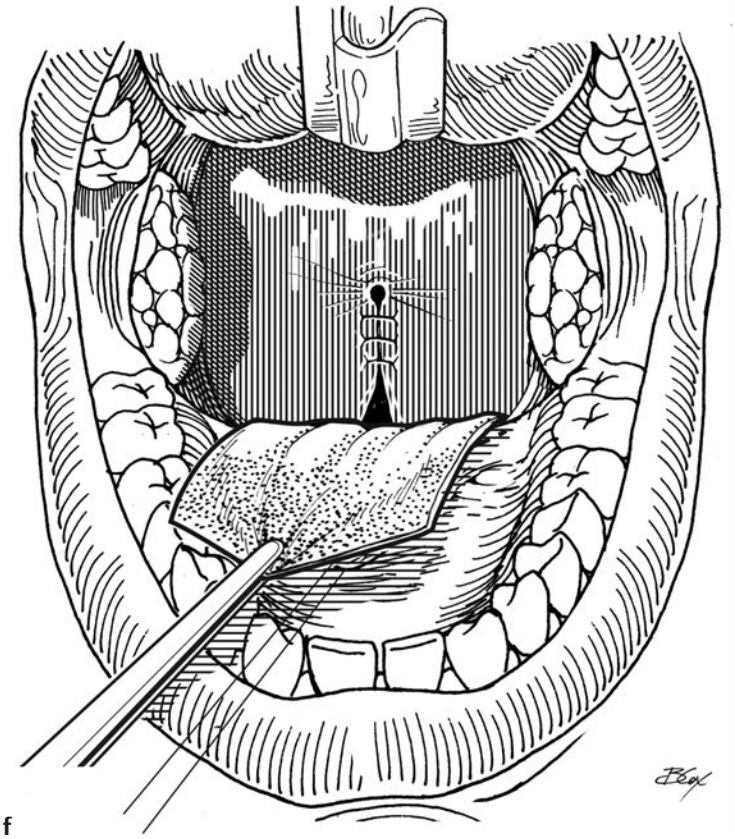


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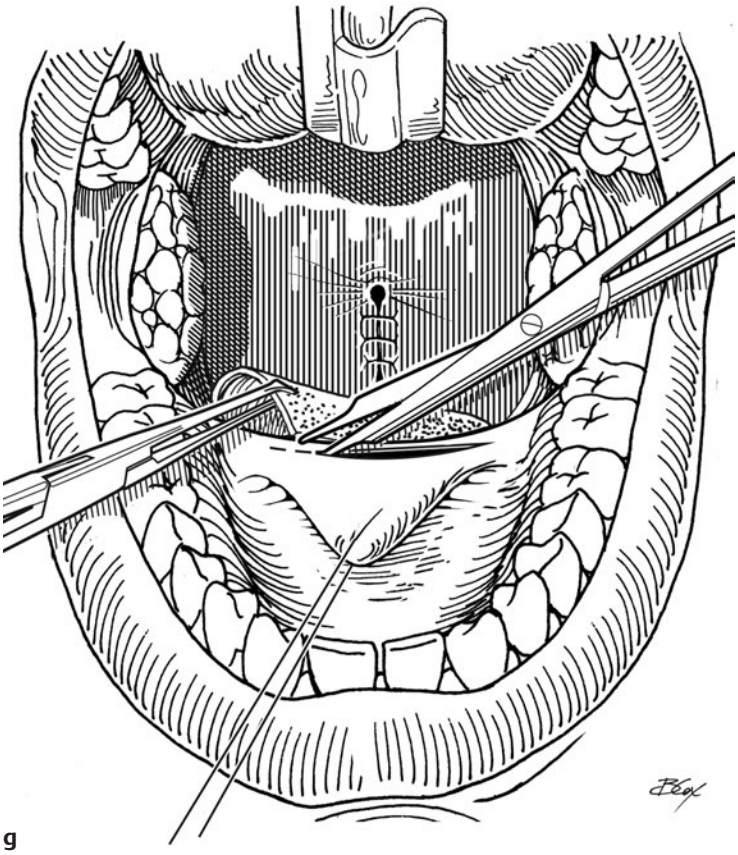


e

Fig. 17.1d,e

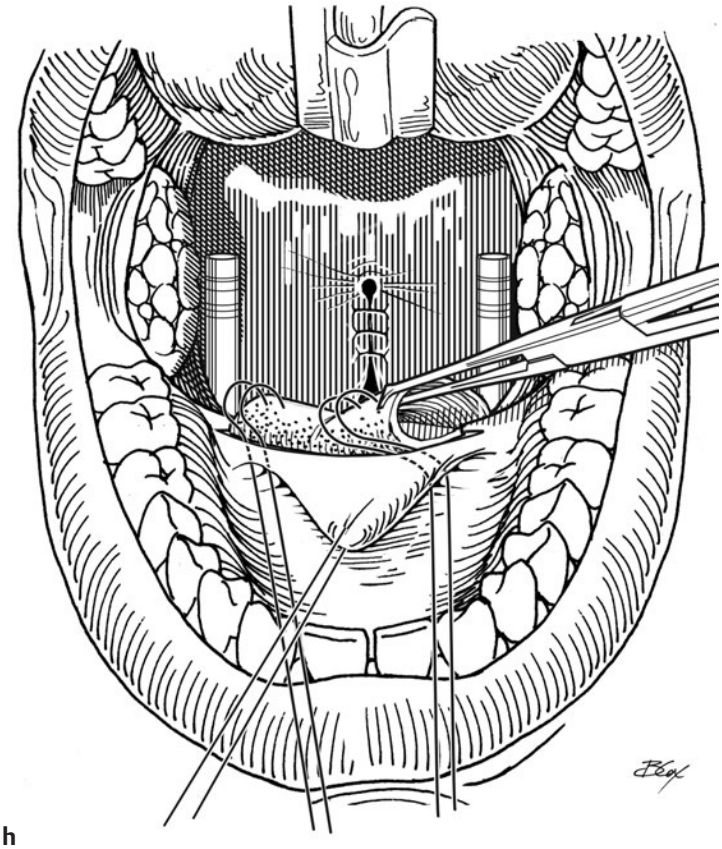


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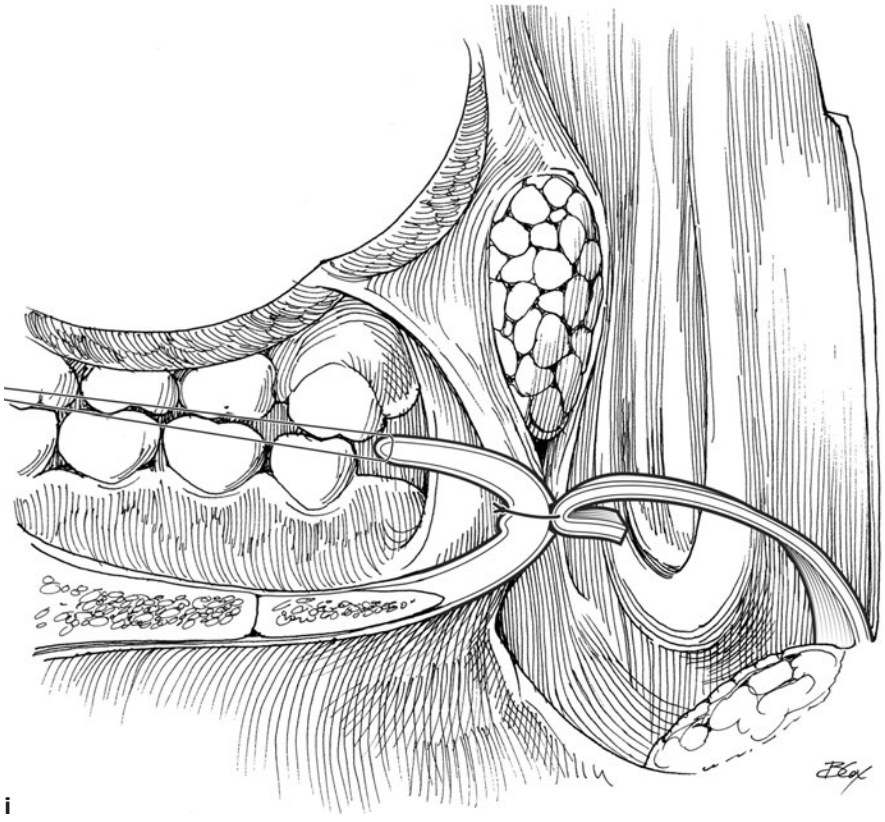


g

Fig. 17.1f,g

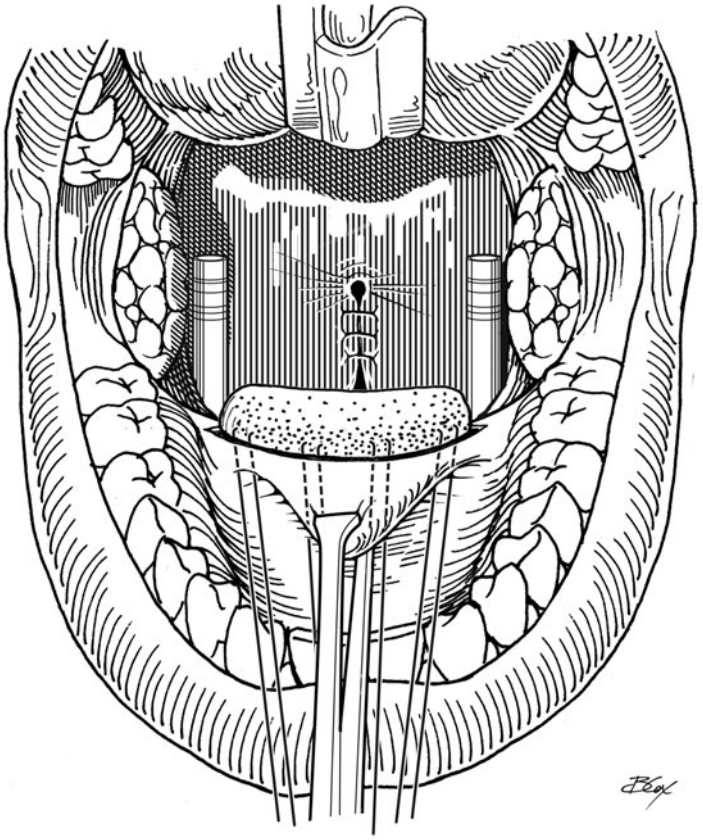


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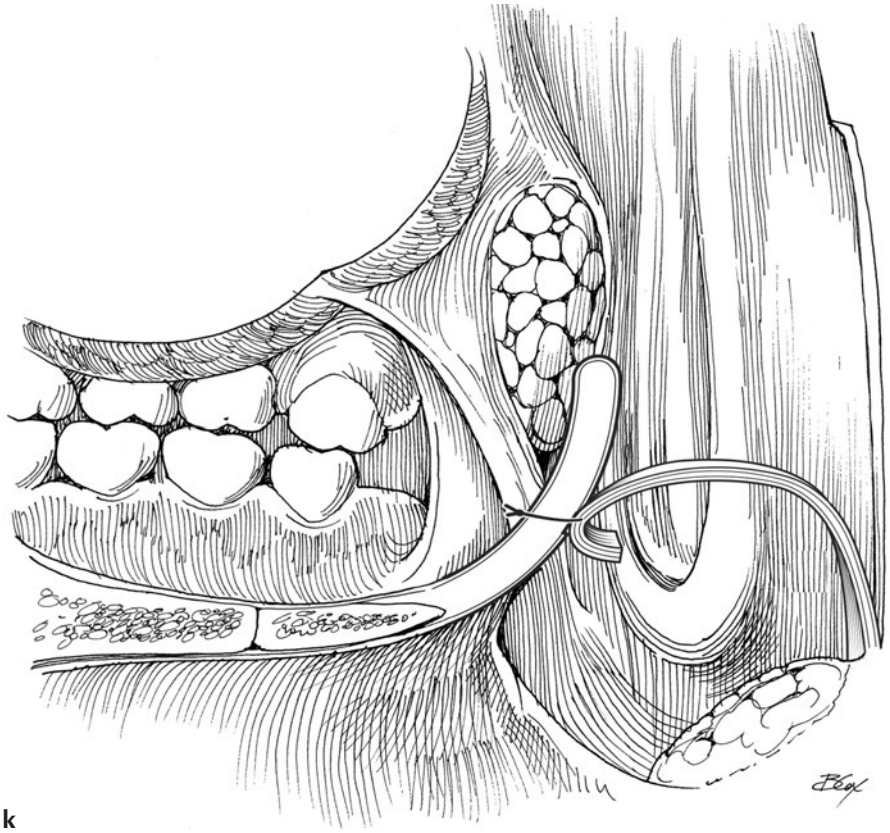


i

Fig. 17.1h,i



j



k

Fig. 17.1j,k

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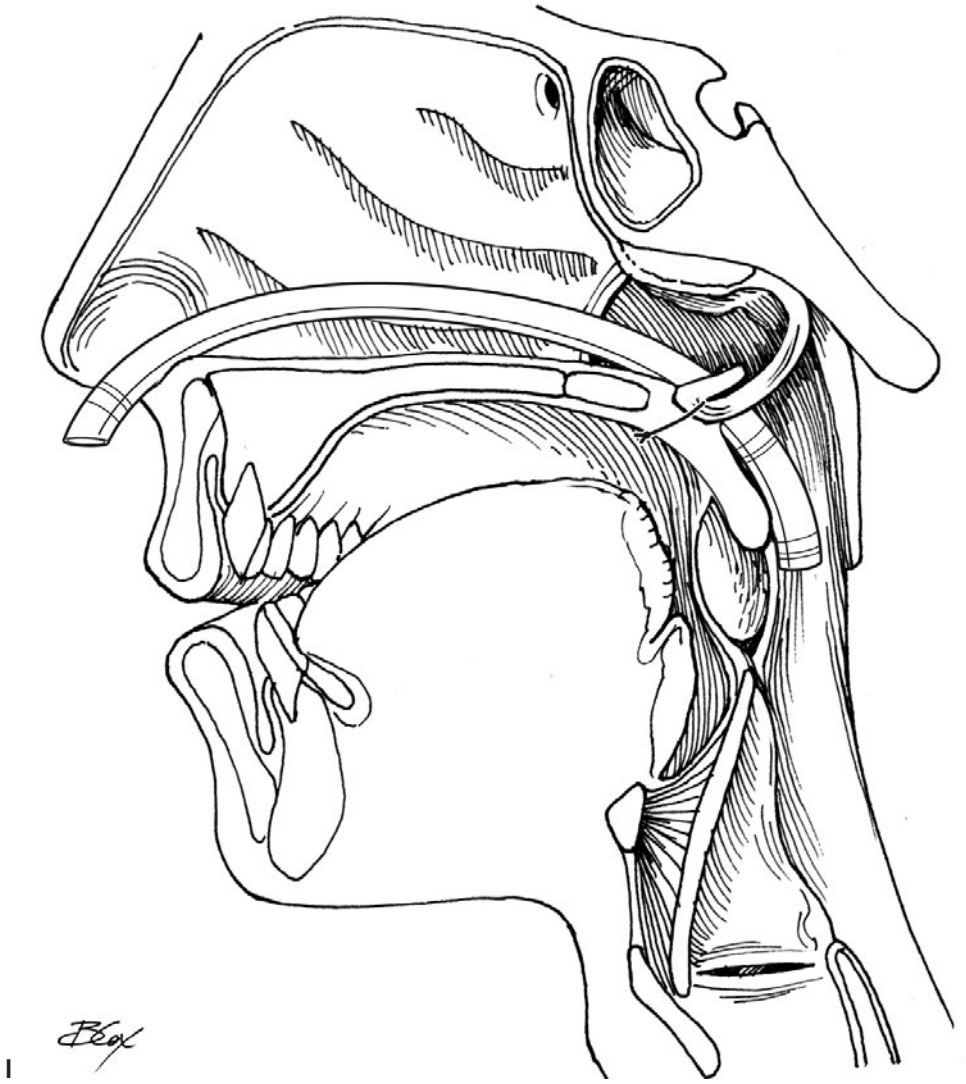


Fig. 17.1l

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17-2 Palatoplasty (Push-Back)

Indications

Palatoplasty is indicated in a patient with a submucous cleft palate and persistent velopharyngeal insufficiency (VPI).

Preoperative Evaluation

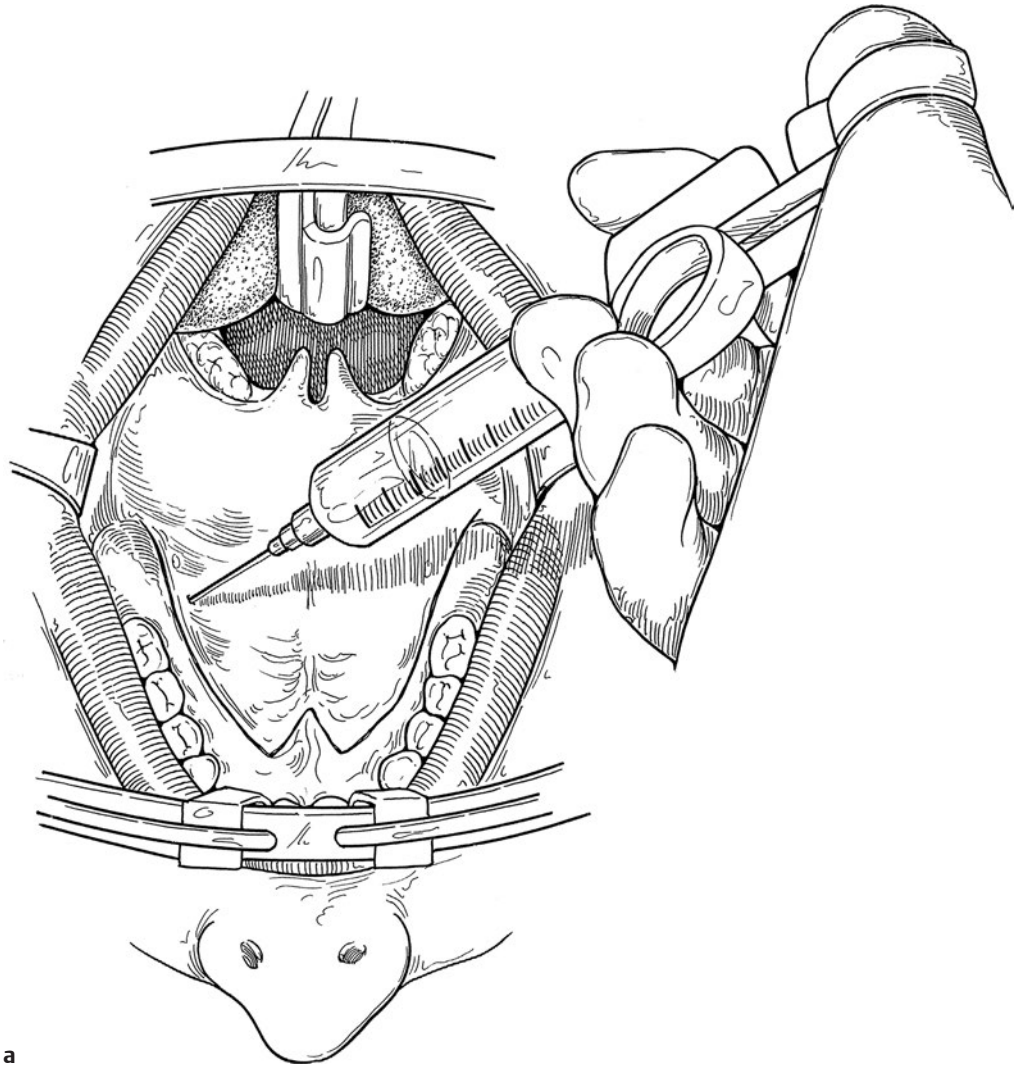
See the preoperative evaluation described in Section 17-1.

Operative Technique

1. With the patient under orotracheal anesthesia administered through an oral RAE tube, a Dingman mouth gag is placed, and 1% lidocaine with 1:100,000 epinephrine is injected into the palate around the greater palatine artery, taking care not to inject directly into the artery (**Fig. 17.2a**).
2. A W incision is made down to the bone of the hard palate (**Fig. 17.2b**). A strip of gingival mucosa adjacent to the teeth should be preserved to facilitate closure upon completion of the procedure.
3. The mucosa of the hard palate is elevated to the posterior edge of the hard palate. The greater palatine vessels are mobilized and isolated at the foramen (**Fig. 17.2c**).
4. The oral mucosa of the soft palate is separated from the underlying muscle (**Fig. 17.2d**).
5. The muscle is detached from the posterior border of the hard palate. Any soft tissue attachment limiting mobilization of the greater palatine vessels is divided (**Fig. 17.2e**).
6. The soft palate musculature is lifted and separated from the nasopharyngeal mucosa (**Fig. 17.2f**).
7. The levator muscles are displaced posteriorly to reconstruct the levator sling. These muscles are sutured together in the midline with 3-0 Vicryl sutures (**Fig. 17.2g**).
8. The tips of the hard palate flap are approximated with 4-0 Vicryl sutures. To accomplish the push-back maneuver, the hard palate flap is opposed to the mucosa covering the nasopalatine foramina with 4-0 Vicryl suture (**Fig. 17.2h**).
9. Two additional sutures are used to tack the hard palate mucosa into its new position. The resulting closure leaves two areas of exposed bone anteriorly that will granulate and heal by secondary intention (**Fig. 17.2i**).
10. If the uvula is bifid, the opposing surfaces of the two uvulae can be freshened and sewn together along both the anterior and posterior surfaces (**Fig. 17.2j**).

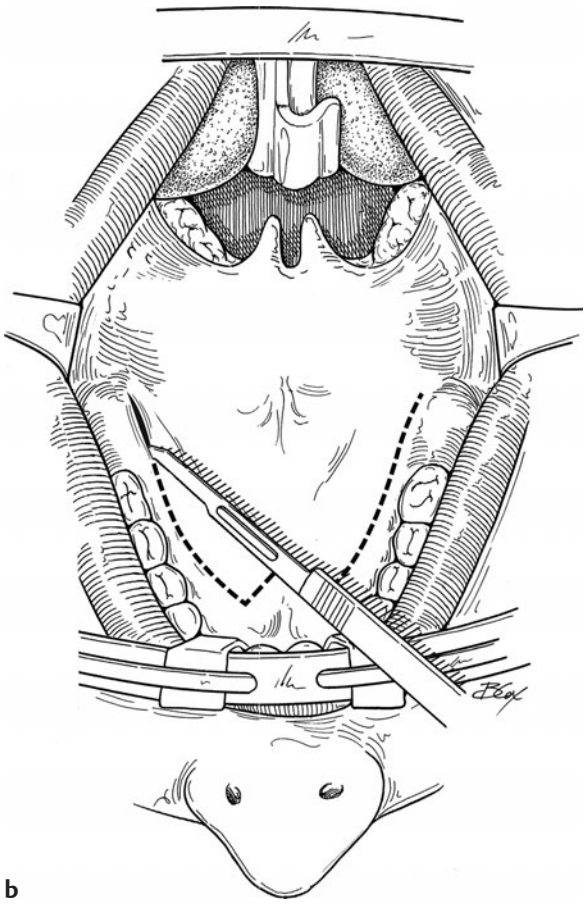
Complications

1. Persistent VPI
2. Palatal fistula

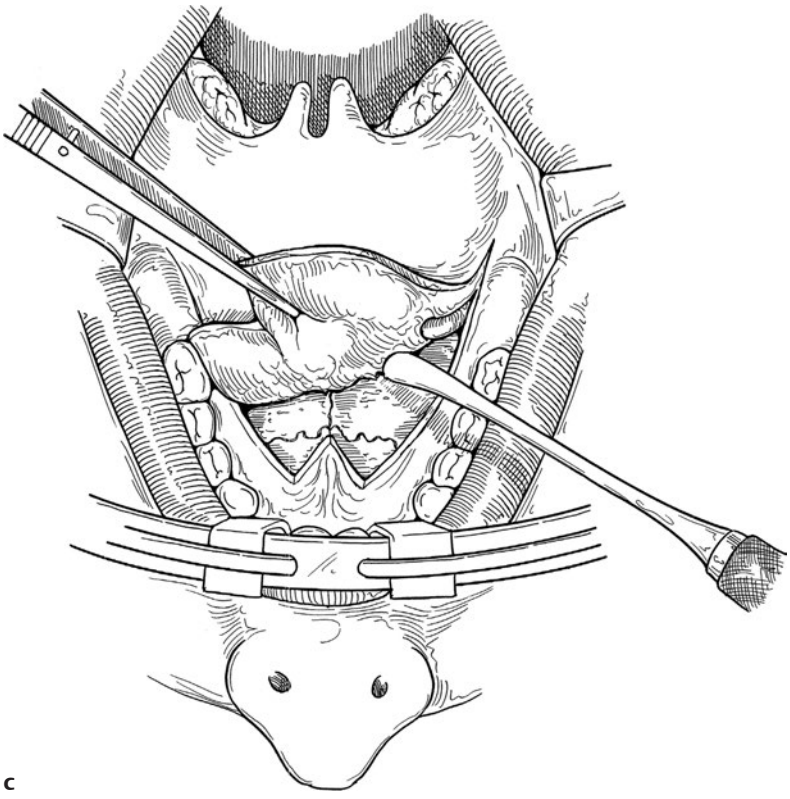


a

Fig. 17.2a

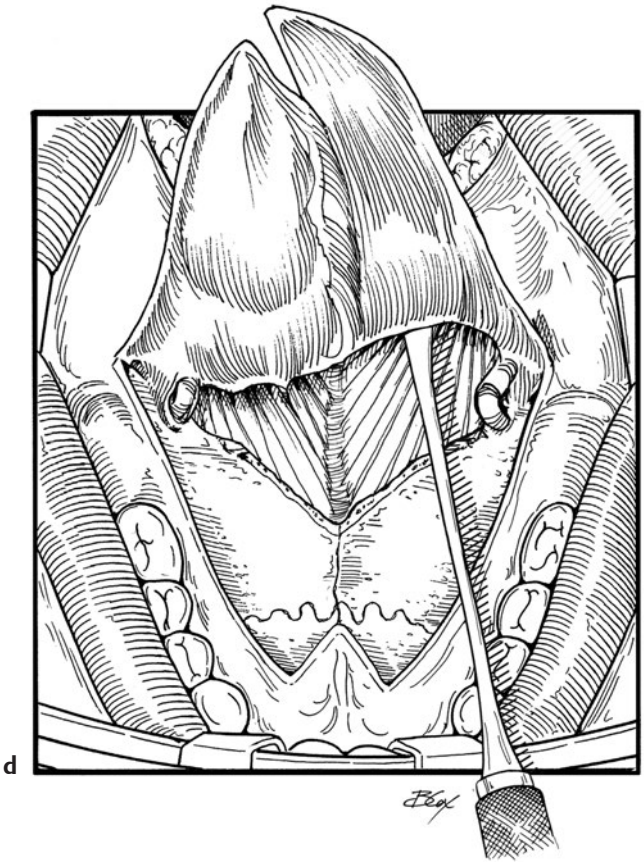


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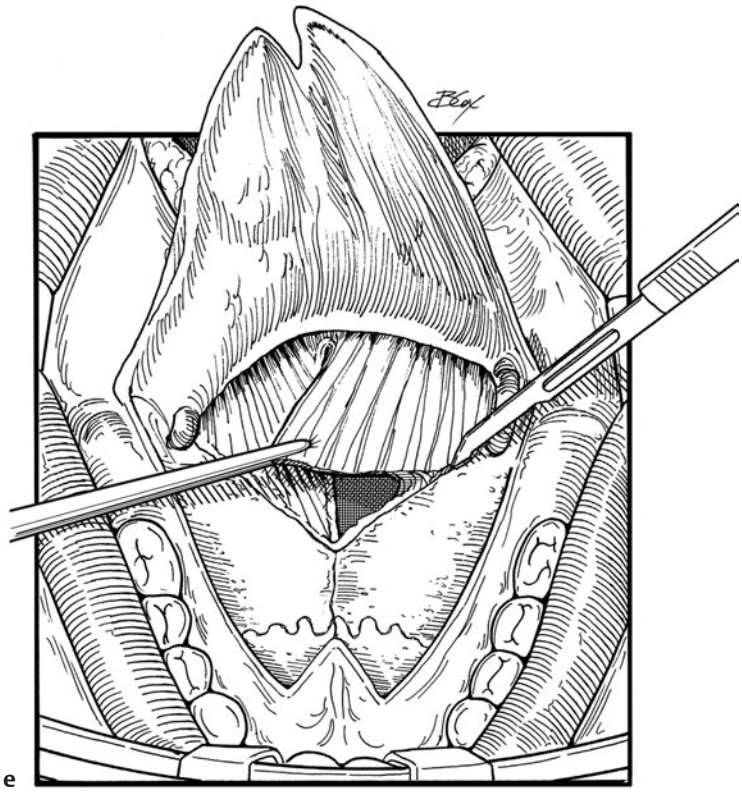


c

Fig. 17.2b,c

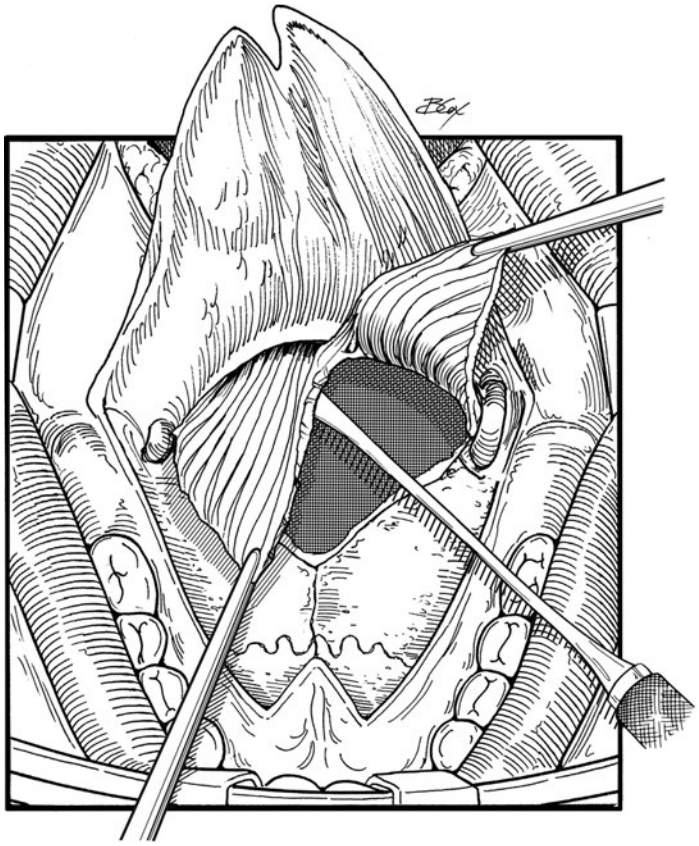


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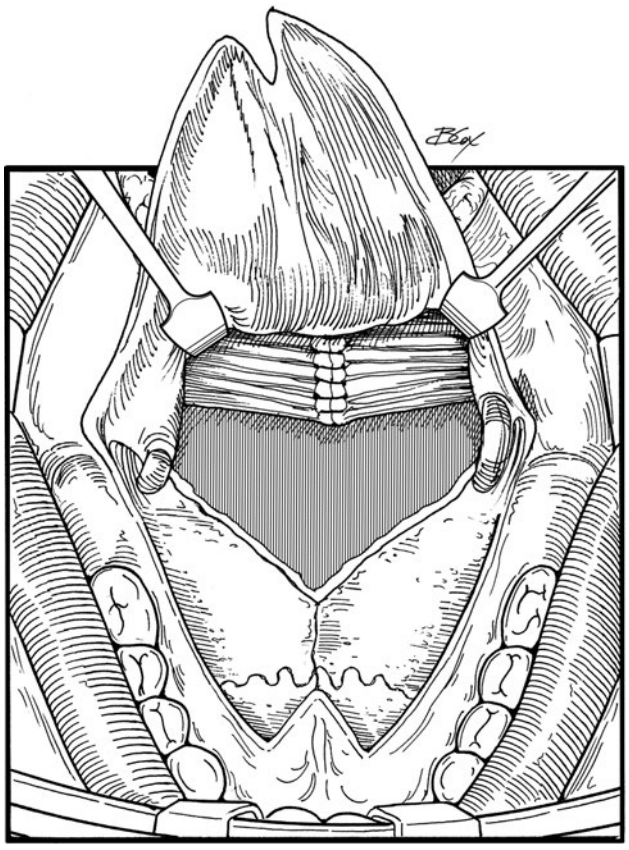


e

Fig. 17.2d,e

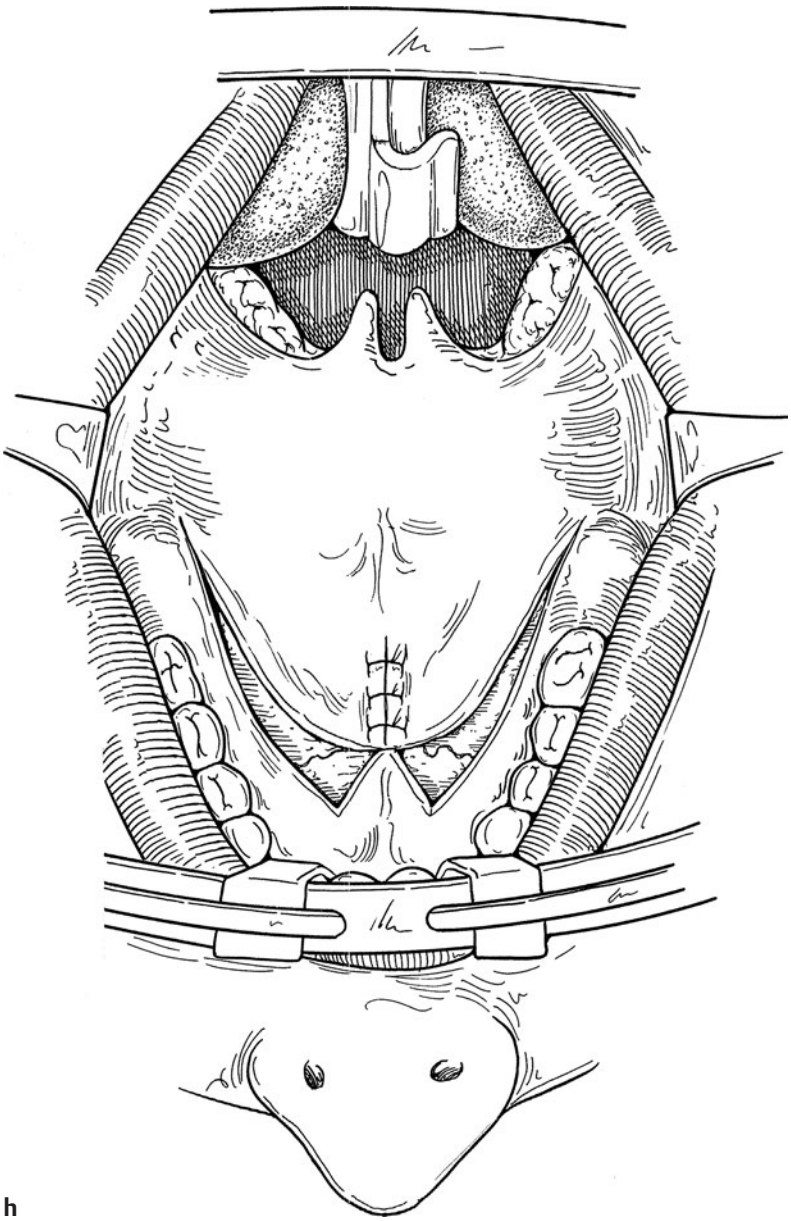


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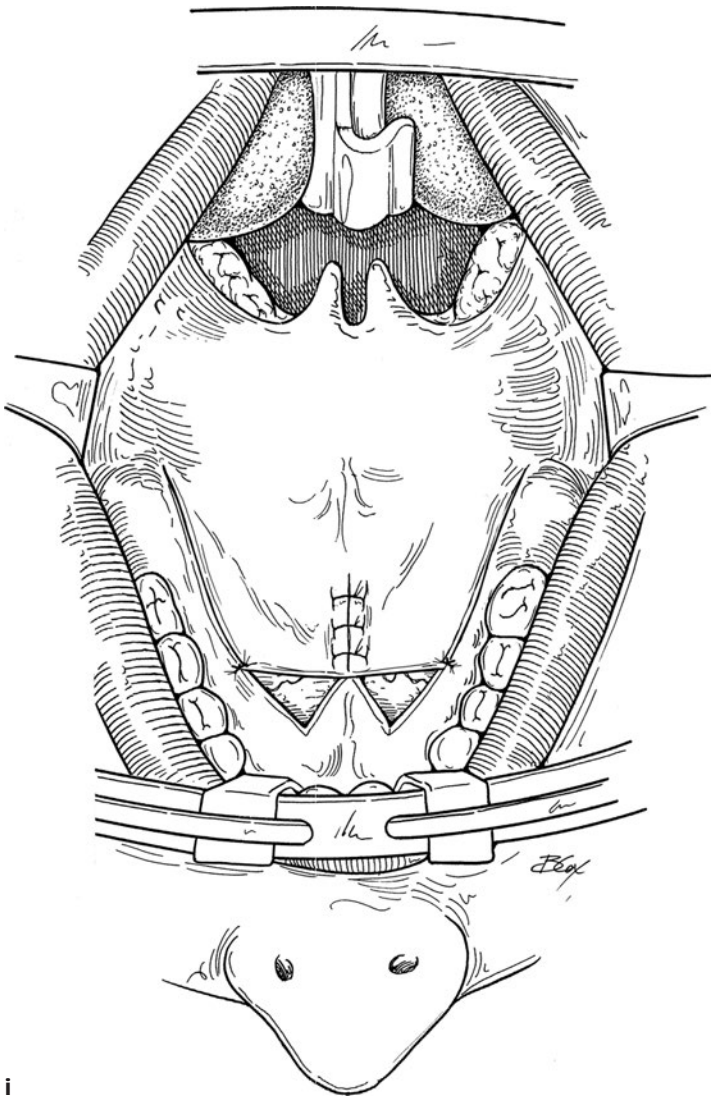
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Fig. 17.2f,g

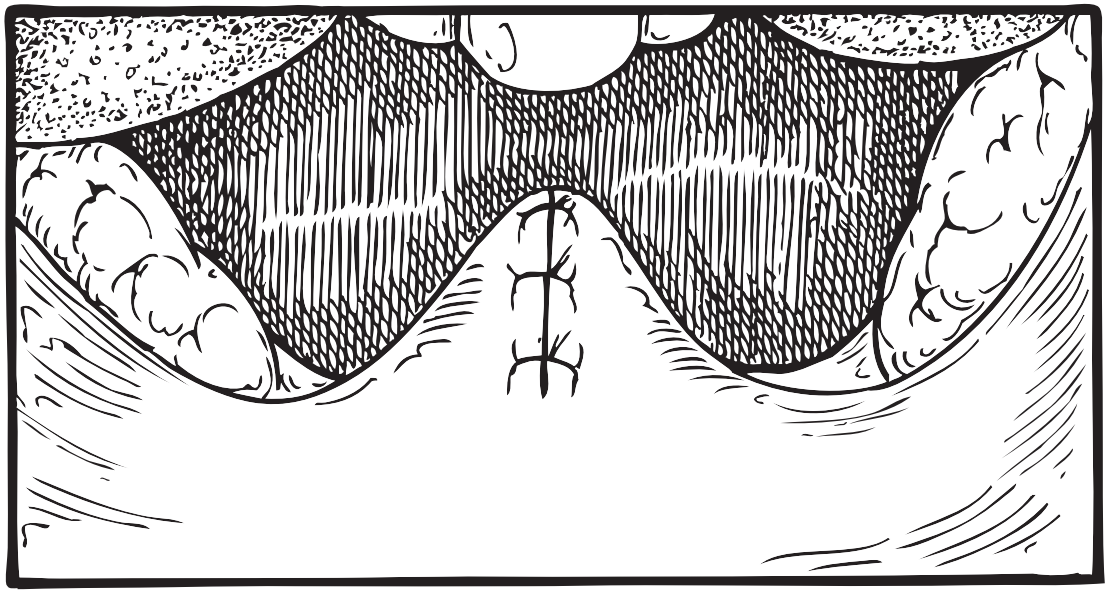


h

Fig. 17.2h



i



j

Fig. 17.2i,j

17-3 Closure of Palatal Fistula

Introduction

A palatal fistula may occur following transpalatal surgery (e.g., palatoplasty, transpalatal choanal atresia repair).

Indications

A palatal fistula requires closure if it is associated with a leak of fluid or food into the nasal cavity.

Preoperative Evaluation

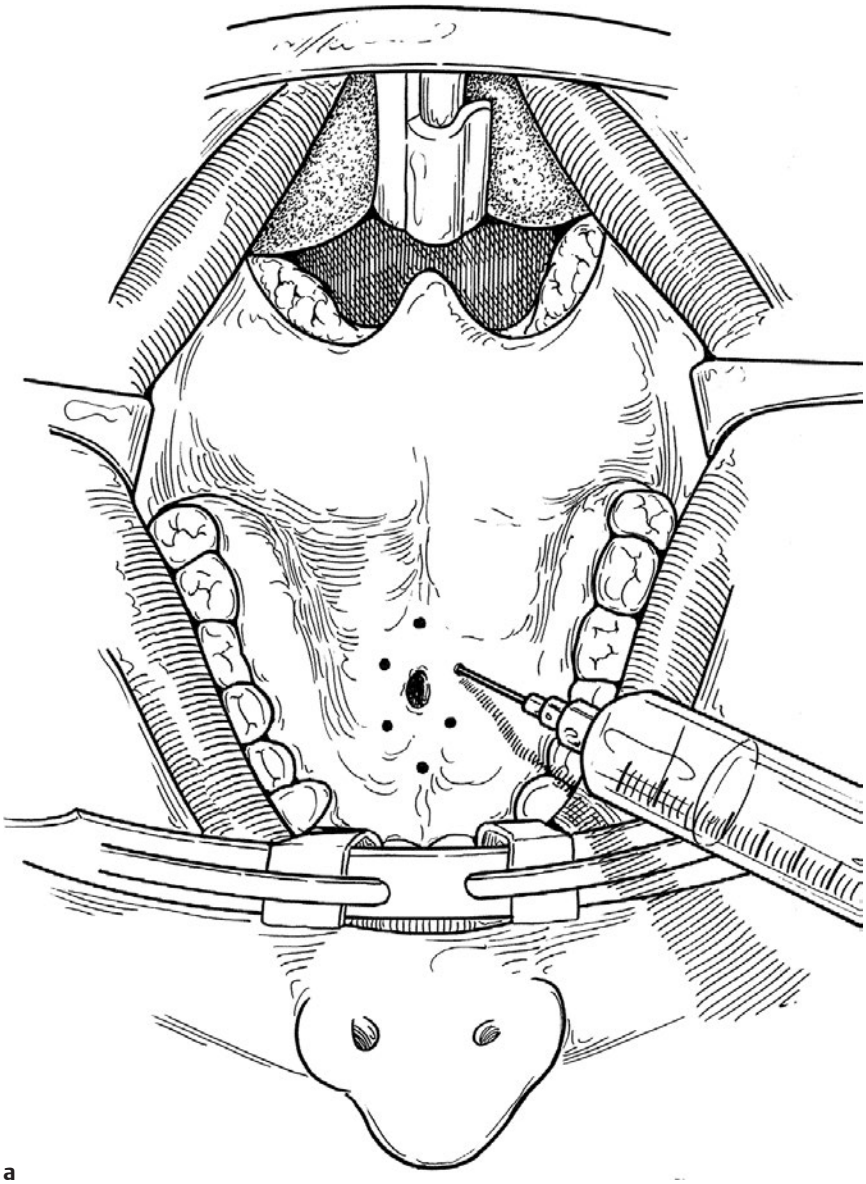
The preoperative evaluation involves inspection of the palate.

Operative Procedure

1. Closure of a palatal fistula is performed under general anesthesia administered through an oral RAE tube.
2. After a Dingman mouth gag is placed, the edges of the fistula are injected with 1% lidocaine and 1:100,000 epinephrine **(Fig. 17.3a)**.
3. Repair of the palatal fistula is accomplished by creating a two-layered closure. The oral mucosa surrounding the fistula is incised such that, when elevated, it can be reflected into the fistula site **(Fig. 17.3b,c,d)**.
4. An adjacent rotational flap is fashioned; it is elevated and rotated over the fistula site. To minimize the risk of breakdown, this rotated flap must be larger than the original fistula **(Fig. 17.3e)**.
5. The flaps are sewn with 4-0 Vicryl. The underlying bone of the donor site is left to granulate and close by secondary intention **(Fig. 17.3f)**.

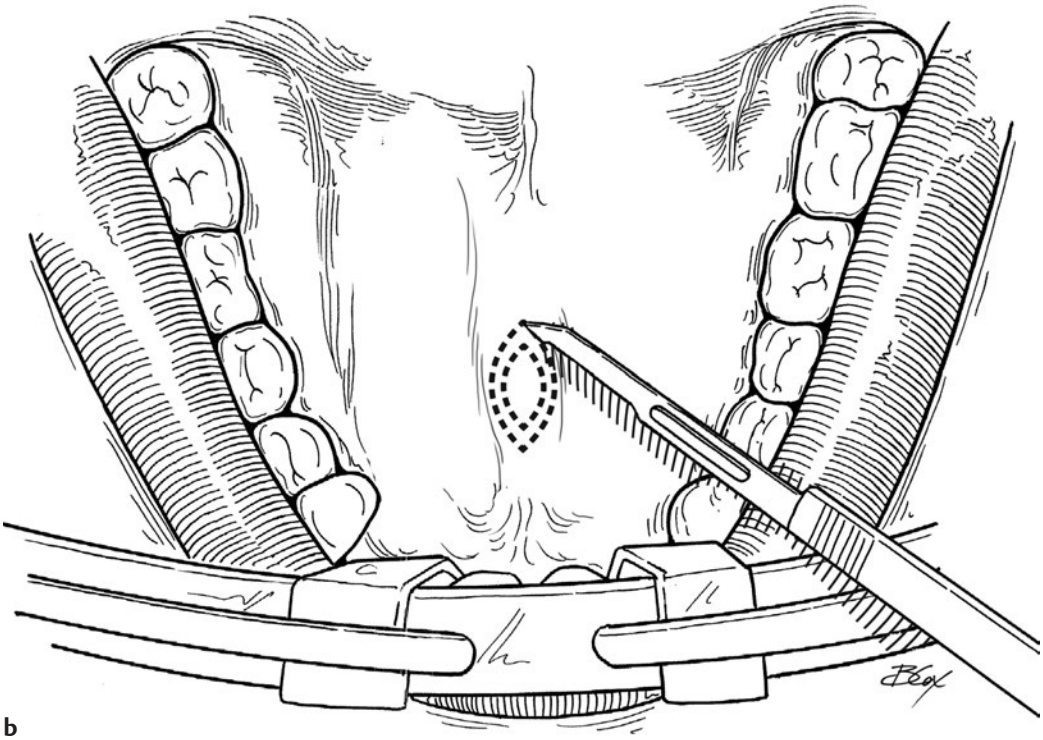
Complications

Recurrence of the palatal fistula

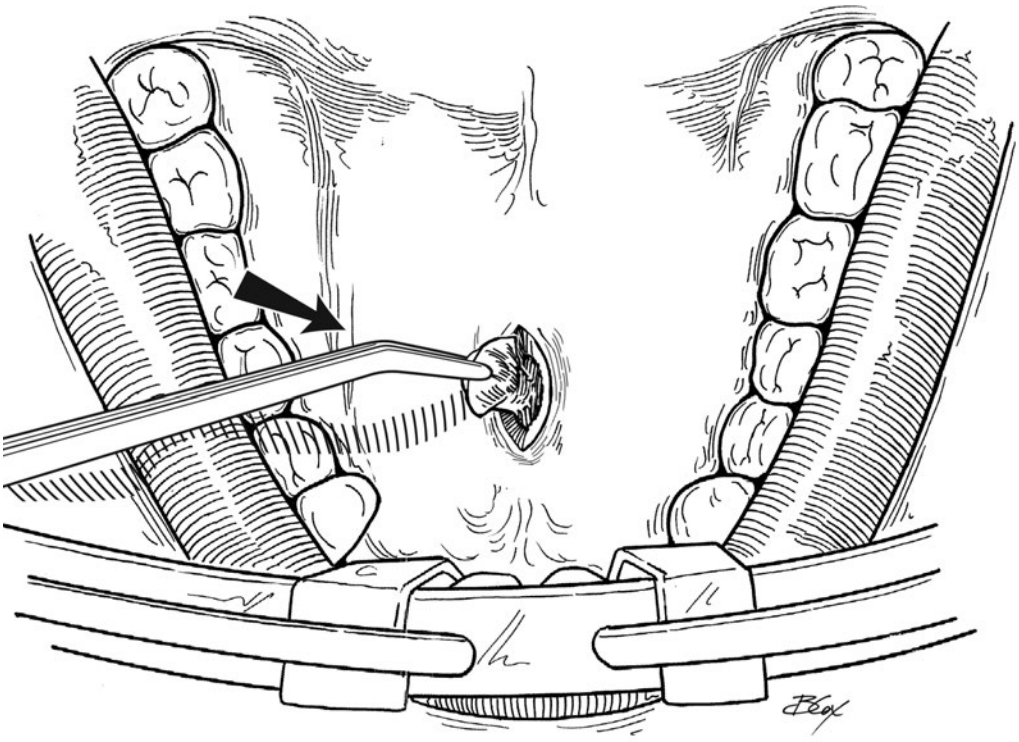


a

Fig. 17.3a

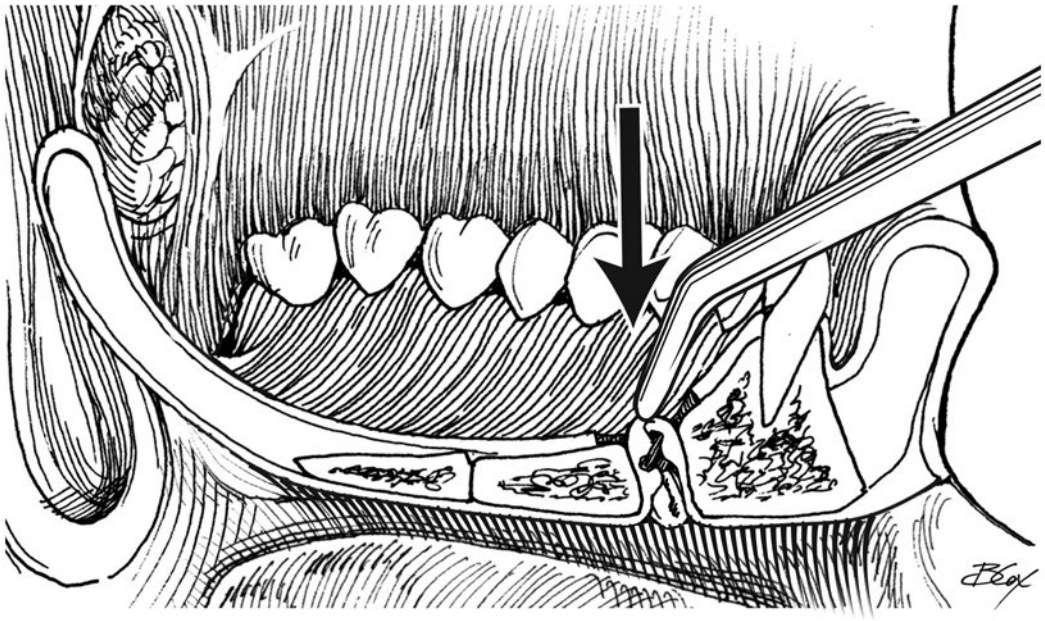


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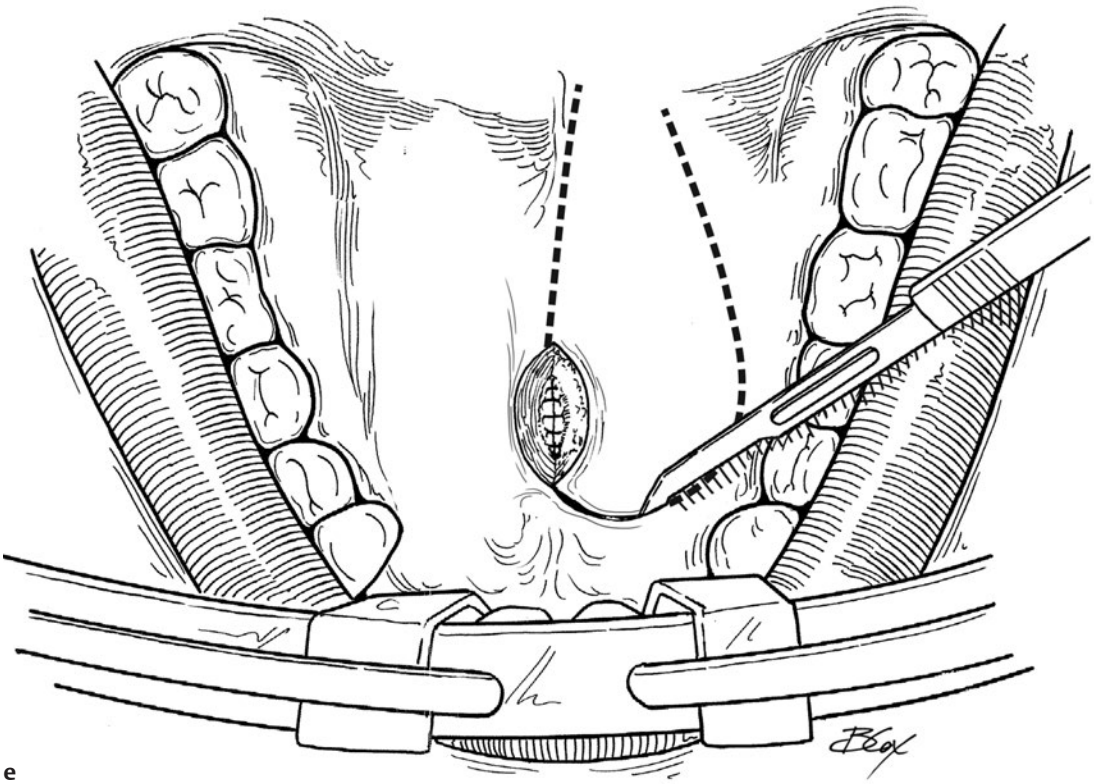


c

Fig. 17.3b,c

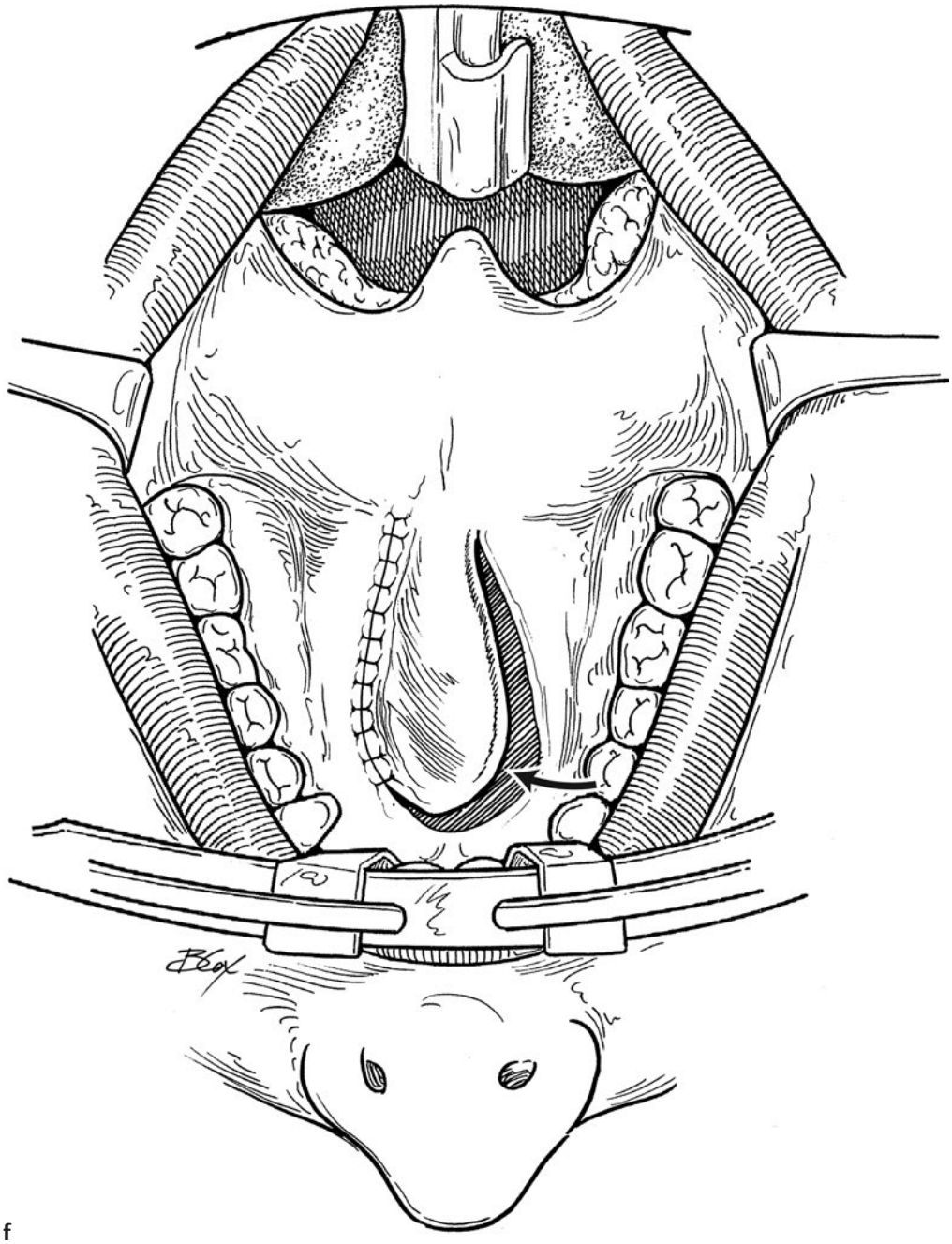


d



e

Fig. 17.3d,e



f

Fig. 17.3f

18 Adenoids

Sally R. Shott

Adenoid tissue may enlarge (hyperplasia) and/or become infected during bouts of pharyngitis. Adenoids can be removed with curettes, suction cautery, coblation, or a microdebrider.

18-1 Adenoidectomy with a Curette

Indications

Adenoidectomy is indicated for the relief of nasal obstruction, sleep apnea, recurrence of chronic infection, and as part of the surgical therapy of chronic ear disease.

Preoperative Evaluation

A lateral X-ray of the neck and nasoendoscopy are two reliable methods of assessing adenoid size. Careful evaluation of the palate to detect a submucous cleft palate or occult submucous cleft palate is necessary to minimize the incidence of velopharyngeal insufficiency (VPI) after adenoidectomy. The classic triad of a submucous cleft palate can be seen with careful inspection of the palate: (1) the abnormal insertion of levator palatine muscle; (2) a zona pellucida; and (3) a notch in the posterior border of the palate instead of the posterior nasal spine felt on palpation. The occult (or hidden) submucous cleft palate can only be determined by nasoendoscopy. Nasoendoscopy is not required in all cases planned for adenoidectomy.

Operative Technique

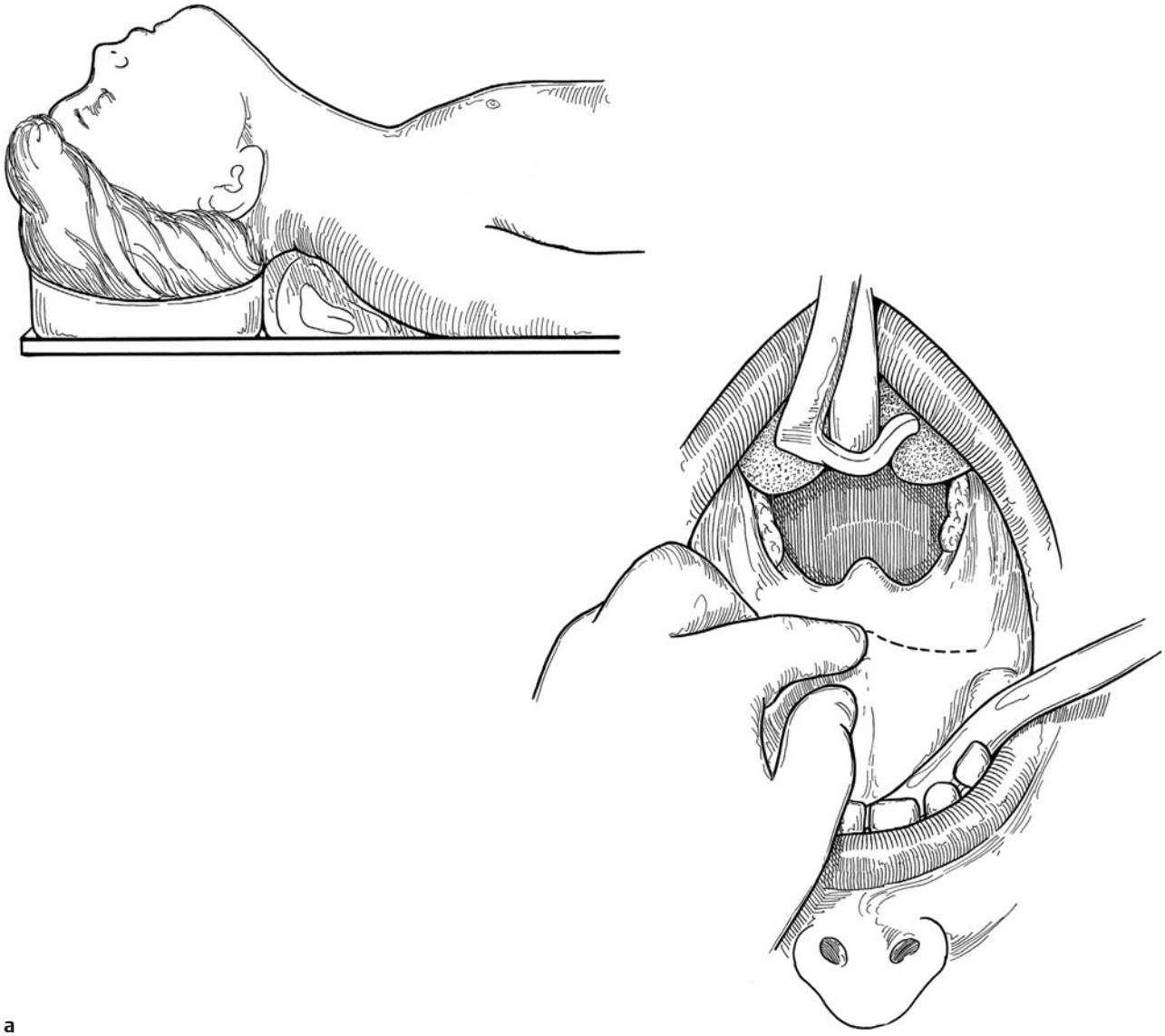
1. Adenoidectomy is performed under general anesthesia administered through an oral RAE tube. The patient is placed in the Rose position as for a tonsillectomy (see Section 19-1, Fig. 19.1a). A Crowe-Davis mouth gag or Dingman retractor is inserted and suspended onto a Mayo stand. Care is taken not to overextend the neck in patients suspected of having cervical spine abnormality. It is suggested that no shoulder roll be used in a patient with possible C-spine abnormalities and that the mouth gag be supported on the anterior chest wall of the patient with a small roll of towels such that the neck remains in neutral anatomical position.
2. The hard palate is carefully palpated to exclude the presence of a submucous cleft palate (**Fig. 18.1a**).
3. One or two red rubber catheters are placed through the nose to retract the palate (**Fig. 18.1b**). Alternately, if a latex-free environment is preferred, a 10-Fr suction catheter can be used.
4. A mirror is used to inspect the nasopharynx (**Fig. 18.1c**). It is important to visually inspect and palpate the posterior wall of the nasopharynx for any signs of abnormal arterial pulsation. A variety of arterial malformations, including severe tortuosity of the internal carotid artery, can occur in the nasopharynx.
5. Using the mirror for visualization, a sharp curette of suitable width is placed at the base of the vomer under direct vision (**Fig. 18.1d**).
6. The mirror is removed, and using the thumb as a fulcrum (**Fig. 18.1e**), the adenoid tissue is carefully removed in one slow, gentle sweep of the curette. Any residual adenoid tissue in the posterior choanae is removed using a small angled curette, again placed under direct vision (**Fig. 18.1f**). Alternatively, the entire adenoid can be removed with a suction cautery.
7. If curette is used, the nasopharynx is packed for a minimum of 2 minutes before suction cautery is used to cauterize any persistent bleeding vessels and to remove any residual adenoid tissue (**Fig. 18.1g**).
8. It is important to remove as much of the superior adenoid tissue as possible. Residual adenoid tissue often makes it difficult to obtain adequate hemostasis and may lead to regrowth of the adenoid and recurrence of nasopharyngeal obstruction. Care should be taken in removing the adenoid tissue surrounding the eustachian tube for fear of

causing scarring at the end of the tube or nasopharyngeal stenosis.

9. It is also important to leave an inferior rim of adenoid tissue in place at the level of Passavant's ridge to decrease the risk of postoperative VPI (**Fig. 18.1h**). If there is evidence of a submucous cleft palate, only the superior half of the adenoids should be removed.

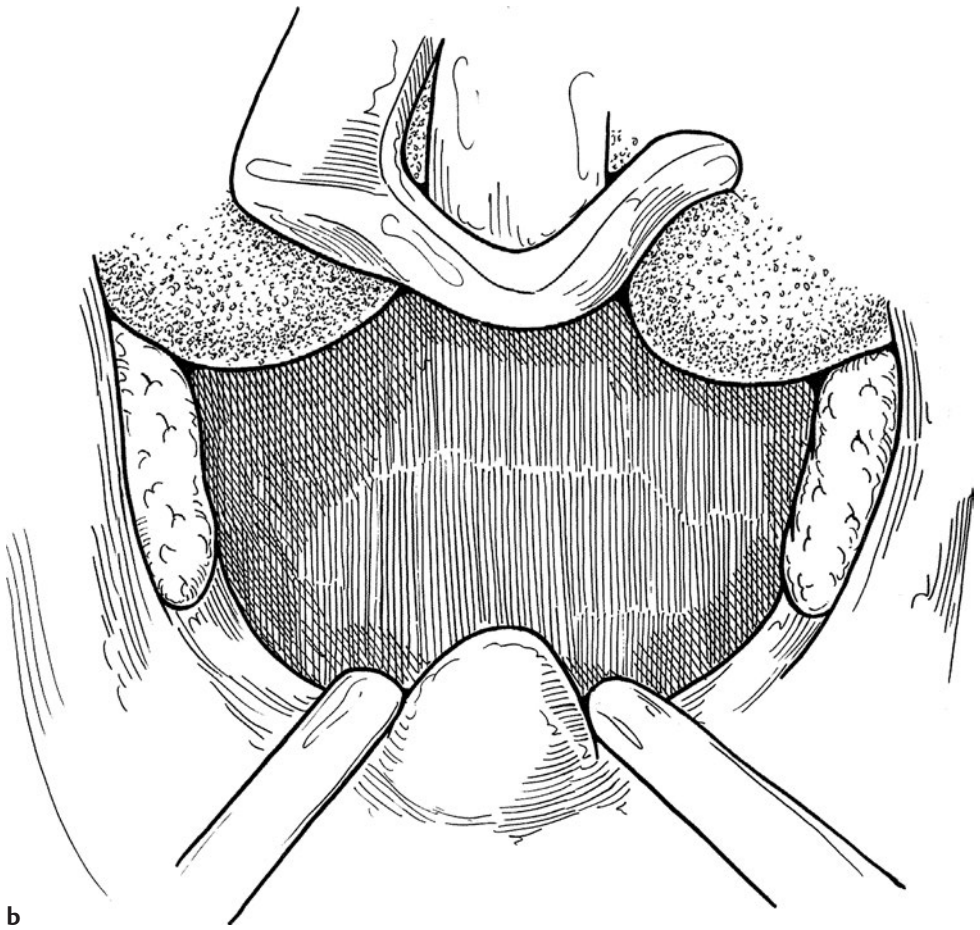
Complications

1. Postoperative hemorrhage
2. Adenoid regrowth
3. VPI
4. Pharyngeal stenosis

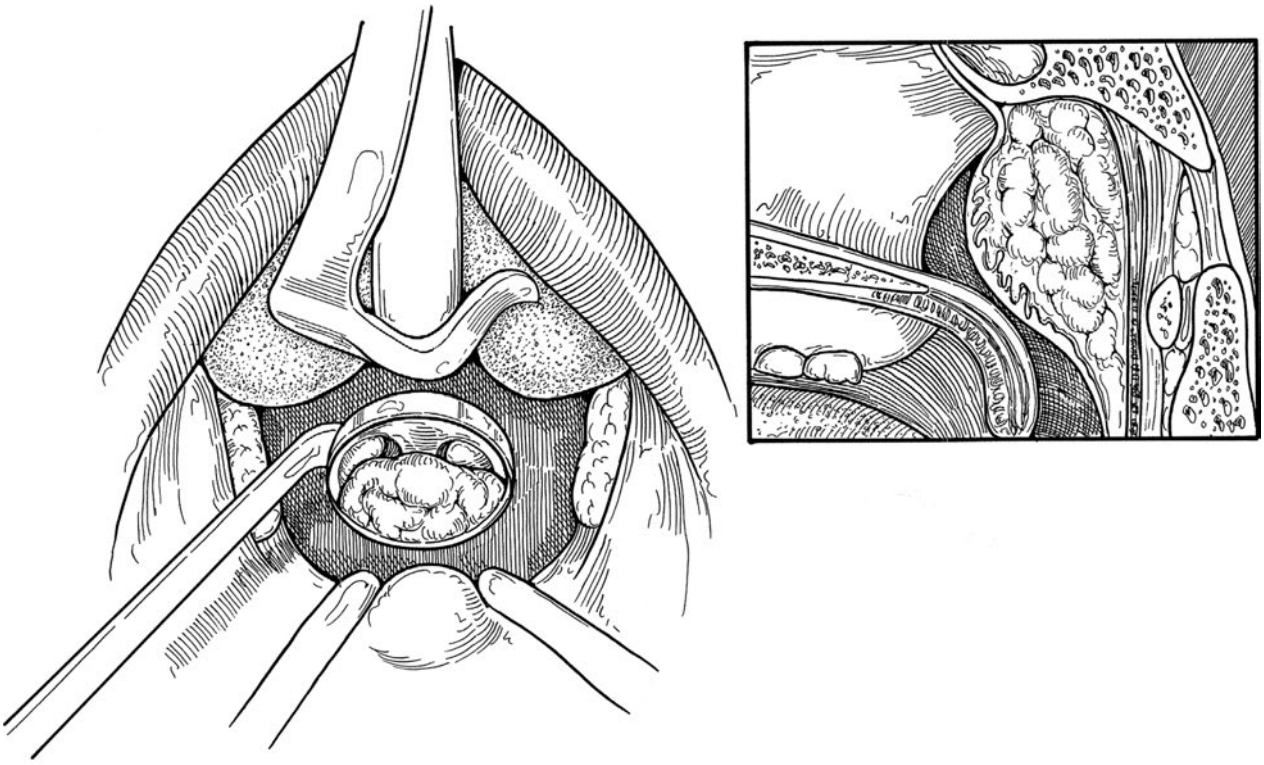


a

Fig. 18.1a

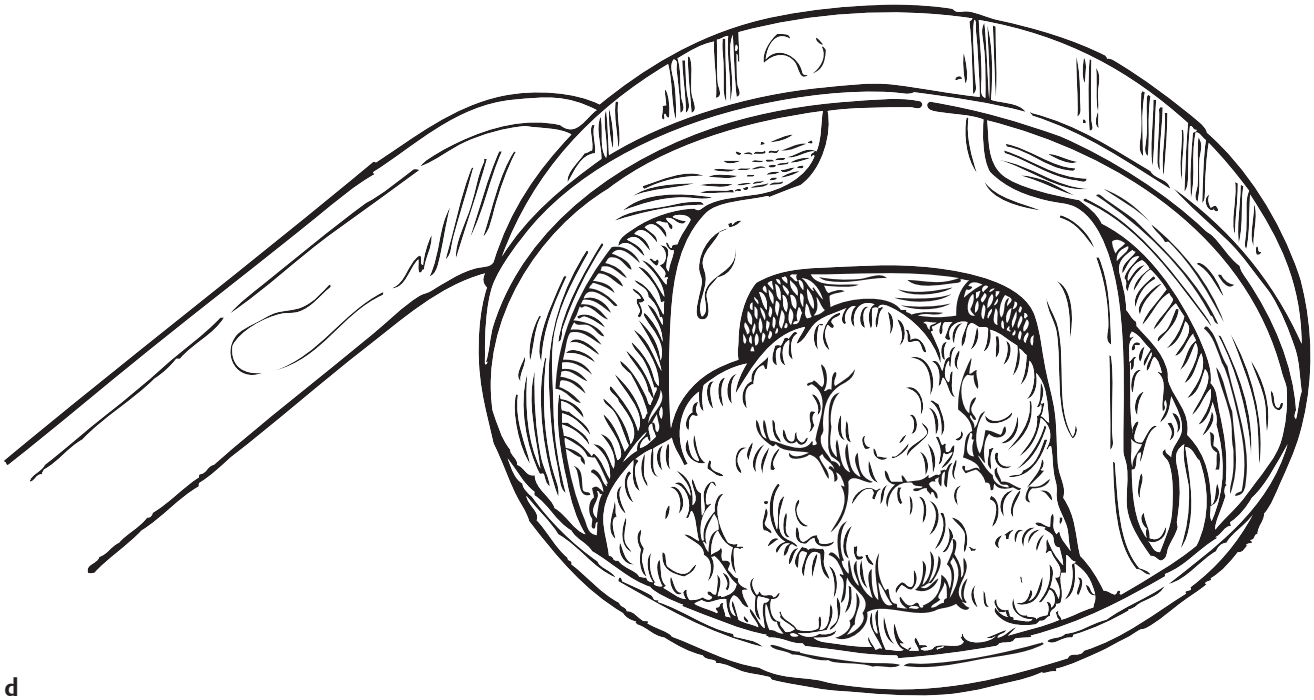


b

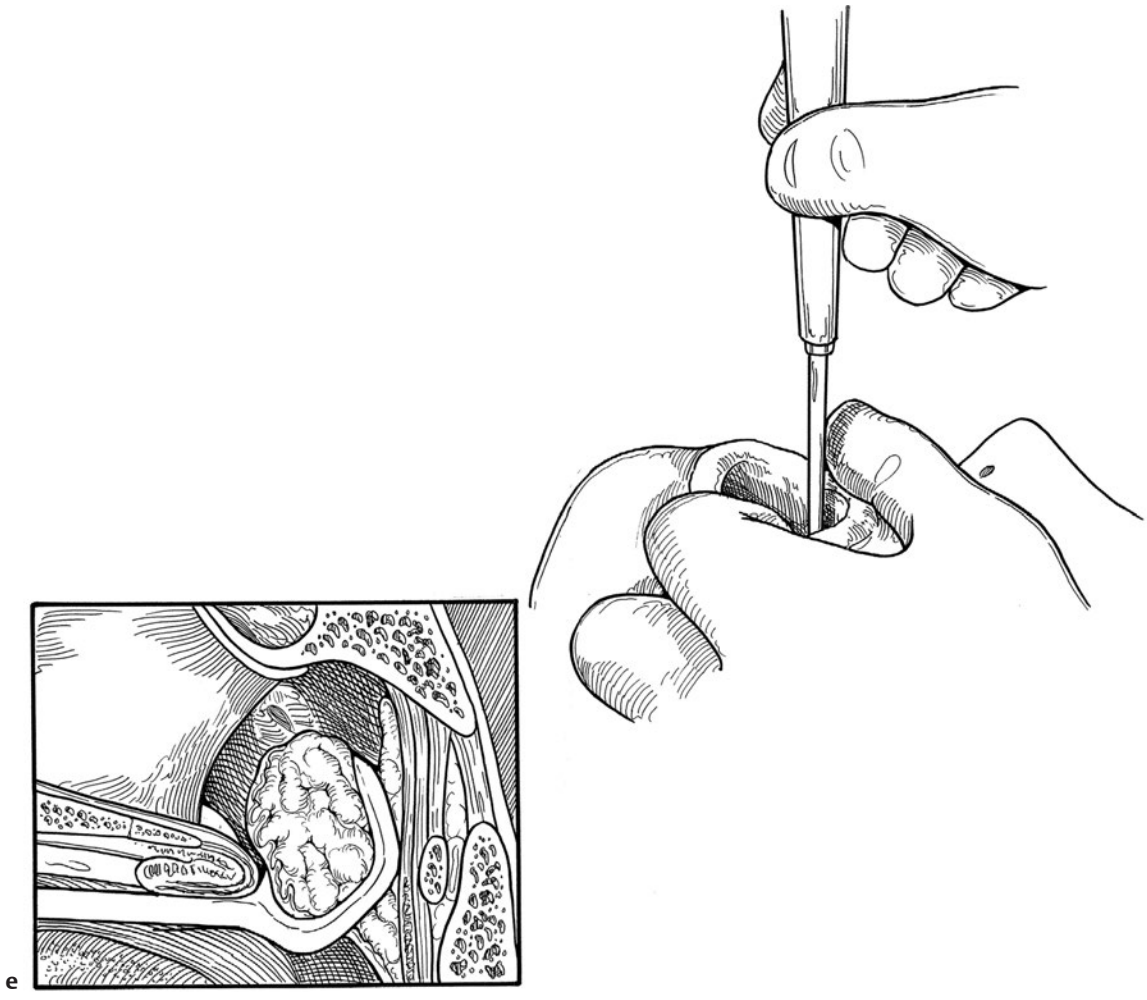


c

Fig. 18.1b,c

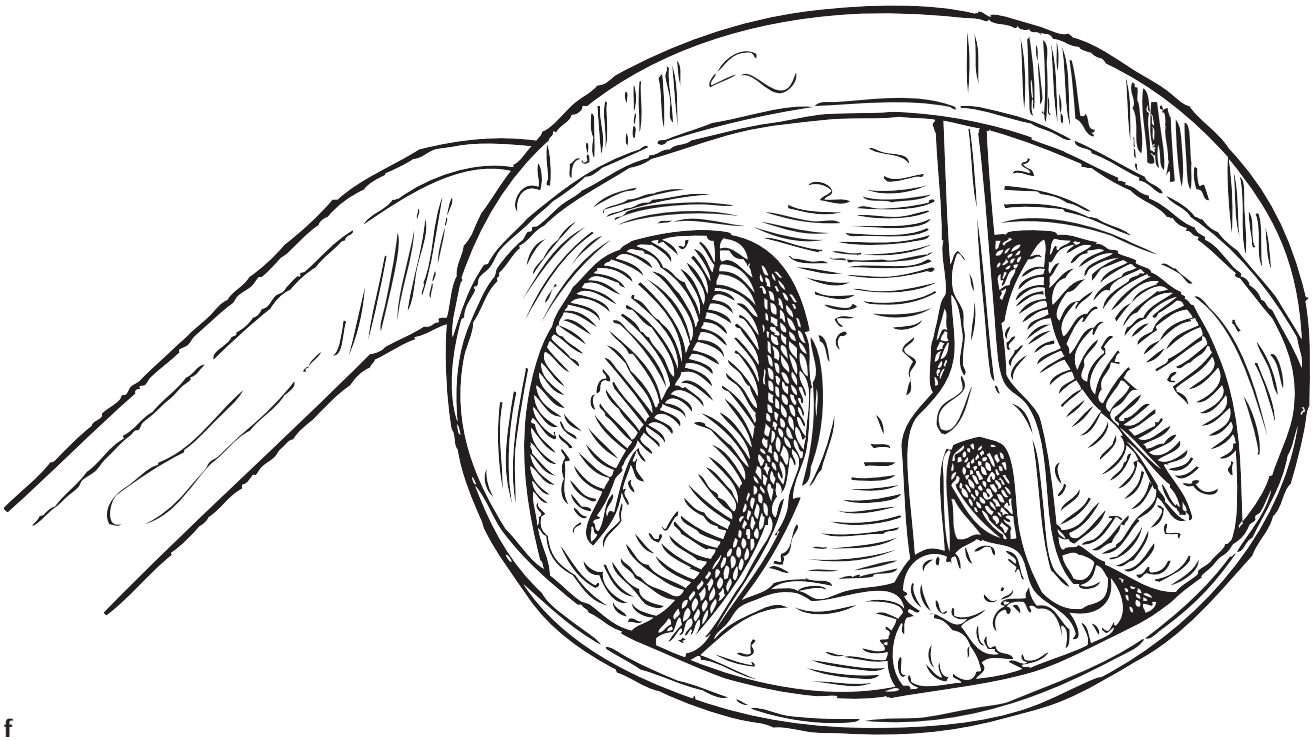


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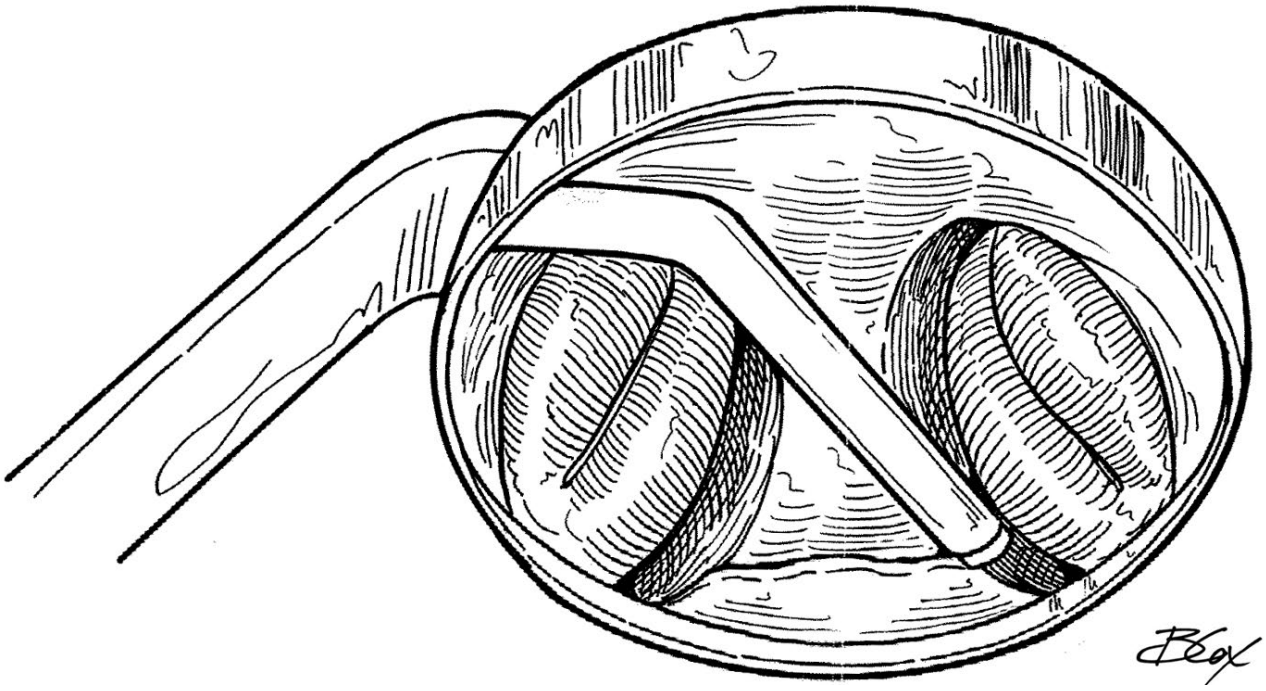


e

Fig. 18.1d,e



f



g

Fig. 18.1f,g

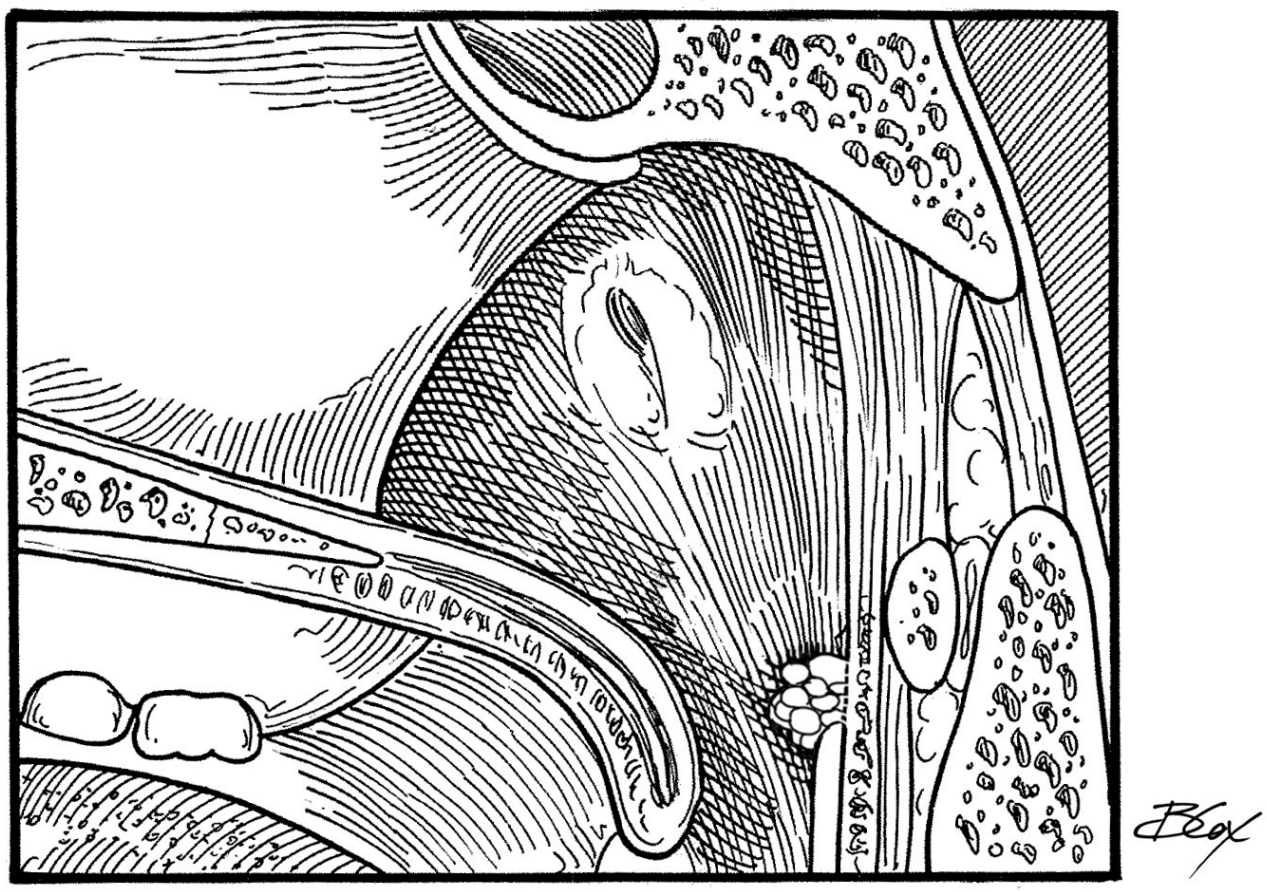
h 

Fig. 18.1h

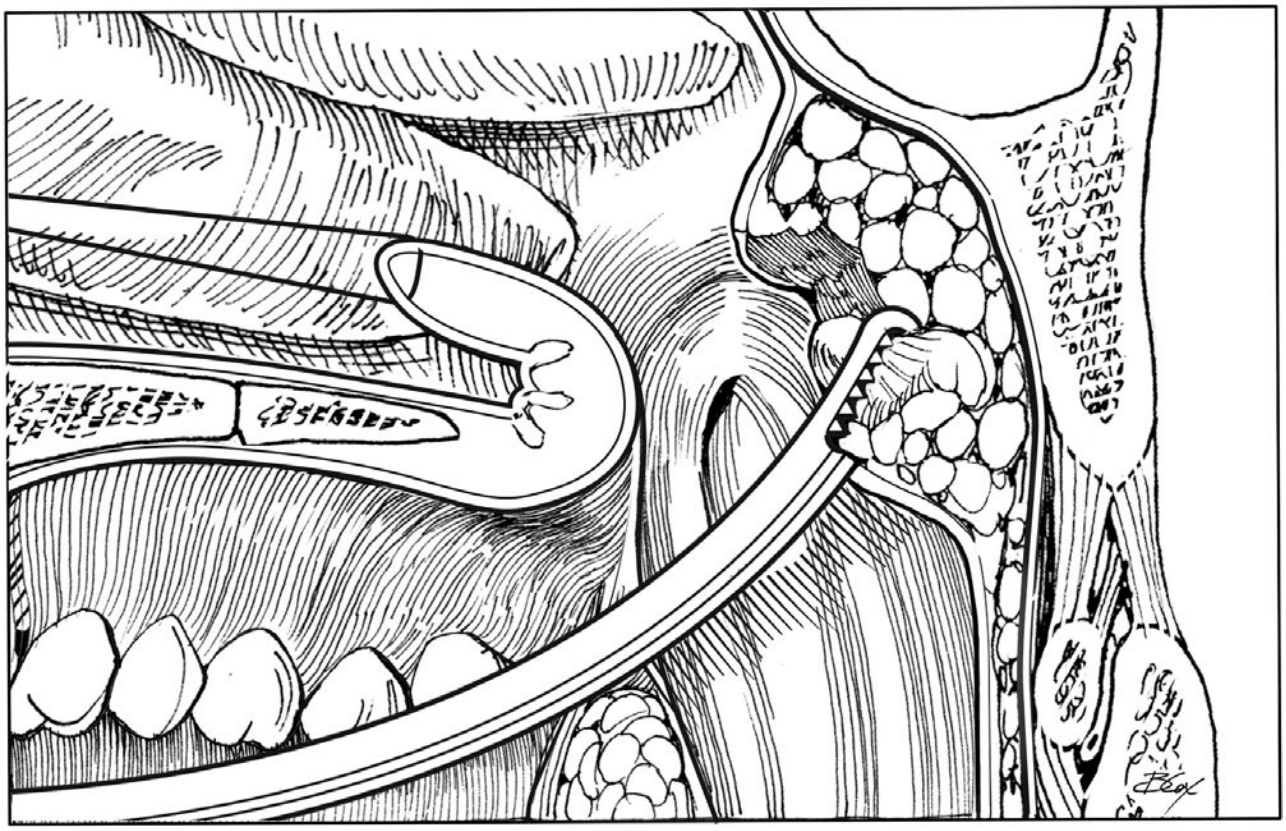
18-2 Adenoidectomy with Microdebrider

Introduction

A microdebrider can also be used to remove the adenoids (**Fig. 18.2a,b**). Hemostasis is achieved with either packing of the nasopharynx or with a suction cautery device.

Complications

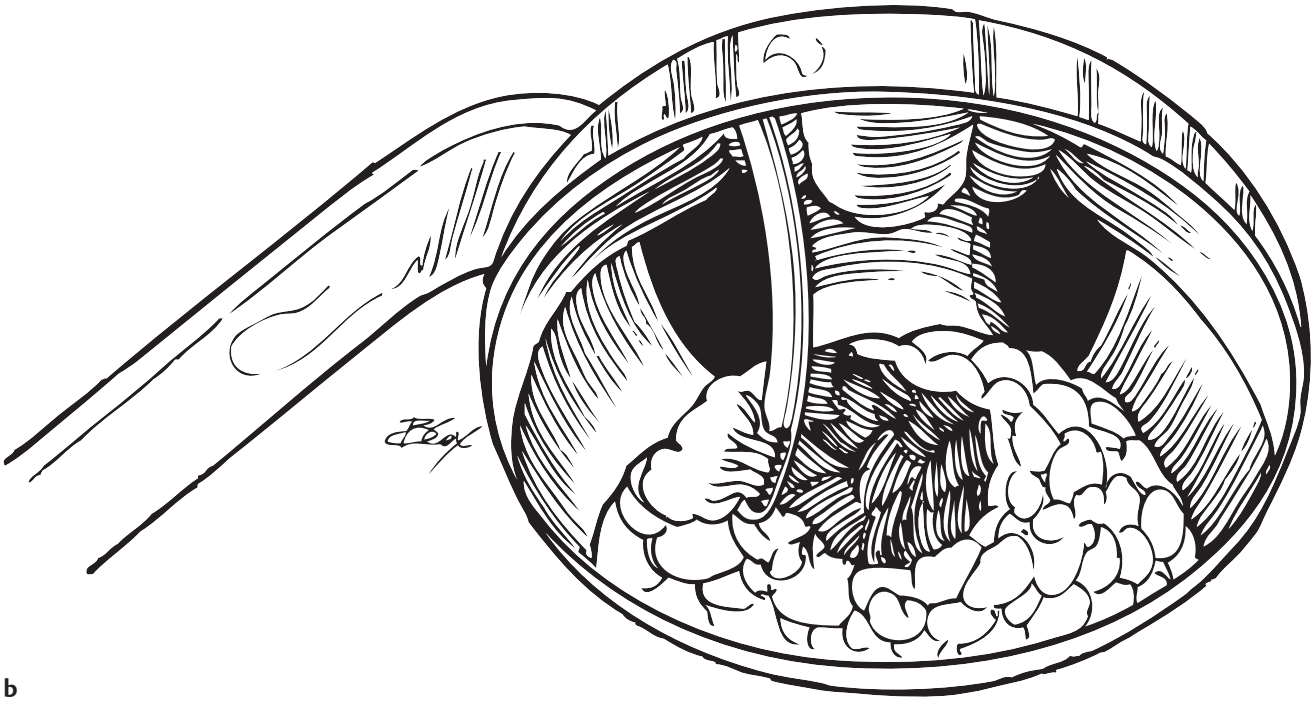
1. Postoperative hemorrhage
2. VPI
3. Nasopharyngeal stenosis
4. Regrowth of adenoids



a

Fig. 18.2a

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b

Fig. 18.2b

www.Ebook777.com

18-3 Adenoidectomy with Suction Cautery

Introduction

Adenoidectomy can also be performed using a suction cautery instrument.

Operative Technique

1. The patient is similarly positioned as described in Section 18-1. If a suction cautery instrument is used, it is advisable to place a moist sponge at the oral commissure to protect the corner of the mouth from excessive heat from the suction cautery device.
2. The adenoids are visualized with a laryngeal mirror.
3. The adenoid tissue is both cauterized and scraped with the suction cautery instrument to remove charred tissue as the dissection progresses (**Fig. 18.3a,b**). It is also important that there is no air leak around the endotracheal tube when cautery is performed to avoid an airway fire. Options to achieve this include use of a cuffed endotracheal tube or a throat pack.

Complications

1. Postoperative hemorrhage
2. VPI
3. Nasopharyngeal stenosis
4. Regrowth of adenoids

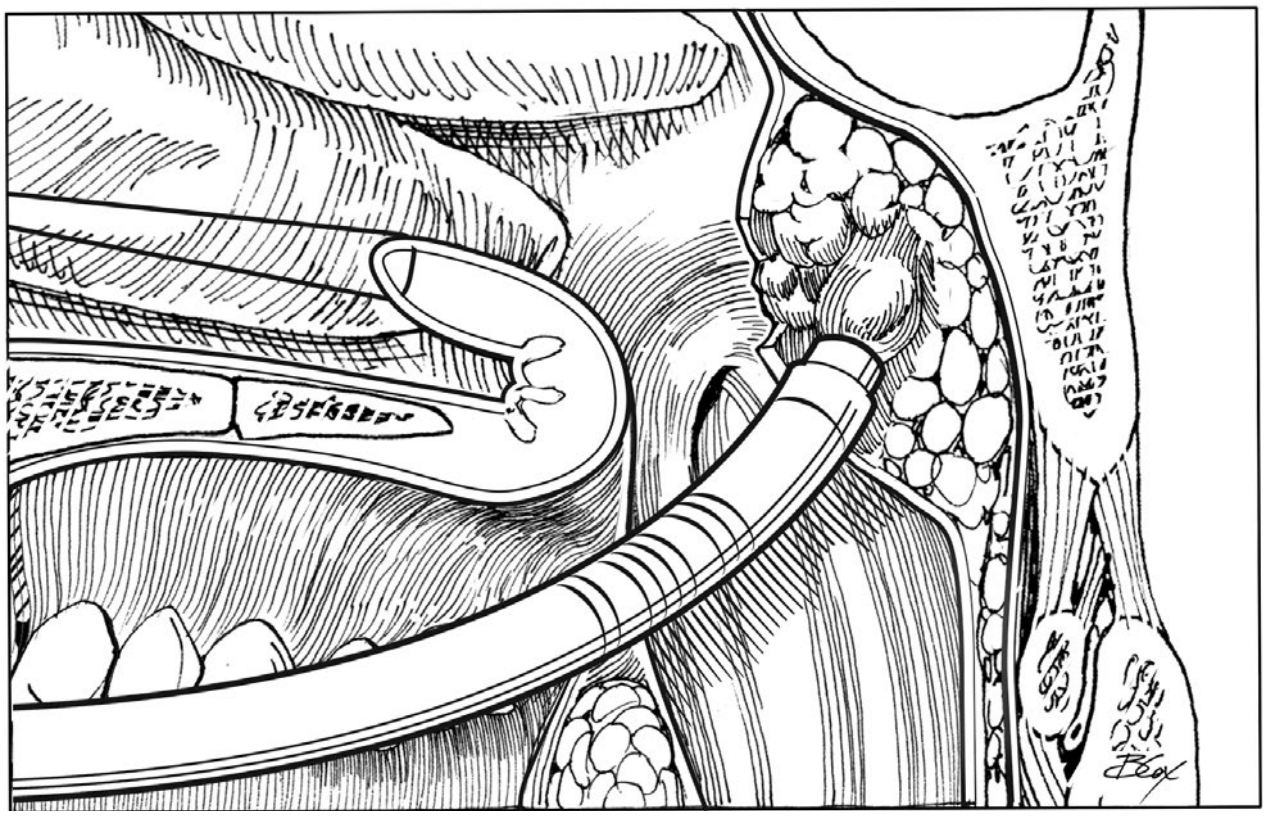
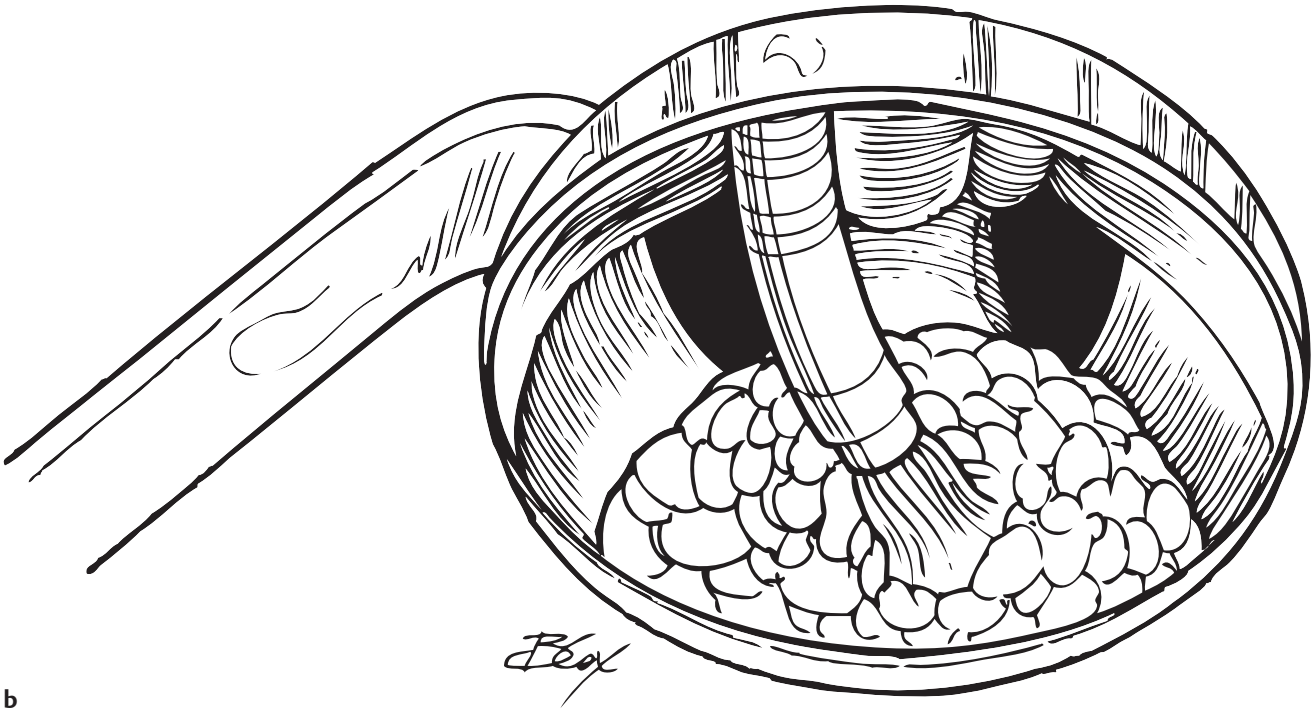
a 

Fig. 18.3a



b

Fig. 18.3b

19 Tonsils

Sally R. Shott

Tonsillar hyperplasia and recurrent pharyngotonsillitis are common disorders in children. Tonsillar hyperplasia may cause sleep disorders, disordered breathing, or apnea. Recurrent infections, which are often debilitating on their own, may be associated with complications of streptococcal infection (e.g., rheumatic heart disease, glomerulonephritis, scarlet fever).

19-1 Tonsillectomy (Extracapsular and Intracapsular)

Indications

Removal of the pharyngeal tonsils is indicated to relieve pharyngeal obstruction and to reduce the frequency and severity of pharyngeal infection.

Preoperative Evaluation

The history and physical examination are usually sufficient to determine the need for tonsillectomy. Nasopharyngoscopy may be helpful in cases of smaller appearing tonsils that have a significant inferior extension.

Operative Technique: Extracapsular

1. Tonsillectomy is usually performed under general anesthesia utilizing an oral RAE tube. A cuffed tube or a throat pack around the tube is suggested to prevent an air leak and to avert the risk of an airway fire. The patient is placed in the Rose position at the end of the operating table. A shoulder roll is placed under the shoulders and the head rests in a doughnut (**Fig. 19.1a**).
2. A tonsil gag (Crowe-Davis or Dingman) is introduced and opened, keeping the tongue in the midline. The mouth gag is suspended from a Mayo stand. Care is taken not to overextend or hyperflex the neck in patients suspected of having cervical spine abnormality. It is suggested that no shoulder roll be used in a patient with possible C-spine abnormalities and that the mouth gag be supported on the anterior chest wall of the patient with a small roll of towels such that the neck remains in a neutral anatomical position.
3. The posterior and lateral walls of the pharynx are carefully inspected and palpated to detect abnormally positioned vessels.
4. The hard palate is palpated to detect a submucous cleft palate (**Fig. 19.1b**).
5. The superior pole of the right tonsil is grasped with an Allis clamp, and the mucosal cut on the anterior pillar is outlined with a protected cautery, preserving as much mucosa as possible (**Fig. 19.1c,d**). The guarded cautery blade prevents inadvertent burns. It is suggested to use cautery settings for this procedure that will both allow dissection of the tissue and achieve hemostasis.
6. The cautery blade can be used for both cutting through the tissue as well as blunt dissection and, after careful dissection, the plane of the tonsillar capsule is located.
7. The tonsil is removed by dissection with the cautery as the tonsil is retracted medially with the Allis clamp (**Fig. 19.1e**). Larger vessels, when encountered, may need additional cauterization. As the tonsil is removed, the posterior pillar attachment of the tonsil is also incised. The plane of dissection is onto the tonsil capsule and not into the underlying muscle.
8. The attachment of the inferior portion of the pharyngeal tonsil to the lingual tonsil is transected with the cautery (**Fig. 19.1f**).
9. Residual bleeding vessels are cauterized with a suction cautery while the tonsil fossa is exposed using a hemostat or a Hurd dissector for retraction (**Fig. 19.1g**).
10. The recessed superior pole of the tonsillar fossa is best visualized using a mirror (**Fig. 19.1h**).
11. This procedure is repeated on the opposite side.
12. When the tonsillectomy is completed, the mouth gag is released for a brief period along with light massage of the lateral neck and/or the tonsillar fossae; the gag is then reopened to inspect the oral cavity to make sure that there

is no further bleeding from vessels that might have been compressed by the mouth gag. The gag is then carefully removed from the oral cavity to avoid accidental extubation of the patient.

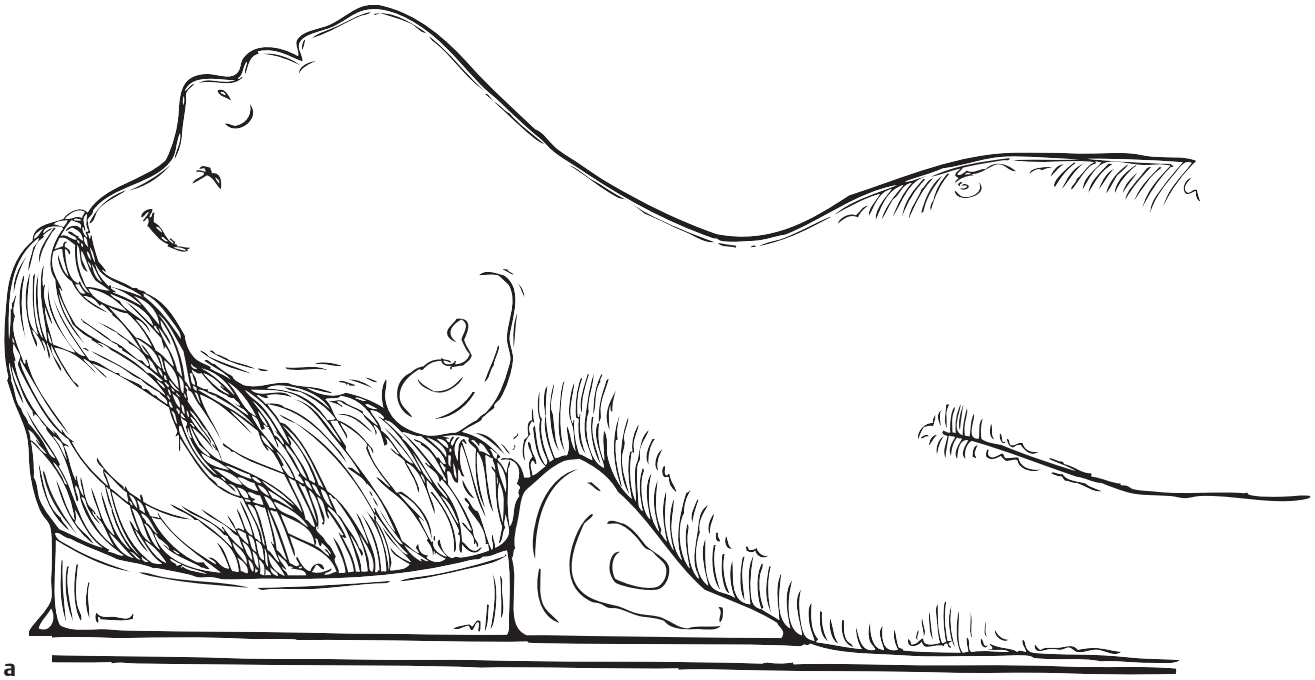
With this technique, 90–95% of the tonsil tissue is removed, starting at the medial aspect of the tonsil and continuing into the tonsil fossa, leaving behind a thin layer of tonsil tissue and the tonsil capsule (**Fig. 19.1i**). Cauterization of any residual vessels is done as described in steps 9-12 above.

Operative Technique: Intracapsular

The intracapsular tonsillectomy, also referred to as a tonsillotomy, can be performed using a microdebrider or a coblation wand.

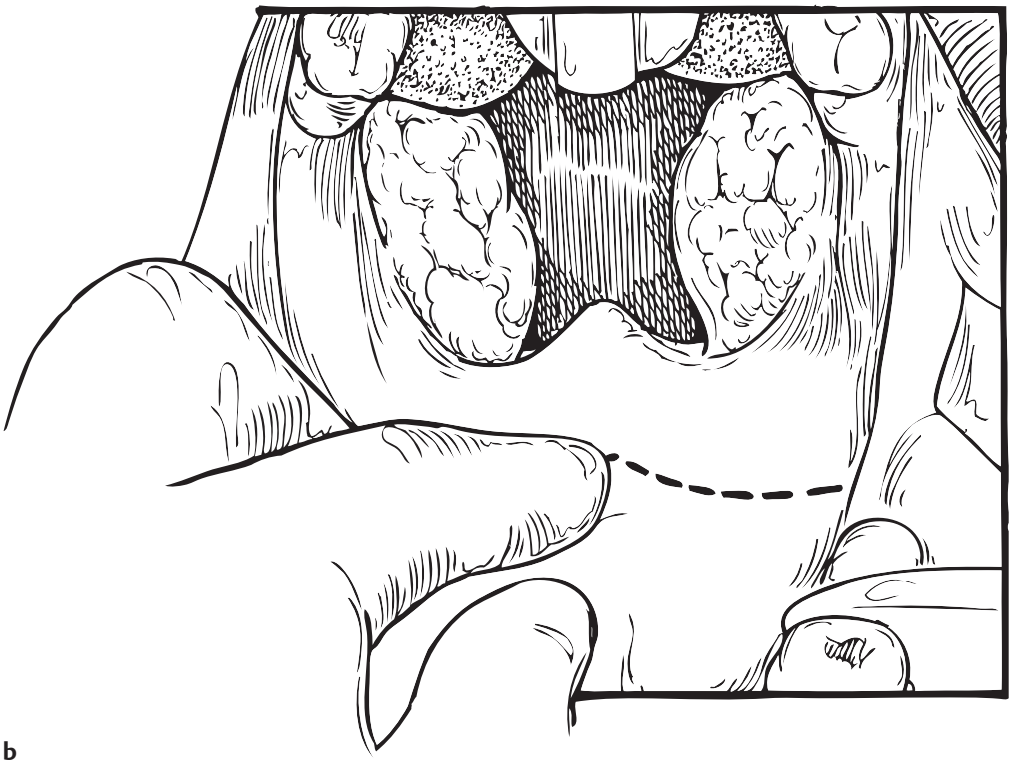
Complications

1. Postoperative hemorrhage
2. Tonsil regrowth

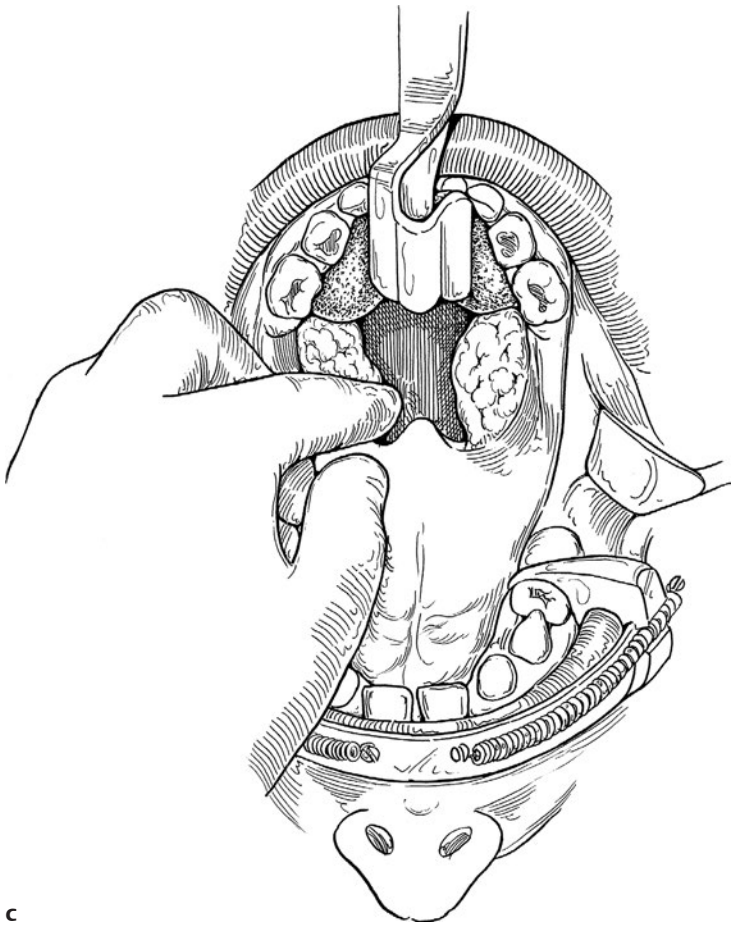


a

Fig. 19.1a

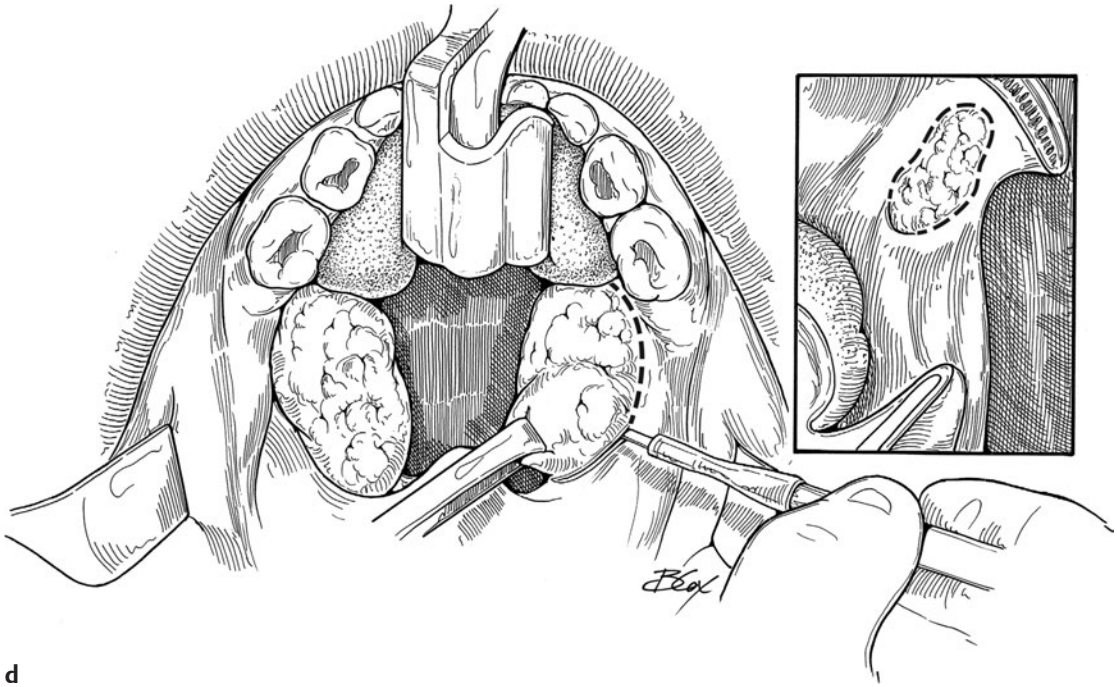


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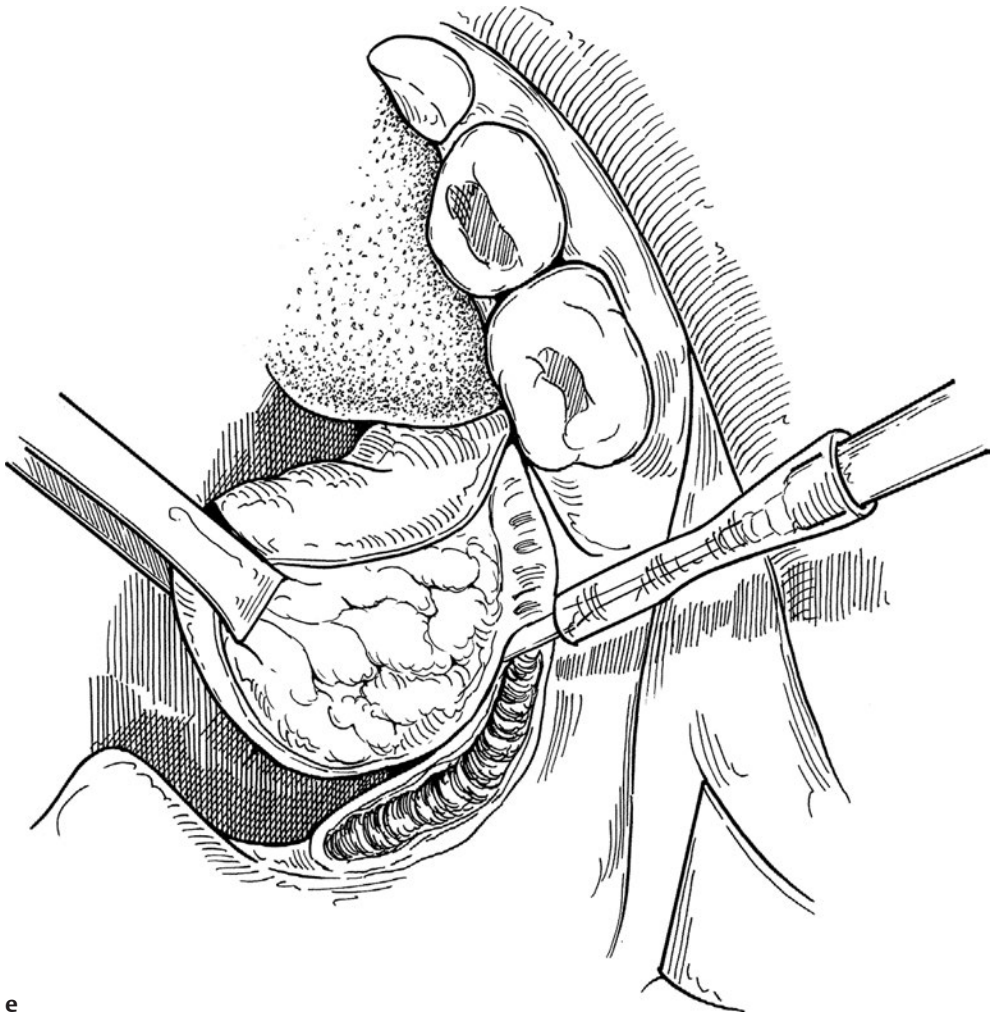


c

Fig. 19.1b,c

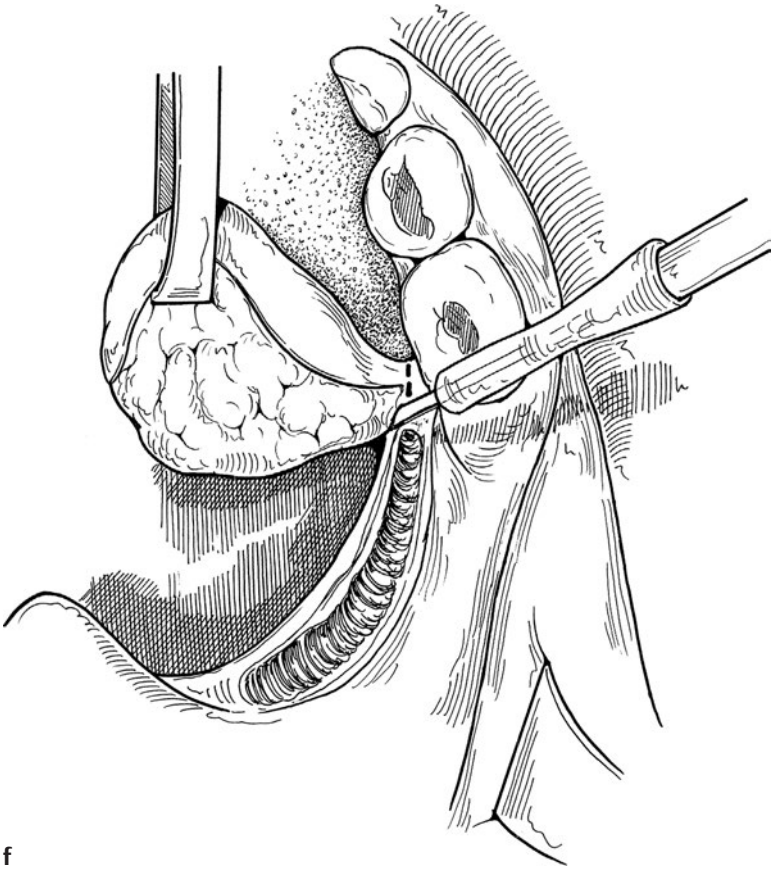


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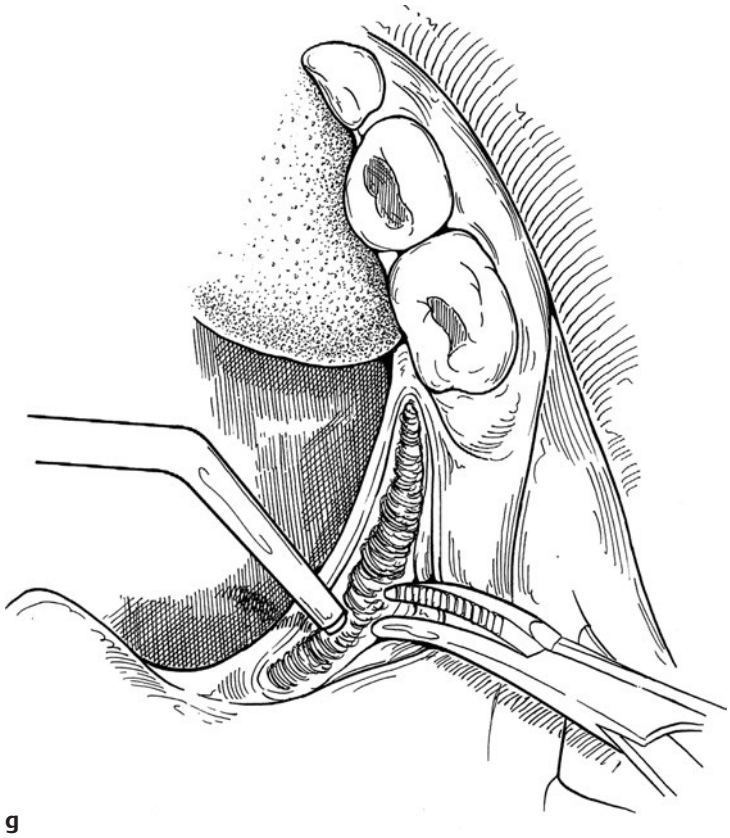


e

Fig. 19.1d,e

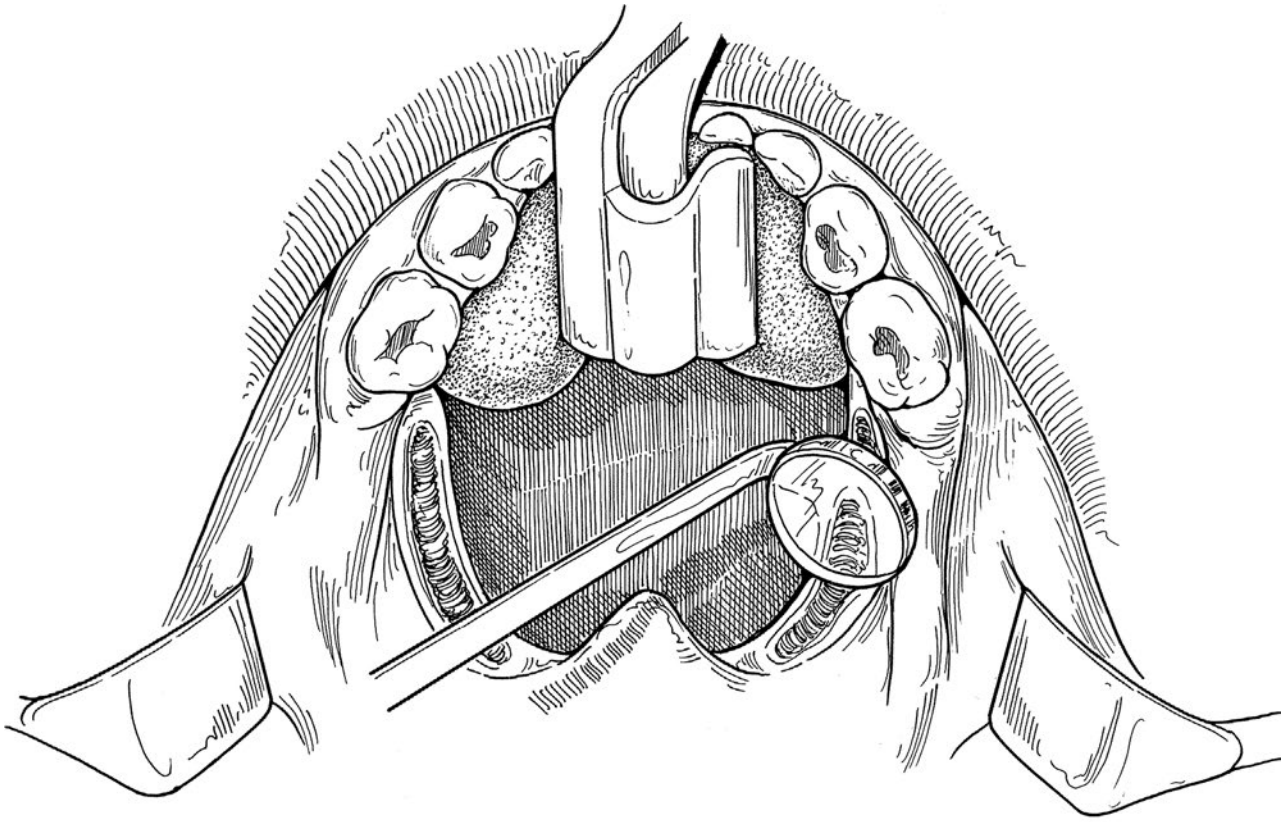


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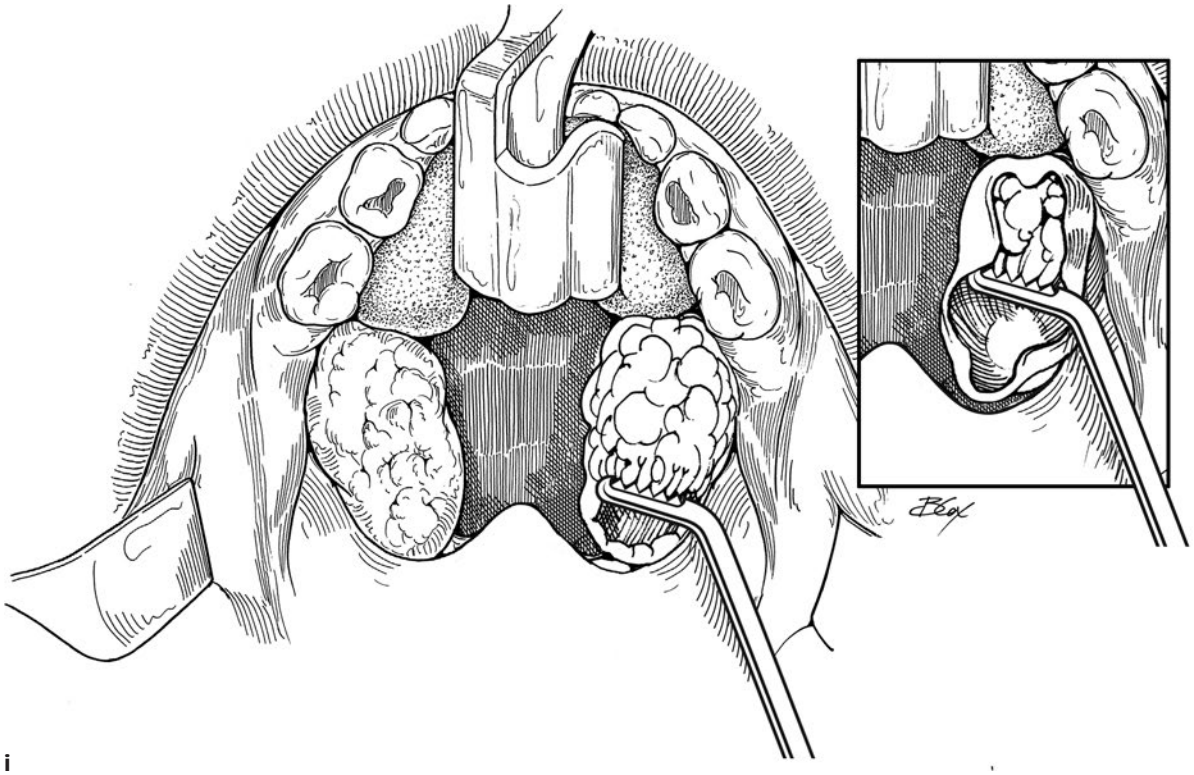


g

Fig. 19.1f,g



h



i

Fig. 19.1h, i

19-2 Lingual Tonsillectomy

Indications

Enlarged lingual tonsils can cause sleep-disordered breathing, including obstructive sleep apnea, and can also be a source of recurrent infections.

Preoperative Evaluation

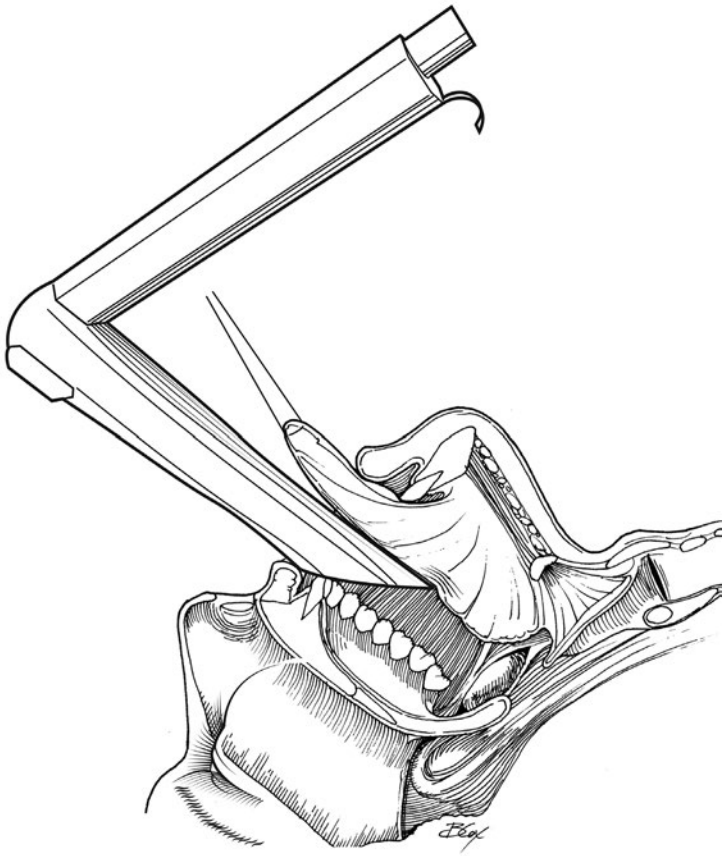
Flexible endoscopy of the upper airway is an effective way to diagnose enlarged lingual tonsils. They can also be evaluated by lateral neck X-ray or by sagittal views on T2-weighted magnetic resonance images.

Operative Technique

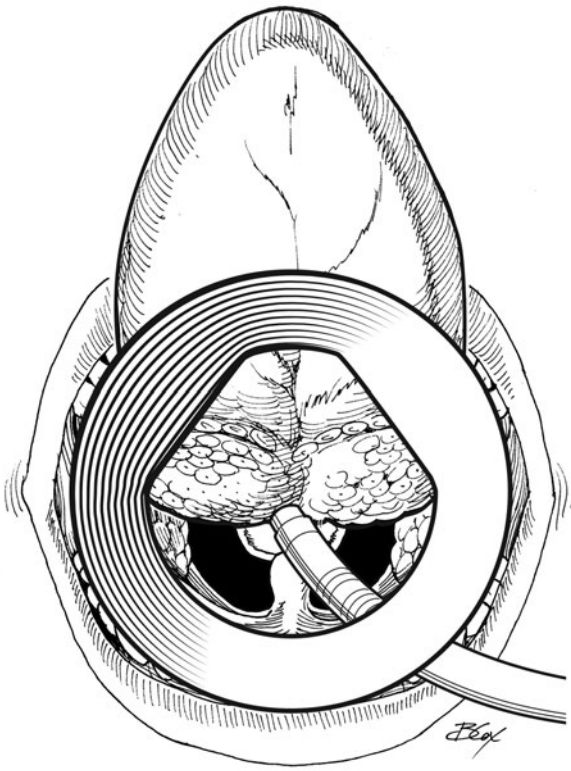
1. Lingual tonsillectomy is performed under general anesthesia utilizing a cuffed nasotracheal tube. The patient can be in Rose position with neck hyperextended or in a more neutral position. This latter position is required for a patient with potential C-spine anomalies (**Fig. 19.2a**).
2. A 3-0 silk suture is placed through the anterior tongue tip for retraction purposes.
3. A Lindholm laryngoscope is used to visualize the base of the tongue and the lingual tonsils. The laryngoscope can either be suspended onto a Mayo stand or held by the operating surgeon. The latter allows for more mobility of the laryngoscope and better visualization of the more lateral lingual tonsils (**Fig. 19.2a**).
4. Using a gently curved coblation wand or, alternatively, a suction Bovie instrument, and placing it into the mouth, but lateral to the laryngoscope, the surgeon can then visualize the instrument tip through the distal opening of the laryngoscope. The lingual tonsils are then removed. The laryngoscope is repositioned to allow visualization of the right, left, and midline lingual tonsil tissue (**Fig. 19.2b,c,d**).
5. Special care should be taken not to disturb the mucosa of the lingual, or posterior, aspect of the epiglottis, also easily visualized through the laryngoscope opening.

Complications

1. Regrowth of the lingual tonsils
2. Scarring of the epiglottis if lingual mucosa of epiglottis is disturbed
3. Side view of lingual tonsils
4. Lindholm laryngoscope in place in the mouth with lingual tonsils visualized through the distal opening and curved coblation wand also seen

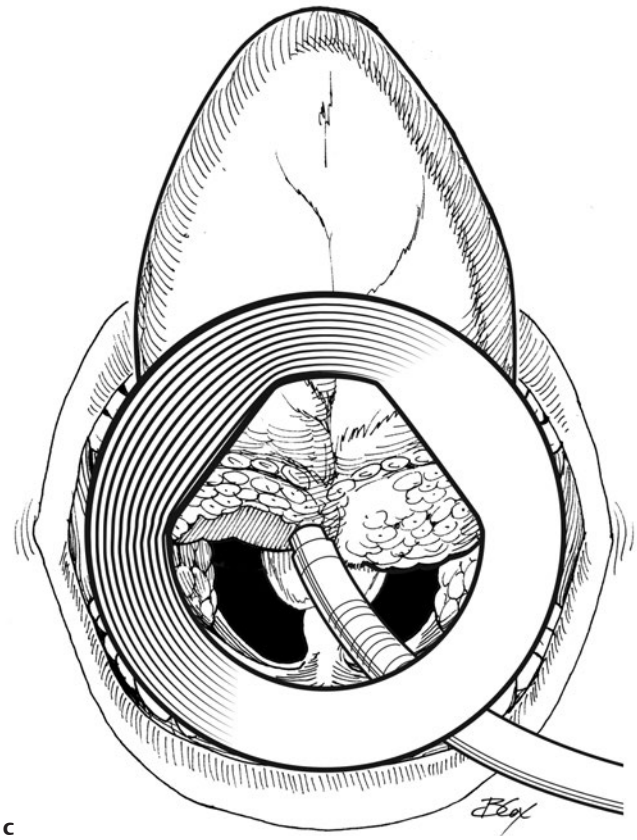


a

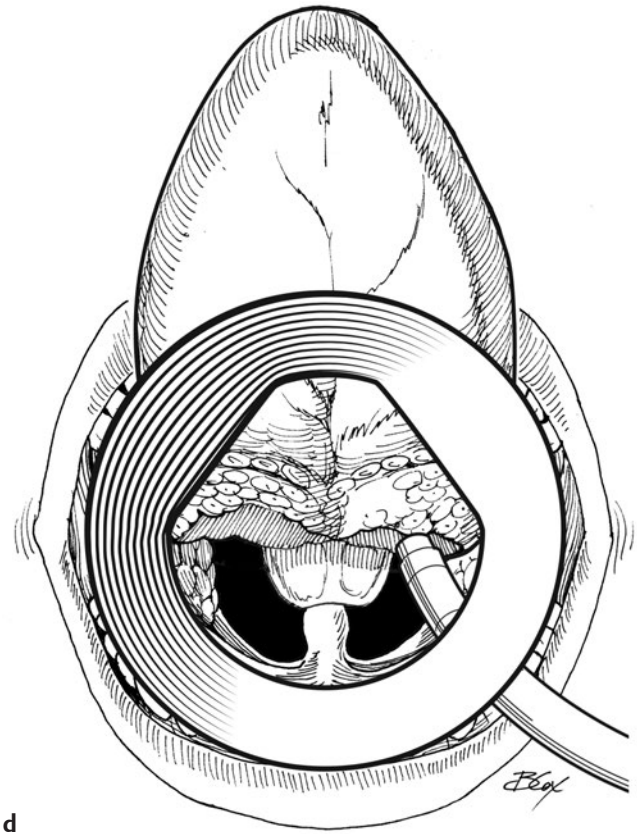


b

Fig. 19.2a,b



c



d

Fig. 19.2c,d

20 Tongue

Sally R. Shott

The tongue is an active participant in feeding. Restrictions of tongue mobility may interfere with nutrition, growth, and development in the neonate.

20-1 Frenulectomy/Frenulotomy

Introduction

Ankyloglossia is a common cause of feeding problems in neonates. It is a very infrequent cause of articulation problems. Tethering of the tongue can limit its mobility resulting in poor latching and sucking ability in newborns. Severe, thick ankyloglossia may cause pressure against the teeth or trauma to the lingual frenulum itself by rubbing against the lower teeth. The frenulum can get caught in between the lower, central incisors. Tethering of the tongue also limits one's ability to clean away debris in the gingiva-buccal sulcus and can contribute to dental disease.

Indications

Frenulectomy or frenulotomy is indicated in symptomatic ankyloglossia in newborns or young children.

Preoperative Evaluation

Inspection of the floor of the mouth or frenulum is sufficient. No additional evaluation is required. A speech evaluation may be helpful in the verbal child to determine if the ankyloglossia is contributing to articulation difficulties.

Operative Technique

1. The procedure can be done in the outpatient clinic.
2. The child is held by an assistant. The tongue is elevated with a tongue blade or heart-shaped retractor (**Fig. 20.1**), and the frenulum is divided sharply with scissors, taking care to stay superior to the submandibular ducts; 1% lidocaine may be applied to the frenulum with a small pledget for mucosal analgesia.
3. Digital pressure with a finger and a sponge is then applied to achieve hemostasis. Oxymetazoline spray can also be applied to the tongue if needed.

Complications

1. Postoperative hemorrhage
2. Submandibular duct injury
3. Recurrence of ankyloglossia
4. Submandibular gland swelling

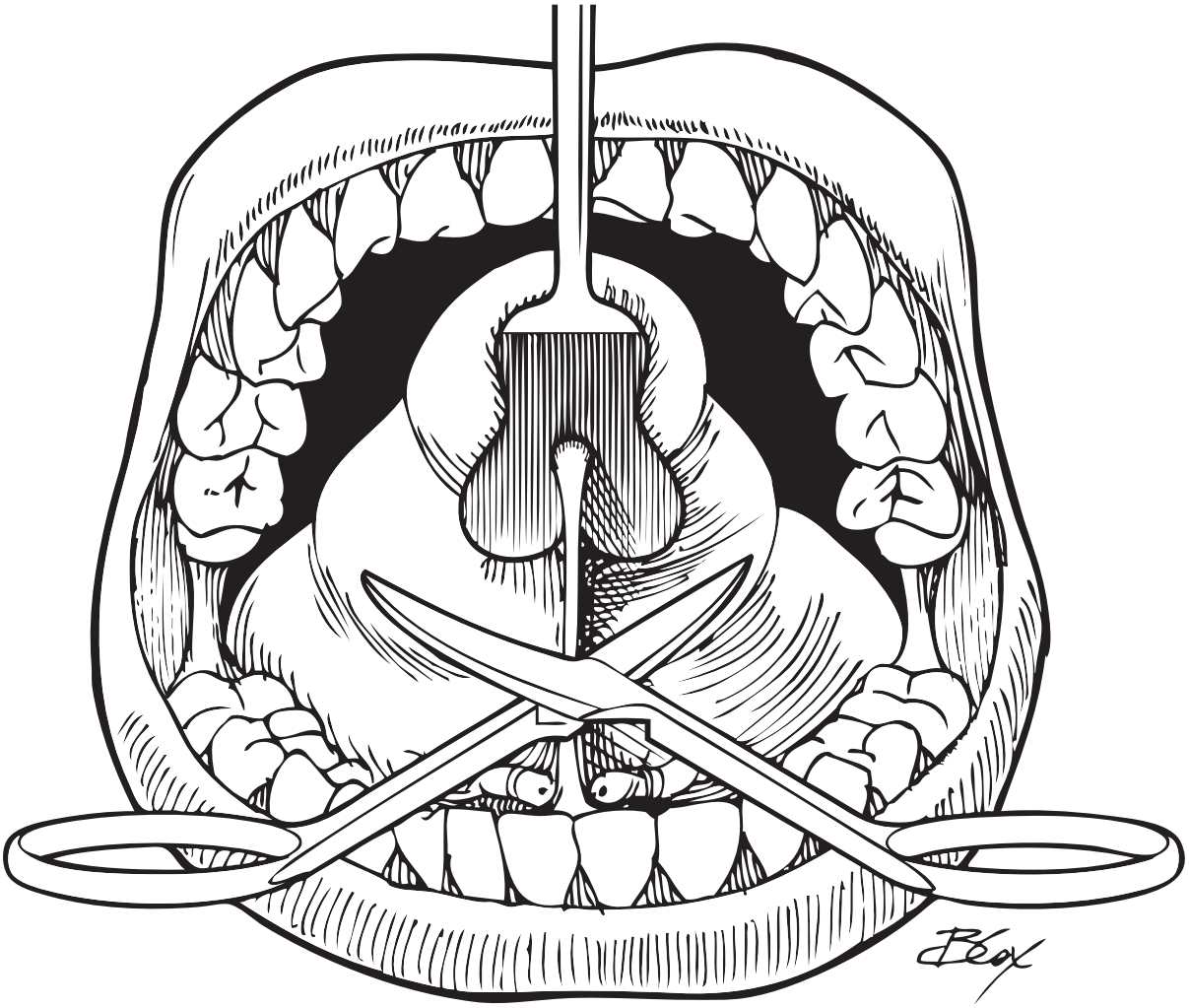


Fig. 20.1

20-2 Frenuloplasty

Introduction

Once teeth have erupted, the procedure is done under general anesthesia. If the frenulum is very short or thick, a larger horizontal incision through the frenulum is needed. By closing the incision in a vertical direction, the incision site is lengthened, providing further mobility of the tongue.

Indications

Frenuloplasty is indicated for symptomatic severe ankyloglossia.

Preoperative Evaluation

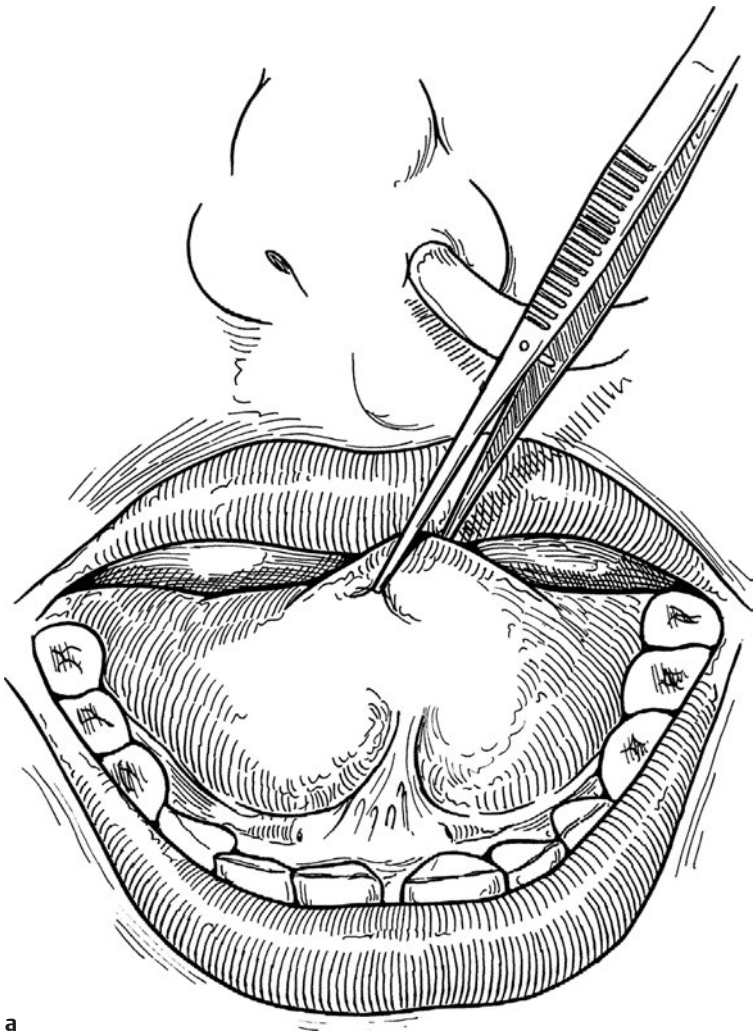
Inspection of the floor of the mouth or frenulum is sufficient. No additional evaluation is required.

Operative Technique

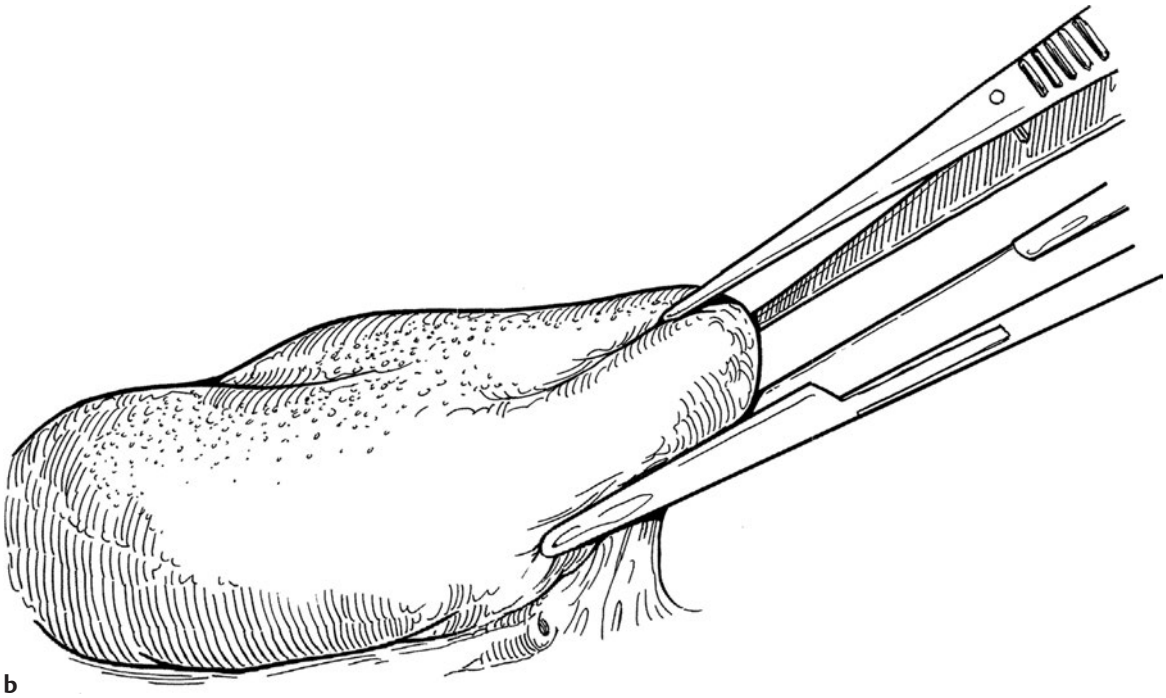
1. Frenuloplasty in children is performed using general anesthesia. This can be done by mask induction, by nasotracheal intubation, or with an oral tracheal tube taped to one side of the mouth.
2. The tongue is grasped with toothed forceps and the frenulum is stretched (**Fig. 20.2a**).
3. The frenulum is crushed with a straight clamp above the submandibular ducts, taking care to avoid injury to the orifices (**Fig. 20.2b**).
4. The crushed frenulum is cut with scissors up to the base of the sublingual area, releasing the frenulum (**Fig. 20.2c**).
5. Alternately, the frenulum can be divided with a guarded needle point cautery.
6. This releases the tongue and leaves a mucosal defect on the tongue, extending to the floor of the mouth (**Fig. 20.2d**).
7. Three or four 4-0 interrupted chromic sutures are placed to close the incision on the ventral surface of the tongue (**Fig. 20.2e**). No sutures are placed in the floor of the mouth because of potential injury to the submandibular ducts and to allow drainage of the intraoral incision site.
8. If the frenulum is thin, suturing may not be needed.

Complications

1. Submandibular duct injury
2. Recurrence of ankyloglossia
3. Submandibular gland swelling

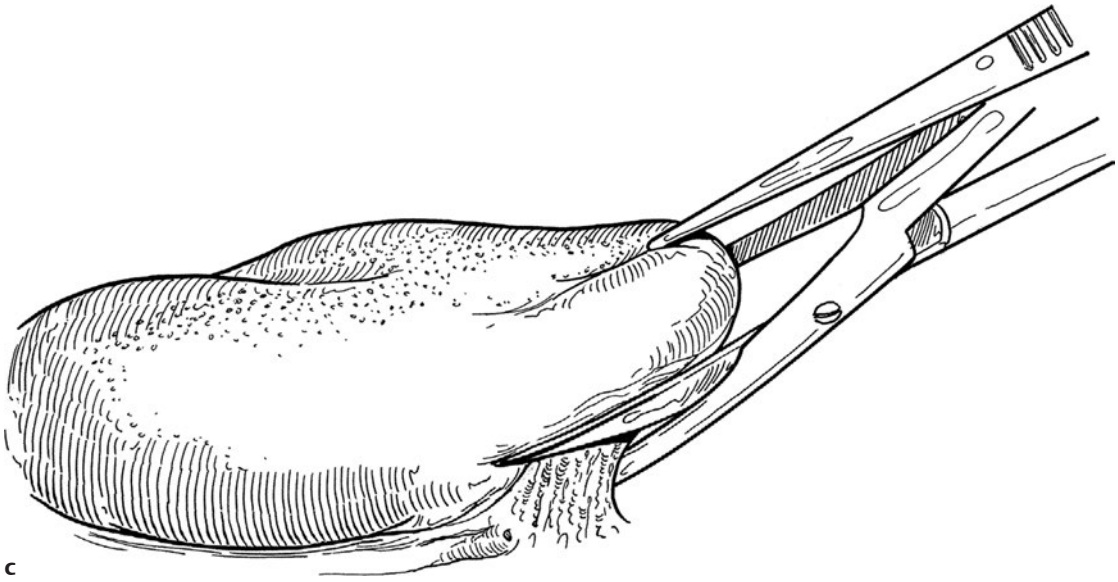


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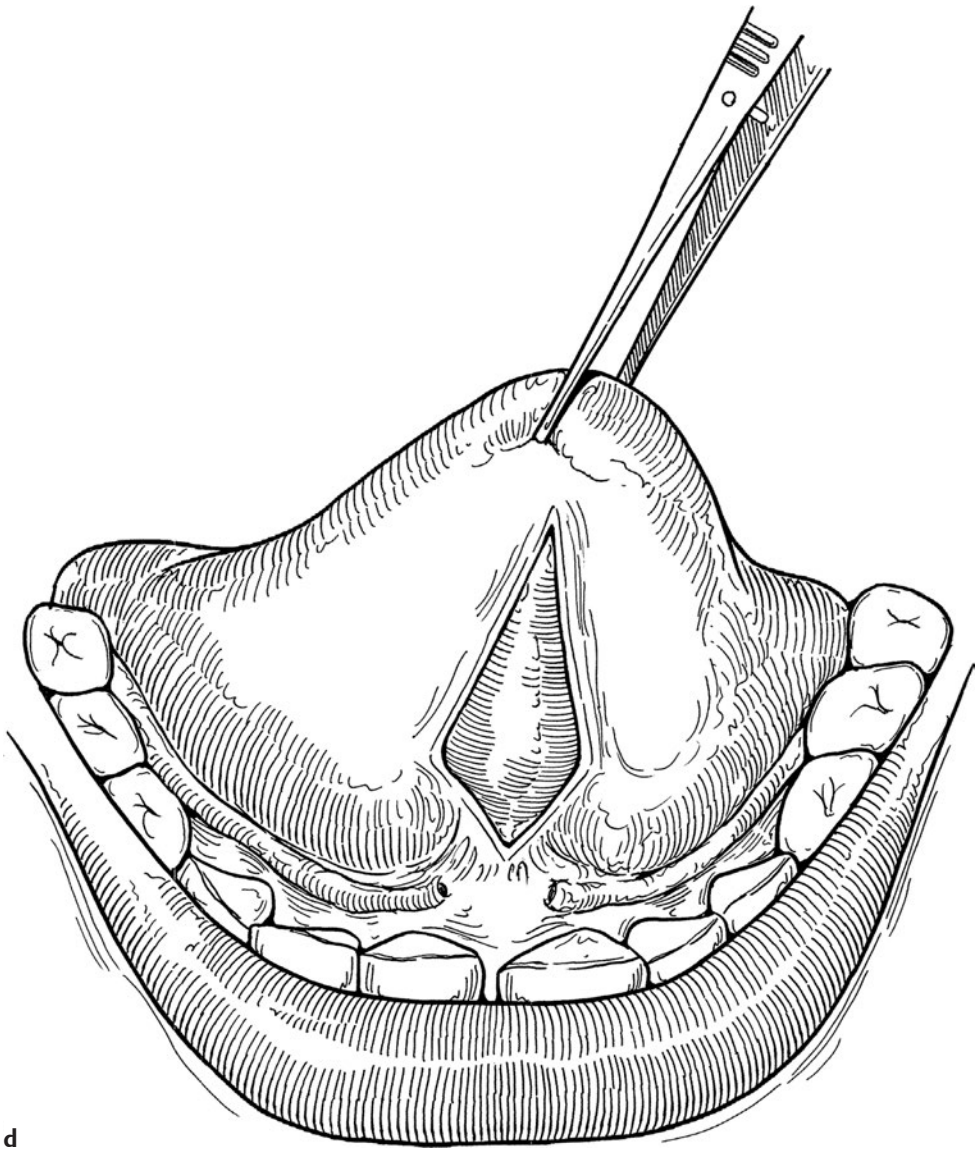


b

Fig. 20.2a,b

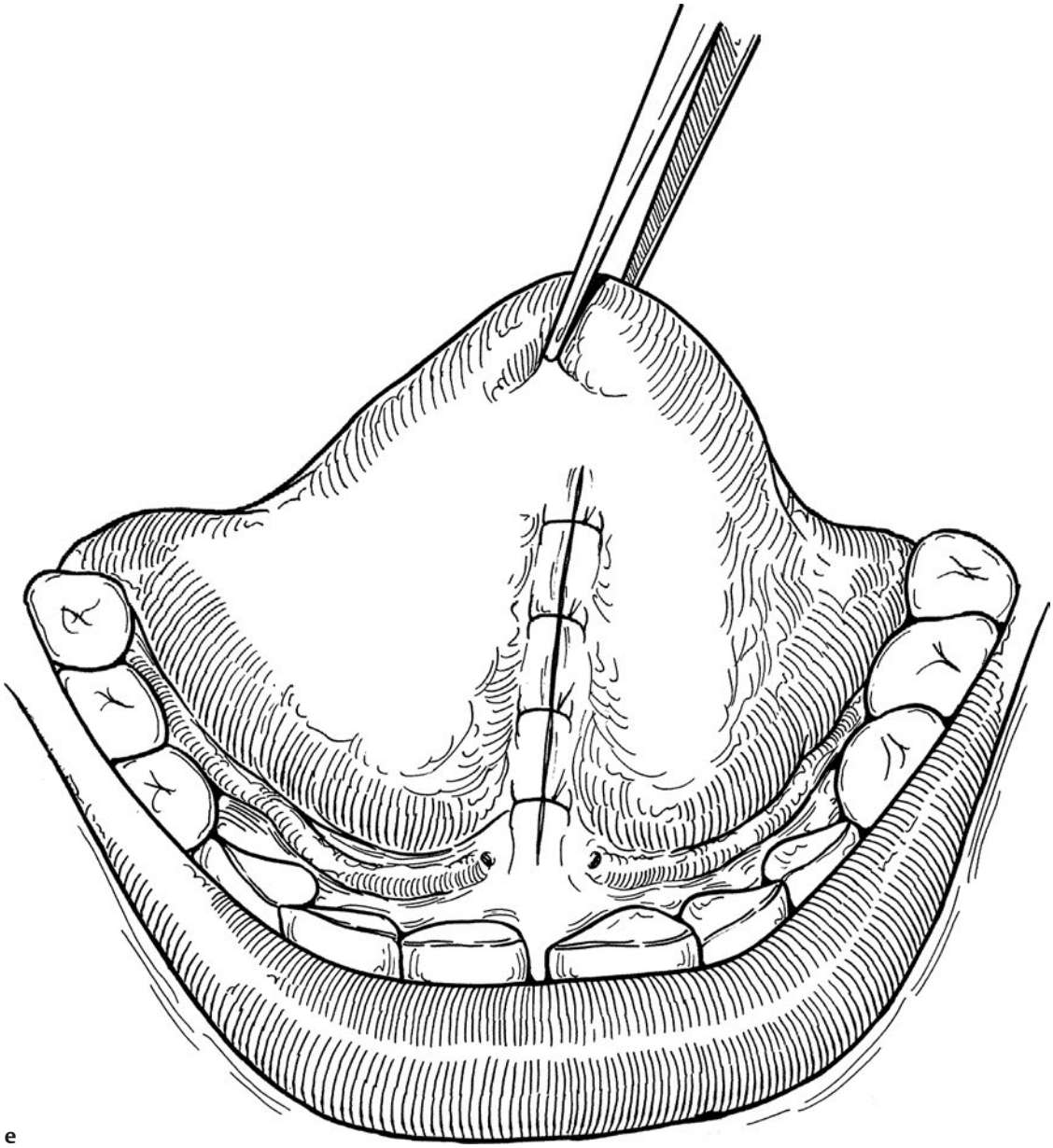


c



d

Fig. 20.2c,d



e

Fig. 20.2e

20-3 Excision of Discrete Tongue Lesions

Introduction

Discrete lesions of the tongue such as papillomas, granulomas, and fibromas may present in children. Lingual thyroid can also present on the surface of the tongue or submucosally at the tongue base.

Indications

Suspicious lesions on the anterior third of the tongue require excisional biopsy.

Preoperative Evaluation

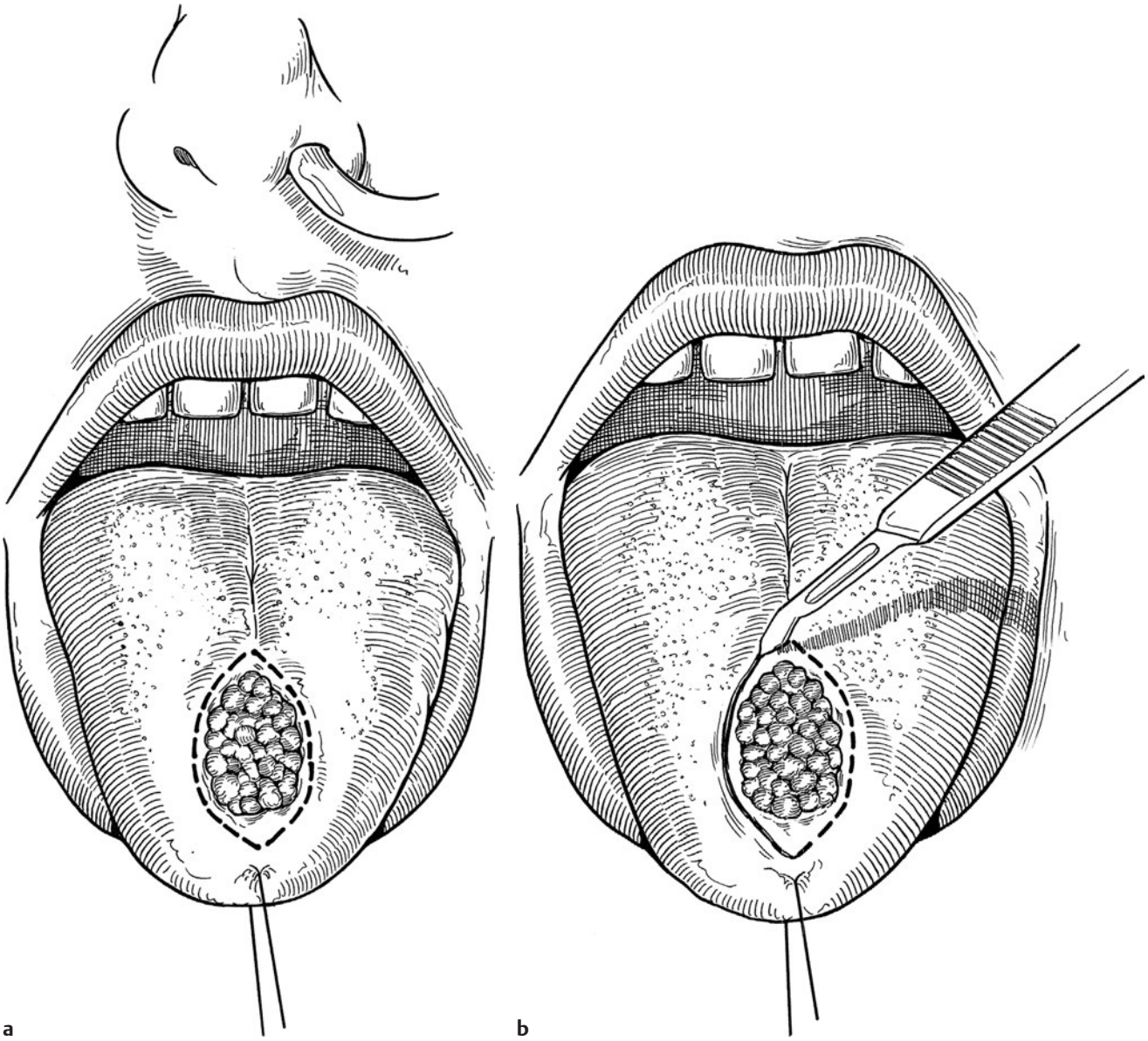
Inspection of the anterior tongue lesion is all that is required. No further evaluation is needed. Posterior tongue lesions may require magnetic resonance imaging (MRI) or computed tomography (CT) for complete evaluation. Ultrasound may also be helpful.

Operative Technique

1. Discrete lesions of the tongue are excised using general anesthesia administered through nasotracheal intubation to facilitate intraoral exposure.
2. A 3-0 silk suture is passed through the anterior portion of the tongue and used for traction (**Fig. 20.3a**).
3. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
4. The lesion is excised with an elliptical incision through mucosa and into the underlying muscle (**Fig. 20.3b,c**).
5. The incision is closed with a single layer of 3-0 interrupted chromic suture (**Fig. 20.3d**).

Complications

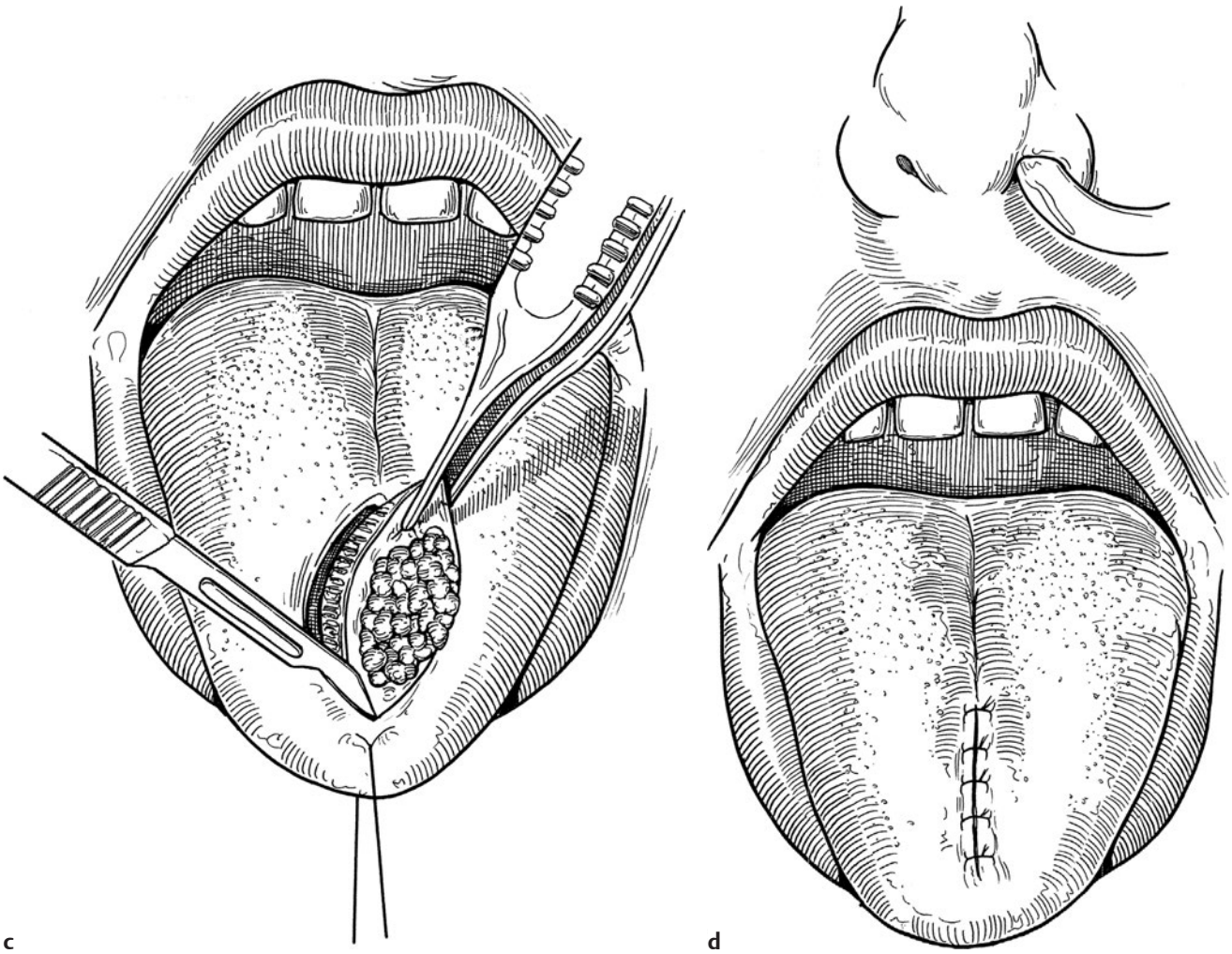
1. Wound dehiscence
2. Bleeding



a b

Fig. 20.3a,b

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c d

Fig. 20.3c,d

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20-4 Excision of Lingual Thyroglossal Duct Cysts

Introduction

Base of tongue masses, such as lingual thyroid tissue or cysts, can present on physical exam or may be diagnosed by CT or MRI.

Indications

Masses within the base of tongue muscle or within the vallecular region at the base of tongue require excisional biopsy.

Preoperative Evaluation

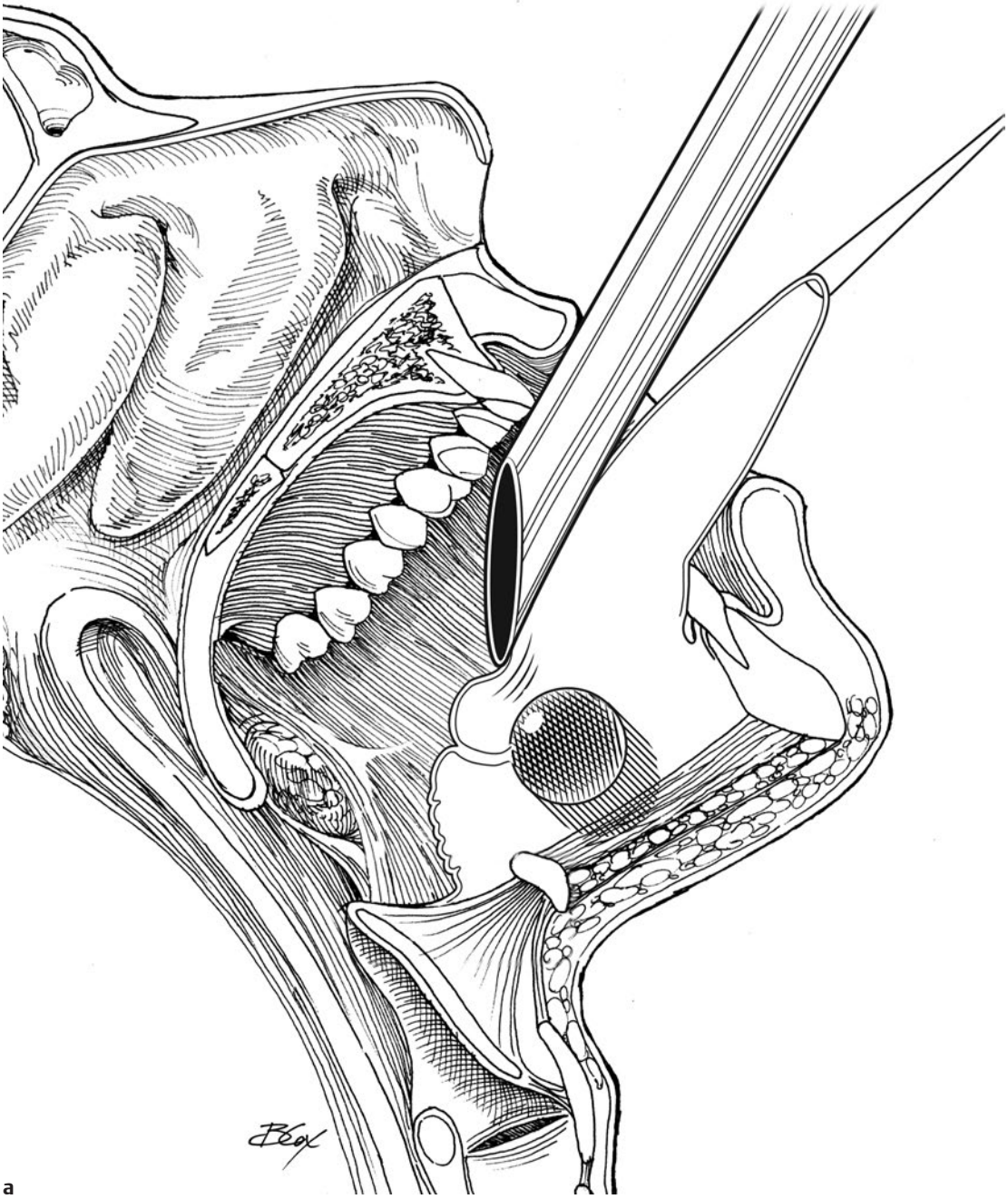
These lesions frequently present with symptoms of dysphagia. CT scanning or MRI evaluation is helpful for masses or cysts within the tongue musculature to delineate depth and extent of the cyst. Preoperative evaluation of presumed lingual thyroid cysts should include an ultrasound of the neck or thyroid scan to confirm the presence of normal thyroid tissue.

Operative Technique

1. Surgery is performed under general anesthesia utilizing a cuffed nasotracheal tube. The patient can be in Rose position with neck hyperextended or in a more neutral position. This latter position is required for a patient with potential C-spine anomalies.
2. Antibiotic coverage is suggested for masses that are within the tongue musculature.
3. A 3-0 silk suture is placed through the anterior tongue tip for retraction purposes.
4. A Lindholm laryngoscope is used to visualize the base of the tongue, and the laryngoscope is suspended from a Mayo stand (**Fig. 20.4a**).
5. Alternatively, depending on the location of the lesion to be excised, visualization of the appropriate area of the tongue may be done with either a Dingman or Crowe-Davis mouth gag or suspension.
6. One percent lidocaine with 1:100,000 epinephrine is injected submucosally at the site of the incision for hemostasis.
7. Vallecular cysts can be fully excised with sharp and blunt dissection using scissors (**Fig. 20.4b**) or with a guarded needle point cautery (**Fig. 20.4c**) with extended hand piece.
8. Intramuscular cysts of the tongue require incision into the tongue base and dissection to locate the cyst wall with further sharp and blunt dissection. The base of the cyst should be tied off in case there is an associated tract.
9. Incision sites are either left open for secondary closure or closed loosely with interrupted Vicryl (Ethicon) or chromic sutures.

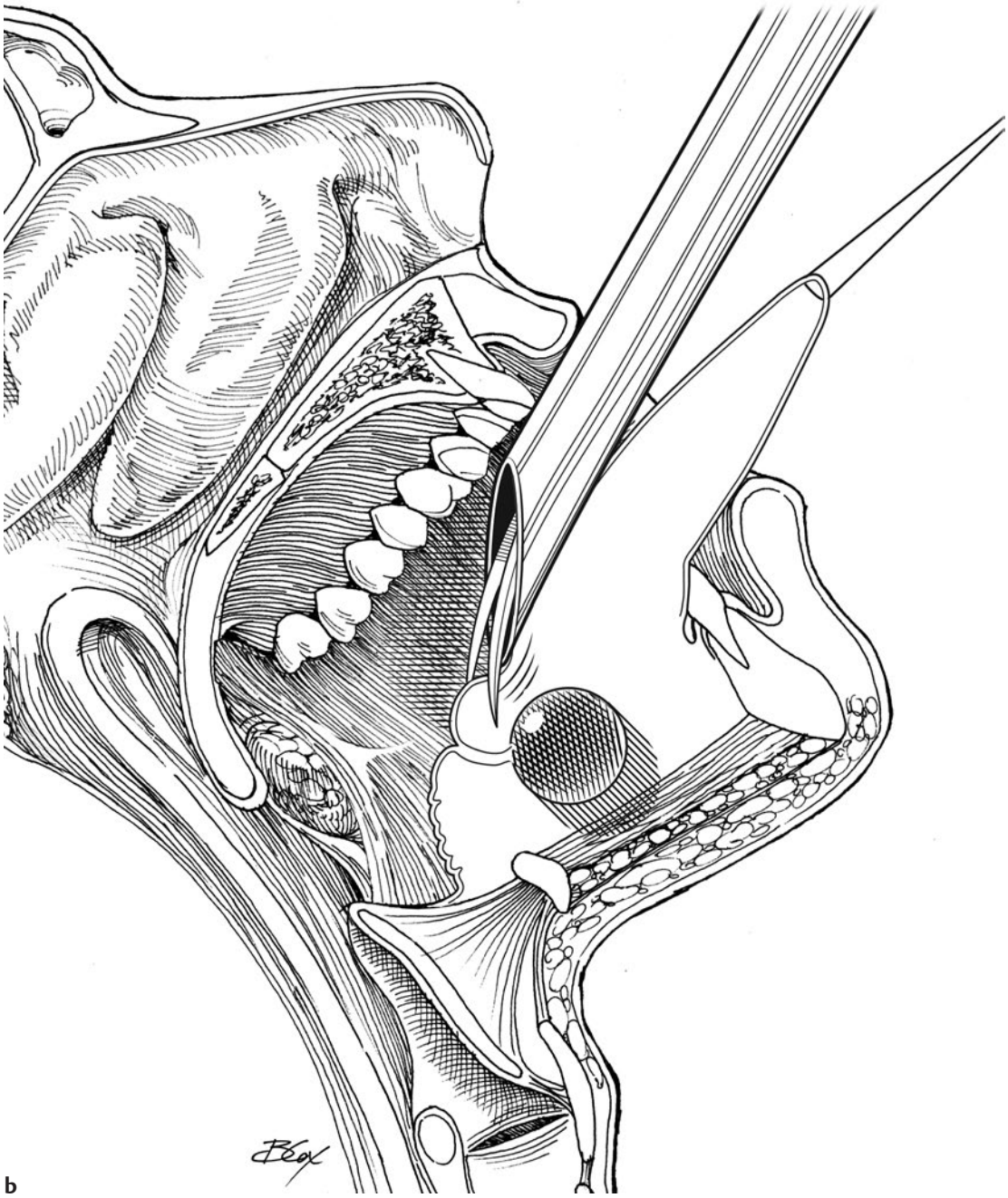
Complications

1. Recurrence of cyst
2. Base of tongue infection



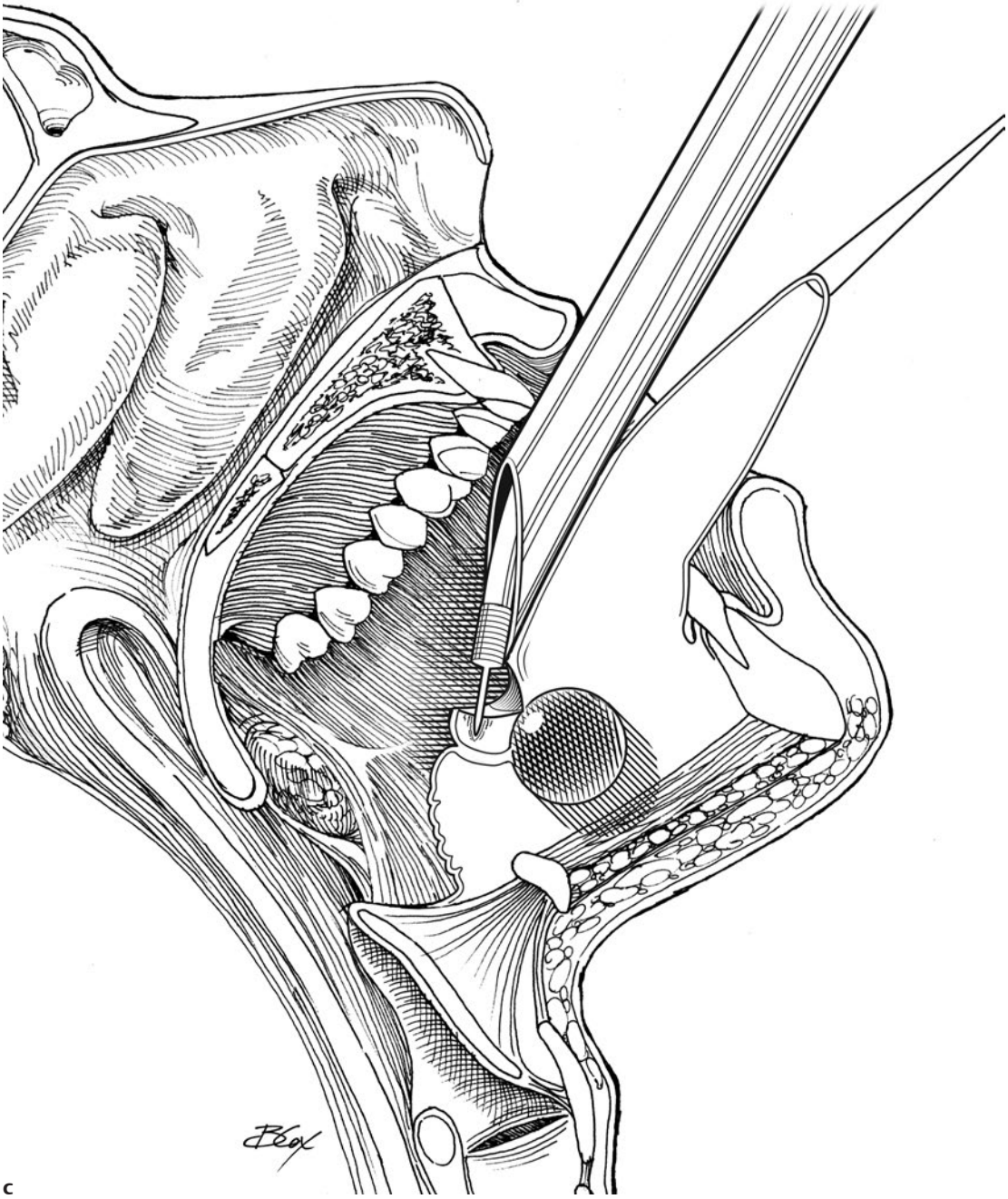
a

Fig. 20.4a



b

Fig. 20.4b



c

Fig. 20.4c

20-5 Excision of Diffuse Tongue Lesions

Introduction

Diffuse lesions of the tongue are usually hemangiomas or lymphangiomas.

Indications

Surgical treatment of lymphangiomas or hemangiomas of the tongue is required when there is recurrent bleeding, tissue necrosis, infection, or airway obstruction. A large lesion may cause disfigurement, dysphagia, or an articulation disorder.

Preoperative Evaluation

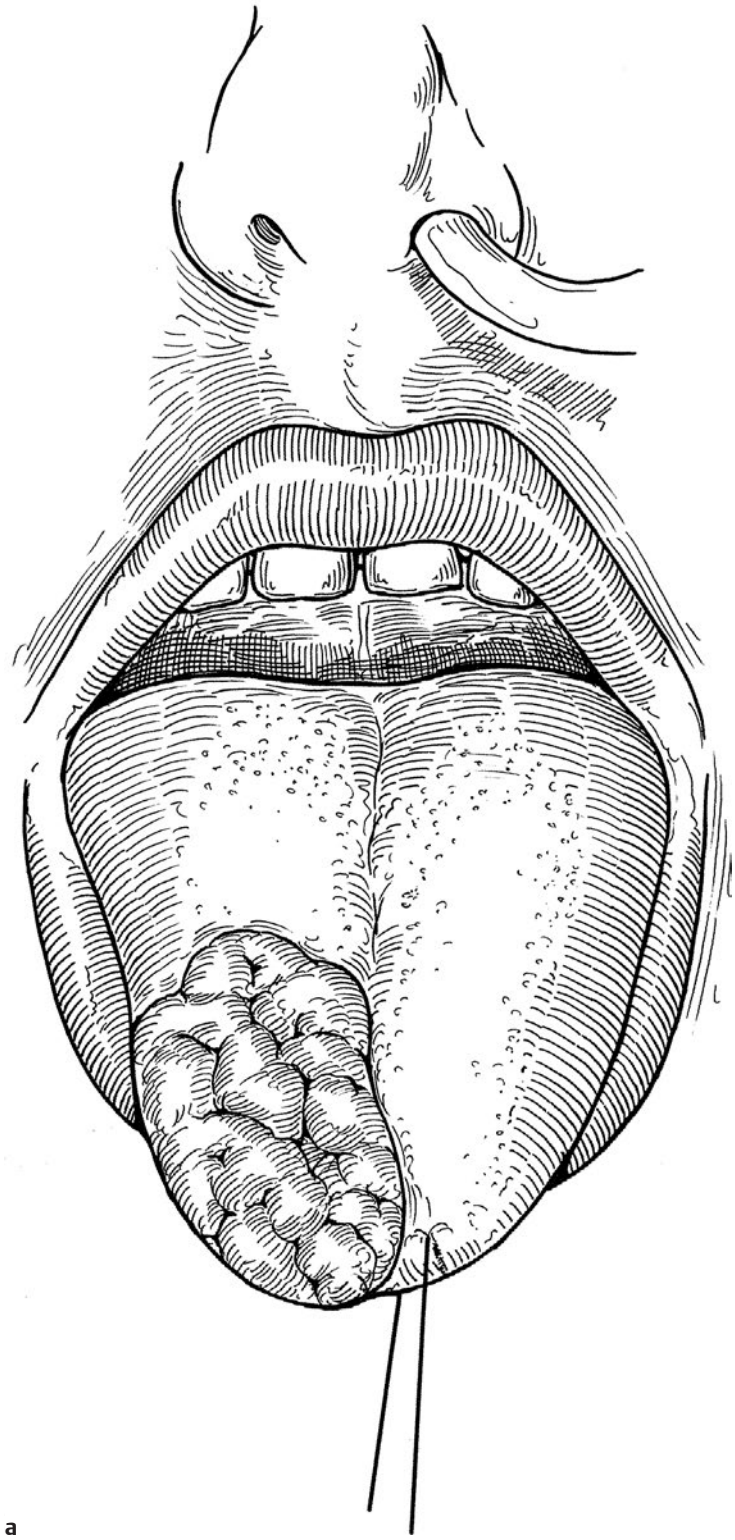
Inspection of the lesion is sufficient for small focal lesions. A CT scan or MR angiogram (MRA) scan is needed for other lesions to define the extent of involvement of the floor of the mouth. Preoperative embolization is recommended for large vascular lesions.

Operative Technique

1. Surgery for diffuse lesions of the tongue is performed under general anesthesia utilizing nasotracheal intubation.
2. A 3-0 silk suture in the tip of the tongue is used for traction (**Fig. 20.5a**).
3. A CO_2 or KTP laser is used to vaporize and "sculpt" the lesion until it is flush with the surface of tongue muscle (**Fig. 20.5b,c**). The KTP laser works well for venous malformations. Coblation should be considered for excision of lymphatic malformations.
4. Deep or large defects may require multilevel closure using multiple figure-of-eight knots of 3-0 or 4-0 chromic suture.

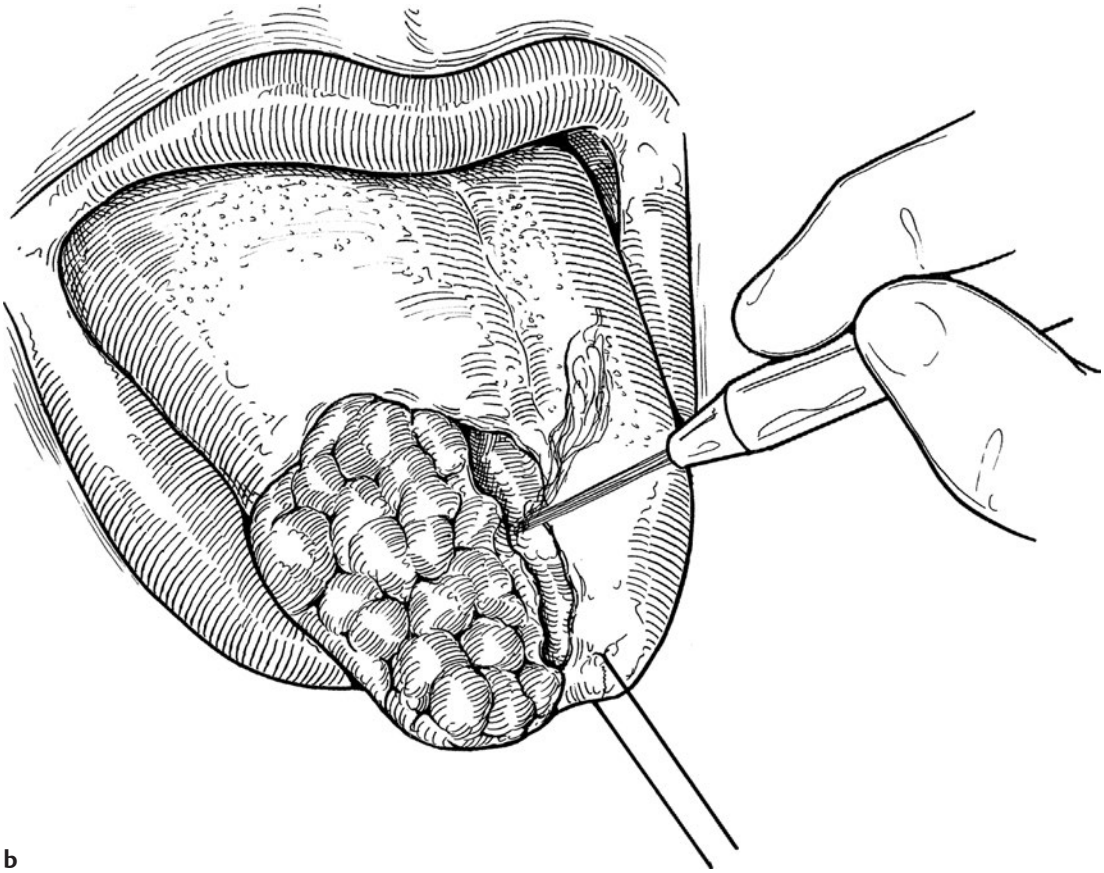
Complications

1. Recurrence of the lesion
2. Tongue swelling with airway obstruction
3. Bleeding

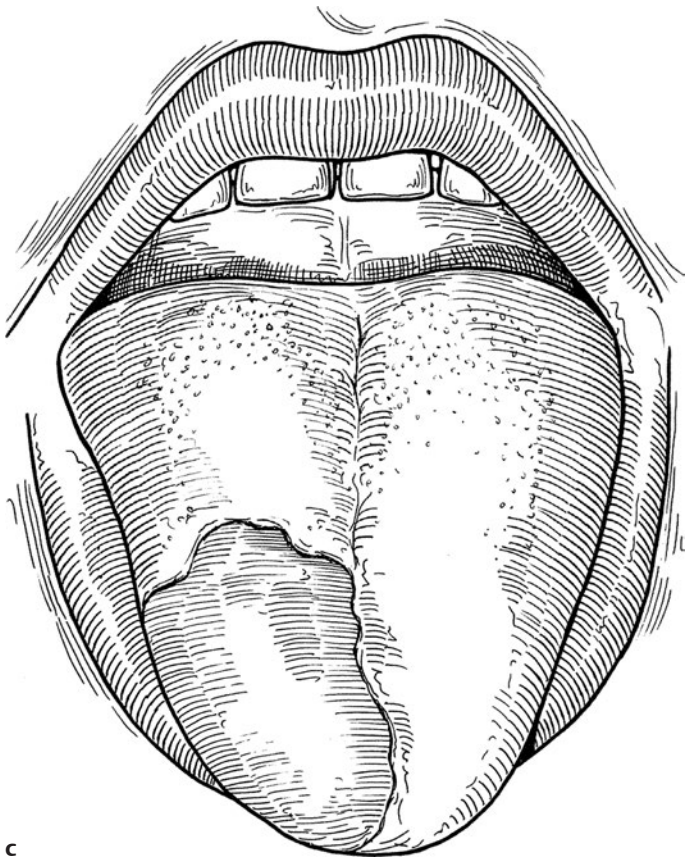


a

Fig. 20.5a



b



c

Fig. 20.5b,c

20-6 Anterior Tongue Reduction

Introduction

Macroglossia often causes feeding and breathing difficulties. Tongue reduction by excision provides reliable results and limited postoperative morbidity. Two of the most commonly used techniques involve excision of the lateral and anterior borders of the tongue or removal of a central wedge of tongue tissue. These two procedures, used separately or together, are usually sufficient to accomplish anterior tongue reduction.

Indications

Anterior tongue reduction is performed when the protuberant tongue causes oral dysfunction such as problems with oral hygiene, airway compromise, deglutition, articulation, or orthognathic complications. The child's appearance may be psychologically distressing to both the parents and the child.

Preoperative Evaluation

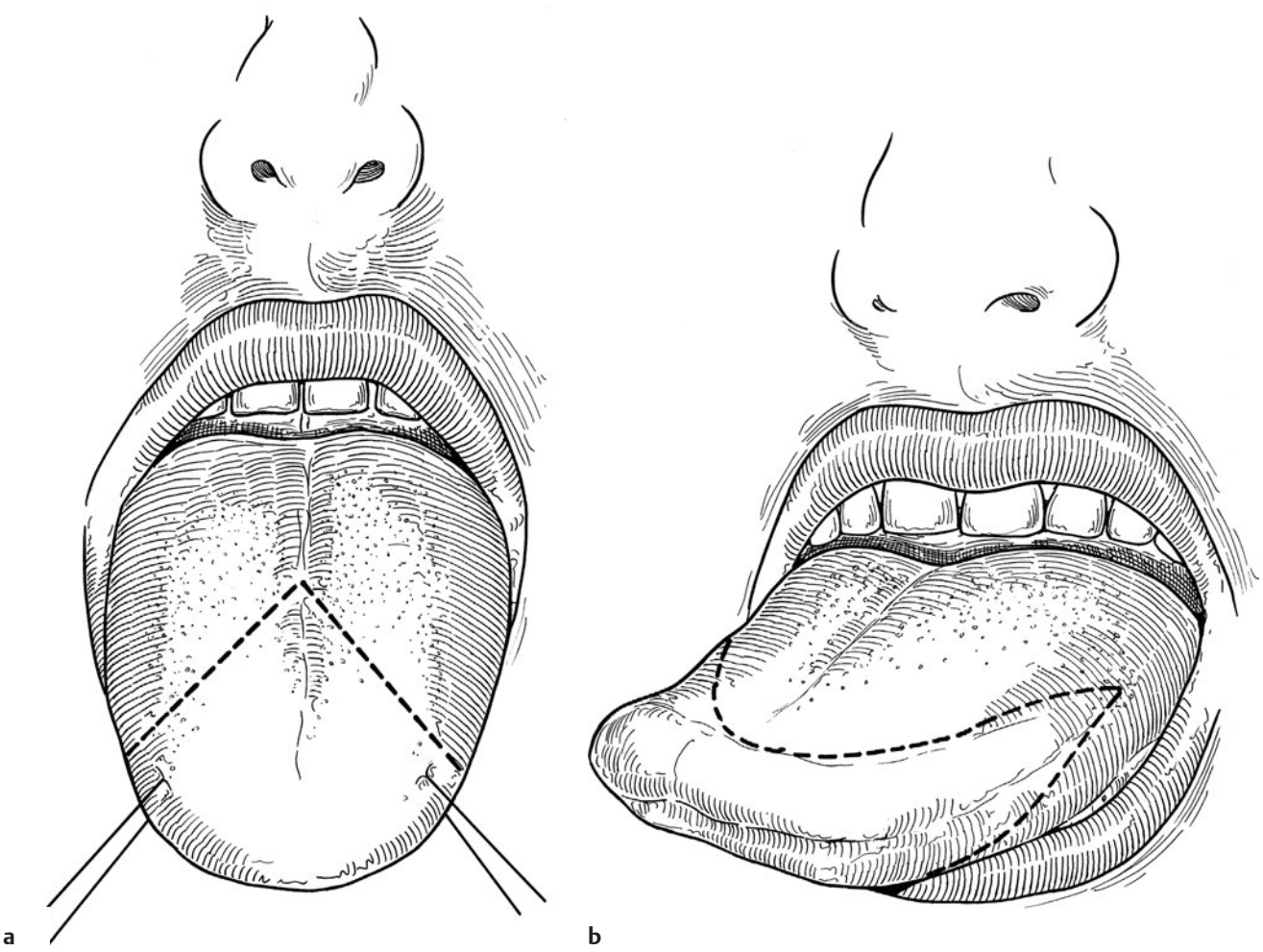
Inspection of the tongue and evaluation of the complications of macroglossia are sufficient. A preoperative sleep study is helpful to determine if obstructive sleep apnea is present. A preoperative speech evaluation should be obtained if appropriate for the child's age.

Operative Technique

1. Tongue reduction is best performed under general anesthesia utilizing a nasotracheal tube.
2. The lines of excision are drawn on the tongue with a marking pencil (**Fig. 20.6a,b**); 3-0 silk sutures are used for traction.
3. One percent lidocaine with 1:100,000 epinephrine can be injected submucosally at the site of the incision to aid in hemostasis.
4. The appropriate portion of tongue tissue is removed with a knife or cutting cautery to achieve the desired result (**Fig. 20.6c,d**).
5. The wound is closed with deep and mucosal 3-0 Vicryl suture after hemostasis is obtained (**Fig. 20.6e,f**).
6. Dexamethasone is given intraoperatively and tapered over 3 days postoperatively to reduce edema.
7. The patient is usually kept intubated for 12–24 hours and broad-spectrum antibiotics are given for 10–14 days.

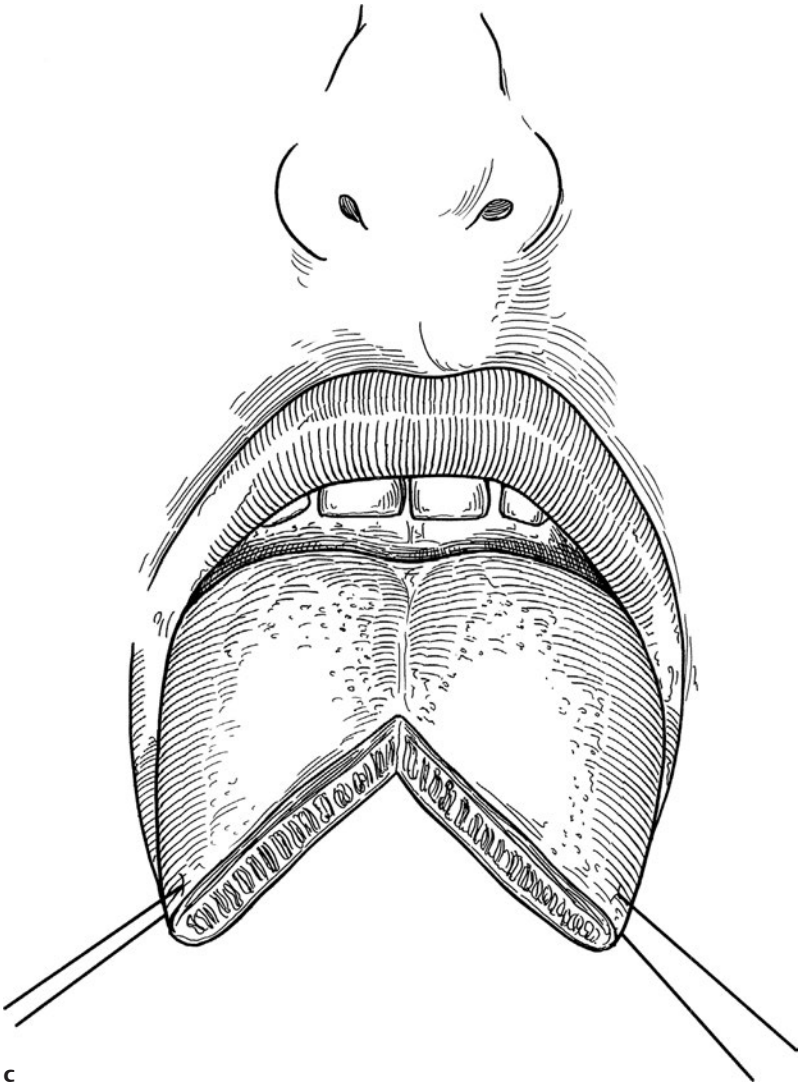
Complications

1. Tongue swelling with airway obstruction
2. Wound dehiscence
3. Bleeding

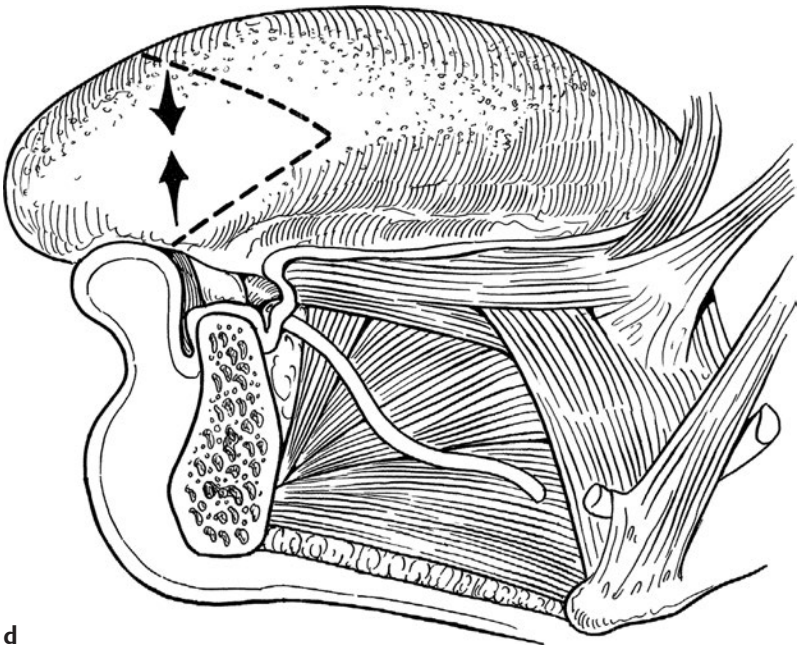


a b

Fig. 20.6a,b

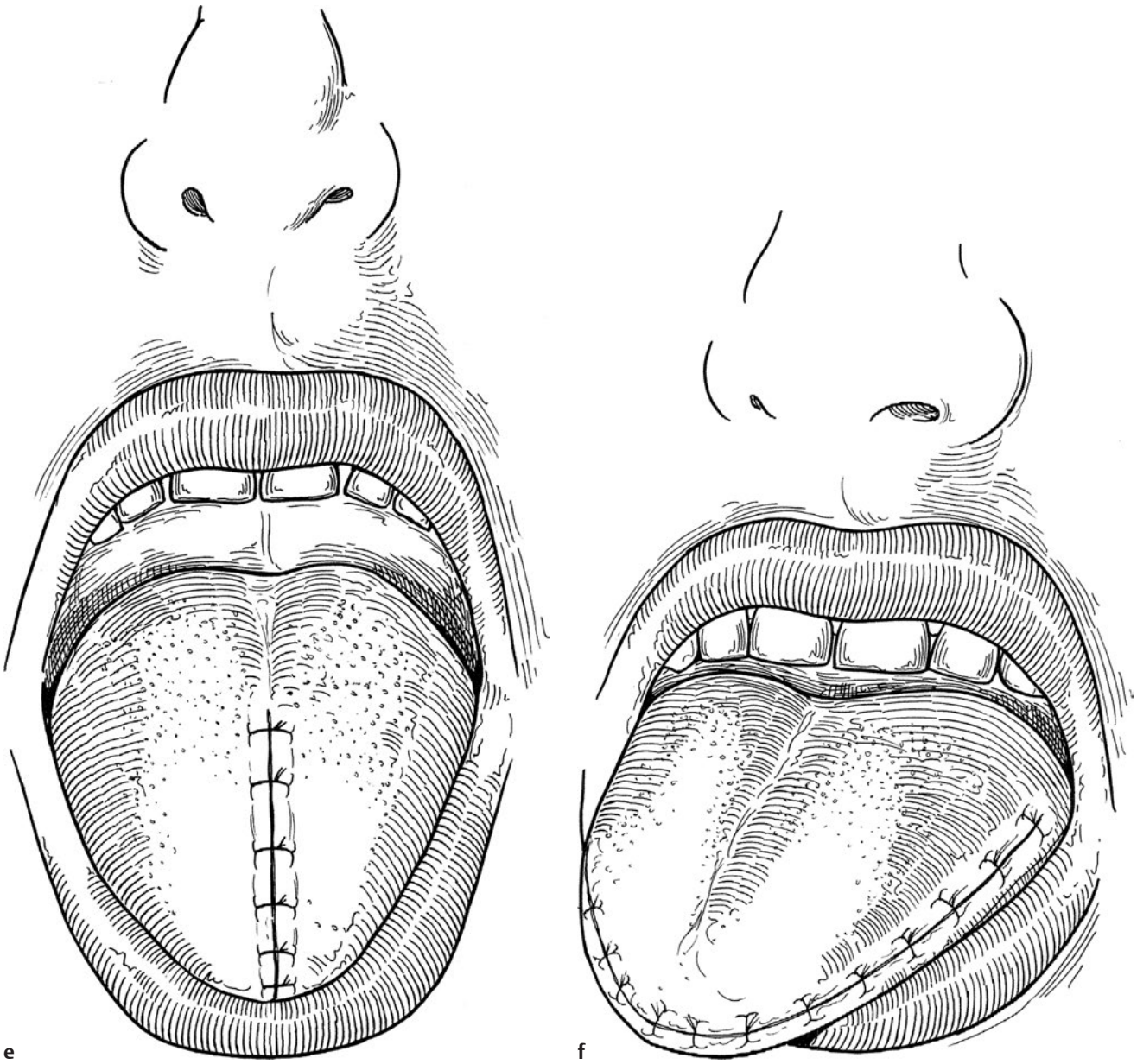


c



d

Fig. 20.6c,d



e f

Fig. 20.6e,f

20-7 Posterior Tongue Reduction

Introduction

Anterior tongue reduction is helpful for cases of macroglossia that cause chronic tongue protusion, eating, and speech difficulties. In cases of macroglossia causing airway obstruction and obstructive sleep apnea, the obstruction more often occurs at the base of the tongue. Wedge resection of the base of the tongue (**Fig. 20.7a,b**) can be done, but due to the lack of closure of the surgical defect, healing and postoperative pain are prolonged and the procedure is associated with a difficult postoperative course.

The midline posterior glossectomy procedure removes tongue muscle bulk but also allows for closure of the wound.

Indications

This surgery is indicated in cases of relative or true macroglossia and associated airway obstruction or sleep apnea from base of tongue obstruction.

Preoperative Evaluation

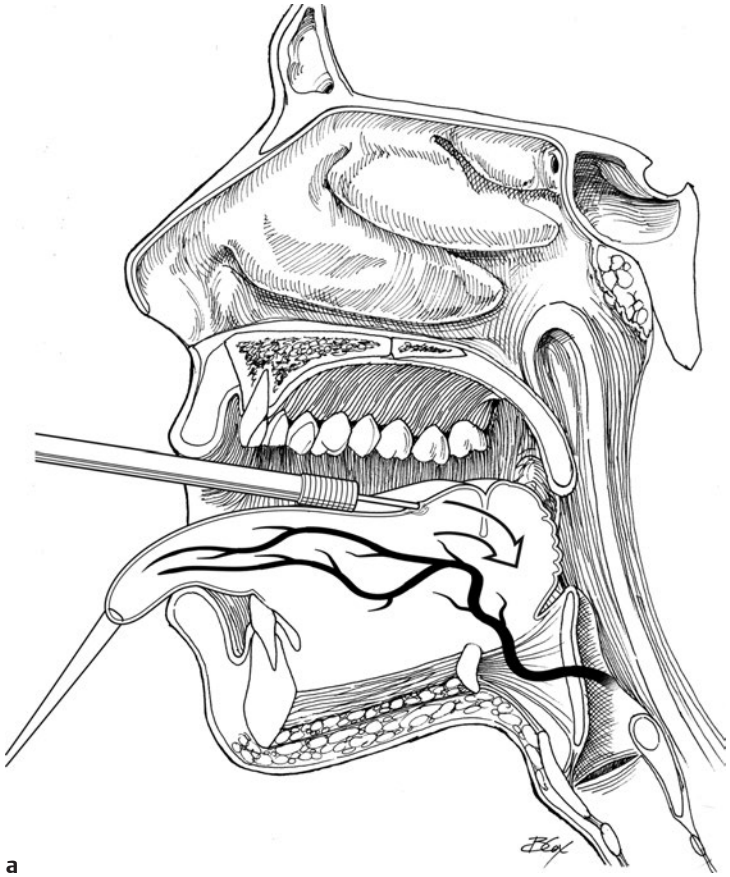
Endoscopy either in the office or operating room can be used to make this diagnosis. Sleep cine MRI is also very helpful in showing the dynamic collapse of the retroglossal area along with the macroglossia.

Operative Technique

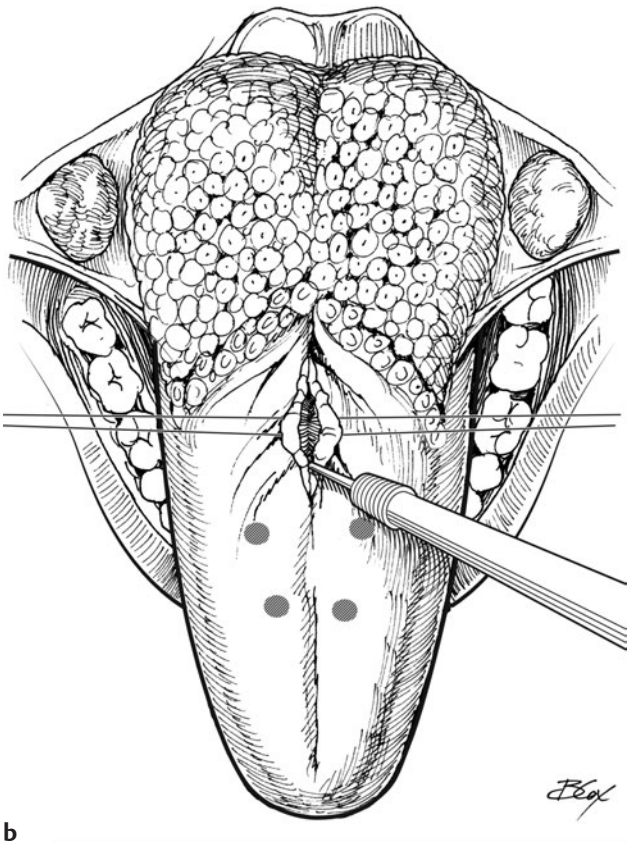
1. Midline posterior glossectomy is performed under general anesthesia utilizing a cuffed nasotracheal tube. The patient should be in a supine position.
2. A 2-0 silk suture is placed into the midline tip of the tongue for retraction purposes. The Jennings mouth gag can be used for good exposure of the tongue.
3. Doppler ultrasound is used to document the location of the lingual arteries. The distance from the midline and depth of the artery on both the right and left side of the midline are determined starting approximately 1–2 cm anterior to the most anterior circumvallate papillae and then at a second point more posterior on the tongue surface. In addition, ultrasound is used to confirm the normal course of the hypoglossal nerve as it courses with the lingual artery lateral and deep to the planned dissection.
4. Local anesthesia of 1% lidocaine with 1:100,000 epinephrine is injected along the midline of tongue into the tongue base.
5. A midline mucosal incision is made with a needle point guarded Bovie cautery, starting 1–2 cm anterior to the most anterior extent of the circumvallate papillae (**Fig. 20.7a,b**).
6. A coblation wand is then used to deepen this initial incision and create lateral flaps of mucosa that are not excised. The needle point Bovie is used to make the midline mucosal incision followed by the coblation wand, which deepens the excision site and elevates mucosal flaps. It is important to keep in mind the location of the lingual artery as the limits of both the lateral extent of the tissue excised and the depth of tissue that is safely removed (**Fig. 20.7c**).
7. Approximately every 1–2 cm, retraction sutures of 3-0 silk are placed in the elevated mucosa flaps to provide better visualization of the base of tongue (**Fig. 20.7d**).
8. As the dissection continues more posteriorly, the area of the vallecula can be visualized with a laryngeal mirror to assist with the dissection to this level.
9. Once adequate tissue has been removed, the anterior aspect of the incision is closed with two 3-0 Vicryl sutures, either simple or mattress sutures. The posterior aspect of the incision remains open for adequate drainage and to minimize the chance for infection in the base of the tongue.
10. Patients receive intraoperative and postoperative antibiotics as well as anti-inflammatory steroids. Discharge from the hospital occurs once the patient is adequately taking fluids and is able to take oral antibiotics.

Complications

1. Sutures used to close anterior aspect of incision can break or prematurely extrude; this still results in appropriate healing, but it takes much longer (up to several weeks) for full closure of the surgical site
2. Injury and bleeding from lingual artery
3. Injury to hypoglossal nerve with loss of nerve function
4. Base of tongue infection

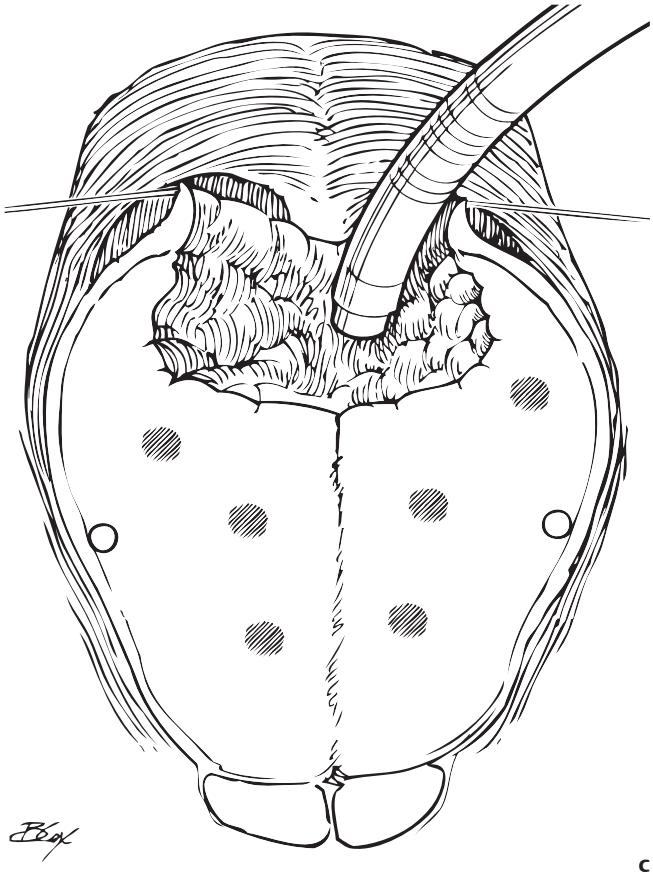


a

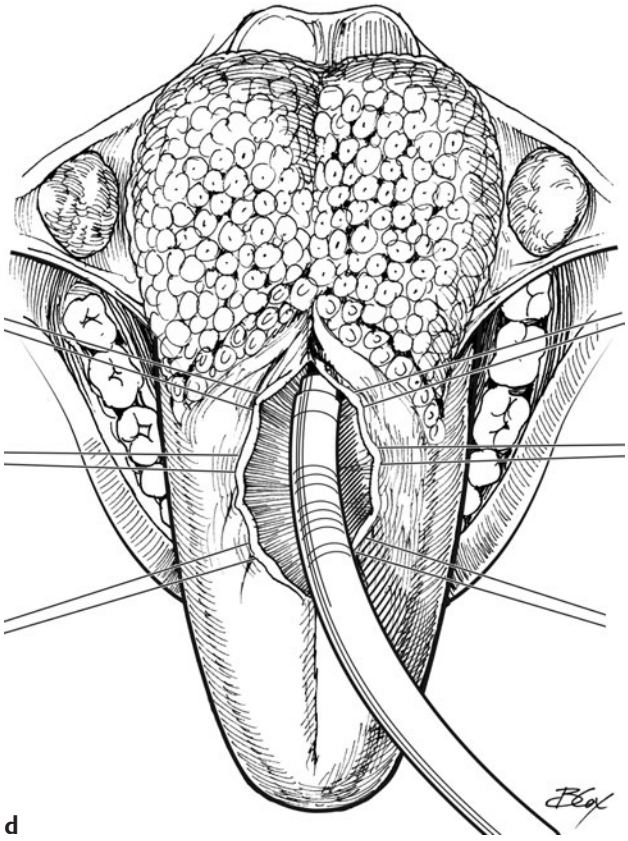


b

Fig. 20.7a,b



c



d

Fig. 20.7c,d

20-8 Tongue Genioglossus Suspension

Introduction

Although advancement of the genioglossus muscle by mandibular osteotomy and advancing a segment of the anterior mandible bone at the level of the genial tubercle has been described for use in adults, this technique is less often an option in most children in whom secondary teeth have not yet erupted. The genioglossus suspension can be used in patients of all ages and applies retraction support more directly to the base of tongue. In this surgery, a 3-mm titanium screw, with attached sutures, creates a sling around the base of tongue to minimize posterior motion and collapse of the base of tongue.

Indications

This surgery is indicated for patients who have obstructive sleep apnea due to glossoptosis, with base of tongue obstruction.

Preoperative Evaluation

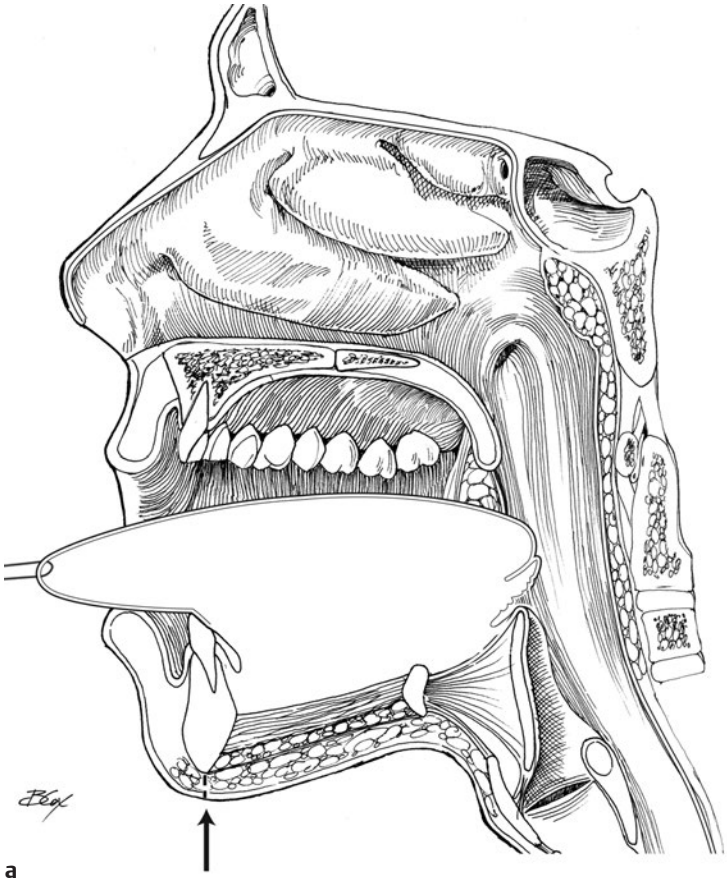
Sleep cine MRI often shows glossoptosis in patients with obstructive sleep apnea. Flexible endoscopy in the office or operating room can also provide evidence of glossoptosis.

Operative Technique

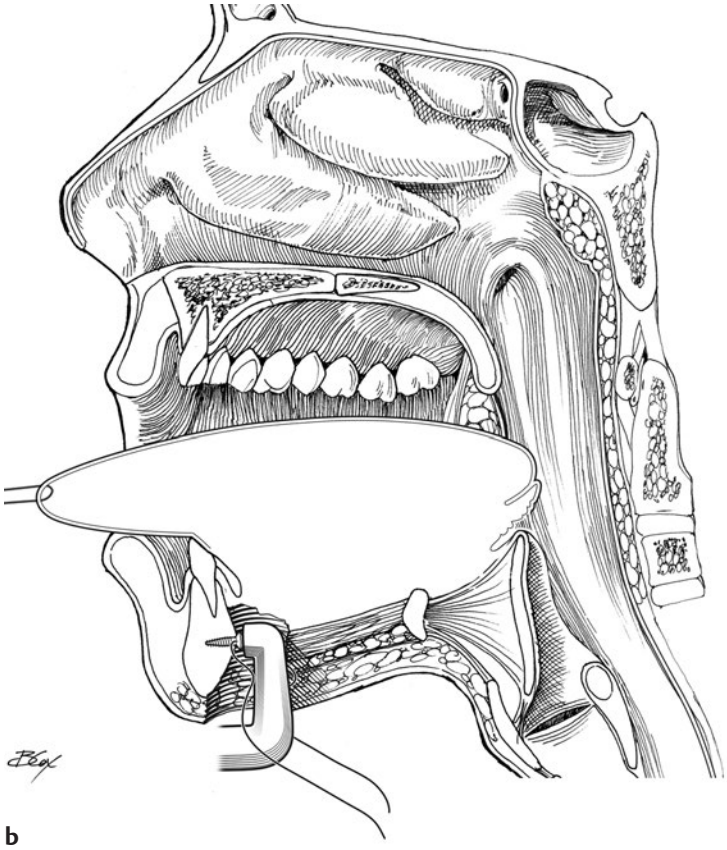
1. The genioglossus suspension is done under general anesthesia utilizing a nasotracheal tube. Refer to the Airvance System (Medtronic) website for description: http://www.medtronic.com/for-healthcare-professionals/products-therapies/ear-nose-throat/sleep-disordered-breathing-products/airvance-system-for-obstructive-sleep-apnea/
2. Intraoperative intravenous antibiotics are given and are continued for 10 days postoperatively.
3. After injection of local anesthesia of 1% lidocaine with 1:100,000 epinephrine, a submental skin incision, approximately 2 cm in length, is made in the submental region (**Fig. 20.8a**).
4. After the skin incision is made, blunt dissection through the submental fat and muscles is done until the oral side of the midline mandible is reached. A Cottle elevator is used to elevate the periosteum from the area of the genial tubercle. Using a kit supplied by Medtronics, Airvance Tongue Suspension, a drill with attached 3-mm titanium screw is used to place the screw into the oral side of the mandible at this level. Attached to this screw are two O-Prolene sutures (**Fig. 20.8b**).
5. Using a passing needle instrument supplied in this kit, a passing suture is placed through the submental incision, coursing through the floor of mouth component of the genioglossus muscles, and then comes out intraorally, 1–1.5 cm lateral to the midline on one side of the tongue, approximately 1–2 cm posterior to the apex of the circumvallate papillae (**Fig. 20.8c,d**). The loop suture attached to this passing instrument is released from the needle, and the oral and submental ends of this suture are secured with a hemostat temporarily.
6. One of the Prolene sutures (Ethicon) is then passed, using the same needle instrument, through the submental incision and through the floor of mouth and comes out intraorally, 1–1.5 cm lateral to the midline on the opposite side, approximately 1–2 cm posterior to the apex of the circumvallate papillae (**Fig. 20.8e**). The suture is then threaded onto a curved needle, and starting at the same site where the previously used needle came out of the tongue muscle (**Fig. 20.8f**), the curved needle courses across the base of tongue in the fibrous submucosal tissue, coming out on the same side of the midline, at the level of the first looped passing suture (**Fig. 20.8g**).
7. The Prolene suture is then looped into one of the ends of the passing suture and pulled out anteriorly through the submental incision.
8. The two Prolene sutures are then tied in the submental incision such that retraction of the base of tongue can be palpated. It is useful to place a finger in the area of the base of tongue as the suture is tied down to feel this traction applied to tongue base. This creates a triangular sling with the Prolene suture (**Fig. 20.8h,i**).
9. The submental incision is then copiously irrigated. A Penrose drain is placed, and the submental incision is closed with interrupted sutures. The drain is removed the next day.
10. Antibiotics are given intra- and postoperatively.
11. Patients are discharged home once able to take fluids adequately and take oral antibiotics.

Complications

1. Submental seroma or infection. There is the potential for osteomyelitis if this infection is not treated fully, due to the foreign body in the mandible (e.g., titanium screw).
2. Suture can pull anteriorly, through tongue muscle if it is the horizontal component of sling, across the base of tongue if placed too deeply, and not within the more superficial fibrous mucosal level.

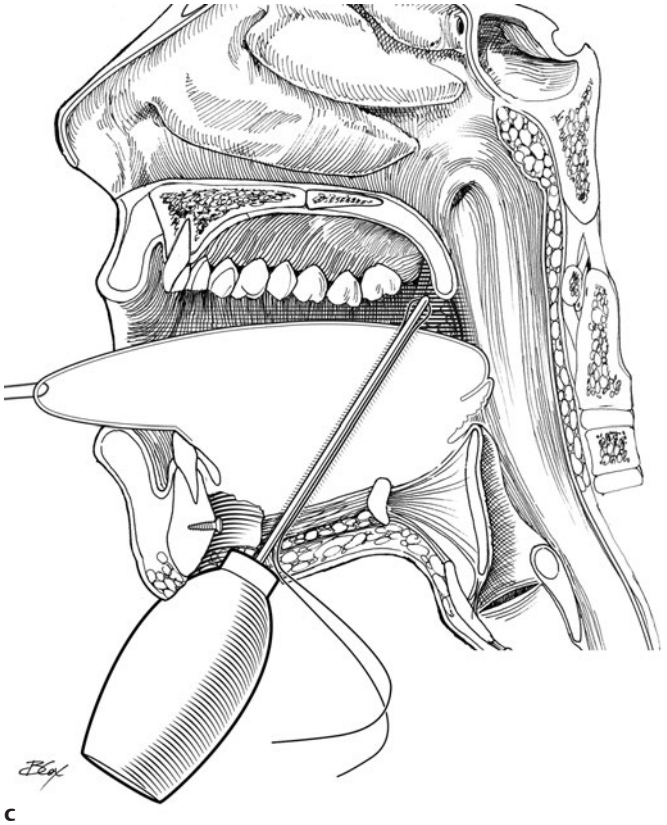


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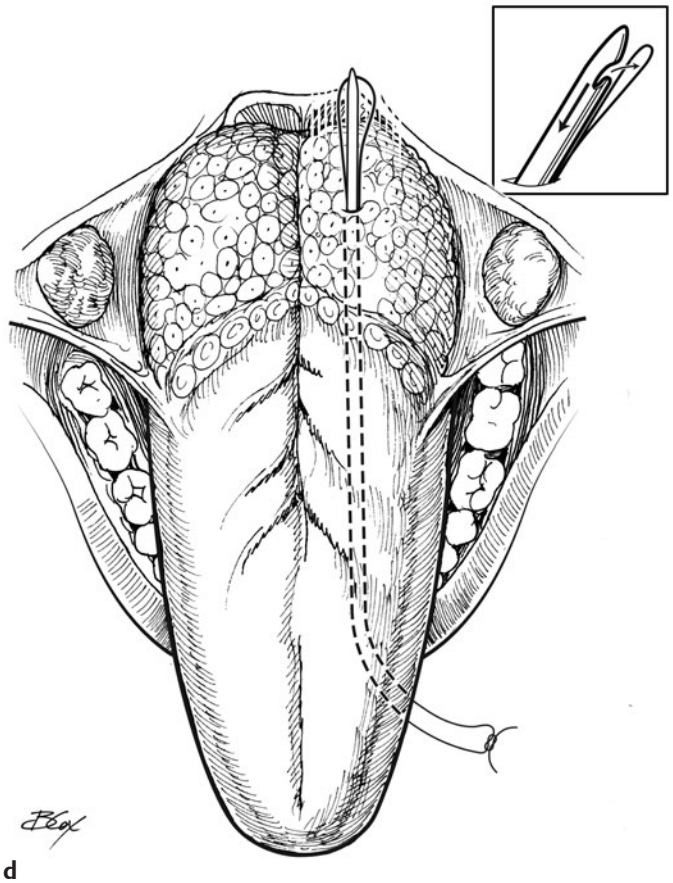


b

Fig. 20.8a,b

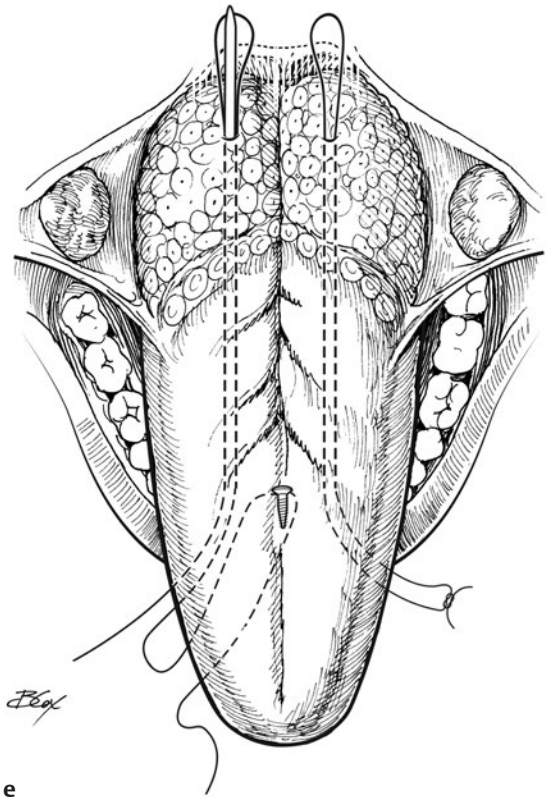


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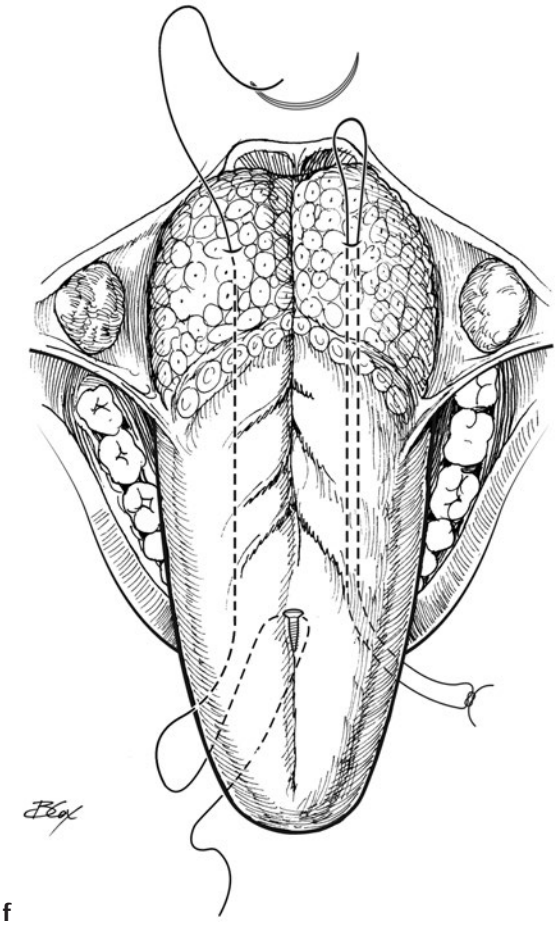


d

Fig. 20.8c,d

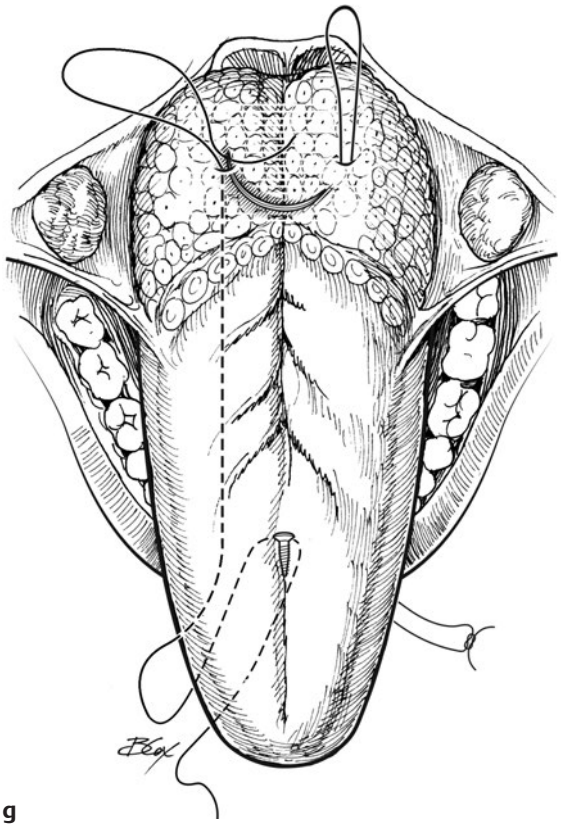


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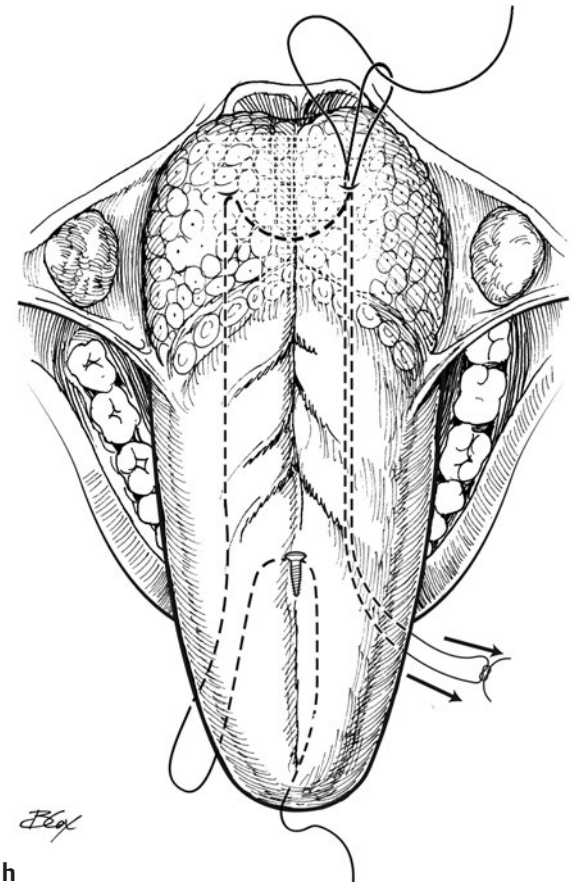


f

Fig. 20.8e,f

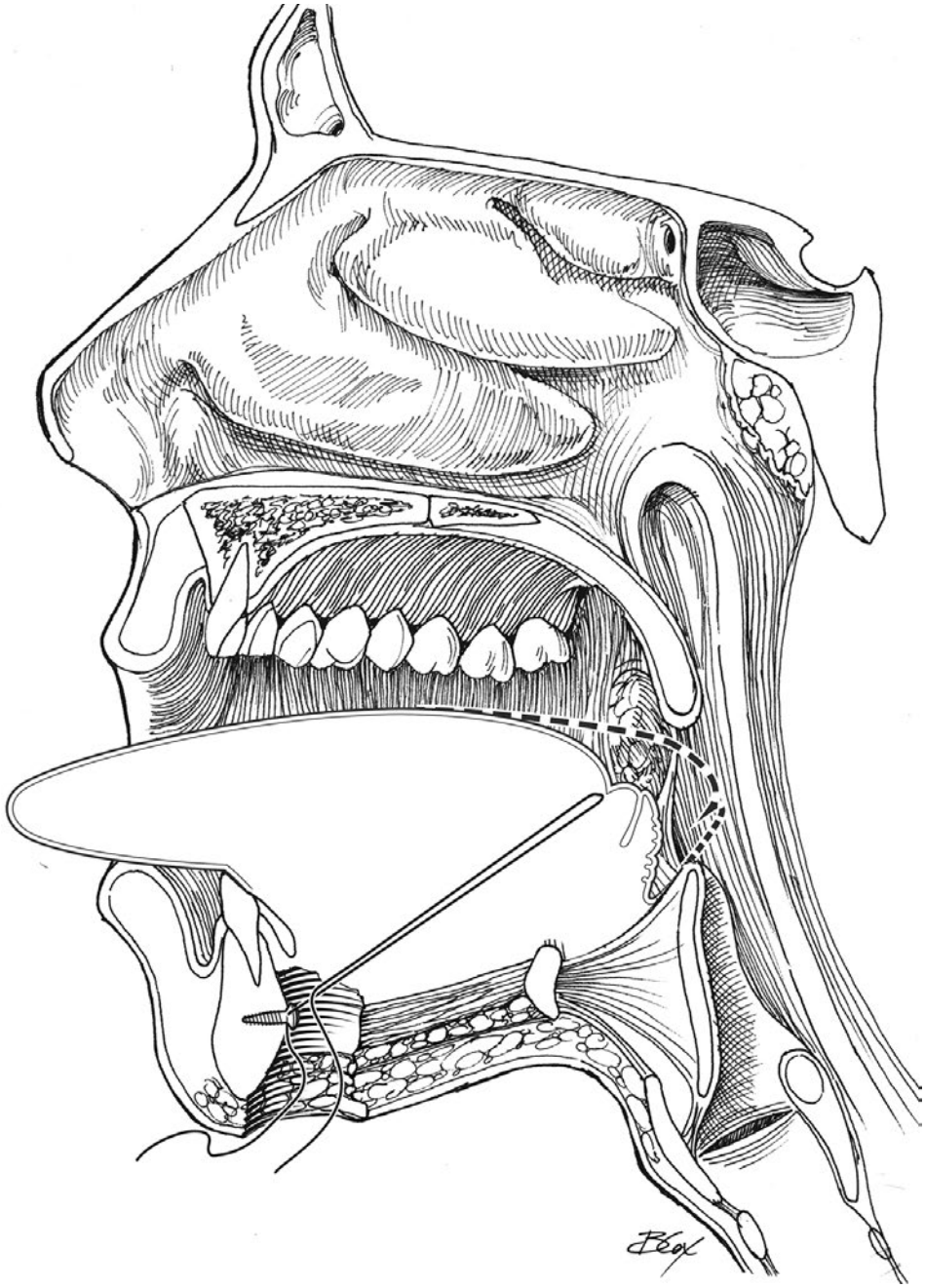


g



h

Fig. 20.8g,h



i

Fig. 20.8i

21 Tumors of the Oral Cavity and Jaw

Sally R. Shott

Tumors of the jaw may impinge on the oral cavity and alter oral function as well as affect facial appearance.

21-1 Excision of Fibrous Dysplasia

Introduction

Fibrous dysplasia is a benign locally invasive fibro-osseous disorder. In its most common monostotic form, it involves the maxilla more often than the mandible. The lesion usually presents with an obvious deformity of the involved bony structure (**Fig. 21.1a**).

Indications

Surgery is indicated both to confirm the diagnosis and to sculpt the lesion to restore normal anatomy and function. Radical excision of this lesion is never indicated. Repeat procedures may be required to treat this slow-growing lesion.

Preoperative Evaluation

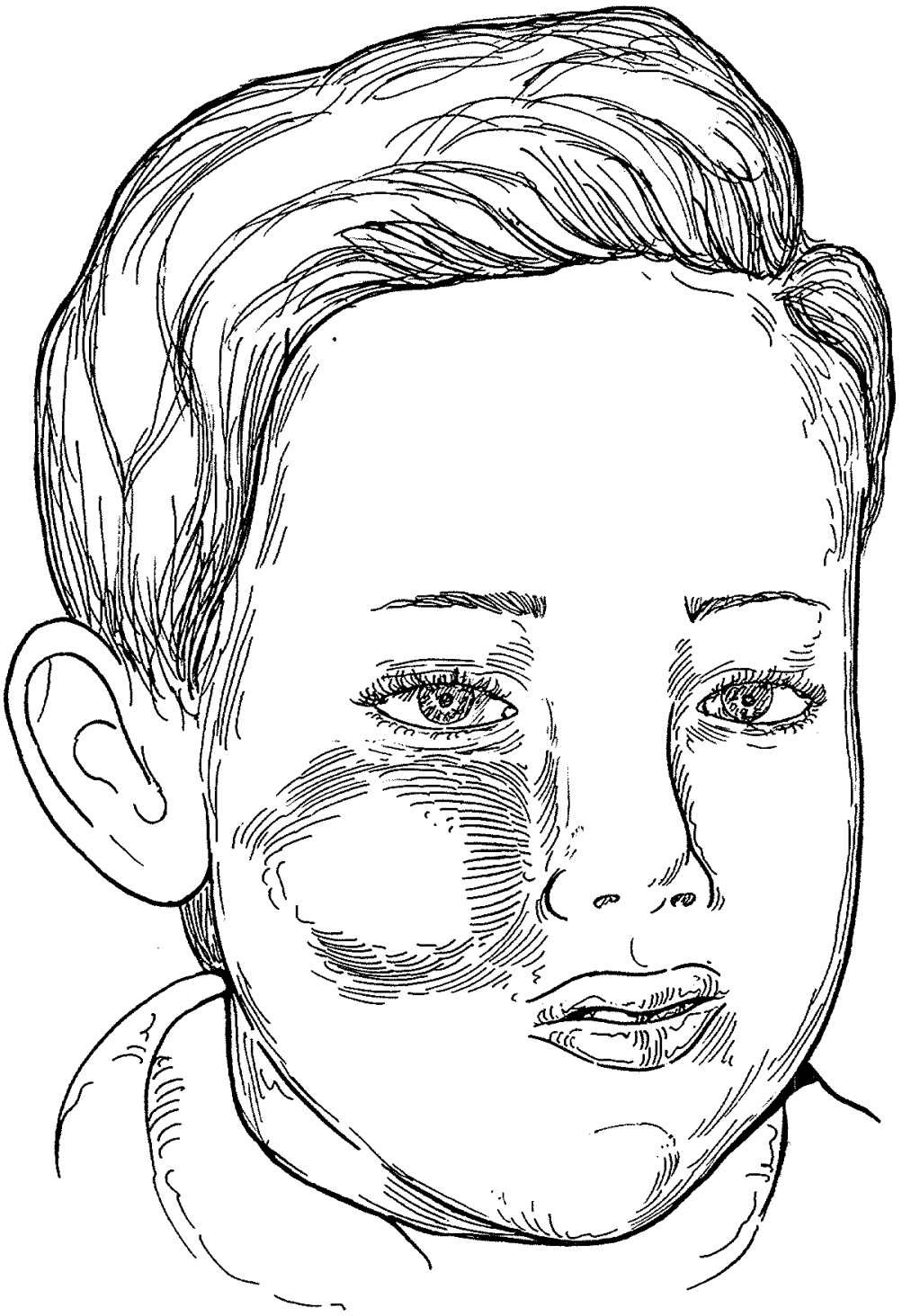
Computed tomography (CT) scan of the affected bony area is mandatory before surgical intervention.

Operative Technique

1. General anesthesia is administered through a nasal endotracheal tube placed in the uninvolved side. If the lesion involves the maxilla, the usual approach to this area is the gingivobuccal approach as in the Caldwell-Luc procedure.
2. One percent lidocaine with 1:100,000 epinephrine is injected into the gingivobuccal sulcus (**Fig. 21.1b**).
3. An incision in the gingivobuccal sulcus 5 mm above the gum line is made with a no. 15 blade. The incision is carried down to the periosteum of the maxilla with the cutting cautery (**Fig. 21.1c**).
4. A periosteal elevator is used to elevate the soft tissues of the cheek off of the face of the maxilla until the infraorbital nerve is identified (**Fig. 21.1d**).
5. If there is a thin layer of normal bony cortex, this is cracked and removed with a small curved clamp or elevator (**Fig. 21.1e**).
6. The tumor is debulked with a knife or large cup forceps (Takahashi) or curette, depending on its gritty nature. When the desired contour has been obtained, the operation is terminated (**Fig. 21.1f**). If there is a patent maxillary sinus cavity, patency of the maxillary ostia should be confirmed with nasal endoscopy, and endoscopic antrostomy should be done if needed.
7. The mucosa of the cheek is sutured loosely with interrupted 4-0 chromic sutures. These sutures are left in place until they dissolve on their own (**Fig. 21.1g**).

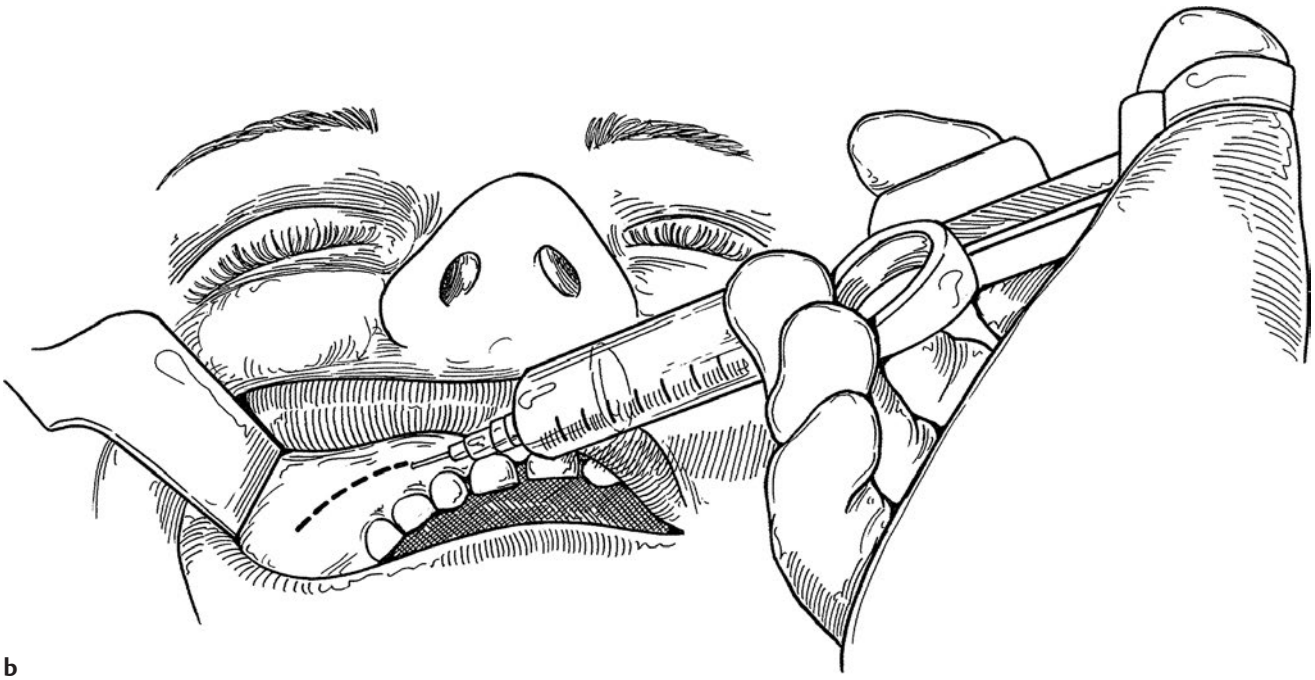
Complications

1. Recurrence from incomplete excision
2. Ocular injury
3. Infraorbital nerve injury

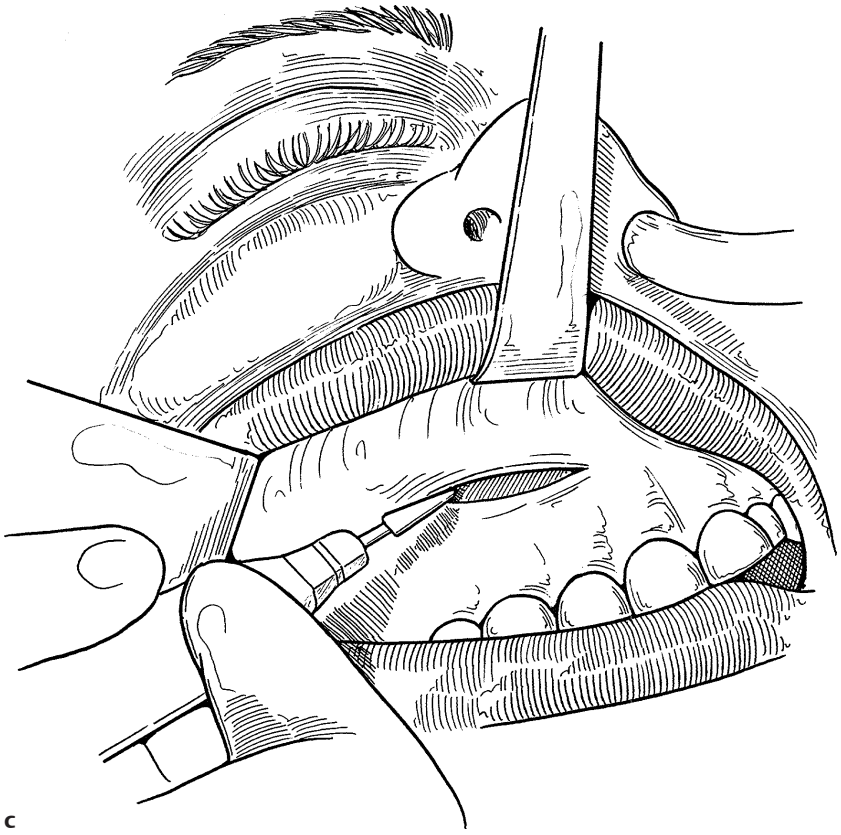


a

Fig. 21.1a

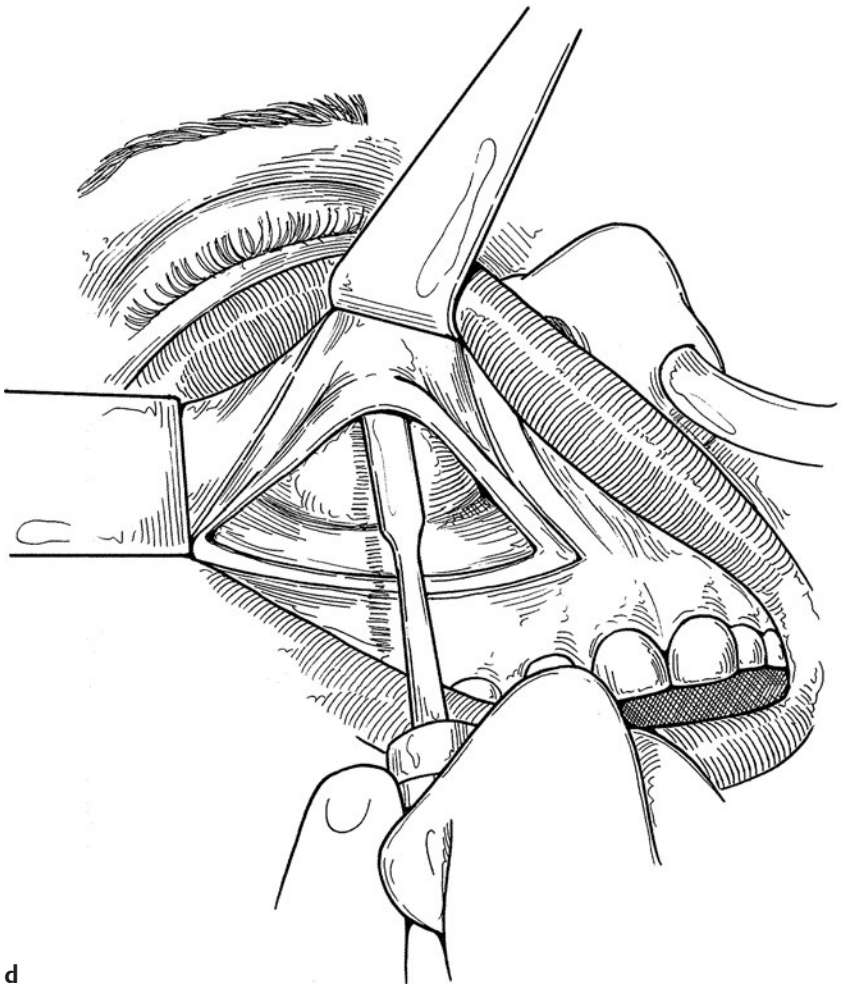


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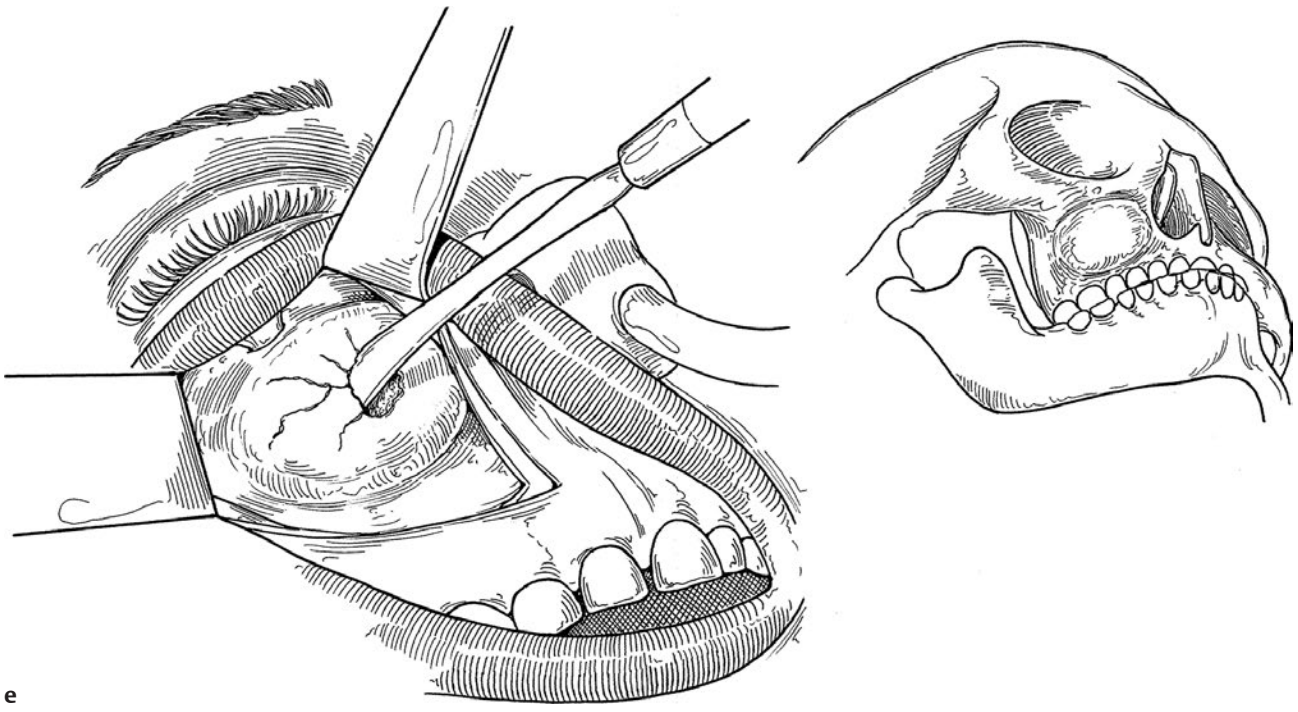


c

Fig. 21.1b,c

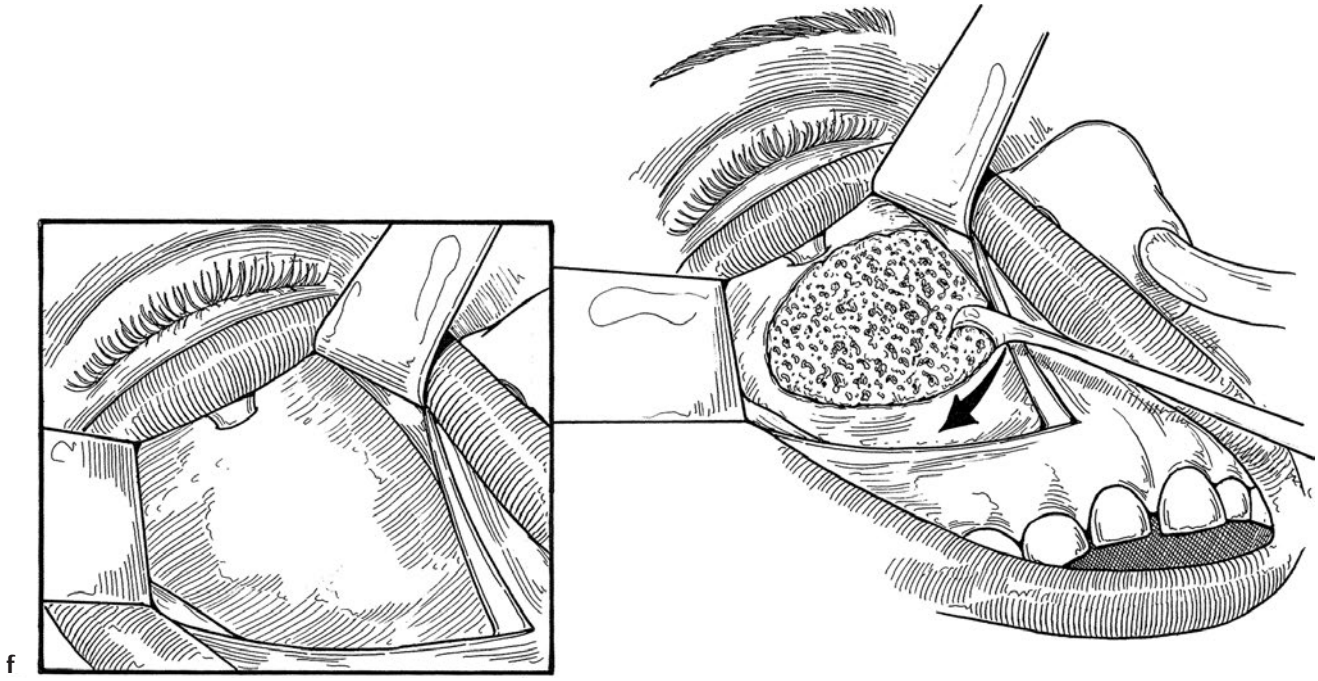


d



e

Fig. 21.1d,e



f



g

Fig. 21.1f,g

21-2 Excision of Benign Fibro-osseous Tumors

Introduction

Benign fibro-osseous tumors include a variety of slow-growing lesions, such as ossifying fibroma, aneurysmal bone cyst, and osteomas that create a pseudocapsule of compressed normal tissue. These often occur in the area of the ethmoid or maxillary sinus.

Indications

The presence of the bony lesion is the indication for removal (**Fig. 21.2a**). Complete removal of the lesion is required to prevent recurrence. A CT angiogram can demonstrate the vascularity of an aneurysmal bone cyst.

Preoperative Evaluation

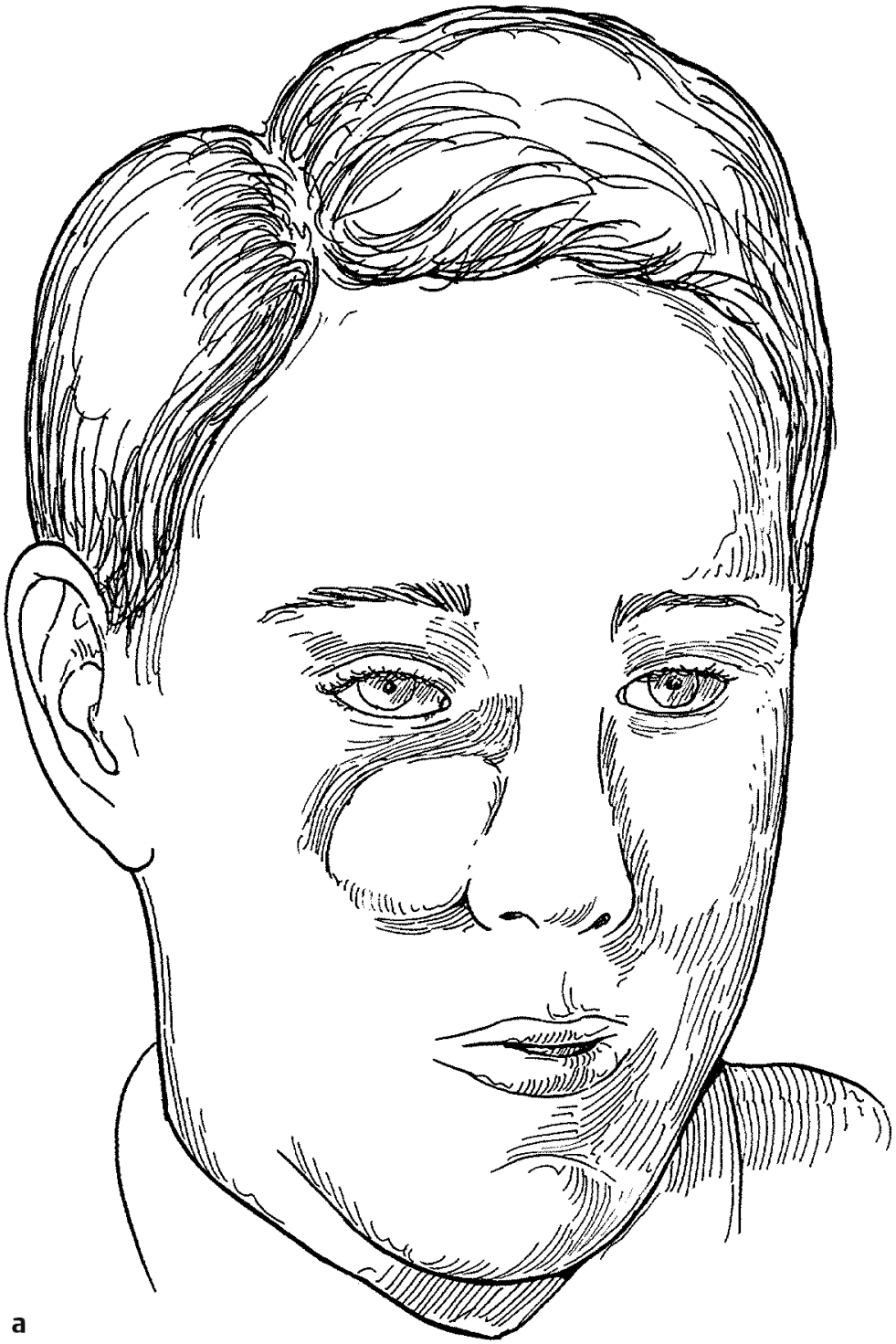
CT scan of the area is mandatory before surgical treatment.

Operative Technique

1. General anesthesia is administered through a nasal endotracheal tube placed in the uninvolved side. One percent lidocaine with 1:100,000 epinephrine is injected in the proposed incision site. For maxillary sinus lesions, a gingivobuccal sulcus incision that extends along the side of the nose is utilized.
2. An incision is made with a no. 15 blade down to the periosteum overlying the involved bone (**Fig. 21.2b**).
3. If there is normal bone overlying the lesion, the bone is cracked and removed using osteotomes and small bone-biting rongeurs (**Fig. 21.2c**).
4. The lesion is removed piecemeal with cup forceps, curettes, and periosteal elevators (e.g., a Freer). It is important to remove the entire tumor to prevent recurrence (**Fig. 21.2d**).
5. The resulting cavity is loosely packed with antibiotic-impregnated gauze, which can be brought out into the nose through the middle meatus or inferior meatus for ethmoid or maxillary lesions, respectively. The packing is removed in 24–36 hours (**Fig. 21.2e**).
6. The incision is closed with interrupted 4-0 chromic sutures in the gingivobuccal sulcus or subcuticular sutures in the ethmoid area (**Fig. 21.2f**).
7. Antibiotics are prescribed for 7–10 days to prevent infection in the cavity that is usually connected to a paranasal sinus.

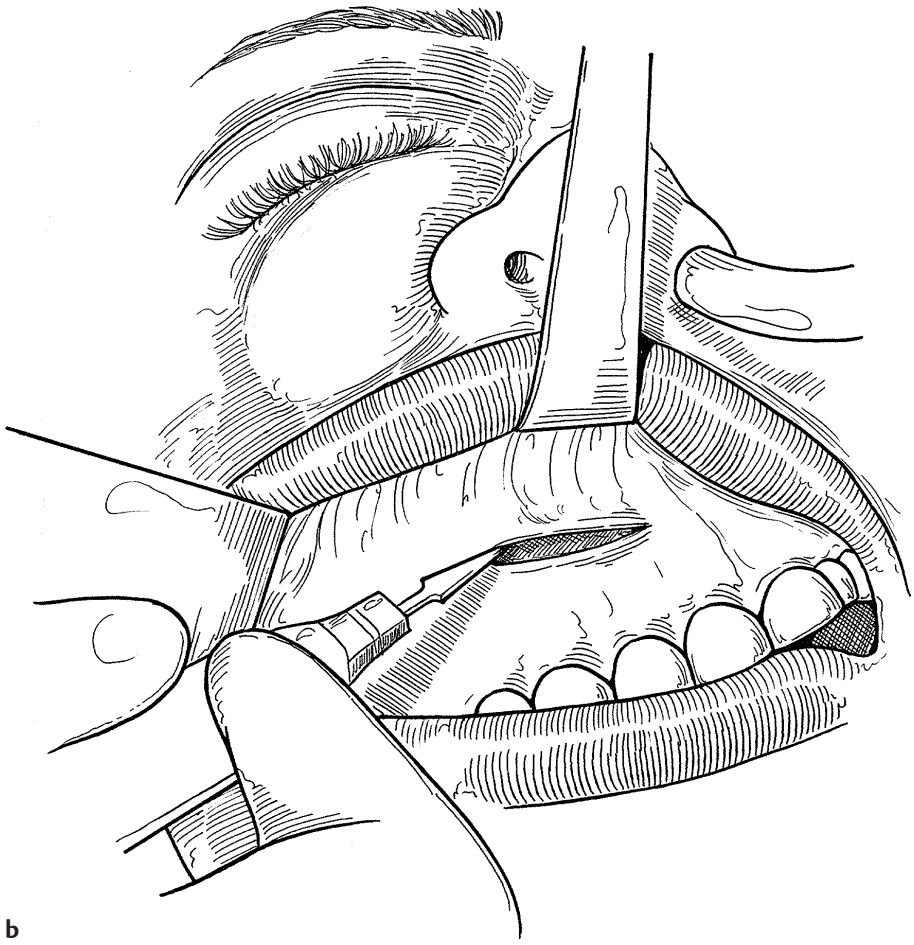
Complications

1. Recurrence from incomplete excision
2. Ocular injury
3. Infraorbital nerve injury

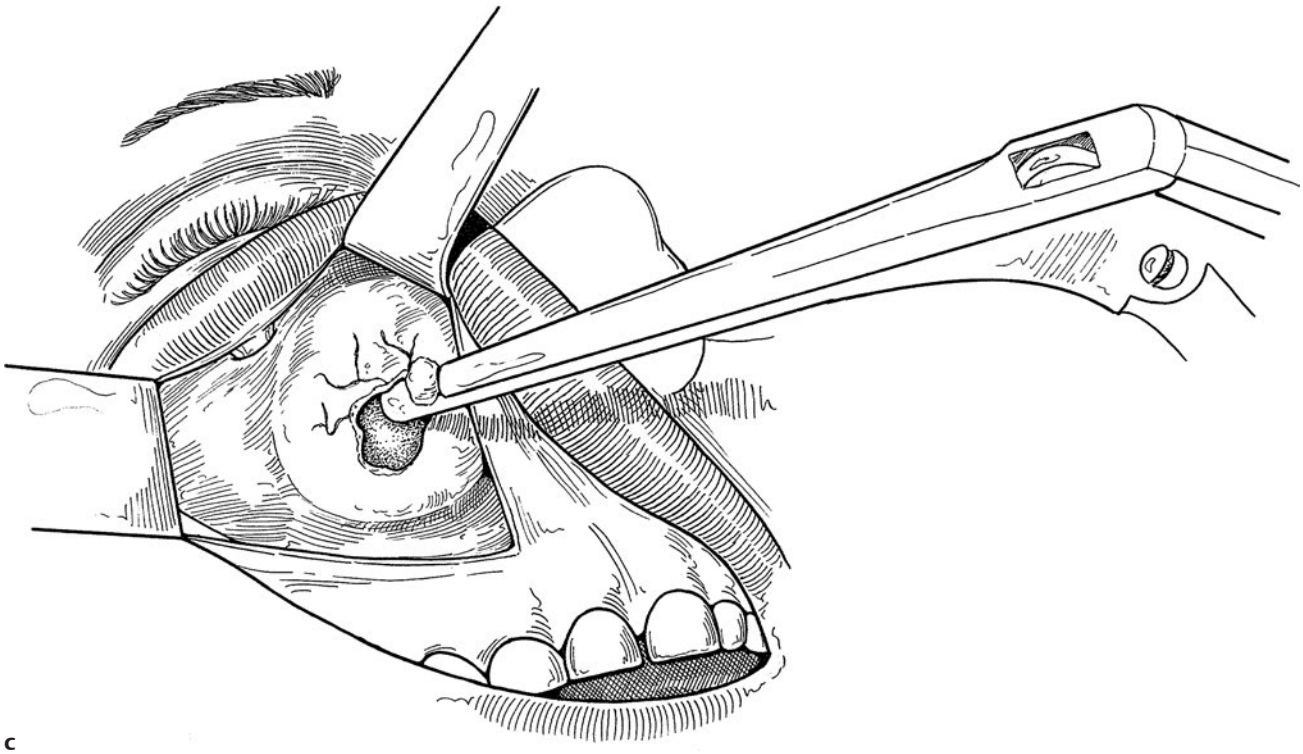


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Fig. 21.2a

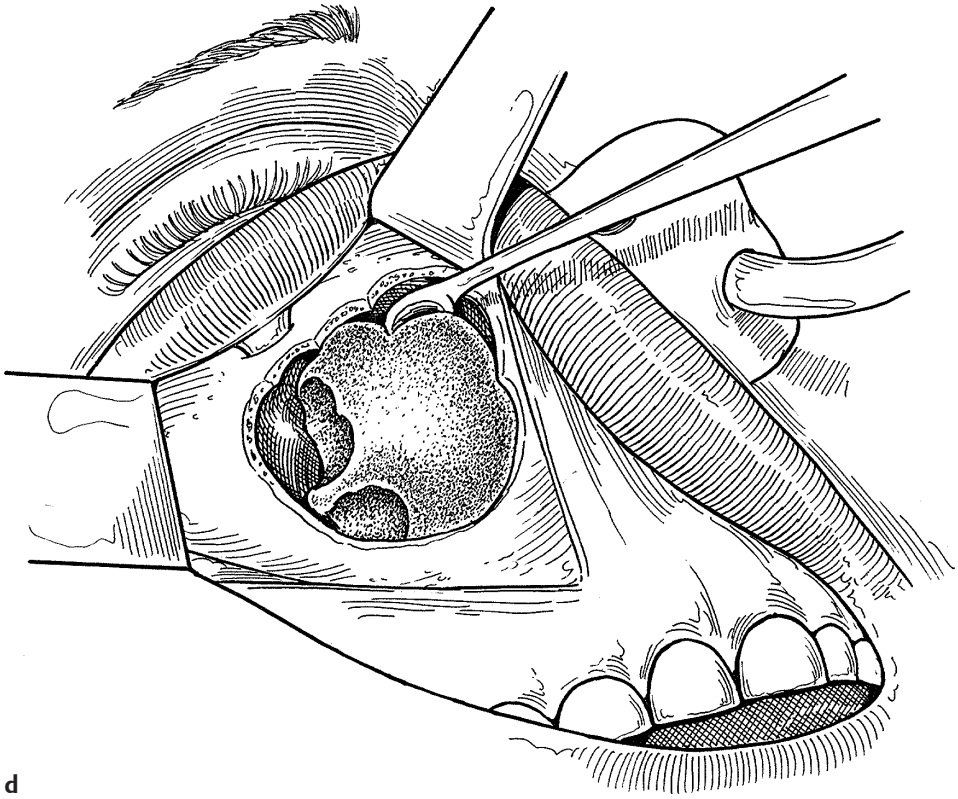


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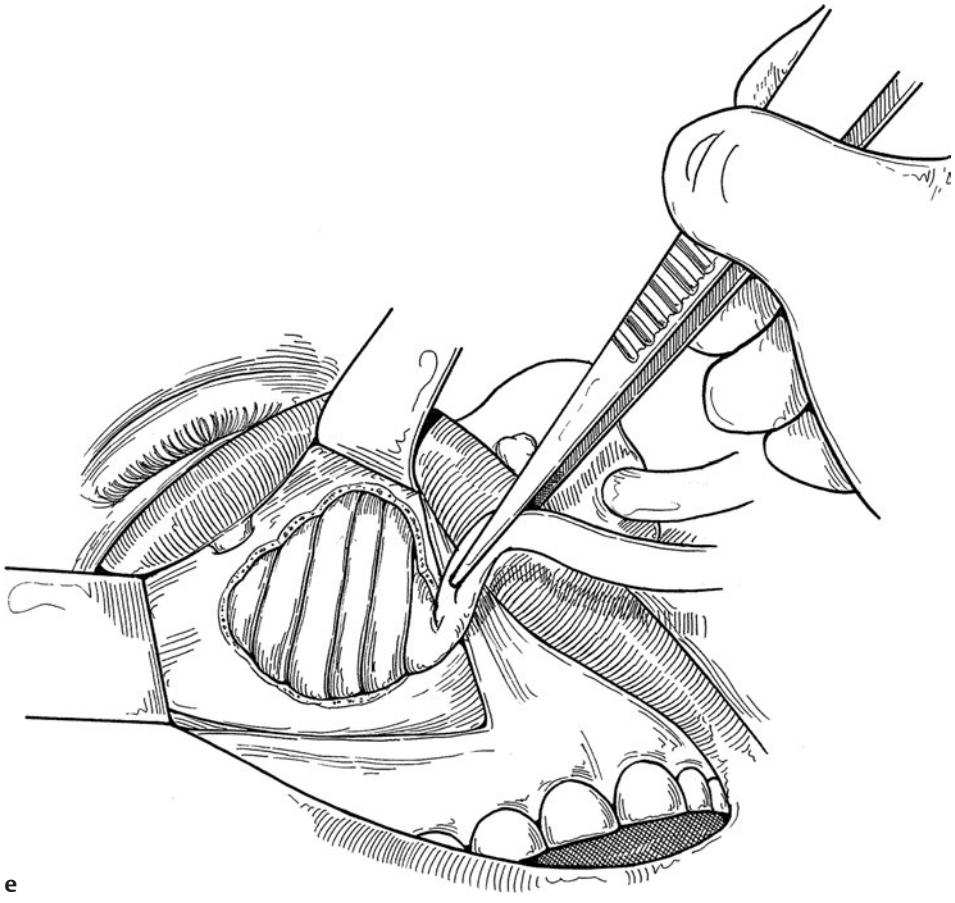


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Fig. 21.2b,c

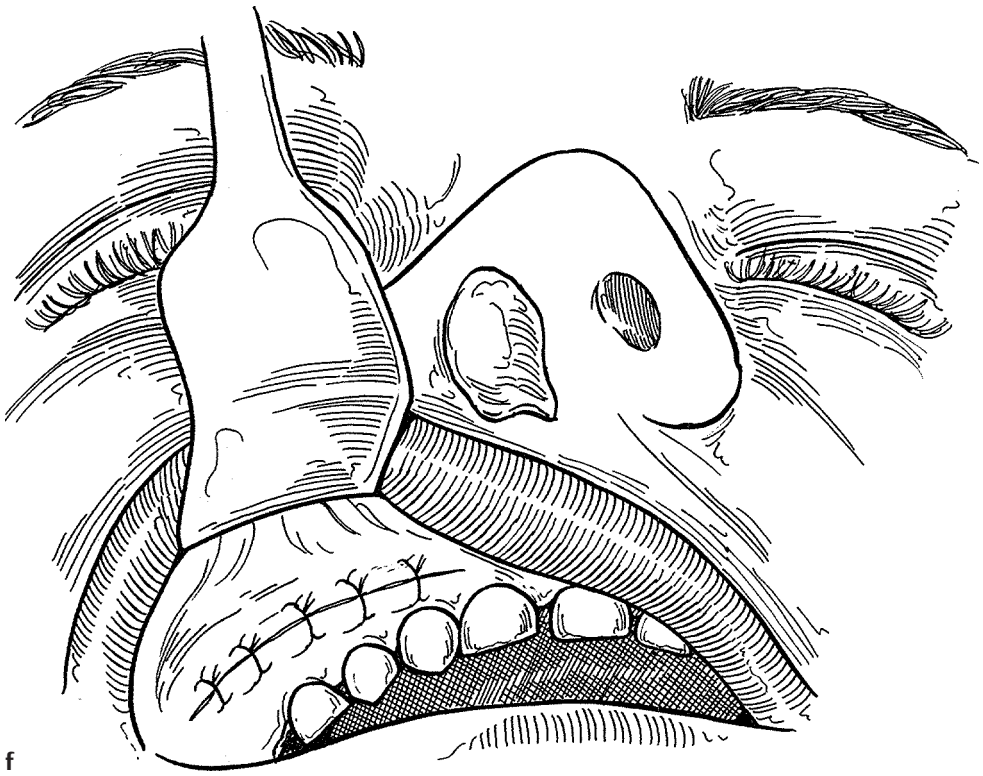


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e

Fig. 21.2d,e



f

Fig. 21.2f

21-3 Excision of Palatal Tumors

Introduction

Palatal tumors may involve the hard and/or soft palate.

Indications

The presence of a lesion of the hard and/or soft palate is the indication for surgical excision of the lesion.

Preoperative Evaluation

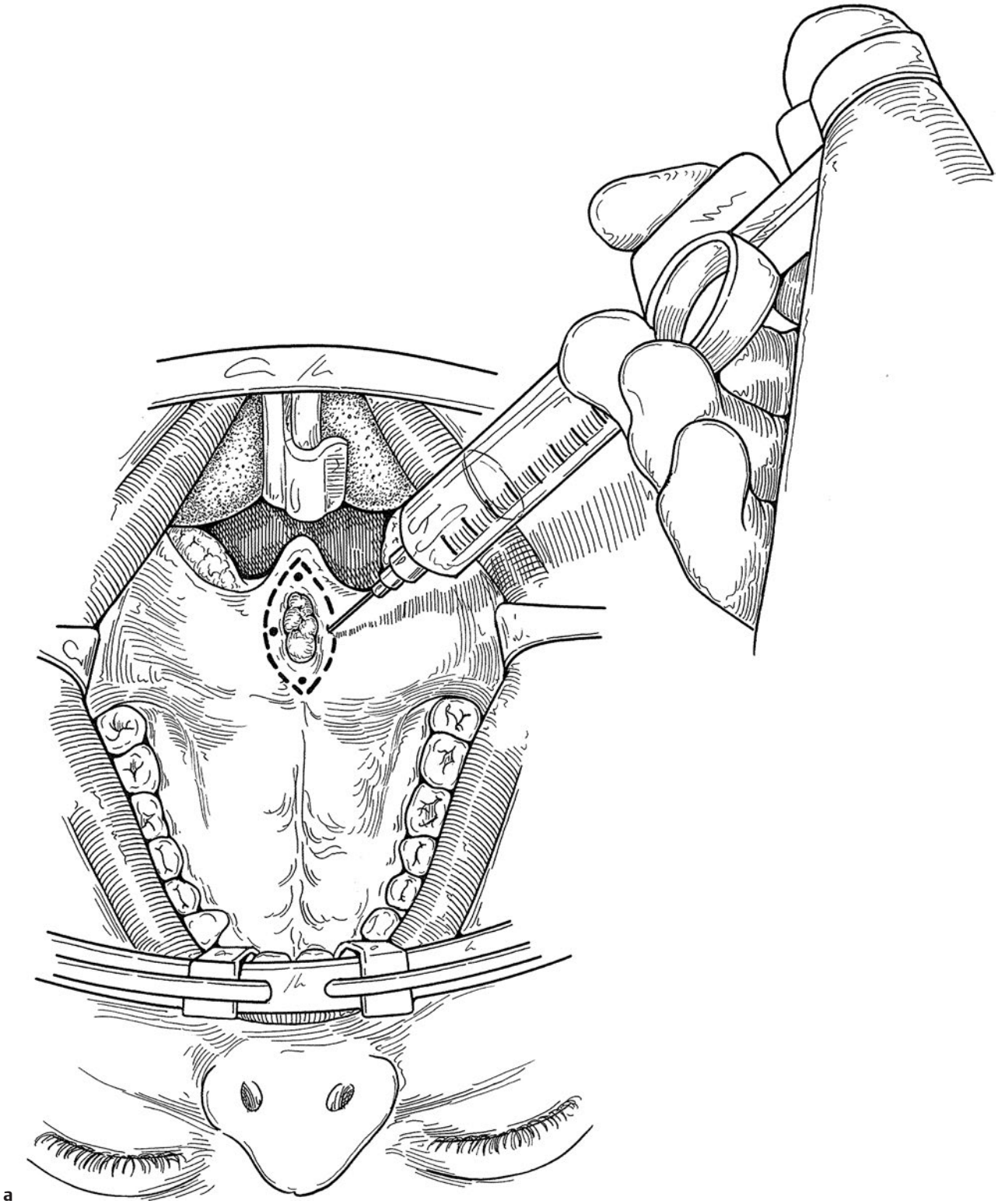
CT scans are helpful in the preoperative evaluation of these lesions to determine if they extend into the nasopharynx or nasal cavity. Attention must be directed to preserving normal palatal function. This is especially important in lesions of the soft palate where velopharyngeal insufficiency can result from excess tissue removal.

Operative Technique

1. The patient is placed on a shoulder roll and in a position similar to that used when performing a tonsillectomy. General anesthesia is administered through an oral RAE tube. A Dingman mouth gag is used to provide adequate exposure.
2. One percent lidocaine with 1:100,000 epinephrine is injected submucosally around the lesion (**Fig. 21.3a**).
3. An elliptical incision is utilized to encompass the lesion (**Fig. 21.3b**).
4. Sharp dissection with a knife or scissors is performed to excise the lesion.
5. If a large defect is created in the soft palate and there is the possibility of postoperative velopharyngeal insufficiency (VPI), a rotating flap is created and moved in from the adjacent hard palate (**Fig. 21.3c,d**). Care is taken not to cut or compromise the blood supply to the palate via the laterally placed palatal vessels.
6. The flap is rotated into the defect and sutured into place with interrupted 4-0 chromic sutures (**Fig. 21.3e**).
7. The defect in the mucosa overlying the hard palate is allowed to heal by secondary intention.
8. Superficial lesions of the mucosa of the hard palate are excised with an elliptical incision (**Fig. 21.3f**), and the mucosal defect is left to heal by secondary intention (**Fig. 21.3g**).
9. If the lesion involves the underlying bone of the soft palate, the bone is removed with rongeurs or osteotomes **(Fig. 21.3h**).
10. Lateral relaxing incisions can be created to permit undermining and medial movement of the mucosa to allow closure of the incision and to prevent an oronasal fistula (**Fig. 21.3i**). (If necessary, a rotation flap from an adjacent portion of the hard palate can be created, as described above.) Small defects in the mucosa overlying intact portions of the bony maxilla are allowed to heal by secondary intention.

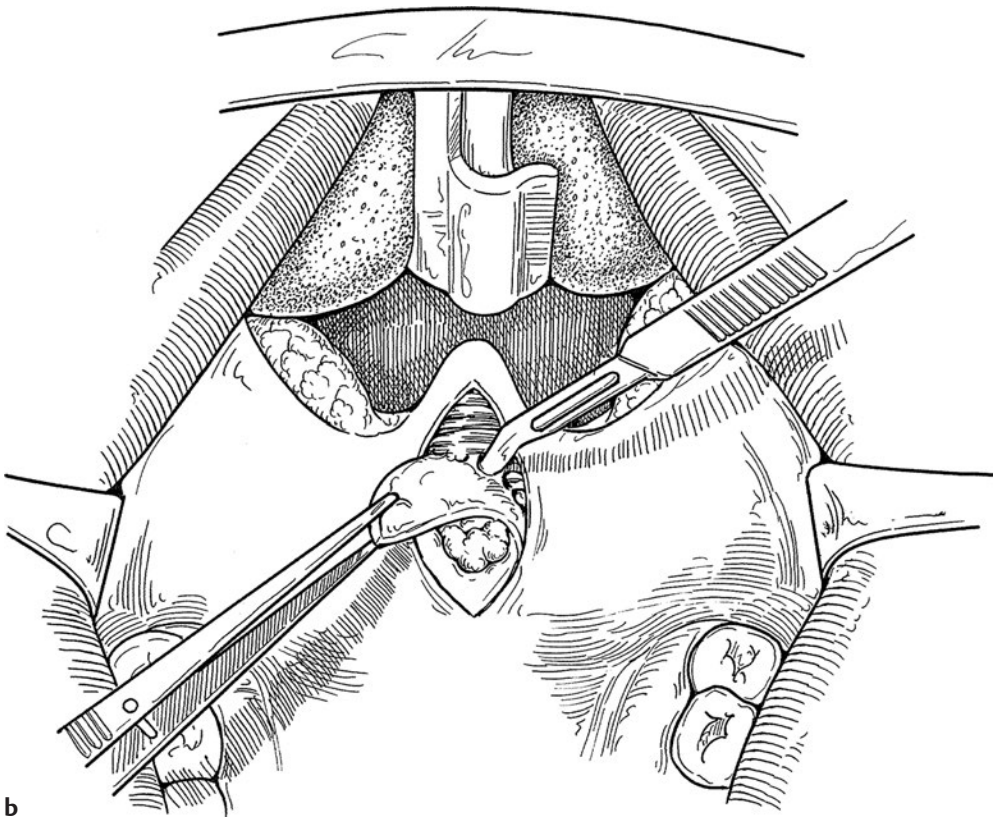
Complications

1. Velopharyngeal insufficiency
2. Oronasal fistula

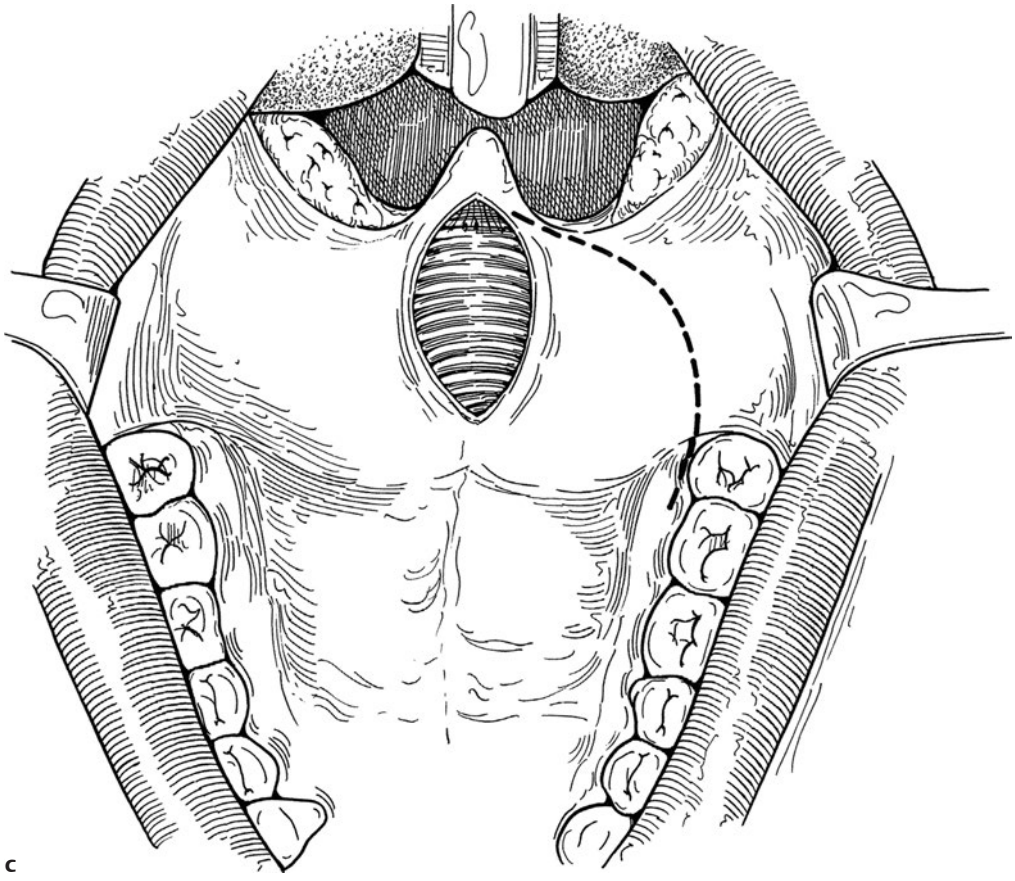


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Fig. 21.3a

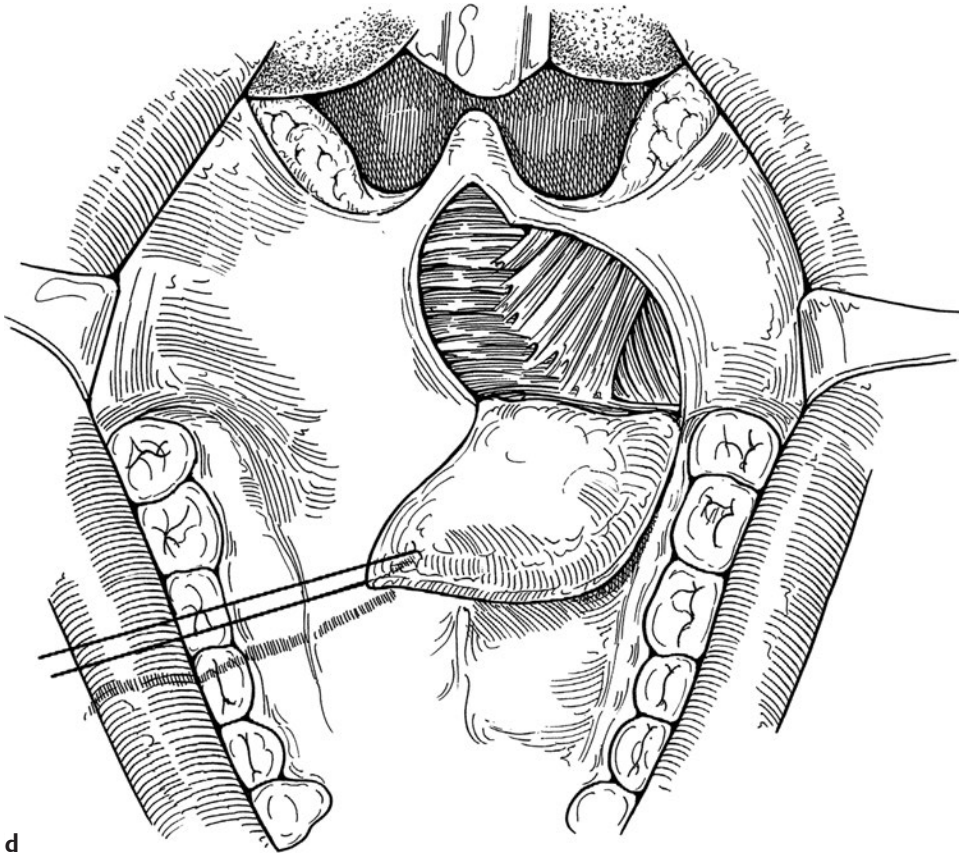


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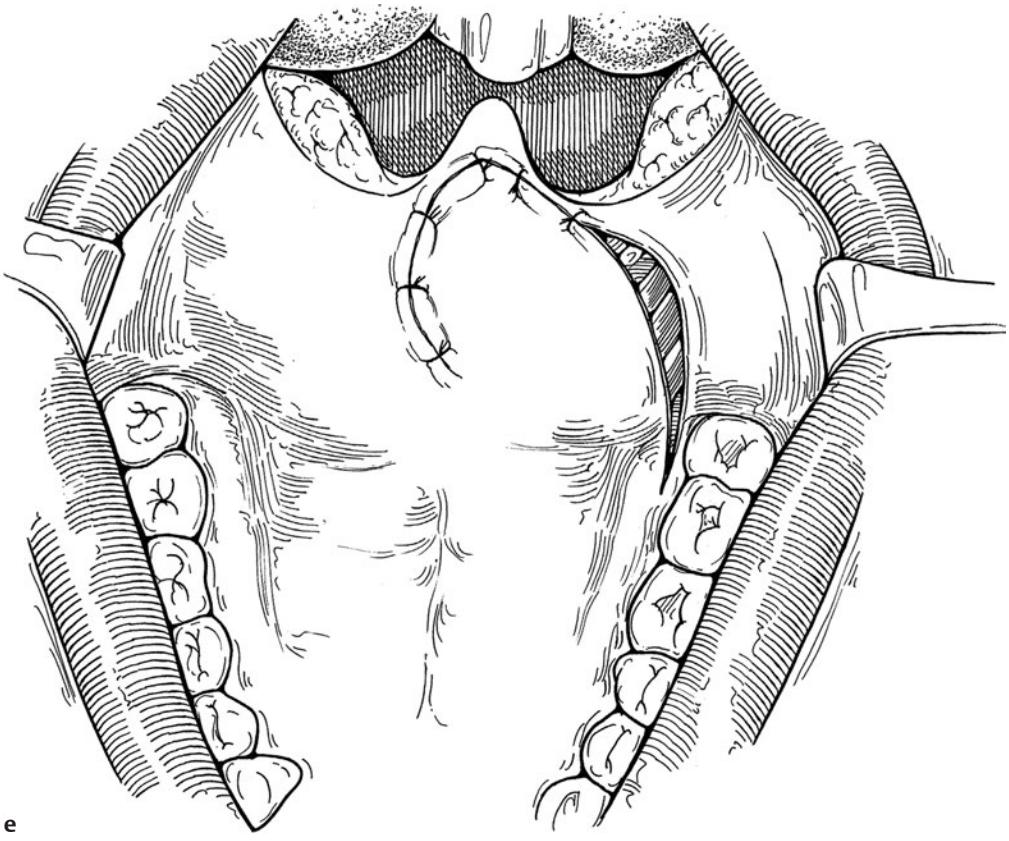


c

Fig. 21.3b,c

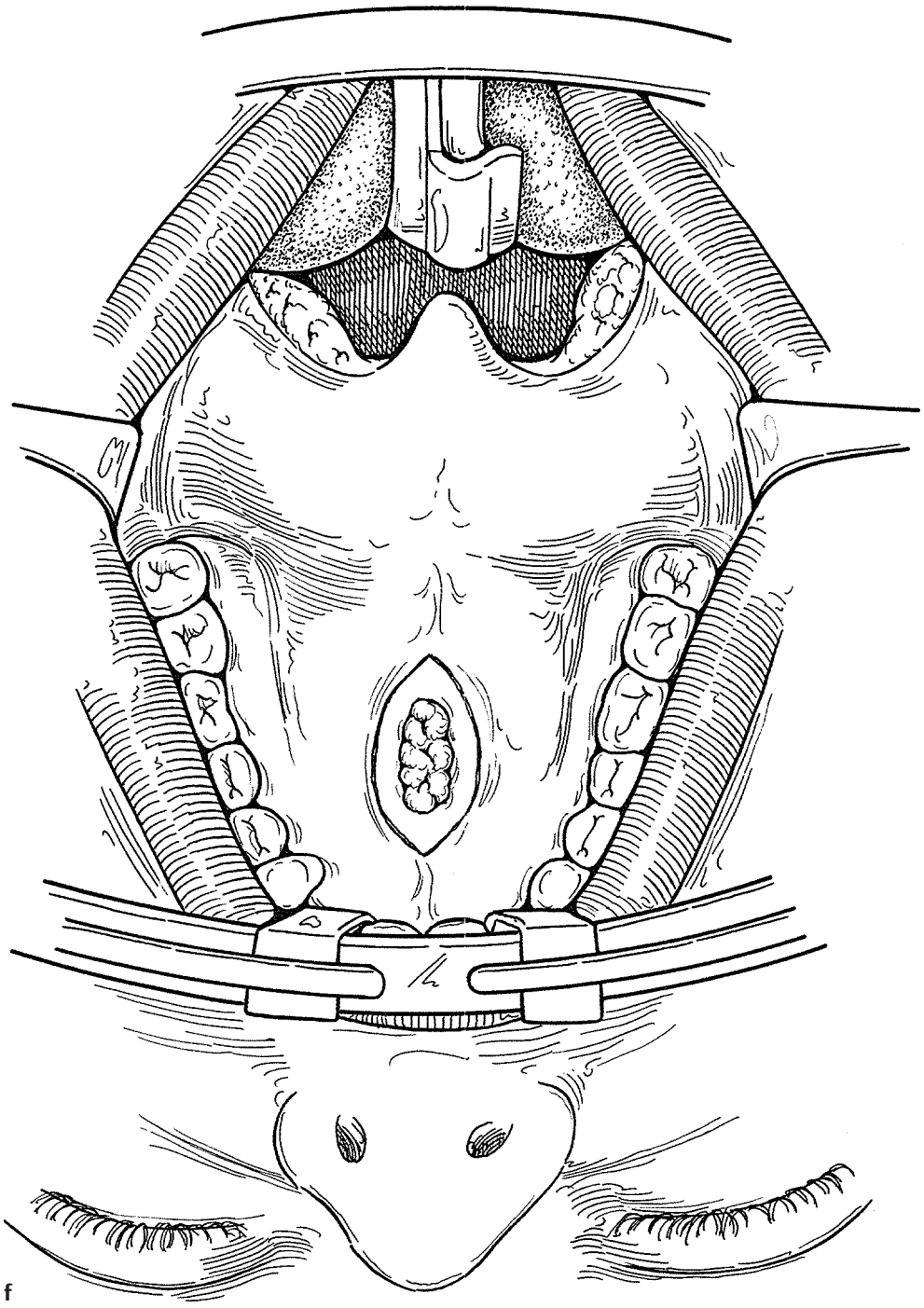


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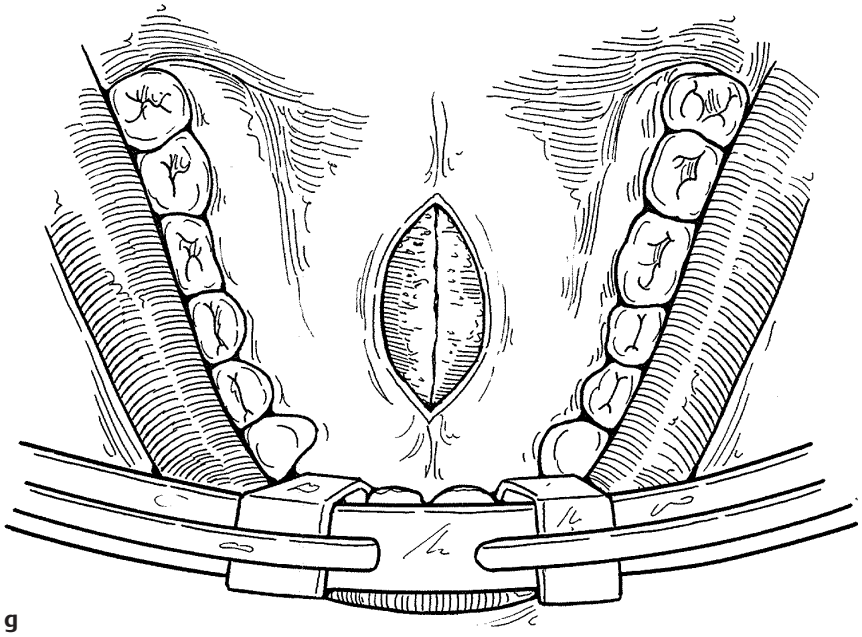
e

Fig. 21.3d,e

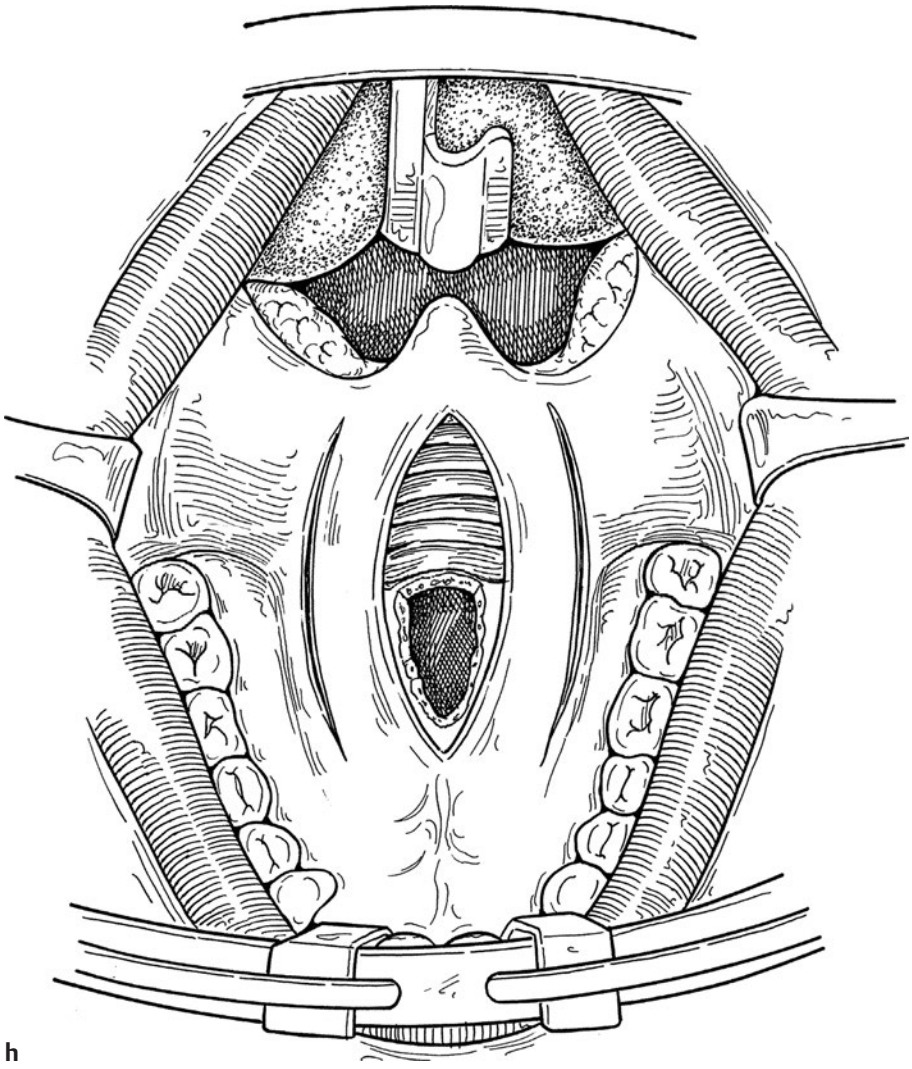


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Fig. 21.3f

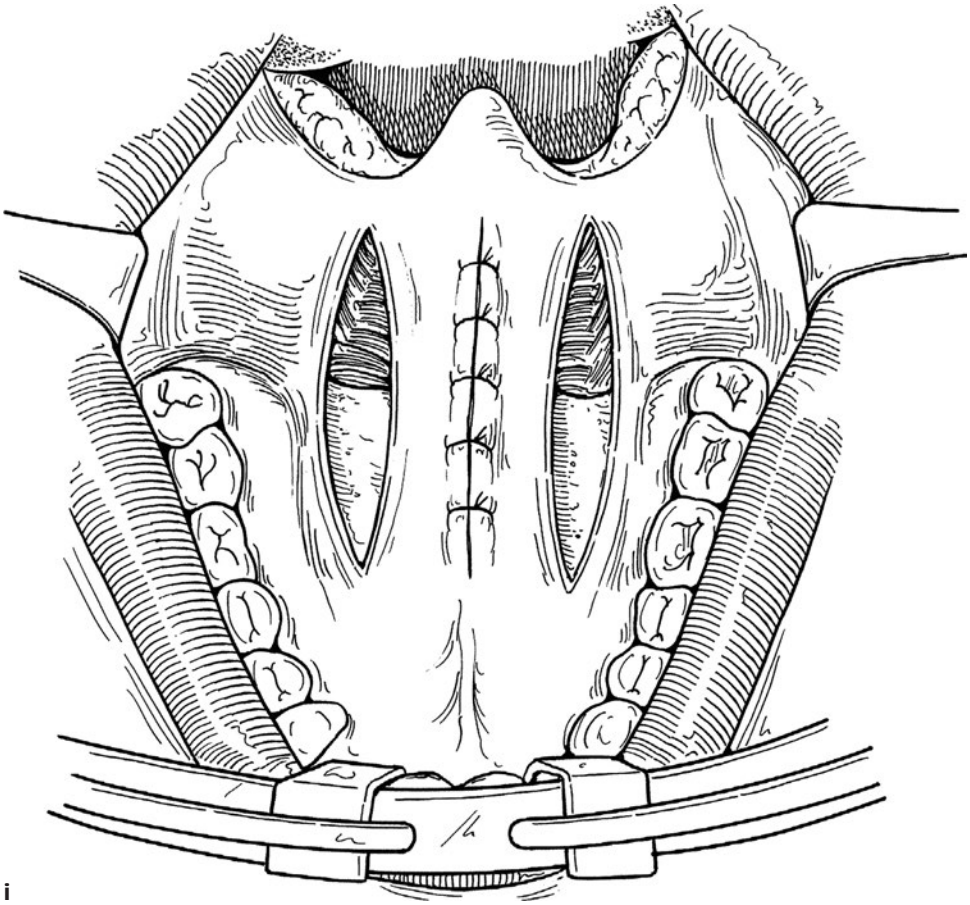


g



h

Fig. 21.3g,h



i

Fig. 21.3i

Section IV

Endoscopic Sinus Surgery

IV

22 Endoscopic Sinus Surgery

Lawrence W.C. Tom

Endoscopic sinus surgery has revolutionized the surgical management of paranasal sinus disease and is now the standard surgical approach to the nose and sinuses. Chronic sinusitis remains the most common condition requiring pediatric endoscopic sinus surgery, but with modifications of this approach, indications have been expanded to include excision of endonasal and sinus lesions, drainage of subperiorbital abscesses, treatment of epistaxis, and nasal septoplasty.

Pediatric endoscopic sinus surgery presents challenges. The preoperative examination may be more difficult. The small nasal cavities make surgery more difficult, and pediatric-sized instruments must be available.

22-1,2 Endoscopic Sinus Surgery

Indications

The most common indication for endoscopic sinus surgery is chronic sinusitis that has failed 4 to 6 weeks of medical management with long-term broad-spectrum antibiotics and topical nasal steroid and saline sprays. The child must have significant symptoms and computed tomography (CT) evidence of sinusitis. If they are suspected, contributing factors such as allergies, adenoid hypertrophy and/or infection, cystic fibrosis, gastroesophageal reflux, immune deficiencies, and ciliary dyskinesia should be evaluated and treated before surgery. It is also critical that secondhand smoke be eliminated from the patient's environment prior to surgery. Other indications for this approach include endonasal and sinus lesions, drainage of subperiosteal abscesses, ligation of the sphenopalatine artery, and nasal septoplasty.

Preoperative Evaluation

Preoperative examination includes anterior rhinoscopy. Ideally, this would be with a telescope, but because of poor patient cooperation, examination with an otoscope may be the only evaluation that can be performed. A CT of the sinus should be performed after medical therapy to assess the child's anatomy and extent of disease.

Operative Technique

Endoscopic sinus surgery in children is performed under general anesthesia. After intubation an orotracheal tube is taped to the corner of the mouth opposite the surgeon to provide the best access to the nose.

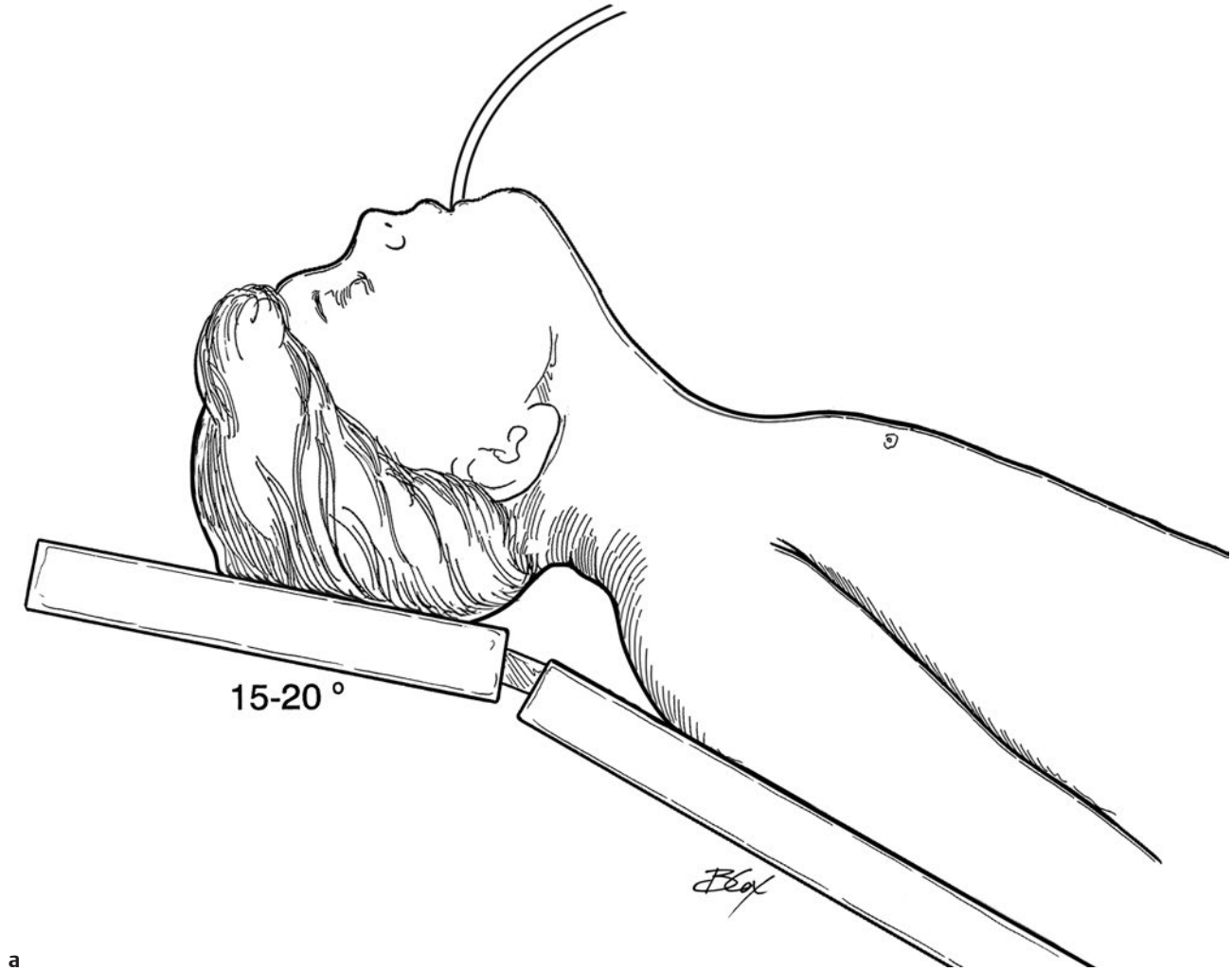
1. The patient is positioned with the head slightly elevated, in the midline, and with the neck slightly extended. The patient is draped with eyes exposed. Lacri-Lube (Allergan) is placed in the eyes to prevent eye injury (**Fig. 22.1a**).
2. Both nasal cavities are vasoconstricted with 0.05% oxymetazoline (Afrin) on 3 × 1/2 inch neuropledgets (**Fig. 22.1b**). The pledgets should be placed under direct vision to prevent mucosal trauma. After 5 minutes, the pledgets are removed from the side that is to be operated on first.
3. The nasal cavity is examined to the nasopharynx with a 4.0-mm 0-degree telescope; a 30-degree telescope may also be used (**Fig. 22.1c,d**). If the nasal cavity is small, a 2.7-mm telescope may be substituted. The surgeon may look directly through the telescope or use a monitor.
4. The middle meatus is then examined (**Fig. 22.1e**). If access is difficult, a Freer elevator may be used to medialize the middle turbinate (**Fig. 22.1f**).
5. Under direct visualization, the lateral nasal wall just anterior to the uncinate process is injected with 1–3 mL of 1% lidocaine with 1:100,000 epinephrine using a 25-gauge needle bent 10 degrees toward the bevel on a 3-mL syringe (**Fig. 22.1g,h**). Blanching of the lateral nasal wall and middle turbinate should occur.
6. New neuropledgets soaked with 0.05% oxymetazoline are replaced into the nasal cavity and middle meatus for an additional 5 minutes.
7. After the pledgets are removed, a Freer elevator is used to medialize the middle turbinate, and the middle meatus is re-examined with a 0-degree telescope.

8. The uncinate process and ethmoid bulla are identified. With gentle palpation, the uncinate process should move (**Fig. 22.1i**).
9. If a concha bullosa is present and obstructing, the lateral lamella is removed. Using a sickle knife, an incision is made along the anterior face of the middle turbinate (**Fig. 22.1j,k**), and the lateral lamella is removed with scissors and through cut forceps. The medial lamella is left intact (**Fig. 22.1l**).
10. The uncinate process is removed to open the infundibulum, expose the ethmoid bulla, and increase access to the anterior ethmoid area. It can be removed using a ball tip seeker and backbiting forceps. The seeker is inserted posterior to the free edge of the uncinate and advanced anteriorly and medially to elevate the edge (**Fig. 22.1m**). A backbiting forceps is inserted posterior to the edge, and the middle and inferior portions of the uncinate are removed (**Fig. 22.1n,o**). The inferior portion of the uncinate must be removed completely. The maxillary sinus ostium lies in the anterior inferior portion of the infundibulum (**Fig. 22.1p**), and any inferior remnants may obscure the ostium. These may be removed with upbiting forceps or a microdebrider (**Fig. 22.1q**).
11. The uncinate process may also be removed by incising the anterior attachment with a sickle knife. The incision begins superiorly and curves inferiorly to parallel the free border of the uncinate (**Fig. 22.1r,s**). The uncinate process is subluxed medially and removed with a Blakesley forceps exposing the ethmoid bulla (**Fig. 22.1t,u,v**).
12. The natural ostium of the maxillary sinus is identified with a seeker and a 0- or 30-degree telescope (**Fig. 22.1w,x,y**). If the ostium is patent and disease free, it is left alone.
13. If the ostium is obstructed or disease is present, it is opened and enlarged. The ostium is enlarged posteriorly and inferiorly with through cut biting forceps, bent spoon, or small curette (**Fig. 22.2a**). Anteriorly, the ostium may be opened with a backbiting through cut forceps, but care must be taken not to injure the nasolacrimal duct (**Fig. 22.2b,c,d**). If secondary ostia are identified, the natural and secondary ostia are connected by removing the intervening tissue.
14. The maxillary sinus is then inspected with a 30- or 45-degree telescope. Diseased mucosa may be removed with a microdebrider and/or forceps.
15. The anterior inferior medial portion of the ethmoid bulla, the largest anterior ethmoid cell, is then infractured with a J-curette (**Fig. 22.2e**) and opened with forceps. The opening is enlarged by moving the curette anteriorly and laterally.
16. A 45-degree through cutting forceps or microdebrider can be used to remove the anterior face of the ethmoid bulla (**Fig. 22.2f**).
17. The medial wall of the bulla is then removed to its attachment to the middle turbinate (**Fig. 22.2g**). This identifies the basal lamella (**Fig. 22.2h**).
18. The remainder of the ethmoid bulla mucosa and cells are removed with through cutting forceps or microdebrider. Using a 30-degree telescope, the lamina papyracea is identified (**Fig. 22.2i,j**). It is thin bone, has a yellow tint, is smooth, and should not be penetrated. This completes the dissection of the maxillary sinus antrostomy and anterior ethmoidectomy. In most children, no further dissection is necessary.
19. If CT demonstrates significant posterior ethmoid disease, a posterior ethmoidectomy is performed. The basal lamella, the anterior wall of the posterior ethmoid cells, is infractured inferiorly with a J-curette and is removed (**Fig. 22.2k,l**). It is vital to keep the dissection at or below the level of the roof of the maxillary sinus to avoid violating the skull base as it slopes inferiorly and posteriorly.
20. The posterior ethmoid cells are entered after dissection of the vertical portion of the basal lamella. The posterior ethmoid cells are opened with a J-curette. Mucosa and bony partitions are removed with an appropriate forceps or microdebrider (**Fig. 22.2m,n**).
21. As the bony partitions are removed, the roof of the ethmoid sinus, which marks the skull base, is identified. The skull base has a slightly different color than the surrounding bone and is at its most inferior position in the posterior ethmoid cells. Only after it has been identified should the dissection along the skull base proceed. Failure to do so increases the risk of penetration of the skull base and a cerebrospinal fluid (CSF) leak.
22. If it is needed, a sphenoidotomy is performed. The safest method of entering the sphenoid sinus is by identifying the sphenoethmoid recess and natural ostium, which both are medial to the superior turbinate (**Fig. 22.2o**). The superior turbinate can be lateralized with a Freer elevator to access the sphenoethmoid recess. If access remains difficult, the inferior one third of the superior turbinate is removed with through-cutting instruments.
23. The sphenoid ostium can be visualized in the sphenoethmoidal recess along the anterior face of the sphenoid. If the ostium is obstructed, it may be located by palpation with a ball tip seeker.
24. A J-curette is placed in the ostium and is directed inferiorly and laterally to fracture the anterior face of the sphenoid and to open the ostium (**Fig. 22.2p**). The opening can be enlarged with a curette or Stammberger mushroom punch.
25. Mucus or infected fluid can be suctioned from the sinus. Lesions may be removed or biopsied with forceps. Care must be taken to avoid injury to the optic nerve and internal carotid artery, both of which are usually located just lateral to the sinus but may run along the lateral wall and to the cavernous sinus.
26. If a complete ethmoidectomy is required, attention is returned to the previously identified skull base. A 30-degree telescope is used to visualize the skull base. Since the lowest point of the skull base is in the posterior ethmoid cells, dissection must proceed from posterior to anterior. The vertical ethmoid partitions are removed with upbiting through cut forceps while the mucosa is preserved along the roof of the ethmoid to promote better healing. It is essential to palpate behind the partitions with the upbiting forceps prior to bone removal to prevent violation of the skull base. Since the skull base slopes down medially and is also thinnest medially, it is also important to keep the forceps pointed slightly laterally.
27. The dissection is completed when the frontal recess is reached. Since most children have small developing frontal sinuses, dissection in the region of the frontal recess is rarely performed. When it is performed, image guidance must be considered.

28. If dissection is required, it should be limited. The frontal recess is bordered by the superior attachment of the ethmoid bulla posteriorly and the agger nasi cell anteriorly (**Fig. 22.2q**). Using a 45- or 70-degree telescope, the superior attachment of the ethmoid bulla is identified and then removed with upbiting instruments (**Fig. 22.2r**).
29. Using a 0-degree telescope, the uncinate process is reexamined. Any residual superior attachment of the uncinate is removed. This will expose the agger nasi cell.
30. Returning to an angled telescope, the agger nasi cell is identified and opened. A frontal sinus curette is inserted posterior and superior to the posterior wall of the agger nasi. The curette is gently directed anteriorly and laterally fracturing the wall to provide access to the frontal recess (**Fig. 22.2s**). Remaining portions of the agger nasi are removed with an upbiting forceps (**Fig. 22.2t**). The frontal recess should be open.
31. At the conclusion of the procedure, neuropledgets moistened with 0.05% oxymetazoline are placed into the nasal cavity
32. The opposite side, if necessary, is then operated on in the same fashion.
33. Nasal secretions are then suctioned clear from both nasal cavities.
34. If there has been no significant bleeding, packing is not placed. Packing can be placed for hemostasis but should be removed in 1 or 2 days
35. The patient remains on antibiotics and steroid and saline nasal sprays until seen in the office in 2 to 3 weeks.

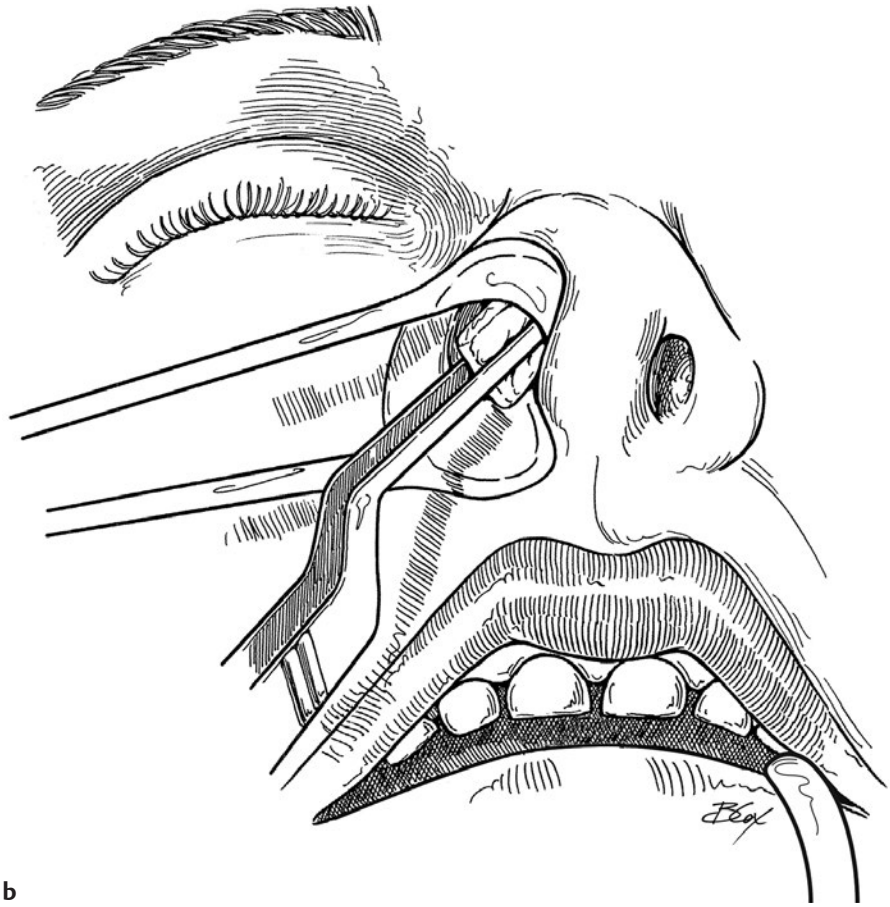
Complications

1. Recurrence of disease
2. Intranasal complications
   a. Scarring of frontal recess
   b. Scarring of maxillary sinus ostium
   c. Adhesion between the middle turbinate and lateral wall of the nose
3. Orbital injury
   a. Diplopia
   b. Blindness
   c. Hematoma
   d. Infection
   e. Epiphora
4. Intracranial complications
   a. CSF rhinorrhea
   b. Intracranial trauma
   c. Meningitis
5. Internal carotid artery injury
6. Optic nerve injury
7. Cavernous sinus injury

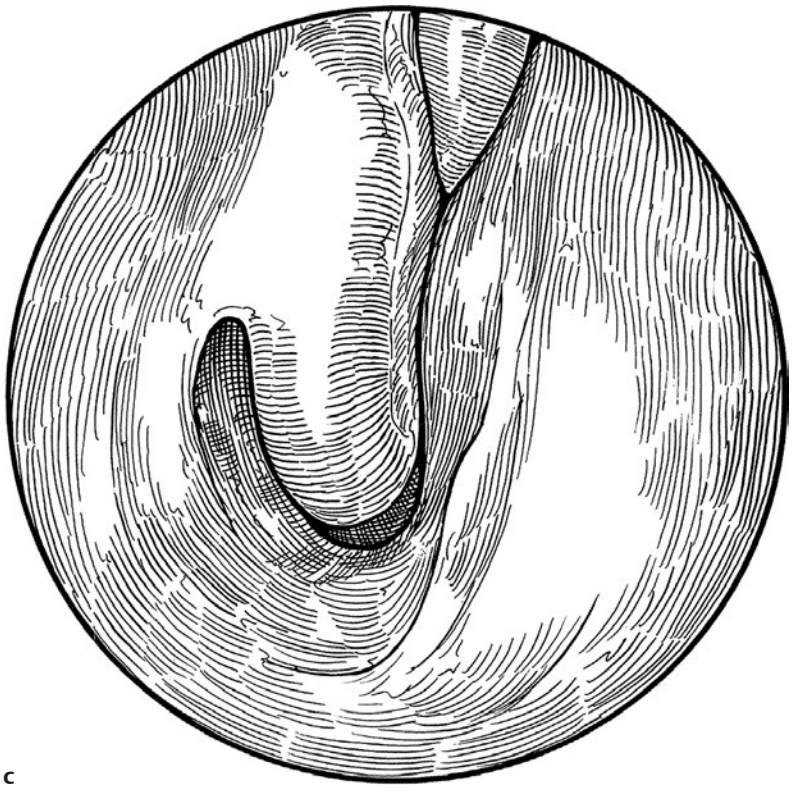


a

Fig. 22.1a

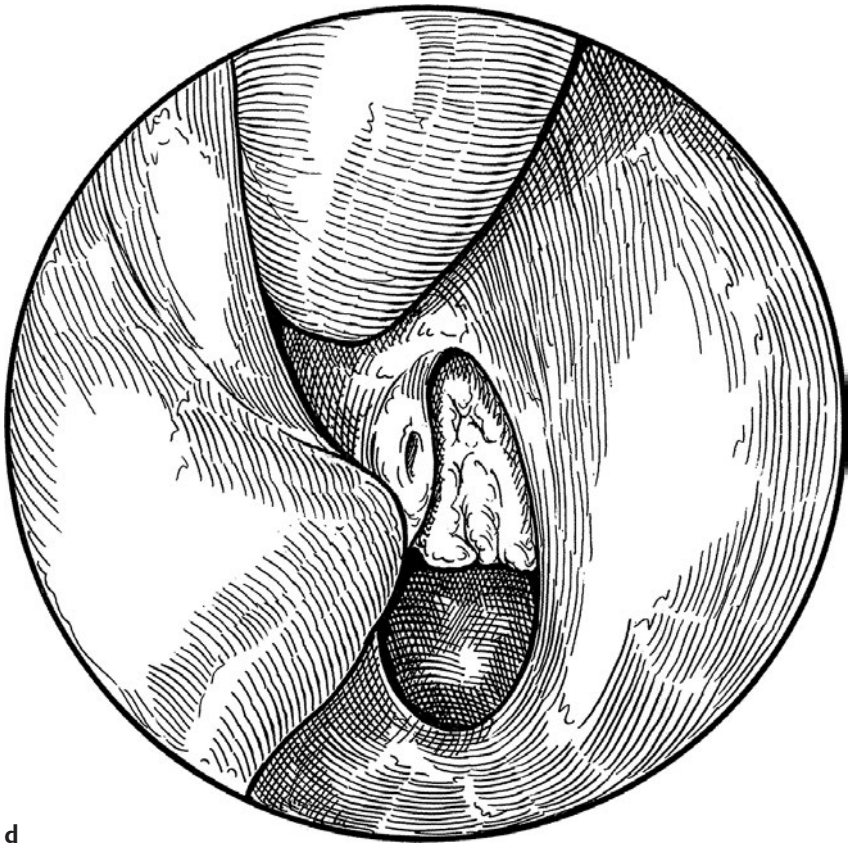


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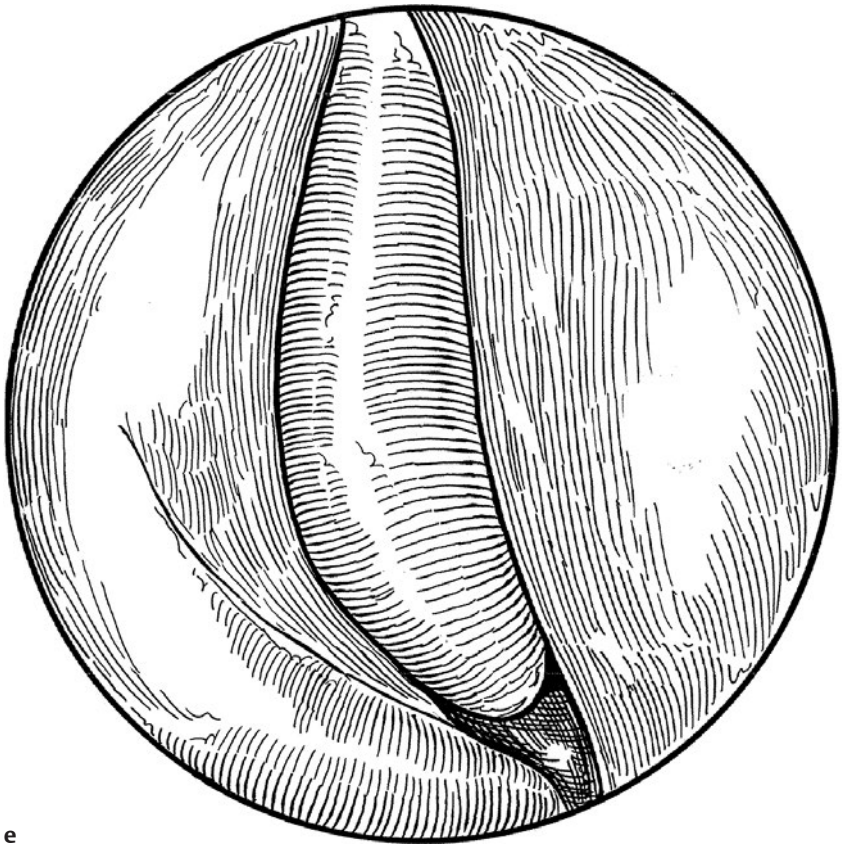


c

Fig. 22.1b,c

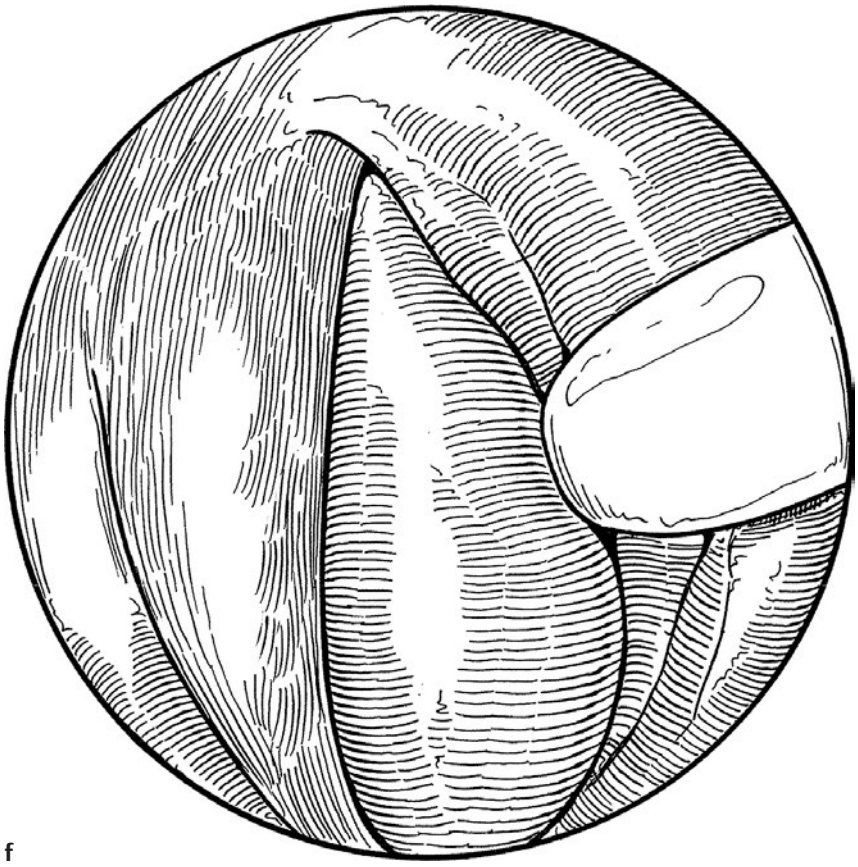


d

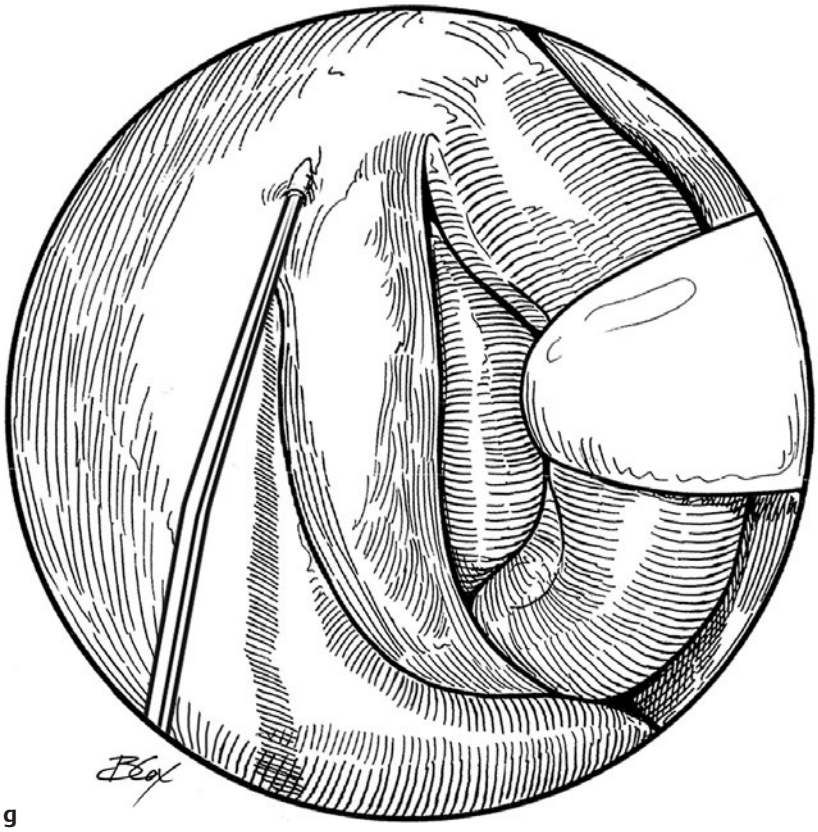


e

Fig. 22.1d,e



f

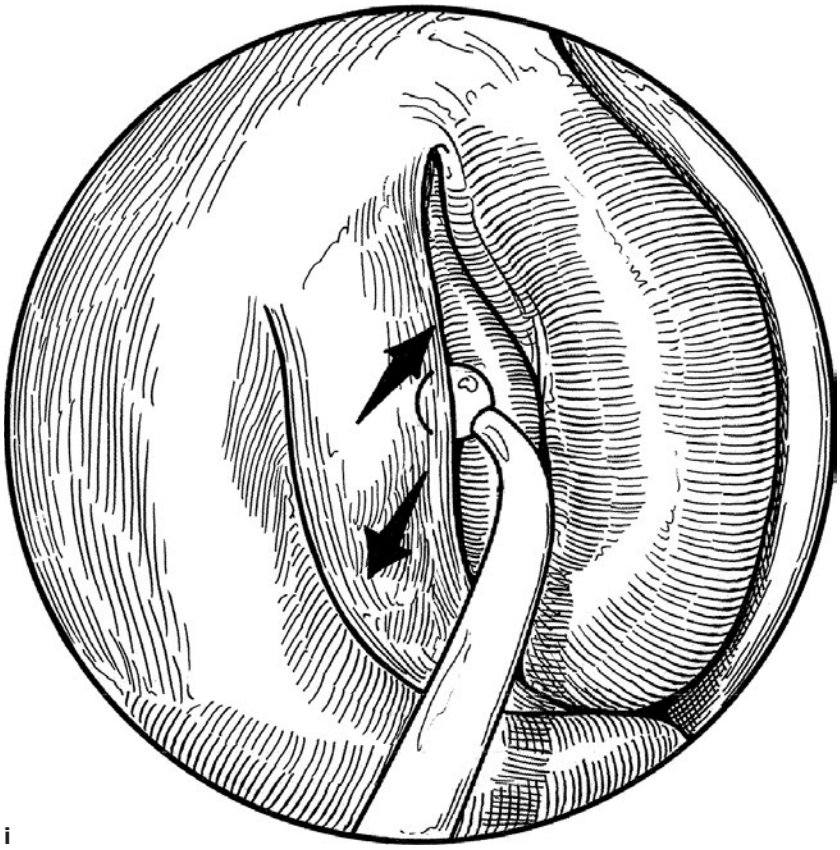


g

Fig. 22.1f,g

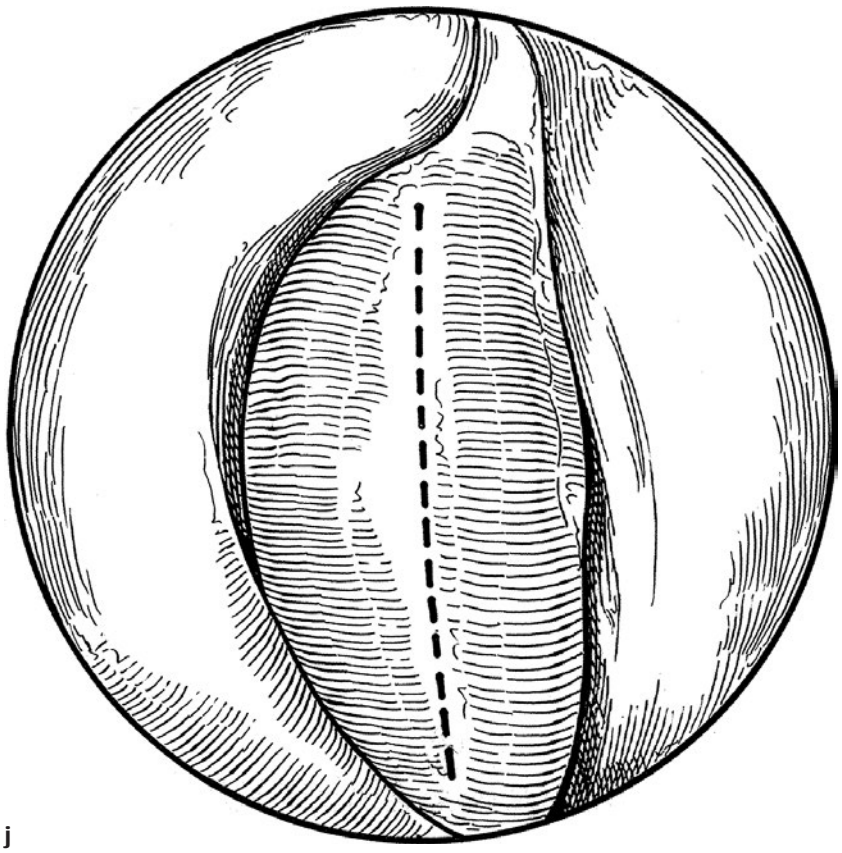


h

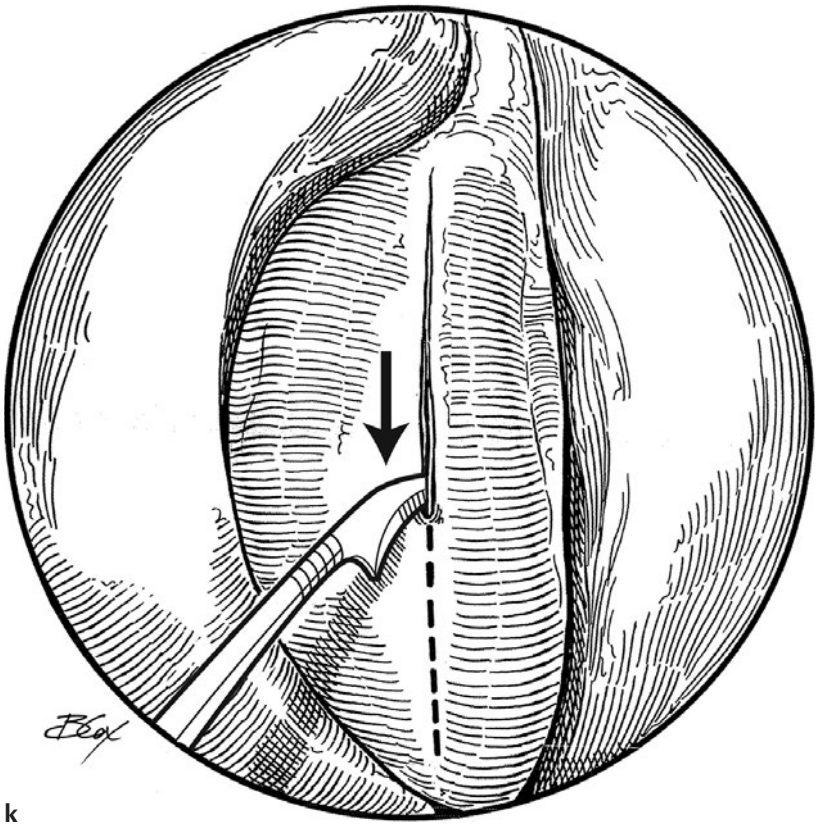


i

Fig. 22.1h,i

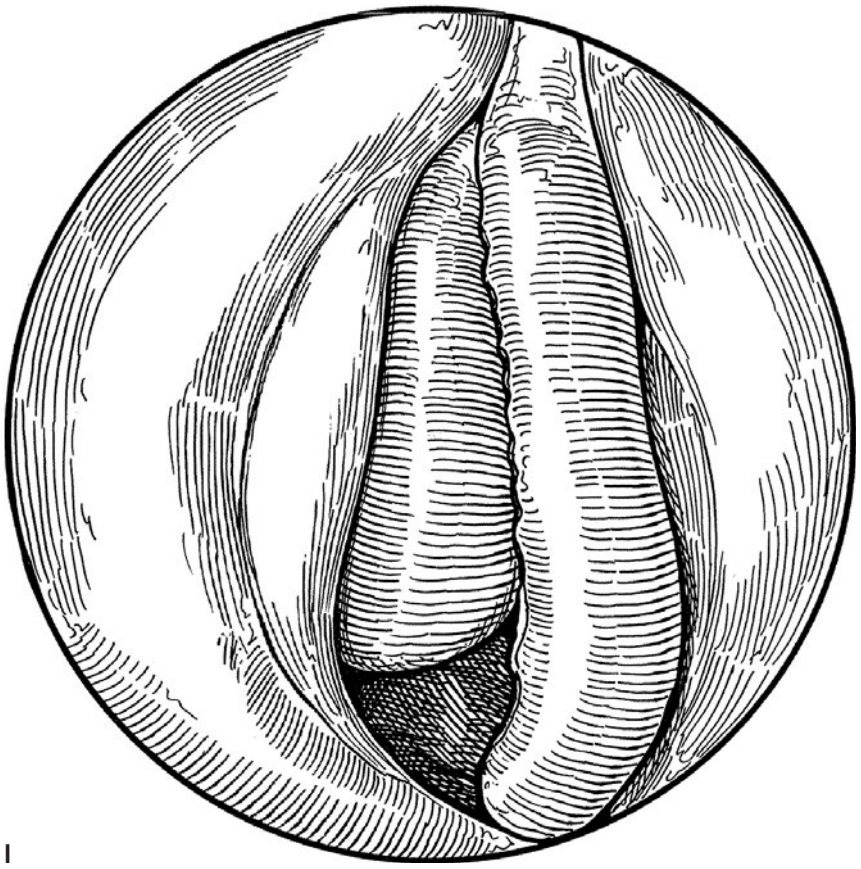


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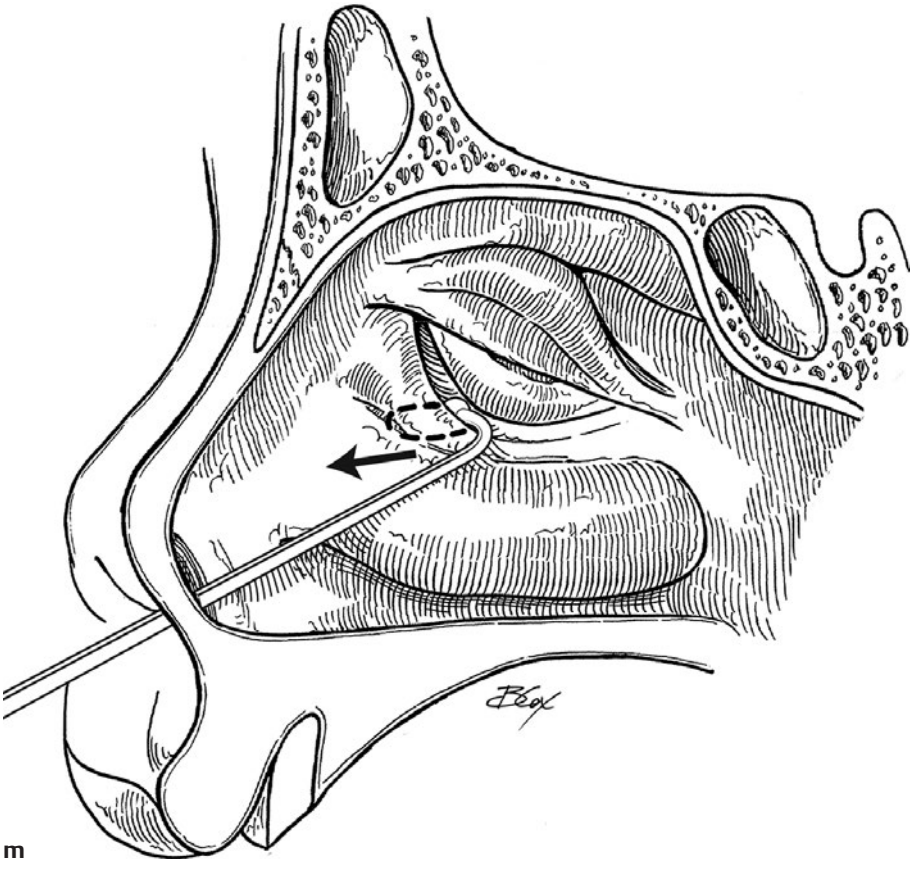


k

Fig. 22.1j, k

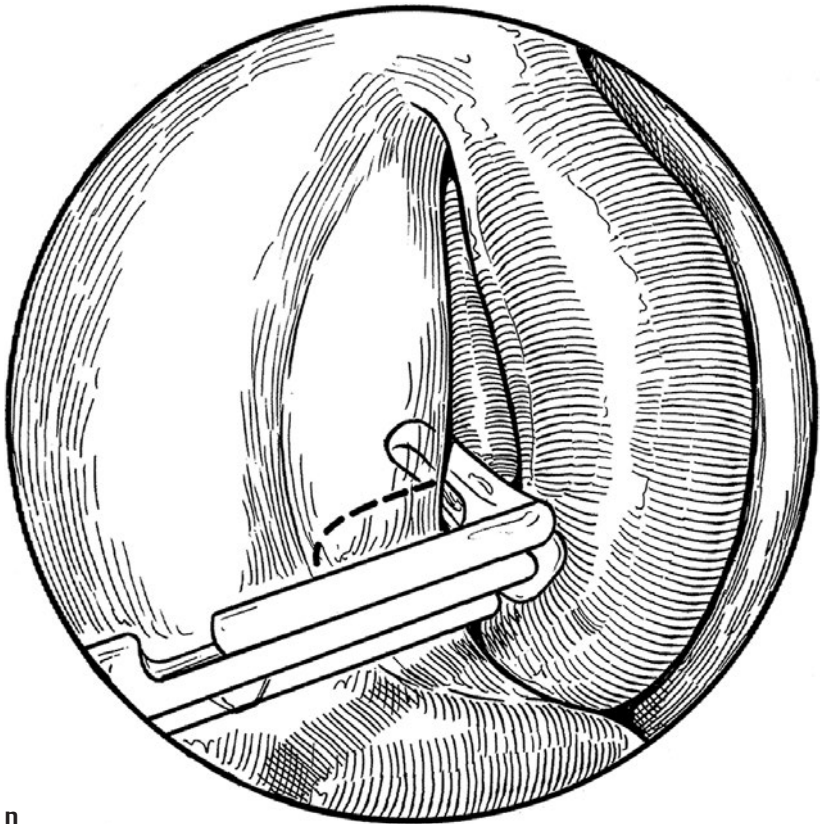


l

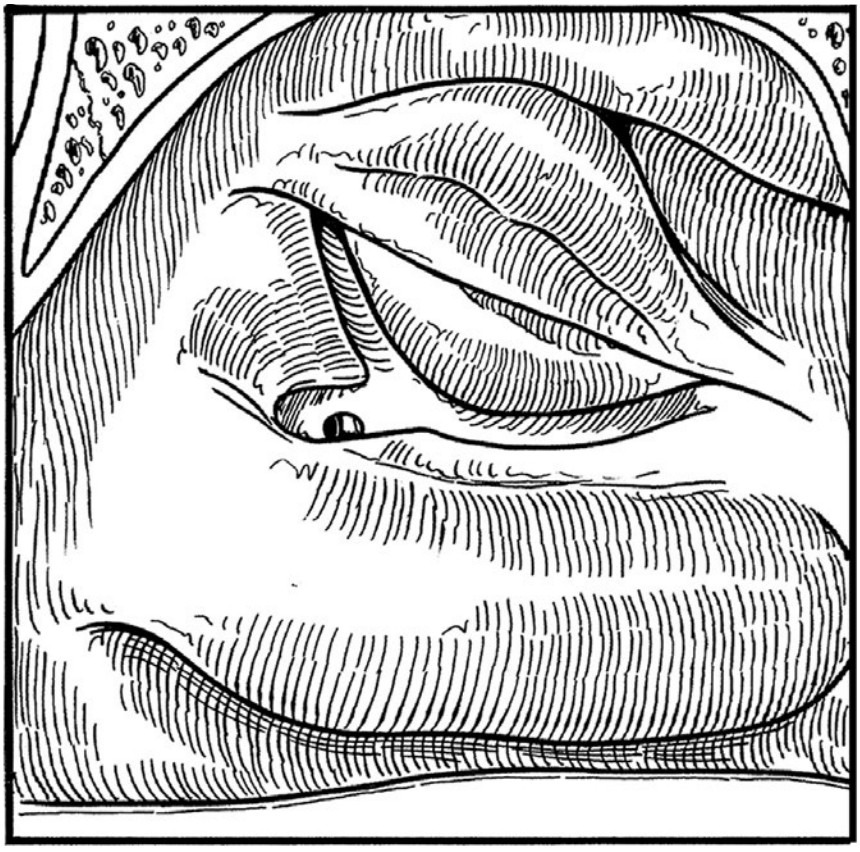


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Fig. 22.1l,m

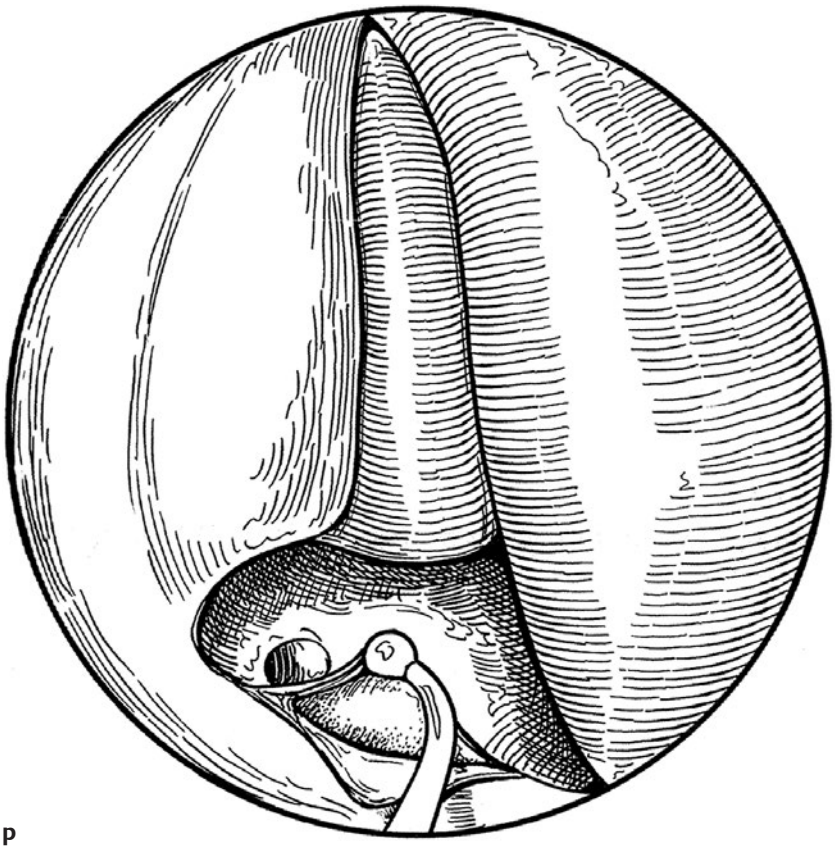


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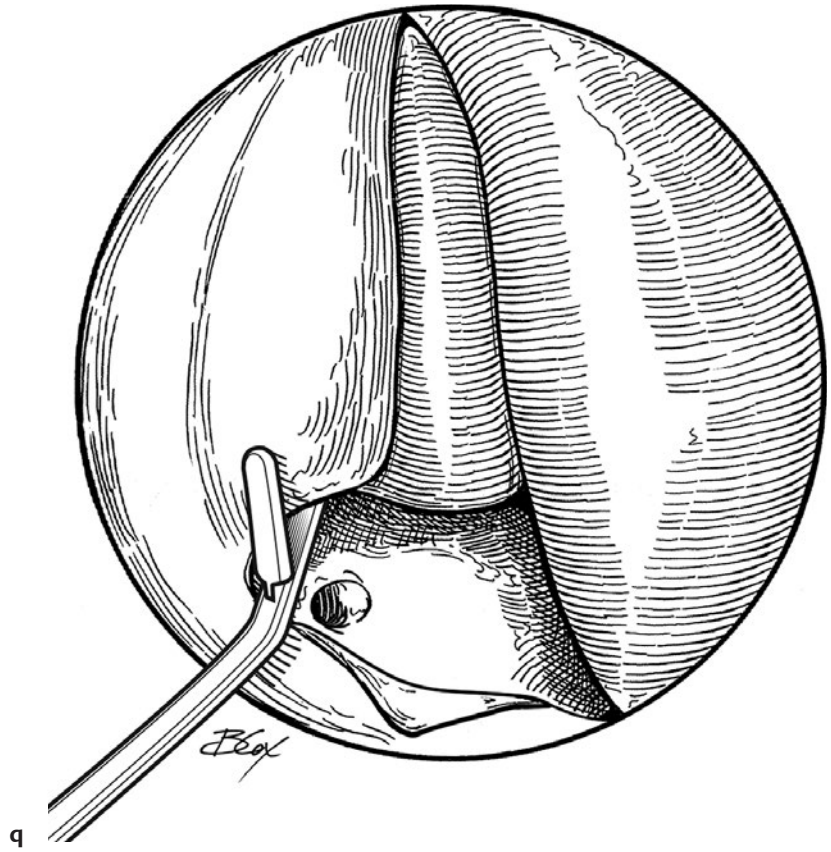


o

Fig. 22.1n,o



p

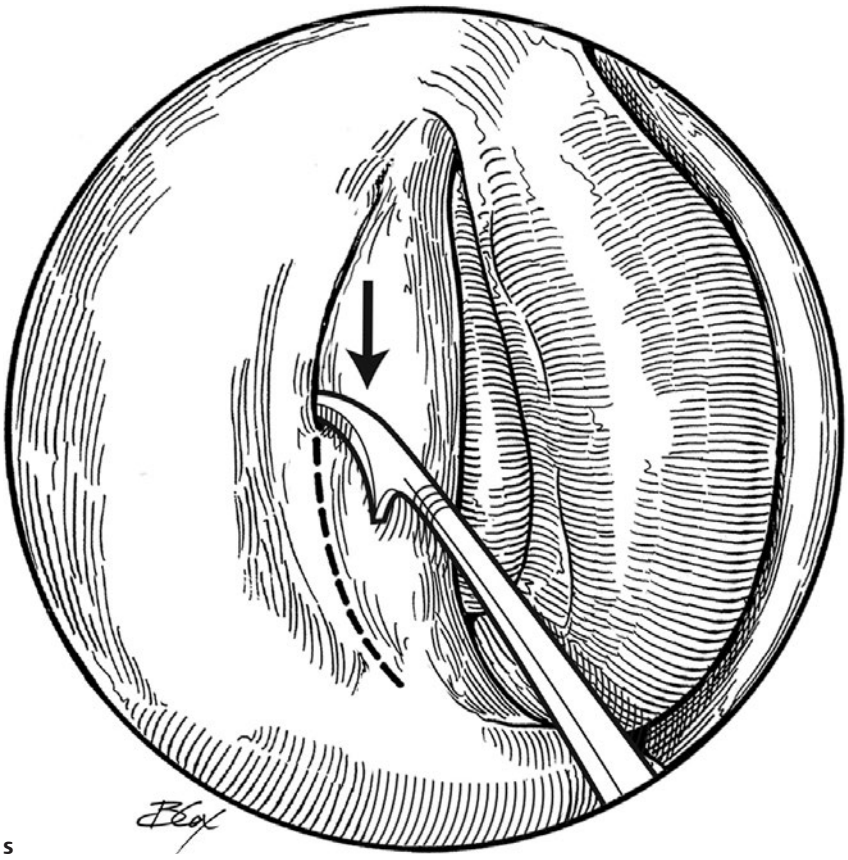


q

Fig. 22.1p,q

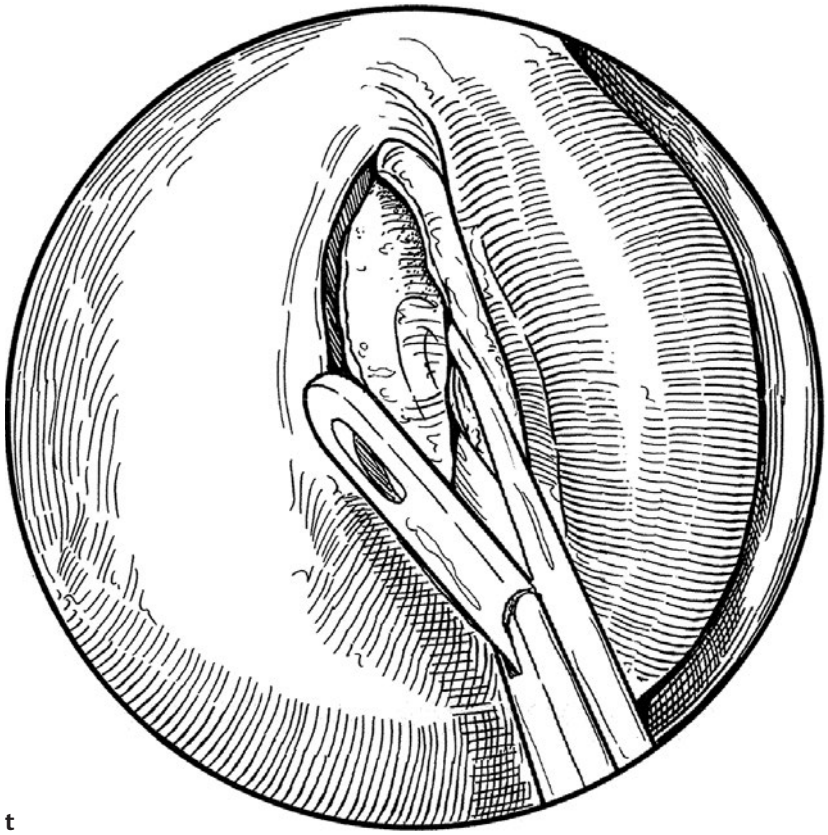


r

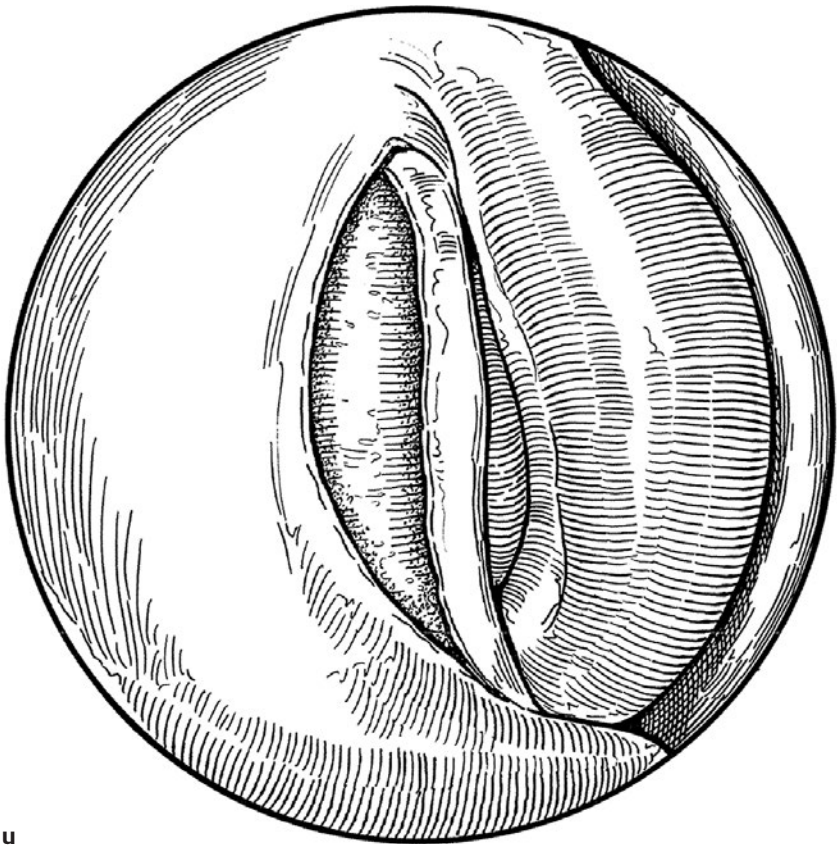


s

Fig. 22.1r,s

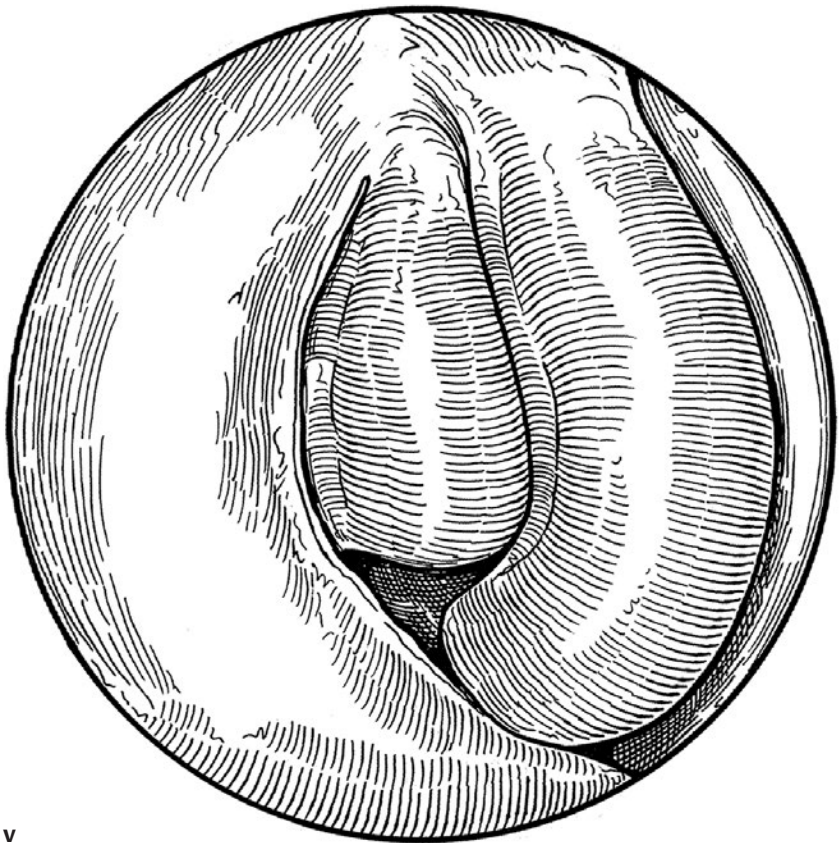


t

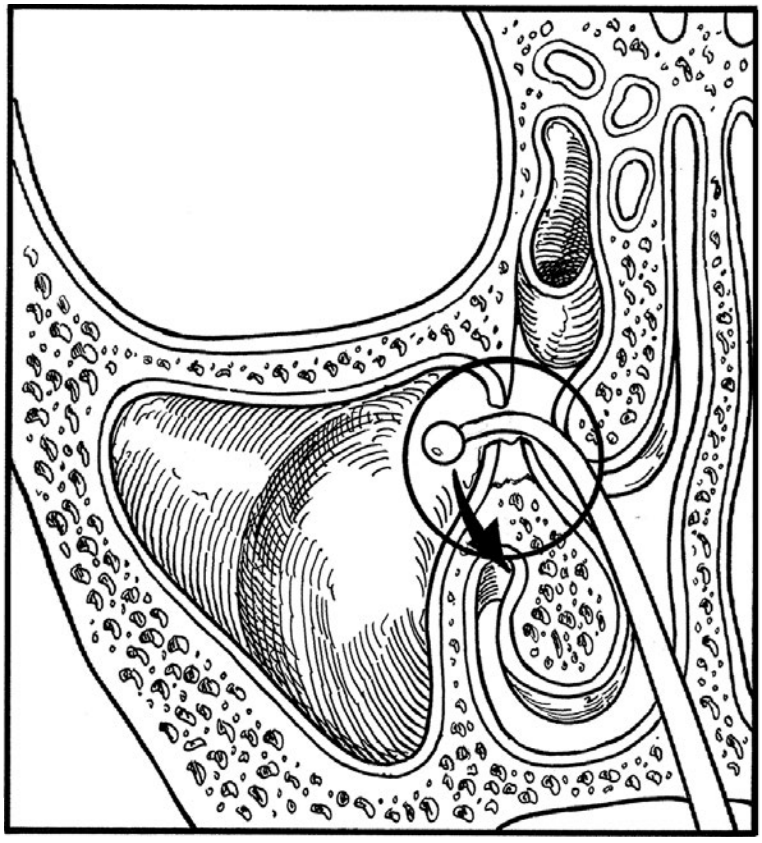


u

Fig. 22.1t,u

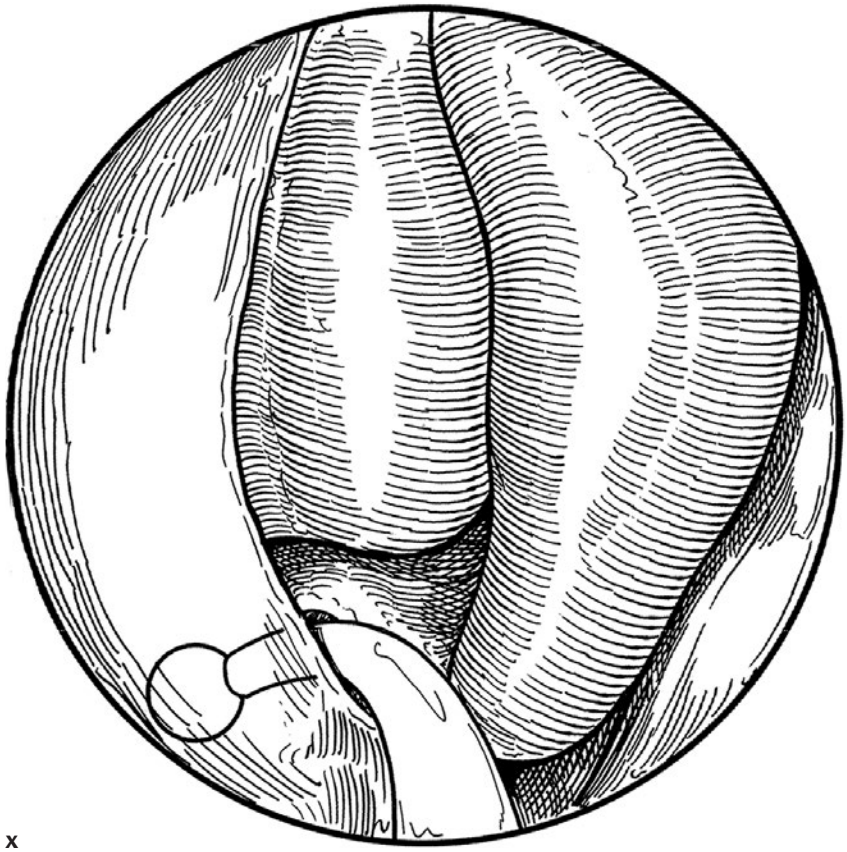


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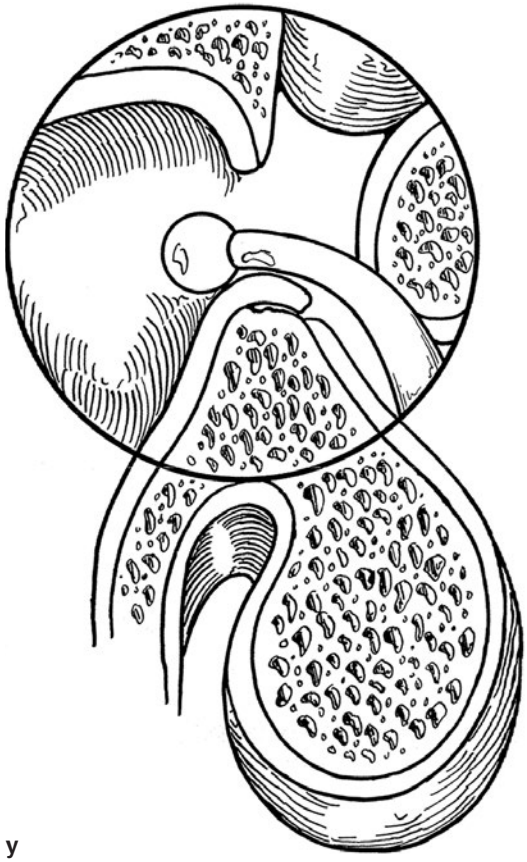


w

Fig. 22.1v,w

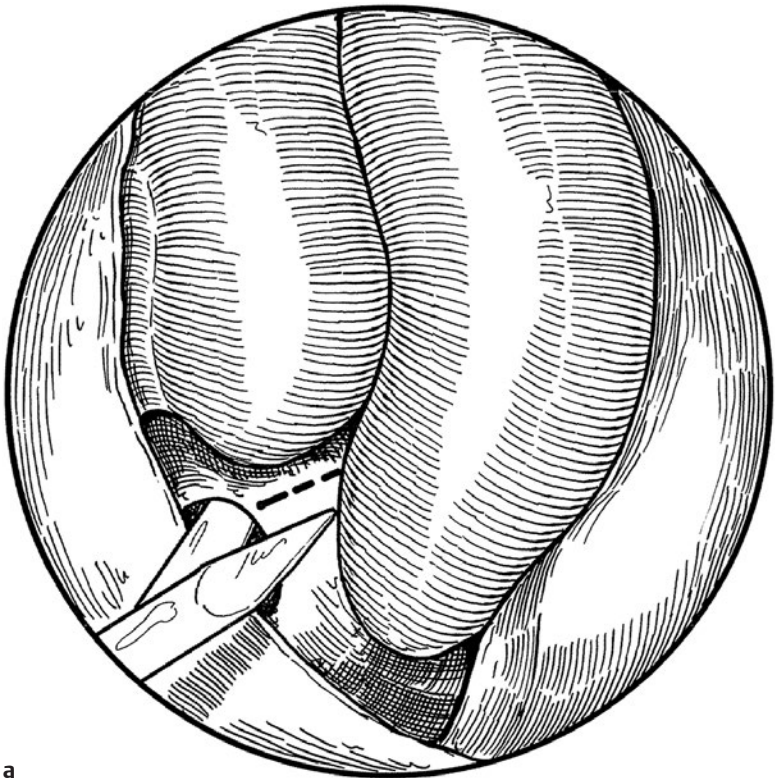


x

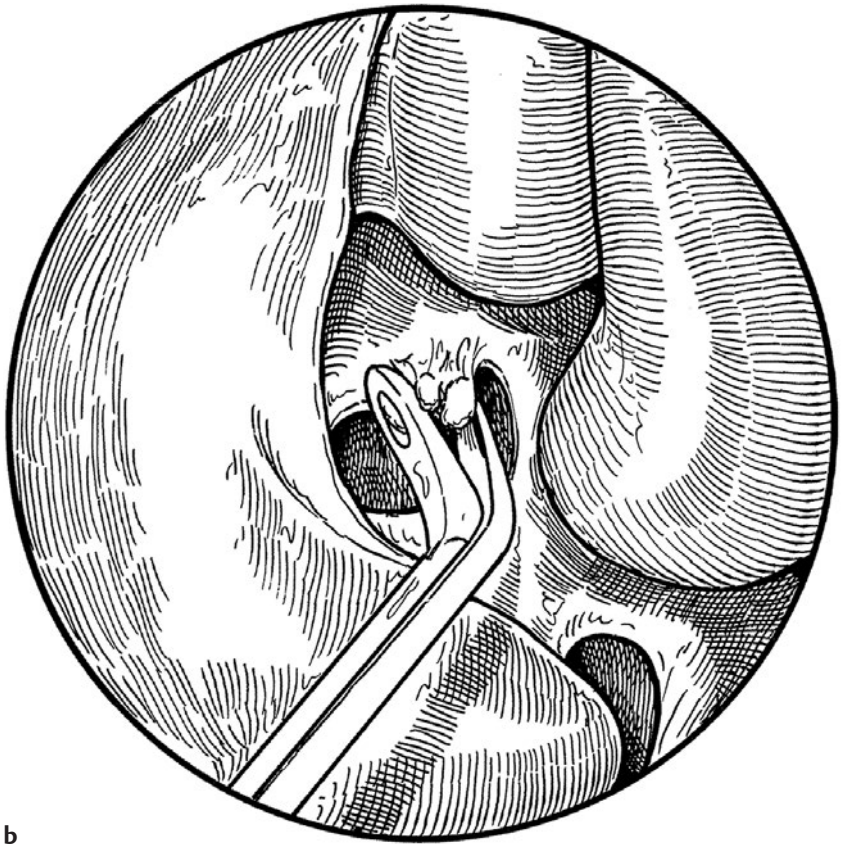


y

Fig. 22.1x,y

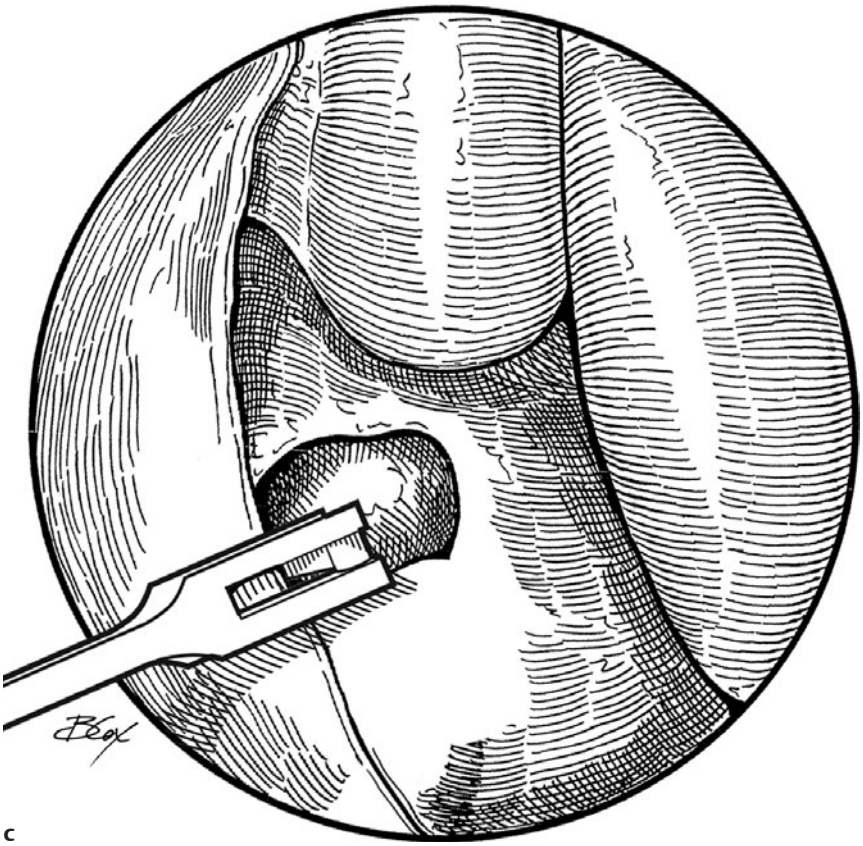


a

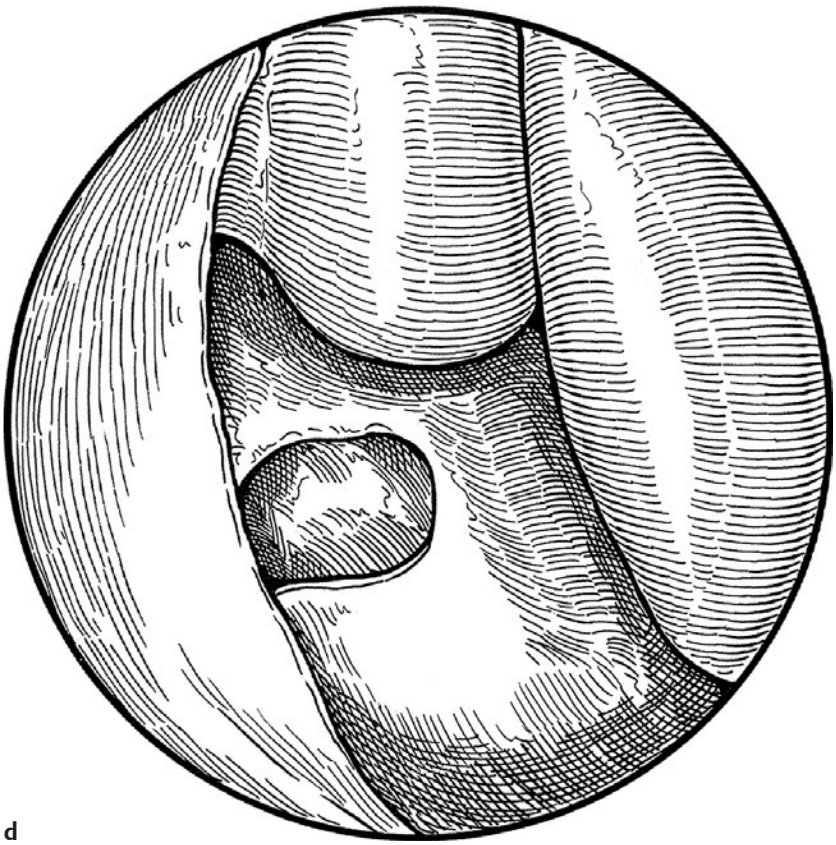


b

Fig. 22.2a,b

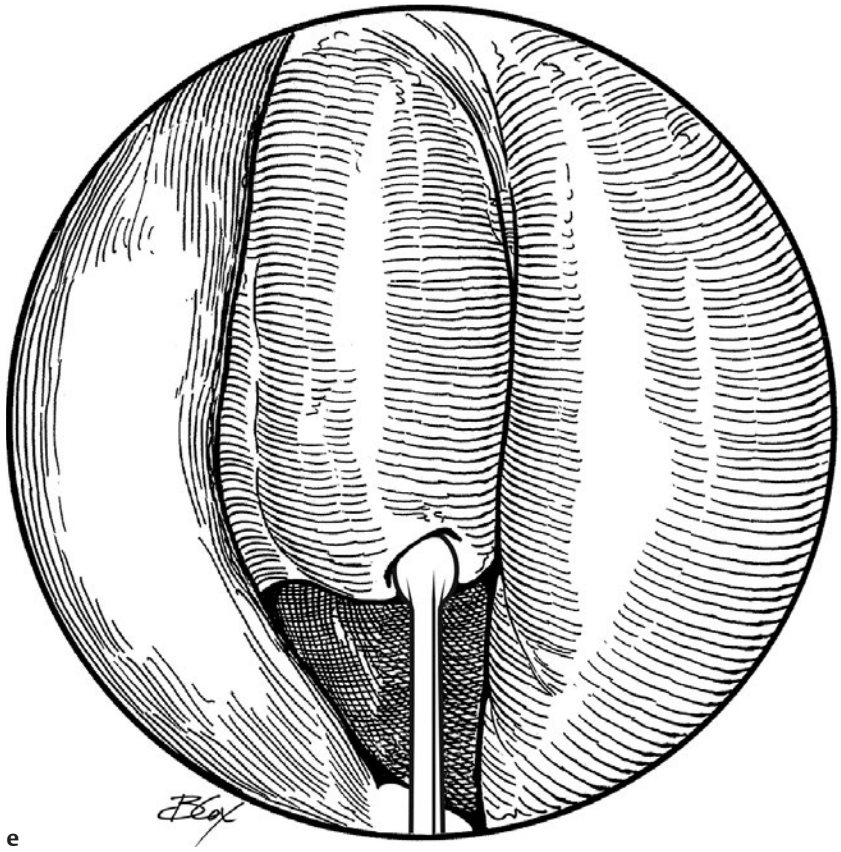


c

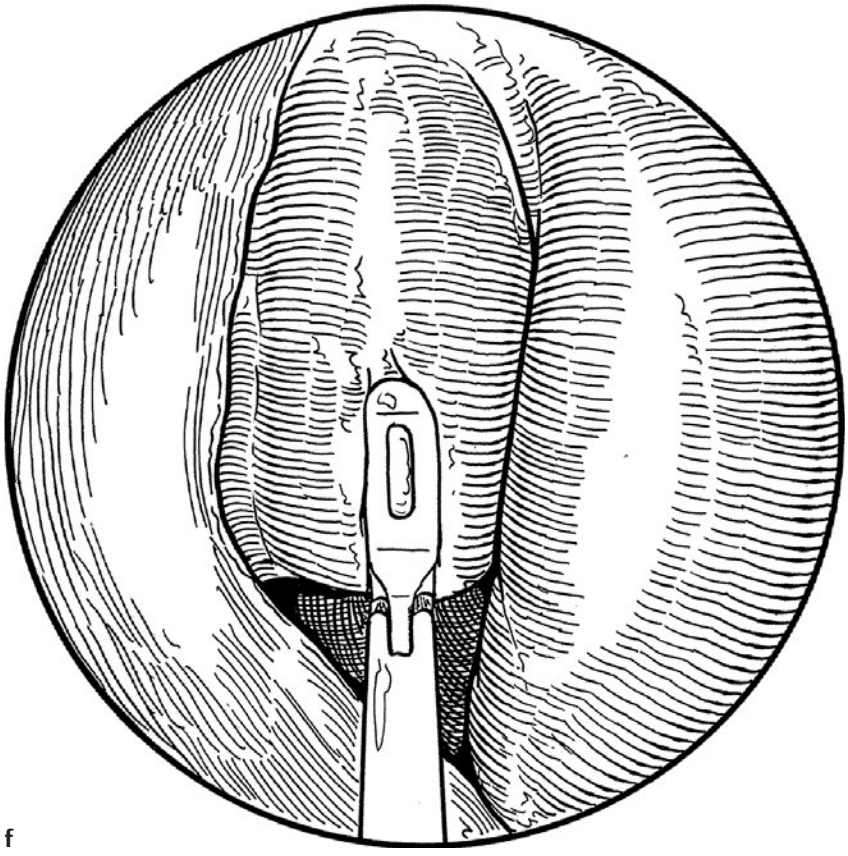


d

Fig. 22.2c,d

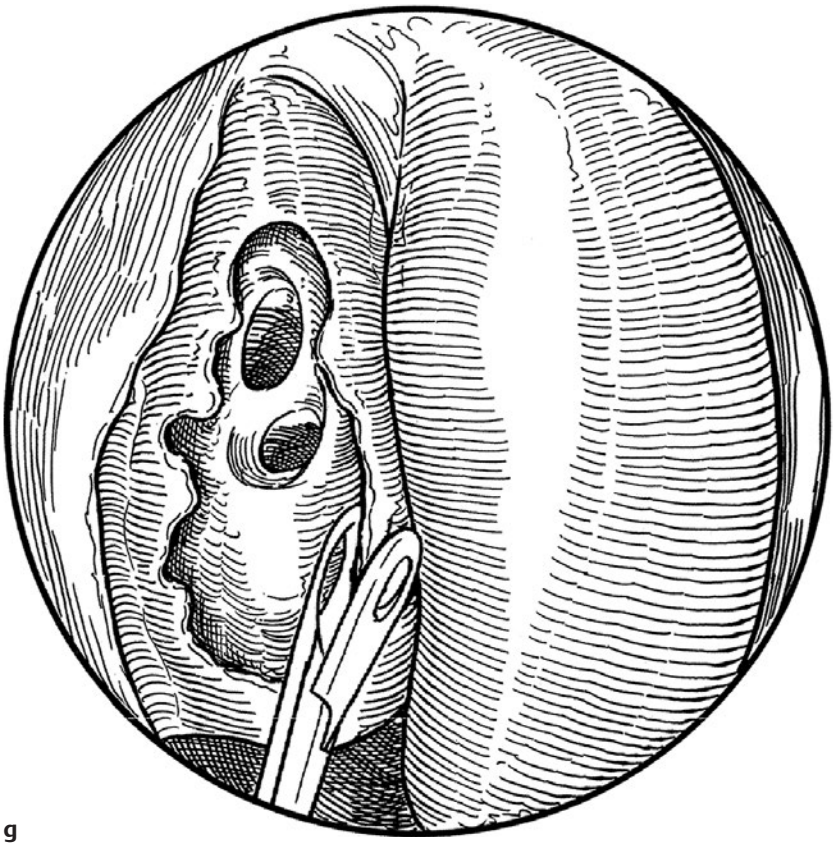


e

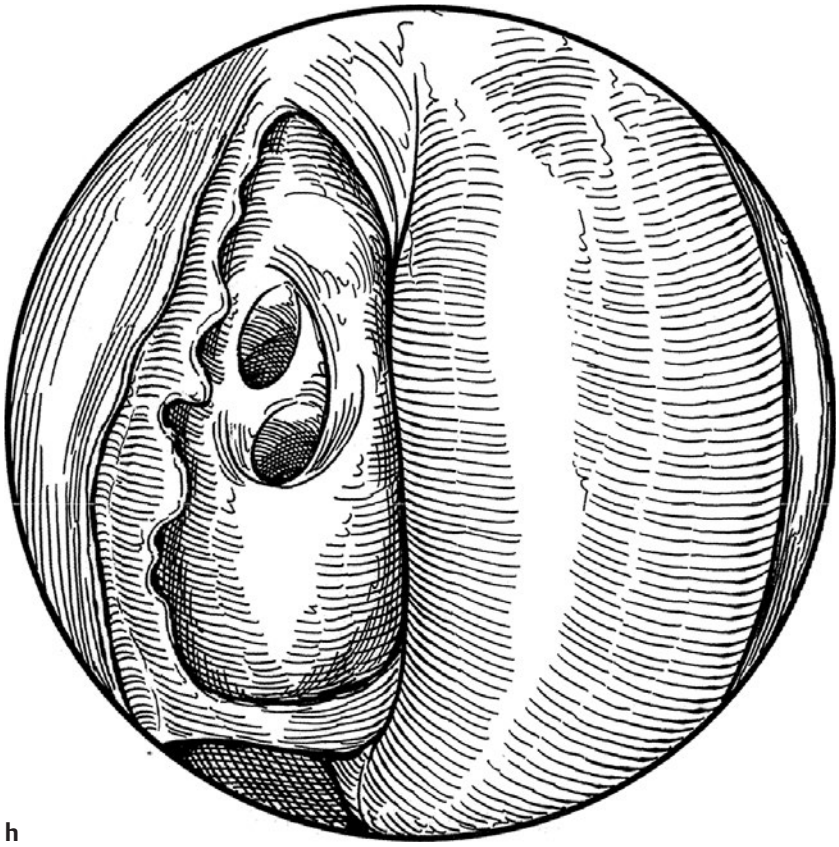


f

Fig. 22.2e,f

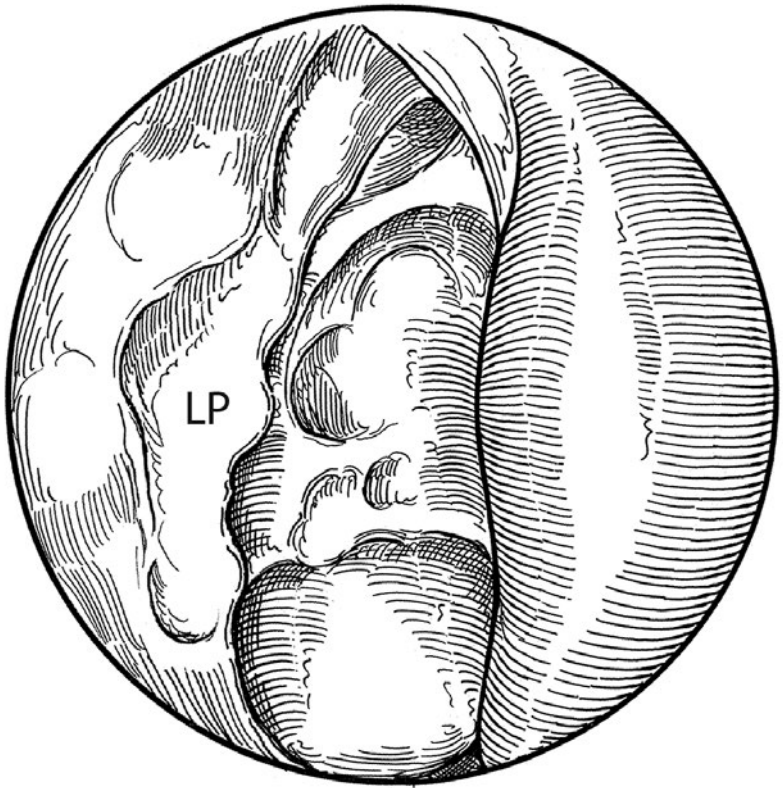


g

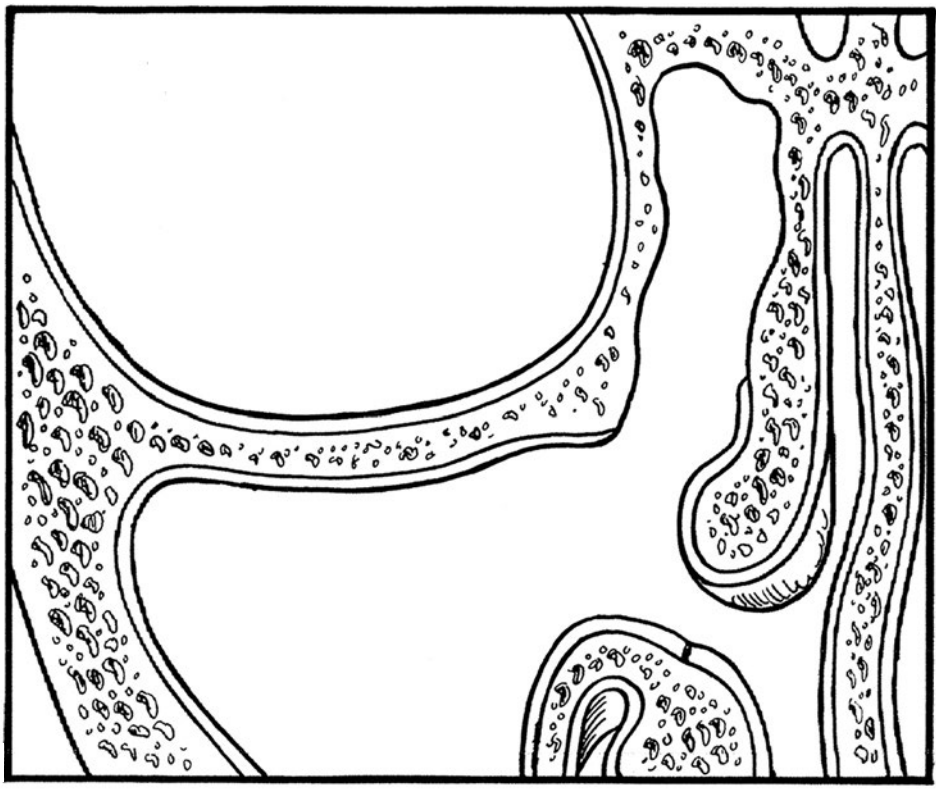


h

Fig. 22.2g,h

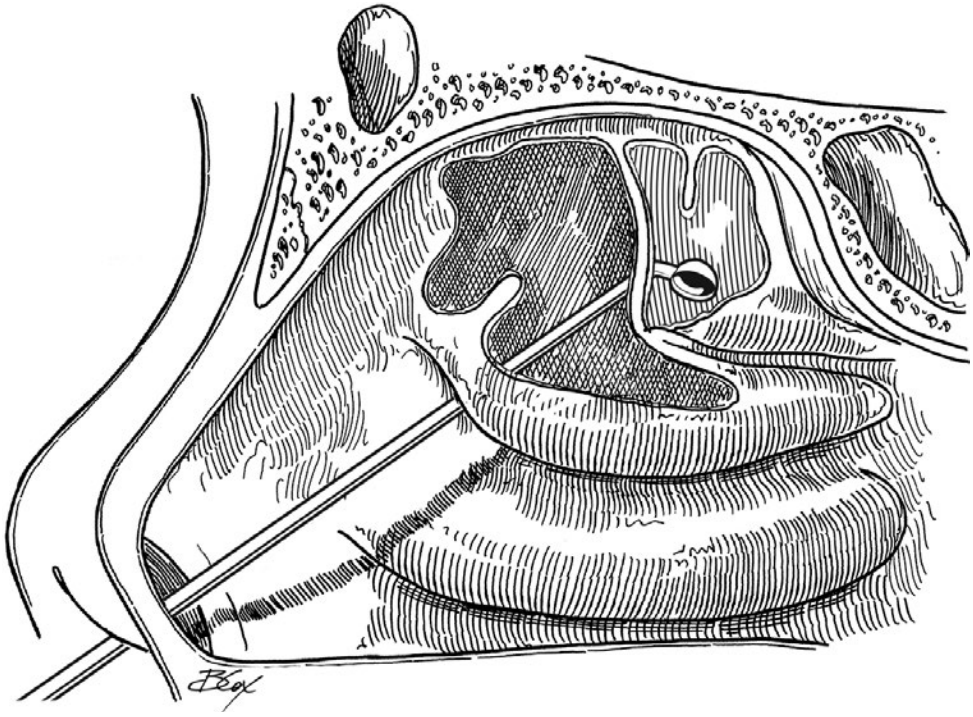


i

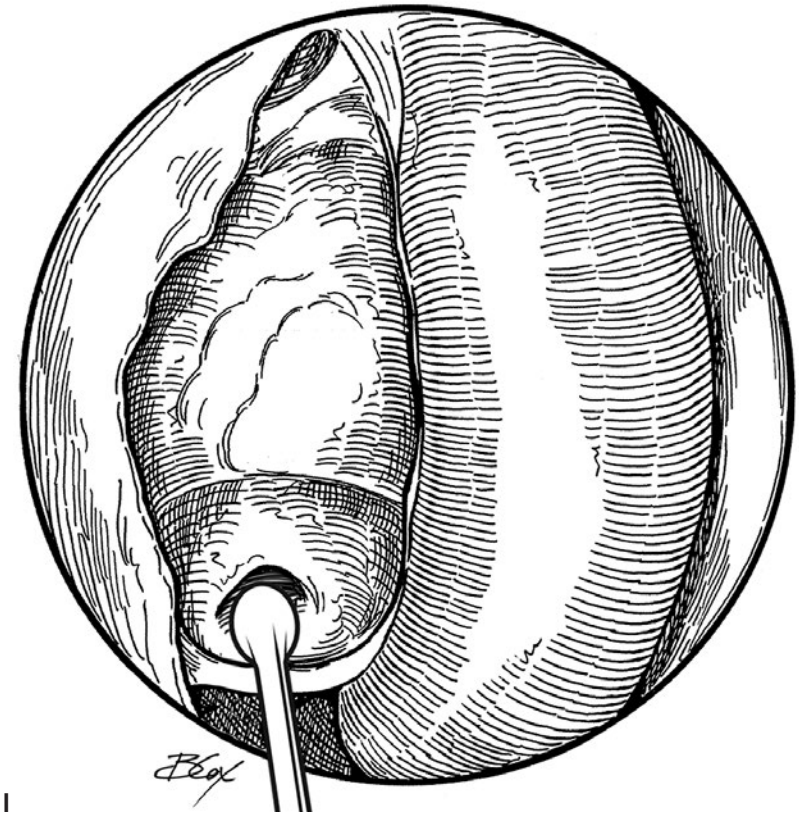


j

Fig. 22.2i,j

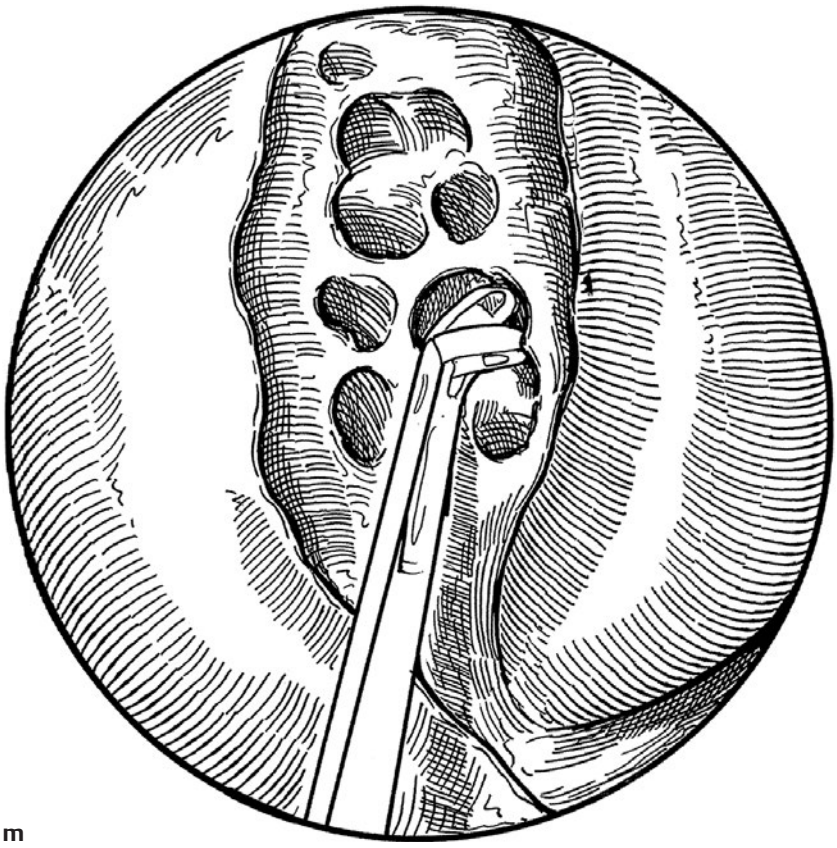


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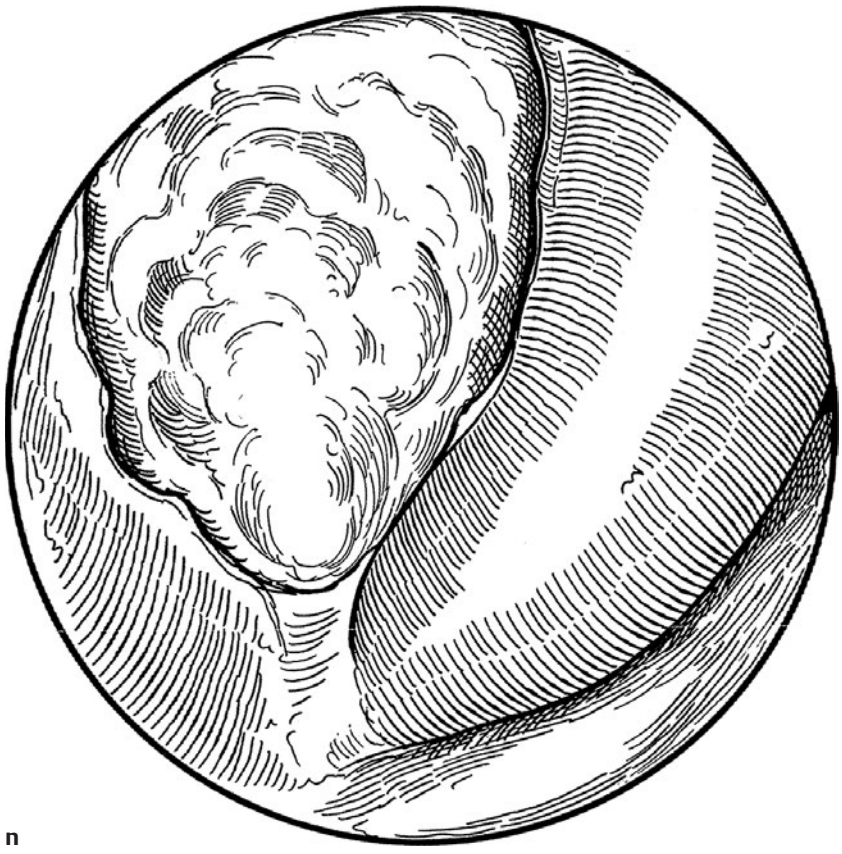


l

Fig. 22.2k,l

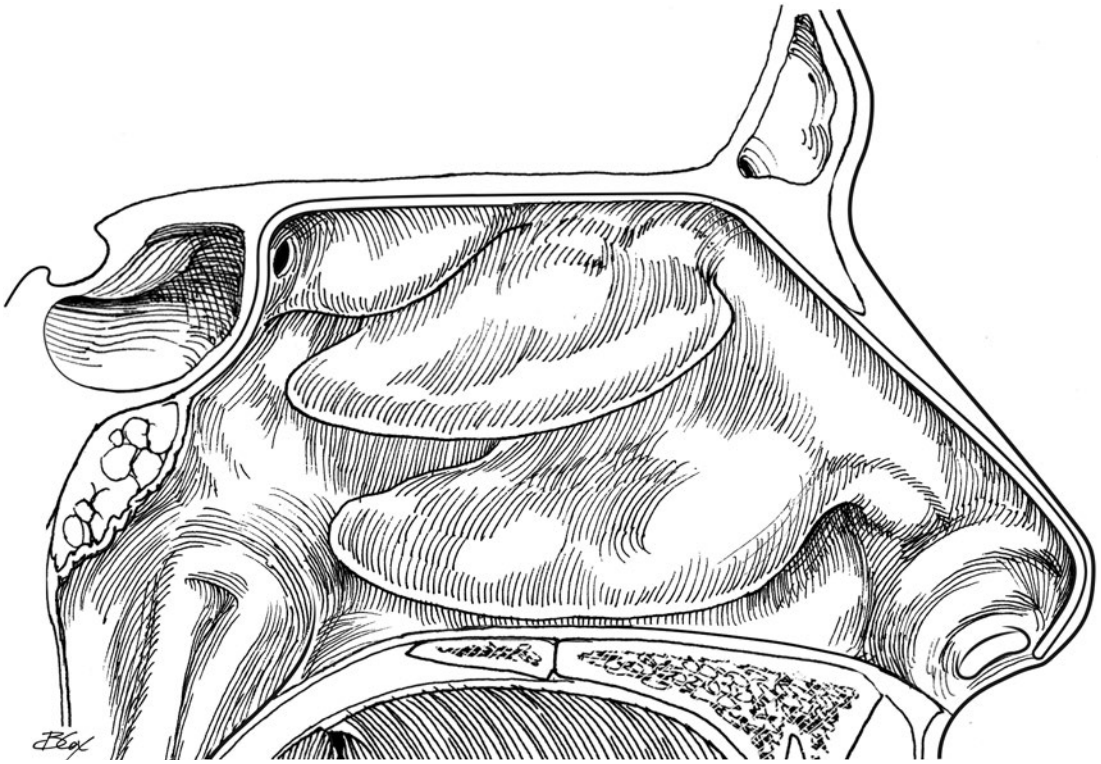


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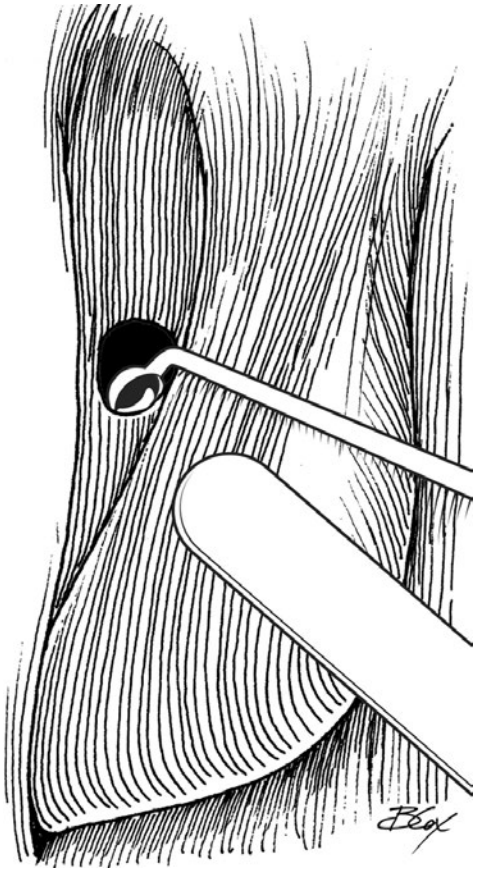


n

Fig. 22.2m,n



o



p

Fig. 22.2o,p

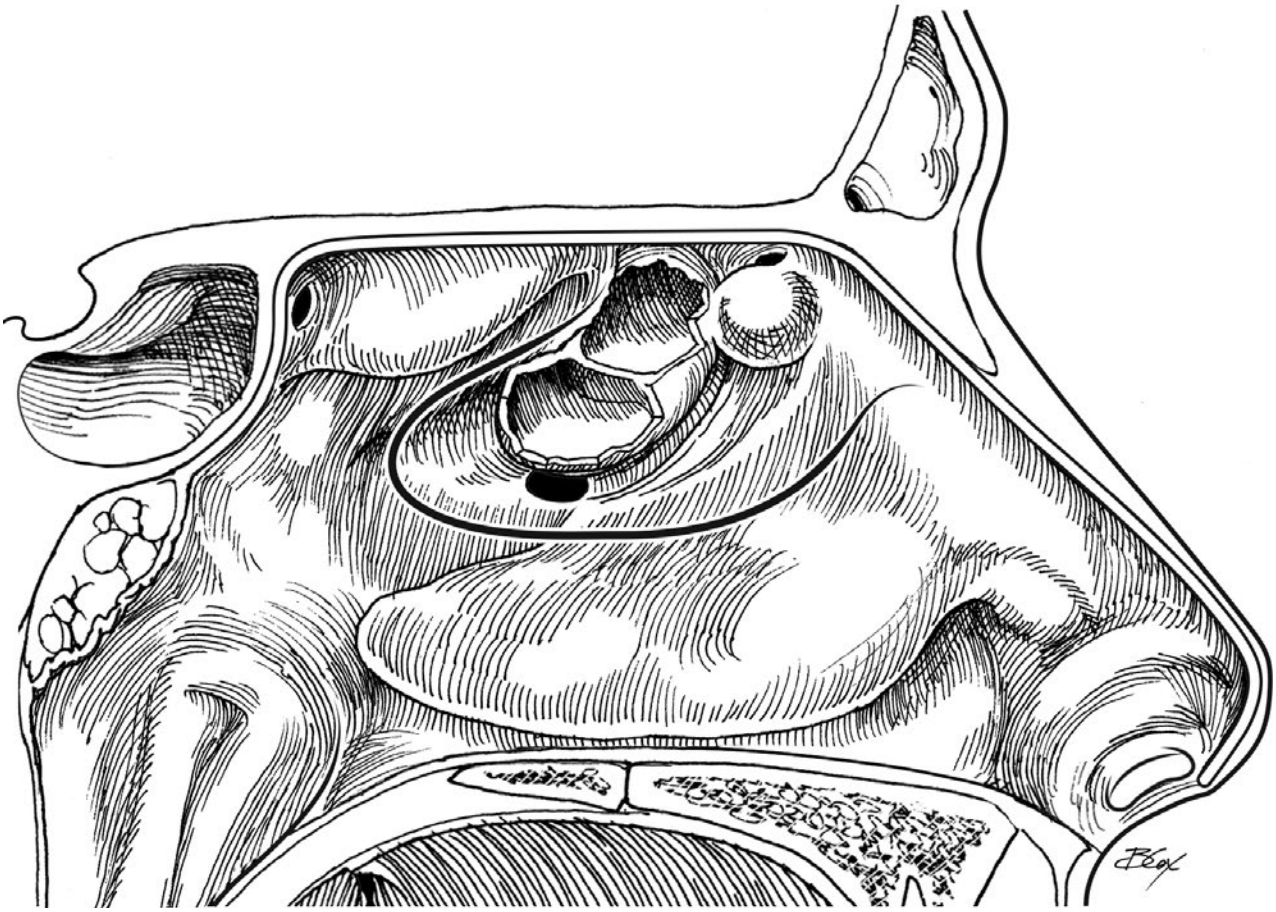
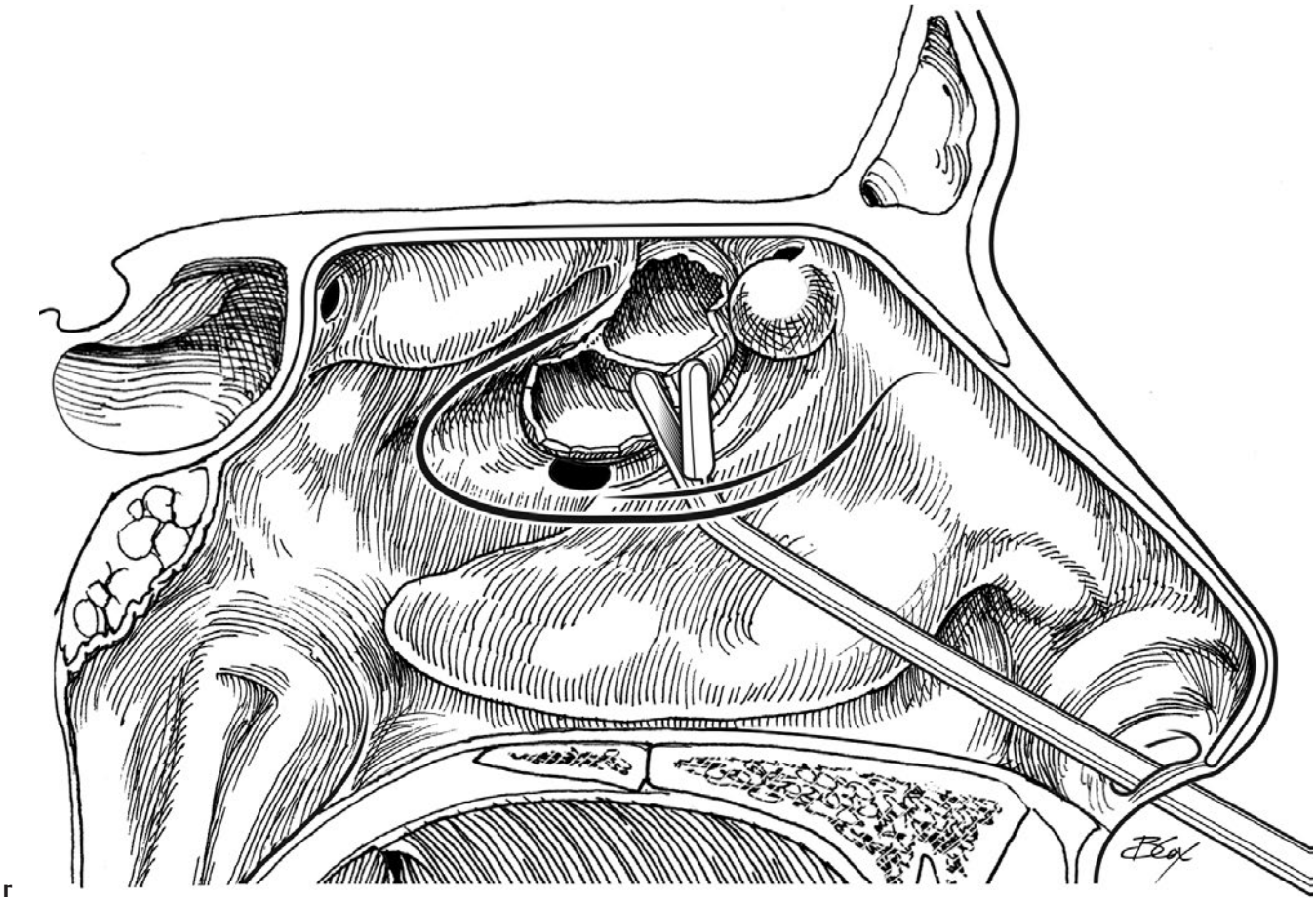
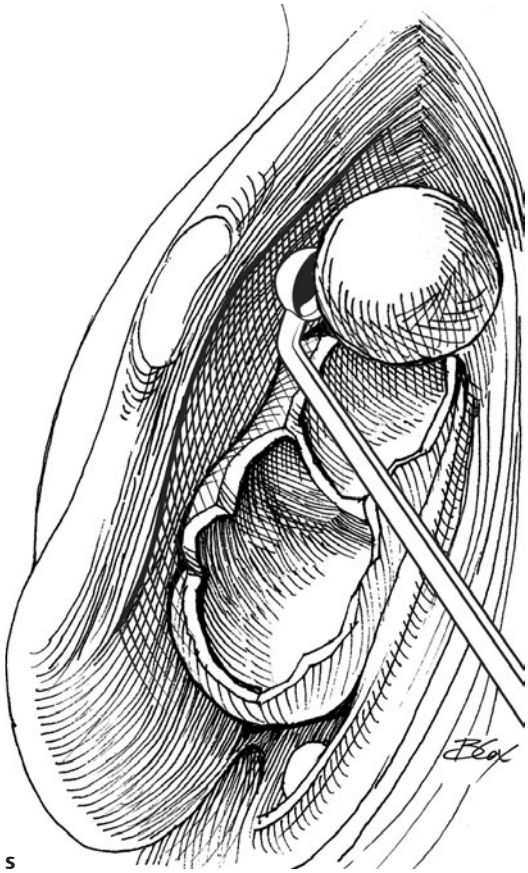
q 

Fig. 22.2q

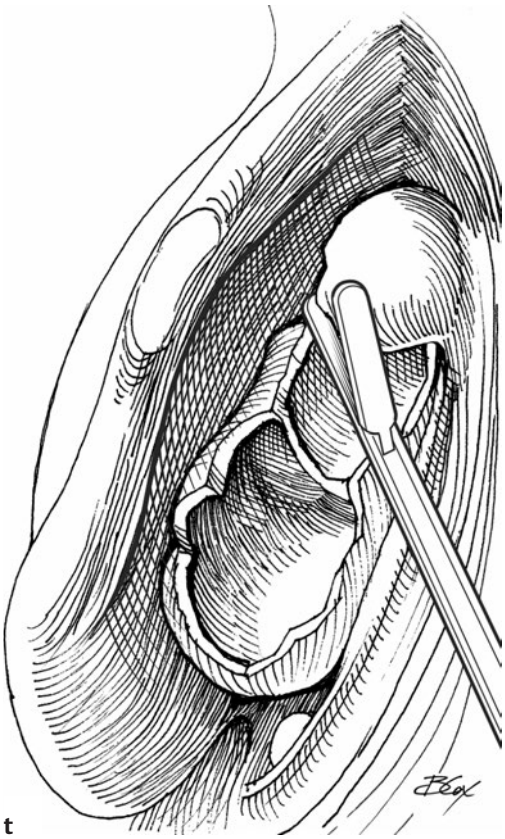


r

Fig. 22.2r



s



t

Fig. 22.2s,t

22-3 Computer-Assisted Image Guidance Endoscopic Sinus Surgery

Introduction

Computer-assisted image guidance allows accurate intraoperative anatomical localization during endoscopic sinus surgery. Many different systems are available, and all provide for a three-dimensional link between a preoperative CT and the intraoperative anatomy. This allows the surgeon to identify the location of a probe or surgical instrument to within 2 mm of accuracy. These systems improve safety and permit more complete surgery. Image guidance is a valuable adjunct to surgery but not a substitute for training, surgical technique, and knowledge of anatomy.

Indications

Image guidance is not indicated for all endoscopic sinus surgery cases. Indications may include complicated or unusual cases such as revision surgery, extensive disease that has altered the anatomy, unusual anatomy, or surgery involving the frontal sinus, walls of sphenoid sinus, skull base, and orbit.

Preoperative Evaluation

A special high-resolution CT is performed, and the images are loaded into a computer in the operating room creating two-dimensional images.

Operative Technique

1. The patient is positioned and prepared for endoscopic sinus surgery in the usual manner.
2. A headset is secured into place, and the patient is draped (**Fig. 22.3a**).
3. The computer screen, which displays axial, coronal, and sagittal CT mages and an endoscopic view, is positioned opposite the surgeon (**Fig. 22.3b**).
4. A special probe, which communicates with the computer system, is placed on anatomical landmarks on the face, and these locations are entered into the computer. This registration process correlates the patient's anatomy with the imaged anatomy in the computer.
5. Registration is verified by placing the probe on a specific anatomical landmark on the patient's face and viewing the position on the computer image. When the two positions correspond precisely, the verification is accurate. This verification process may be repeated during surgery.
6. Once registration is verified, surgery proceeds. When there is any question about the anatomical location, the tip of a specialized probe or instrument is placed on the site and can be located on the displayed images on the computer screen (**Fig. 22.3c**).

Complications

Inaccurate registration or verification, which may lead to incorrect identification of an anatomical location and subsequent intraoperative complications.

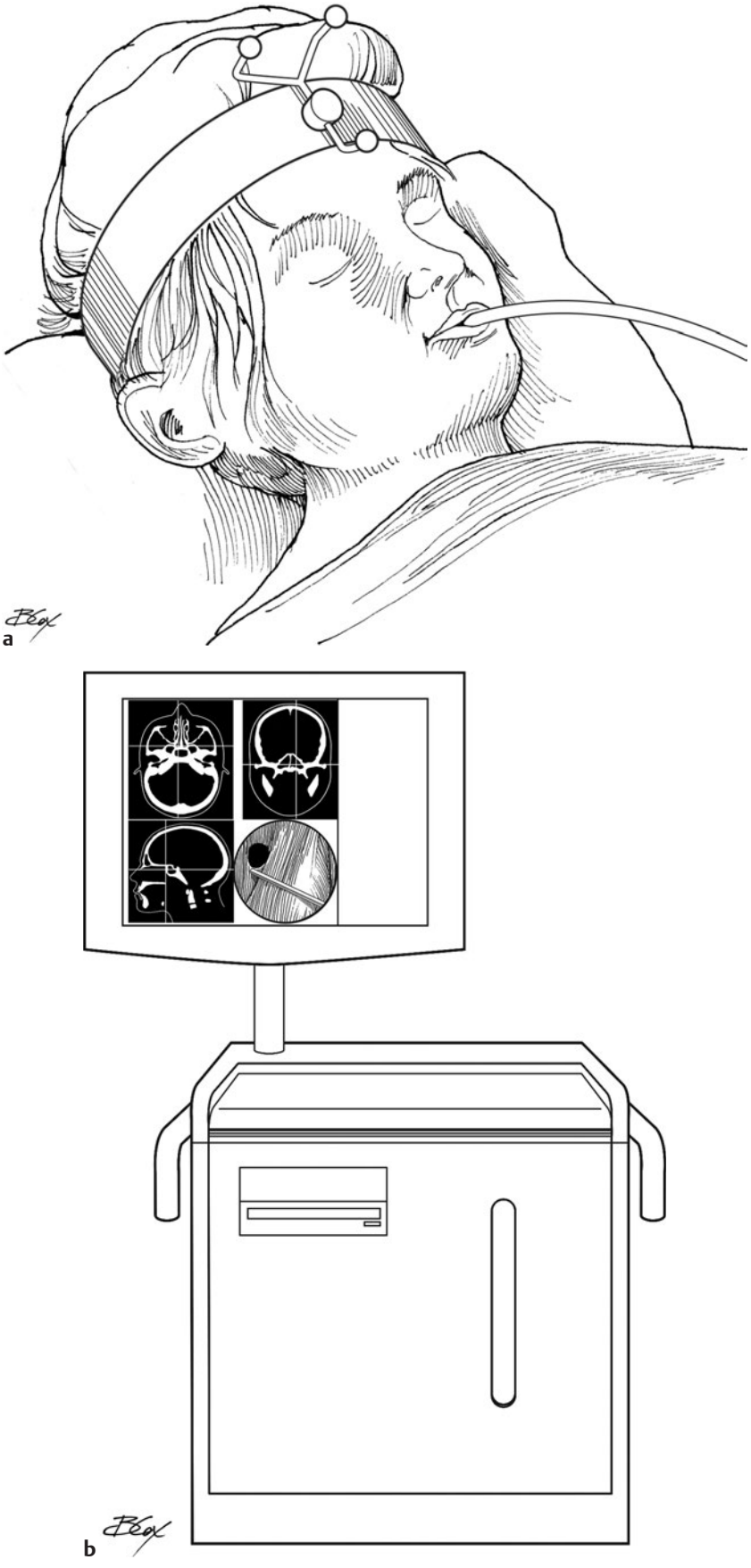
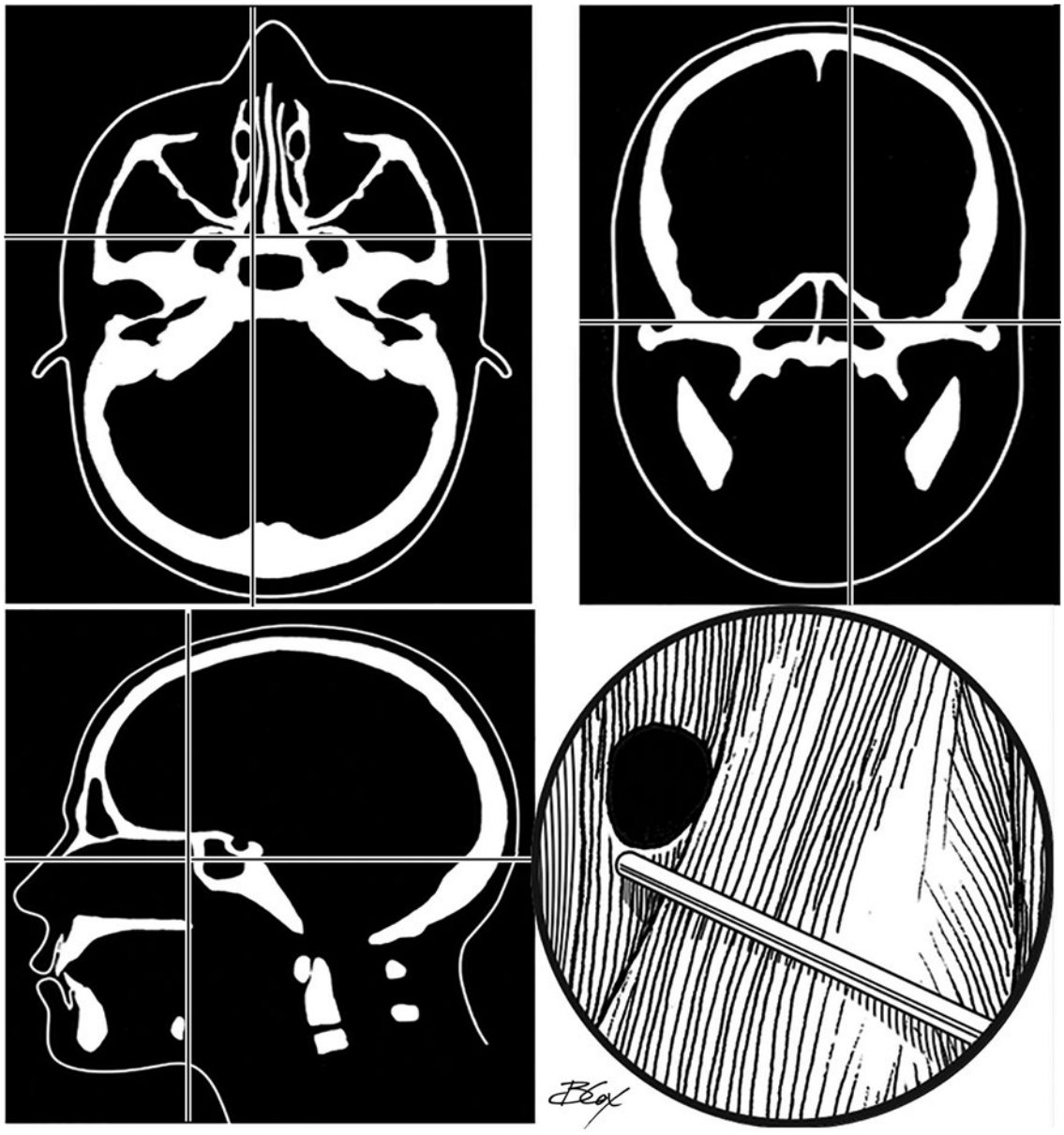


Fig. 22.3a,b



c

Fig. 22.3c

23 Periorbital Abscess

Lawrence W.C. Tom

The most common complication of sinus infections in children is a periorbital subperiosteal abscess: a collection of pus between the bony orbital wall and periorbita. This most often occurs secondary to ethmoid sinusitis but may be caused by frontal and maxillary disease. The clinical presentation of an abscess includes pain, orbital erythema and swelling, chemosis, proptosis, gaze restriction, and visual disturbances.

23-1 Endoscopic Drainage of a Periorbital Subperiosteal Abscess

Indications

Presence of an abscess on computed tomography (CT) is an indication for surgery. Progressive or severe proptosis, gaze restriction, or decrease in visual acuity makes surgical drainage urgent. Periorbital subperiosteal abscesses that are located between the periorbita and medial orbital wall may be drained endoscopically. The endoscopic approach can provide excellent visualization of the lamina papyracea and adjacent periorbita. The advantages of this approach include avoidance of a facial scar, more rapid resolution of the periorbital inflammation, and shorter hospitalization.

Preoperative Evaluation

Children suspected of having a periorbital subperiosteal abscess should immediately be treated medically with intravenous antibiotics, nasal decongestants, steroids, and saline nasal sprays. An initial ophthalmologic consultation and, when indicated, serial assessments are essential. CT of the sinuses that identifies the involved sinuses, extent of disease, and location and size of the abscess is necessary. Only abscesses that are located between the medial orbital wall and periorbita can be drained endoscopically. Magnetic resonance imaging (MRI) should be performed if an associated intracranial complication is suspected.

Operative Technique

1. The preliminary steps for endoscopic sinus surgery are performed as described in Section 22-1, steps 1 through 6.
2. An uncinectomy and anterior ethmoidectomy are performed in a similar manner to endoscopic sinus surgery (see Section 22-1).
3. Unlike endoscopic sinus surgery for chronic sinus disease, bleeding is more likely to occur from the inflamed, infected mucosa, and visualization may be more difficult. If this occurs, oxymetazoline-soaked pledgets should be reinserted and left in place for at least 3 minutes to achieve hemostasis before proceeding with the dissection. This may have to be repeated throughout the surgery.
4. Using an upbiting forceps, suction, and/or microdebrider, the pus and inflammatory tissue are thoroughly removed from the anterior ethmoid cavity to expose the lateral ethmoid wall (lamina papyracea) (**Fig. 23.1a**).
5. While visualizing the lamina papyracea with the telescope, gentle pressure is placed on the globe. The periorbita may bulge into the ethmoid cavity through the dehiscence in the lamina papyracea, or pus may drain through the bony defect (**Fig. 23.1b**).
6. The dehiscence can be enlarged with a J-curette. Care must be taken to avoid violating the periorbita (**Fig. 23.1c**).
7. No packing or stents are placed to permit further intranasal drainage.
8. The patient remains on antibiotics, steroids, and saline nasal sprays until seen in the office in 2–3 weeks.

Advantages

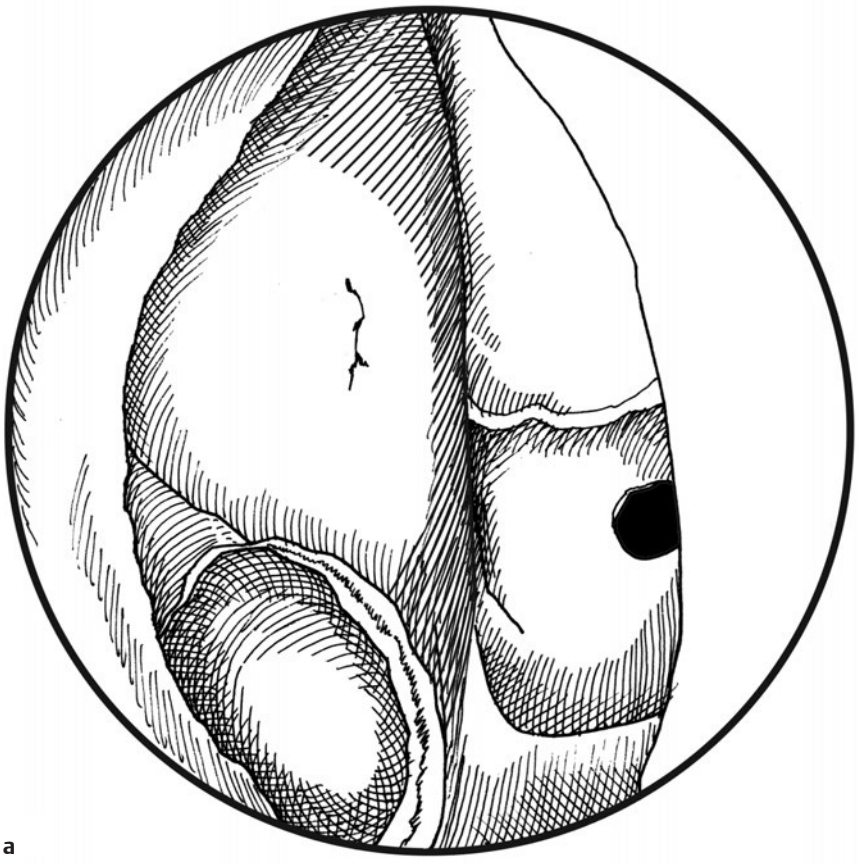
1. No external scar
2. Less postoperative edema
3. More rapid resolution of signs and symptoms
4. Shorter hospital stay

Disadvantages

1. Visualization may be difficult because of smaller anatomy and bleeding
2. Need for pediatric instruments
3. Not applicable for superior, lateral, and inferior abscesses

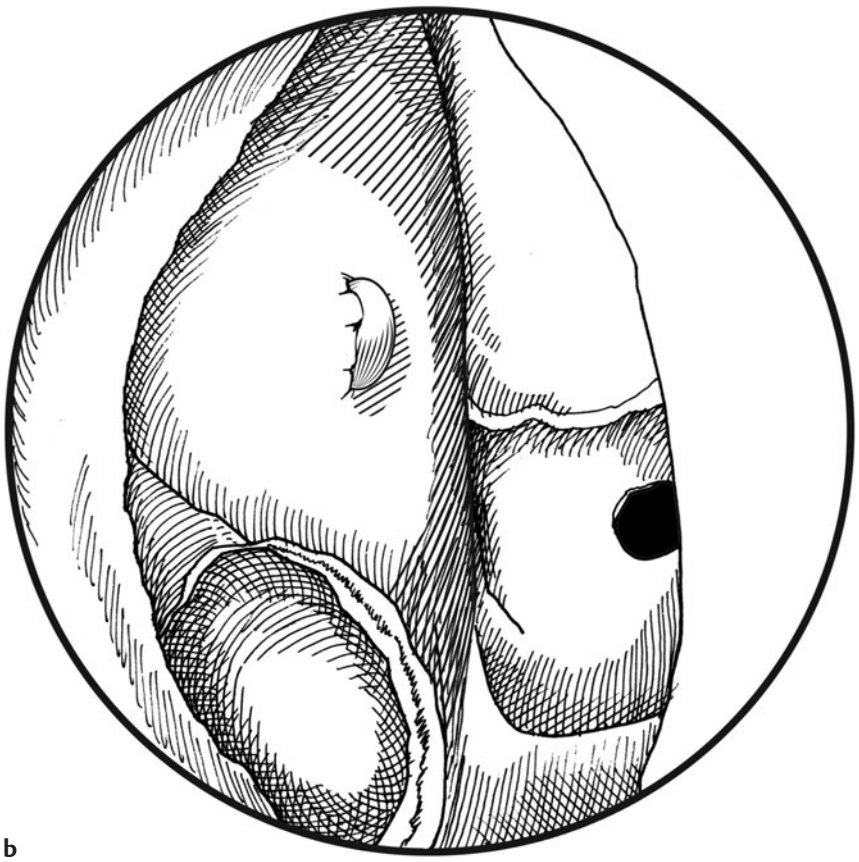
Complications

1. Recurrence of abscess
2. Complications of endoscopic sinus surgery

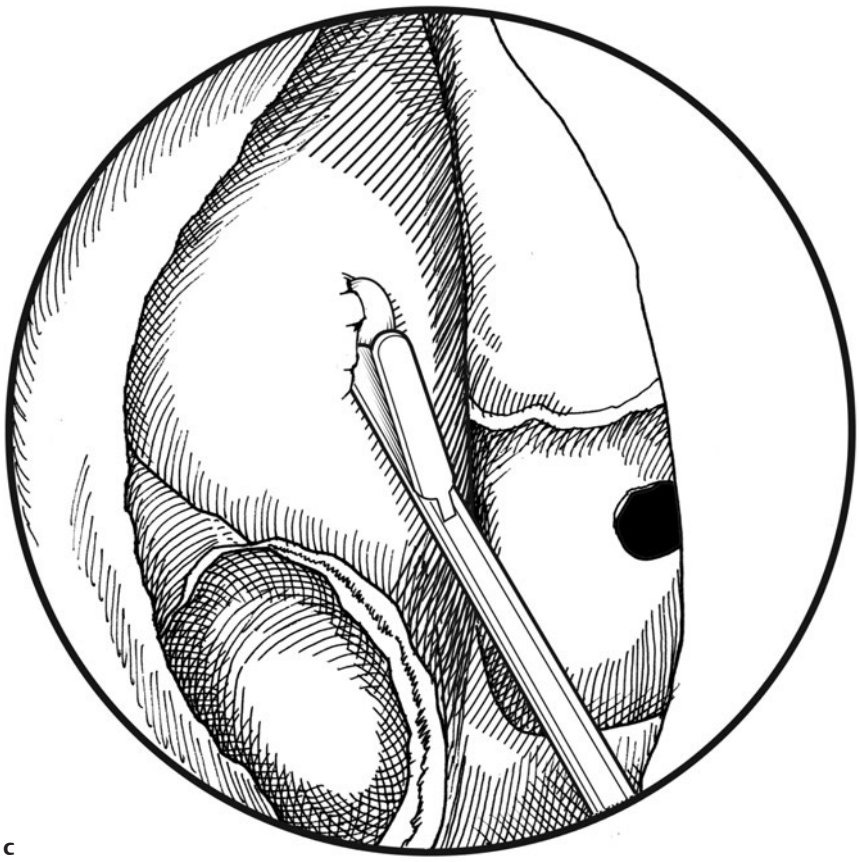


a

Fig. 23.1a



b



c

Fig. 23.1b,c

23-2 External Drainage of a Subperiosteal Abscess

Indications

External drainage of a subperiosteal abscess should be considered when bleeding or poor visualization of the lamina papyracea prevents completion of endoscopic drainage, the abscess is not located between the periorbita and medial orbital wall, there is recurrence or persistence following endoscopic drainage, or the surgeon is more comfortable with this approach.

Preoperative Evaluation

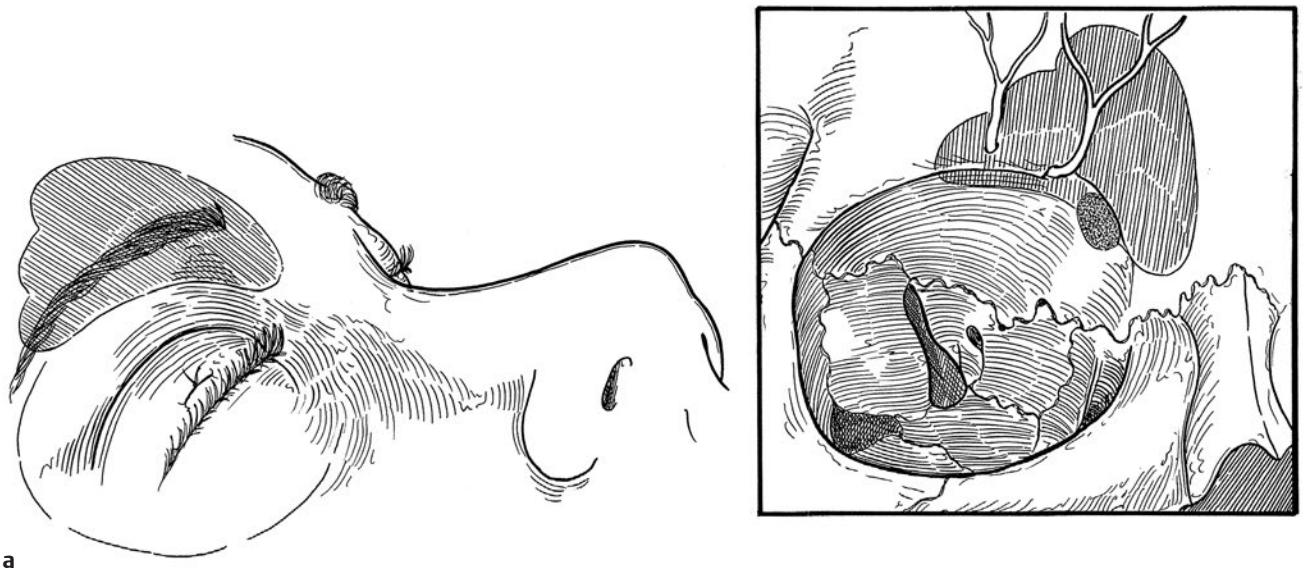
The preoperative evaluation is identical for all patients with suspected periorbital subperiosteal abscesses.

Operative Technique

1. Under general anesthesia, the skin overlying the proposed incision is injected with 1% lidocaine and 1:100,000 epinephrine to reduce bleeding.
2. For a periorbital subperiosteal abscess in the frontal sinus region, the same incision described for frontal sinus trephination is used to drain the abscess (**Fig. 23.2a**) and trephination of the frontal sinus is performed if desired.
3. If the abscess is caused by ethmoid sinusitis, the incision (**Fig. 23.2b**) and procedure described for external ethmoidectomy are employed (**Fig. 23.2c**).
4. A drain may be placed in the abscess cavity and brought out through the incision. This is rarely required for an abscess caused by ethmoid disease because the abscess cavity is drained into the nose through the now widely opened ethmoid sinus system.
5. A broad-spectrum antibiotic is administered for 7 to 10 days.

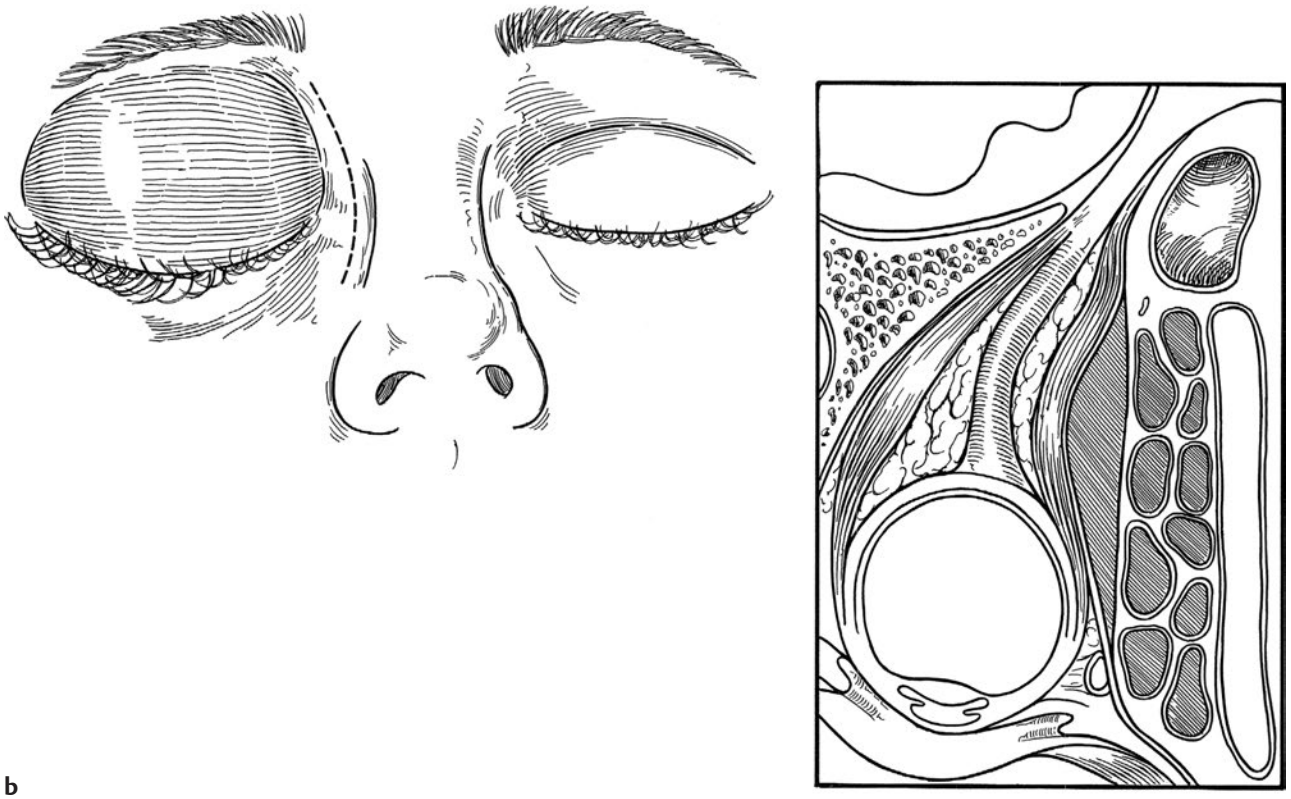
Complications

1. Recurrence of abscess
2. Complications of external ethmoidectomy

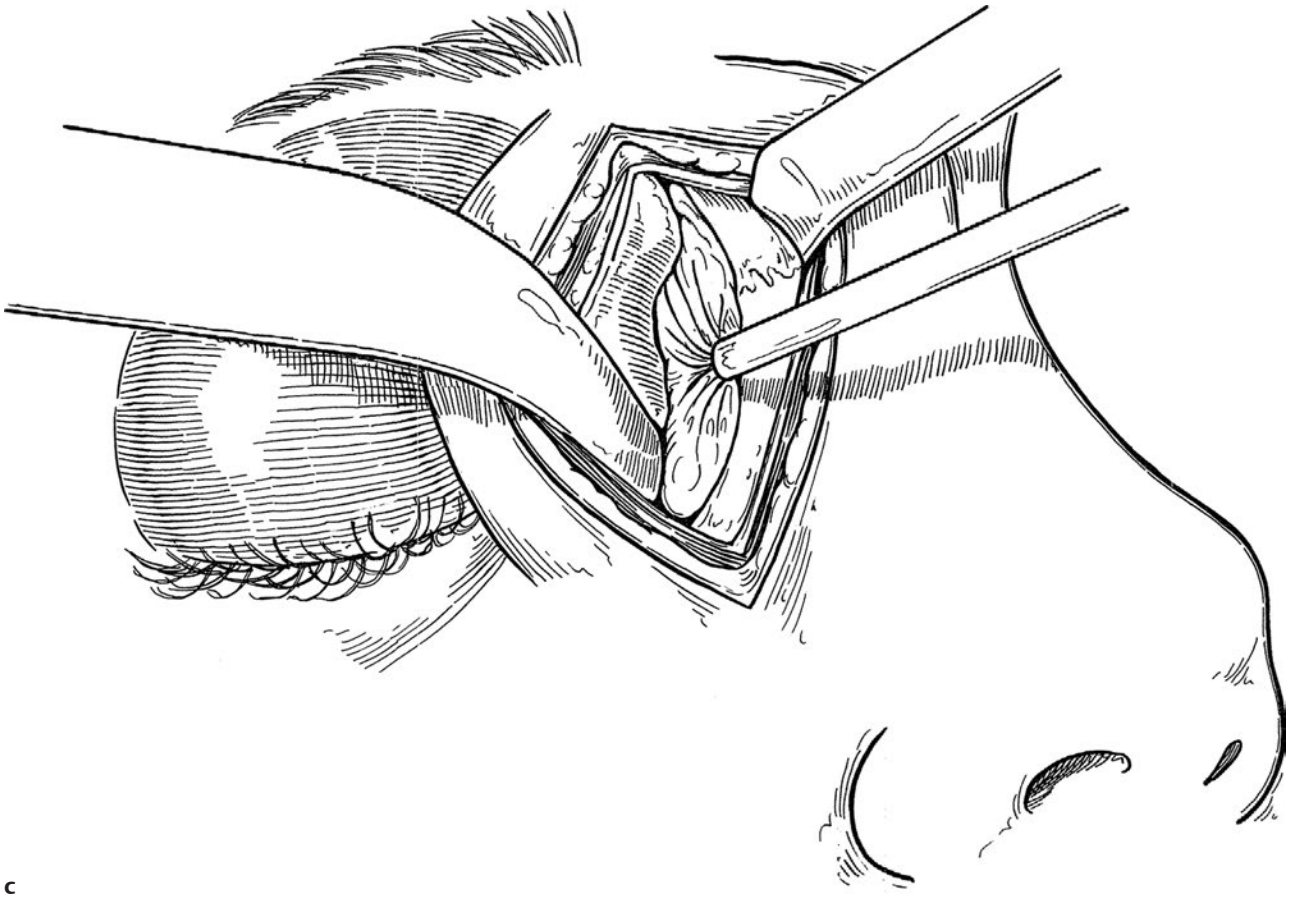


a

Fig. 23.2a



b



c

Fig. 23.2b,c

24 Endoscopic Sphenoidotomy

Lawrence W.C. Tom

The sphenoid sinus is opened in less than 10% of children with sinus disease. The sphenoidotomy can be performed with an ethmoidectomy or alone in the case of isolated sphenoid disease. The safest approach to the sphenoid sinus is through identification of the natural ostium in the sphenoethmoid recess.

24-1 Endoscopic Sphenoidotomy

Indications

Endoscopic sphenoidotomy is indicated for children who remain symptomatic and demonstrate evidence on computed tomography (CT) of sphenoid disease after aggressive medical management with long-term, broad-spectrum antibiotics and topical nasal steroid sprays.

Preoperative Evaluation

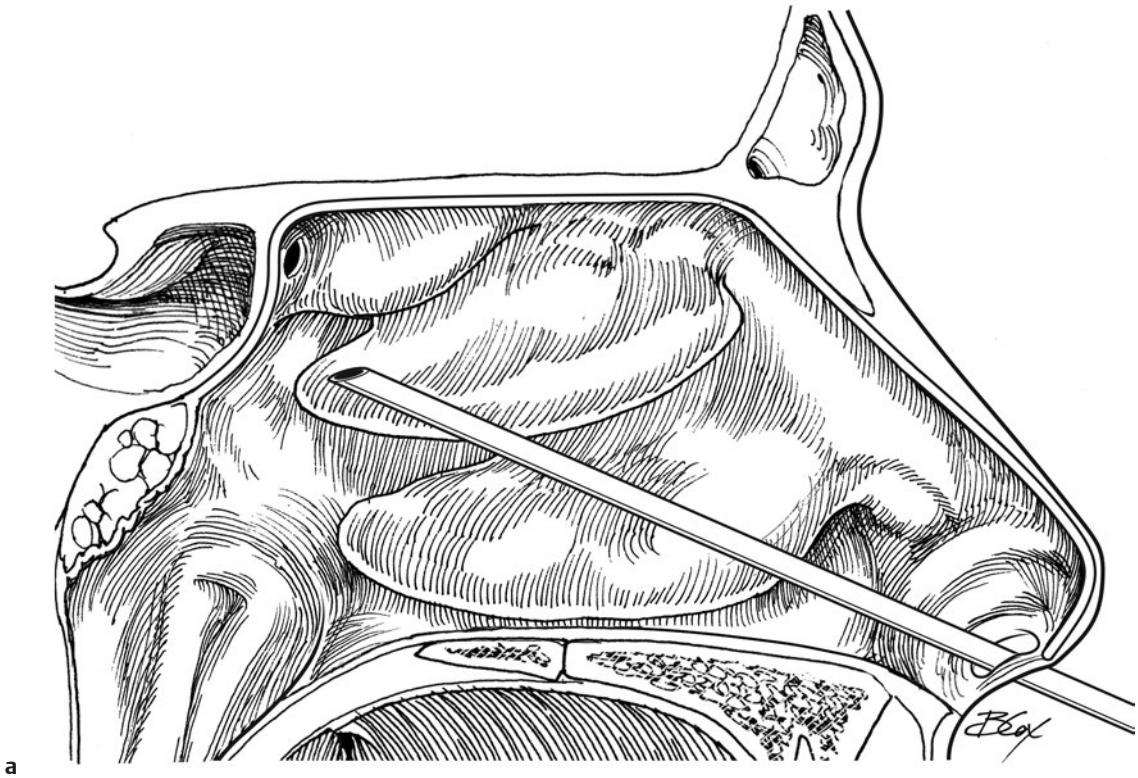
Preoperative evaluation includes outpatient anterior rhinoscopy with a telescope or otoscope and CT of the sinuses with coronal views to define the anatomy of the sinuses and extent of sinus disease. The CT should be obtained after a 4- to 6-week course of medical management.

Operative Technique

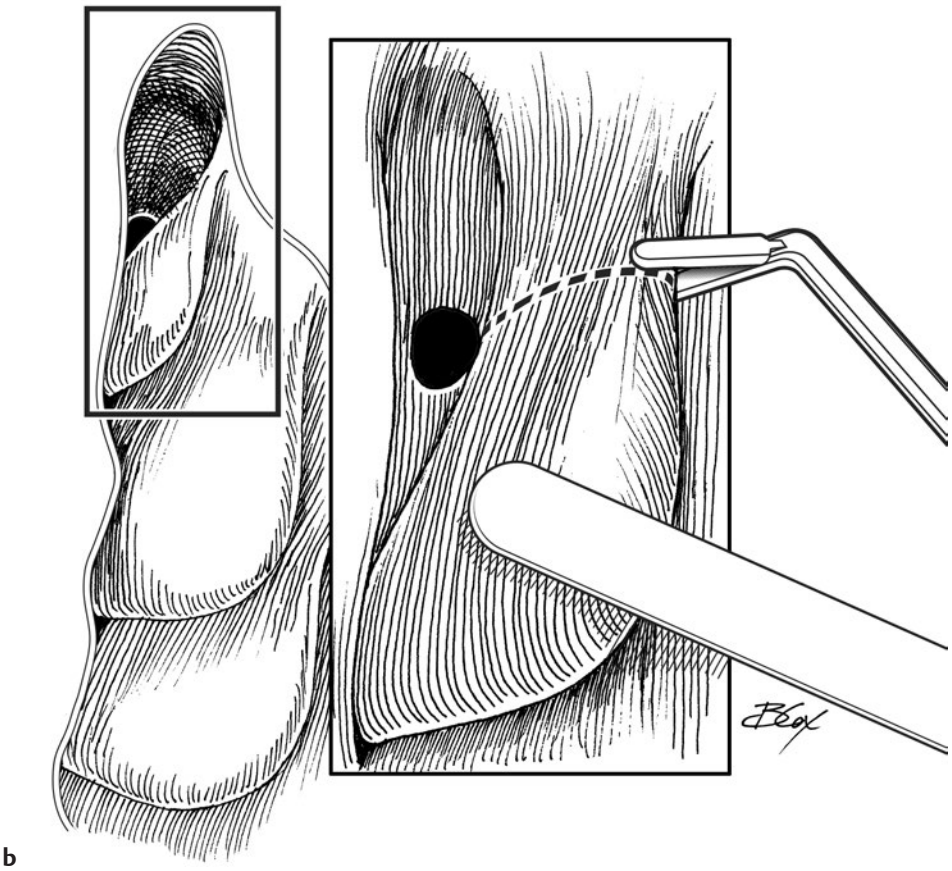
1. The preliminary steps for endoscopic sinus surgery are performed as described in Section 22-1, steps 1 through 6.
2. For isolated sphenoid sinus disease, the sphenoid ostium can be directly located in the sphenoethmoid recess. First, the superior turbinate in the nasal cavity is identified using a 30- or 45-degree telescope (**Fig. 24.1a**).
3. The superior turbinate is then lateralized with a Freer elevator to expose the sphenoethmoid recess, which lies medial to this turbinate. If visualization and access are difficult, the inferior half of the superior turbinate is removed with through-cutting instruments or a microdebrider (**Fig. 24.1b**).
4. The sphenoid ostium can be visualized in the sphenoethmoid recess (**Fig. 24.1c**). If the ostium is obstructed, it may be located by palpation.
5. Once the ostium is identified, it can be opened using a J-curette directed inferomedially (**Fig. 24.1d**). The opening can be enlarged with a curette or Stammberger mushroom punch.
6. Mucus or infected fluid can be suctioned from the sinus. Lesions may be removed or biopsied with forceps. Care must be taken to avoid injury to the optic nerve and internal carotid artery, both of which are usually located just lateral to the sinus but may run along the lateral wall to the cavernous sinus.
7. Packing is not usually necessary for an isolated sphenoidotomy.
8. The patient remains on antibiotics, steroids, and saline nasal sprays until seen in the office in 2–3 weeks.

Complications

1. Intracranial complications
   a. Cerebrospinal fluid rhinorrhea
   b. Intracranial trauma
   c. Meningitis
2. Internal carotid artery injury
3. Optic nerve injury
4. Cavernous sinus injury

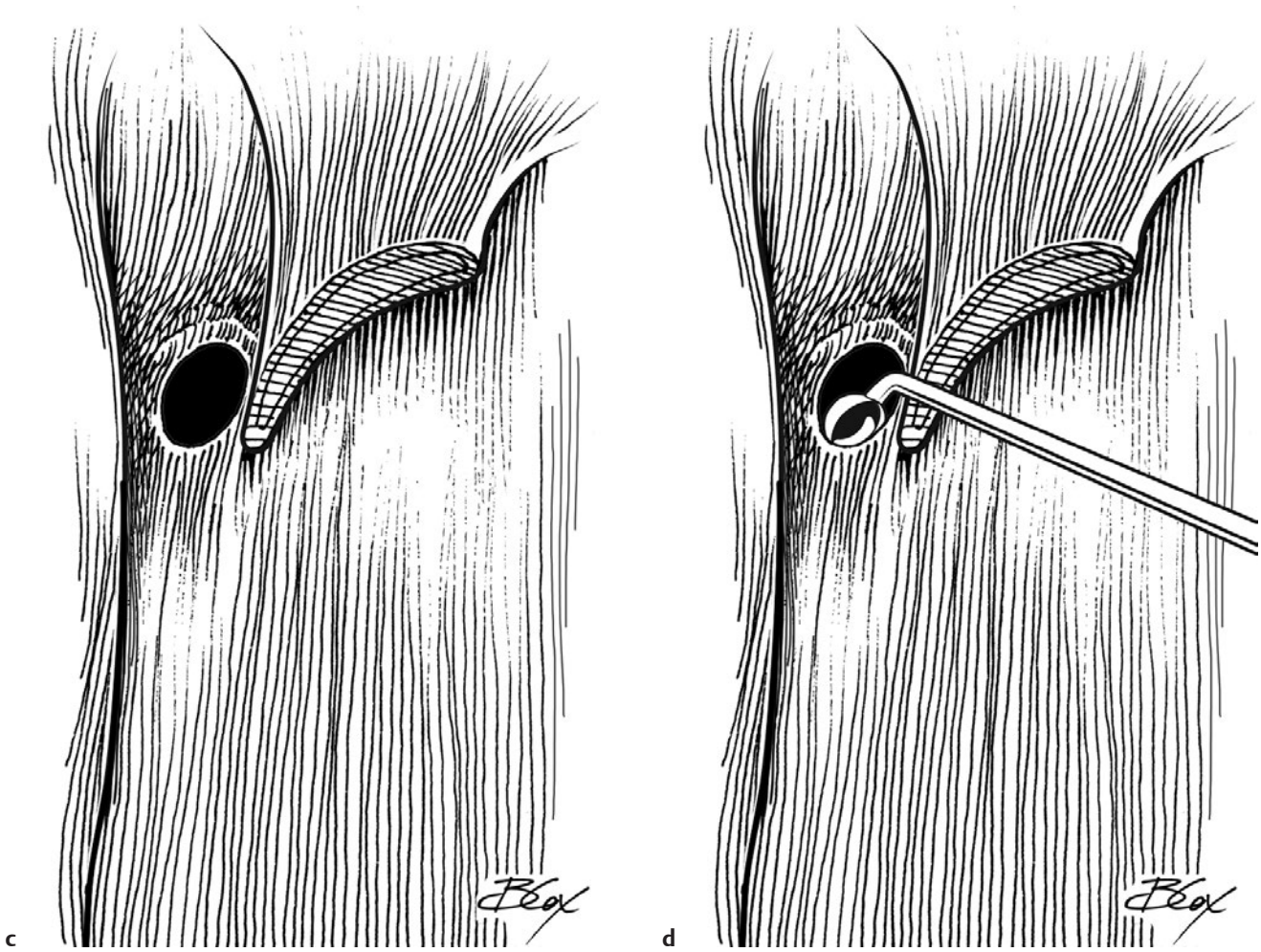


a



b

Fig. 24.1a,b



c d

Fig. 24.1c,d

Section V

The Neck

V

25 Trachea

Michael J. Rutter and Catherine K. Hart

The trachea is the primary route of air for respiration as well as clearing secretions for the respiratory tract.

25-1 Tracheotomy

Introduction

A tracheotomy bypasses laryngeal pathology, permits easy clearing of secretions, and provides a safe route for prolonged assisted ventilation.

Indications

Tracheotomy is indicated when prolonged ventilation or tracheobronchial toilet is required, or when laryngeal pathology is not amenable to immediate correction.

Preoperative Evaluation

A preoperative chest radiograph is helpful in defining the preoperative condition of the lungs and to compare to postoperative films. A microlaryngoscopy and bronchoscopy may be valuable in excluding underlying treatable pathology before proceeding with a tracheotomy.

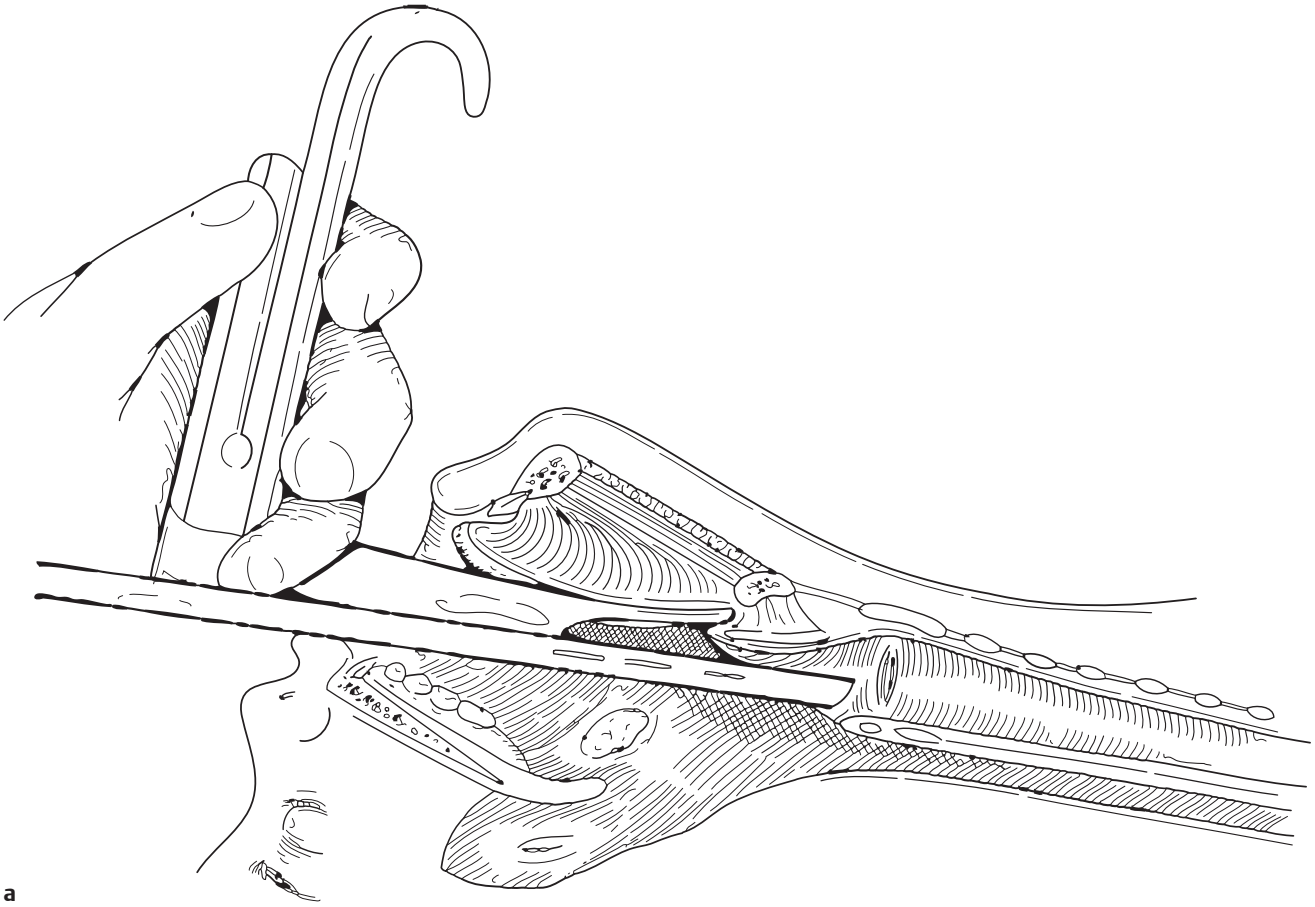
Operative Technique

1. If possible, tracheotomy should be performed with the patient intubated and under general anesthesia.
2. If a bronchoscope is preferred, it should be introduced after a satisfactory plane of anesthesia and relaxation is achieved (**Fig. 25.1a,b,c**).
3. Nasogastric tubes and esophageal stethoscopes are removed prior to positioning the patient to avoid firm objects in the neck that may be confused with the trachea during palpation.
4. The child is positioned on a shoulder roll with the neck extended and the occiput stabilized.
5. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
6. A horizontal skin incision is made halfway between the cricoid and the sternal notch (**Fig. 25.1c**).
7. Subcutaneous fat and tissue are reflected with a clamp, exposing the deep cervical fascia overlying the strap muscles. Ribbon retractors are placed to expose the field and stabilize the trachea in the midline (**Fig. 25.1d**). In a younger child, the amount of subcuticular fat is considerable and should be excised prior to splitting the strap muscles.
8. Vertical dissection with a scissors or electrocautery and a clamp in the midline is carried out until the trachea is exposed (**Fig. 25.1e**).
9. Retractors are used to reflect the strap muscles and visualize the tracheal rings (**Fig. 25.1f**).
10. If the thyroid isthmus is encountered over the trachea, it may be reflected superiorly with a retractor or divided with a Bovie to provide better tracheal exposure (**Fig. 25.1g**).
11. Throughout the procedure, palpation of the trachea and laryngeal structures helps maintain the surgeon's orientation.
12. 4-0 nonabsorbable sutures are placed in the trachea on each side of the midline (**Fig. 25.1h**). These sutures are placed securely through the cartilage rings and are used for traction to expose the trachea should accidental decannulation occur before the tract is established.
13. The lateral retractors are removed, and the trachea is elevated by traction on the stay sutures. A midline incision is made through two or three cartilage rings (typically between rings three to five), opening the trachea (**Fig. 25.1i**). The bronchoscope or endotracheal tube can be seen in the tracheal lumen.
14. The skin flaps are sutured to the edges of the tracheotomy using a horizontal mattress stitch for safety in the event of accidental decannulation (**Fig. 25.1j,k**). The two distal sutures are key, and should eliminate the dead space between the skin and the trachea, minimizing the risk of a false passage should the tracheal tube be displaced before the stoma has matured. This step is not universally performed at all institutions.
15. The endotracheal tube or bronchoscope is withdrawn to just above the tracheal incision (**Fig. 25.1k**).

16. A suitably sized, age-appropriate tracheostomy tube is inserted in the trachea (**Fig. 25.1l**). In infants younger than 9 months of age, a neonatal tube is generally used.
17. After satisfactory ventilation is established through the tracheotomy tube, the endotracheal tube or bronchoscope is removed.
18. The stay sutures are clearly labeled for identification and taped to their respective side of the chest for use if accidental decannulation occurs (**Fig. 25.1m**).
19. The tracheotomy tube is securely tied in place with tracheostomy tape while the head is in the neutral position (**Fig. 25.1n**).
20. A flexible endoscope is passed through the tracheostomy tube lumen to confirm position of tube above the carina.
21. A postoperative anteroposterior (AP) chest radiograph is obtained to determine the position of the tip of the tube near the carina and to check for pneumothorax.

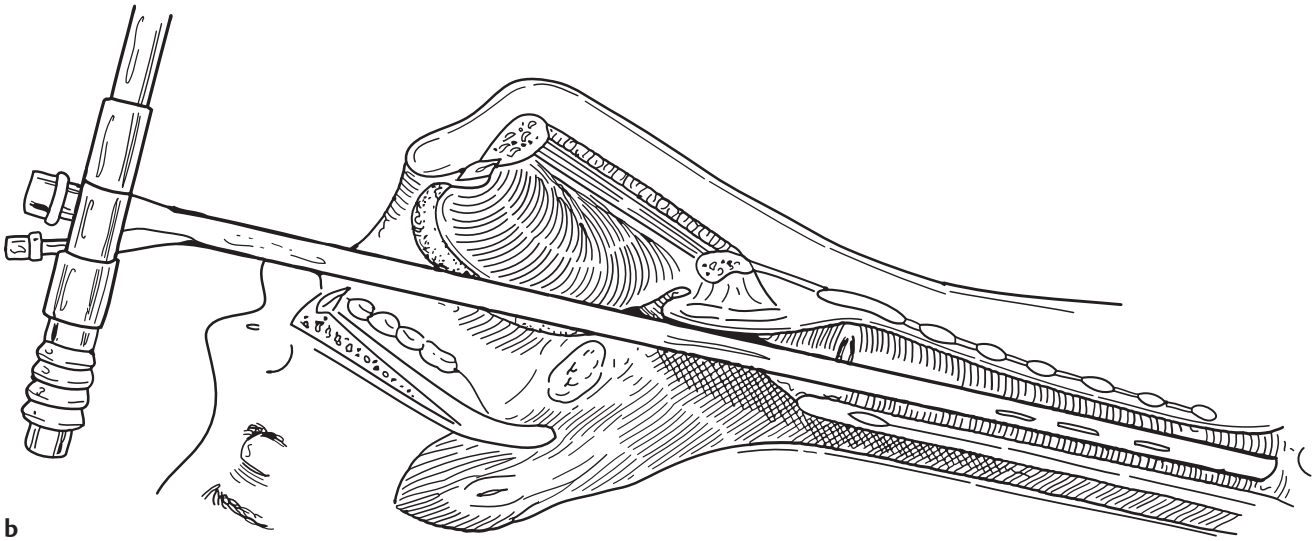
Complications

1. Hemorrhage
2. Pneumothorax
3. Subcutaneous emphysema
4. Formation of granuloma

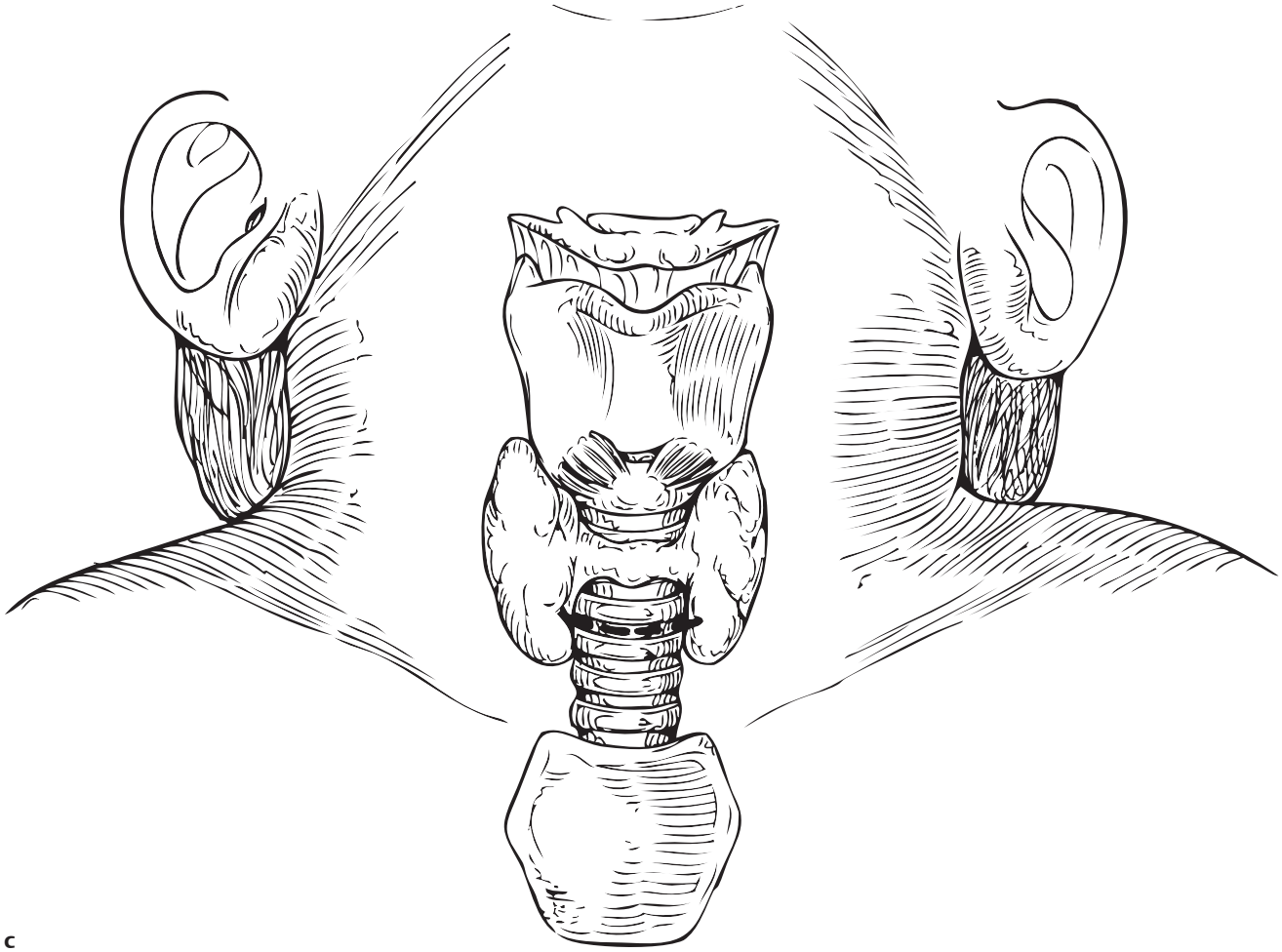


a

Fig. 25.1a

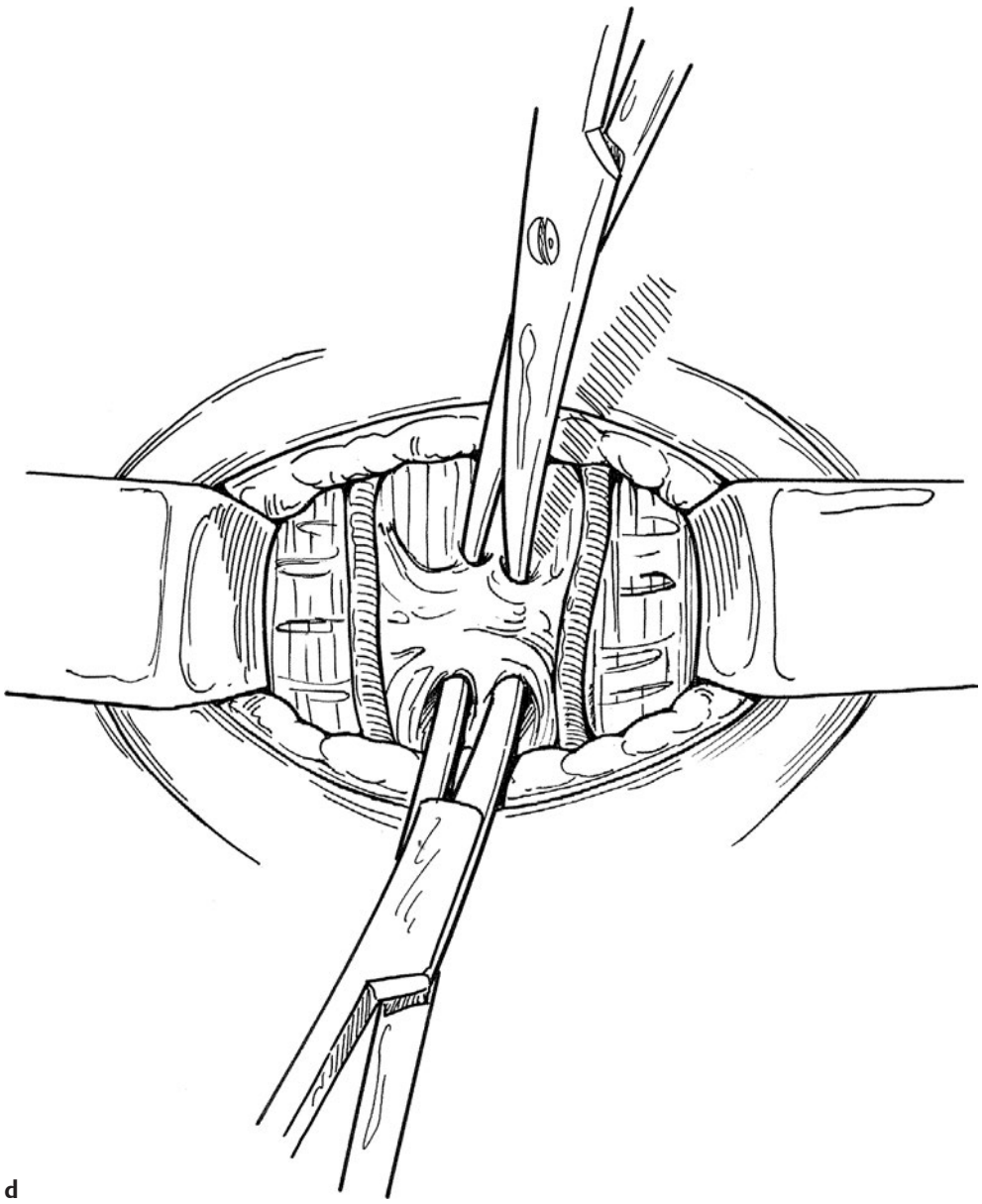


b



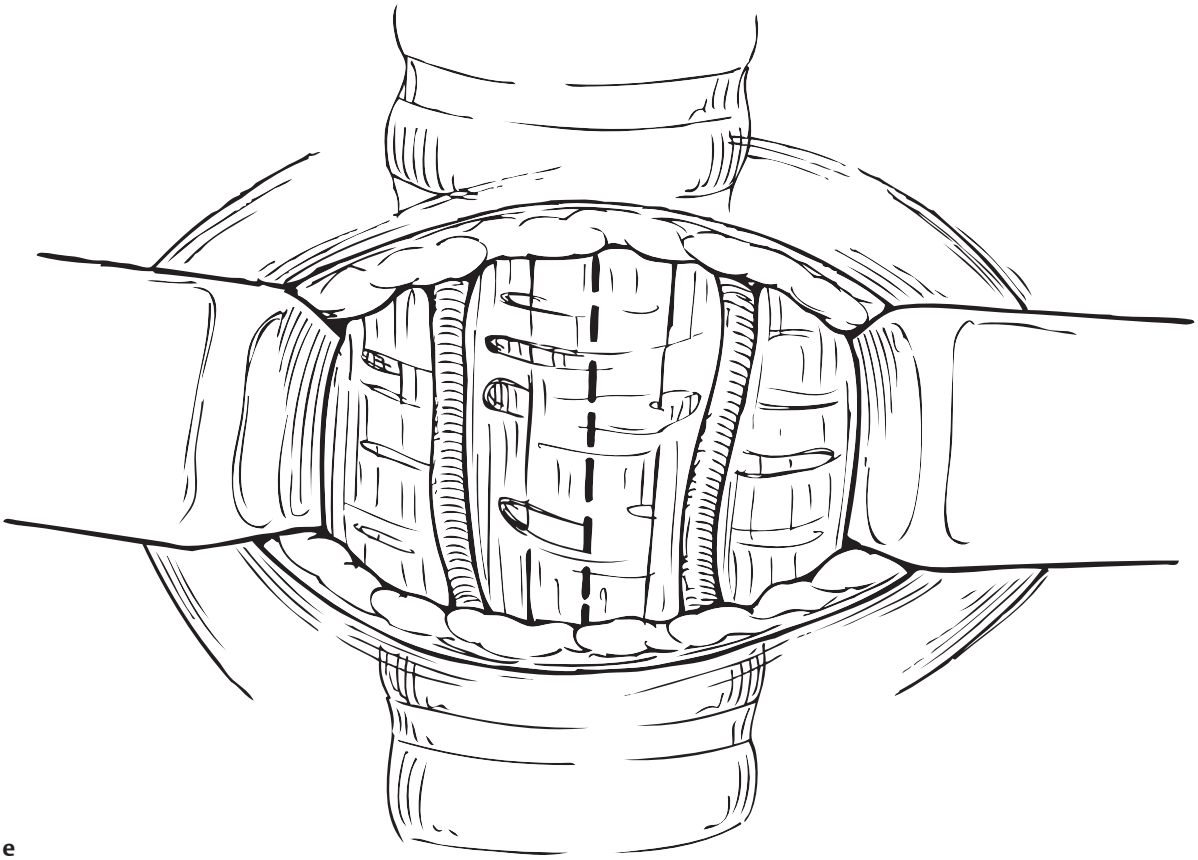
c

Fig. 25.1b,c

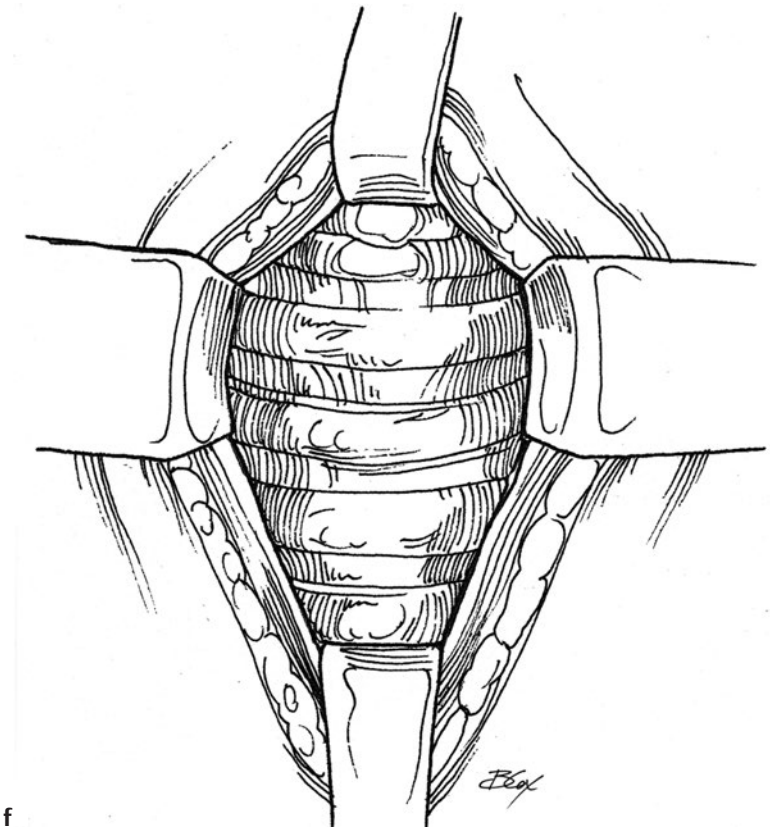


d

Fig. 25.1d

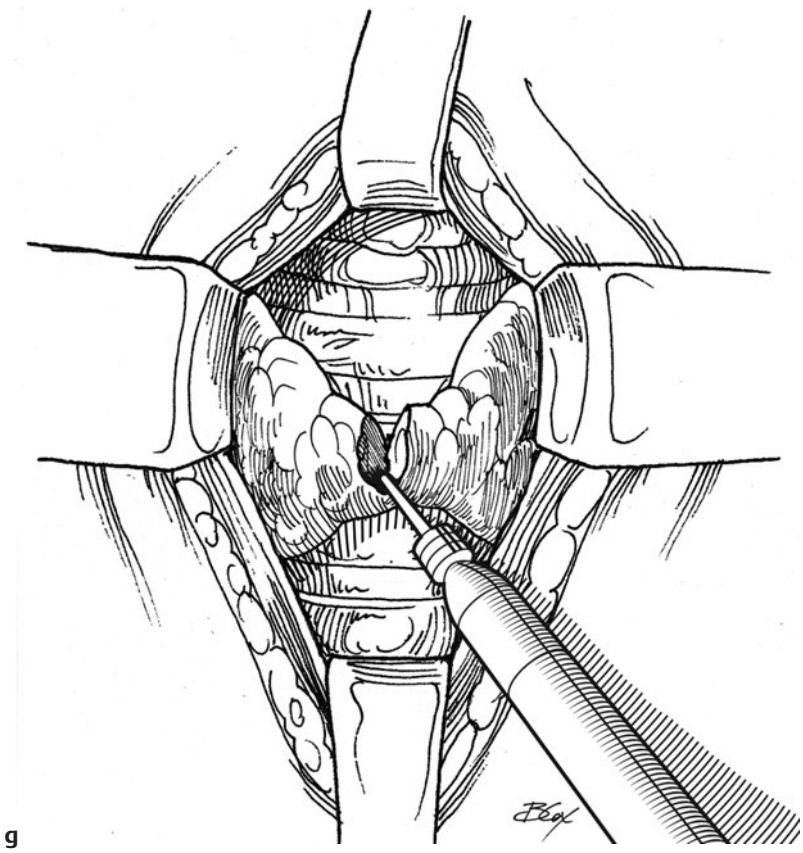


e

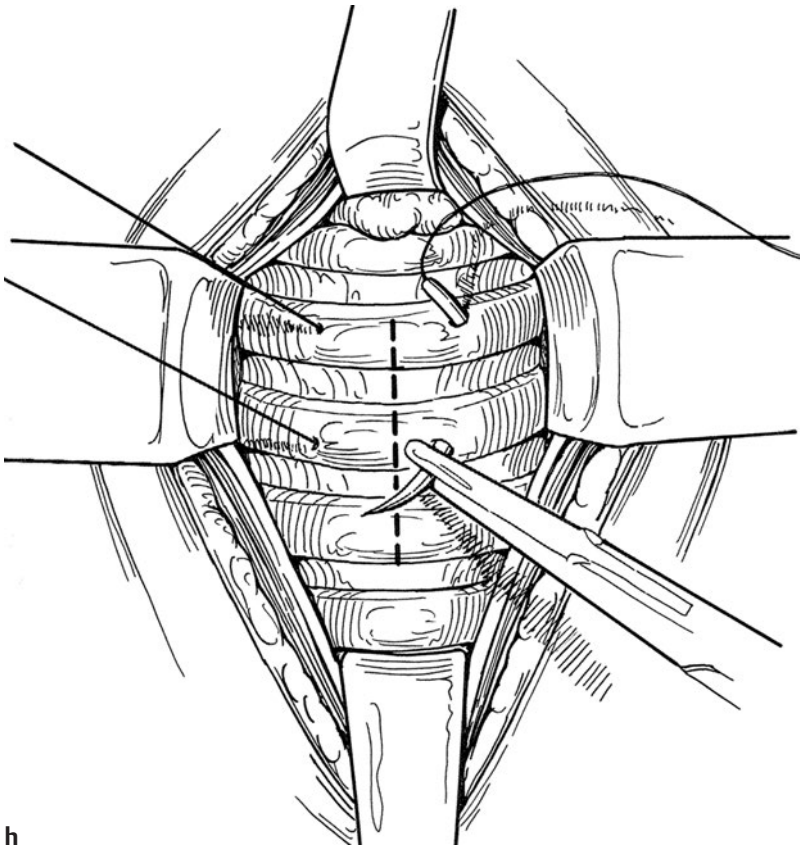


f

Fig. 25.1e,f

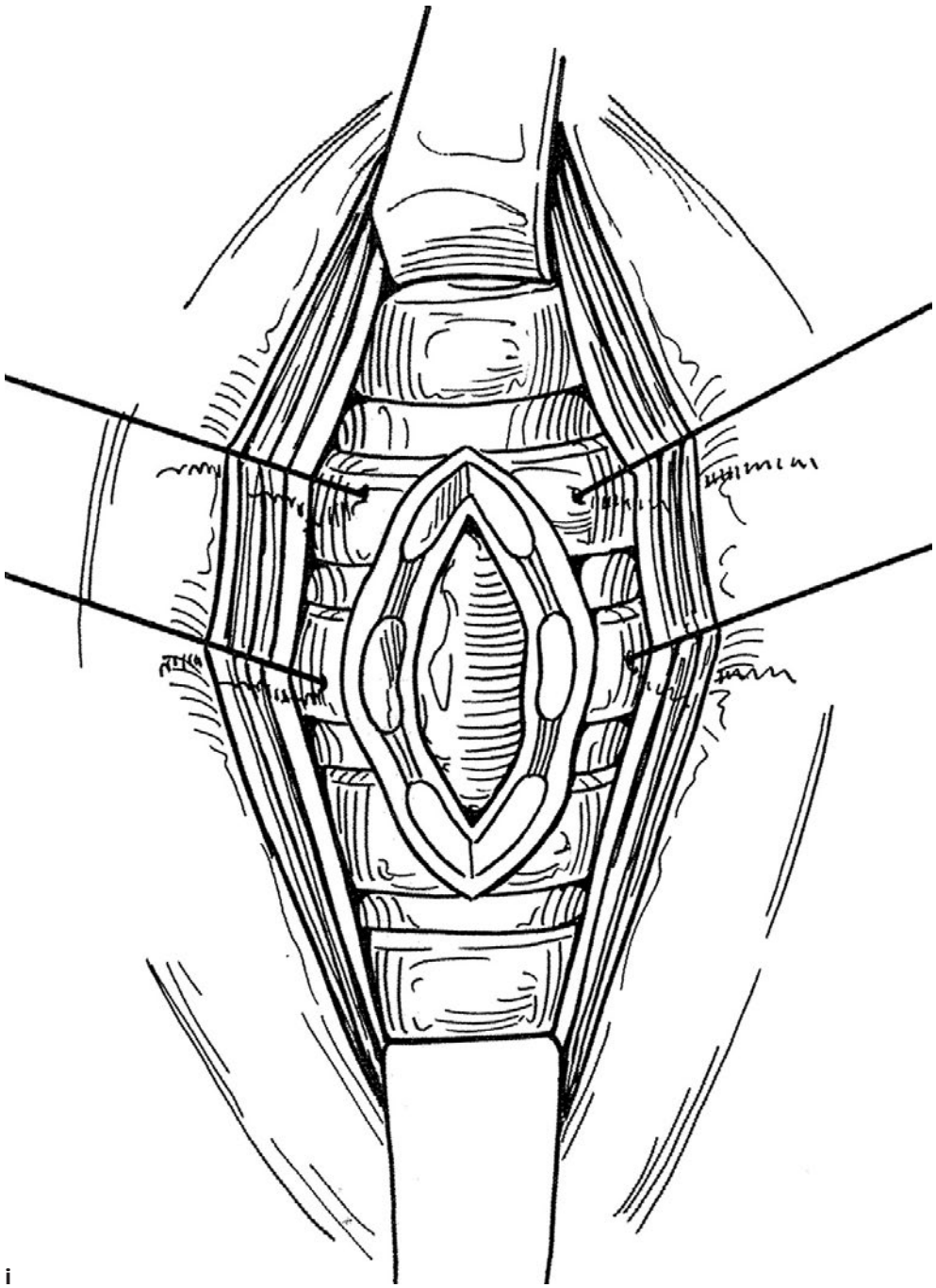


g



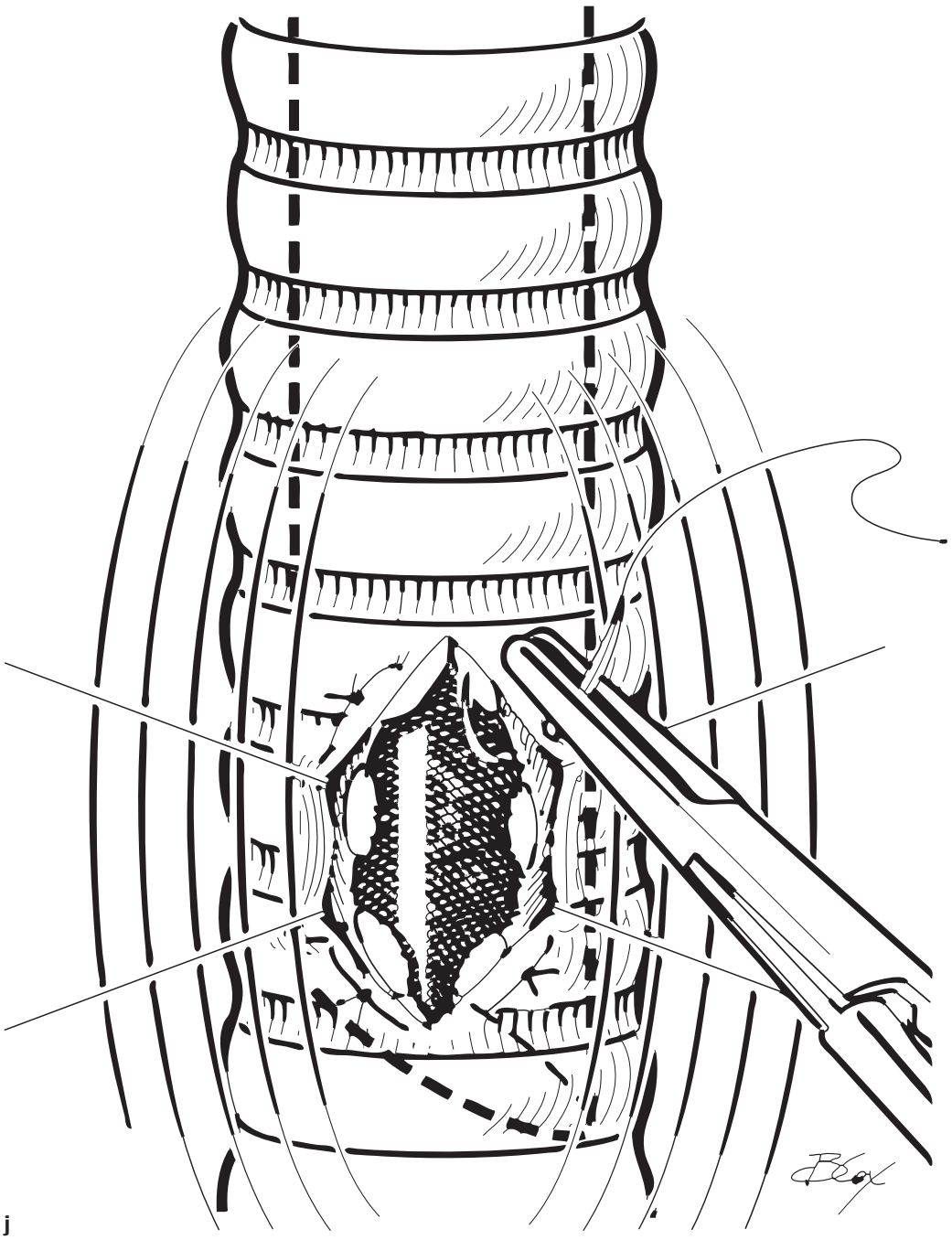
h

Fig. 25.1g,h



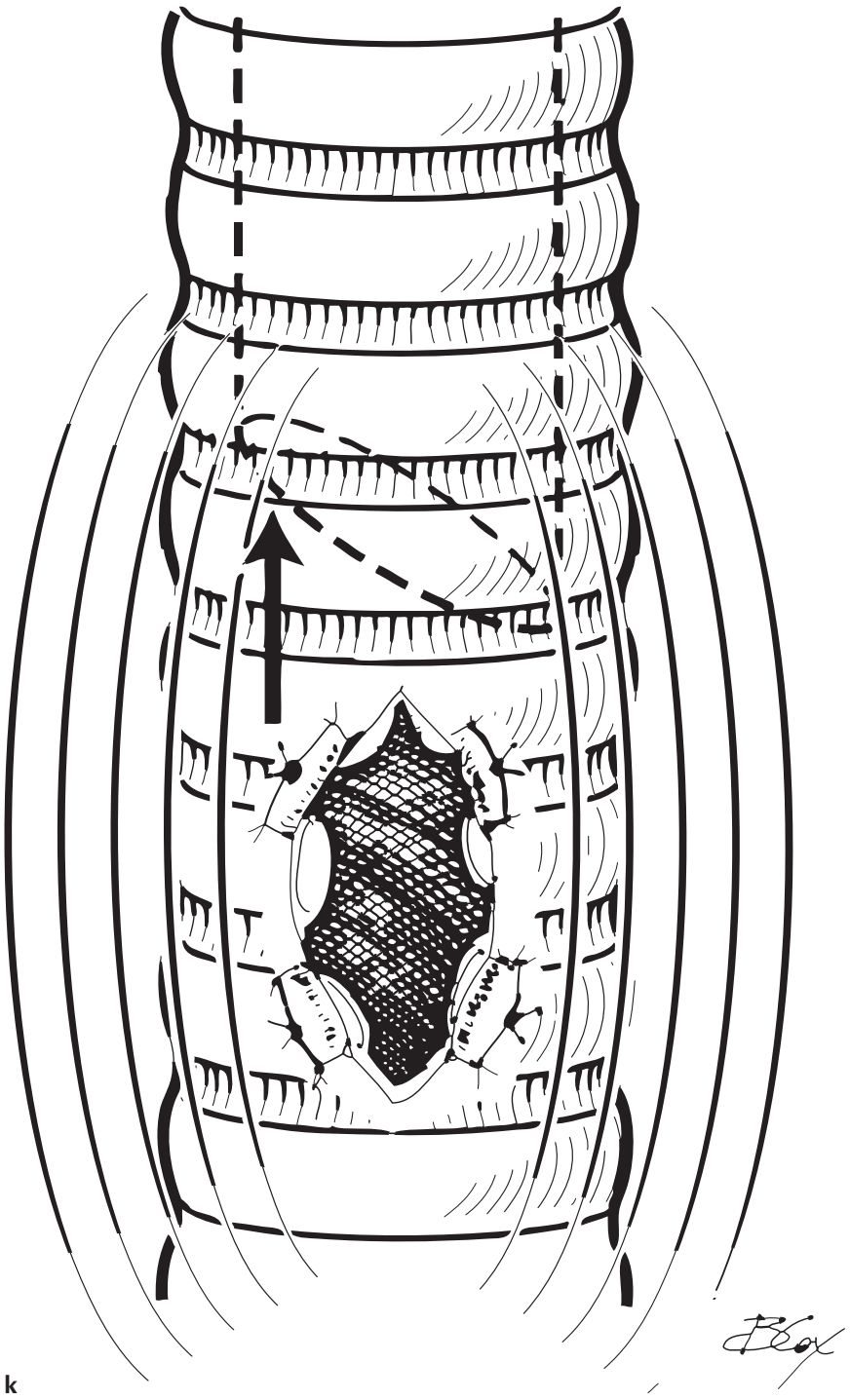
i

Fig. 25.1i



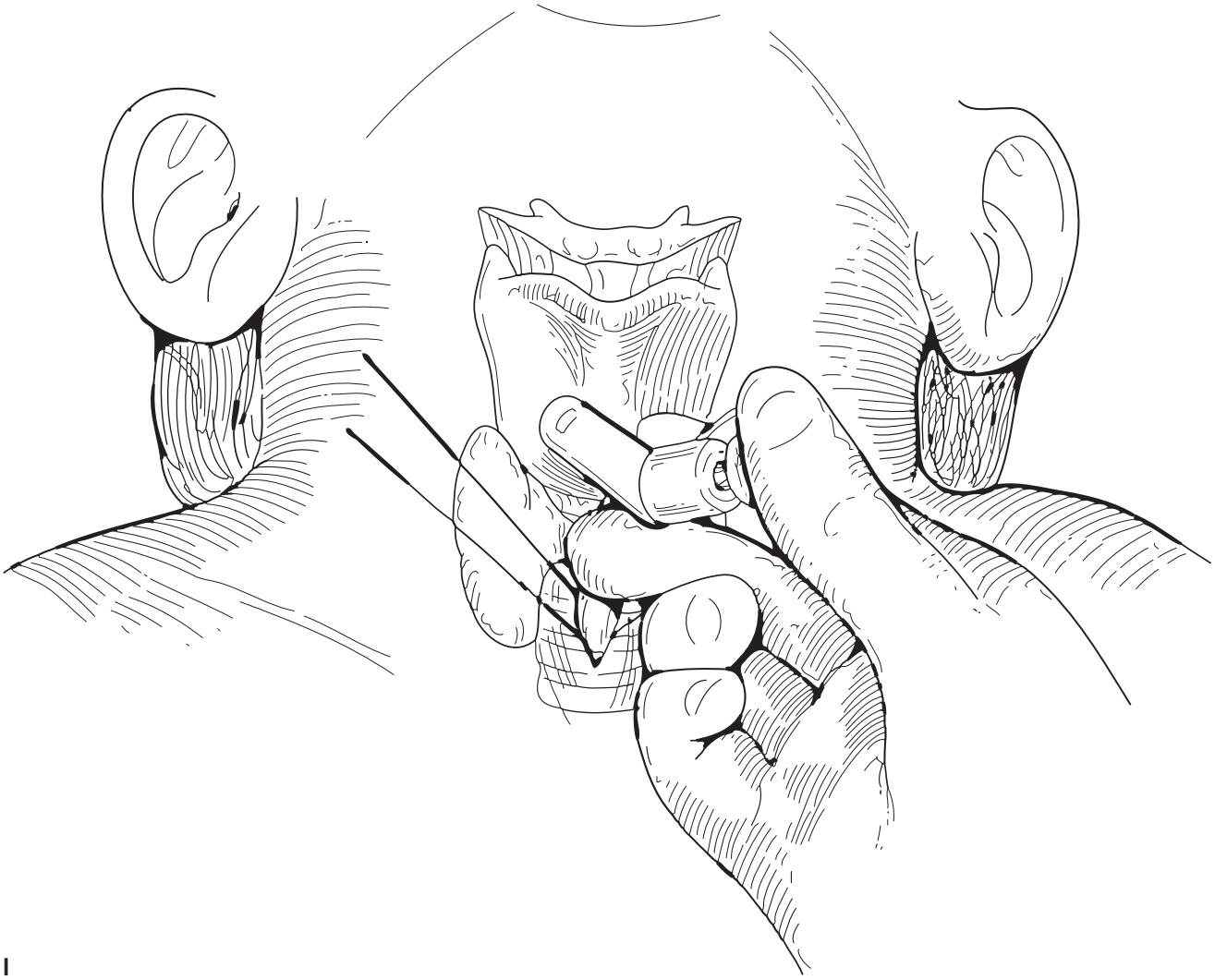
j

Fig. 25.1j



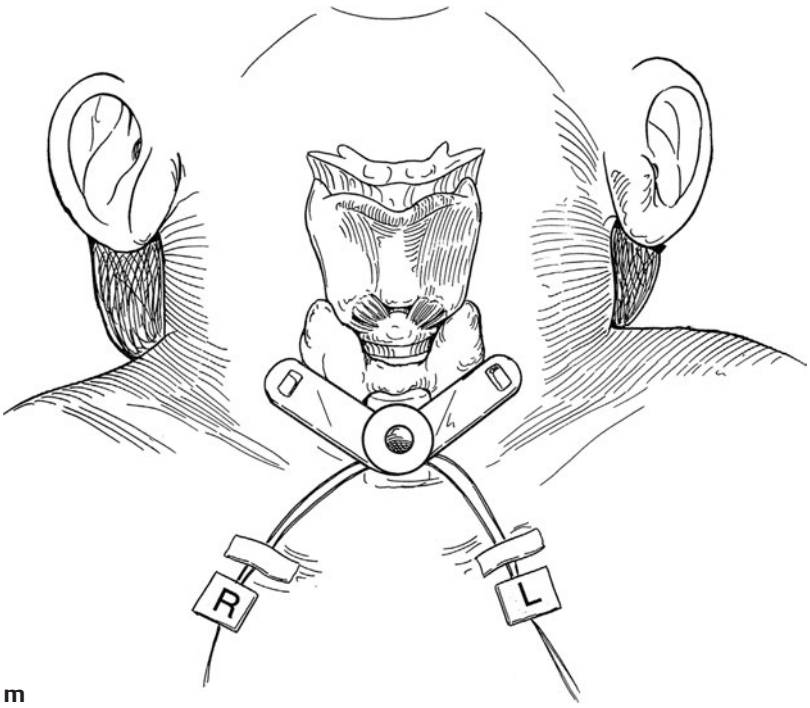
k

Fig. 25.1k



l

Fig. 25.1l



m



n

Fig. 25.1m,n

25-2 Tracheocutaneous Fistula Closure

Introduction

A tracheocutaneous fistula (TCF) may persist following removal of a tracheostomy tube. If it persists, it may permit aspiration of water while bathing or swimming. It may also be a nuisance, allowing mucus to exit the neck during coughing. TCF closure is designed to close the fistula with a low-risk technique, not as a scar revision.

Indications

TCF closure is indicated when the fistula has persisted for 1 year after decannulation, or earlier, if the likelihood of spontaneous closure is low.

Preoperative Evaluation

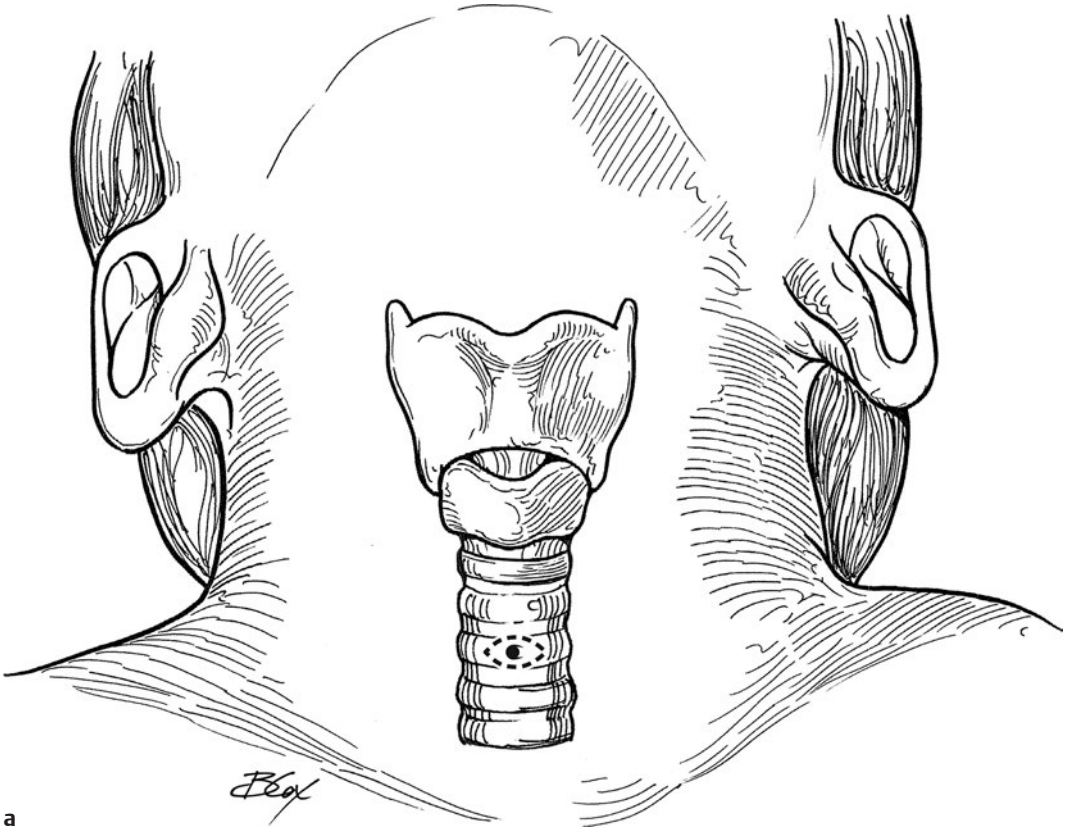
Direct laryngoscopy and bronchoscopy are necessary to be certain that no significant tracheal stenosis is present at or above the stoma. Closure of the stoma under these conditions could precipitate the need for reinserting the tracheotomy.

Operative Technique

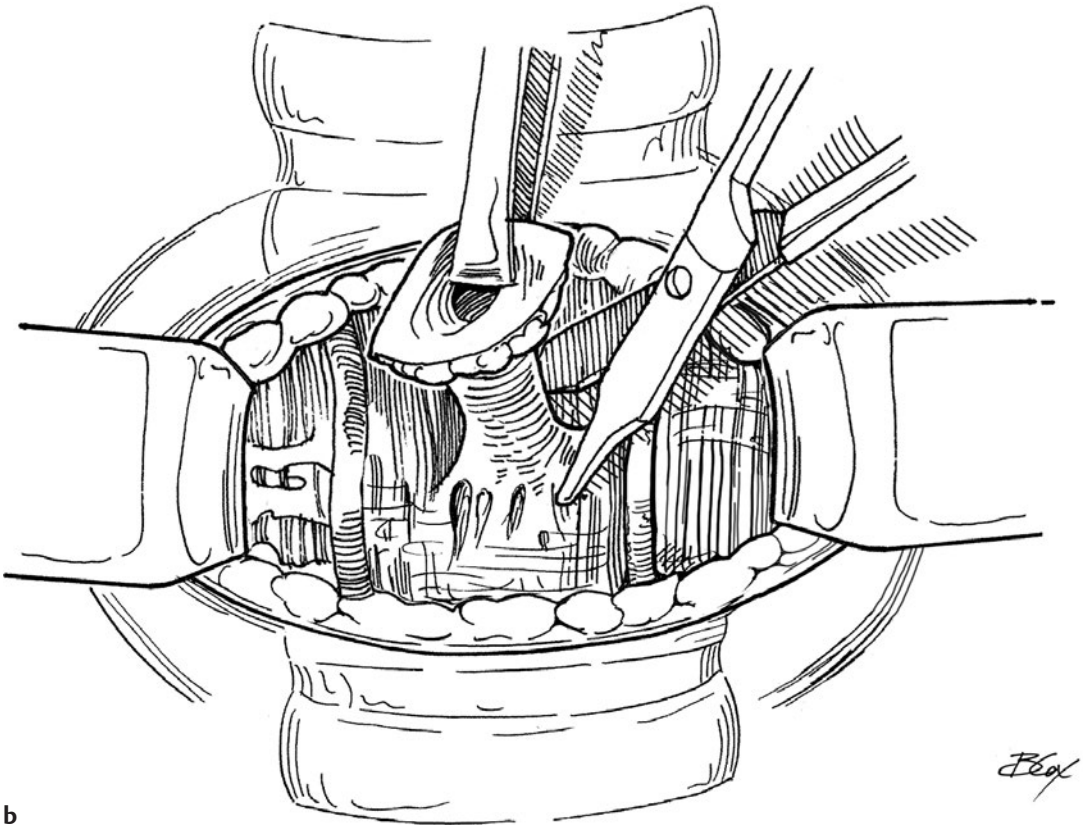
1. TCF closure is performed under general anesthesia with an endotracheal tube that is a half size smaller than age appropriate.
2. One percent lidocaine with 1:100,000 epinephrine is injected in the area of the proposed excision to aid in hemostasis. An elliptical incision with very narrow margins encompassing the fistula is made using a no. 15 blade scalpel (**Fig. 25.2a**).
3. The TCF tract is dissected free from the surrounding skin down to the trachea. The tract is then amputated at the level of the tracheal cartilage (**Fig. 25.2b,c**).
4. To minimize the risk of subcutaneous emphysema, a small (2.5 or 3.0) tracheotomy tube is inserted into the opening in the trachea (**Fig. 25.2d**).
5. The tracheotomy tube is removed in the recovery room or intensive care unit (ICU) once the patient is completely awake. The wound is left to heal by secondary intention.

Complications

1. Subcutaneous emphysema
2. Pneumothorax
3. Respiratory distress
4. Formation of a granuloma

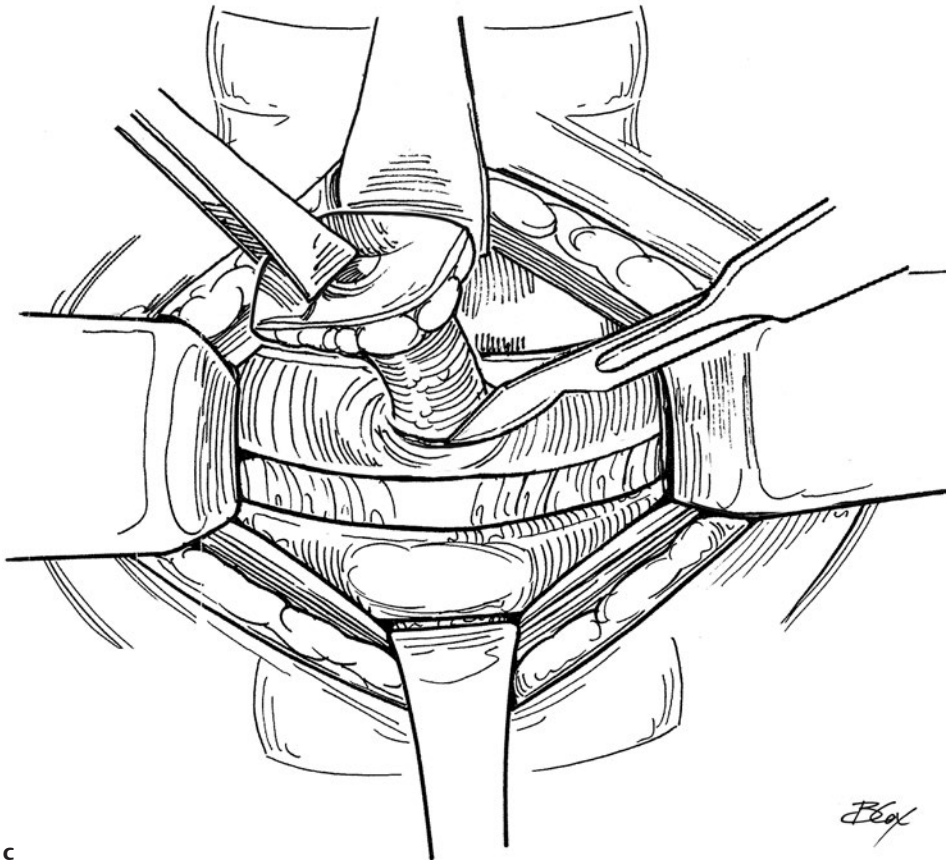


a

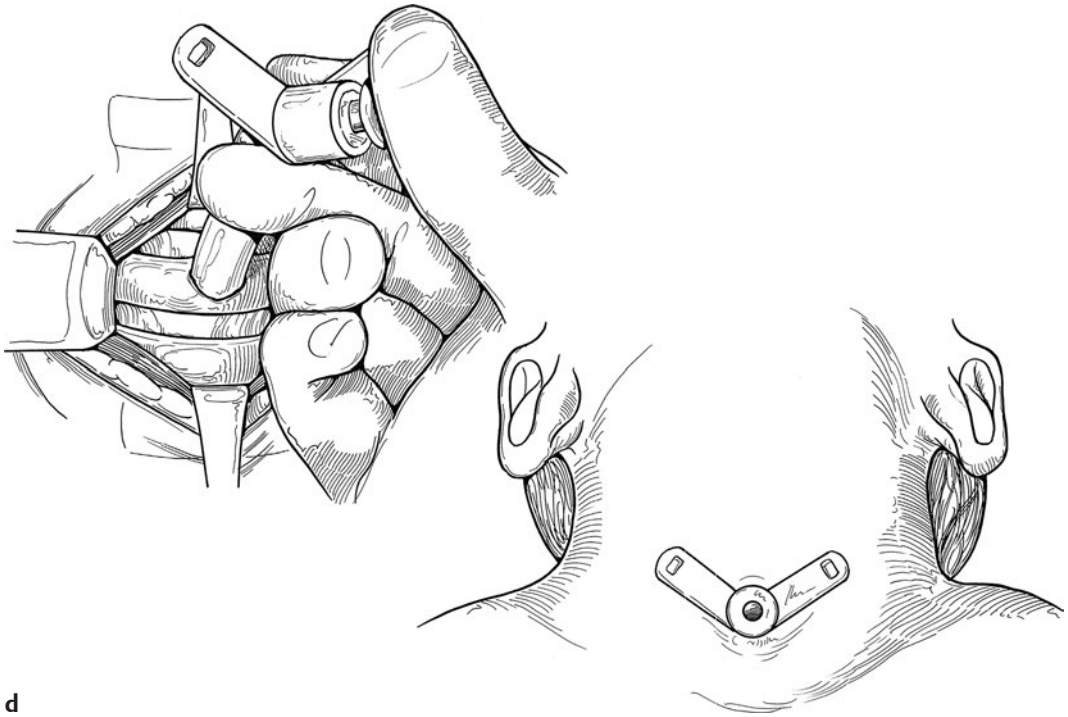


b

Fig. 25.2a,b



c



d

Fig. 25.2c,d

25-3 Tracheal Stenosis—End-to-End Anastomosis

Introduction

Resection of a portion of the cervical trachea with an end-to-end anastomosis is a useful technique in the armamentarium for repair of tracheal stenosis.

Indications

Resection of a segment of trachea with end-to-end anastomosis is indicated for severe tracheal stenosis that involves no more than one-third of the cervical trachea. An alternative technique is to perform a cervical slide tracheoplasty.

Preoperative Evaluation

Standard radiography may be helpful; however, a computed tomography (CT) scan or magnetic resonance imaging (MRI) of the tracheobronchial tree clearly outlines the length and shape of the stenosis. Direct laryngoscopy and bronchoscopy are essential to examine the intraluminal configuration.

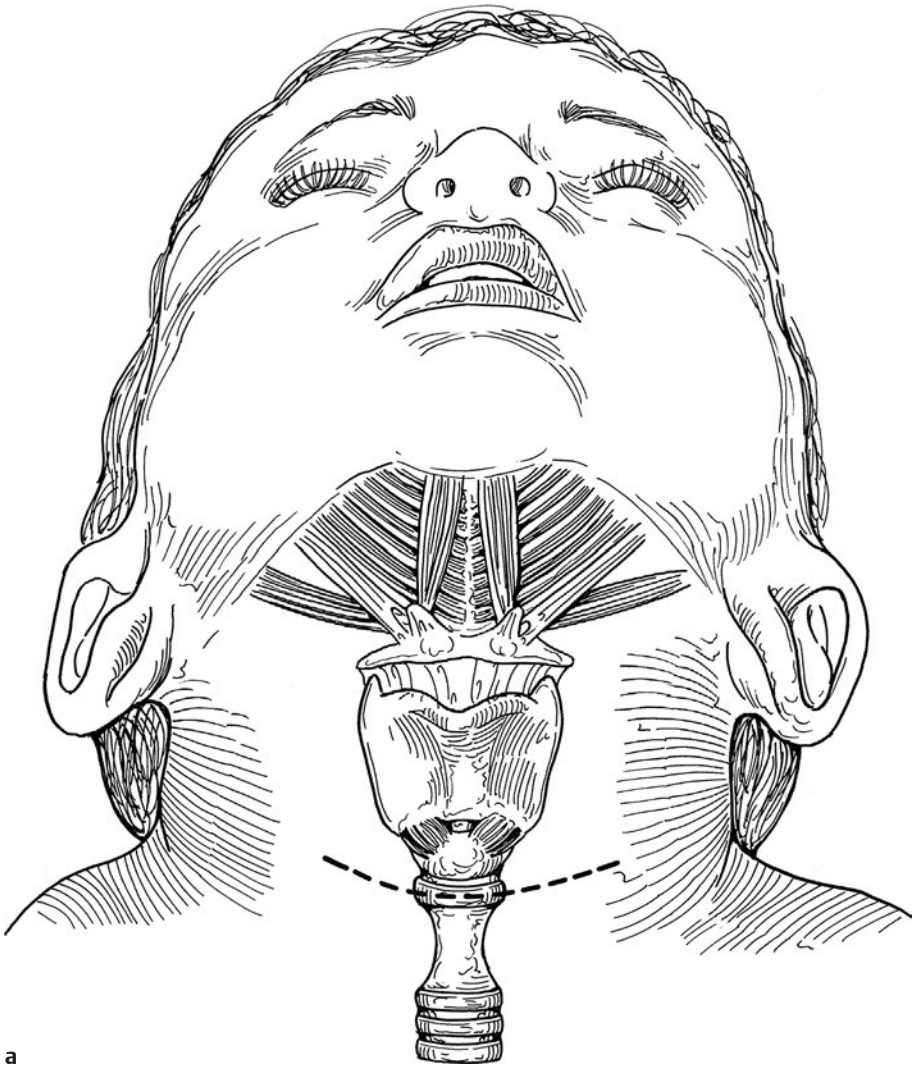
Operative Technique

1. Tracheal resection is performed under general endotracheal anesthesia. If the child has a tracheotomy tube in place, the tube is removed and a cuffed, armored endotracheal tube is placed in the stoma.
2. The patient is placed on a shoulder roll with the neck extended as for tracheotomy.
3. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
4. A transverse incision is made in the neck overlying the area of tracheal stenosis (**Fig. 25.3a**).
5. The incision is carried through the subcutaneous tissues and deep cervical fascia, exposing the strap muscles. Superior and inferior subplatysmal skin flaps are created.
6. The strap muscles are divided in the midline and retracted laterally with 4-0 silk sutures (**Fig. 25.3b**).
7. The pretracheal fascia is then incised with a scissors and reflected laterally, exposing the trachea above and below the tracheal stenosis (**Fig. 25.3c**).
8. A vertical incision is made in the midline of the trachea through the stenotic segment, identifying the limits of the stenosis (**Fig. 25.3d**).
9. 3-0 Prolene (Ethicon) retention sutures are placed along the lateral distal trachea (bilaterally) to prevent retraction of the trachea (**Fig. 25.3e**). The endotracheal tube is pulled back to a level above the stenosis, and the lower segment of the trachea is intubated with a cuffed reinforced endotracheal tube as for laryngotracheal reconstruction (**Fig. 25.3f**).
10. The trachea is transected with a knife above the stenosis at the lower border of a normal tracheal ring (**Fig. 25.3g**). The incision includes the posterior tracheal wall, but the integrity of the esophagus is preserved (**Fig. 25.3h**). Care is taken to avoid injury to the recurrent laryngeal nerves.
11. The trachea is dissected away from the esophagus along the party wall with a scissors (**Fig. 25.3i**).
12. When the stenotic segment has been separated from the esophagus, the lower portion of the trachea is transected and the stenotic segment is removed (**Fig. 25.3j**).
13. If the anastomosis is under tension, the larynx may be released from its suprahyoid attachments.
14. A transverse incision is made just above the hyoid bone with cautery, releasing the geniohyoid and hyoglossal muscles from the hyoid bone (**Fig. 25.3k**).
15. The hyoid bone can be divided at the insertion of the lesser cornu, which is the site of attachment of the digastric muscle (**Fig. 25.3l**). This releases the larynx, allowing it to move inferiorly.
16. The inferior trachea is released by carefully dissecting anterior and posterior to the trachea while maintaining a lateral blood supply.
17. A running continuous suture technique using a double-armed 4.0 polydioxanone suture (PDS) is used to complete the anastomosis from posterodistally to anteroproximally (**Fig. 25.3m**). The suture is placed to allow the final knot to be extraluminal (**Fig. 25.3n**).
18. Prior to completing the anterior aspect of the anastomosis, the reinforced endotracheal tube is removed and the patient is reintubated from above with an age-appropriate endotracheal tube.
19. Typically, two or three additional tension-releasing sutures are placed, encompassing two tracheal rings above and two below the anastomosis (**Fig. 25.3o**).
20. A Penrose drain is placed in the wound, and the strap muscles are reapproximated over the trachea (**Fig. 25.3p**).
21. The subcutaneous tissues are closed with 3-0 interrupted Vicryl (Ethicon) suture and the skin is closed with 5-0 running subcuticular Monocryl (Ethicon) suture.
22. Two sutures are placed from the skin of the chin to the skin of the chest with 0-Prolene to keep the neck from extending (**Fig. 25.3q**). If the anastomosis is not under undue tension, an alternative is a cervical collar.
23. The endotracheal tube is removed in 12 to 24 hours. In older patients, extubation in the operating room at the conclusion of the case may be considered.

24. The drain is left in place for 2 to 3 days.
25. Antibiotics are administered while the drain remains in place.
26. Ten days after the procedure, the chin to chest sutures or cervical collar are removed and direct laryngoscopy and bronchoscopy are performed under general anesthesia. If present, granulation tissue is removed.

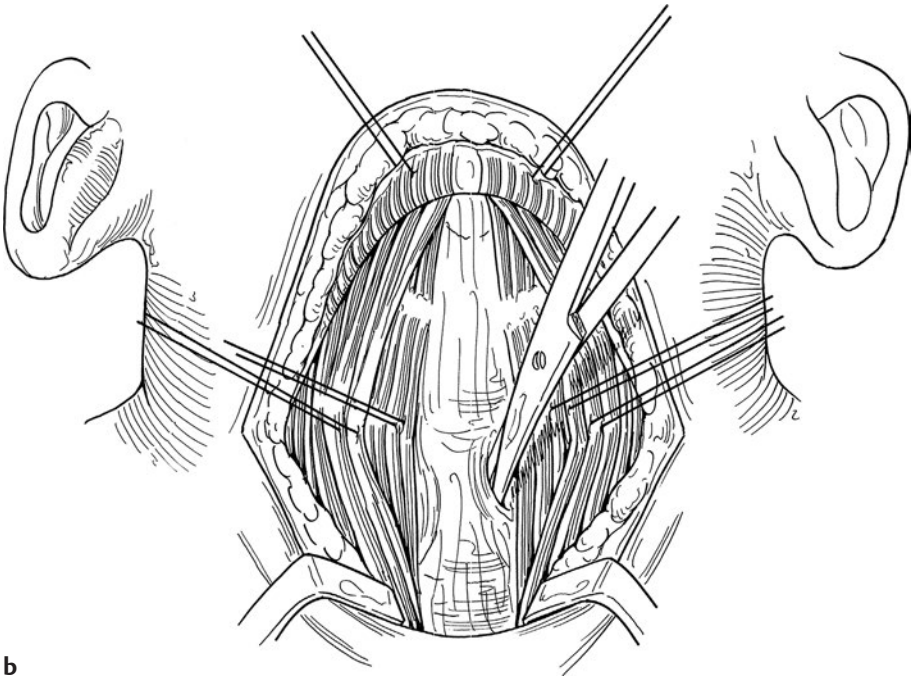
Complications

1. Restenosis
2. Pneumothorax
3. Vocal fold paralysis
4. Esophageal perforation

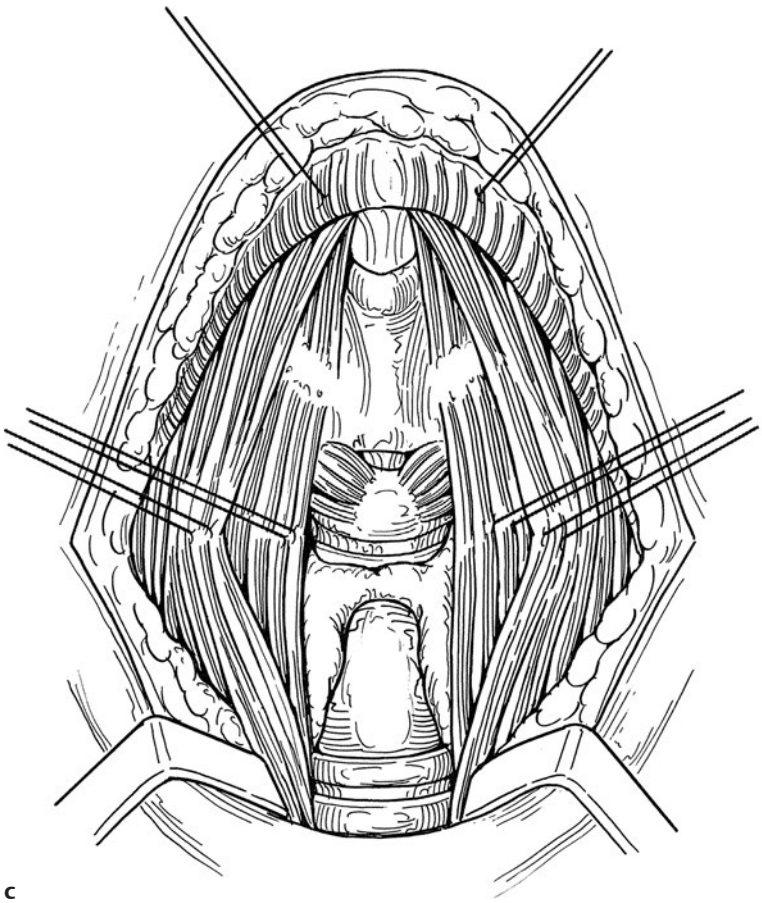


a

Fig. 25.3a

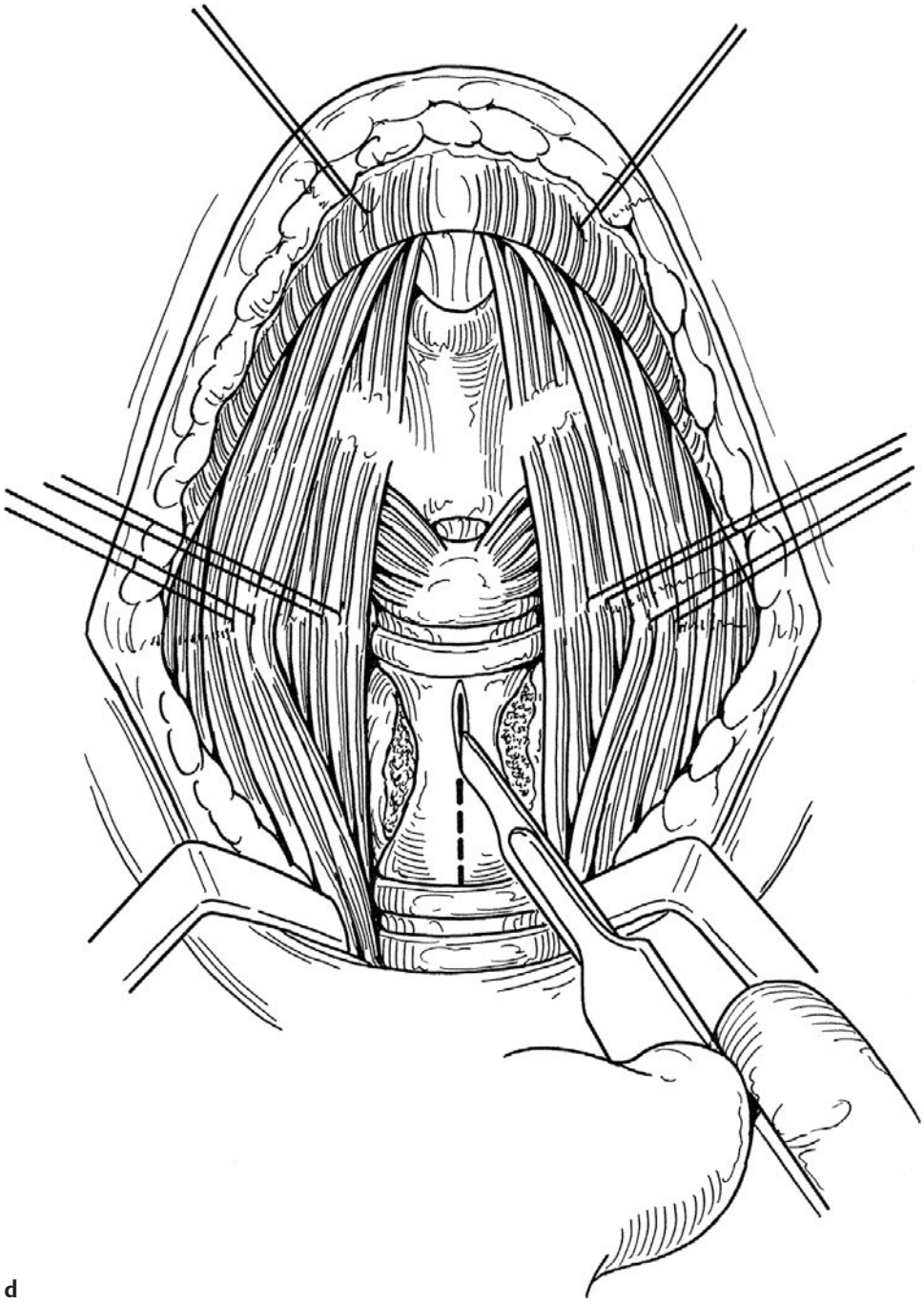


b



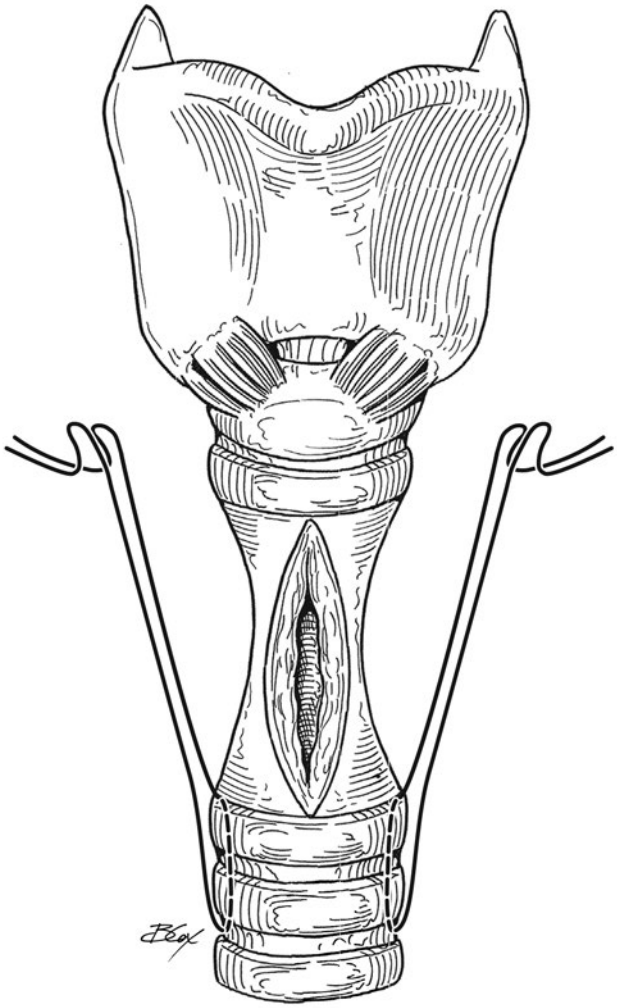
c

Fig. 25.3b,c

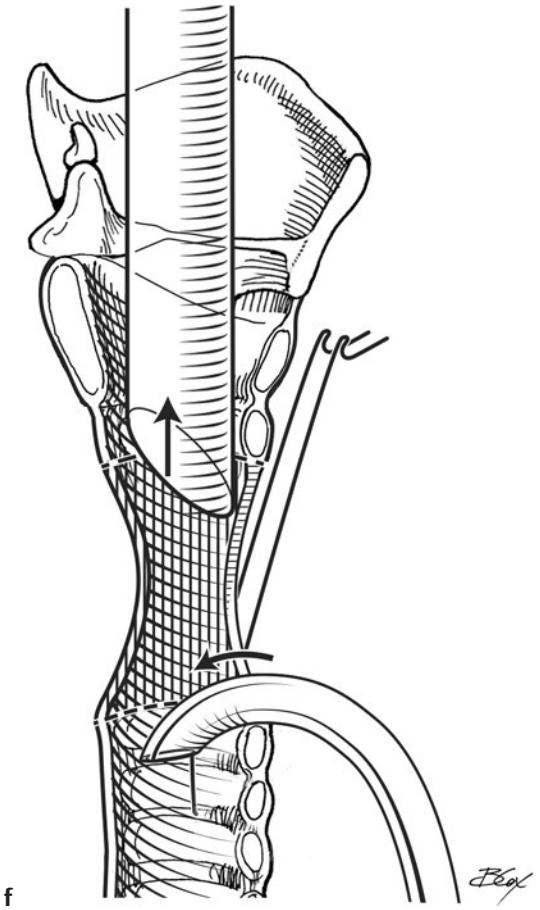


d

Fig. 25.3d

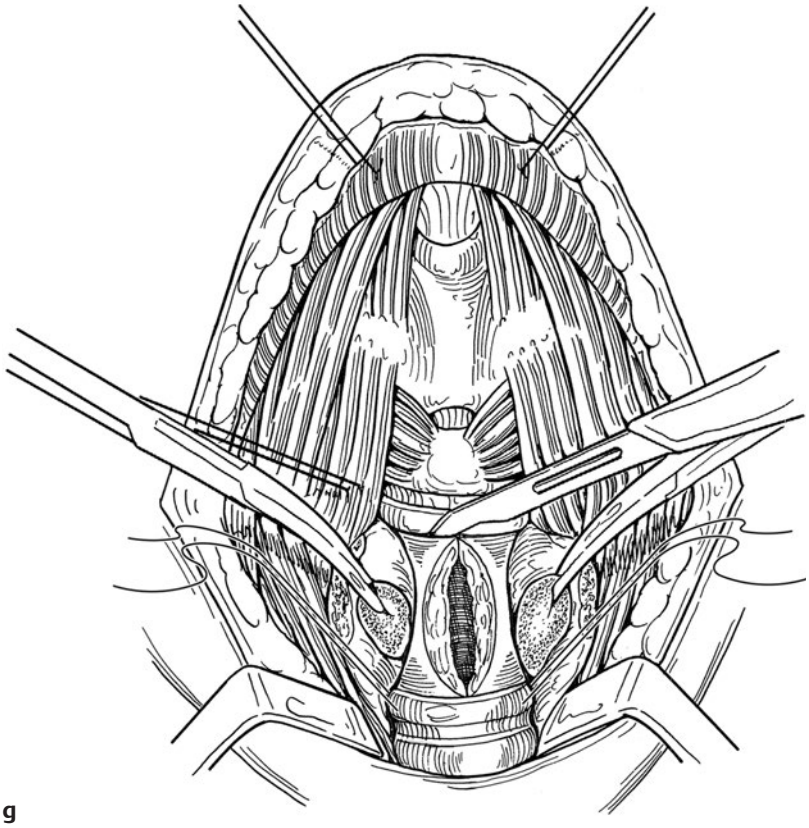


e

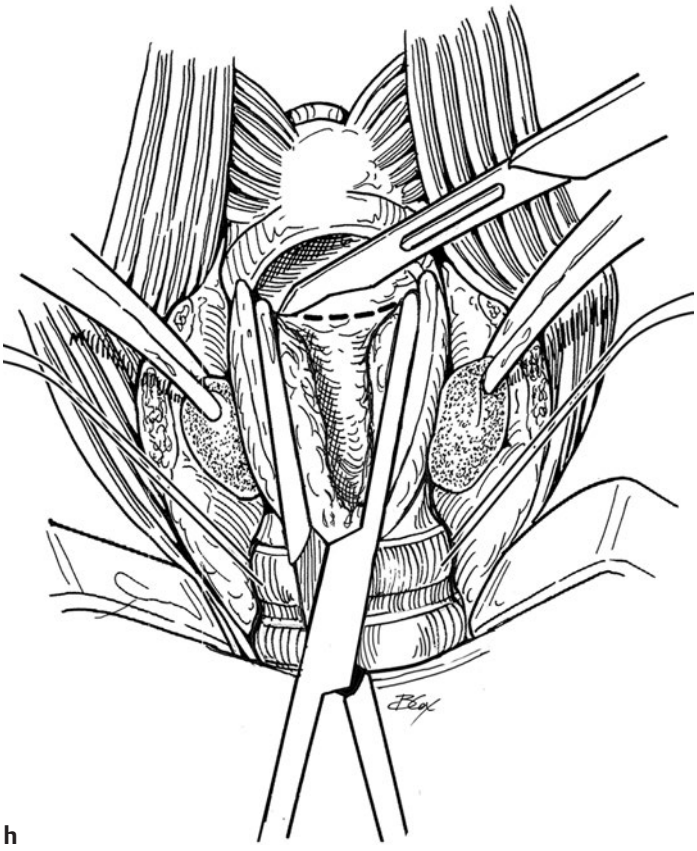


f

Fig. 25.3e,f

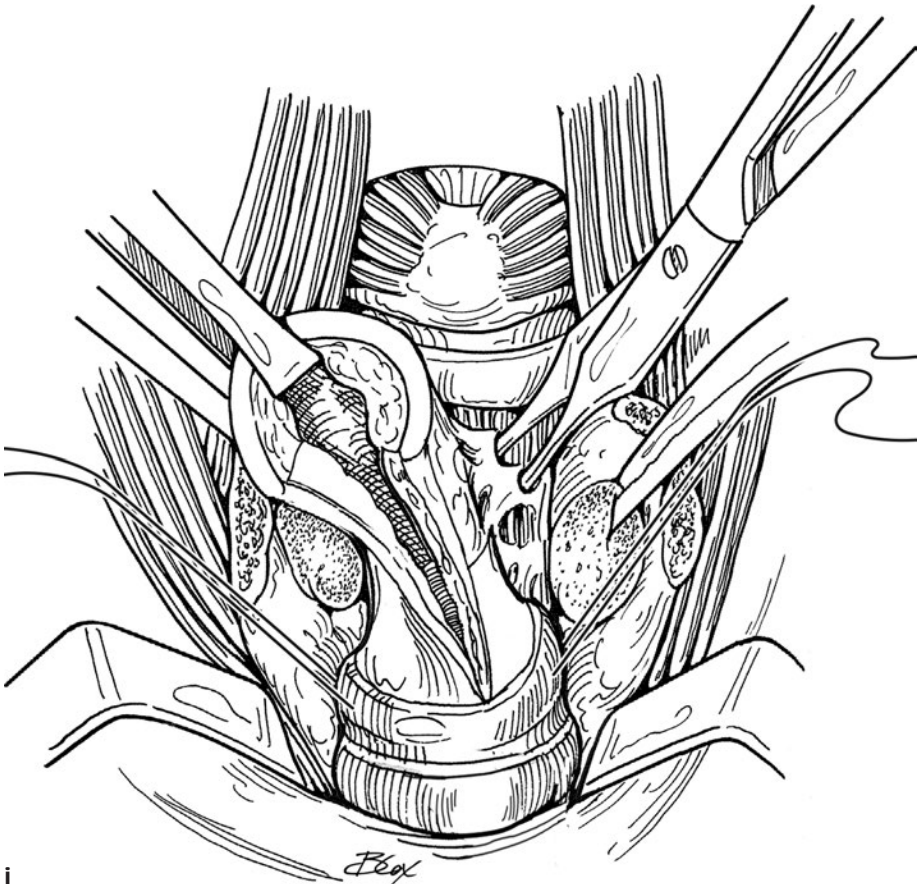


g

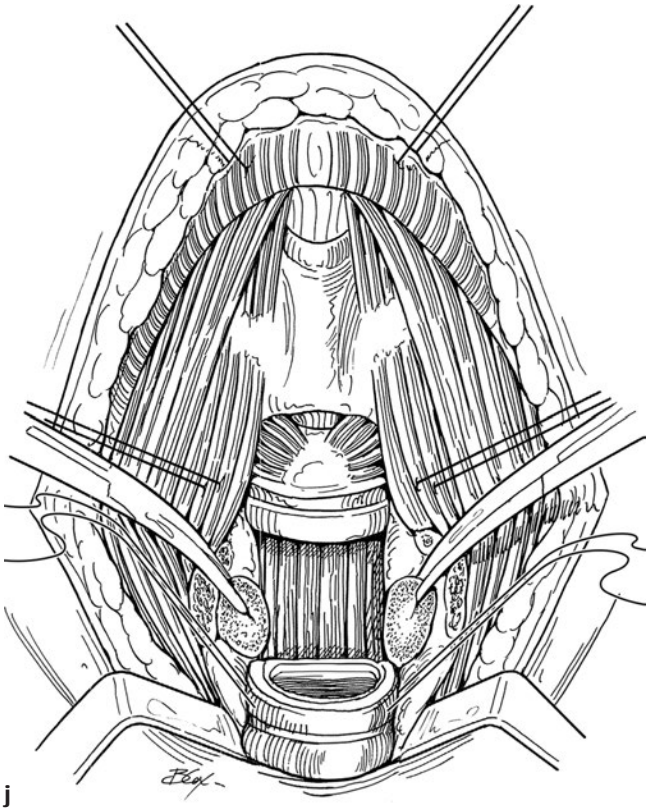


h

Fig. 25.3g,h

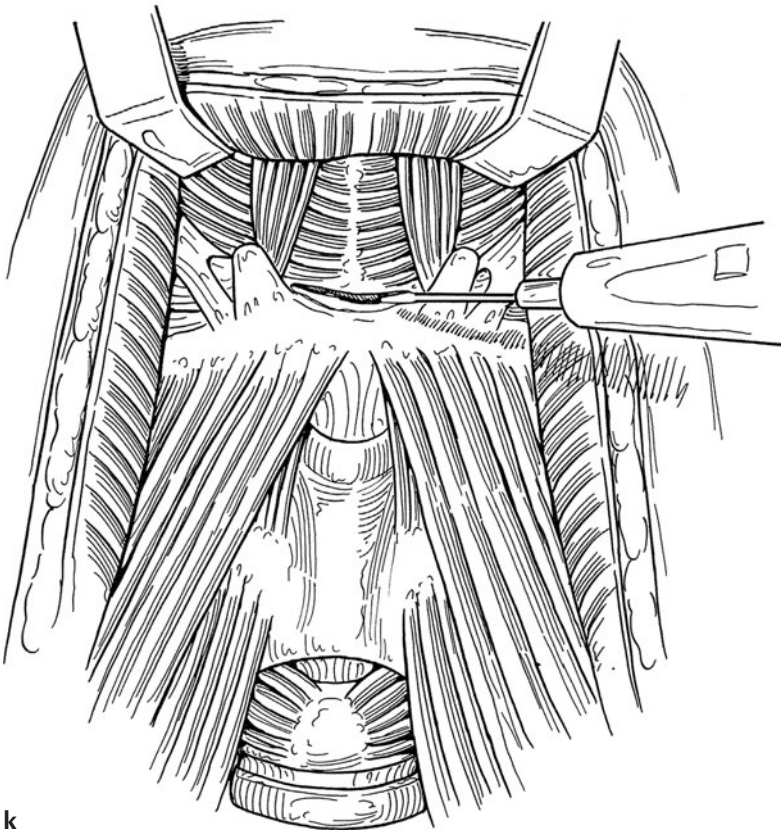


i

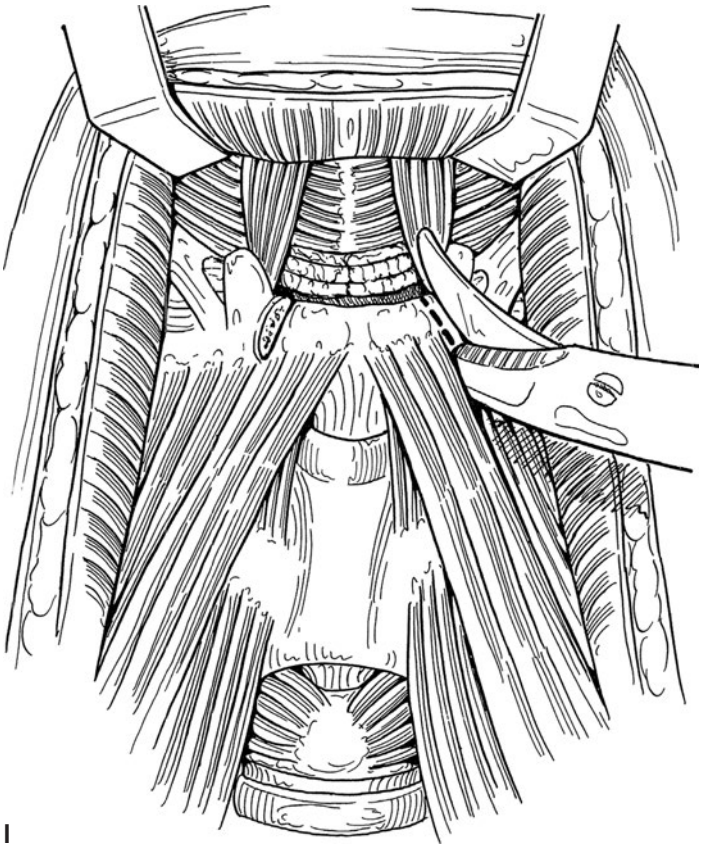


j

Fig. 25.3i,j

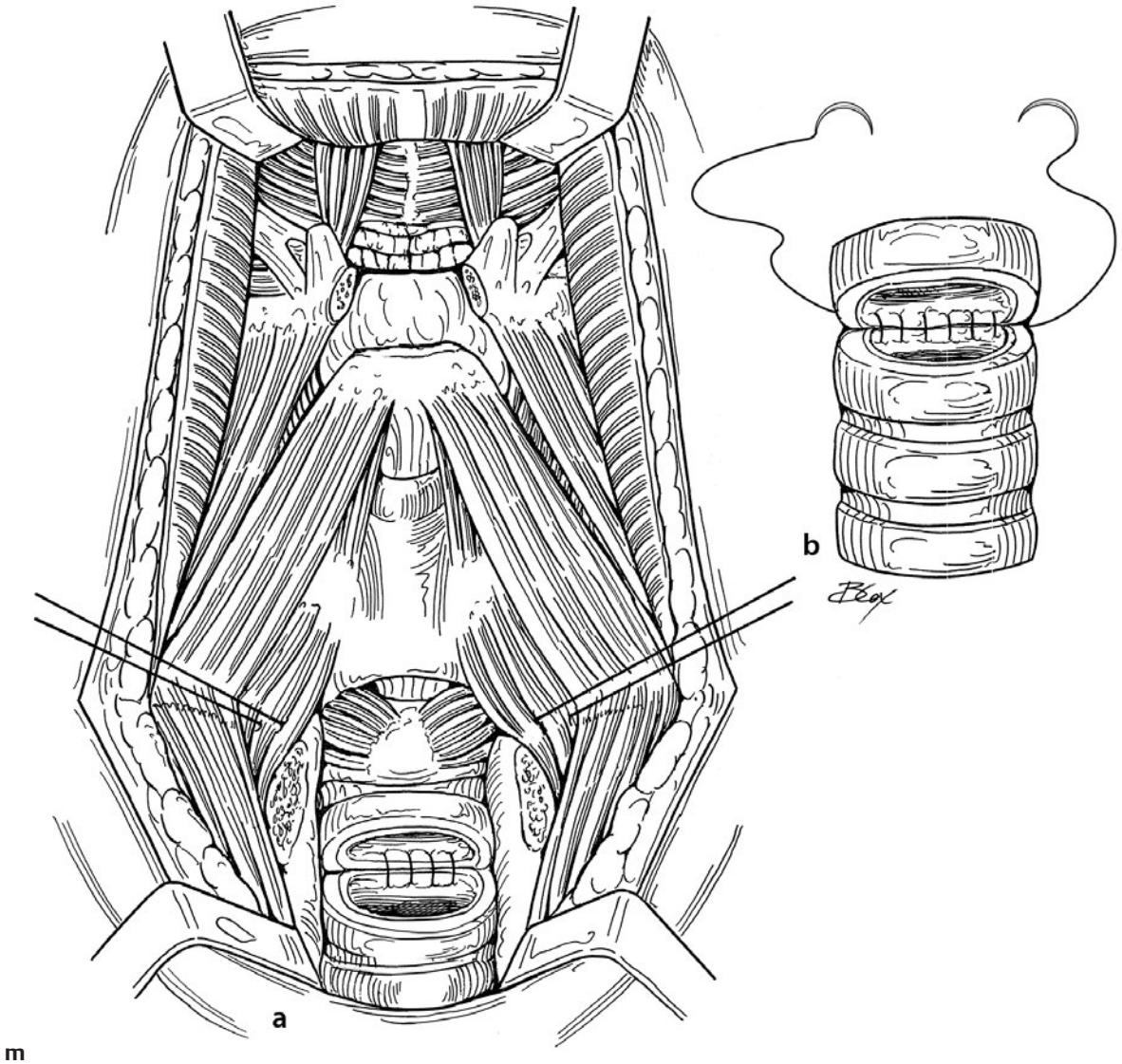


k

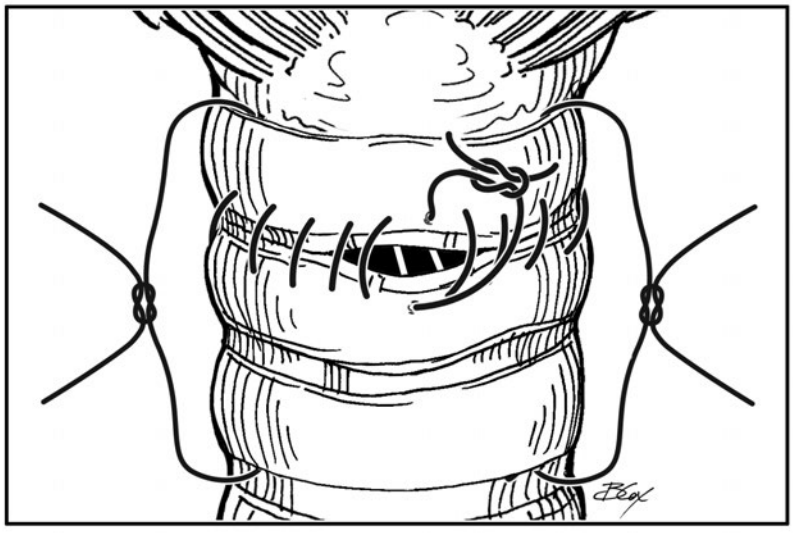


l

Fig. 25.3k,l

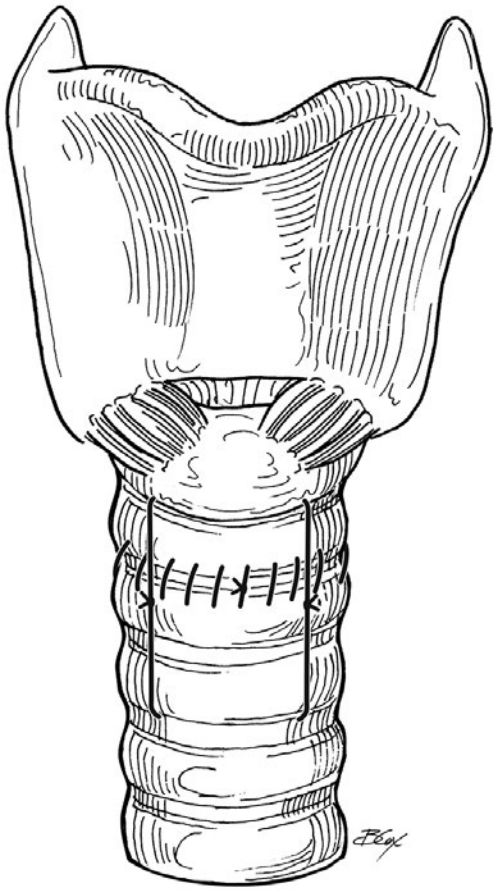


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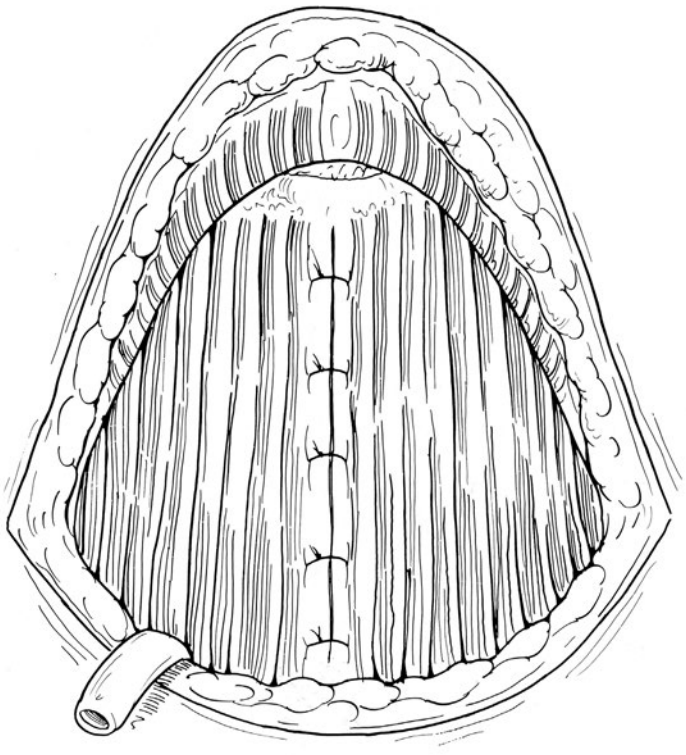


n

Fig. 25.3m,n



o



p

Fig. 25.3o,p



q

Fig. 25.3q

25-4 Cricotracheal Resection

Introduction

Tracheal atresia, severe subglottic tracheal stenosis, and proximal tracheal stenosis present challenges for survival as well as reconstruction. Cricotracheal resection is the treatment of choice for these conditions.

Indications

Cricotracheal resection is indicated for severe subglottic and/or proximal tracheal stenosis.

Preoperative Evaluation

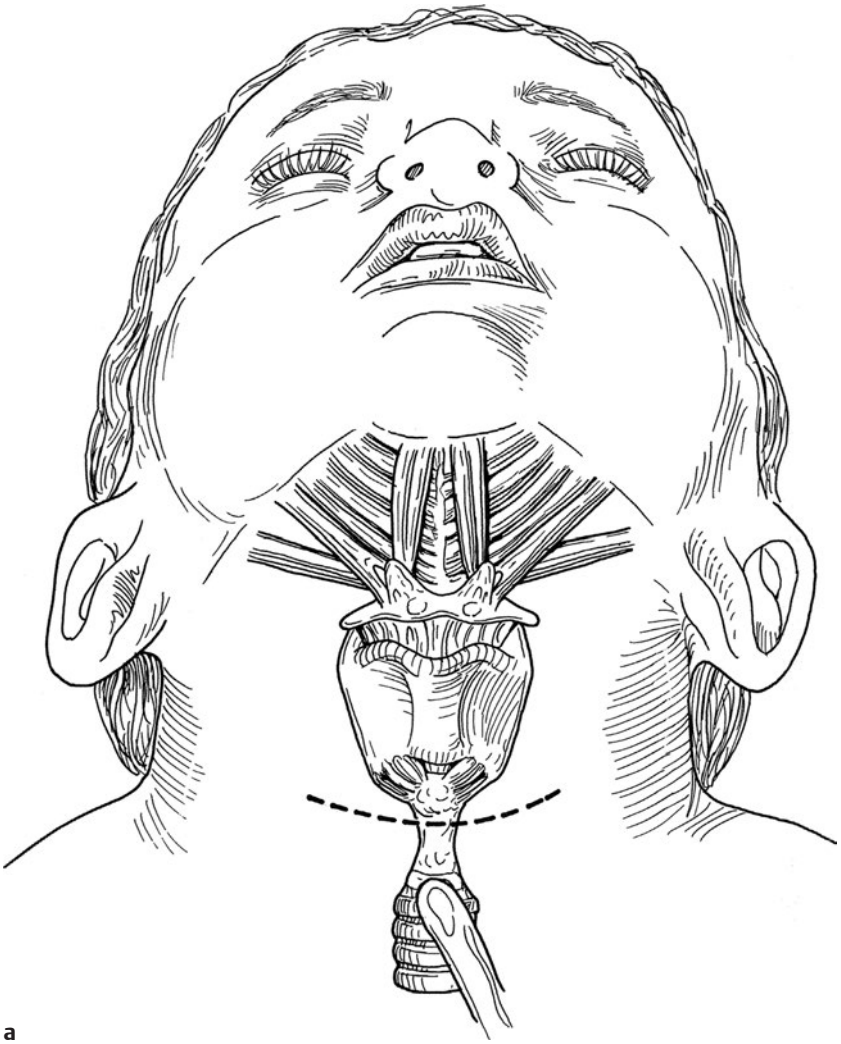
Microlaryngoscopy and bronchoscopy are essential to examine the intraluminal configuration of the stenosis. Standard radiography may be helpful. However, if more detailed anatomical information is required, CT or MRI should be obtained.

Operative Technique

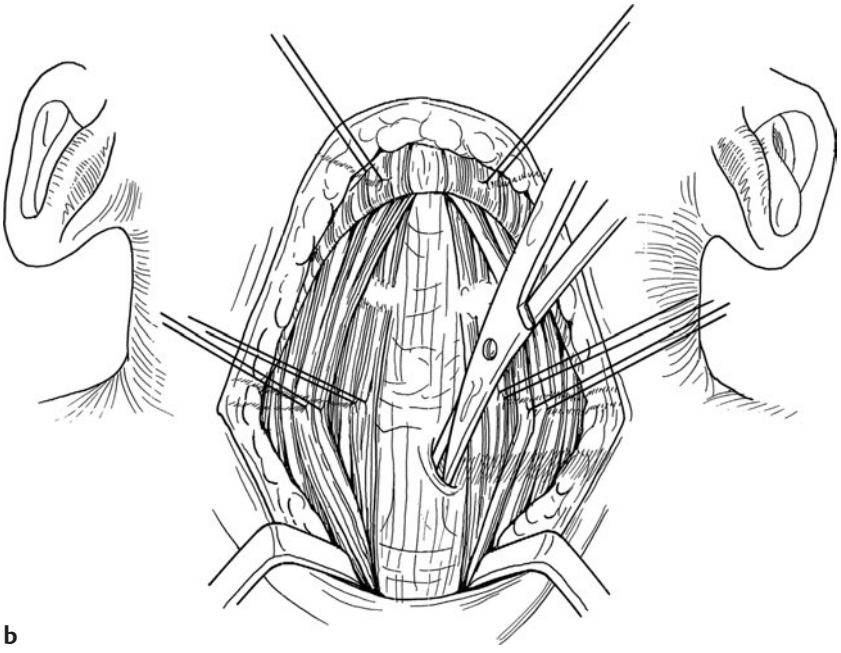
1. Tracheal resection is performed under general anesthesia administered through a reinforced endotracheal tube in the tracheostomy site (**Fig. 25.4a**).
2. The patient is placed on a shoulder roll with the neck extended as for tracheotomy.
3. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
4. A transverse incision is made in the neck overlying the lower border of the cricoid (**Fig. 25.4a**).
5. The incision is carried through the subcutaneous tissues and the deep cervical fascia, exposing the strap muscles. Superior and inferior subplatysmal skin flaps are created.
6. The strap muscles are divided in the midline and retracted laterally with 4-0 silk sutures (**Fig. 25.4b**).
7. The pretracheal fascia is incised, providing exposure of the trachea as well as of the cricoid and thyroid cartilages (**Fig. 25.4c**).
8. A vertical incision is made through the cricoid and stenotic segment extending to the normal trachea below (**Fig. 25.4d,e**).
9. The trachea is transected below the stenosis with a knife, preserving the integrity of the esophagus (**Fig. 25.4f**). The recurrent laryngeal nerves are not routinely dissected unless it is a revision procedure. The inferior border and anterior body of the cricoid cartilage are resected with a knife (**Fig. 25.4f,g**). Care is taken to stay anterior to the cricothyroid joint. The portion of larynx and trachea resected is shown in **Fig. 25.4g,h**.
10. The larynx is then released from its suprahyoid attachments (**Fig. 25.4i**). A transverse incision is made just above the hyoid bone using electrocautery, releasing the geniohyoid and hyoglossal muscles from the hyoid bone.
11. The hyoid bone can be divided with a scissors at the insertion of the lesser cornu, which is the site of attachment of the digastric muscle (**Fig. 25.4j**). This releases the larynx, allowing it to move inferiorly.
12. The inferior portion of the trachea is released by careful dissection of soft tissue of the party wall to facilitate the anastomosis (**Fig. 25.4k,l**).
13. Two 2-0 polydioxanone (PDS) traction sutures are placed 2–3 cm distal to the stenosis in the anterolateral trachea. These will be passed around the hyoid using a half circle McGowan needle once the anastomosis is complete (**Fig. 25.4m**).
14. A running continuous suture technique using a double-armed 4-0 PDS suture is used to complete the anastomosis from posterodistally to anteroproximally (**Fig. 25.4m**).
15. Once the posterior half of the anastomosis is complete, the reinforced endotracheal tube is removed and nasotracheal intubation is performed with an age-appropriate endotracheal tube (**Fig. 25.4n**).
16. The anastomosis is completed by running the 3-0 PDS suture anteriorly through the lower thyroid cartilage and lateral cricoid cartilage to connect to the tracheal rings (**Fig. 25.4o,p**).
17. The tension-releasing sutures placed above are now tied (**Fig. 25.4q,r**).
18. Additional tension-releasing sutures are placed bilaterally in the posterolateral trachea using 3-0 PDS that is passed through the posterolateral aspect of the thyroid cartilage (**Fig. 25.4q,r**).
19. A Penrose drain is placed in the wound, and the strap muscles are reapproximated over the larynx and trachea (**Fig. 25.4s**).
20. The subcutaneous tissues are closed with 3-0 interrupted Vicryl sutures, and the skin is closed with 5-0 running subcuticular Monocryl sutures.
21. Two sutures are placed from the skin of the chin to the skin of the chest with 0-Prolene to prevent extension of the neck (**Fig. 25.4t**). If the anastomosis is not under undue tension, a cervical collar is a good alternative.
22. The endotracheal tube is removed in 12 to 24 hours. In older patients, extubation in the operating room at the conclusion of the case may be considered.
23. The drain is left in place for 2 to 3 days.
24. Antibiotics are administered until the drains are removed.
25. Ten days after the procedure, the chin to chest sutures or the cervical collar are removed and a direct laryngoscopy and bronchoscopy are performed under general anesthesia.

Complications

1. Restenosis
2. Pneumothorax
3. Vocal cord paralysis
4. Dehiscence

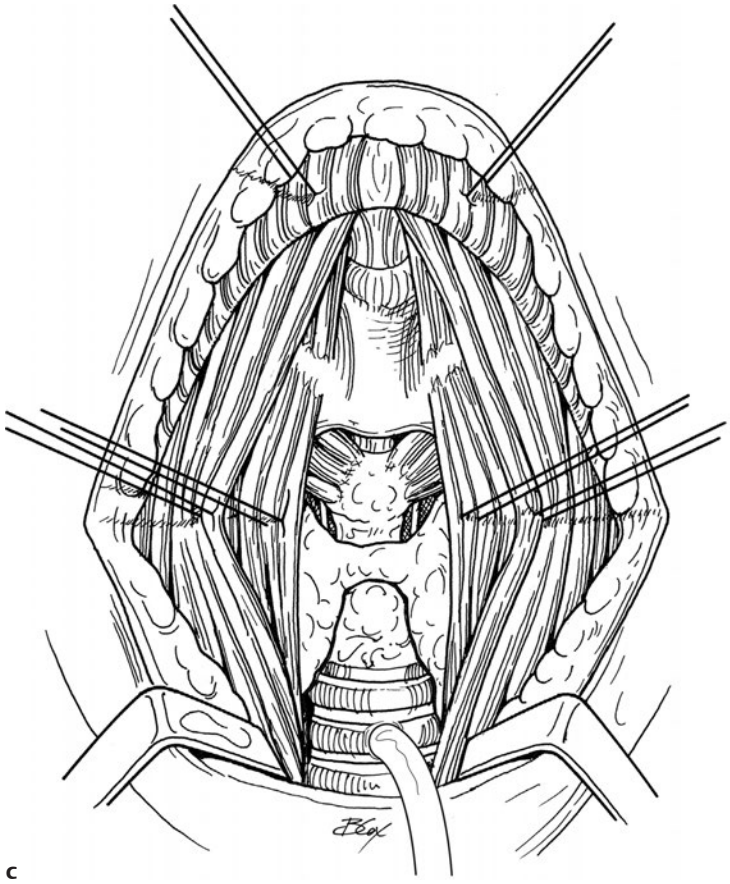


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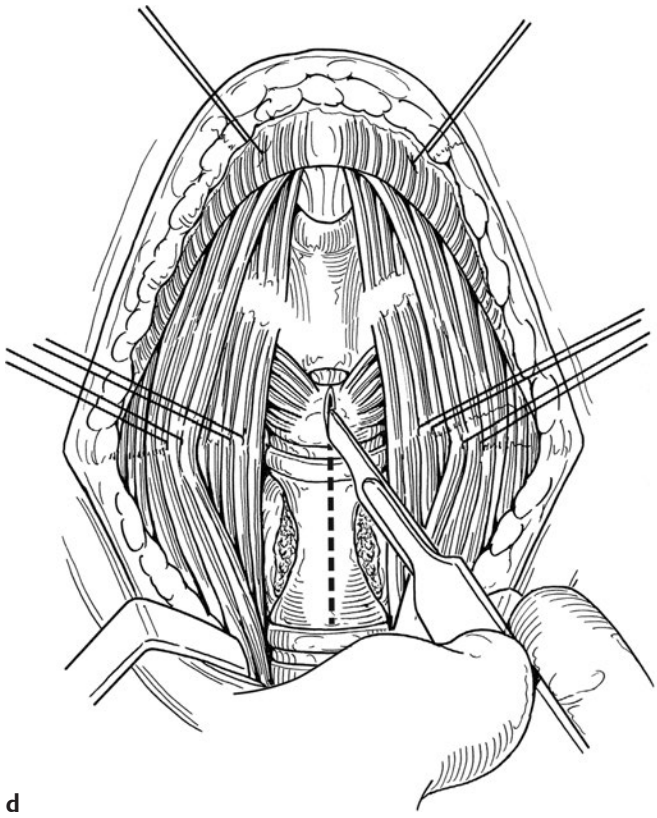


b

Fig. 25.4a,b

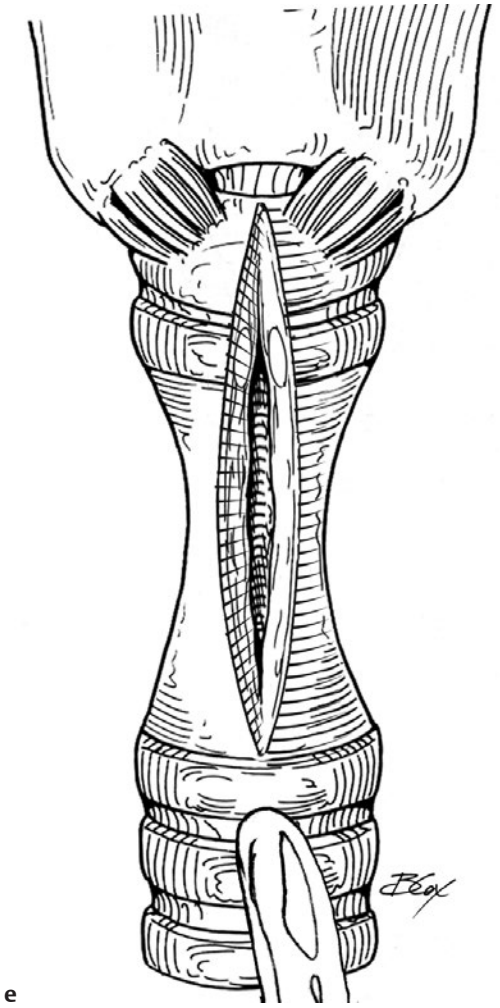


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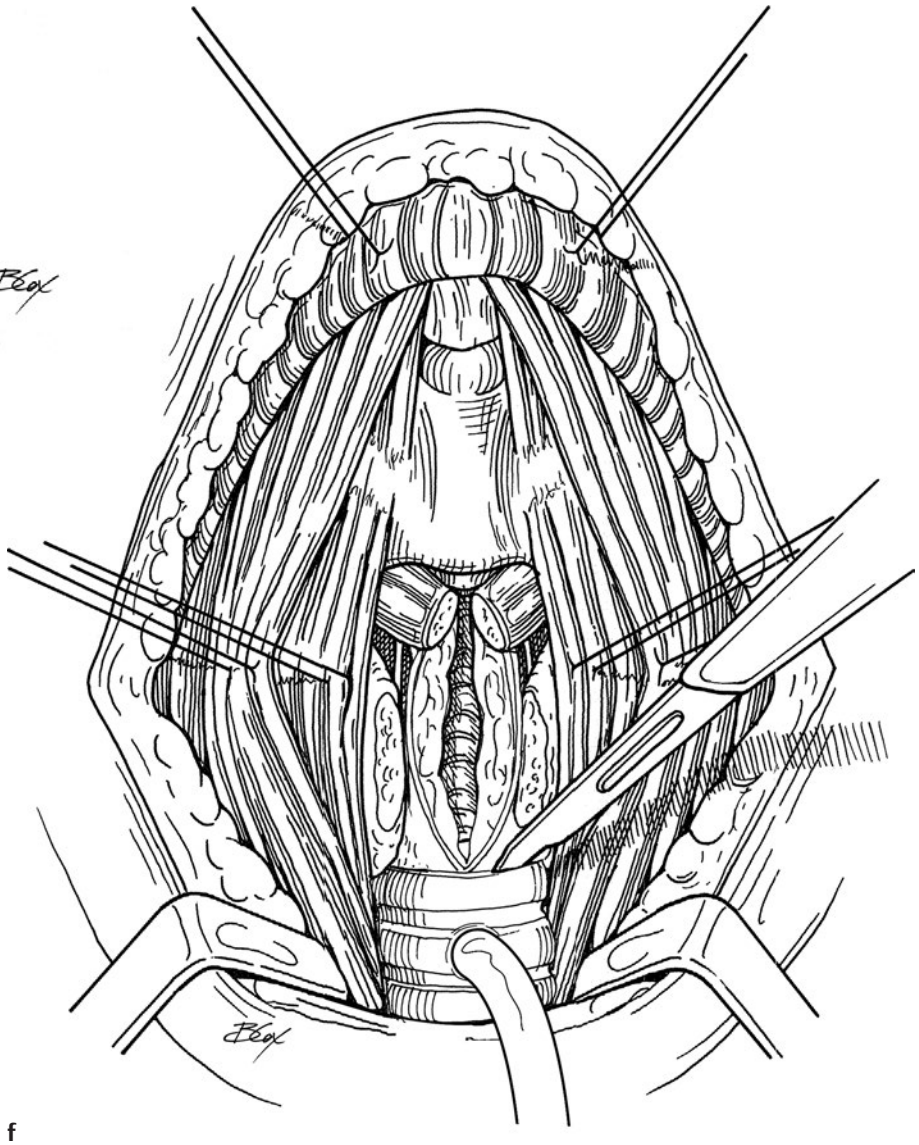


d

Fig. 25.4c,d

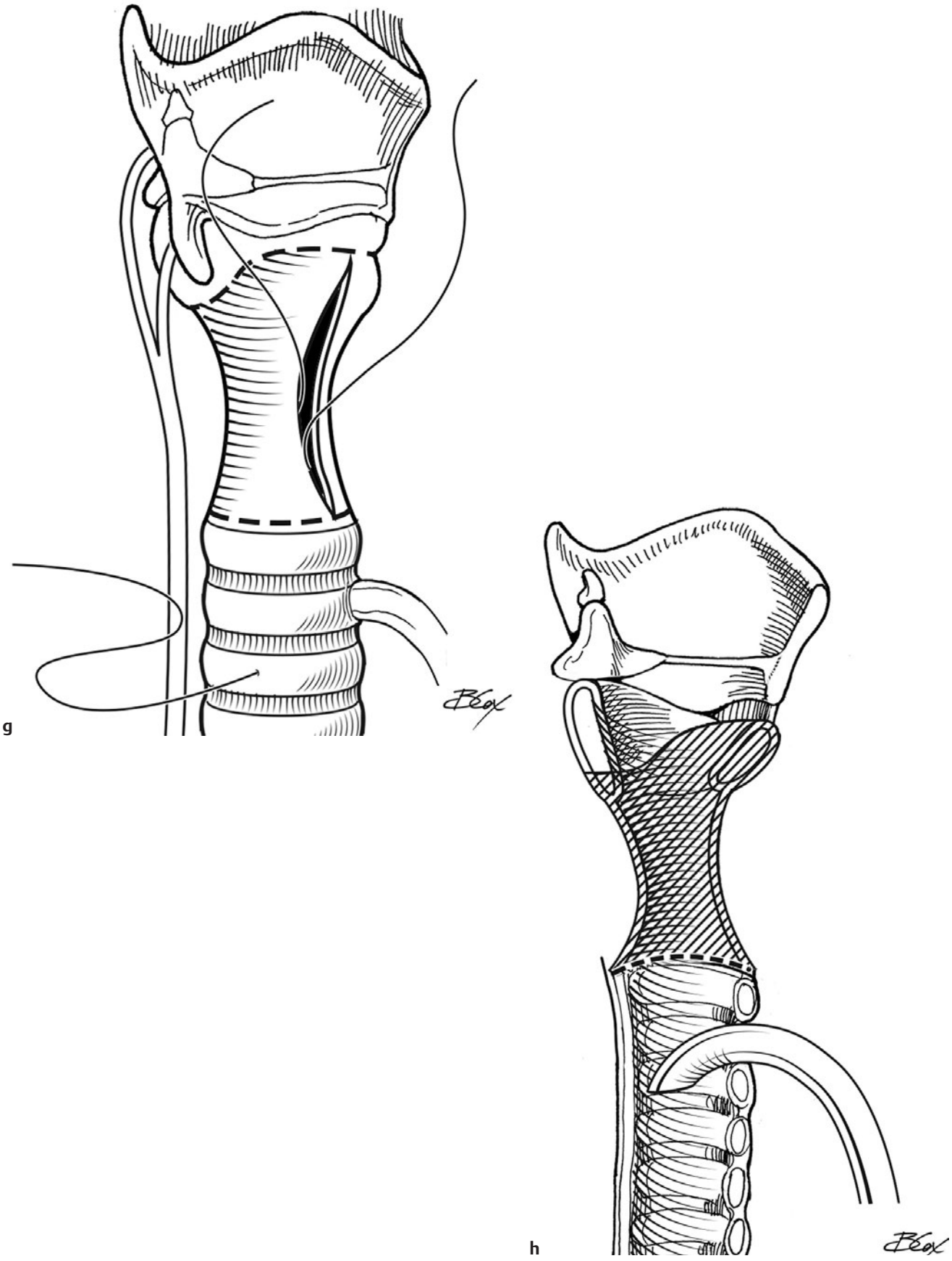


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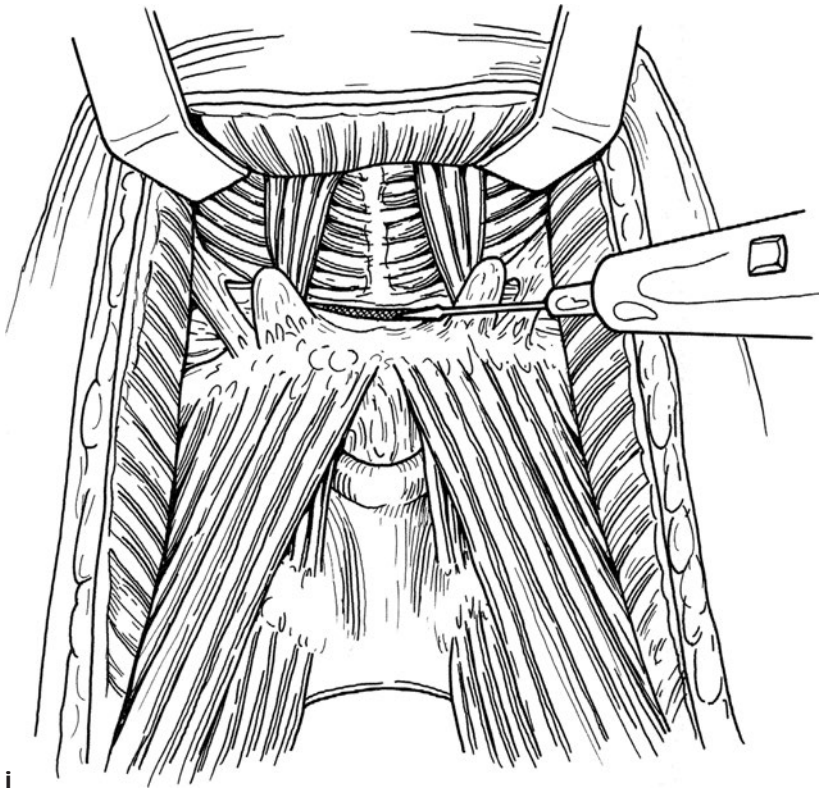
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Fig. 25.4e,f

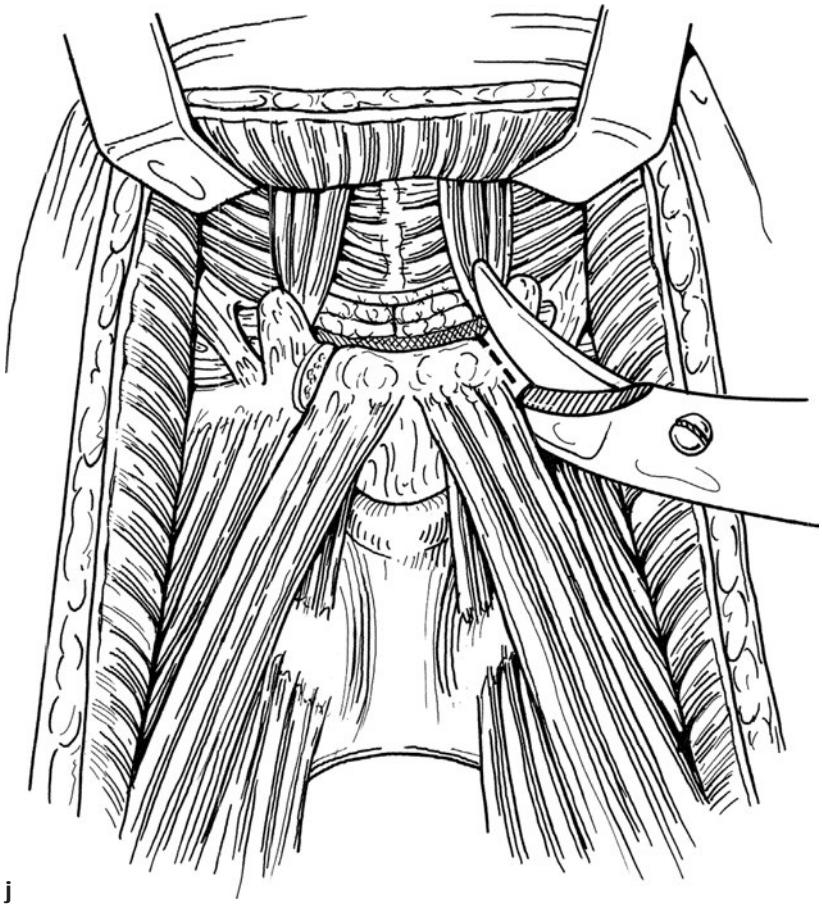


g h

Fig. 25.4g,h

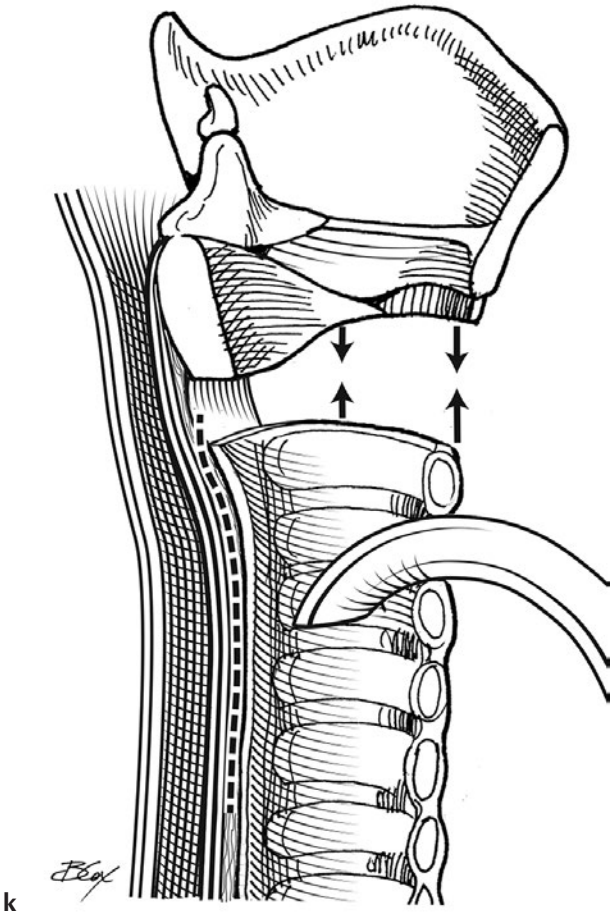


i

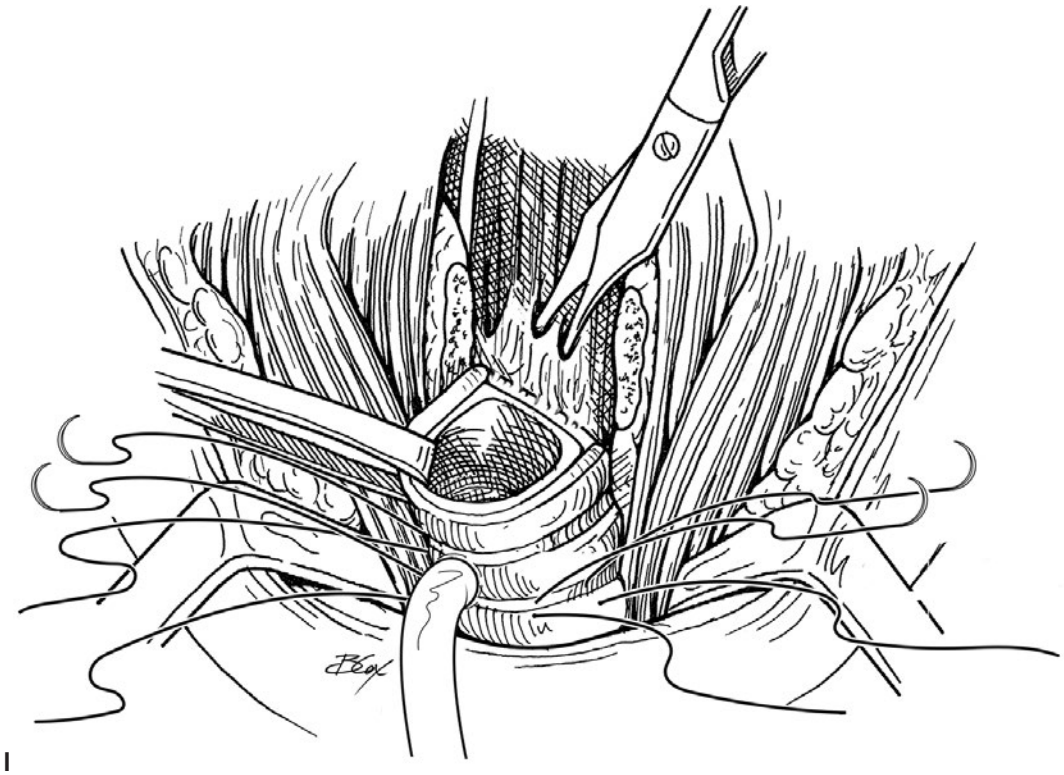


j

Fig. 25.4i,j



k



l

Fig. 25.4k,l

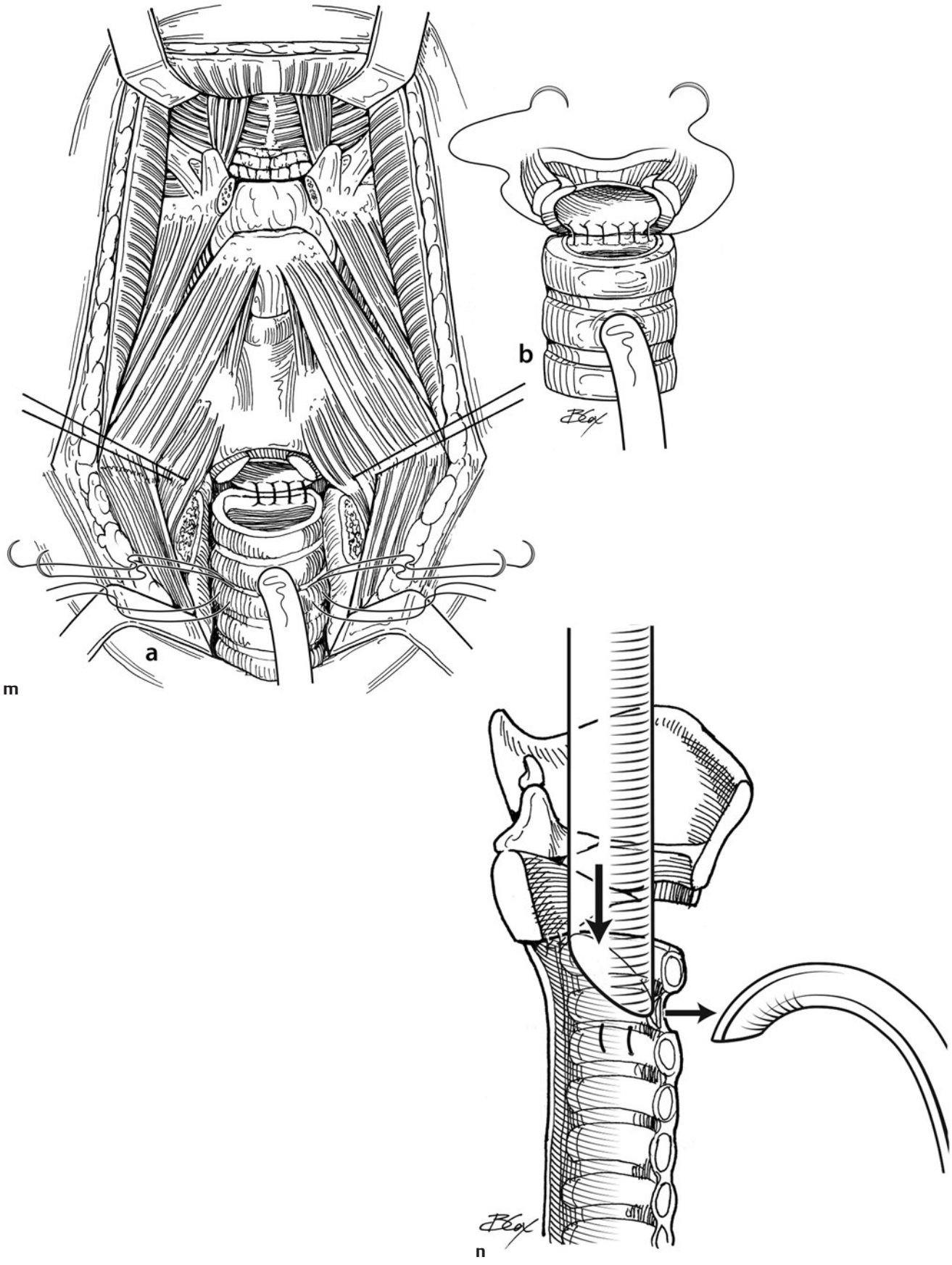
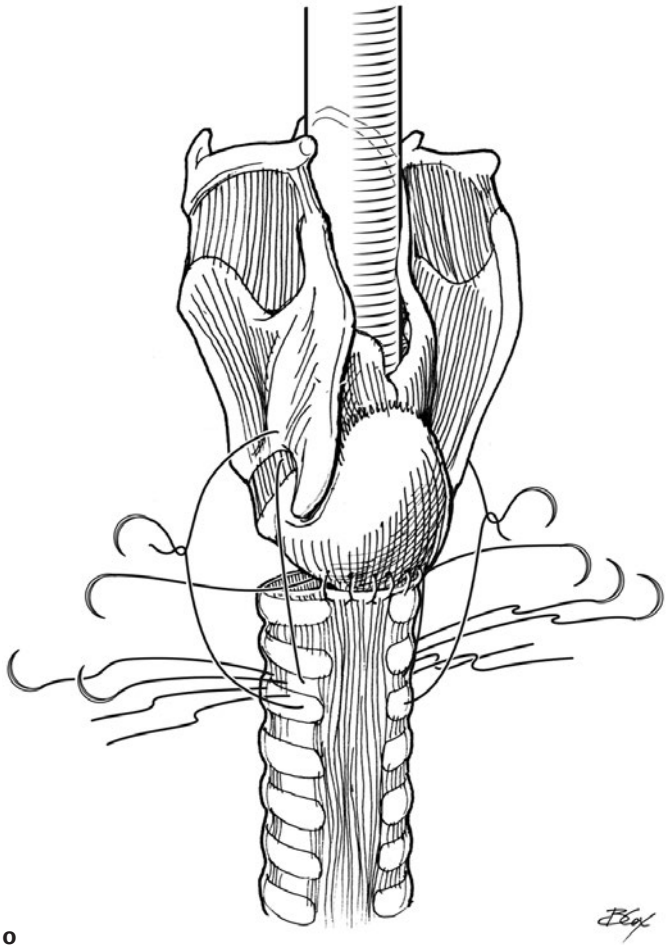
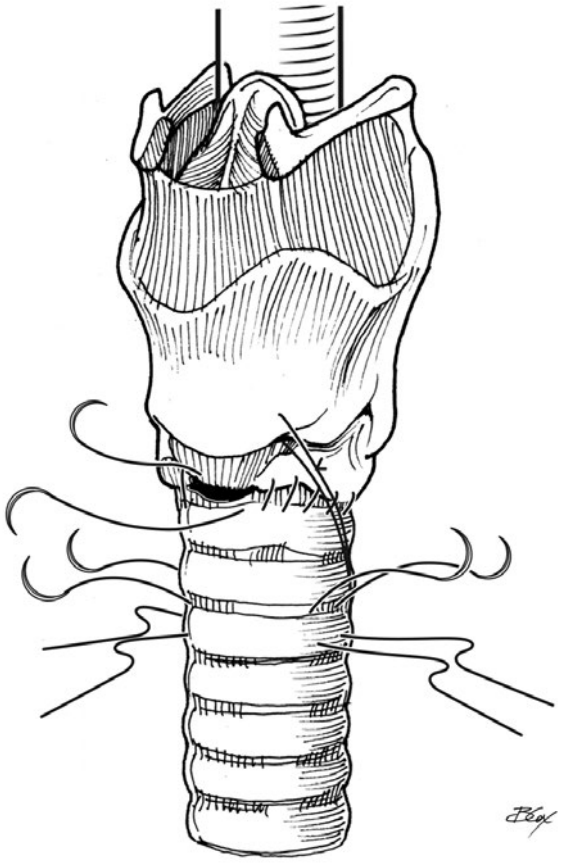


Fig. 25.4m,n

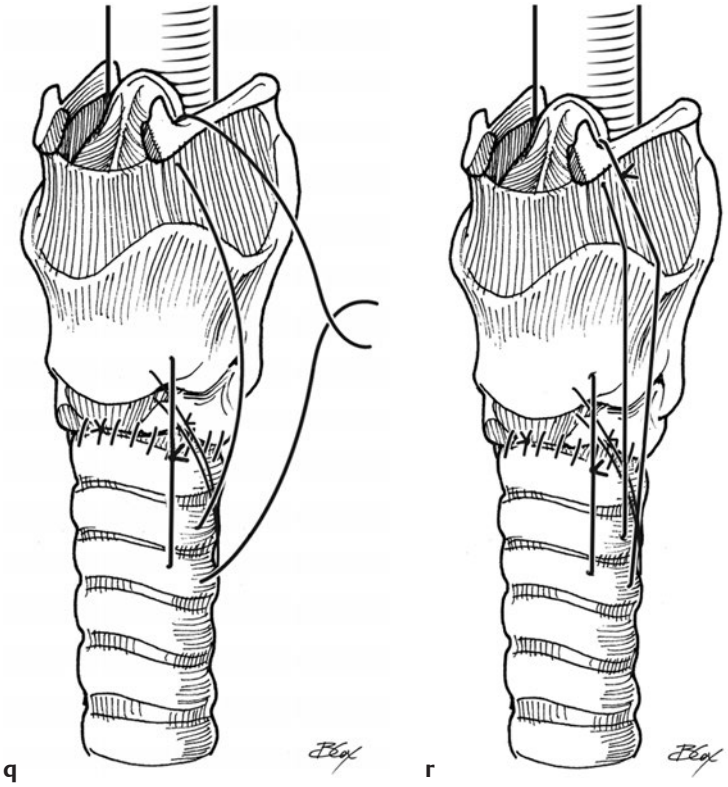


o

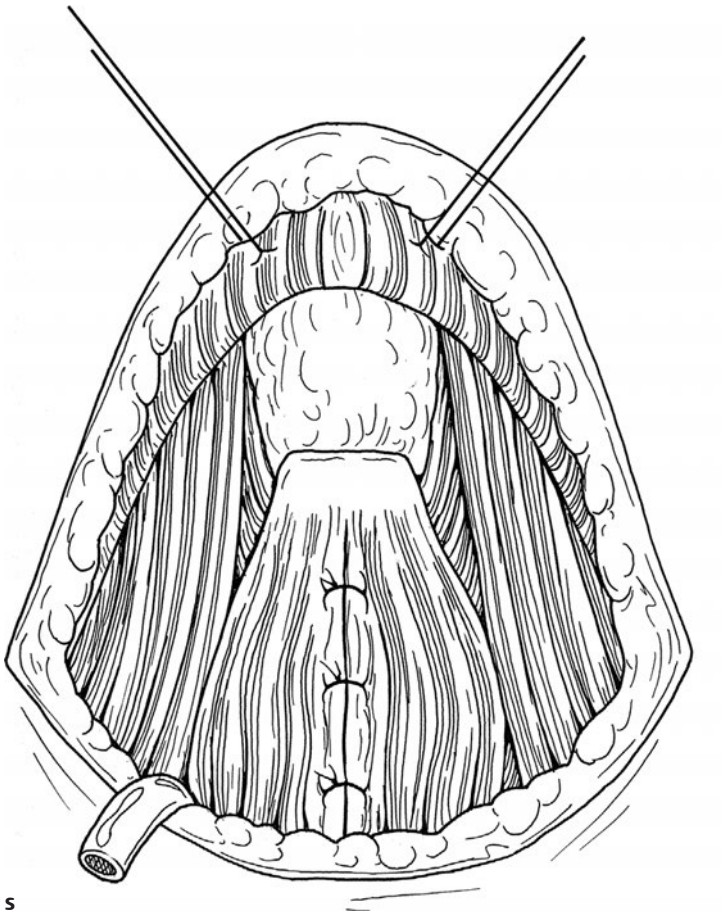


p

Fig. 25.4o,p



q r



s

Fig. 25.4q,r,s



t

Fig. 25.4t

25-5 Slide Tracheoplasty

Introduction

Tracheal stenosis may result from complete tracheal rings, absent tracheal rings, sleeve trachea, intubation injury, or infection.

Indications

The repair of tracheal stenosis is indicated when respiratory distress is sufficient to interfere with growth and development or the child presents with a life-threatening obstruction.

Preoperative Evaluation

Children with complete tracheal rings often have associated cardiovascular or pulmonary anomalies making a comprehensive evaluation necessary.

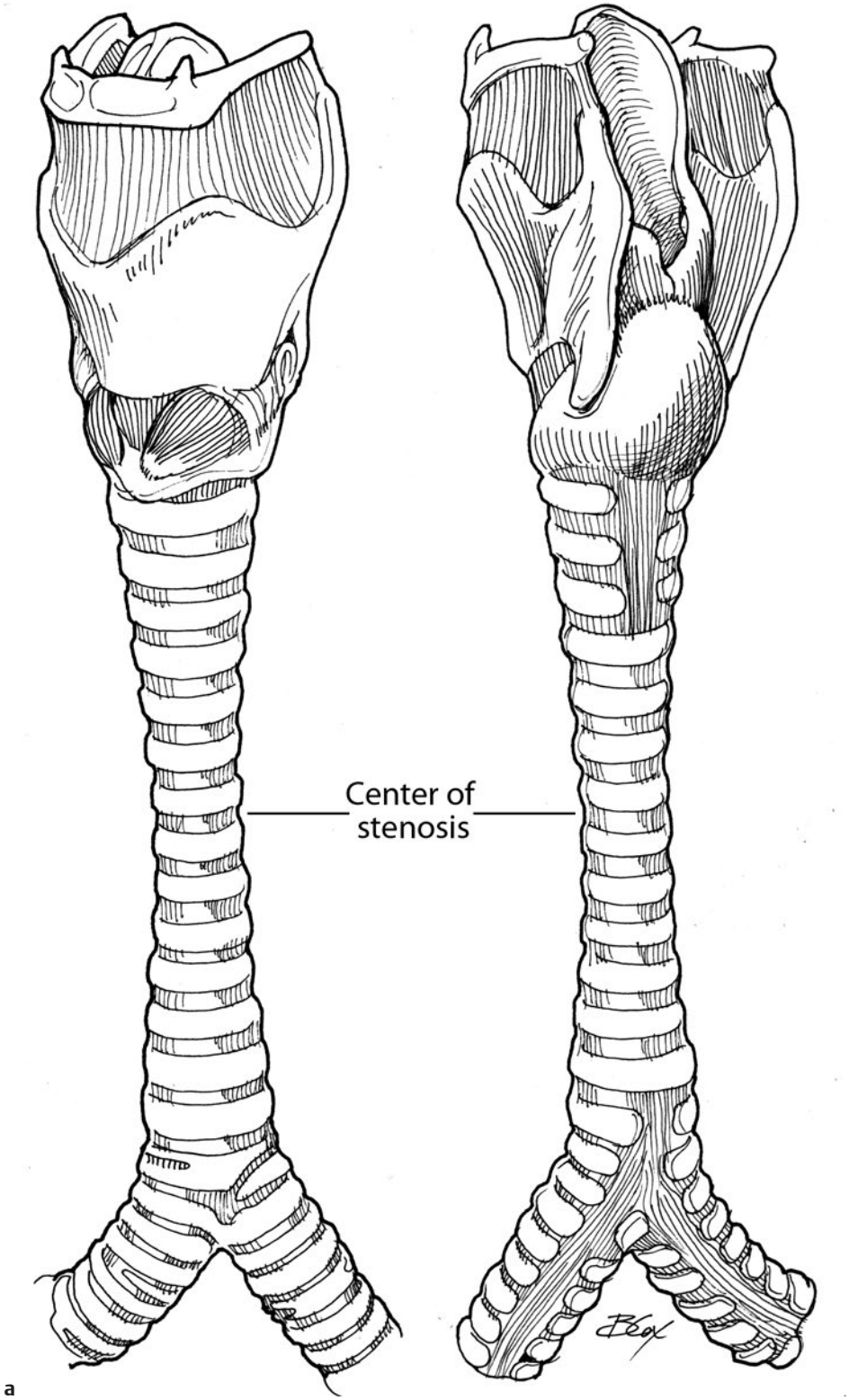
1. Microlaryngoscopy and bronchoscopy supplemented by flexible bronchoscopy are preformed to assess for aberrant bronchial anatomy. Great care must be taken to avoid passing an endoscope that is too large through the area of stenosis as this can convert a tenuous airway into a critical airway.
2. A CT angiogram of the chest, with images including the neck from the mandible through the lungs, is obtained, thus providing a complete study of the airway, surrounding vascular structures, and lungs. Three-dimensional reconstructions are created to facilitate surgical planning.
3. Cardiology and cardiothoracic surgery consultations including an echocardiogram are mandatory for all patients.

Operative Technique

1. Slide tracheoplasty is performed with the child on cardiopulmonary bypass.
2. The patient is positioned supine with the neck extended.
3. Microlaryngoscopy and bronchoscopy are performed with great care to avoid causing edema that may convert a marginal airway to a critical airway. The patient is ideally intubated above the stenosis with an endotracheal tube large enough to accommodate a flexible bronchoscope.
4. The patient is placed on cardiopulmonary bypass. If cardiac repair is required, this is performed first.
5. The trachea is then exposed via dissection between the aorta and superior vena cava. Removal of the paratracheal lymph nodes facilitates exposure and the carina is identified deep to the right pulmonary artery. The anterior trachea is exposed from carina to above the proximal extent of the tracheal rings.
6. Flexible bronchoscopy is then performed to identify the upper and lower extent of the stenosis using a 30-gauge needle passed through the anterior tracheal wall and visualized intraluminally.
7. The length of the stenosis is measured and the trachea transected at the midpoint of the segment of complete rings (**Fig. 25.5a**).
8. The proximal and distal aspects of the trachea are then dissected posteriorly to mobilize the trachea. Care is taken to preserve the lateral attachments of the trachea to maintain good vascular supply.
9. The distal segment is then split posteriorly until normal trachealis or the carina is reached, and the proximal segment is split anteriorly until normal rings or the cricoid is encountered. The corners are trimmed (**Fig. 25.5b,c,d**).
10. A running continuous suture technique using a double-armed 5-0 or 6-0 PDS suture is used to complete the anastomosis from posterodistally to anteroproximally. A 4-0 PDS suture may be used in teenage or older patients (**Fig. 25.5e**).
11. A leak test is performed to confirm airtight closure. Surgical clips are used to mark the proximal and distal aspects of the anastomosis. Fibrin tissue glue is applied.
12. The patient is taken off cardiopulmonary bypass and the chest closed. A mediastinal drain is placed.
13. A flexible bronchoscope is passed through the endotracheal tube, which is gradually withdrawn until the anastomosis can be visualized. The endotracheal tube is positioned under direct visualization, and therapeutic aspiration of the bronchial tree is performed to remove blood and secretions.
14. The patient is extubated within 24–48 hours if there are no comorbid conditions.
15. Maintaining high humidification facilitates clearance of secretions and decreases risk of mucous accumulating along the suture line.
16. Microlaryngoscopy and bronchoscopy are performed 1 week postoperatively.

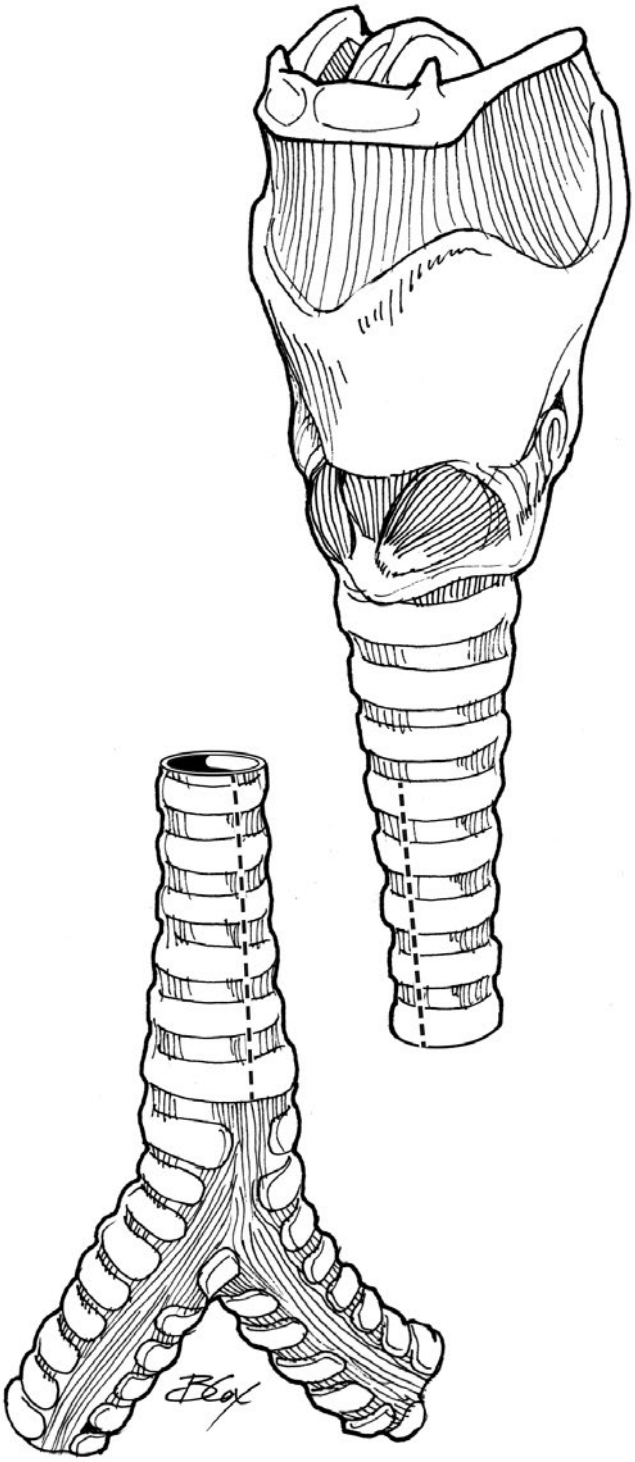
Complications

1. Mucous plugging
2. Dehiscence at anastomosis
3. Recurrent laryngeal nerve injury



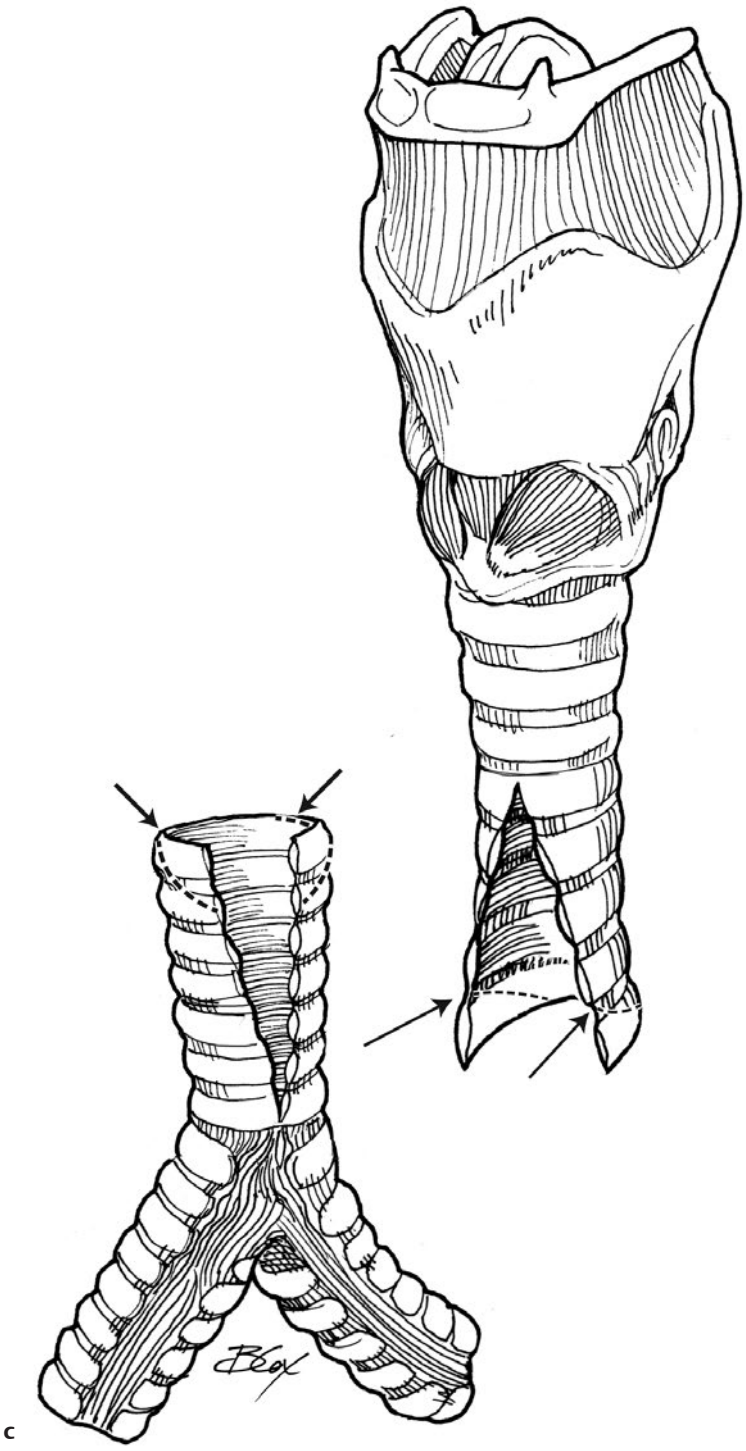
a

Fig. 25.5a



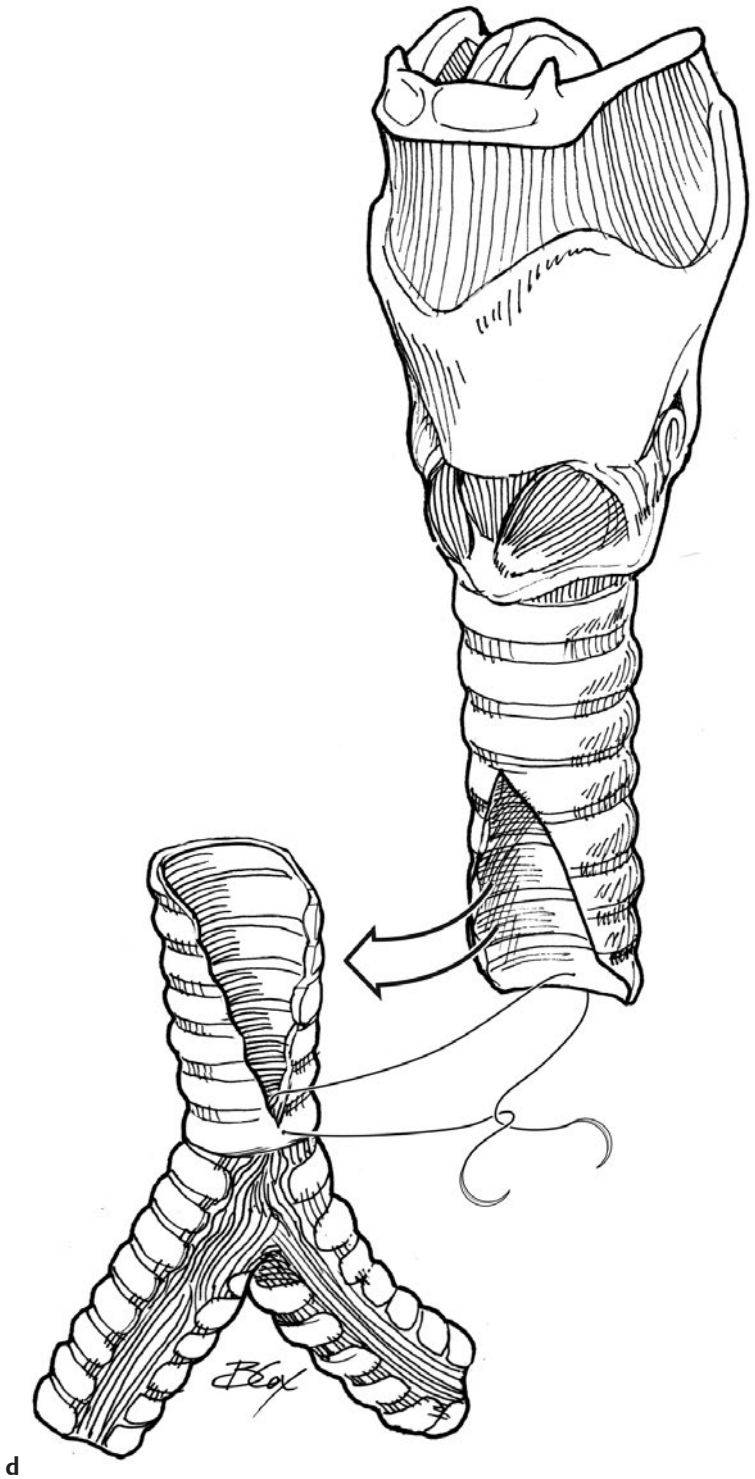
b

Fig. 25.5b



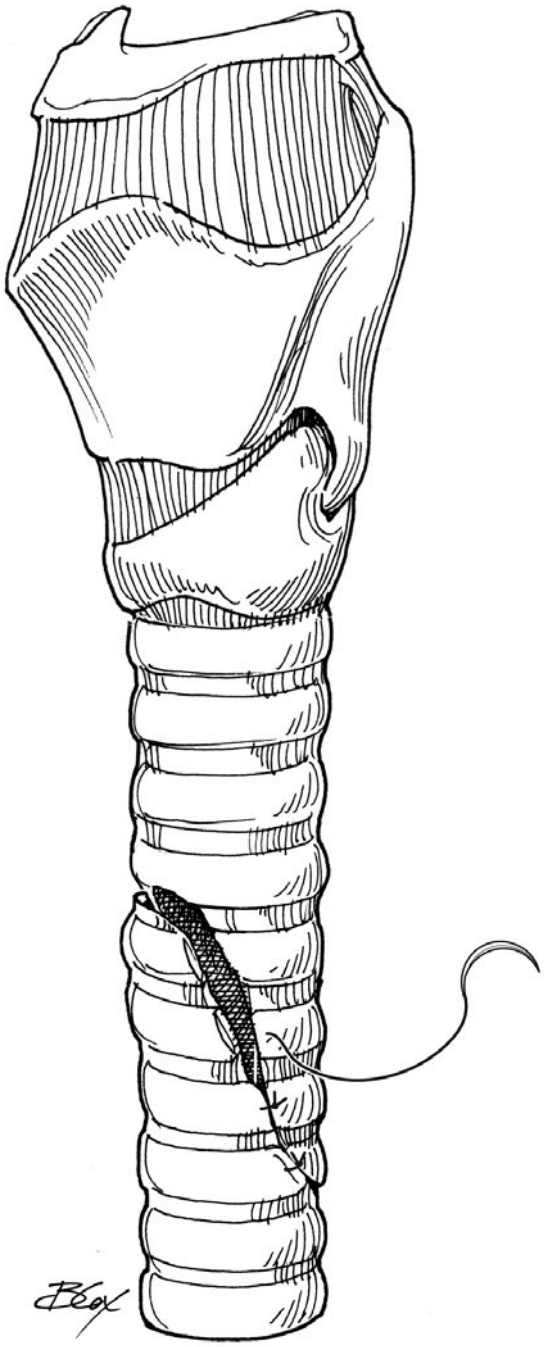
c

Fig. 25.5c



d

Fig. 25.5d



e

Fig. 25.5e

25-6 Removal of Suprastomal Fibroma

Introduction

Granulation tissue, suprastomal depression, and suprastomal fibroma formation at the anterosuperior edge of the tracheostomy site are common occurrences with a pediatric tracheostomy.

Indications

Removal of a suprastomal fibroma is indicated when it occludes the trachea. Its presence creates a critical airway, prevents phonation around the tracheostomy tube, and precludes decannulation.

Preoperative Evaluation

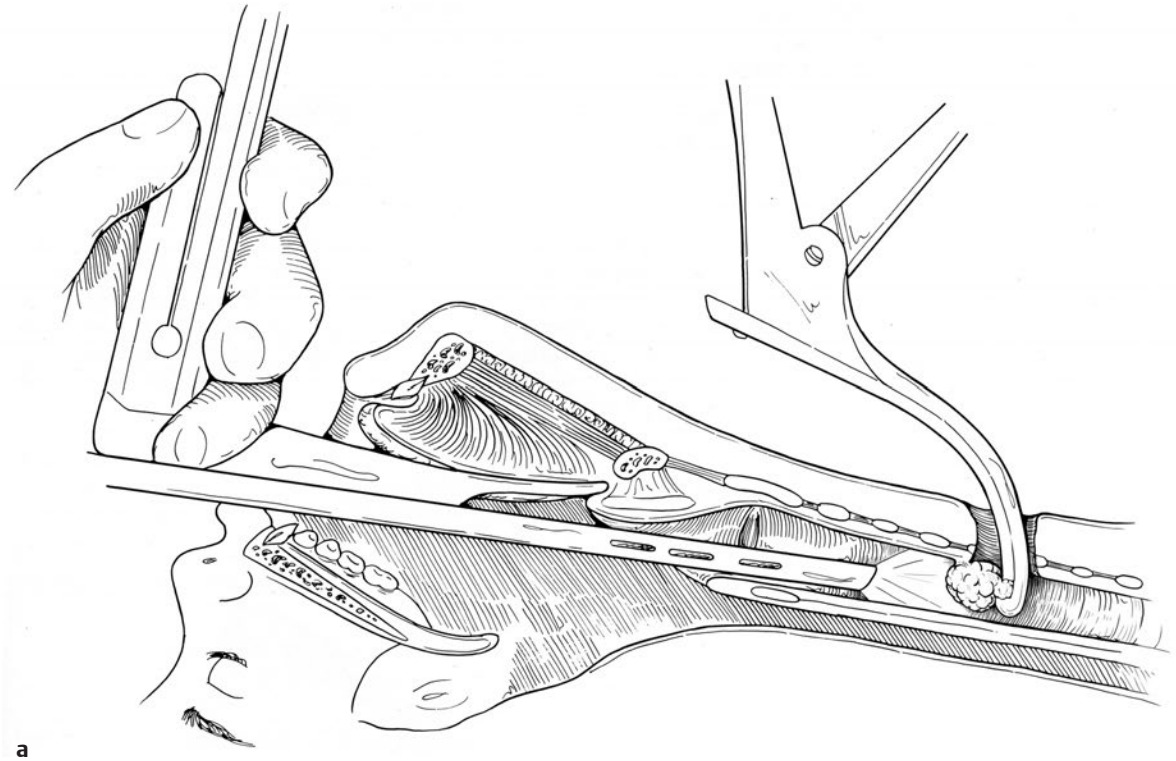
Microlaryngoscopy and bronchoscopy are sufficient to evaluate a suprastomal fibroma. Radiography is not helpful.

Operative Technique

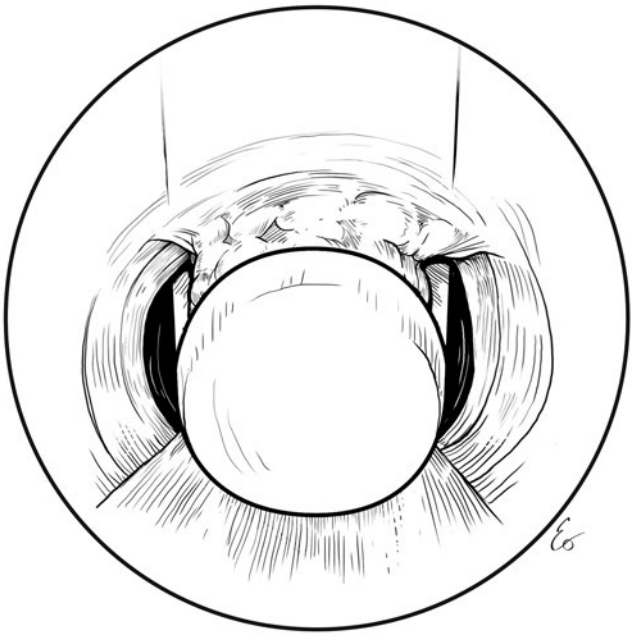
1. The suprastomal fibroma is visualized directly with an open bronchoscope under general anesthesia (**Fig. 25.6a**). The tracheostomy tube is removed.
2. A curved Kerrison or sphenoid punch is placed in the tracheal stoma, and the fibroma is removed with the punch under direct vision (**Fig. 25.6b**). Alternatively, the granuloma/fibroma may be pulled out of the tracheostoma with a skin hook and severed with a knife, scissors, or cautery.
3. The tracheostomy tube is replaced. If the patient is a candidate for decannulation, a plugging trial with a small tracheotomy tube should be performed prior to eventual decannulation.

Complications

1. Stenosis at stoma site
2. Reformation of granuloma



a



b

Fig. 25.6a,b

26 Larynx

The larynx is the primary organ for voice production which provides protection from aspiration and contributes to the clearing of secretions.

26-1 Injection Laryngoplasty

Karen B. Zur

Indications

1. Vocal fold paralysis/immobility resulting in aspiration or dysphonia.
2. Glottic insufficiency resulting in aspiration or dysphonia.

Relative Contraindication

Medical contraindication to anesthesia

Preoperative Evaluation

1. If the etiology of the vocal fold immobility is unclear (i.e., no known history of cardiac surgery, tumor resection, extracorporeal membranous oxygenation [ECMO], etc.), then obtain magnetic resonance imaging (MRI) of the brain, neck, and chest.
2. Medical clearance for anesthesia
3. Modified barium swallow or a functional endoscopic evaluation of swallowing (FEES) to evaluate swallowing and confirm aspiration
4. Laryngoscopy/stroboscopy to evaluate vocal fold motion
5. Discussion that the injection is a temporary measure and that there are short-term injections and longer-term injections, lasting 2–3 months and 1–2 years, respectively.

Operative Technique

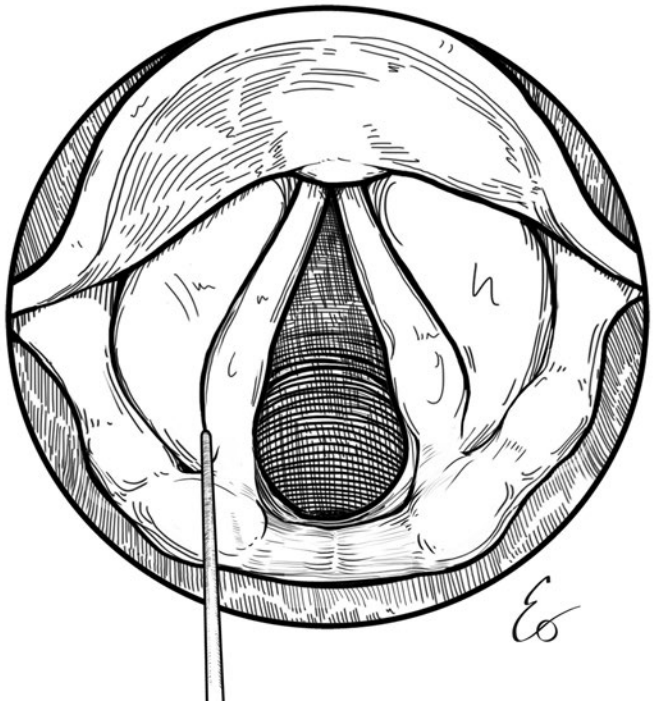
1. Informed parental consent is obtained, and the off-label use of injection material in children is discussed.
2. General anesthesia is administered; spontaneous ventilation is recommended with no indwelling endotracheal tube. Topical lidocaine, 2%, is sprayed. After the initial evaluation, a deeper plane of anesthesia may be needed to avoid laryngospasm. Insufflation can be performed via an endotracheal tube placed into the hypopharynx.
3. A suspension laryngoscope is inserted and placed either in the vallecula or in the glottic introitus, depending on the ability to properly expose the larynx.
4. A microscope is brought into view (a telescope rod can be used as well) to visualize the vocal folds. Palpate the vocal folds to assess for other lesions that may contribute to dysphonia. Palpate the interarytenoid area to rule out arytenoid fixation as an etiologic factor in the immobility that is seen.
5. A sterile-packaged injection material is utilized. Depending on the goals, short-term and long-term injection materials are available. The technique is the same regardless of the type of injection used. Fat and Gelfoam (Pfizer) injections are also possible (the preparation of those is not described here).
6. A needle is used transorally to place the injection. A long transoral needle (provided with some injection materials), a bruning syringe (pressurized syringe), or a 25-gauge butterfly needle that is grasped with a cupped forceps (make sure to cut the flanges so that it can fit through the laryngoscope) can be used.
7. Inject anterior and lateral to the affected vocal process of the arytenoid (**Fig. 26.1a**).
8. Make sure not to place the needle too deep so the material does not extrude intraluminally. Visualize the medial/inferior surface of the vocal fold to ensure no extrusion of the needle or material. You will see the plumping of the vocal fold with gentle continuous pressure of the plunger (**Fig. 26.1b**).

Discharge Instructions

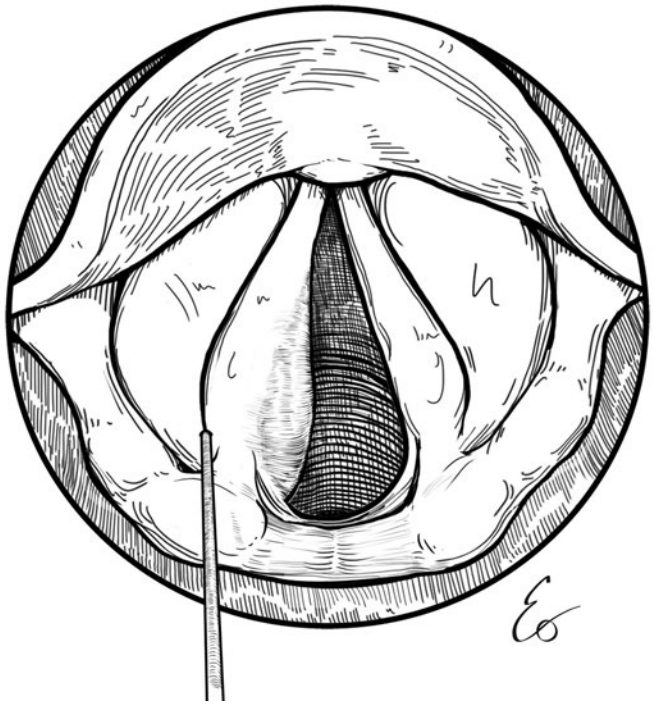
1. No significant limitations are needed.
2. No dietary restrictions are needed.
3. Remind the family that the voice will likely be more strained for the first 2 weeks after the procedure.
4. In very young children, mild stridor may be heard, although this is not commonly an issue.

Complications

1. Anesthesia
2. Lack of response of voice/swallowing to the injection
3. Fibrosis/foreign body reactions reported with some injection materials



a



b

Fig. 26.1a,b

26-2 Recurrent Laryngeal Nerve Reinnervation

Karen B. Zur

Indications

1. Persistent vocal fold paralysis after injury to the recurrent laryngeal nerve
2. Intact donor nerve

Relative Contraindications

1. Inability to identify a recurrent laryngeal nerve stump
2. Extensive neck scarring
3. High vagal injury (unknown at this time)

Preoperative Evaluation

If the etiology of the vocal fold immobility is unclear (i.e., no known history of cardiac surgery, tumor resection, ECMO, etc.), then obtain an MRI of the brain, neck, and chest.

Operative Technique

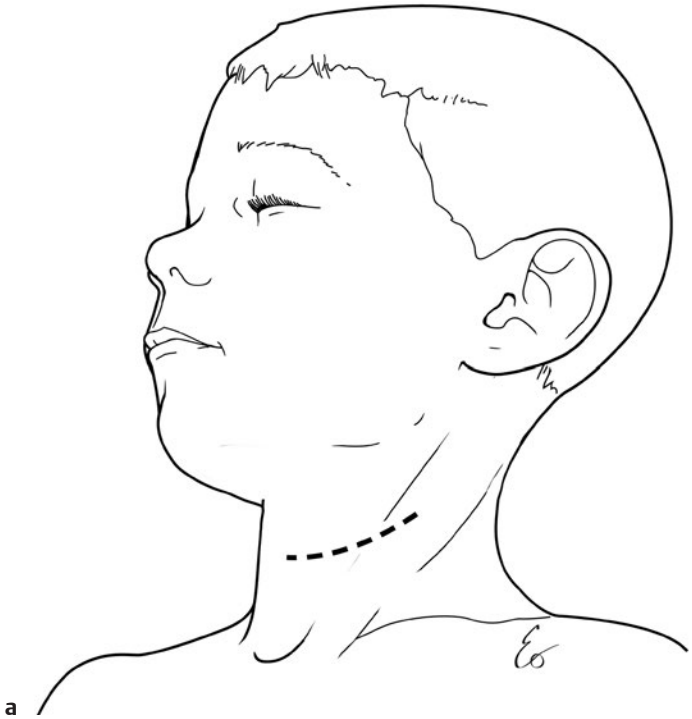
1. A laryngeal electromyography (EMG) is obtained intraoperatively to confirm the asymmetric function of the thyroarytenoid muscle (TA), supporting the clinical opinion of a persistently paralyzed vocal fold.
2. The procedure is often performed in conjunction with a temporary vocal fold injection using rapidly resorbing filler material to allow for some improvement in the quality of the voice while the reinnervation takes effect (refer to **Fig. 26.1a,b**)
3. A small shoulder role is placed. The neck is prepared and draped in standard surgical fashion.
4. No paralysis is administered.
5. A curvilinear incision is fashioned such that the midpoint of the incision would lie over the portion of the sternocleidomastoid (SCM) muscle where the omohyoid muscle crosses the carotid sheath. The incision does not need to cross over the midline of the neck (**Fig. 26.2a**).
6. A no. 15 blade is used to incise the skin, and subplatysmal flaps are elevated superiorly and inferiorly and secured to the drapes.
7. The anterior border of the SCM muscle is identified and skeletonized (**Fig. 26.2b**).
8. The omohyoid muscle is identified as it crosses over the inferior extent of the SCM and partially skeletonized in order to allow it to be retracted inferiorly (**Fig. 26.2b**).
9. The ansa cervicalis nerve is identified overlying the internal jugular vein (IJV), and its inferior loop is localized. The branches emanating from the inferior loop (i.e., the omohyoid, sternohyoid, and sternothyroid branches) are identified and preserved (**Fig. 26.2c**).
10. If in doubt, a hand-held nerve stimulator can be used to stimulate the branches of the ansa cervicalis. Look for strap muscle twitches.
11. Next, attention is shifted to identifying the recurrent laryngeal nerve (RLN) as it courses in the tracheoesophageal groove.
12. Elevate the strap muscles from the thyroid gland and retract the muscles laterally (**Fig. 26.2c,d**).
13. Identify the inferior pole of the ipsilateral thyroid gland and dissect inferiorly/distally to it to localize the RLN (**Fig. 26.2d**).
14. If dissection does not allow for easy identification of the nerve, find the superior thyroid pole, and after ligating the vessels at its superior extent, reflect the superior pole inferiorly and medially to identify the RLN near the cricothyroid joint (CTJ). Be careful to avoid damage to the parathyroid glands.
15. Approximately 1–2 cm of RLN is needed for tension-free rotation and anastomosis.
16. Next, the anastomosis will take place. Create a tunnel between the two compartments by elevating the strap muscles. Use a ¼-inch Penrose drain to retract the strap musculature medially and secure it to the drapes (**Fig. 26.2e,f**).
17. Determine which of the ansa cervicalis branches has the best size match to the caliber of the RLN, and transect that branch at a distal portion of it, allowing for tension-free rotation and anastomosis with the RLN (**Fig. 26.2e,f**).
18. Transect the RLN distally, again, allowing for tension-free arc rotation toward the lateral neck (**Fig. 26.2e,f**).
19. Use a sterile-draped microscope to perform the neurorrhaphy.
20. A BV100-4 9-0 monofilament nylon suture is used to approximate the epineurium at two points approximately 180 degrees apart. Microinstruments are utilized (**Fig. 26.2g**).
21. Lay the anastomosed nerves in a natural position under the strap muscles and remove the Penrose drain.
22. Optional: Place a Penrose drain superficial to the strap muscle tunnel. (No drain needed in most cases.)
23. Reapproximate the strap muscles and SCM with 4-0 Vicryl suture (Ethicon) in an interrupted fashion (**Fig. 26.2h**).
24. Reapproximate the platysma muscle with a 4-0 Vicryl suture in an interrupted fashion.
25. Skin closure is performed with 5-0 Monocryl suture (Ethicon), subcuticular closure.
26. Discharge home on day of surgery unless a drain was needed.

Discharge Instructions

1. No significant limitations are needed.
2. No dietary restrictions are needed.
3. Remind the family that the voice will likely begin to worsen about 2 months postop once the injection material resorbs, and then will hopefully gain more power at least 3 months postoperatively when the reinnervation begins to take effect.

Complications

1. Wound infection
2. Lack of improvement of the voice
3. Airway obstruction



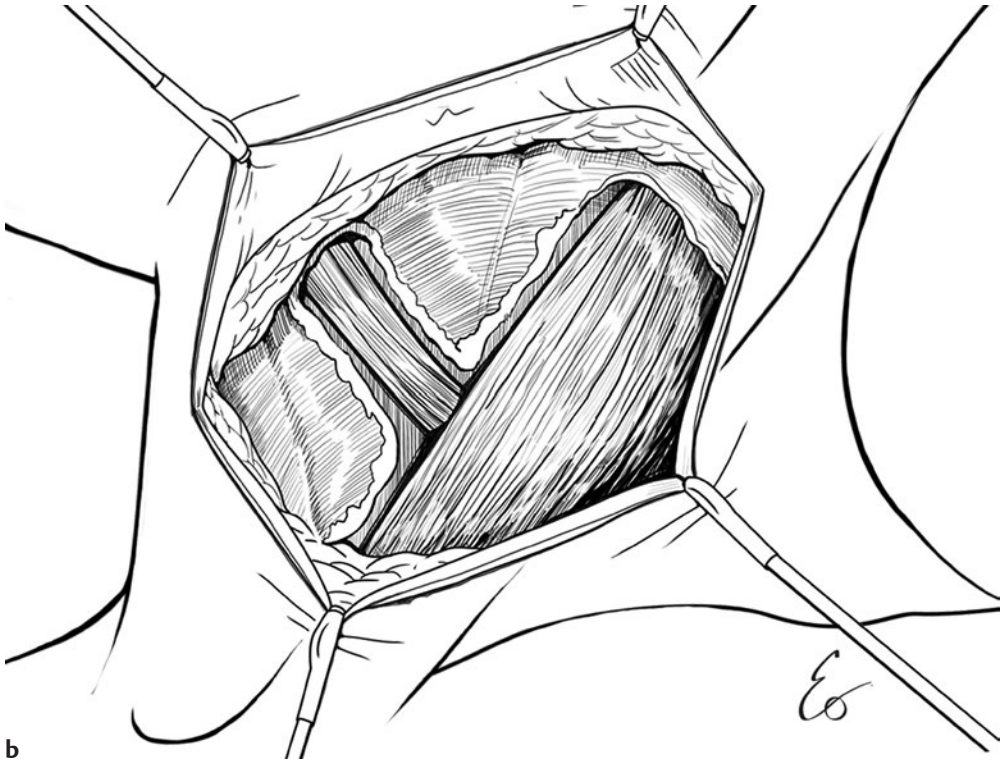
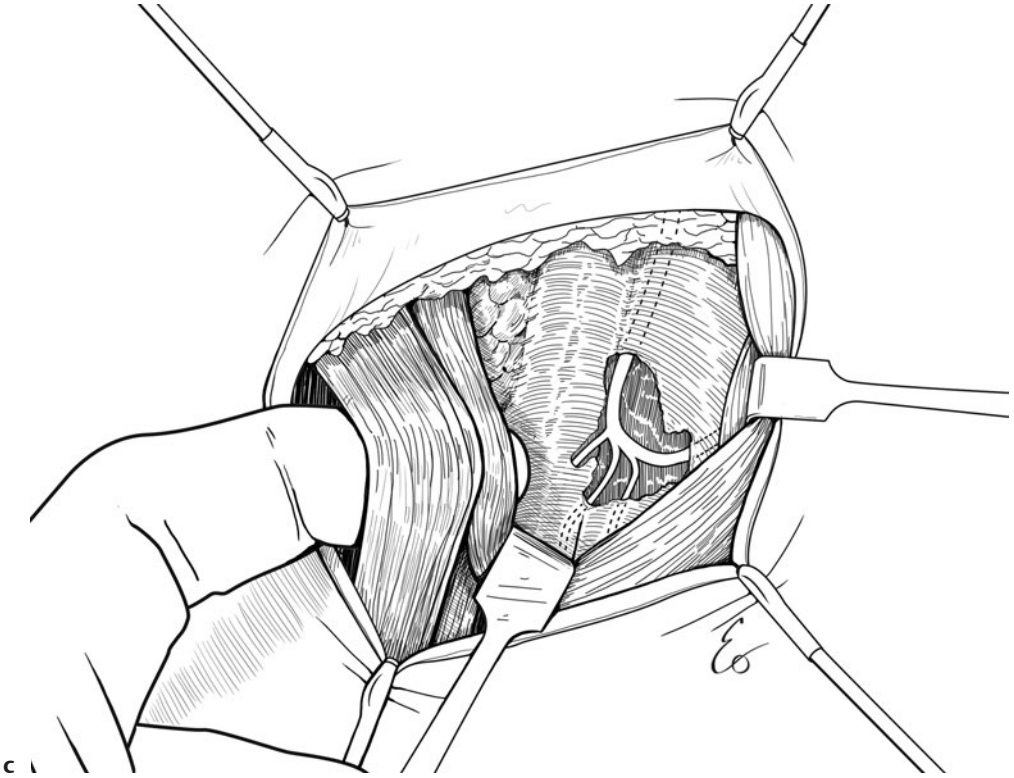
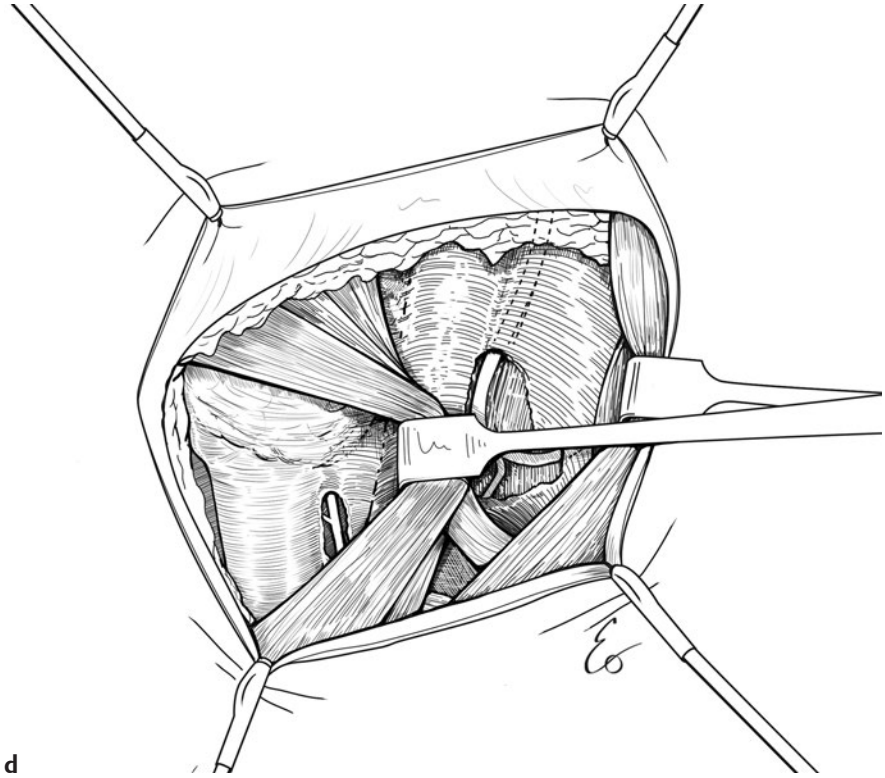


Fig. 26.2a,b

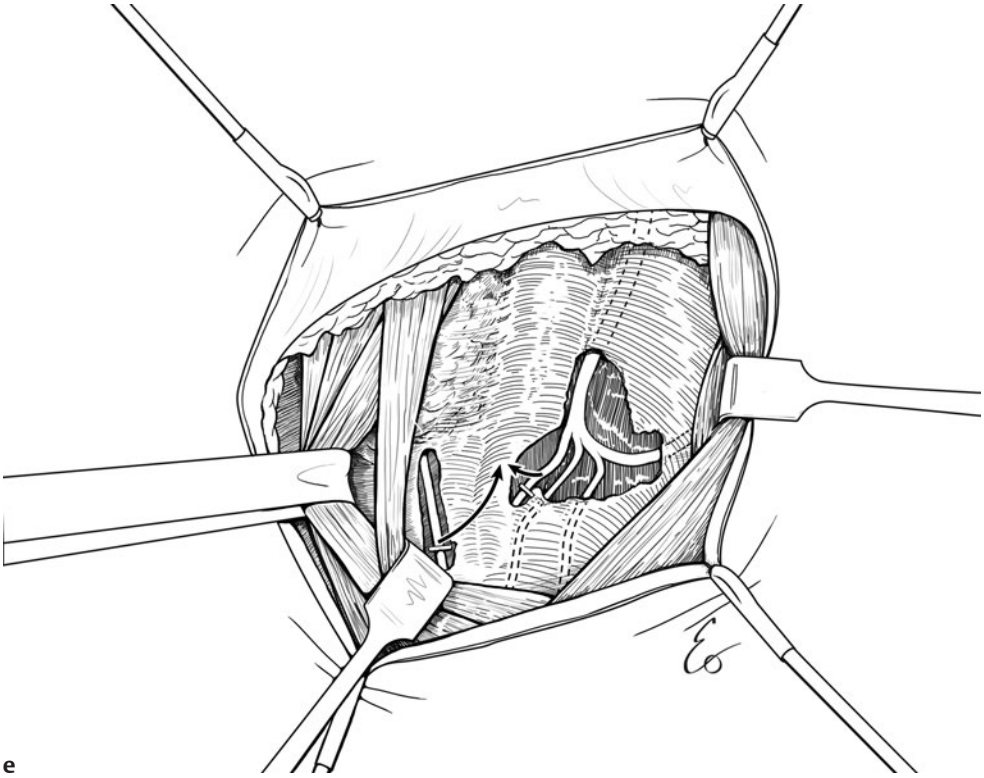


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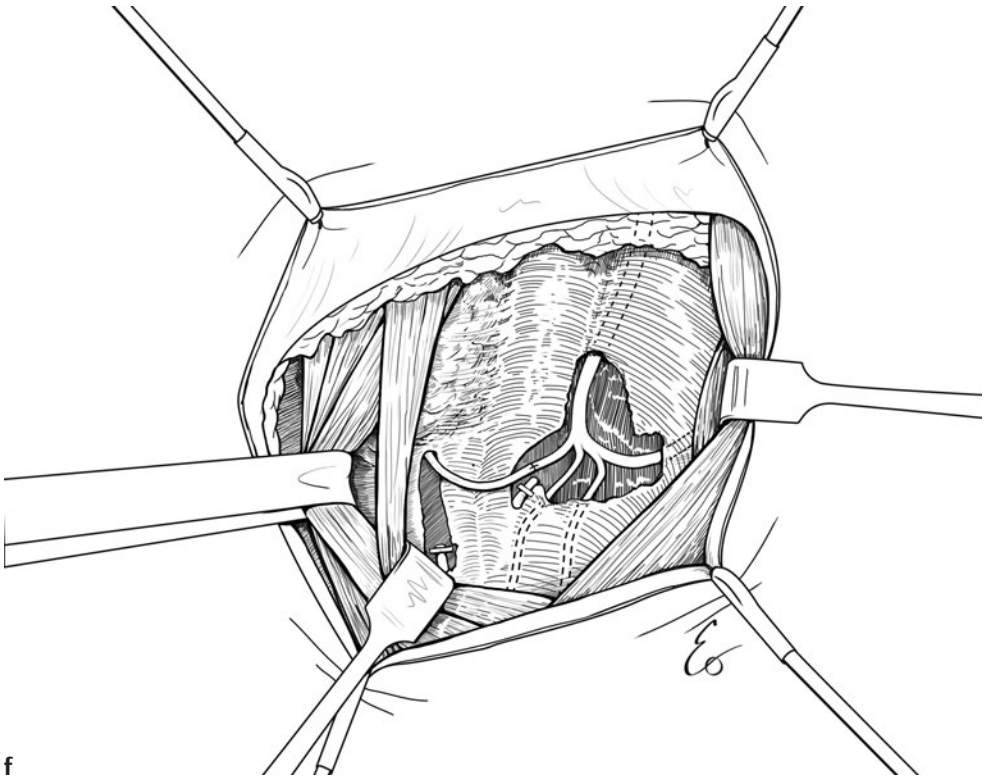


d

Fig. 26.2c,d

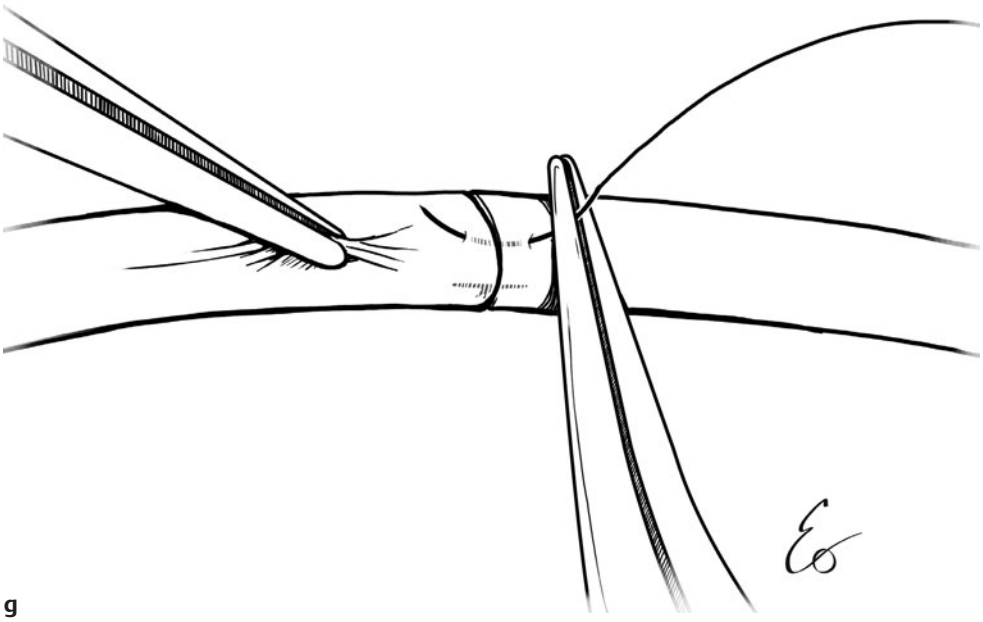


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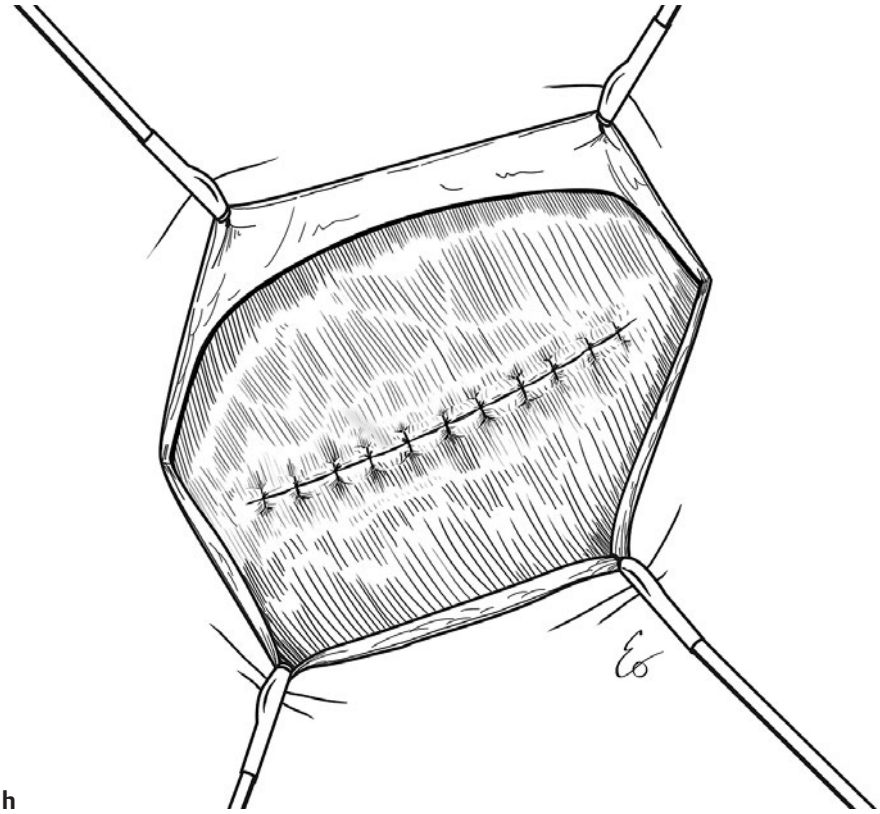


f

Fig. 26.2e,f



g



h

Fig. 26.2g,h

26-3 Laryngotracheal Separation

Steven E. Sobol

Introduction

Laryngotracheal separation is a rarely performed procedure that serves as a definitive management option for severe, intractable aspiration secondary to laryngeal incompetence.

Indications

Laryngotracheal separation is indicated for severe, life-threatening aspiration and for progressive pulmonary complications. Given that the procedure results in the complete loss of voice, it should only be considered when alternative medical and surgical options have been exhausted.

Preoperative Evaluation

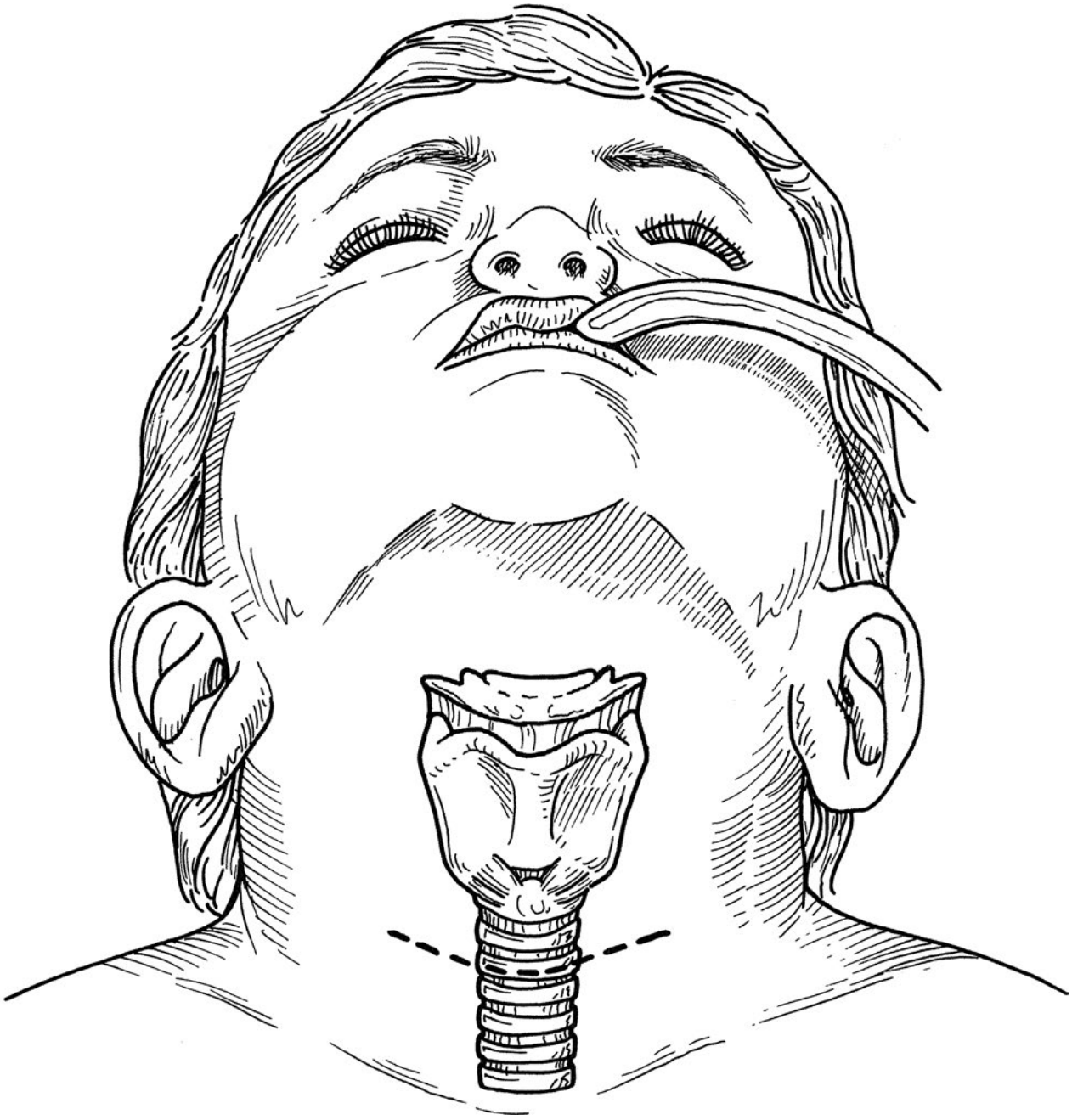
Office evaluation of patients with aspiration should include a head and neck history and physical examination, focusing on vocal quality, airway complaints, and feeding issues. A multidisciplinary evaluation is paramount and should include assessments from pulmonology, gastroenterology, speech therapy, respiratory therapy, social work, and occasionally neurology. Flexible fiberoptic laryngoscopy should be performed, assessing laryngeal structure and function. Aspiration should be confirmed by modified barium swallow and/or a functional endoscopic evaluation of swallowing. Reflux management, aggressive swallow therapy, and alternate feeding strategies are indicated prior to surgical consideration.

Operative Technique

1. Laryngeal diversion is performed using general anesthesia with an endotracheal tube in place.
2. The patient is positioned on a shoulder roll with the neck extended as for tracheotomy (see Section 25-1).
3. A horizontal skin incision is made halfway between the cricoid and the sternal notch (**Fig. 26.3a**). One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
4. Subcutaneous fat and tissue are reflected with a clamp, exposing the deep cervical fascia overlying the strap muscles, and ribbon retractors are placed to expose the field as well as stabilize the trachea in the midline (**Fig. 26.3b**); 3-0 silk sutures may be used to stabilize the superior flap.
5. Vertical dissection with a scissors and clamp in the midline is carried out until the trachea is exposed. After the trachea is exposed, the strap muscles are separated in the midline to expose the cricoid and thyroid cartilage (**Fig. 26.3c**).
6. The trachea is transected between the fourth and fifth rings horizontally, sloping the incision superiorly (**Fig. 26.3d**).
7. The oral endotracheal tube is removed, and a reinforced endotracheal tube with a microcuff is placed into the stoma to facilitate ventilation during the completion of the operation.
8. The trachea is mobilized inferiorly from the tracheoesophageal septum (**Fig. 26.3e**).
9. The anterior edge of the trachea is sutured to the inferior edge of the skin incision with 4-0 Prolene suture (Ethicon) (**Fig. 26.3f**).
10. The upper stump of the trachea is mobilized from the tracheoesophageal septum and then closed with 3-0 Prolene suture, creating a blind pouch (**Fig. 26.3g**).
11. A Penrose drain is placed in the wound.
12. The subcutaneous tissues are closed with 4-0 interrupted Vicryl, and the skin is closed with 4-0 running subcuticular Vicryl. The central portion of the upper skin flap is sutured to the posterior tracheostoma with 4-0 interrupted Prolene (**Fig. 26.3h**).
13. The endotracheal tube is removed from the newly created stoma, and an appropriate-sized tracheostomy tube is secured in place (**Fig. 26.3i**).

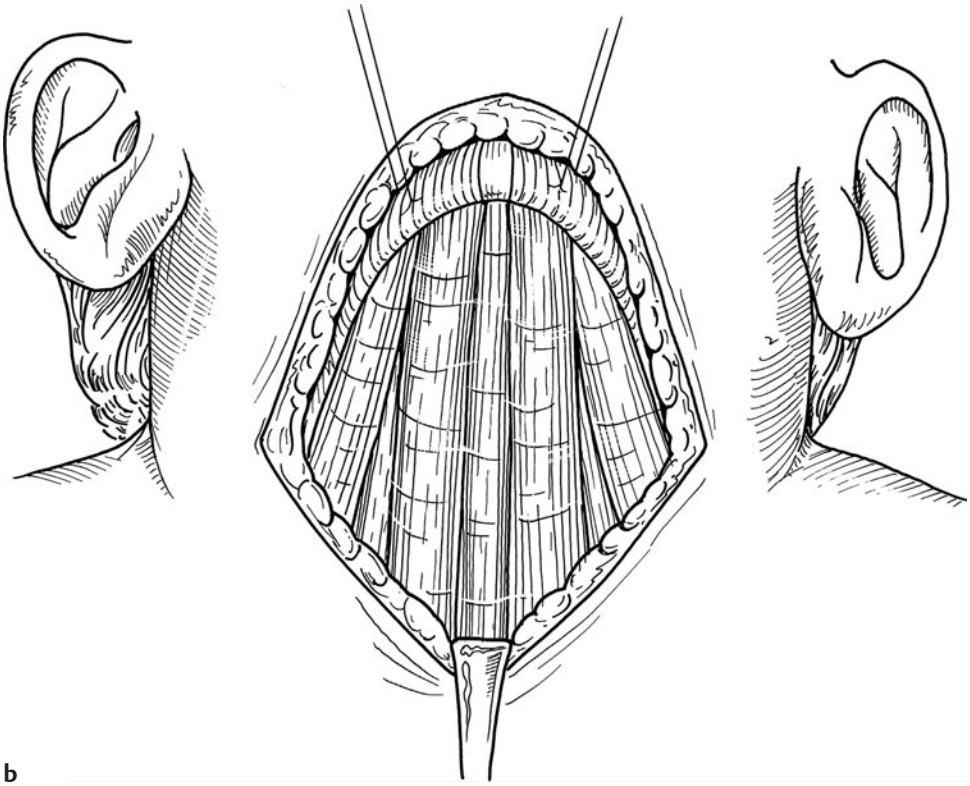
Complications

1. Tracheocutaneous fistula
2. Recurrent aspiration through a persistent fistula
3. Wound infection
4. Hematoma
5. Seroma

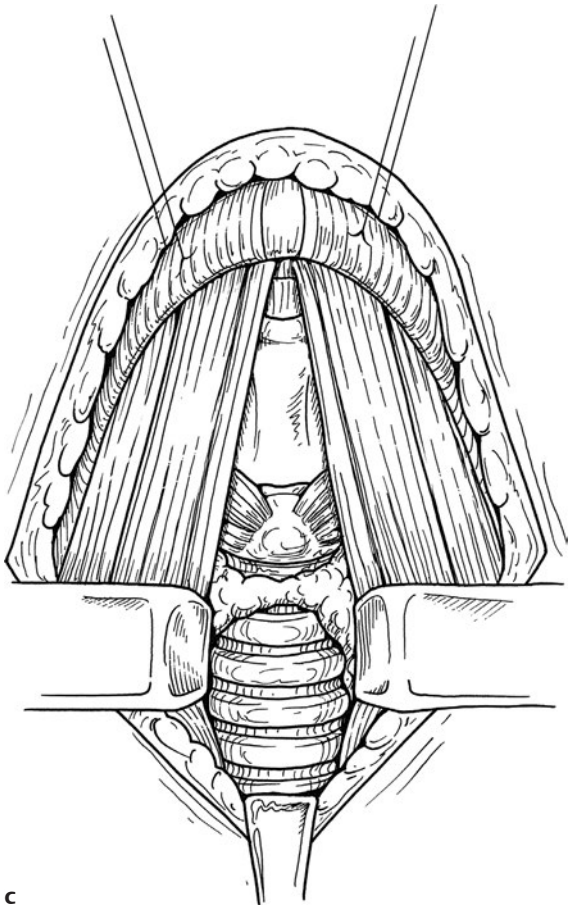


a

Fig. 26.3a

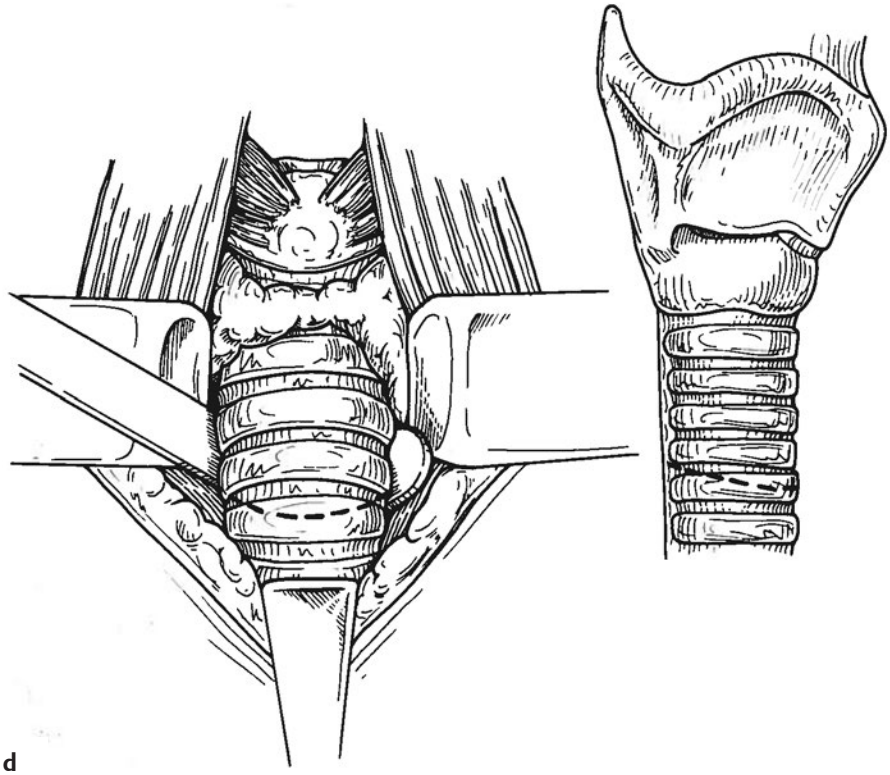


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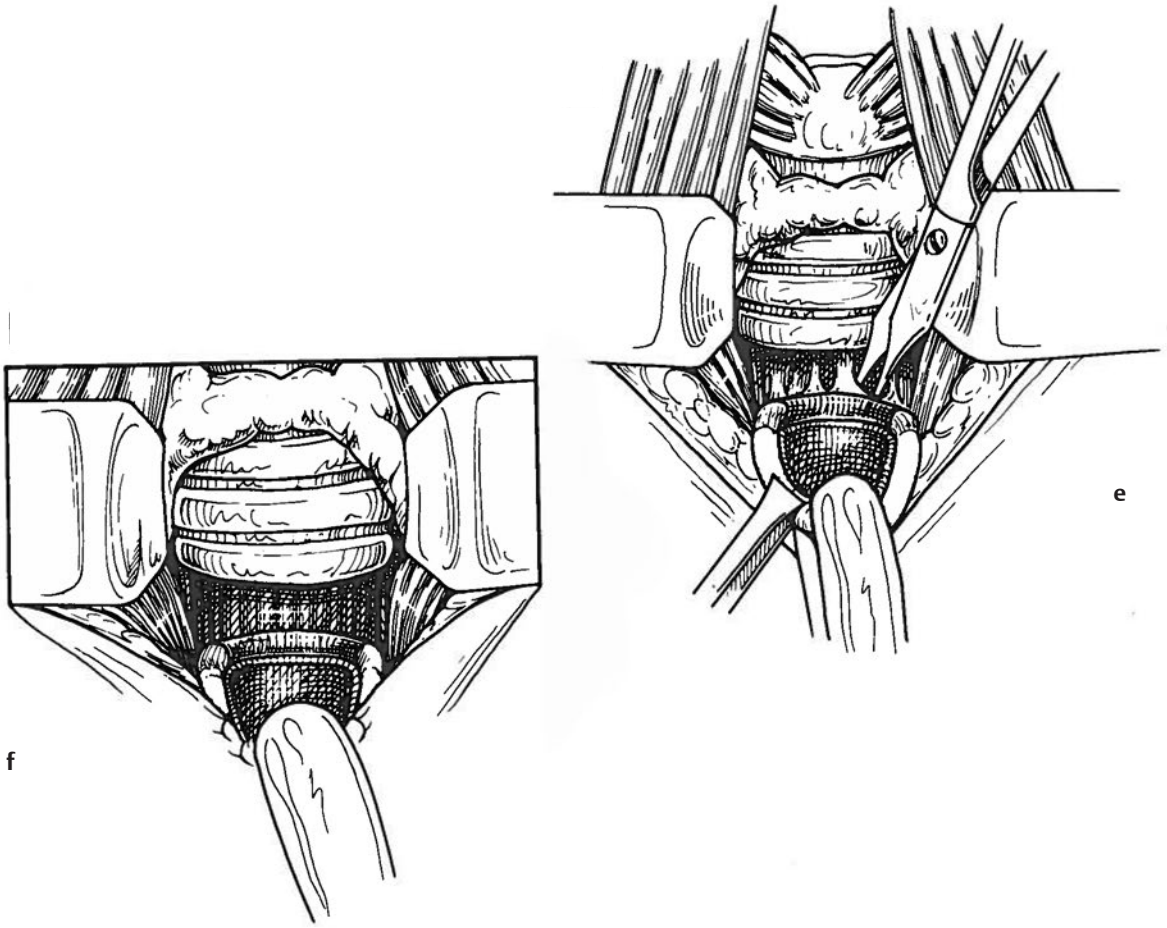


c

Fig. 26.3b,c



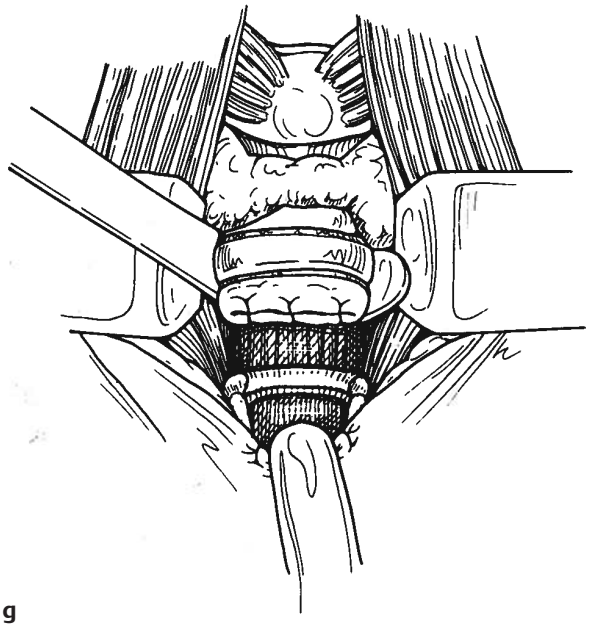
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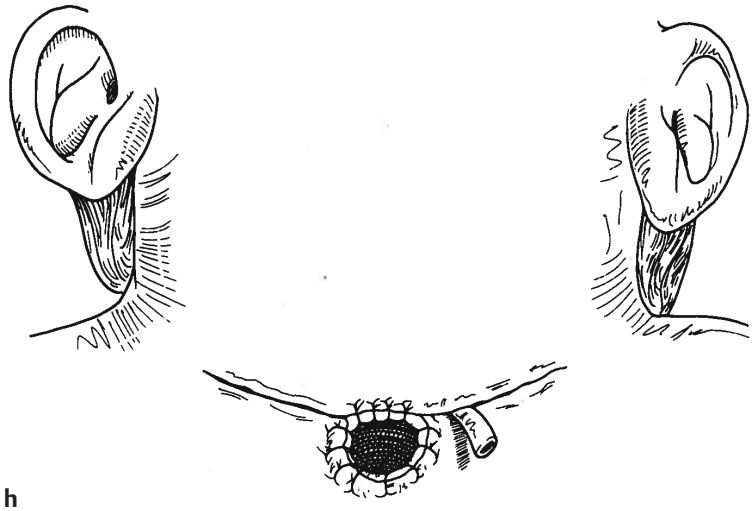
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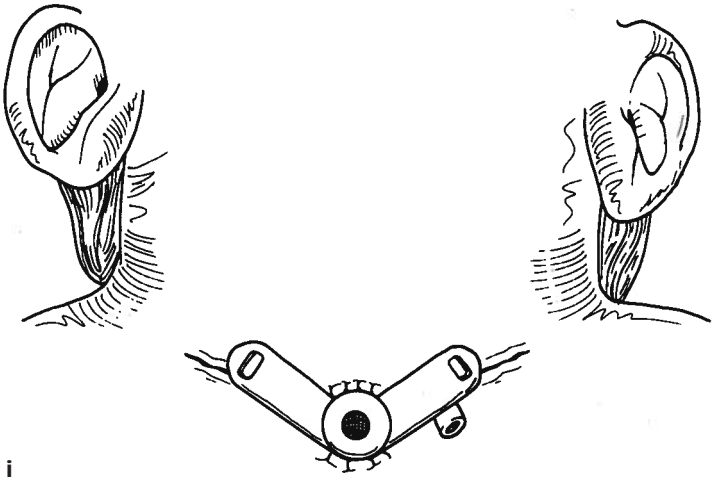
Fig. 26.3d,e,f



g



h



i

Fig. 26.3g,h,i

26-4 Excision of Laryngeal Papillomas, Polyps, and Granulomas

Steven E. Sobol

Introduction

Laryngeal papillomas are rare, benign tumors that occur rarely in children and are the result of mucosal infection with the human papillomavirus (HPV). Laryngeal polyps and granulomas are inflammatory lesions that arise in the larynx secondary to trauma (usually intubation) and/or reflux.

Indications

Laryngeal papillomas are frequently recurring lesions that require excision when they cause dysphonia and/or airway obstruction. Laryngeal polyps and granulomas rarely require excision. Surgery may be considered for symptomatic lesions that fail to respond to voice therapy, reflux management, and vocal hygiene measures.

Preoperative Evaluation

Office evaluation of patients with these benign laryngeal lesions should include a head and neck history and physical examination, focusing on vocal quality and airway complaints. Flexible fiberoptic laryngoscopy should be performed, assessing laryngeal structure and function. Reflux management and/or voice therapy are often indicated and may be complementary to surgery.

Operative Technique

1. After induction of general anesthesia, spontaneous ventilation is maintained using appropriate anesthetic technique. Alternatively, the procedure may be performed using apneic technique with intermittent endotracheal intubation.
2. An appropriately sized Lindholm laryngoscope is inserted into the vallecula and suspended, exposing the larynx (**Fig. 26.4a,b**).
3. Visualizing through the operative microscope, the lesion is excised using a laryngeal microdebrider skimmer blade, taking care to preserve the underlying normal tissue. Alternatively, a CO_2 laser may be used (standard laser precautions need to be applied) (**Fig. 26.4c**).
4. Occasionally, a biopsy is indicated in order to assess for laryngeal dysplasia. A cup forceps is used to obtain the specimen.
5. Hemostasis, if necessary, is obtained by the application of oxymetazoline-soaked pledgets (**Fig. 26.4d**).
6. If tracheobronchial disease is suspected, a rigid telescope may be used to assess the distal airway. Tracheobronchial papillomas may be removed using a longer microdebrider blade under telescopic guidance.

Complications

1. Laryngeal scar
2. Recurrence of the lesion
3. Voice dysfunction
4. Airway obstruction
5. Injury to the oral cavity, oropharynx, or airway
6. Pneumonia
7. Pneumothorax
8. Laser-induced burns or fire

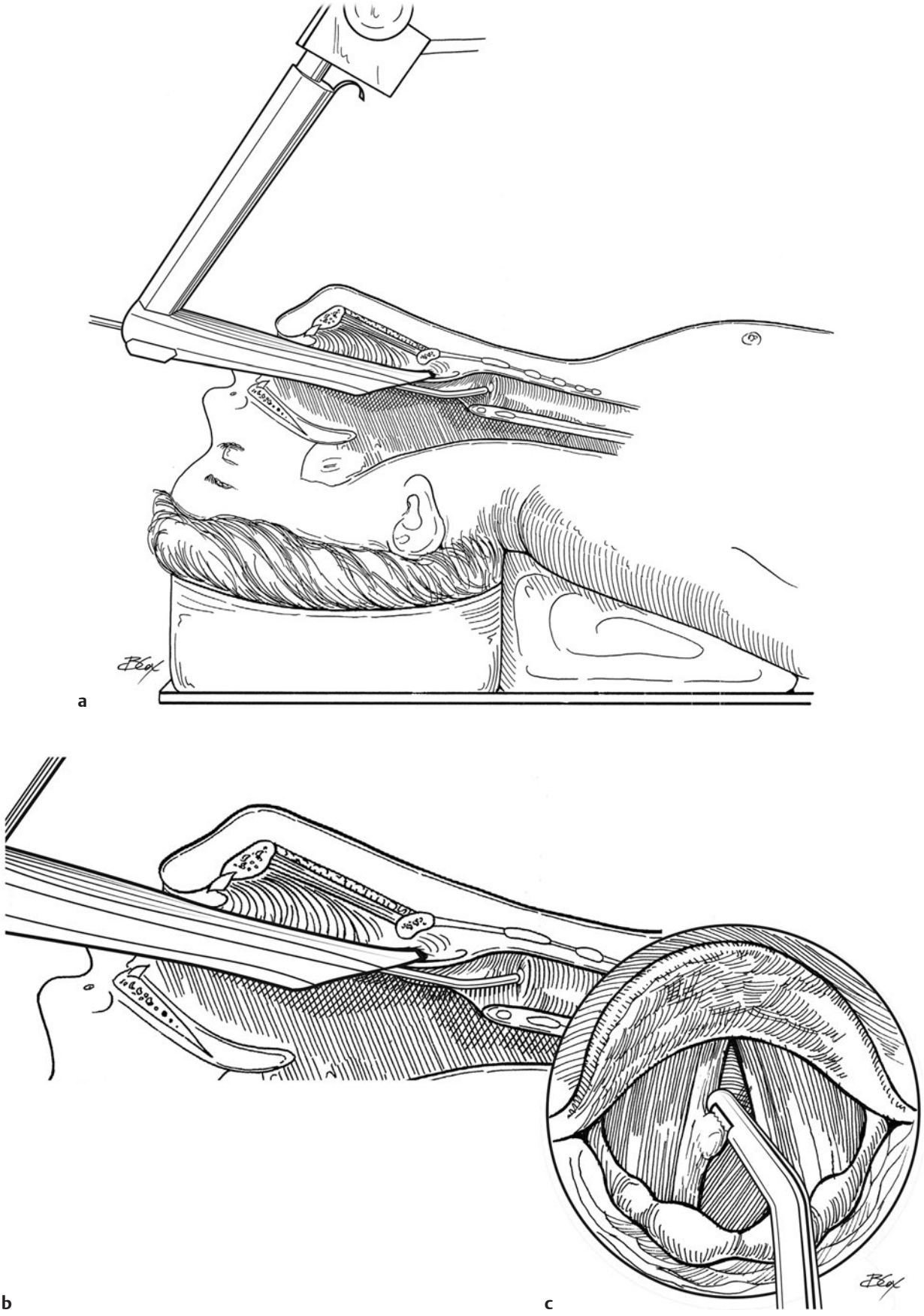
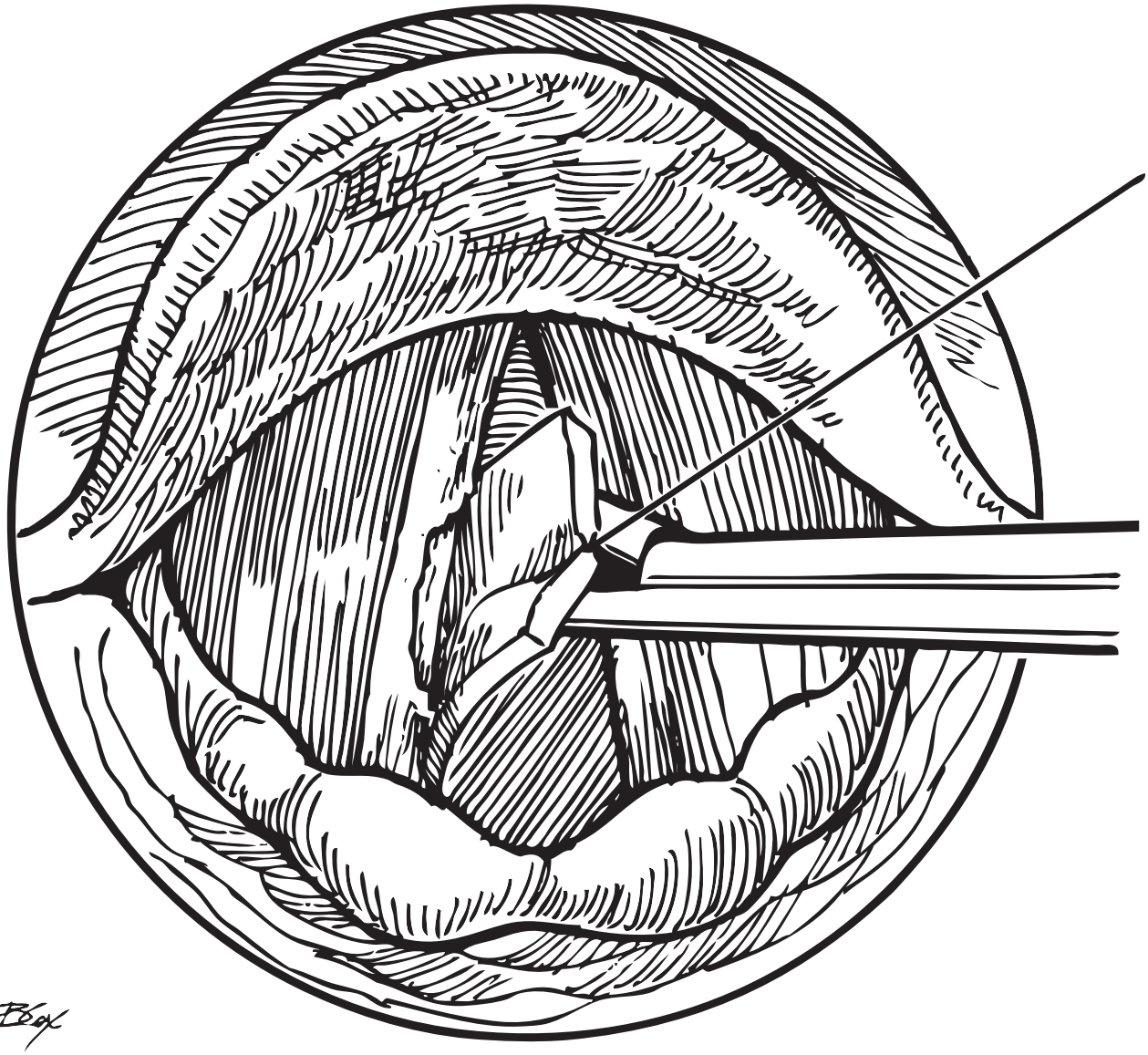


Fig. 26.4a,b,c



d

Fig. 26.4d

26-5 Excision of Subglottic Cysts

Steven E. Sobol

Introduction

Subglottic cysts are uncommon lesions usually presenting in children who have had a prior history of intubation. Commonly, subglottic cysts present with coexisting subglottic stenosis. Subglottic cysts may be single or multiple.

Indications

Subglottic cysts require excision or marsupialization when they cause airway obstruction.

Preoperative Evaluation

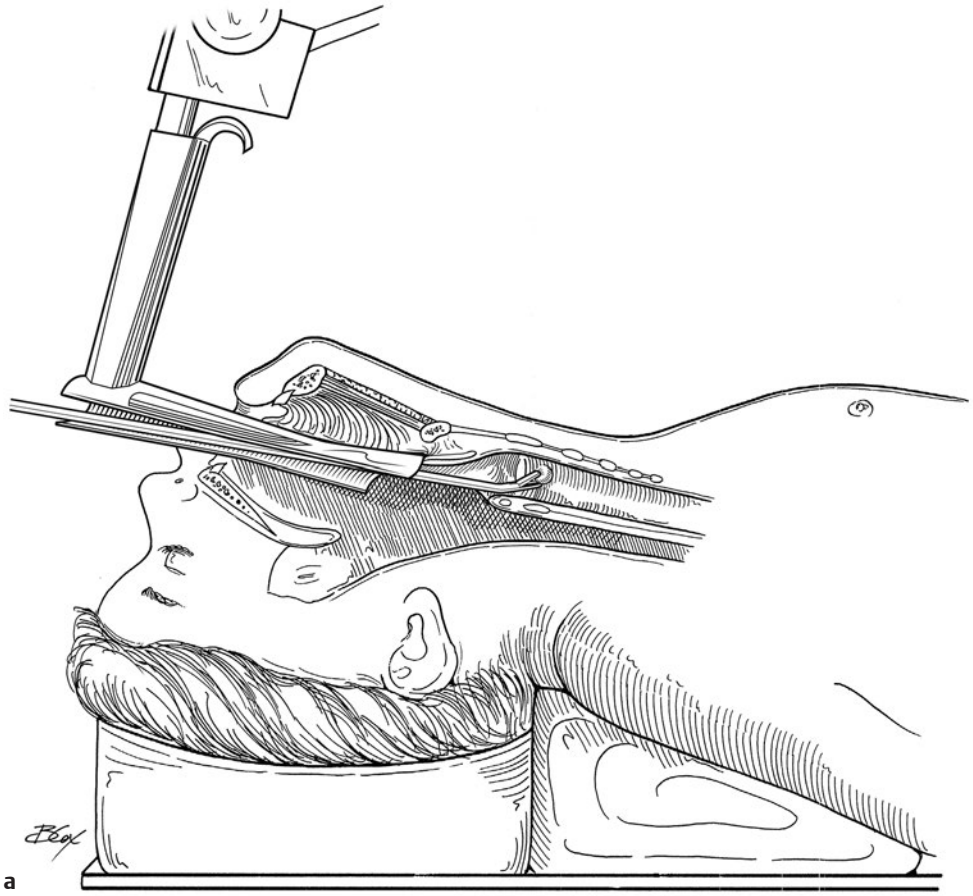
Office evaluation of patients with subglottic cysts should include a head and neck history and physical examination, focusing on airway complaints. Patients typically present with a variable degree of biphasic stridor, which may be exacerbated when the patient develops an upper respiratory tract infection or when crying. Flexible fiberoptic laryngoscopy should be performed, assessing laryngeal structure and function. Reflux management is often indicated and may be complimentary to surgery.

Operative Technique

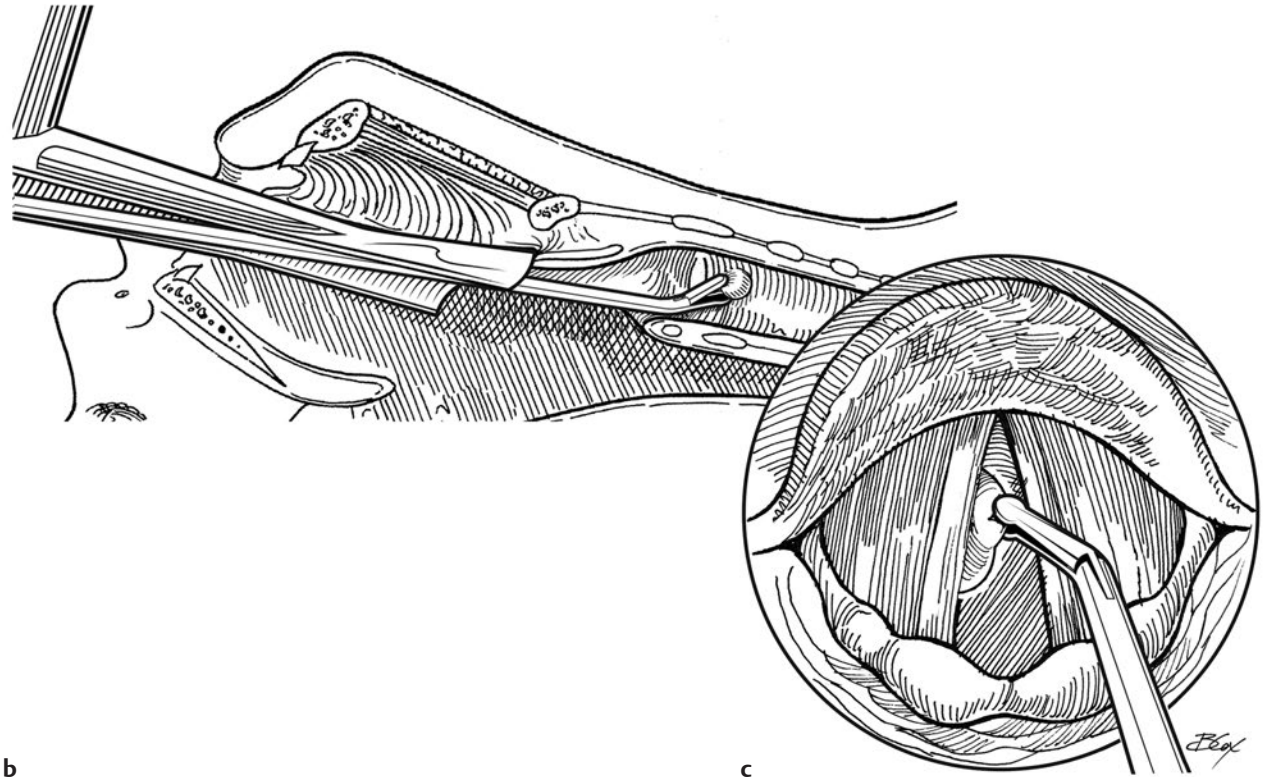
1. After induction of general anesthesia, spontaneous ventilation is maintained using appropriate anesthetic technique. Alternatively, the procedure may be performed using apneic technique with intermittent endotracheal intubation.
2. An appropriately sized Benjamin laryngoscope is inserted into the vallecula and suspended, exposing the larynx (**Fig. 26.5a**).
3. Visualizing through the operative microscope or 0-degree telescope, the cyst is unroofed using a cup forceps (**Fig. 26.5b,c**). The lesion may be further excised using a laryngeal microdebrider skimmer blade, taking care to preserve the underlying normal tissue. Alternatively, a CO_2 laser may be used to marsupialize the lesion (standard laser precautions need to be applied).
4. If the patient has coexisting subglottic stenosis, dilatation using an appropriate sized balloon may be performed.
5. Hemostasis, if necessary, is obtained by the application of oxymetazoline-soaked pledgets.
6. If tracheobronchial disease is suspected, a rigid telescope may be used to assess the distal airway.

Complications

1. Laryngeal scar
2. Recurrence of the lesion
3. Voice dysfunction
4. Airway obstruction
5. Injury to the oral cavity, oropharynx, or airway
6. Pneumonia
7. Pneumothorax
8. Laser-induced burns or fire



a



b c

Fig. 26.5a,b,c

26-6 Balloon Laryngoplasty

Steven E. Sobol

Introduction

Subglottic stenosis is an uncommon complication, occurring in children who have had a prior history of intubation. Balloon dilatation is an endoscopic technique used to apply radial force in an effort to expand the narrowed airway.

Indications

Balloon laryngoplasty is indicated for patients with acquired subglottic stenosis presenting with signs and symptoms of airway obstruction. The technique may also be used to address restenosis in patients who have undergone laryngotracheal reconstruction. Balloon laryngoplasty is often performed with adjunctive procedures, including division of scar tissue, topical application of mitomycin C, or removal of granulation tissue or cysts.

Preoperative Evaluation

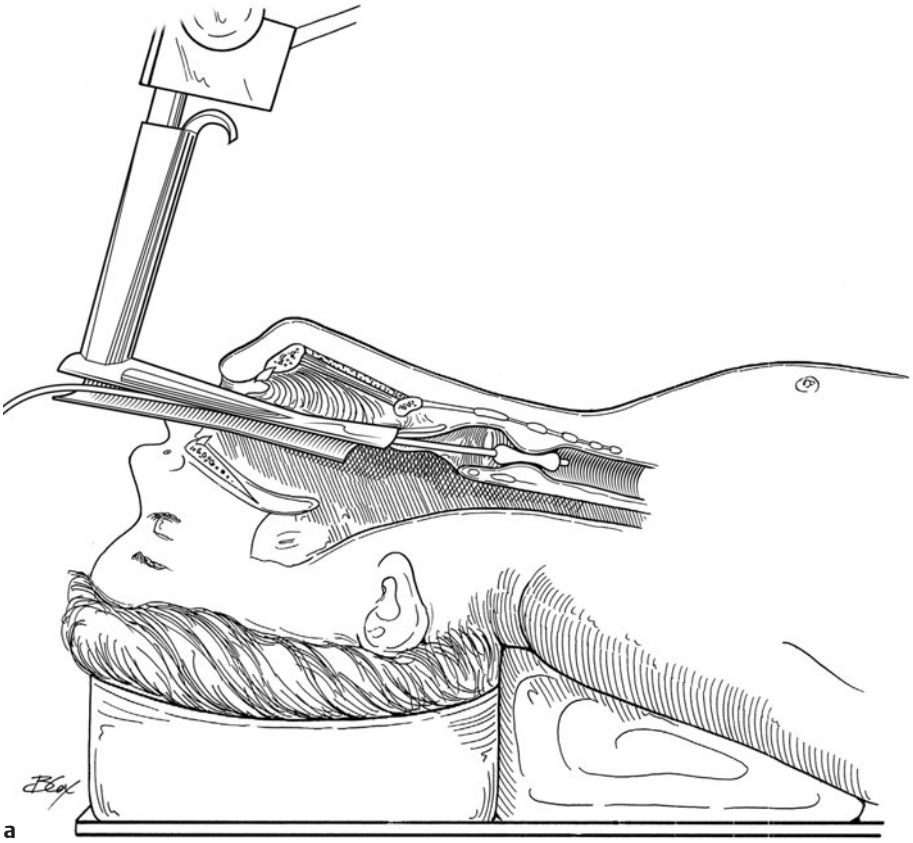
Office evaluation of patients with subglottic stenosis should include a head and neck history and physical examination, focusing on airway complaints. Patients typically present with a variable degree of biphasic stridor, which may be exacerbated when the patient develops an upper respiratory tract infection or when crying. Flexible fiberoptic laryngoscopy should be performed, assessing laryngeal structure and function. Reflux management is often indicated and may be complimentary to surgery.

Operative Technique

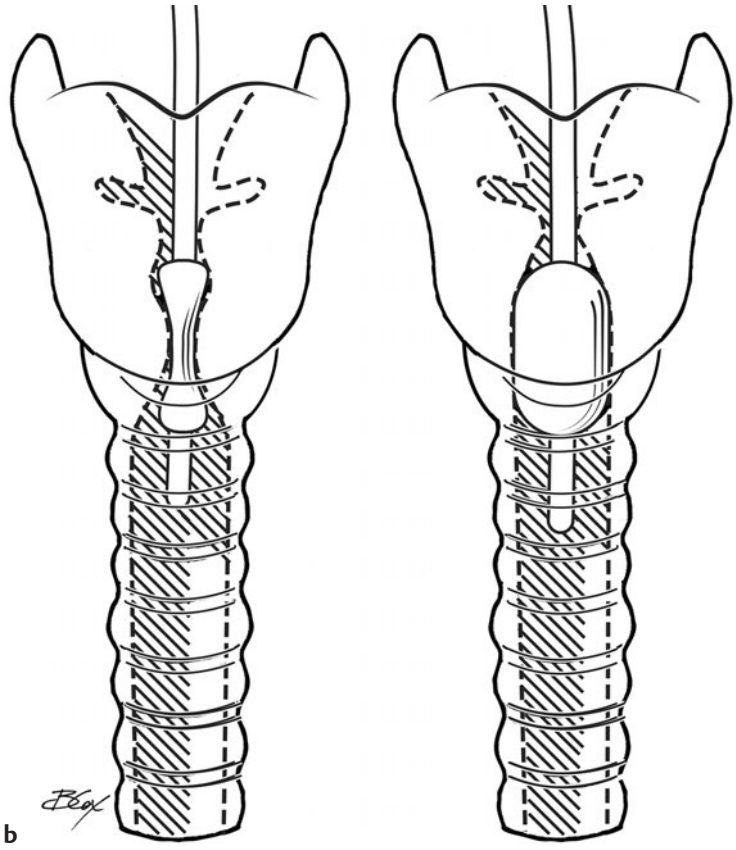
1. After induction of general anesthesia, spontaneous ventilation is maintained using appropriate anesthetic technique. Alternatively, the procedure may be performed using apneic technique with intermittent endotracheal intubation.
2. An appropriately sized Benjamin laryngoscope is inserted into the vallecula and suspended, exposing the larynx.
3. The larynx is visualized using the 0-degree telescope, and the degree of stenosis is assessed.
4. An appropriately sized balloon (5–14 mm) is selected and inserted into the stenotic segment and centered. The balloon is inflated using a syringe with a pressure gauge, with care taken to stay below the burst pressure of the balloon (indicated on the packaging). With certain balloons, oxygen may be delivered through a separate port for the duration of balloon inflation (**Fig. 26.6a,b**).
5. The balloon is deflated once the saturation drops below 92%, and the airway is reassessed with repeat dilatation, if necessary.
6. The distal airway is then evaluated using the telescope.
7. The decision to intubate or leave the patient extubated postoperatively should be individualized to the patient's needs.

Complications

1. Laryngeal scar
2. Recurrence of the stenosis
3. Voice dysfunction
4. Airway obstruction
5. Rupture of airway
6. Pneumonia
7. Pneumothorax



a



b

Fig. 26.6a,b

26-7 Repair of Laryngeal Fracture

Alessandro de Alarcon

Introduction

Laryngeal fractures in children usually occur from a direct blow to the neck resulting from a "clothesline injury" or a motor vehicle accident. Patients may arrive at the emergency department intubated, tracheotomized, without a secure airway, and with significant endolaryngeal mucosal injuries.

Indications

Displaced laryngeal fractures require treatment (i.e., reduction) to avoid laryngeal stenosis and airway obstruction.

Preoperative Evaluation

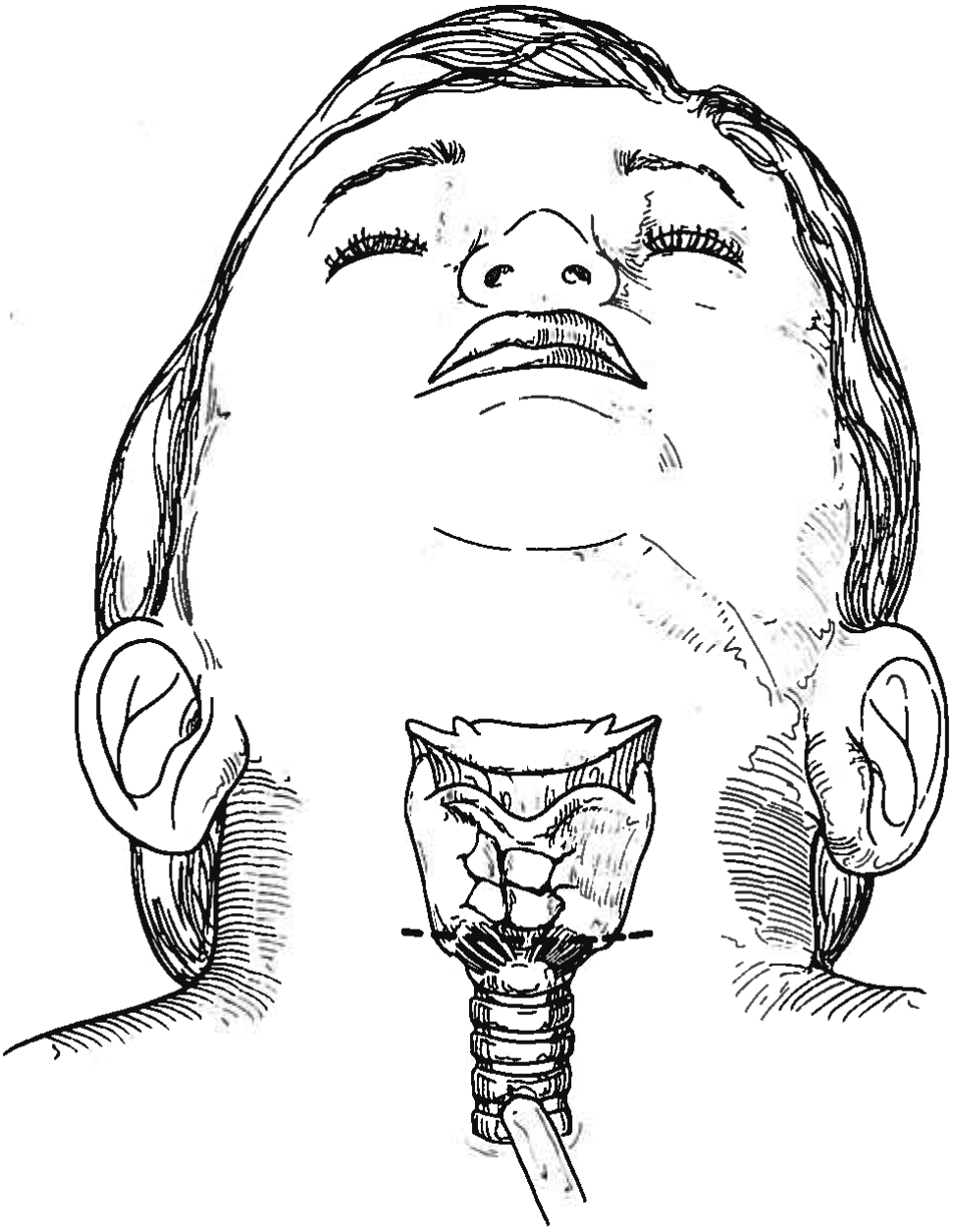
Standard cervical and chest radiographs are obtained to rule out associated injuries. Computed tomography (CT) scan of the larynx helps delineate the fractures. Flexible laryngoscopy should be performed in the awake, unintubated patient. Direct laryngoscopy and bronchoscopy define the configuration of the lumen and identify other laryngeal pathology, including vocal fold injuries, hematoma, and arytenoid dislocation.

Operative Technique

1. Reduction of a laryngeal fracture is performed under general anesthesia administered either through an endotracheal tube or an oral RAE tube placed in a tracheostoma.
2. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
3. A transverse incision is made at the level of the cricothyroid membrane down to the strap muscles (**Fig. 26.7a**).
4. A superior skin flap is elevated to the level of the hyoid bone. An inferior skin flap is elevated, exposing the strap muscles over the upper trachea (**Fig. 26.7b**).
5. The midline fascia is divided and the strap muscles are retracted laterally with 4-0 silk suture clamped with a hemostat; the thyroid lamina, cricoid cartilage, and trachea are thereby exposed (**Fig. 26.7c**).
6. Depressed thyroid cartilage fragments are aligned with a Cottle elevator (**Fig. 26.7c**).
7. If significant mucosal injury or vocal fold injuries were noted on endoscopy, a complete laryngofissure should be performed to expose these areas. Wounds should be reapproximated using absorbable polydioxanone (PDS) or Vicryl suture (4-0 or smaller).
8. The cartilage fragments are sutured in place with 4-0 PDS suture (**Fig. 26.7d**).
9. If the thyroid lamina is ossified, small holes are drilled to hold the sutures.
10. The strap muscles are reapproximated in the midline with 4-0 Vicryl suture (**Fig. 26.7e**).
11. A Penrose drain is placed in the wound, and the subcutaneous tissue is closed with 4-0 Vicryl suture (**Fig. 26.7f**).
12. The skin is closed with 4-0 Vicryl suture.
13. Patients who do not have a tracheostomy tube in place should remain intubated with an endotracheal tube for 7–10 days. If a tracheotomy is in place, the oral RAE tube is removed and replaced with a tracheostomy tube, and an age-appropriate size Rutter stent or superior limb of a cut T-tube that has been oversewn to prevent aspiration is placed in the larynx (**Fig. 26.7g**).
14. Intravenous broad-spectrum antibiotics are continued until the drains and stents are removed after 7 days. The stent is removed by direct laryngoscopy and bronchoscopy.
15. If the cricoid cartilage is fractured, displaced, and comminuted, a decision to perform a cricotracheal resection (CTR) may be indicated (see Section 25-4).
16. If present, the tracheostomy tube may be removed when the upper airway lumen is sufficient to permit normal respiration.

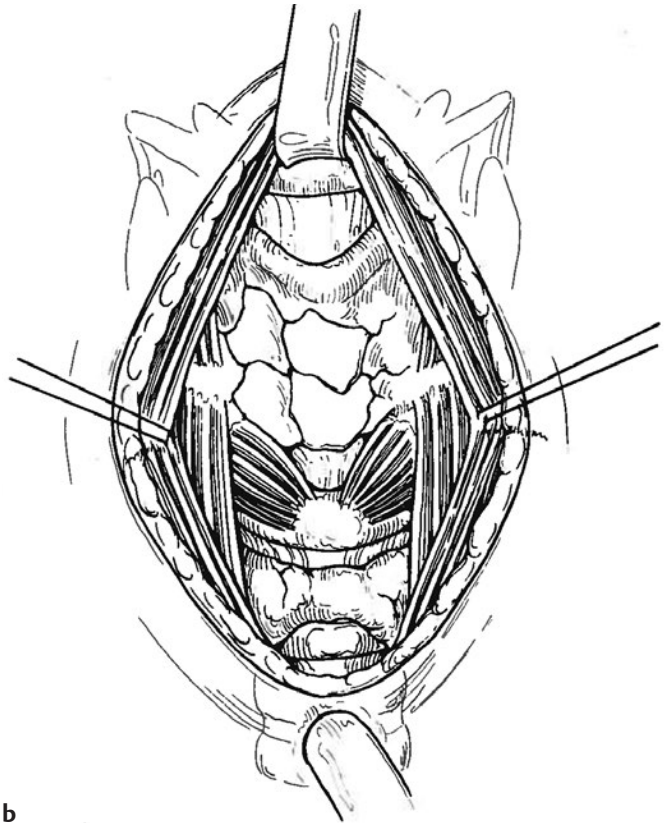
Complications

1. Laryngeal stenosis
2. Dysphagia
3. Dysphonia
4. Aspiration

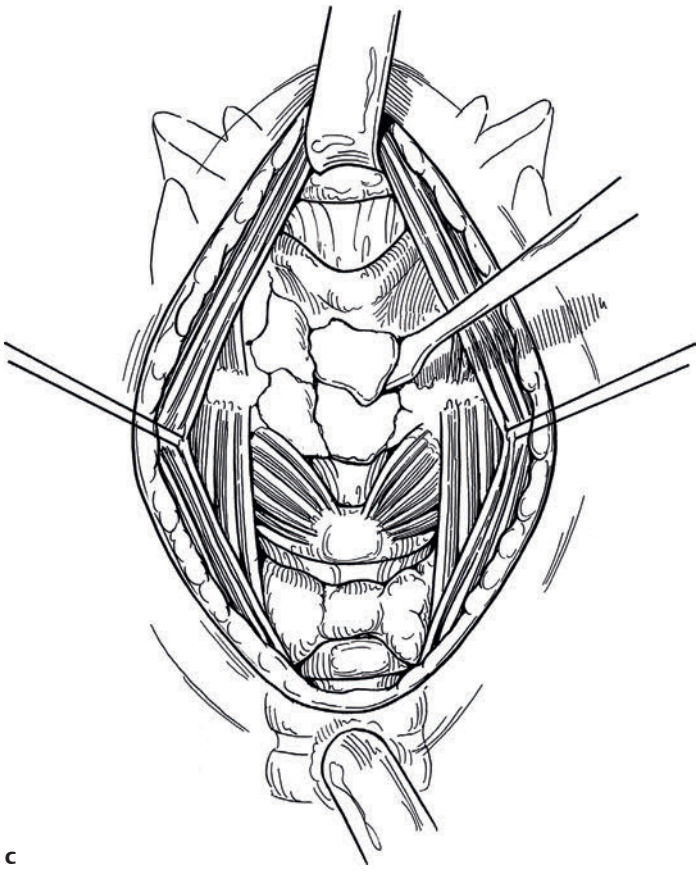


a

Fig. 26.7a

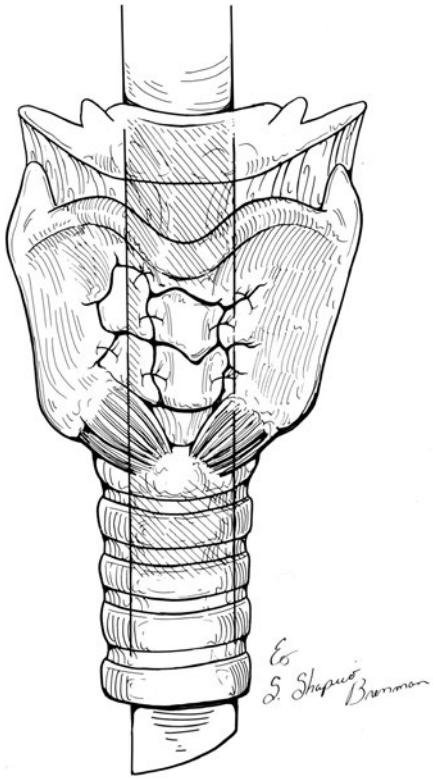


b

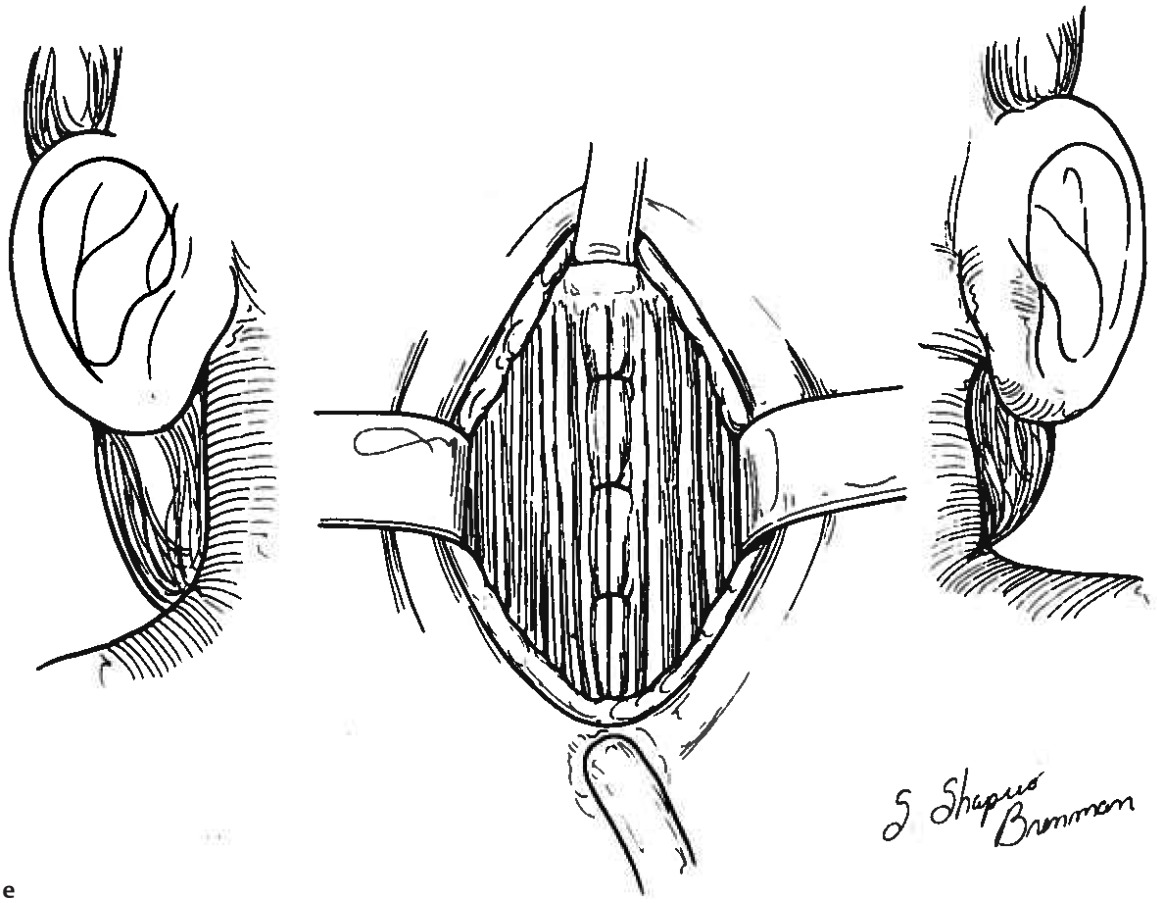


c

Fig. 26.7b,c



d

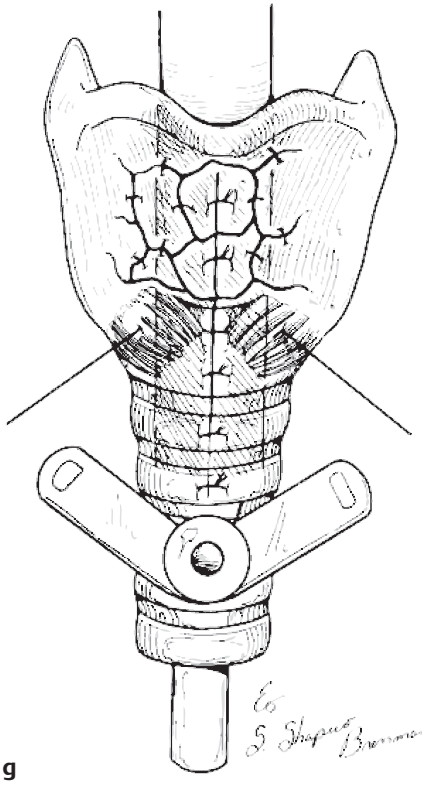


e

Fig. 26.7d,e



f



g

Fig. 26.7f,g

26-8 Laryngotracheoplasty with Thyroid Ala Graft

Steven E. Sobol

Introduction

Laryngotracheoplasty with thyroid alar cartilage graft (LTP-TAC) is a modification of the cricoid split procedure and is employed for patients with subglottic stenosis. In LTP-TAC, the expanded laryngotracheal framework is maintained with the interposition of a portion of the patient's thyroid ala. The theoretical advantage of this procedure over the cricoid split without a cartilage graft is that it maintains the expansion and prevents inadvertent displacement of the endotracheal tube through the split segment.

Indications

The LTP-TAC procedure is indicated for patients with subglottic stenosis who meet the criteria for cricoid split (**Fig. 26.8a**). The patient should theoretically be extubatable with the expanded airway, avoiding the need for tracheostomy. In some centers, LTP-TAC is occasionally employed as an alternate to standard LTP (costal cartilage graft) in patients who have mild subglottic stenosis but are tracheostomy tube–dependent. It is also offered in patients who do not require intubation but have sufficient airway compromise to require surgical intervention for subglottic stenosis.

Preoperative Evaluation

In many cases, patients require intubation in the intensive care setting. Evaluation of these patients should include an assessment for candidacy (failed extubation attempts, adequate cardiopulmonary status, and controlled reflux). Microlaryngoscopy and bronchoscopy should be performed in order to assess the status of the airway.

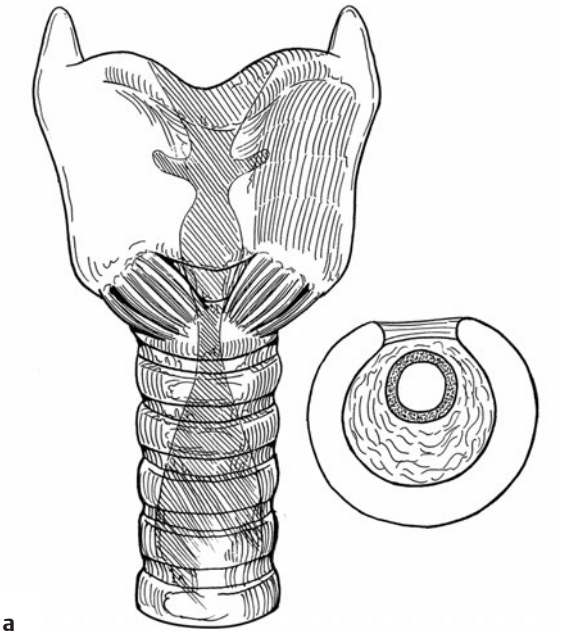
Office evaluation of patients with known subglottic stenosis should include a head and neck history and physical examination, focusing on vocal quality, swallowing, and airway complaints. A multidisciplinary evaluation is paramount and should include assessments from pulmonology, gastroenterology, speech therapy, respiratory therapy, and social work. Flexible fiberoptic laryngoscopy should be performed, assessing laryngeal structure and function. Reflux management and/or voice therapy are often indicated and may be complementary to surgery.

Operative Technique

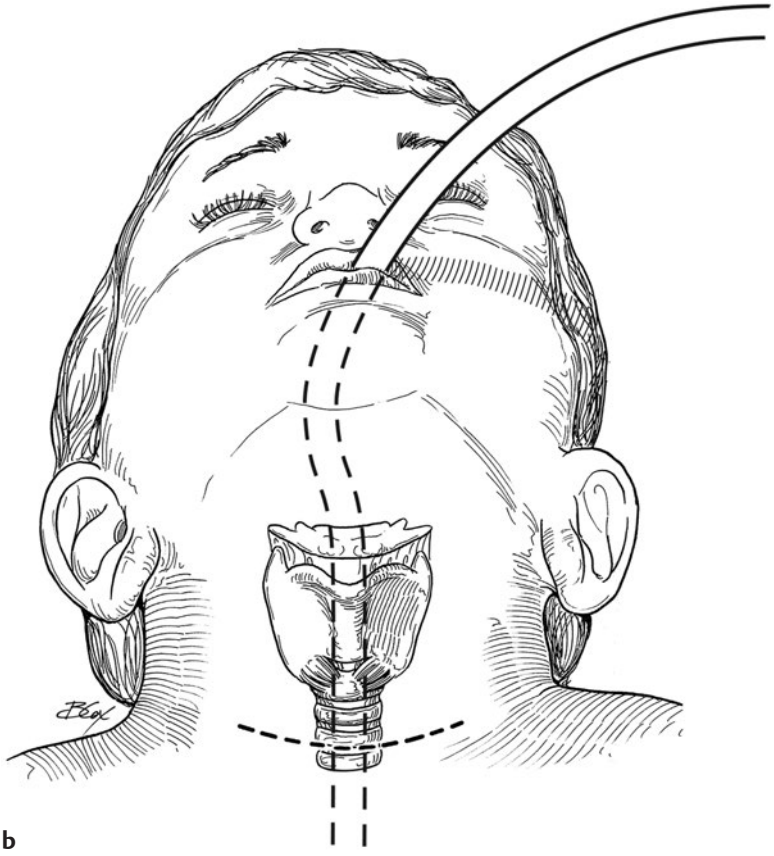
1. After induction of general anesthesia, the patient is positioned on a shoulder roll and a horizontal incision site is marked at the level of the cricoid cartilage (**Fig. 26.8b**).
2. Lidocaine (1%) with epinephrine (1:100,000) is injected into the subcutaneous tissue in order to facilitate hemostasis during the procedure.
3. The patient is then prepped and draped in order to maintain sterility during the procedure.
4. The incision is made using a no. 15 blade and carried through the platysma.
5. Superior and inferior subplatysmal flaps are then elevated using the Metzenbaum scissors and/or monopolar cautery to the level of the hyoid superiorly and to the third or fourth tracheal ring inferiorly. The flaps are secured using 3-0 silk sutures.
6. The strap muscles are divided in the midline using the Metzenbaum scissors and/or monopolar cautery, exposing the entire laryngeal framework, the thyroid gland, and the upper tracheal rings. The strap muscles may be secured using 3-0 silk sutures (**Fig. 26.8c**).
7. The thyroid gland is divided in the midline using the monopolar cautery.
8. A midline laryngotracheofissure is then performed using a fresh no. 15 blade and is to the midpoint of the thyroid ala superiorly and the upper two tracheal rings inferiorly (**Fig. 26.8d**).
9. The edges of the fissure are distracted using silk or Prolene sutures.
10. An appropriately sized nasotracheal tube is then inserted and placed with the tip beyond the fissure.
11. The upper edge of one of the thyroid ala is exposed using the tenotomy scissors and a small retractor. A 3–4 mm tear drop–shaped piece of the thyroid ala is then incised using a Beaver blade. The incised segment is carefully elevated off of the deep perichondrium using a single hook, Freer elevator, and/or scissors (**Fig. 26.8e**).
12. The graft is sutured into the laryngofissure using six to eight interrupted 4-0 or 5-0 PDS sutures (**Fig. 26.8f**).
13. A Valsalva maneuver is performed in order to assess for a leak, and Tisseel (Baxter) is occasionally applied to the suture line.
14. The strap muscles and platysmal layers are closed over a 0.25-inch Penrose drain using interrupted 4-0 Vicryl sutures.
15. The skin is closed using a running subcuticular 5-0 Monocryl suture.
16. The nasotracheal tube is secured to the columella using a 3-0 Prolene suture buttressed with a cut piece of a catheter to prevent suture erosion through the columella (**Fig. 26.8g**).
17. The drain is removed after 3 days and the patient extubated 4–7 days following the procedure. A pre-extubation endoscopy may be performed prior to extubation with exchange of the tube to an orotracheal route.

Complications

1. Recurrent subglottic stenosis
2. Voice dysfunction
3. Aspiration
4. Subcutaneous emphysema
5. Pneumonia
6. Pneumothorax
7. Endotracheal tube complications

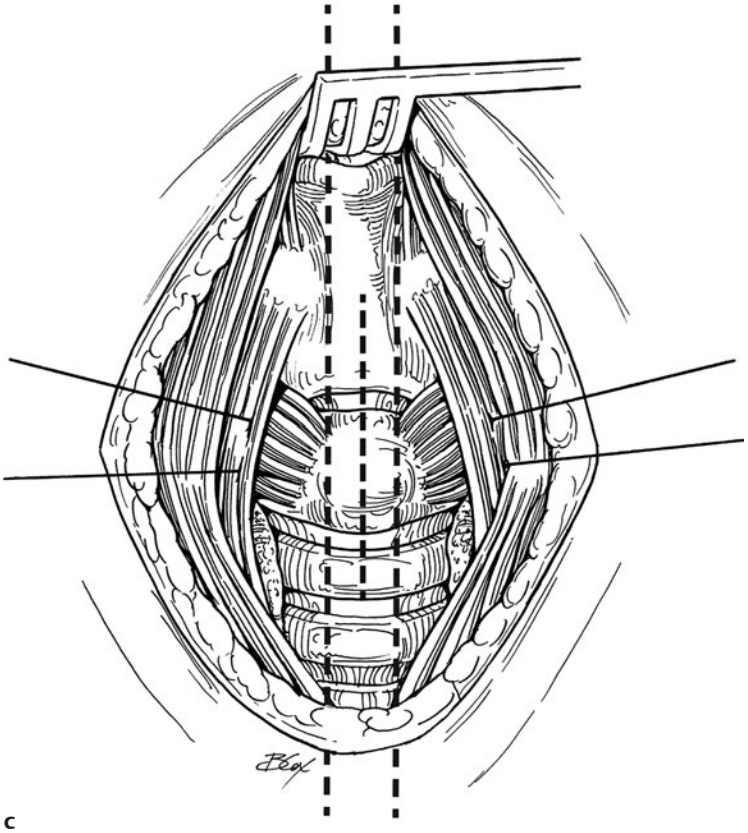


a

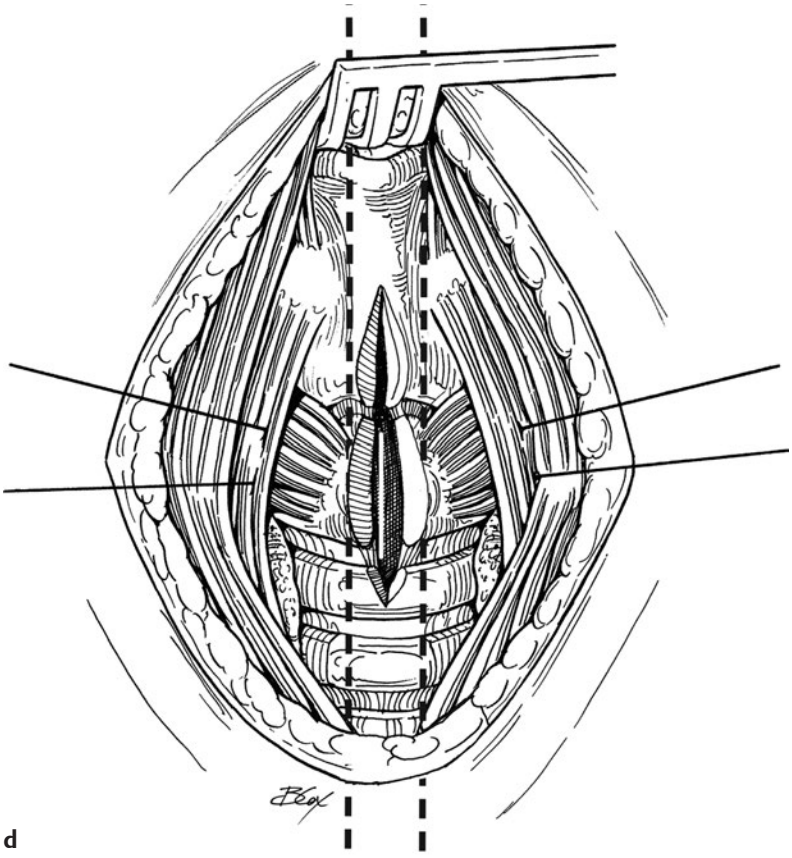


b

Fig. 26.8a,b

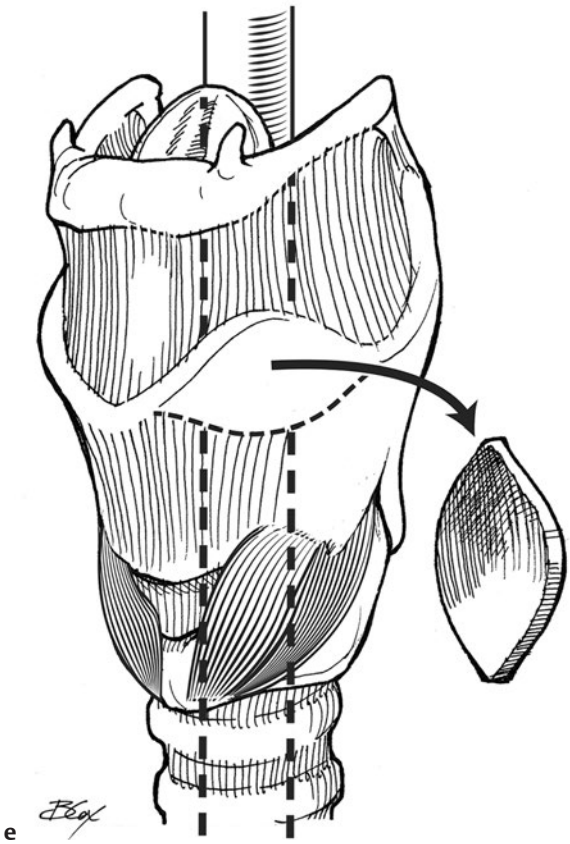


c

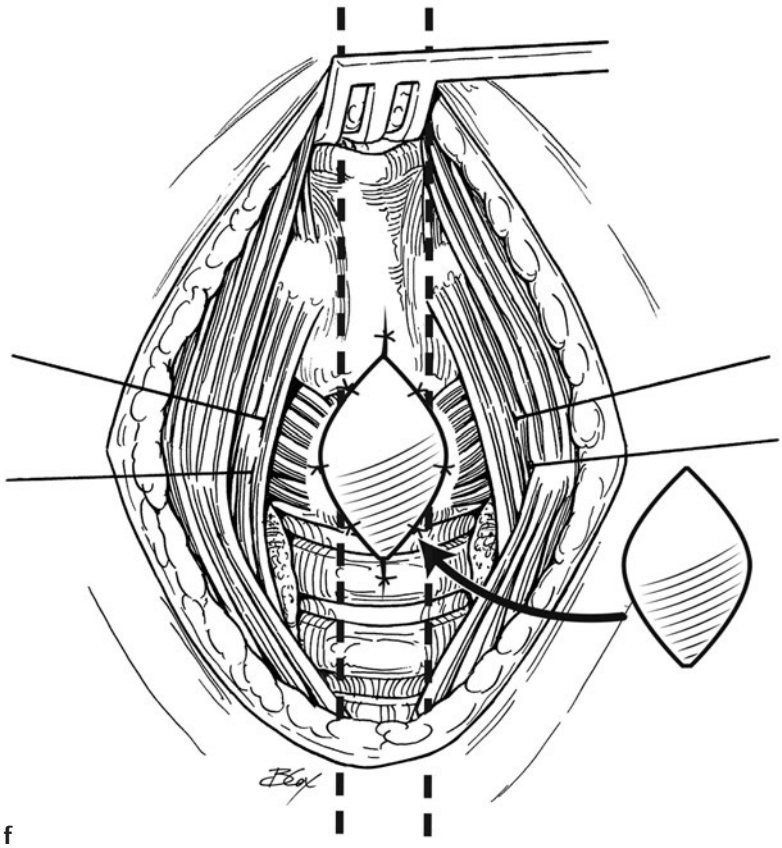


d

Fig. 26.8c,d

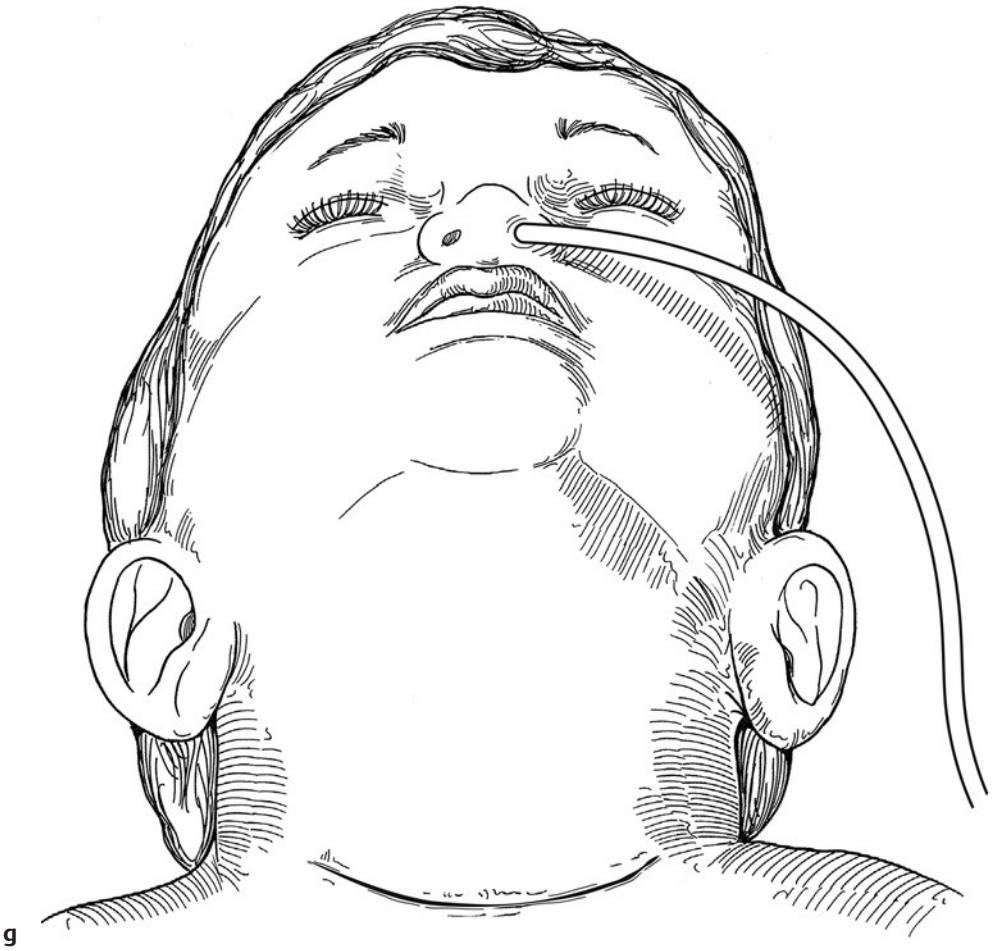


e



f

Fig. 26.8e,f



g

Fig. 26.8g

26-9 Laryngotracheoplasty with Anterior Graft

Michael J. Rutter and Catherine K. Hart

Introduction

Laryngotracheoplasty (LTP) with cartilage graft is a procedure used in the management of subglottic stenosis.

Indications

The indication for LTP with an anterior graft is anterior subglottic stenosis that is most often acquired. This includes patients who have not undergone surgical treatment for their subglottic stenosis and those who have failed other procedures. These patients usually have a tracheotomy in place.

Preoperative Evaluation

The aim of the preoperative evaluation is to facilitate patient optimization prior to airway reconstruction, correcting or minimizing factors known to portend a poor operative outcome. An adequate evaluation should, therefore, not be confined to the stenosis. Consideration should be given to the following:

1. Microlaryngoscopy and bronchoscopy to evaluate the severity and site of the stenosis as well as the possibility of concomitant airway lesions.
2. Impedance probe placement and esophageal biopsies to assess the possible presence and severity of gastroesophageal reflex disease (GERD) and eosinophilic esophagitis.
3. Culture of tracheal aspirate to evaluate for methicillin-resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas* colonization.
4. Pulmonary evaluation to assess for pulmonary comorbidities.
5. Speech evaluation to assess for risk of aspiration.

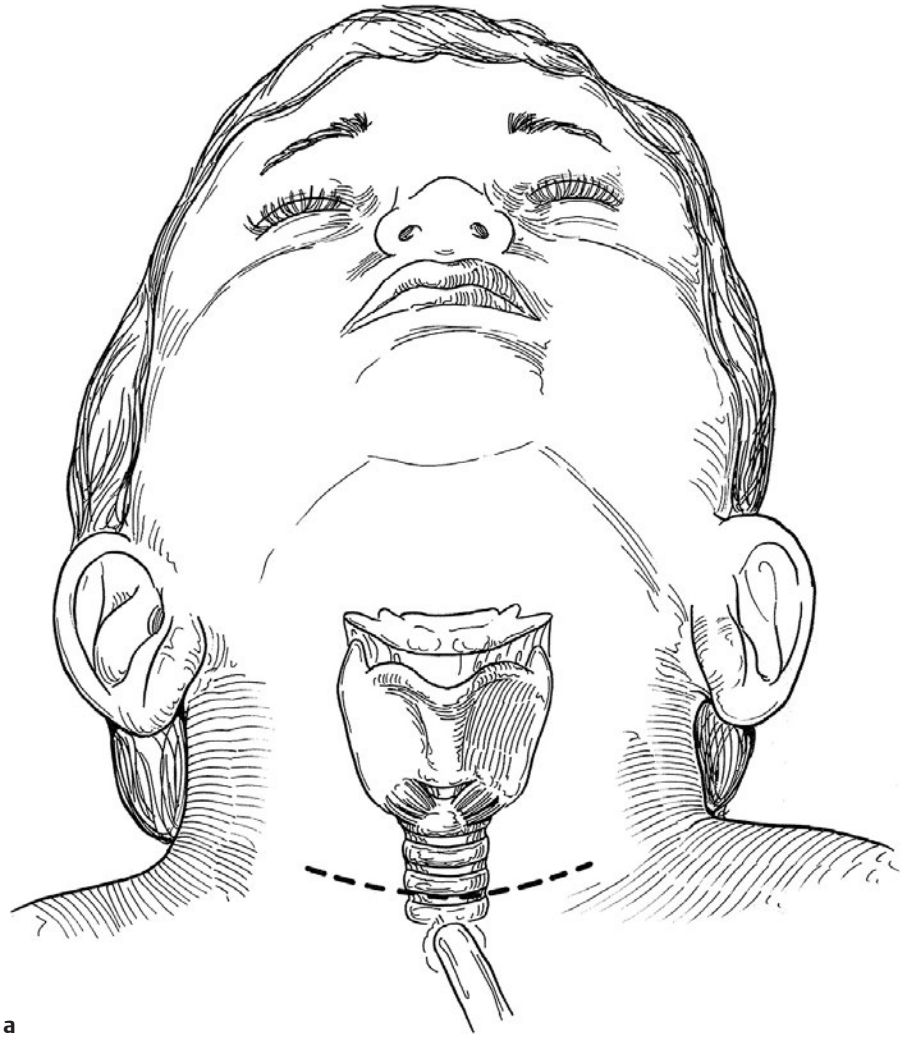
Operative Technique

1. LTP with anterior graft is performed with the patient under general anesthesia. The patient is positioned on a shoulder roll with the neck extended as for tracheotomy. The neck and right chest are prepped to facilitate harvesting the cartilage graft. The upper edge of the drape is placed on the lower lip to provide access to the oral cavity for laryngoscopy during the procedure. A sticky bi-drape is best for this exposure.
2. A cuffed, armored endotracheal tube is placed in the tracheostoma and sutured to the chest.
3. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incisions to aid in hemostasis.
4. A horizontal incision is made above the tracheostoma through the platysma to the cervical fascia (**Fig. 26.9a**).
5. The flap is elevated superiorly to the level of the thyroid notch and is sutured to the drape to provide exposure (**Fig. 26.9b**).
6. The strap muscles are divided in the midline and retracted laterally with silk sutures in the muscle, exposing the larynx and trachea (**Fig. 26.9b**).
7. A midline incision is made in the cricoid and extended inferiorly to a point just above the tracheostoma without entering the stoma (**Fig. 26.9b,c**).
8. The incision is extended superiorly into the thyroid cartilage to a level just below the anterior commissure. Care is taken not to violate the anterior commissure (**Fig. 26.9c**).
9. A neurosurgical pledget soaked with oxymetazoline is placed in the larynx to decongest the mucosa in the region of the laryngeal pathology.
10. Wet 4 × 4 sponges are placed over the neck, and a cartilage graft is taken from the previously prepped right chest (see Section 26-13). The surgeon re-gowns and re-gloves and uses separate instruments for the cartilage graft. Because the laryngotracheal exposure has been completed, the size of graft can be determined prior to harvesting the costal cartilage.
11. The cartilage graft is shaped to create a boat-shaped piece with a beveled edge that will fit into the anterior tracheal wall defect (**Fig. 26.9d**).
12. A suprastomal stent is placed through the larynx with the distal end close to the tracheostoma and the proximal (closed) end at the level of the false vocal fold (**Fig. 26.9e**). The stent size is selected to match the external diameter of the age-appropriate endotracheal tube for that child. Suprastomal stents may be Teflon (Aboulker or Cotton-Lorenz) or silicone (Rutter, Monnier, or the upper limb of a T-tube with the proximal end sewn shut to prevent aspiration).
13. Some surgeons opt to suture the proximal end of the suprastomal stent to reduce aspiration. A 4-0 PDS or 4-0 Prolene is used to place a suture from the inner lumen of the stent and tie multiple knots on the inner lumen, finally tucking the sutures to minimize irritation to the supraglottis (**Fig. 26.9f–i**).
14. The stent is secured with a 2-0 Prolene suture passing through the strap muscles, cricoid, and the stent, and then out the other side (**Fig. 26.9j**).
15. The cartilage graft with the perichondrium facing the airway is placed across the stenosis (**Fig. 26.9k**).
16. The graft is sutured in place with 4-0 PDS suture on a taper needle (**Fig. 26-9l**).
17. The 2-0 Prolene stent suture is threaded through a 16-gauge angiocath. Once the graft is secured and the strap muscles reapproximated, this suture is tied with a knot of 15 to 20 throws, so it can be felt easily through the skin for later removal (**Fig. 26.9m**).
18. Laryngoscopy is performed to confirm stent placement in the appropriate position. The proximal end of the stent should be flush with the top of the arytenoid cartilages (**Fig. 26.9n**).

19. Using 4-0 Vicryl sutures, the strap muscles are approximated over the graft to provide vascularity. A Penrose drain is placed in the wound overlying the strap muscles, but not directly on the graft.
20. The subcutaneous tissues are closed with 4-0 Vicryl and the skin closure is completed with a 5-0 running subcuticular Monocryl suture. A minimal gauze dressing is applied. The endotracheal tube is removed, and the tracheotomy tube is replaced (**Fig. 26.9o**).
21. A chest X-ray is obtained in the operating room or in the recovery room.
22. Broad-spectrum antibiotics are administered until the drains are removed, 48 to 72 hours postoperatively.
23. Stent removal may occur 2 to 6 weeks after LTP. To remove the stent, the right edge of the previous incision is opened, and the 2-0 Prolene retention suture is located and cut, allowing the suture and angiocath to be removed. The stent is grasped transorally and removed once the suture is cut.
24. For the week following stent removal, the patients should be placed on "quad therapy" consisting of an antibiotic, a proton pump inhibitor, dexamethasone (0.5 mg/kg every 48 hours), and antibiotic–steroid combination drops (3 times daily for 3 days down the tracheostomy tube). Repeat microlaryngoscopy and bronchoscopy are performed 1 week following stent removal.
25. When the airway is adequate as determined by microlaryngoscopy and bronchoscopy, a trial of capping the tracheostomy tube can be attempted followed by subsequent decannulation.
26. If a single-stage LTP is done with an anterior graft, the incision through the cricoid is carried inferiorly through the tracheostoma and a longer graft is fashioned. No stent is placed. An age-appropriate endotracheal tube is left in place for 5 to 7 days.

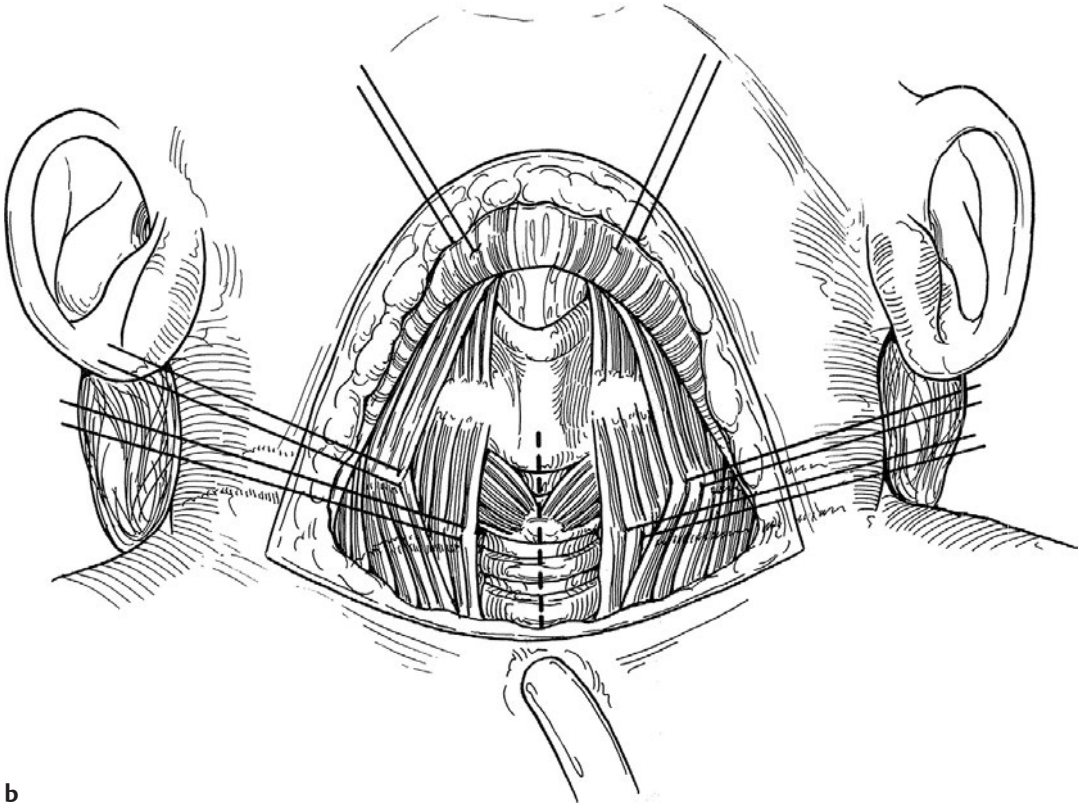
Complications

1. Pneumothorax
2. Failure to decannulate or extubate
3. Restenosis
4. Graft prolapse or necrosis

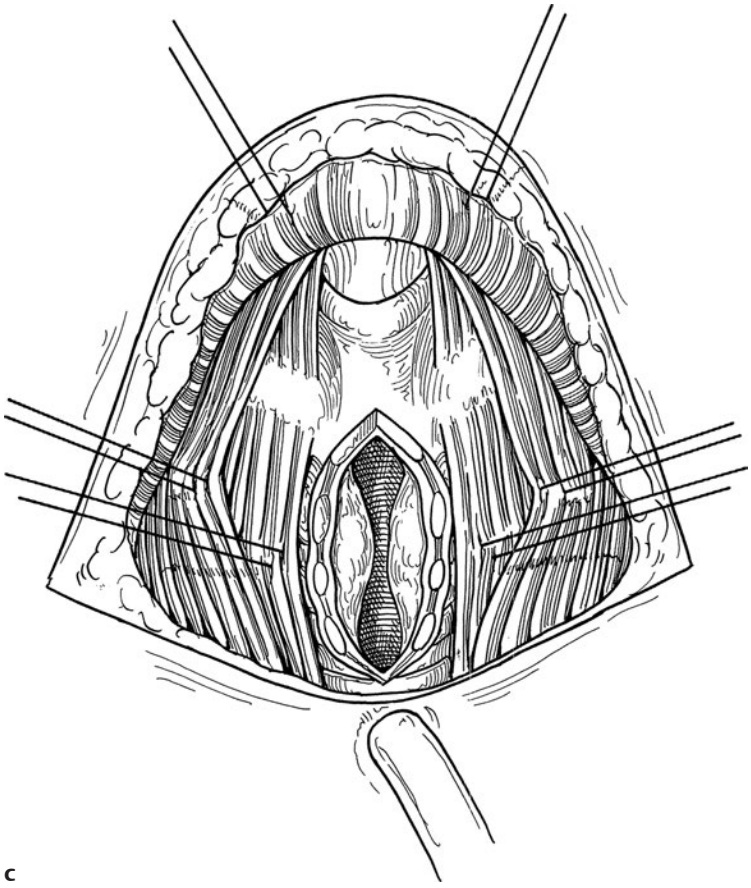


a

Fig. 26.9a

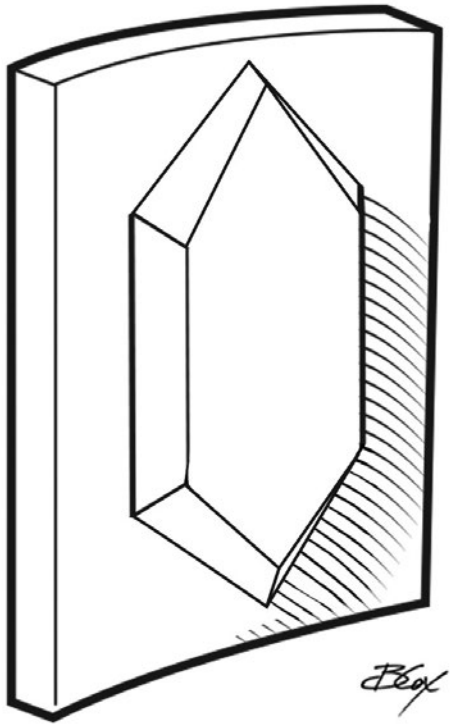


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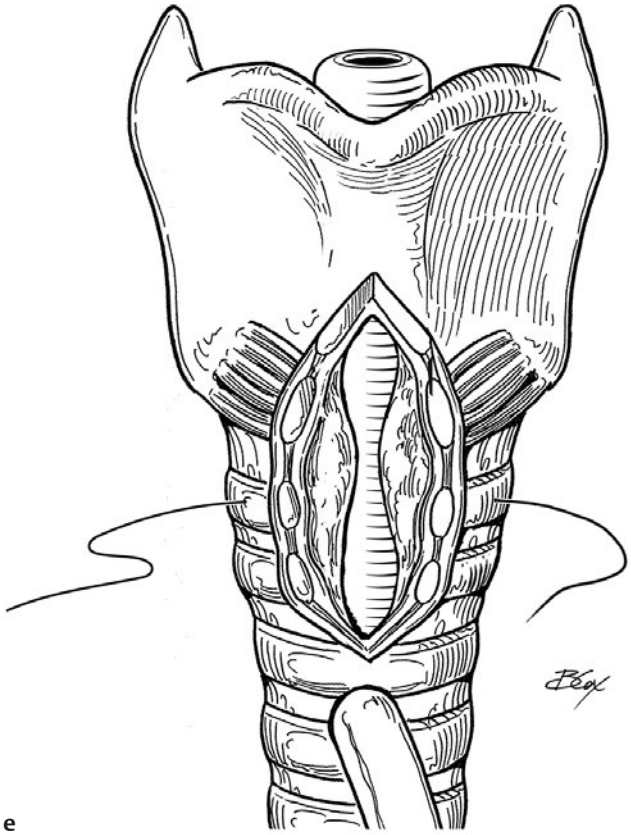


c

Fig. 26.9b,c

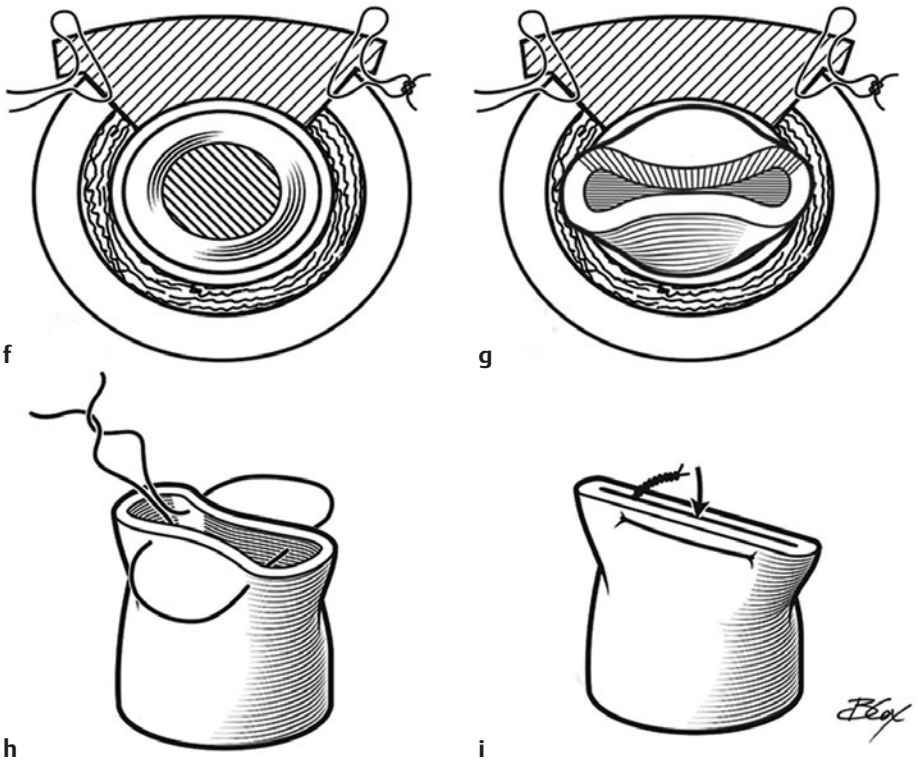


d



e

Fig. 26.9d,e



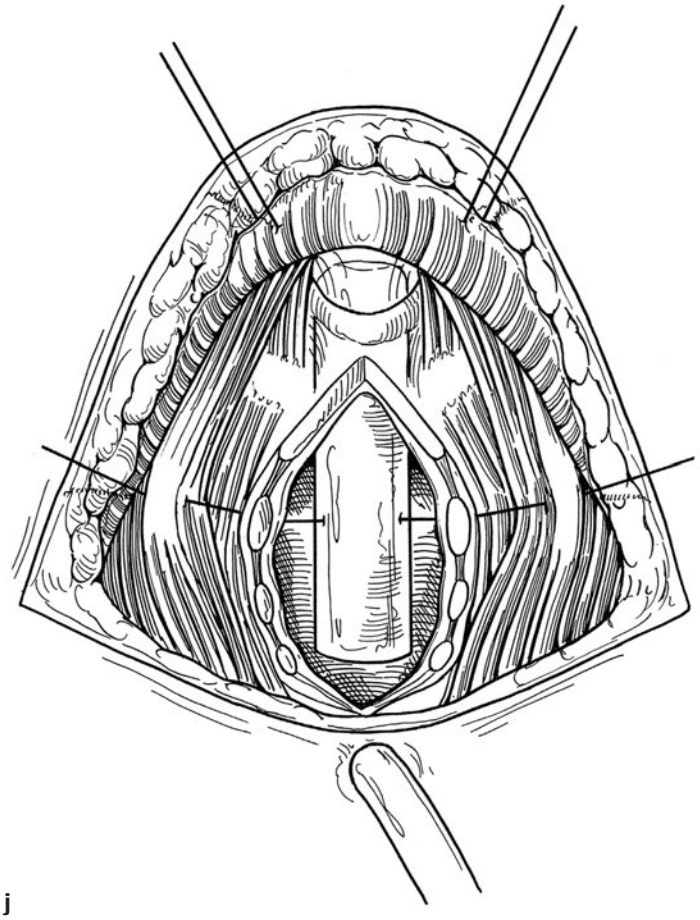
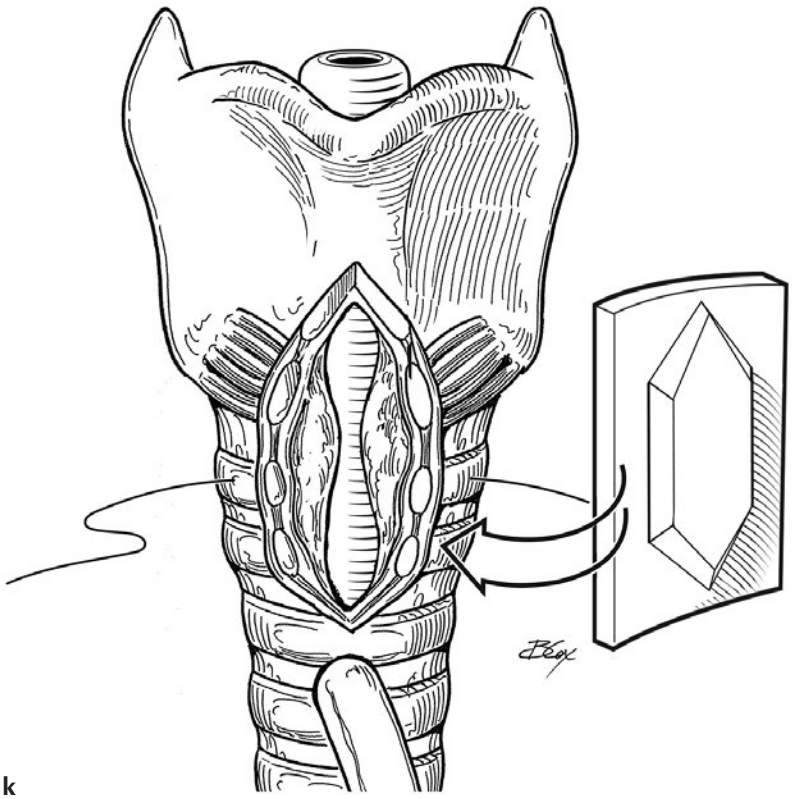
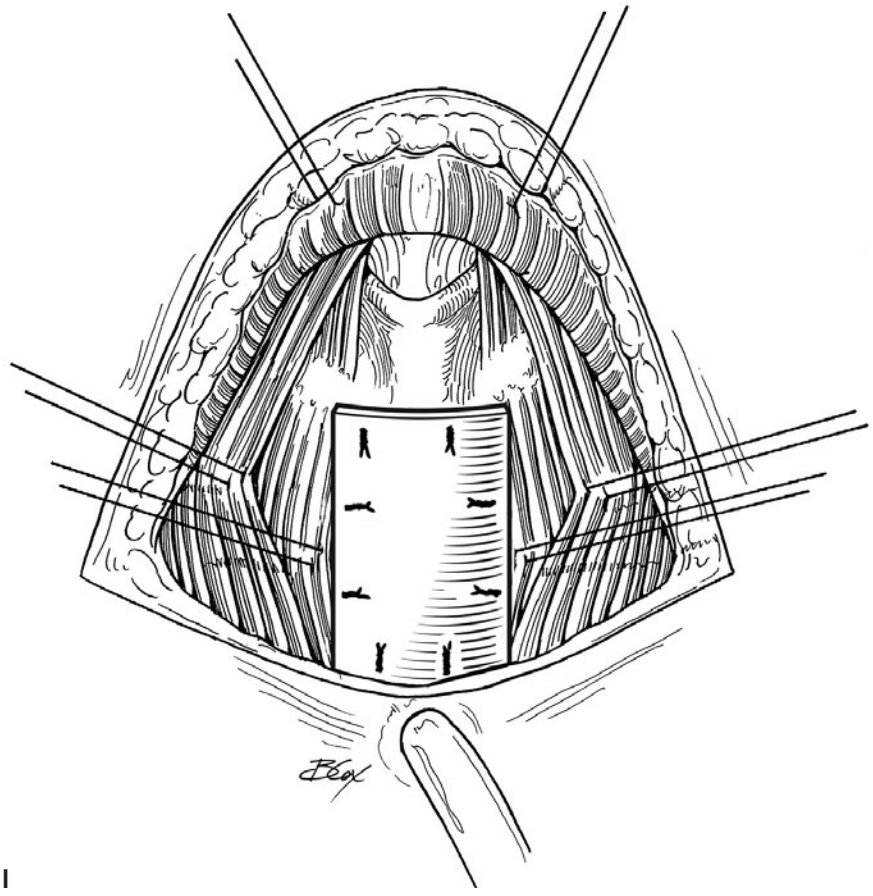


Fig. 26.9f,g,h,i,j

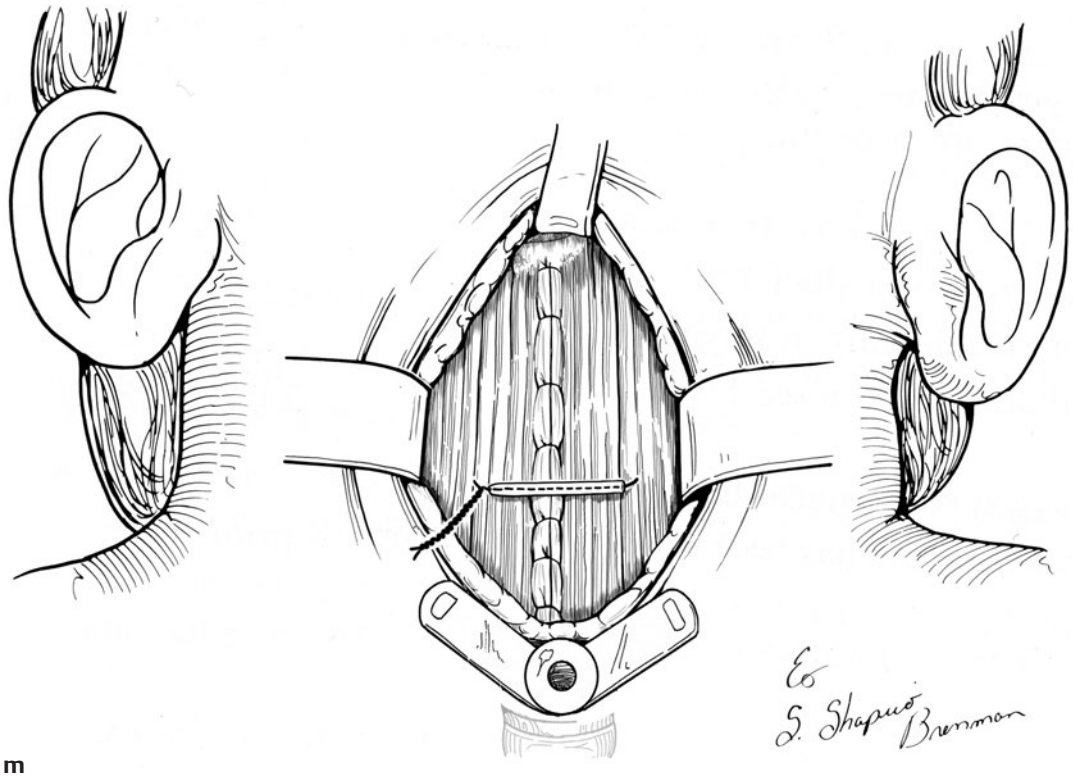


k

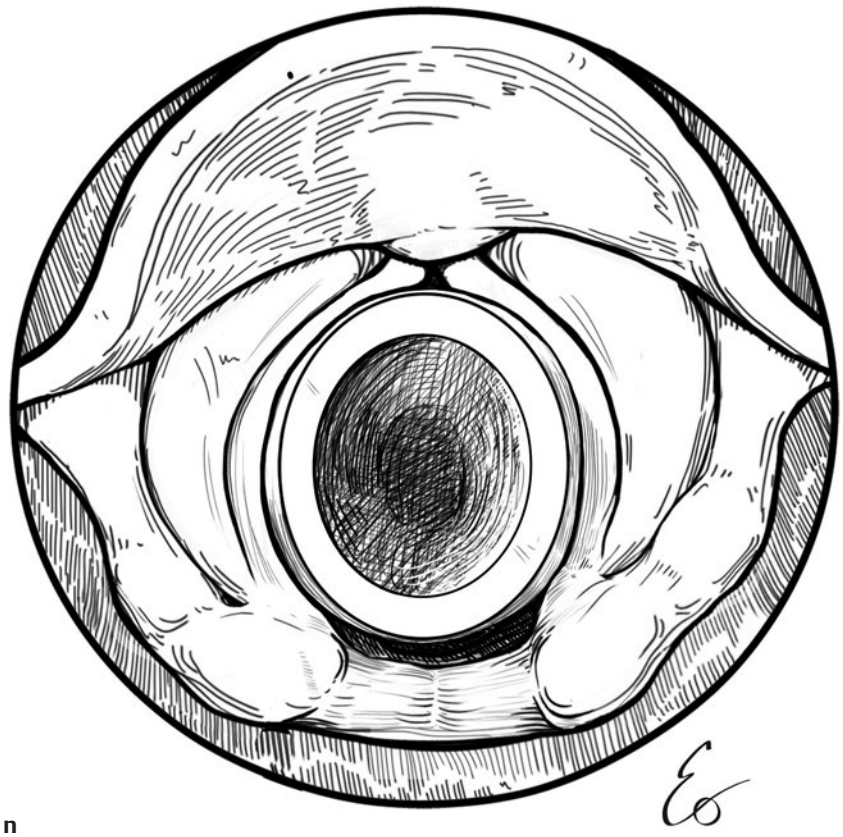


l

Fig. 26.9k,l

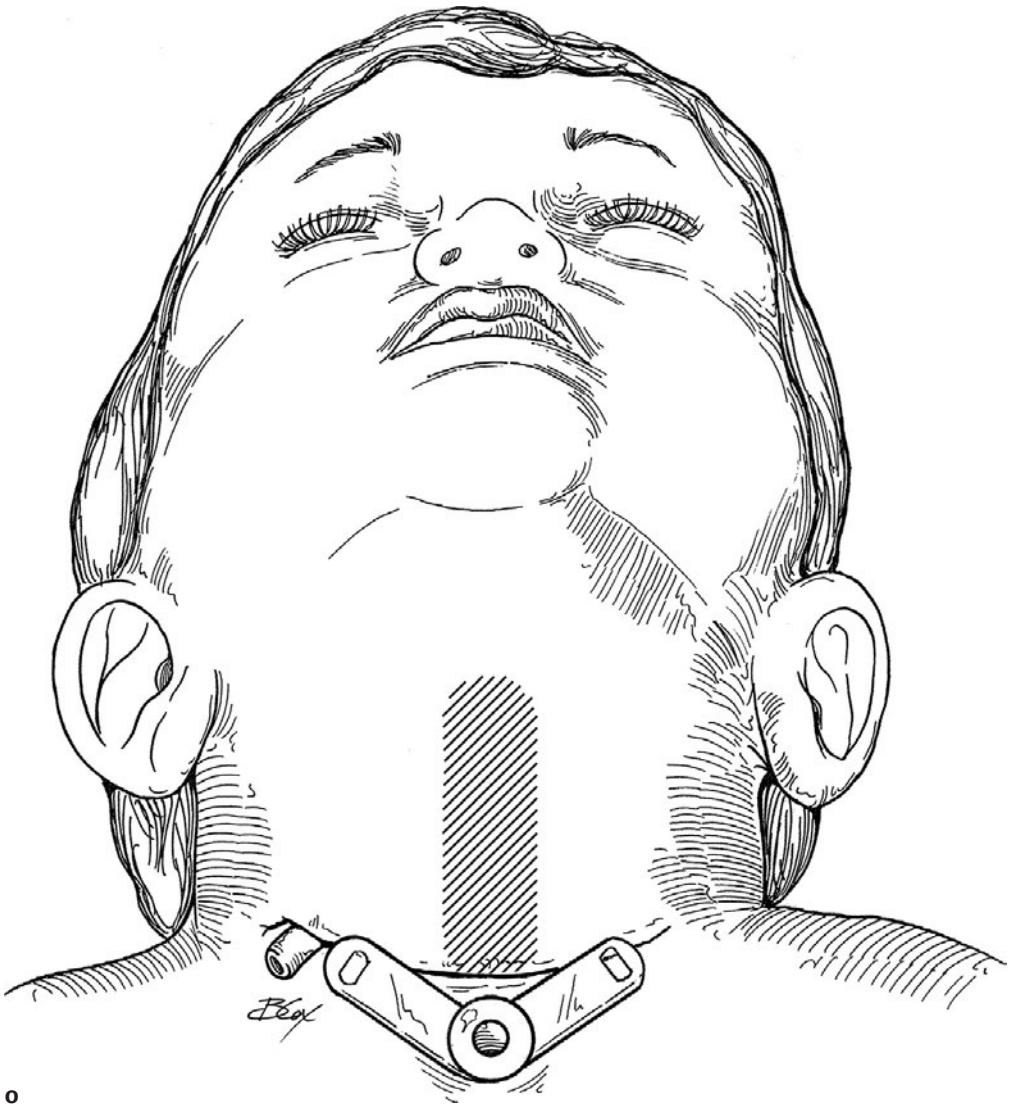


m



n

Fig. 26.9m,n



o

Fig. 26.9o

26-10 Laryngotracheoplasty with Posterior Graft

Michael J. Rutter and Catherine K. Hart

Indications

Posterior costal cartilage grafting is indicated for posterior laryngotracheal stenosis with or without anterior stenosis. It is also effective in the treatment of congenital elliptical cricoid stenosis. In addition, it may be an effective treatment for any form of vocal fold immobility, including posterior glottic stenosis, cricoarytenoid joint fixation, and bilateral vocal fold paralysis. Posterior cricoid cartilage grafting is usually an open procedure; however, endoscopic placement of the cricoid cartilage graft is becoming increasingly popular for isolated posterior glottic pathology. A posterior graft may be used with or without an anterior graft.

Preoperative Evaluation

Refer to the preoperative evaluation as described in Section 26-9.

Operative Technique

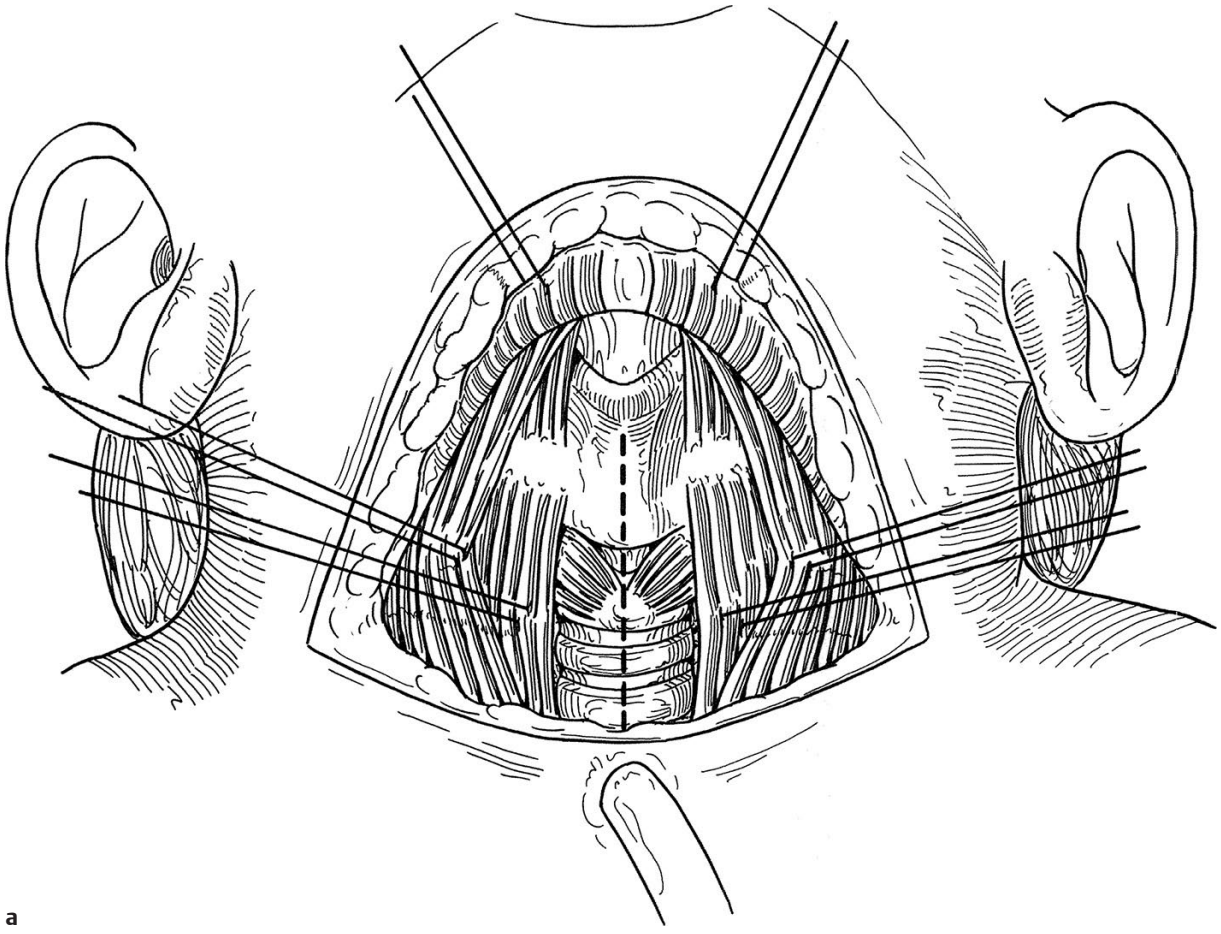
Refer to the operative technique (steps 1 through 7) as described in Section 26-9.

1. The same positioning is used for LTP with a posterior graft as for anterior graft LTP (see Section 26-9) with a cuffed, armored endotracheal tube in the tracheostoma.
2. One percent lidocaine with 1:100,000 epinephrine is injected subcutaneously at the site of the incision to aid in hemostasis.
3. Exposure is obtained as detailed for anterior graft LTP (see Section 26-9, steps 4 through 7).
4. The incision is extended superiorly through the thyroid cartilage to within 2 mm of the thyroid notch; however, the anterior commissure is kept intact, if possible (**Fig. 26.10a**).
5. The thyroid and cricoid cartilages are retracted with 4-0 Prolene suture, exposing the posterior interarytenoid region (**Fig. 26.10b**).
6. One percent lidocaine with 1:100,000 epinephrine is injected submucosally in the posterior midline of the larynx and trachea (**Fig. 26.10c**). The injection needle is then passed through the posterior cricoid plate and additional local anesthetic is infiltrated. This allows the surgeon to estimate the thickness of the posterior cricoid plate (and exclude the submucosal cleft larynx), improves hemostasis in the posterior cricoid region, and increases the distance between the cricoid and the esophageal mucosa to minimize the risk of inadvertent damage to the esophagus while dividing the posterior cricoid plate.
7. A neurosurgical pledget soaked with oxymetazoline is placed in the posterior cricoid region to decongest the mucosa. It is left in place for 2 to 4 minutes.
8. A vertical incision is made through the mucosa, posterior lamina of the cricoid cartilage, and posterior perichondrium with a no. 69 Beaver blade. The incision extends from the interarytenoid muscles to approximately 1 cm below the inferior border of the cricoid cartilage and is taken down to the tracheoesophageal septum (**Fig. 26.10d**). Care should be taken not to enter the epipharyngeal mucosa.
9. Division of the interarytenoid muscle may have a minor negative effect on voicing postoperatively, but it decreases the risk of arytenoid prolapse. If the arytenoid muscle is fibrosed, division is mandatory.
10. If the incision is not in the midline, the posterior cricoarytenoid muscle fibers will guide the surgeon back to the midline.
11. Wet 4 × 4 sponges are placed over the neck and a cartilage graft is taken from the previously prepped right chest. The surgeon re-gowns and re-gloves and uses separate instruments for the cartilage graft. Because the laryngotracheal exposure has been completed, the size of graft can be determined prior to harvesting the costal cartilage.
12. The posterior cricoid is distracted laterally by placing a flanged boat-shaped cartilage graft (**Fig. 26.10e,f,g**). Ideally, the graft should snap into place with the flanges underlying the split posterior cricoid lamina. If the graft is easy to remove, consideration should be given to placing stabilizing sutures; however, if the graft seems stable when snapped into place, suturing is not required.
13. A suprastomal stent is placed through the larynx with the distal end close to the tracheostoma and the proximal (closed) end at the level of the false vocal fold (**Fig. 26.10h**). The stent is secured with a 2-0 Prolene suture passing through the strap muscles, cricoid cartilages, and stent, and out the other side. The suture is threaded through a 16-gauge angiocath (**Fig. 26.10i**).
14. An anterior rib graft, if needed, may be placed at this time (see Section 26-9).
15. Once the strap muscles are closed, the suture is tied with a knot of 15 to 20 throws, so it can be felt easily through the skin for later removal (**Fig. 26.10i,j**). The stent size is selected to match the external diameter of the age-appropriate endotracheal tube for that child. Suprastomal stents may be Teflon (Aboulker or Cotton-Lorenz) or silicone (Rutter, Monnier, or the upper limb of a T-tube with the proximal end sewn shut).
16. Some surgeons opt to place a suprastomal stent that is sutured proximally to minimize aspiration; others maintain the proximal stent open (**Fig. 26.10j**).
17. Laryngoscopy is performed to confirm stent placement in appropriate position.

18. Using 4-0 Vicryl sutures, the strap muscles are approximated over the graft to provide vascularity. A Penrose drain is placed in the wound overlying the strap muscles, but not directly on the graft.
19. The subcutaneous tissues are closed with 4-0 Vicryl and the skin closure is completed with a 5-0 running subcuticular Monocryl suture. A minimal gauze dressing is applied. The endotracheal tube is removed, and the tracheotomy tube is replaced (**Fig. 26.10k**).
20. A chest X-ray is obtained in the operating room or in the recovery room.
21. The patient remains on broad-spectrum antibiotics from the time of the initial procedure until drain removal 48–72 hours postoperatively.
22. Stent removal may occur 4 to 6 weeks after LTP. To remove the stent, the right edge of the previous incision is opened, and the 2-0 Prolene retention suture is located and cut, allowing the suture and angiocath to be removed. The stent is grasped transorally and removed once the suture is cut.
23. For the week following stent removal, the patients should be placed on "quad therapy" consisting of an antibiotic, a proton pump inhibitor, dexamethasone (0.5 mg/kg every 48 hours), and antibiotic–steroid combination drops (3 times daily for 3 days down the tracheostomy tube). Repeat microlaryngoscopy and bronchoscopy are performed 1 week following stent removal.
24. When the airway is adequate as determined by microlaryngoscopy and bronchoscopy, a trial capping the tracheostomy tube can be attempted followed by subsequent decannulation.
25. If a single-stage LTP is done with a posterior graft, no stent is placed. An age-appropriate endotracheal tube is left in place for 7 to 10 days.

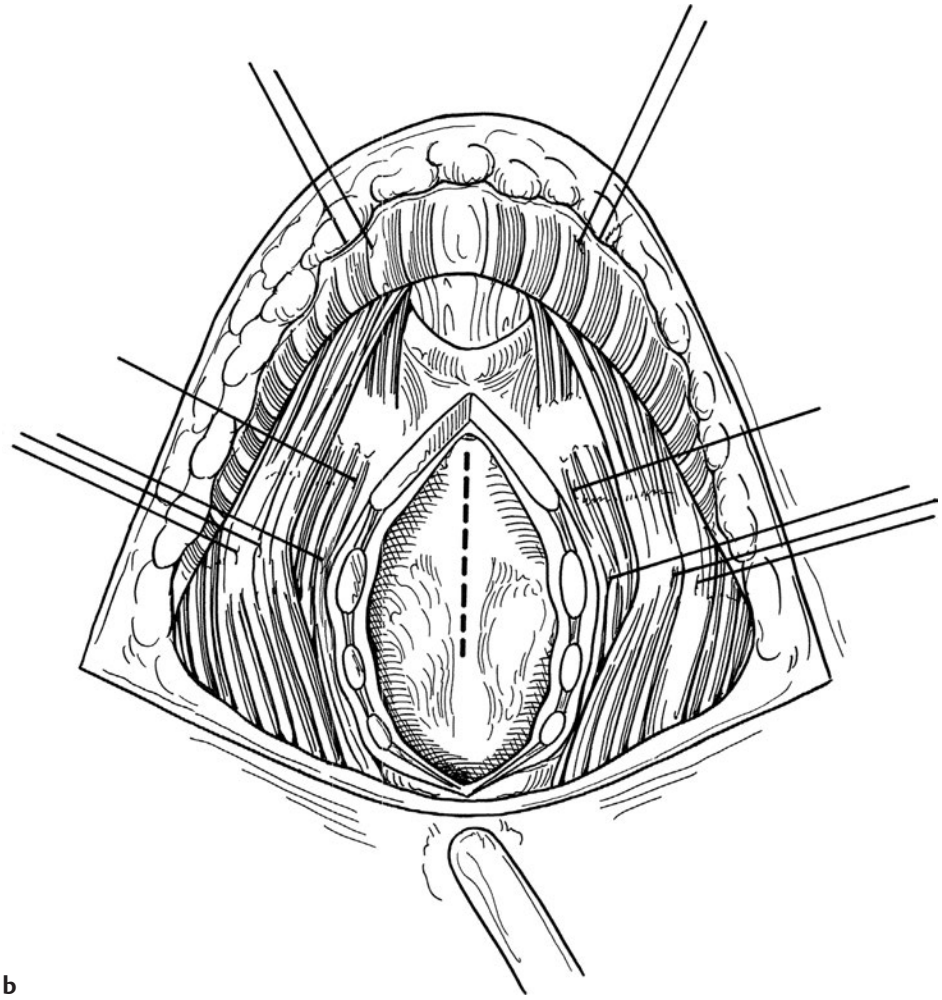
Complications

1. Pneumothorax
2. Failure to decannulate or extubate
3. Restenosis
4. Graft prolapse or necrosis

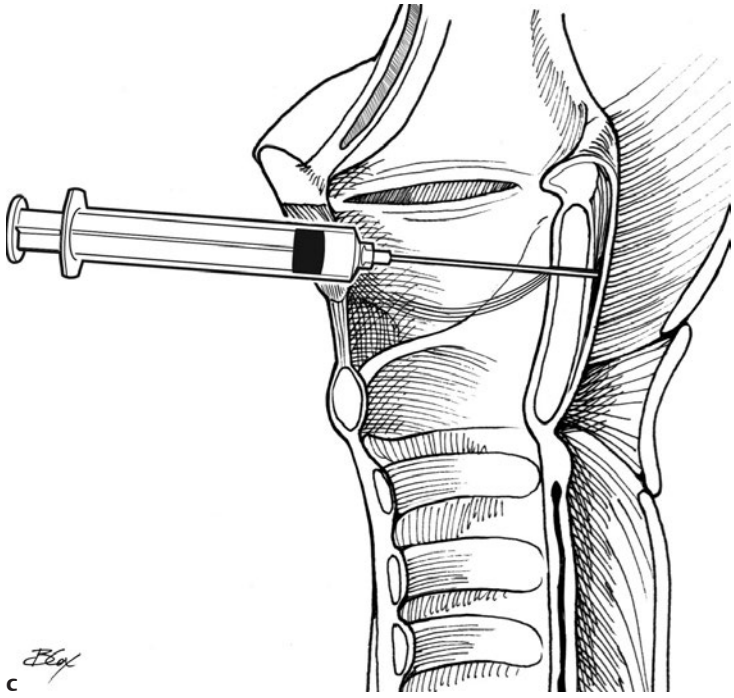


a

Fig. 26.10a

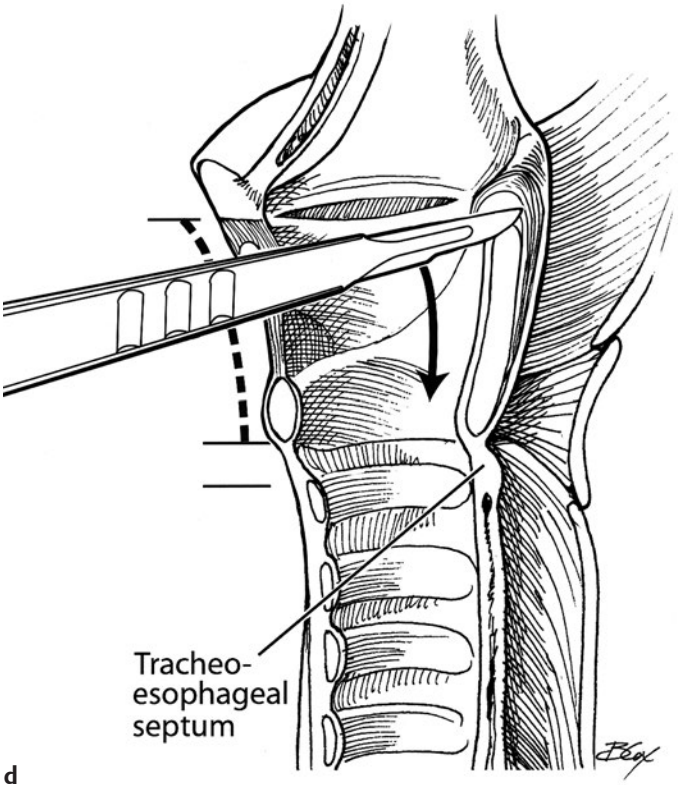


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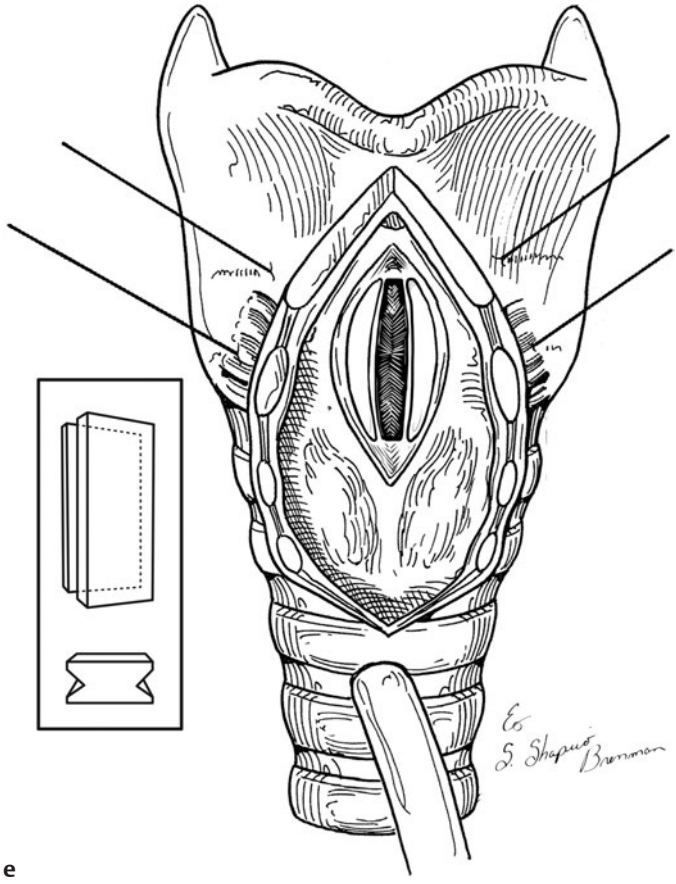


c

Fig. 26.10b,c

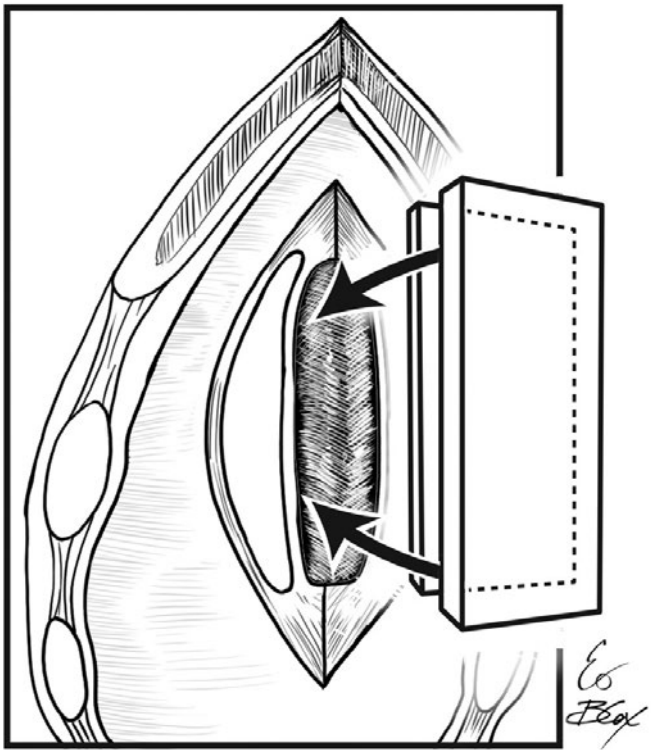


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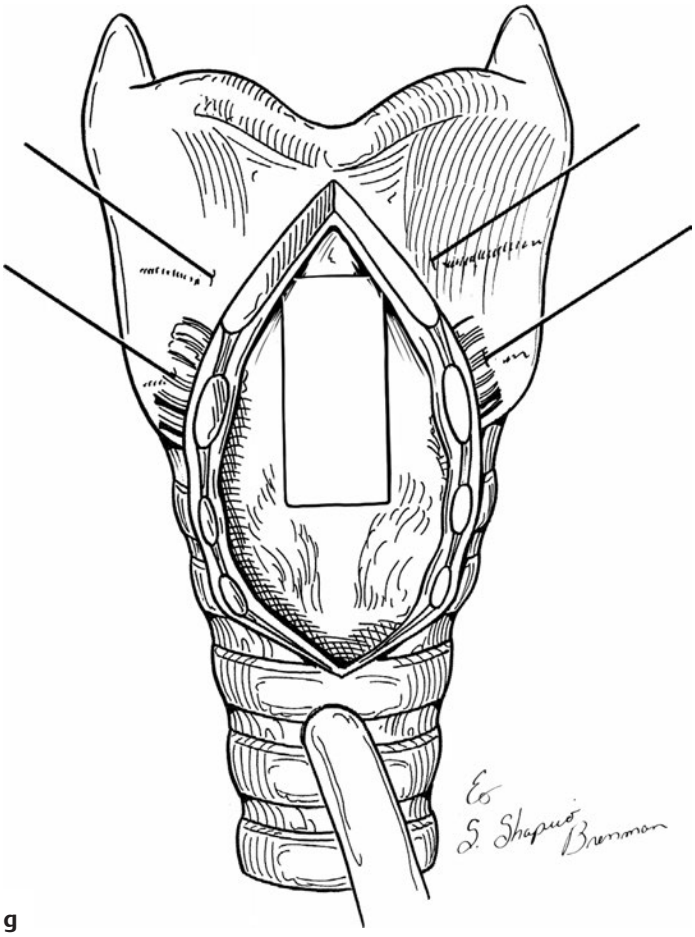


e

Fig. 26.10d,e

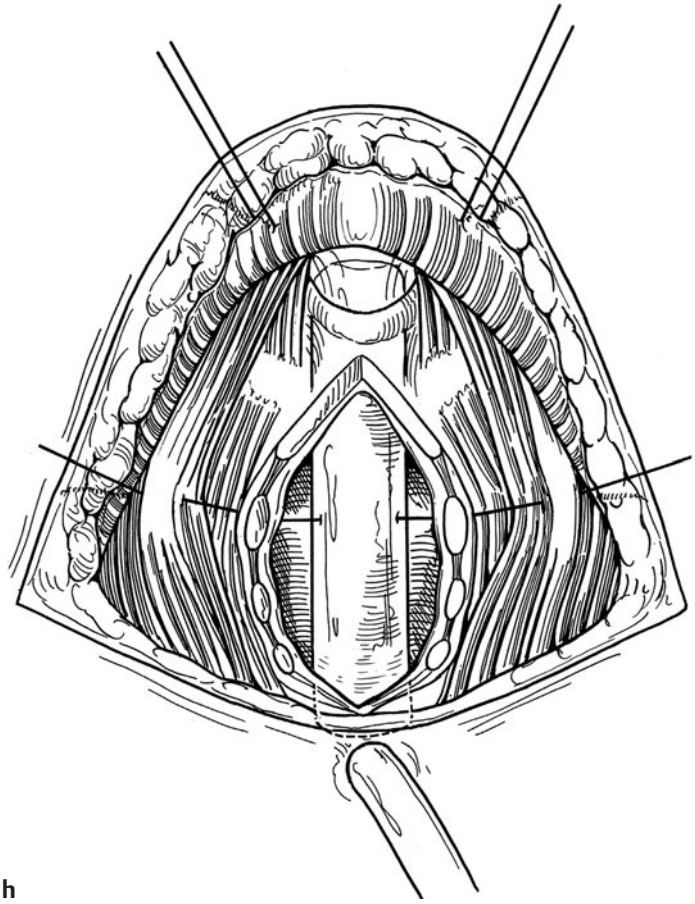


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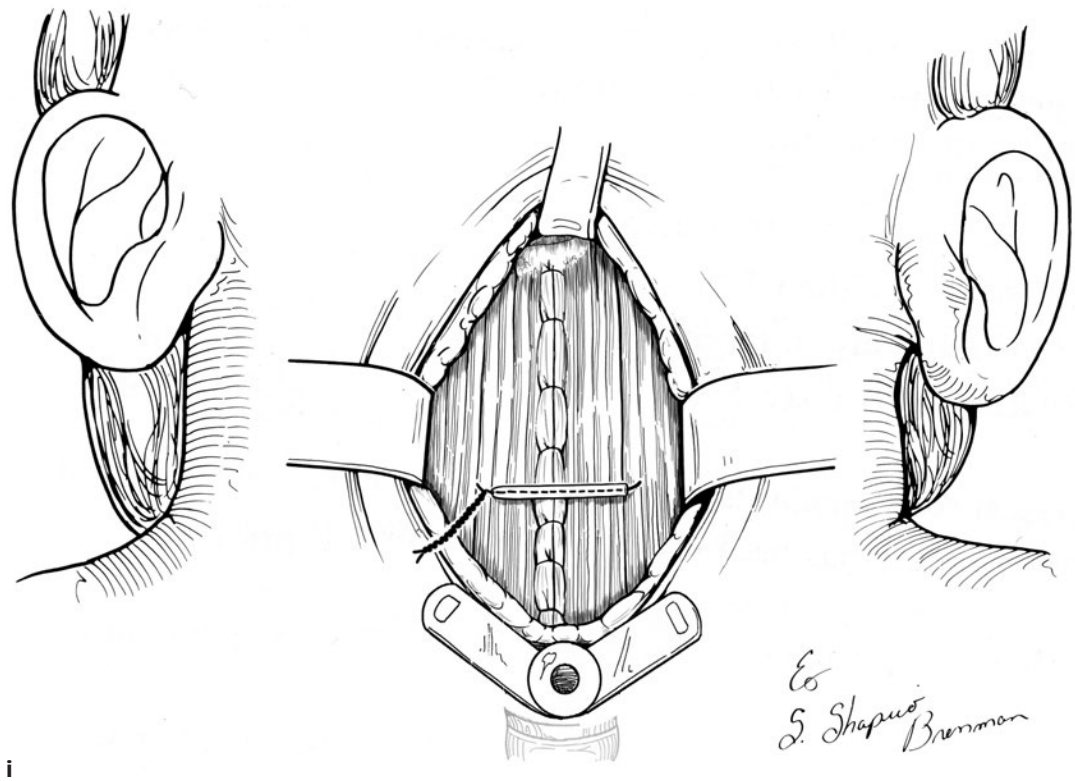


g

Fig. 26.10f,g

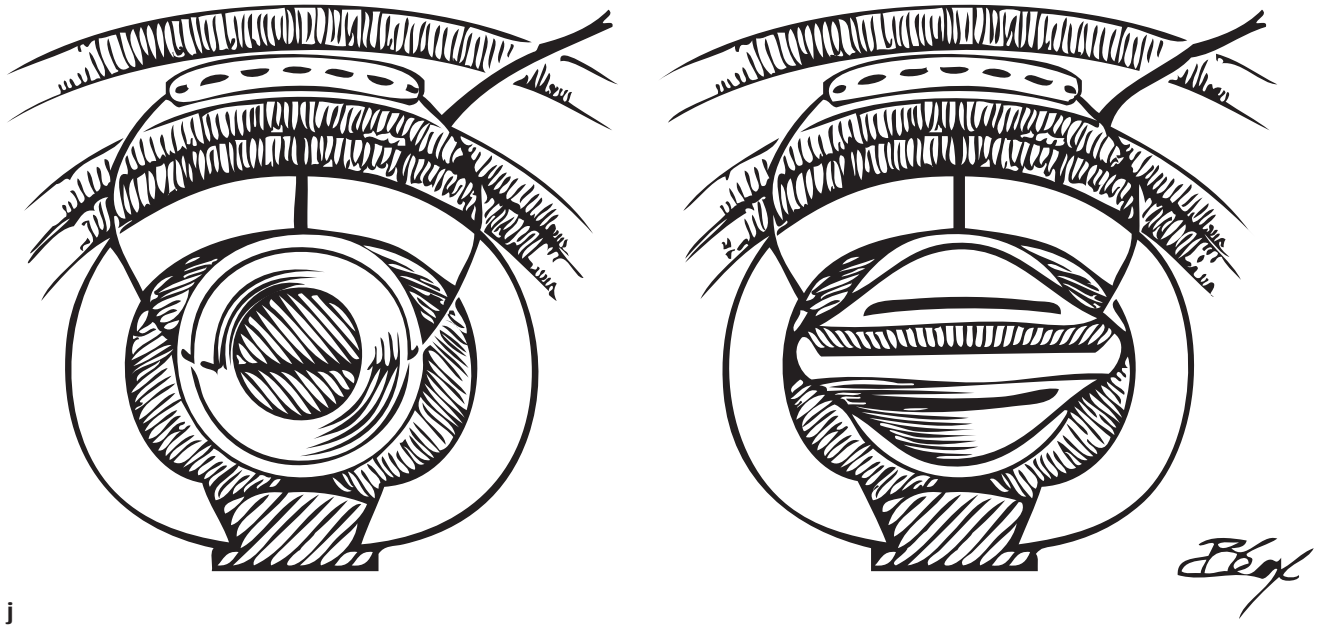


h

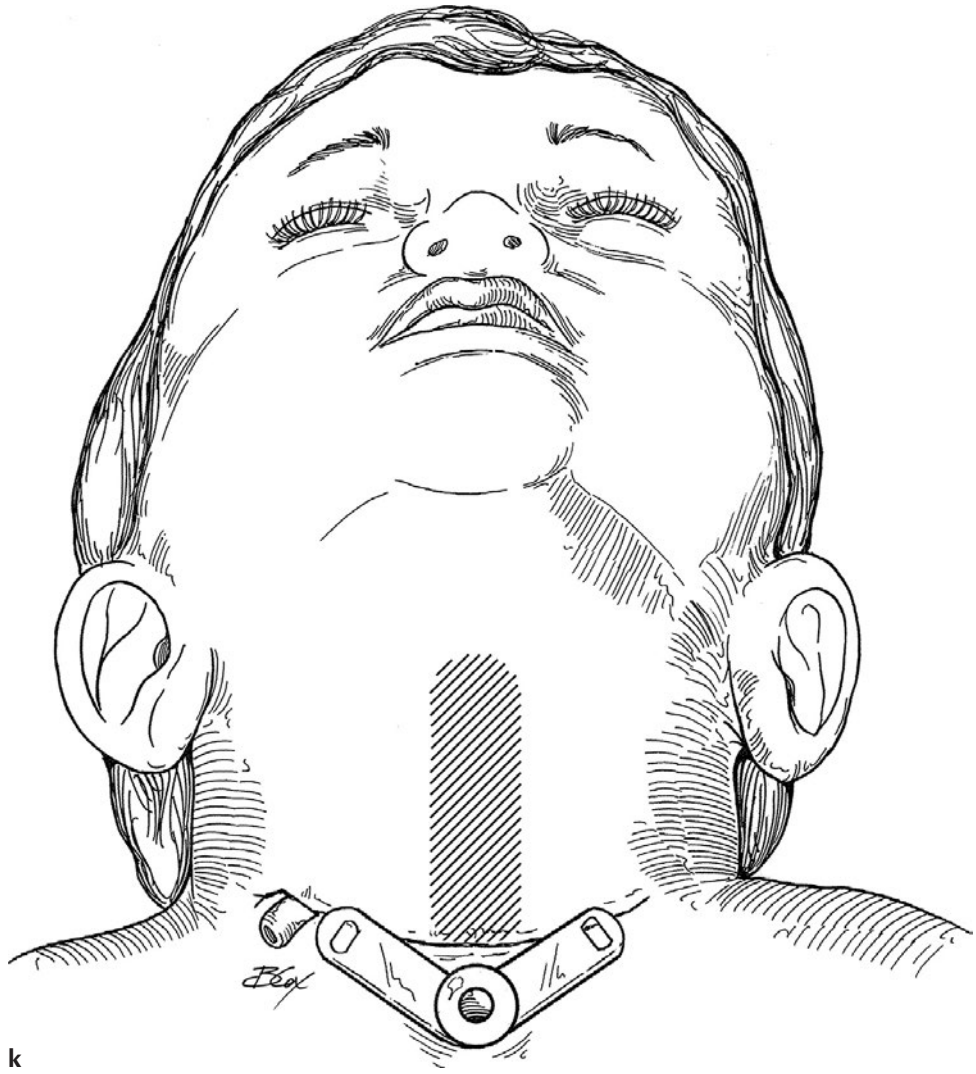


i

Fig. 26.10h,i



j



k

Fig. 26.10j,k

26-11 Tracheoplasty (Repair of Tracheal Stenosis at Tracheostomy Site)

Ian N. Jacobs

Indications

Tracheoplasty is indicated in the management of tracheal stenosis (lambdoid stenosis) or severe tracheomalacia at or above the tracheotomy tube that prevents decannulation or results in severe airway symptoms after decannulation.

Preoperative Evaluation

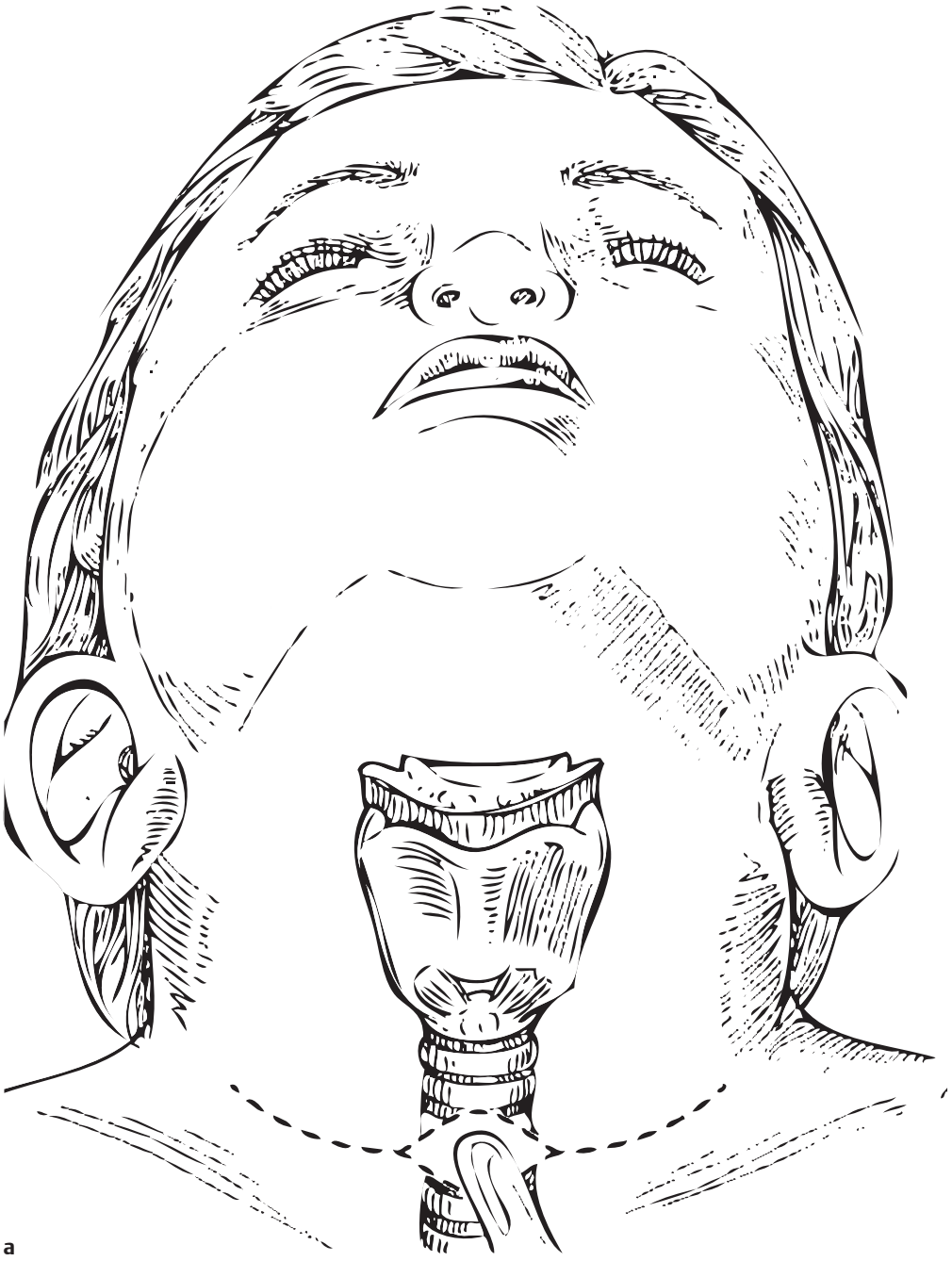
Microlaryngoscopy and bronchoscopy are required to diagnose the problems that will require open tracheoplasty and confirm that a tracheostomy tube is no longer indicated. Sleep apnea should not be present unless there are plans for noninvasive ventilation. Confirm that the tonsils and adenoids are nonobstructing. Radiologic imaging is often not indicated.

Operative Technique

1. Open tracheal reconstruction may be required to correct stenosis or severe suprastomal collapse that often occurs as a direct result of the tracheotomy tube.
2. First a microlaryngoscopy and bronchoscopy are performed under general anesthesia and the airway is assessed for the severity of the airway problem and for signs of infection.
3. A cut oral RAE or anode tube is placed in the tracheostome and adequate ventilation is established.
4. One percent lidocaine with 1:100,000 epinephrine is injected into the incision site.
5. A transverse elliptical incision is made encompassing the stoma (**Fig. 26.11a**).
6. The incision is carried through skin and subcutaneous tissue down to the trachea.
7. The strap muscles are dissected away from the midline and retracted with a silk suture laterally. This will expose the trachea, which is further cleaned with the bipolar cautery.
8. The tracheocutaneous fistula is dissected down to the trachea and excised (**Fig. 26.11b**).
9. The trachea is opened caudally from the stoma with a hemostat in place using a no. 15 blade (**Fig. 26.11b**).
10. A vertical incision is taken through the stenosis under direct endoscopic visualization.
11. An age-appropriate endotracheal tube is placed nasally and secured.
12. The surgeon is gloved and gowned and a large costal cartilage graft is harvested (see Section 26-12).
13. The graft is shaped in an ellipse with a small ledge and sutured to the trachea and cricoid using horizontal mattress sutures of 4-0 PDS (**Fig. 26.11c**).
14. The wound is checked for a leak with positive pressure ventilation and then fibrin glue is placed over the graft/trachea interface.
15. The strap muscles are closed over the graft and a Penrose/rubber drain is placed.
16. The skin incision is closed with 5-0 Monocryl suture.
17. The child undergoes repeat microlaryngoscopy and bronchoscopy in 4–6 days and is extubated when ready.

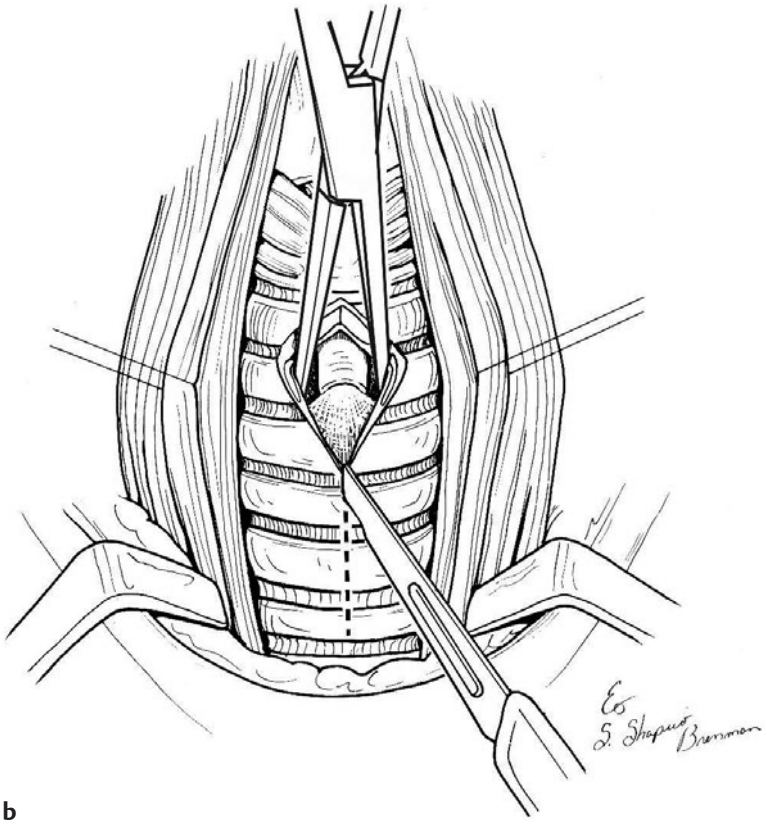
Complications

1. Pneumothorax
2. Failure to decannulate or extubate
3. Restenosis
4. Graft prolapse or necrosis

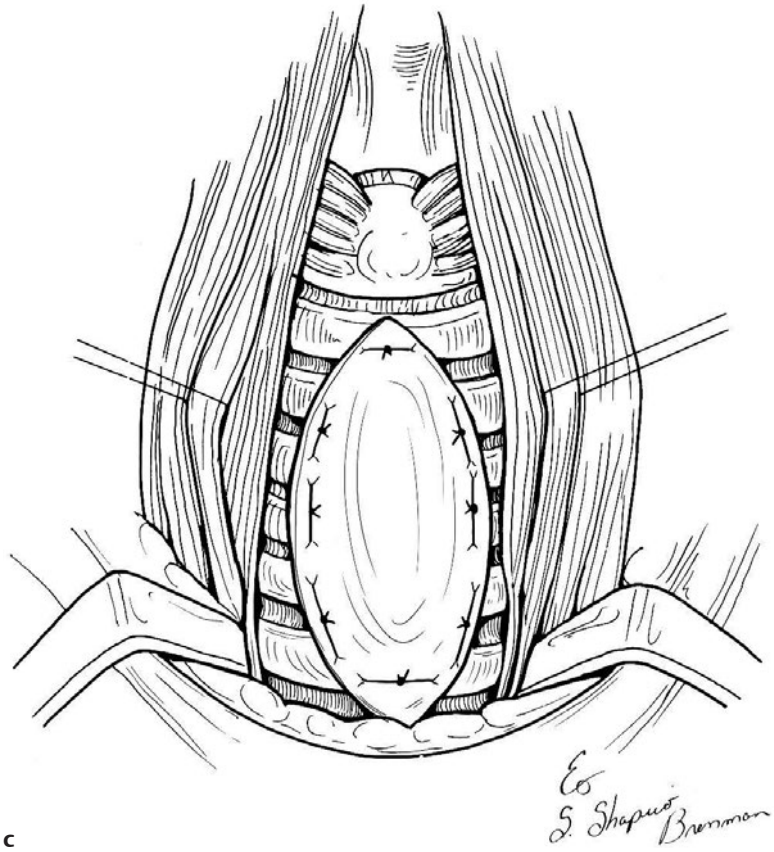


a

Fig. 26.11a



b



c

Fig. 26.11b,c

26-12 Harvesting the Costal Cartilage Graft

Ian N. Jacobs

Introduction

Costal cartilage has been the mainstay of graft material for managing moderate to severe laryngotracheal stenosis. The graft is usually taken after the laryngeal pathology is exposed. This provides the information necessary to determine how much cartilage is needed.

Indications

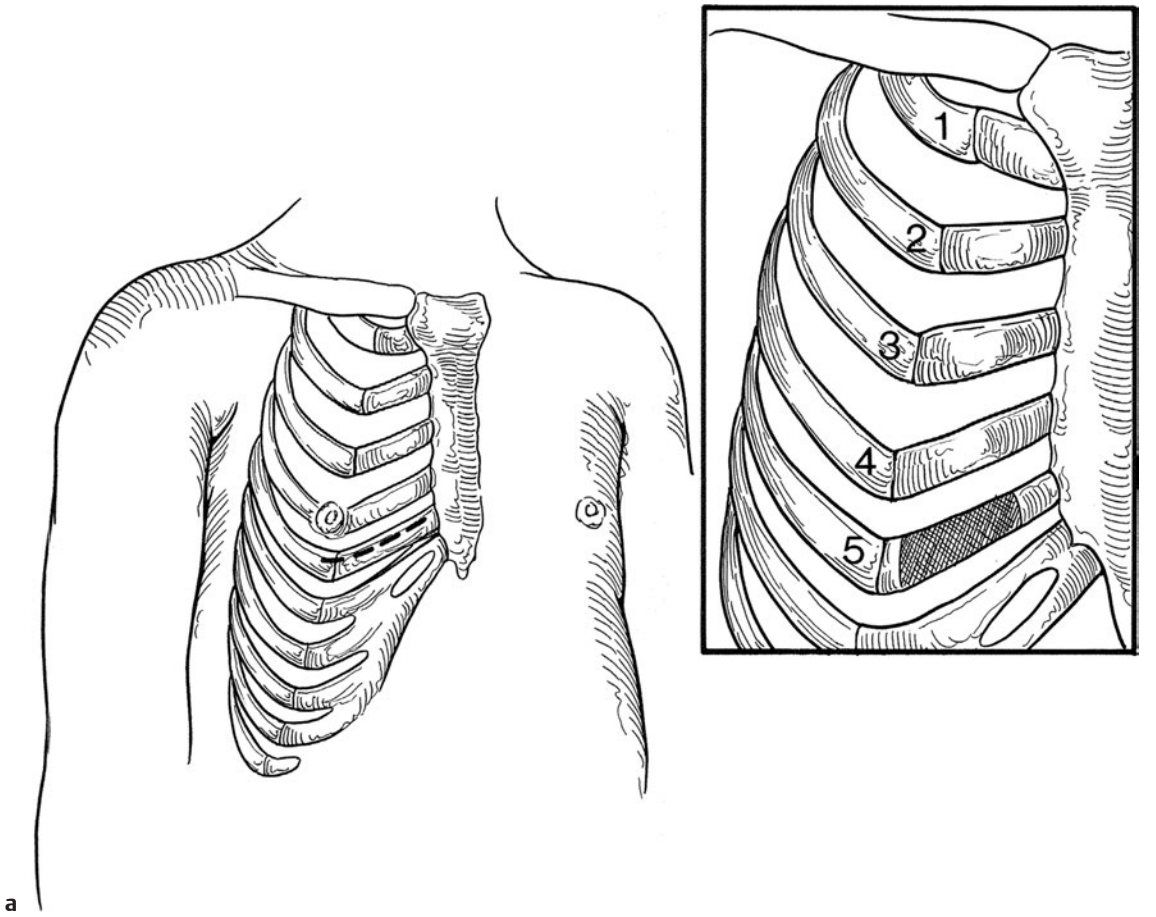
A posteroanterior (PA) and lateral chest X-ray should be obtained prior to harvesting a costal cartilage graft.

Operative Technique

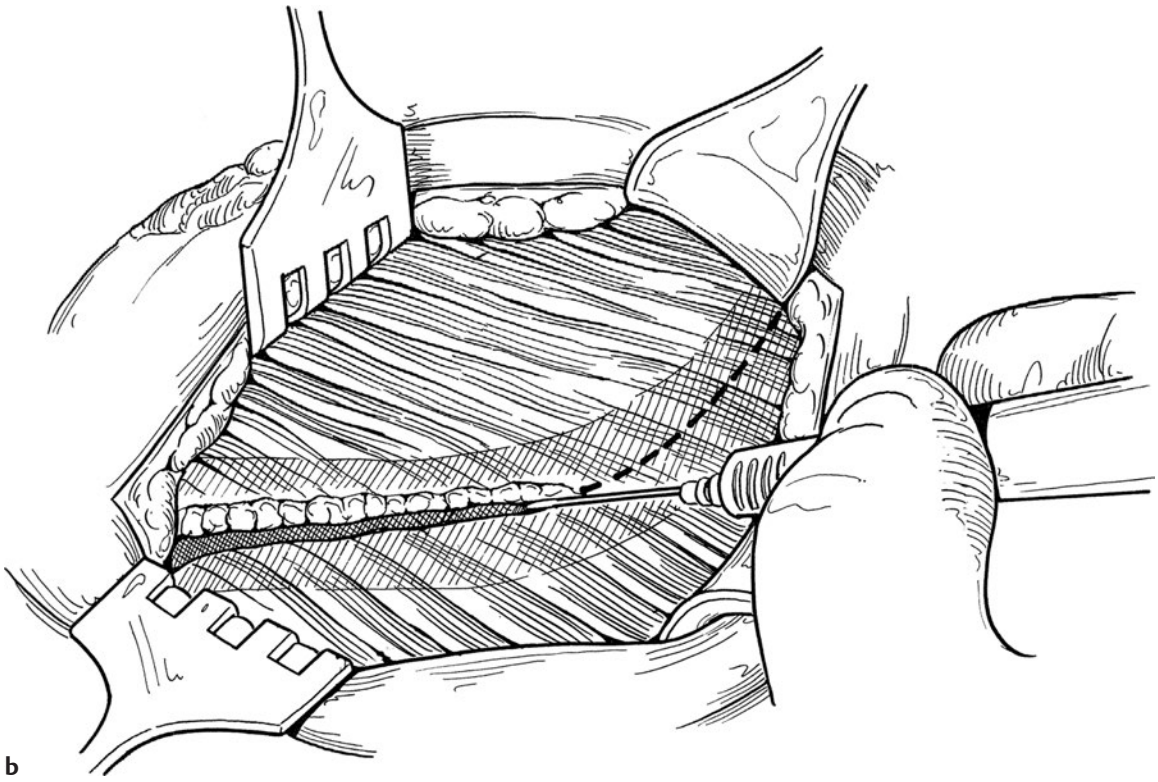
1. After the larynx has been exposed, the surgeon re-gowns and re-gloves to harvest for the costal cartilage graft. This avoids contamination of the sterile chest wound.
2. An incision is made over the fourth or fifth rib where the inframammary crease would be expected (**Fig. 26.12a**).
3. The incision is carried through the subcutaneous tissues and muscle to the rib cartilage perichondrium (**Fig. 26.12b**).
4. The rib is exposed by releasing the overlying fibrous attachments with a scissors, taking care to keep the perichondrium intact.
5. The rib perichondrium is cut at the upper and lower border with a Bovie or Cottle elevator, releasing the intercostal muscles (**Fig. 26.12c**).
6. The deep perichondrium is dissected off of the rib using a periosteal elevator, taking care to leave it intact to avoid a pneumothorax. The dissection is completed with a Doyan rib elevator (**Fig 26.12d,e**).
7. The rib is cut at the costochondral junction with a knife and then as far medially as possible. It is placed in a saline-soaked sponge until needed (**Fig. 26.12f**).
8. Saline is placed in the wound, and the lung is expanded to be certain there is no air leak (e.g., pneumothorax).
9. If a laceration of the parietal pleura is encountered, the defect is closed with 3-0 interrupted chromic suture.
10. The wound is closed with 3-0 interrupted chromic suture in the subcutaneous tissues and a Penrose drain is placed (**Fig. 26.12g**).
11. The skin is closed with 4-0 running subcuticular Vicryl or Prolene suture. A small gauze dressing is applied.
12. A postoperative chest X-ray is taken after completing the laryngotracheoplasty.

Complications

1. Pneumothorax
2. Atelectasis



a



b

Fig. 26.12a,b

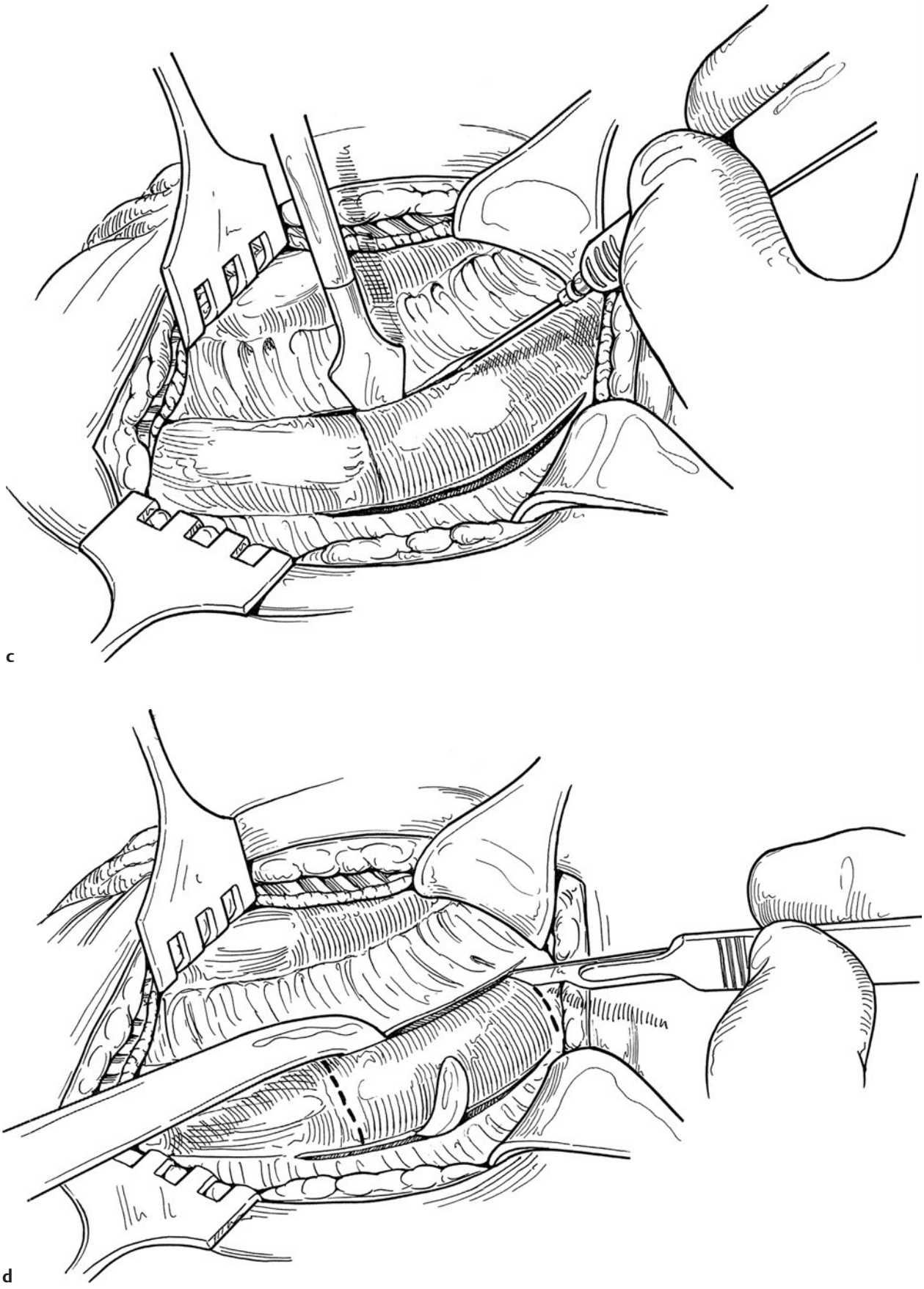
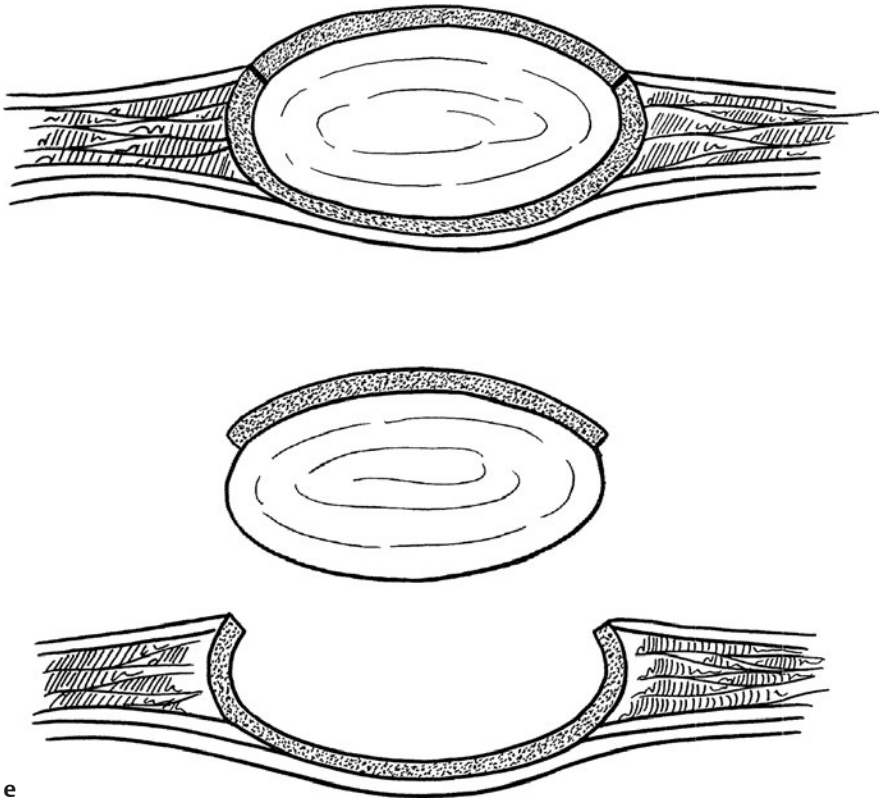
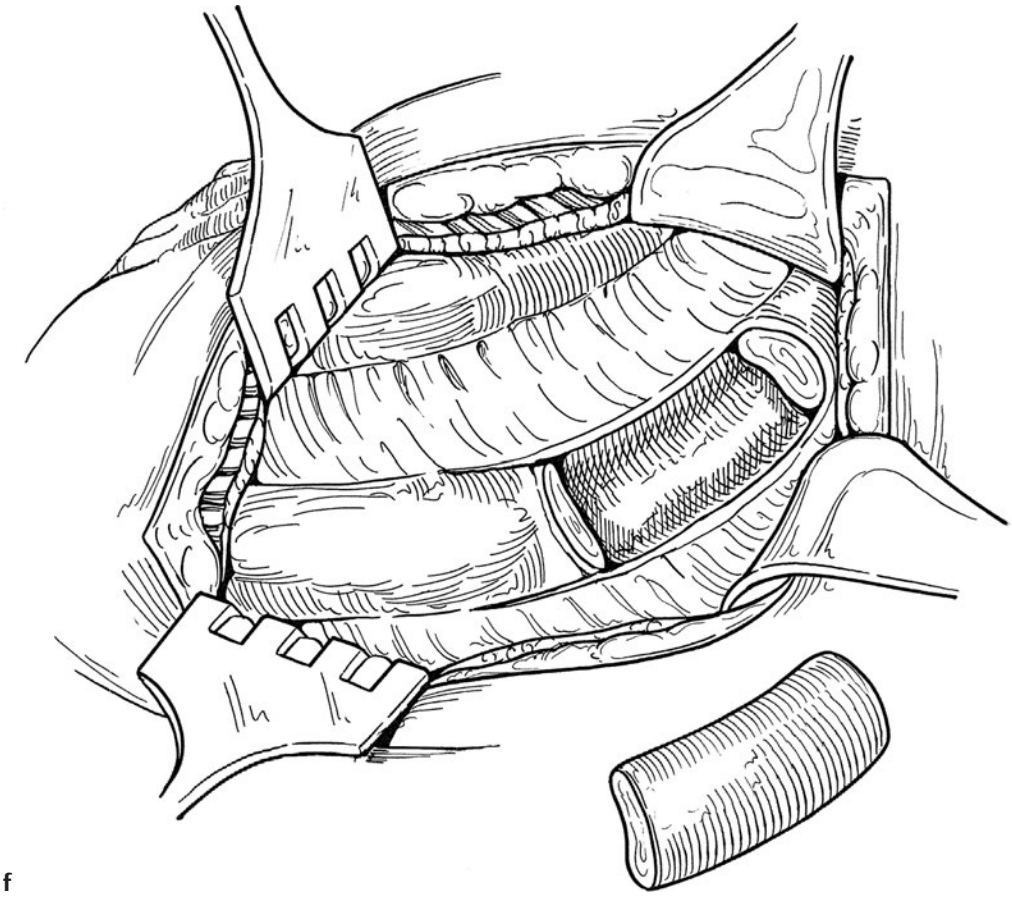


Fig. 26.12c,d

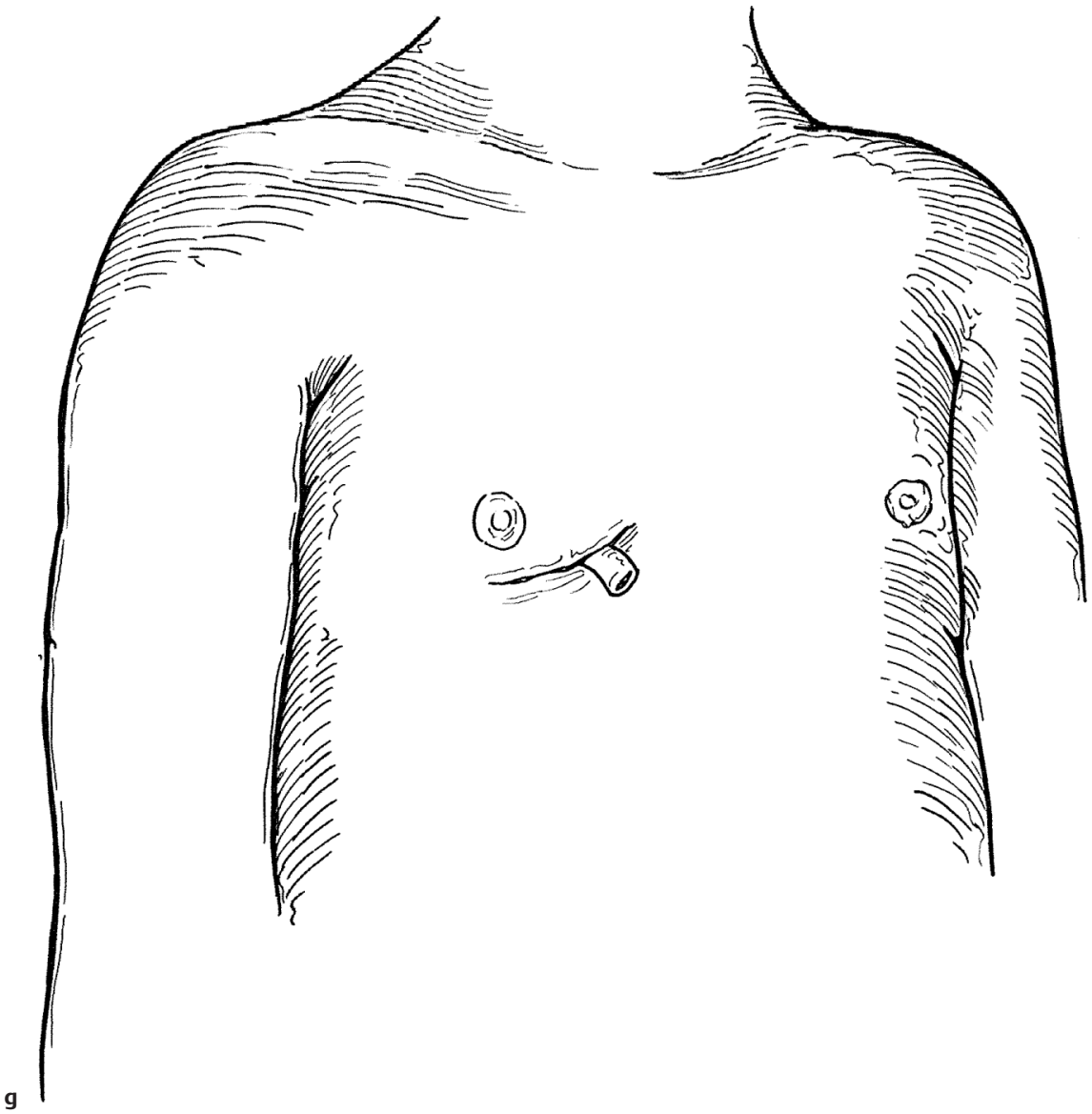


e



f

Fig. 26.12e,f



g

Fig. 26.12g

26-13 Repair of Cleft Larynx and Laryngotracheoesophageal Cleft

Alessandro de Alarcon

Introduction

A cleft larynx is a congenital deformity that may vary in severity from a small notch in the interarytenoid region to a complete cleft through the posterior lamina of the cricoid and into the cervical esophagus (**Fig. 26.13a–d**).

Indications

Repair of a cleft larynx is indicated when the cleft causes debilitating aspiration or airway obstruction.

Preoperative Evaluation

Preoperative evaluation may include a swallowing assessment (video swallowing study [VSS] functional endoscopic evaluation of swallowing [FEES]). Endoscopy should be performed to evaluate the extent of the cleft and identify additional airway pathology such as subglottic stenosis, tracheomalacia, and tracheoesophageal fistula. In some cases, it is also prudent to perform esophagoscopy and flexible bronchoscopy prior to surgical treatment.

Operative Techniques

The length of the cleft determines the surgical approach. Children with type I and type II clefts are generally good candidates for endoscopic repair, whereas children with more extensive clefts generally require open repair.

Open Repair

1. Closure of a laryngeal cleft is performed under general anesthesia.
2. After the airway is exposed, a tracheostomy may be performed to improve exposure of the cleft. The tracheostomy (see Section 25-1) may be left in place and secured in standard fashion at completion of the operation, according to the surgeon's discretion. If one is already present, an oral RAE tube or a reinforced endotracheal tube is used for ventilation.
3. An esophageal bougie is passed through the mouth into the esophagus to improve exposure of the cleft.
4. A horizontal neck incision is made over the cricoid cartilage after infiltrating the area with 1% lidocaine with 1:100,000 epinephrine (**Fig. 26.13e**).
5. A superior skin flap is developed to the level of the hyoid bone and an inferior skin flap is elevated to expose the upper area of the trachea as described for laryngotracheoplasty (**Fig. 26.13f**).
6. The strap muscles are separated by cutting the midline fascia. These muscles are then retracted laterally with 2-0 silk sutures (**Fig. 26.13f**).
7. A midline incision is made through the cricoid and thyroid cartilages as well as the underlying mucosa. Care is taken to be certain that the incision is in the anterior commissure (**Fig. 26.13g**).
8. The endolarynx is exposed by retracting the laryngeal cartilages laterally with 4-0 Prolene sutures (**Fig. 26.13g**).
9. The midline incision may be extended inferiorly in the trachea if the cleft extends below the cricoid.
10. The margins of the cleft are injected with 1% lidocaine with 1:100,000 epinephrine.
11. The margins of the cleft are excised, taking care to preserve as much laryngeal mucosa as possible (**Fig. 26.13h**).
12. The shelf of the cleft is then divided to facilitate a two-layer closure (**Fig. 26.13i**).
13. Starting inferiorly, the esophageal closure is performed with 4-0 Vicryl interrupted suture, placing the knots in the esophageal and hypopharyngeal lumen (**Fig. 26.13i**). The inferior suture is used for traction before each additional suture is placed. The laryngeal and tracheal mucosa is closed in a similar fashion with 4-0 Vicryl interrupted suture, placing the knots in the lumen (**Fig. 26.13j**).
14. The superior limit of the closure is approximately 2 mm above the level of the vocal process of the arytenoids (**Fig. 26.13k**).
15. The laryngofissure is closed with 4-0 PDS suture in the laryngeal perichondrium and tracheal tissues (**Fig. 26.13l**).
16. The strap muscles are reapproximated in the midline with 4-0 Vicryl suture, and subcutaneous tissues are closed with 4-0 Vicryl as well. A drain is placed in the wound.
17. The skin is closed with 5-0 running Monocryl subcutaneous suture.
18. The oral RAE tube is removed and the tracheotomy tube is replaced (**Fig. 26.13m**).
19. The patient is maintained on intravenous antibiotics until the drains are removed. A nasogastric (NG) tube and the tracheotomy are left in place.
20. Direct laryngoscopy and bronchoscopy are performed 1–2 weeks following repair. If the repair is intact, a swallowing assessment (clinical bedside, VSS, or FEES) is performed. If the child advances to adequate oral intake, the NG tube may be removed.
21. Once the child is deemed appropriate for decannulation, this may be attempted.

Complications

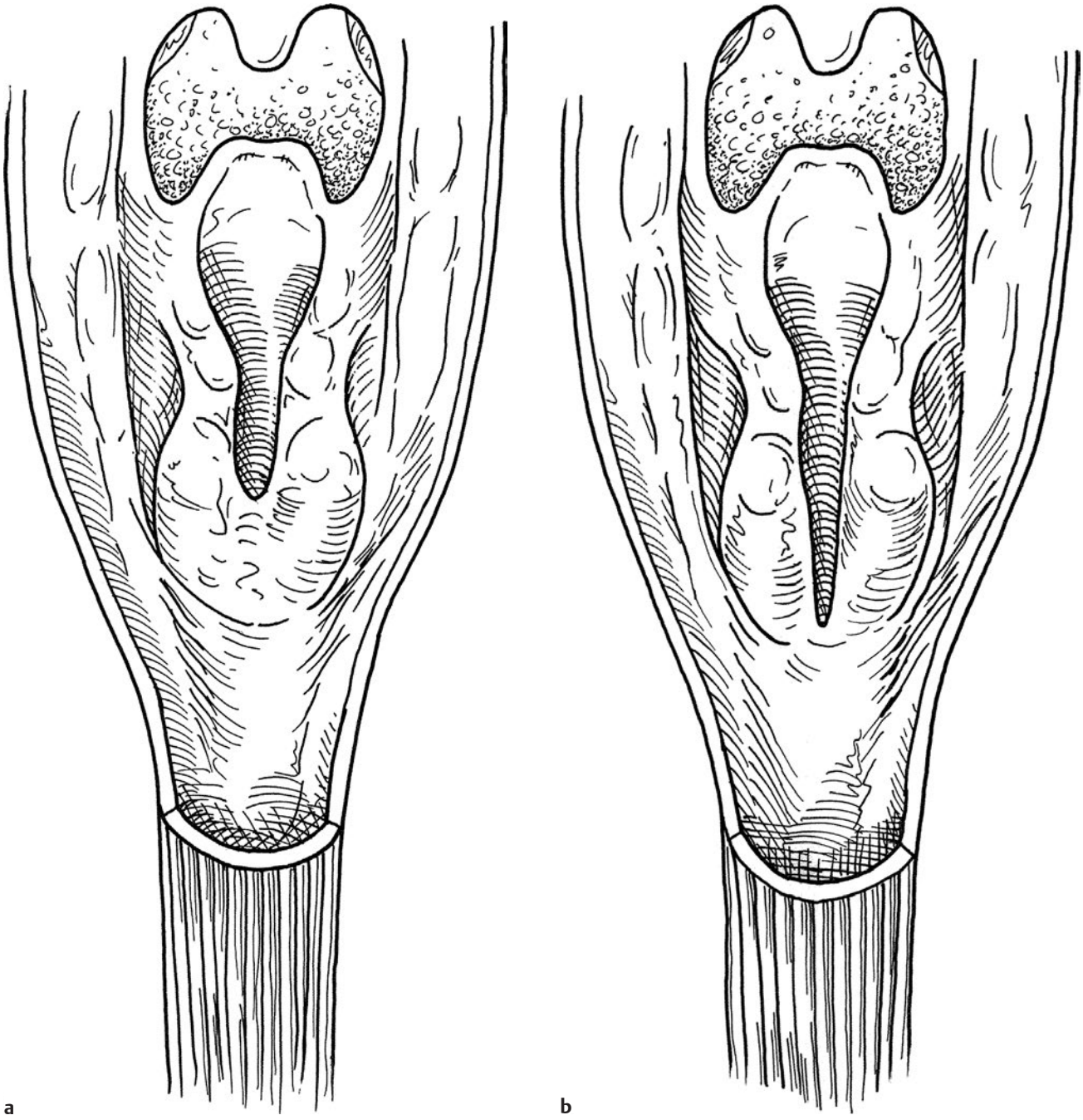
1. Persistent aspiration
2. Recurrence of the laryngeal cleft
3. Partial breakdown of the cleft (TEF)
4. Laryngotracheal stenosis

Endoscopic Repair

1. General anesthesia, along with insufflation, is used in children without a tracheostomy. The larynx is exposed and suspended using a large or medium Lindholm laryngoscope.
2. A false vocal fold retractor is then placed to expose the cleft edges.
3. The cleft edges are then resected using cold instrumentation or are demucosalized using a CO_2 or KTP laser (**Fig. 26.13n**).
4. The cleft edges are then reapproximated using 4-0 or 5-0 interrupted PDS suture, with a knot placed on the esophageal side. Closure should be performed in a distal to proximal fashion (**Fig. 26.13o**).
5. The superior limit of the closure is approximately 2 mm above the level of the vocal process of the arytenoids (see **Fig. 26.13k**).
6. A decision may be made to leave the patient intubated overnight. An NG tube is placed per the discretion of the surgeon. For children with type I clefts, a feeding tube is typically not placed.
7. Direct laryngoscopy and bronchoscopy are performed 4–6 weeks following repair. If the repair is intact, a swallowing assessment (clinical bedside or VSS) is performed. If the child advances to adequate oral intake, the NG tube may be removed. If an NG tube was not placed at the time of surgery, the child may return to the preoperative diet on postop day 1.
8. For the child who is still tracheotomy dependent, decannulation may be attempted when deemed appropriate.

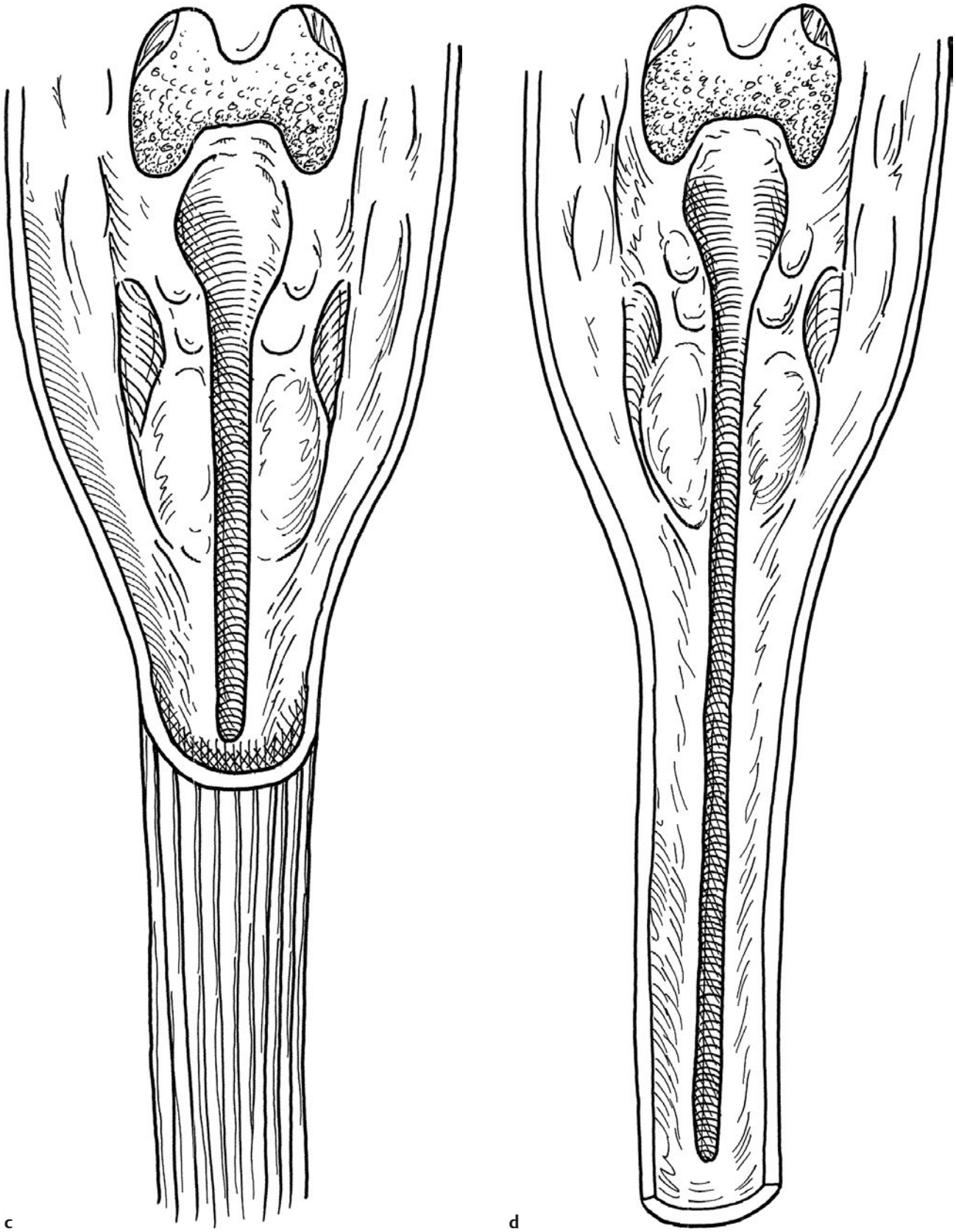
Complications

1. Persistent aspiration
2. Recurrence of the laryngeal cleft
3. Partial breakdown of the cleft (TEF)
4. Laryngotracheal stenosis



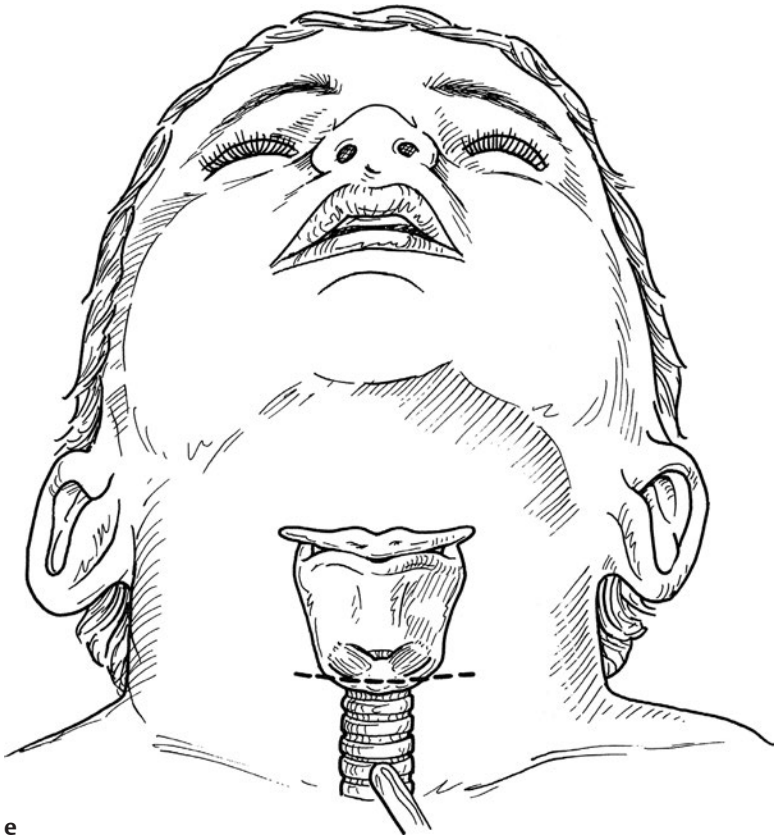
a b

Fig. 26.13a,b

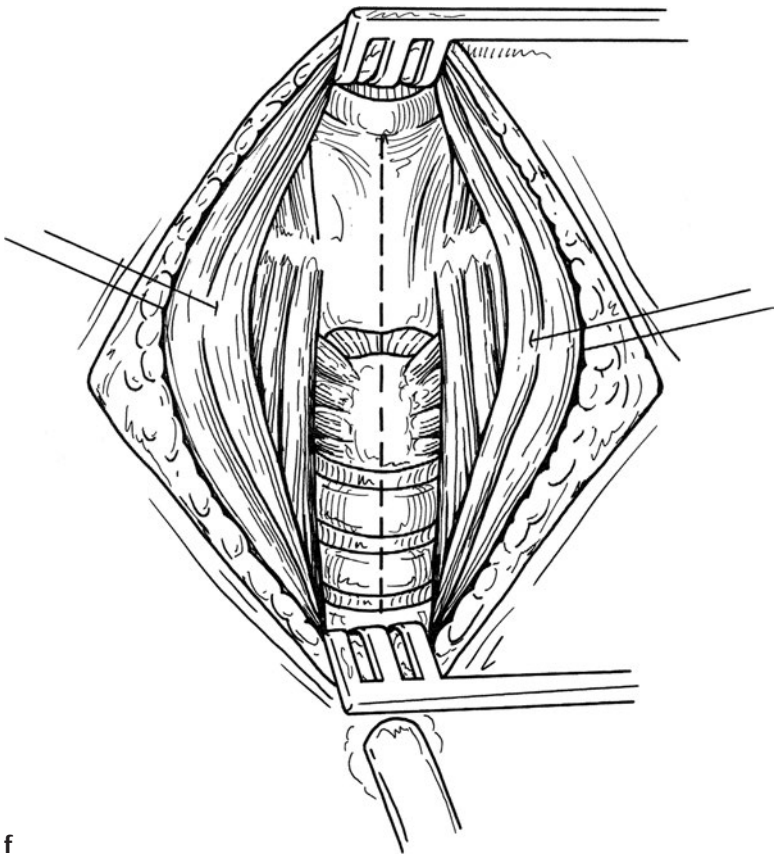


c d

Fig. 26.13c,d

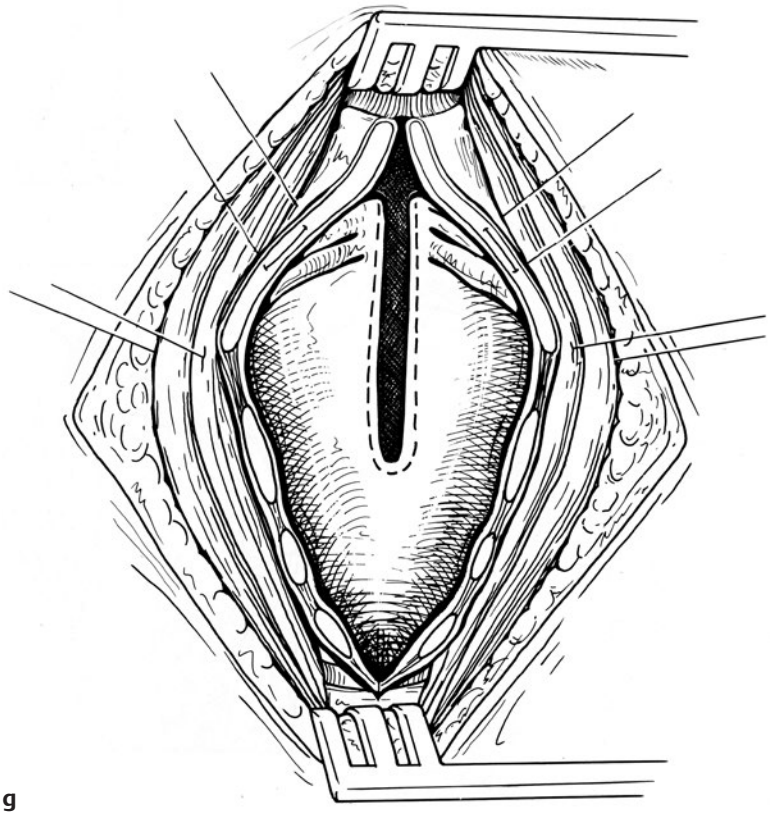


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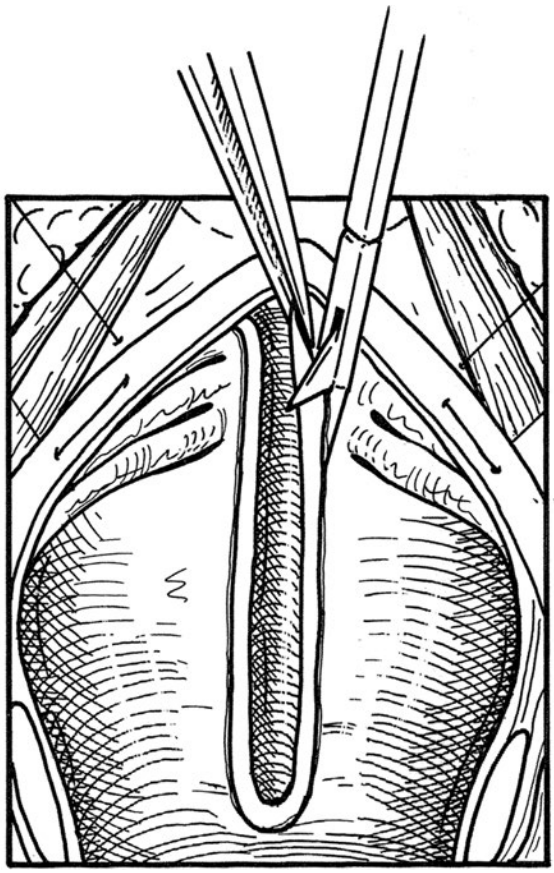


f

Fig. 26.13e,f

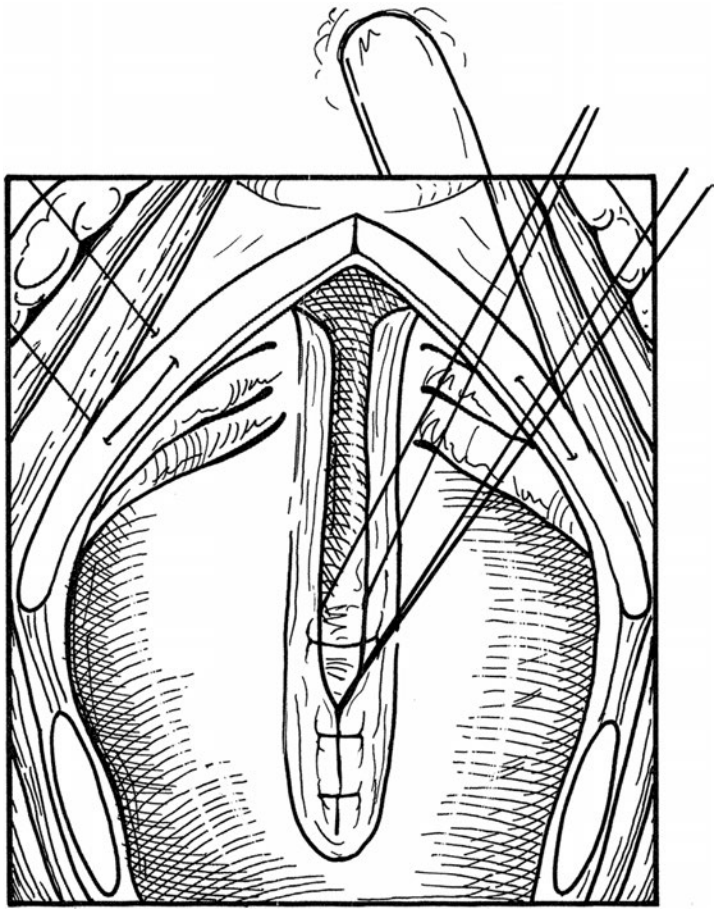


g

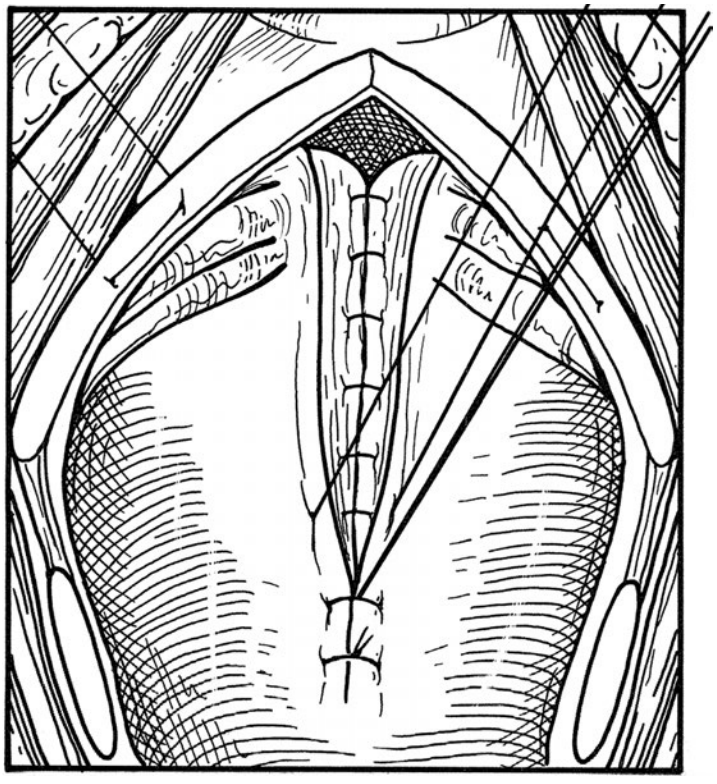


h

Fig. 26.13g,h

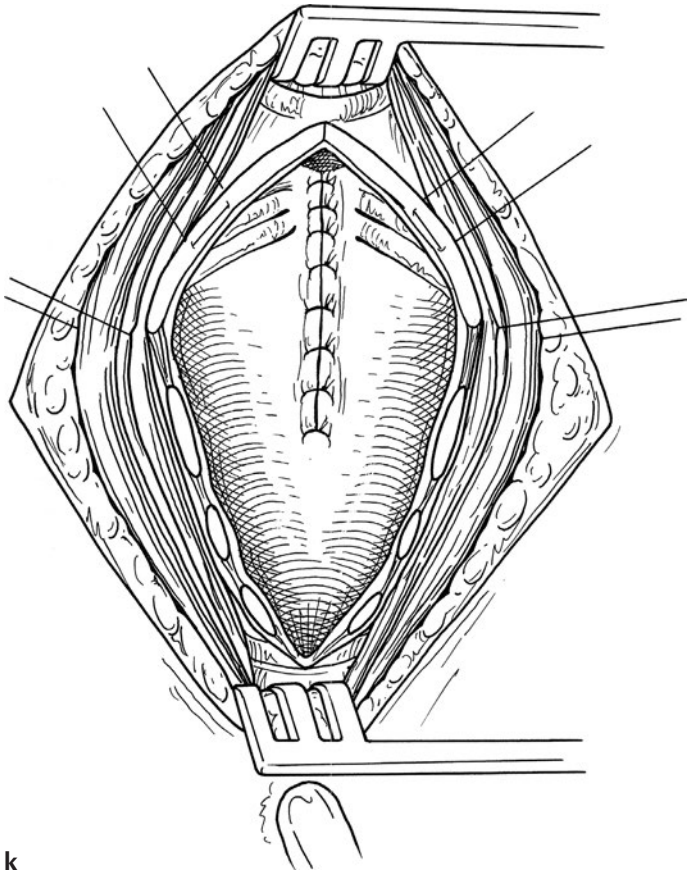


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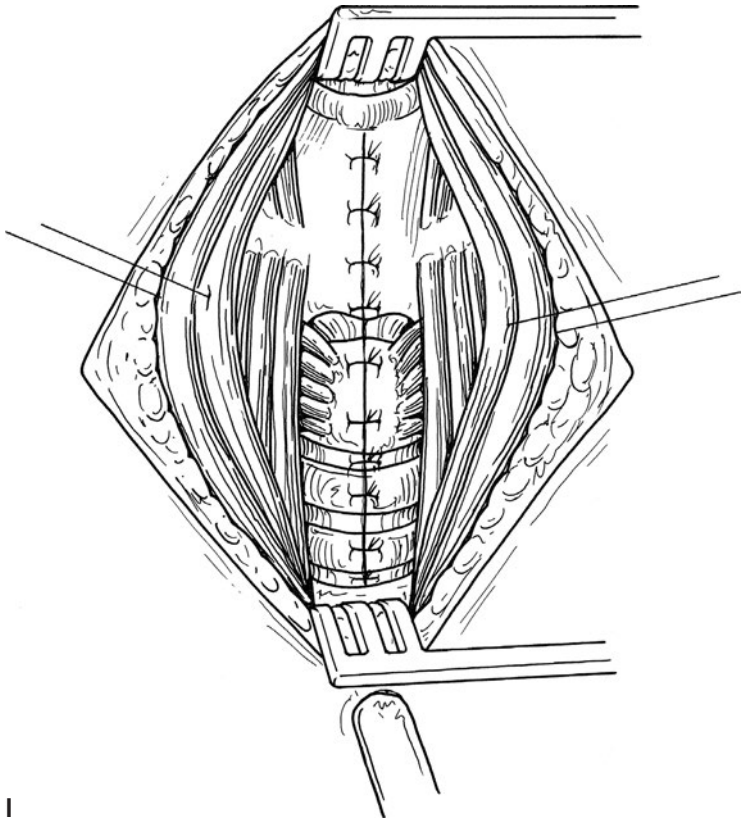


j

Fig. 26.13i,j

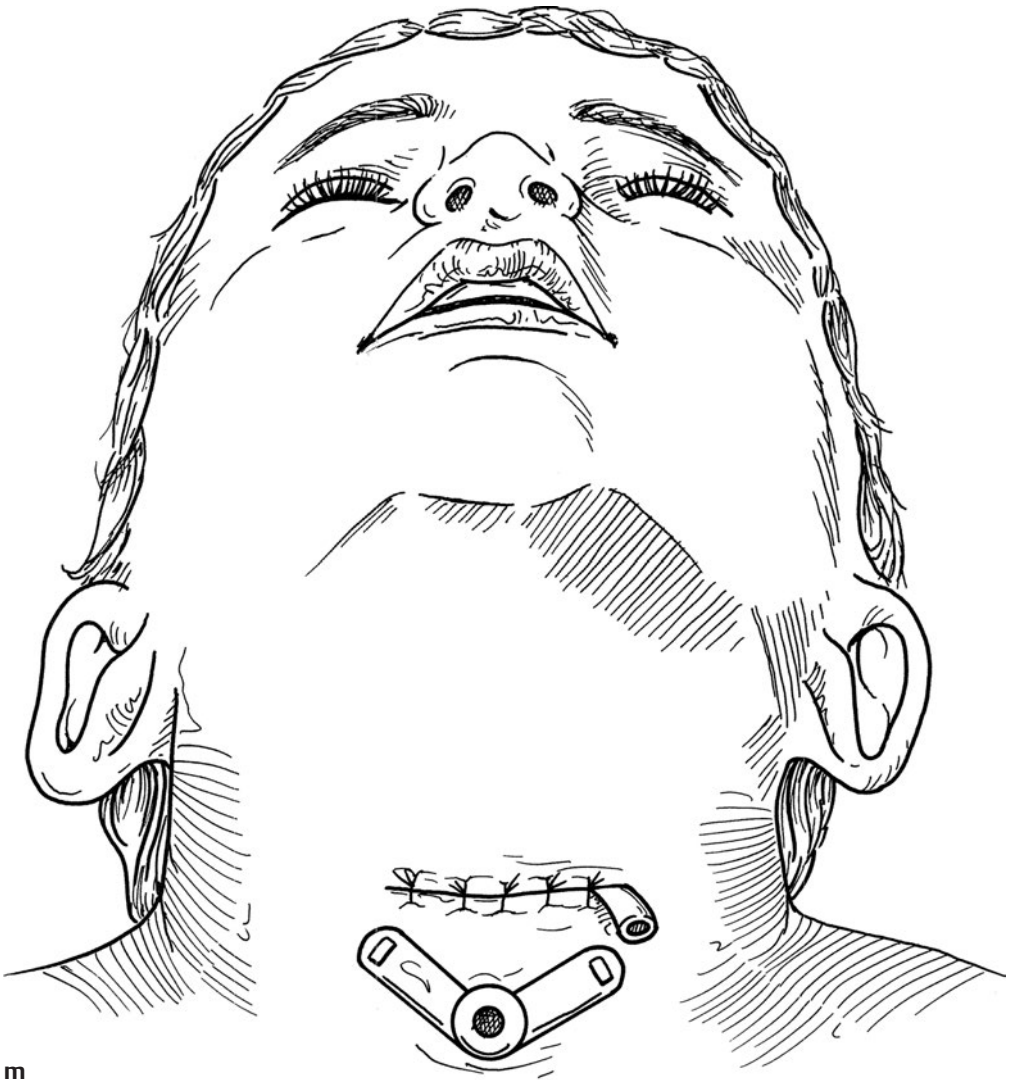


k



l

Fig. 26.13k,l

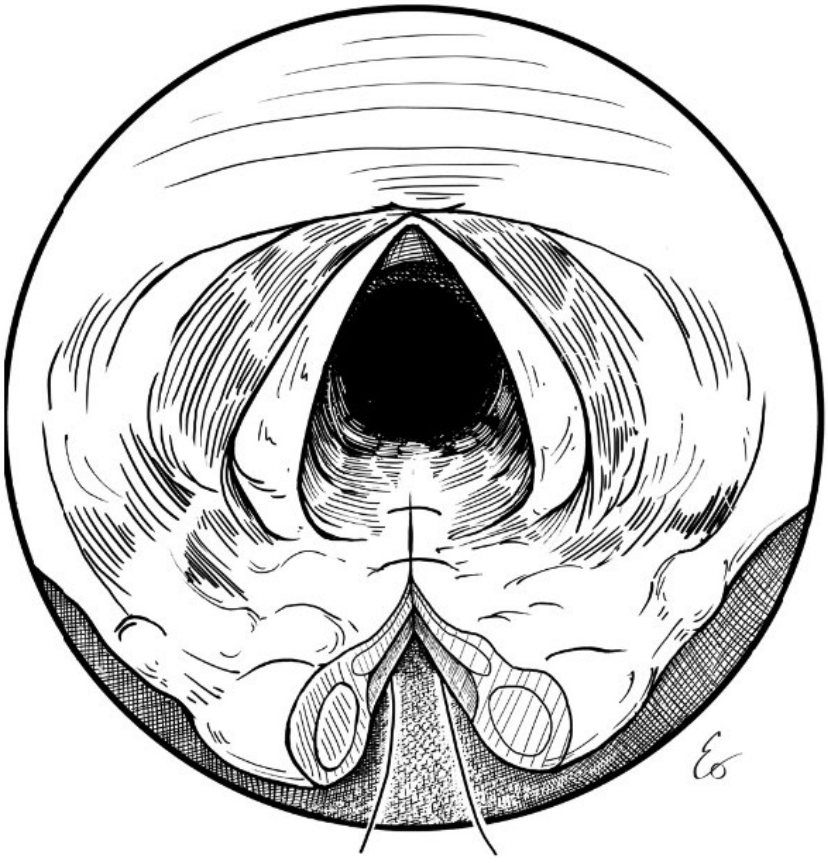


m

Fig. 26.13m



n



o

Fig. 26.13n,o

26-14 Division of Laryngeal Web

Luv R. Javia

Introduction

A laryngeal web occurs when there is fusion of all or part of the vocal cords. This most often presents as a congenital anomaly, although it can be acquired from laryngeal trauma or surgery. Small anterior webs may present with dysphonia or have no presenting symptoms at all. Larger webs are associated with varying degrees of respiratory distress, as the laryngeal lumen is compromised, and vocal alteration (usually high-pitched) or dysphonia. Laryngeal webs can be associated with 22q11.2 deletion syndrome (velo-cardio-facial syndrome).

Indications

Small asymptomatic laryngeal webs require no treatment. Treatment is directed toward relieving airway obstruction and improving vocal quality.

Preoperative Evaluation

Flexible and rigid laryngoscopy and bronchoscopy are required in the preoperative evaluation of a laryngeal web. Bronchoscopy is indicated to determine the thickness of the web and its potential response to simple division. Thin webs are not well seen in conventional radiographs. CT or MRI may demonstrate the presence and extent of thicker webs. Pulmonary function studies may be used to determine the degree of preoperative airway obstruction and the necessity for surgery. Genetics evaluation should also be considered due to its association with 22q11.2 deletion syndrome.

Operative Technique

Thin Webs

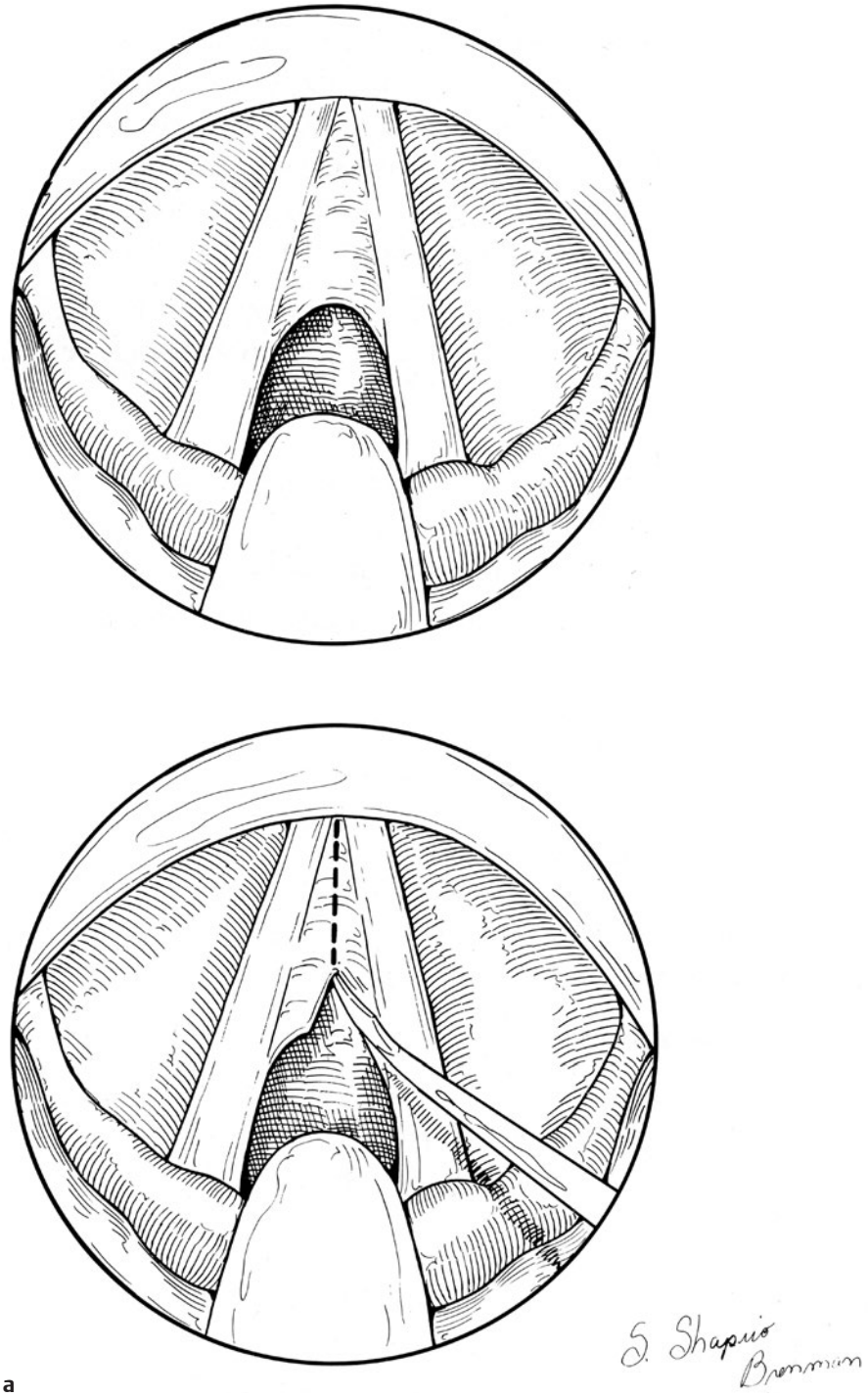
1. Thin webs are incised endoscopically under general anesthesia with a small endotracheal tube in place. If a laser is used to divide the web, a laser-resistant tube must be used in addition to standard laser safety protocols. Alternately, for better visualization, if tolerated by the patient, the tube can be removed just prior to division of the web.
2. A Lindholm, Jako, or Benjamin laryngoscope is placed to expose the larynx, exposing the anterior commissure and full extent of the web. The laryngoscope is placed into suspension.
3. The web is divided all the way to the anterior commissure with a laryngeal sickle blade, scissors, or a laser, taking care not to cut into the substance of the true vocal cords (**Fig. 26.14a**).
4. The child can be left intubated for 24 hours to keep the vocal cords apart to help prevent reformation of the web.
5. Recurrent webs can be lysed again and careful balloon dilation with suspension laryngoscopy can be employed as an adjunct treatment option.
6. Recurrent webs or high-grade thin webs (limited to glottis) may necessitate placement of a laryngeal silicone keel. This can be done endoscopically.
7. The web is divided as described above with a laryngeal sickle blade, scissors, or a laser, carefully done to avoid the true vocal cords (see **Fig. 26.14a**).
8. A silicone keel is fashioned from 0.5-mm thick reinforced silicone sheeting shaped as a rectangle with curved edges. The size is such that the length of the keel is at least 5–10 mm above and below the glottis. And the width is at least twice the length of the web, such that when it is folded lengthwise, the silicone will overlap/protect the raw edges of the cut web.
9. A 2-0 or 3-0 Prolene suture is placed through the keel near the superior and inferior edges.
10. An 18-gauge needle is passed through the cricothyroid membrane and into the airway under direct endoscopic visualization.
11. Once the beveled edge of the needle is seen in the airway, the ends of the distal suture on the silicone keel are advanced through the needle using an alligator forceps under endoscopic guidance. Once the ends are pulled through the skin, the needle can be removed (**Fig. 26.14b**).
12. This is repeated for the proximal suture on the silicone keel. An 18-gauge needle is passed through the thyrohyoid membrane at the level of the thyroid notch and is advanced into the lumen of the airway above the level of the vocal cords at the petiole of the epiglottis.
13. The ends of the proximal suture on the silicone keel are fed through the needle using an alligator forceps under endoscopic guidance. Once the ends are pulled through the skin, the needle can be removed.
14. The keel sutures are pulled through the neck, thus securing the silicone keel into the anterior glottis along the raw edges of mucosa (**Fig. 26.14c**).
15. The keel sutures are secured along the anterior neck with buttons and Telfa (**Fig. 26.14d**).
16. In adolescents, a concurrent tracheostomy may not be needed; however, due to smaller diameter airways in younger children, a temporary tracheotomy should strongly be considered to secure the airway.
17. The keel is left in place for 2 weeks and removed in the operating room under endoscopic visualization and suspension laryngoscopy.

Thick Webs

1. If the web is thick and has subglottic involvement, it is best treated with an open procedure. These children may already have a tracheotomy to maintain a safe airway.
2. A laryngotracheal reconstruction with an anterior costal cartilage graft and possible posterior graft may be needed to fully address this type of web with subglottic involvement (see Section 26-9).

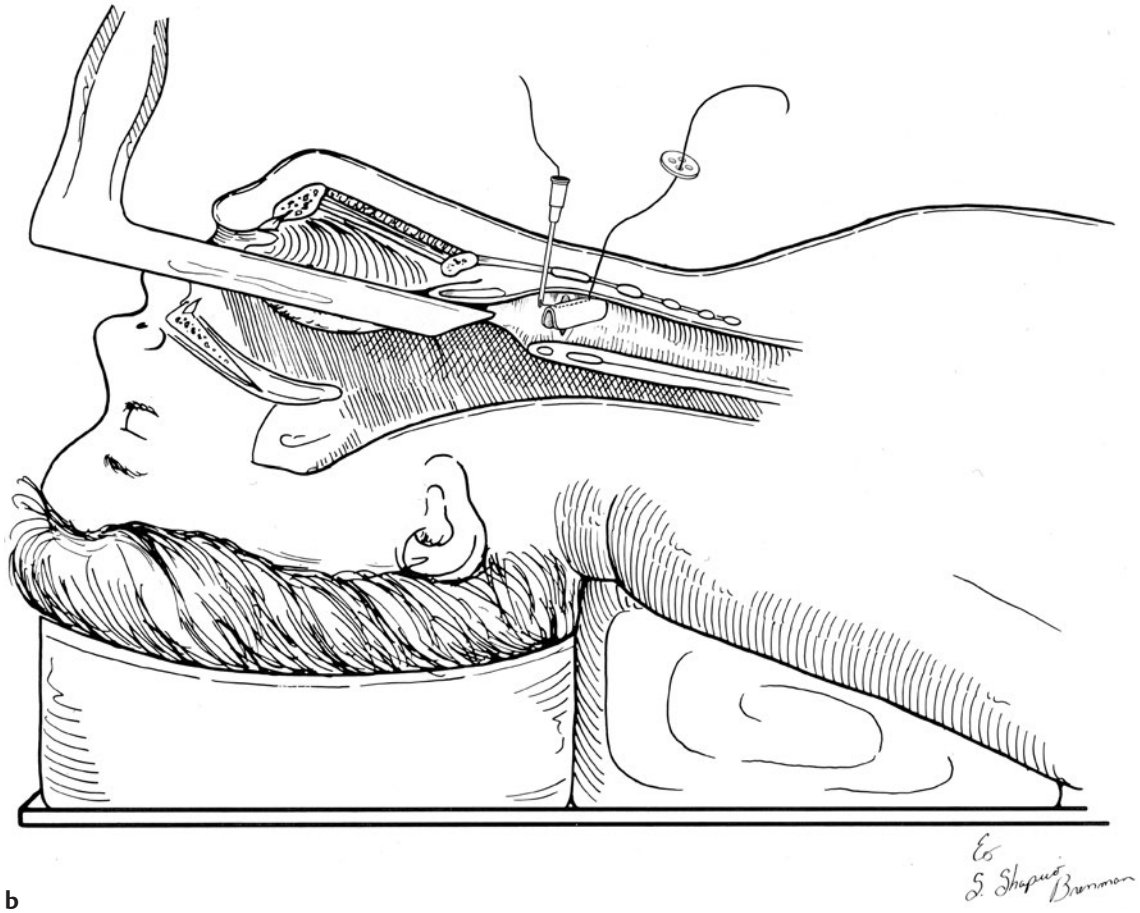
Complications

1. Recurrence of laryngeal web
2. Laryngeal/subglottic stenosis
3. Poor vocal quality—hoarseness, breathiness
4. Laryngeal incompetence
5. Aspiration of Keel

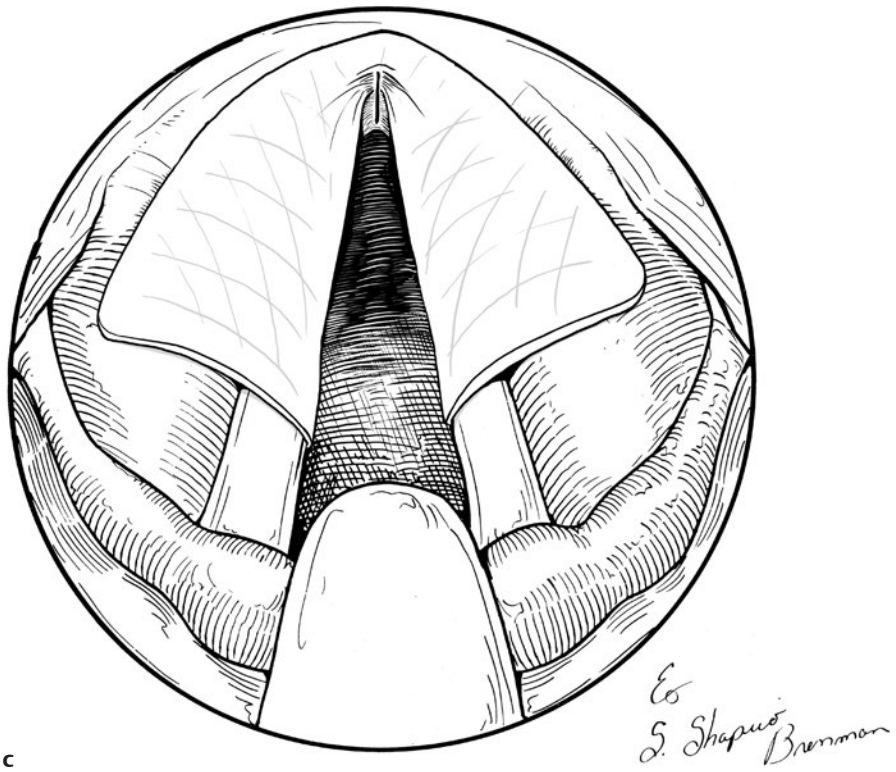


a

Fig. 26.14a



b



c

Fig. 26.14b,c



d

Fig. 26.14d

26-15 Excision of Laryngeal Papilloma

Ravindhra G. Elluru

Introduction

Laryngeal papillomatosis arises from an infection of the epithelial lining of the larynx with HPV subtypes 6 and 11. HPV infection leads to the development of single to multiple reoccurring tumors of the lining of the respiratory tract, leading to hoarseness and respiratory compromise. Laryngeal papillomatosis can present at any age, with time of presentation and the severity of symptoms depending on the number and size of the papillomas present. In addition to surgical debulkment, several adjuvant therapies have been advocated for management.

Indications

Indications for the excision of laryngeal papillomas include significant voice changes and/or respiratory insufficiency.

Preoperative Evaluation

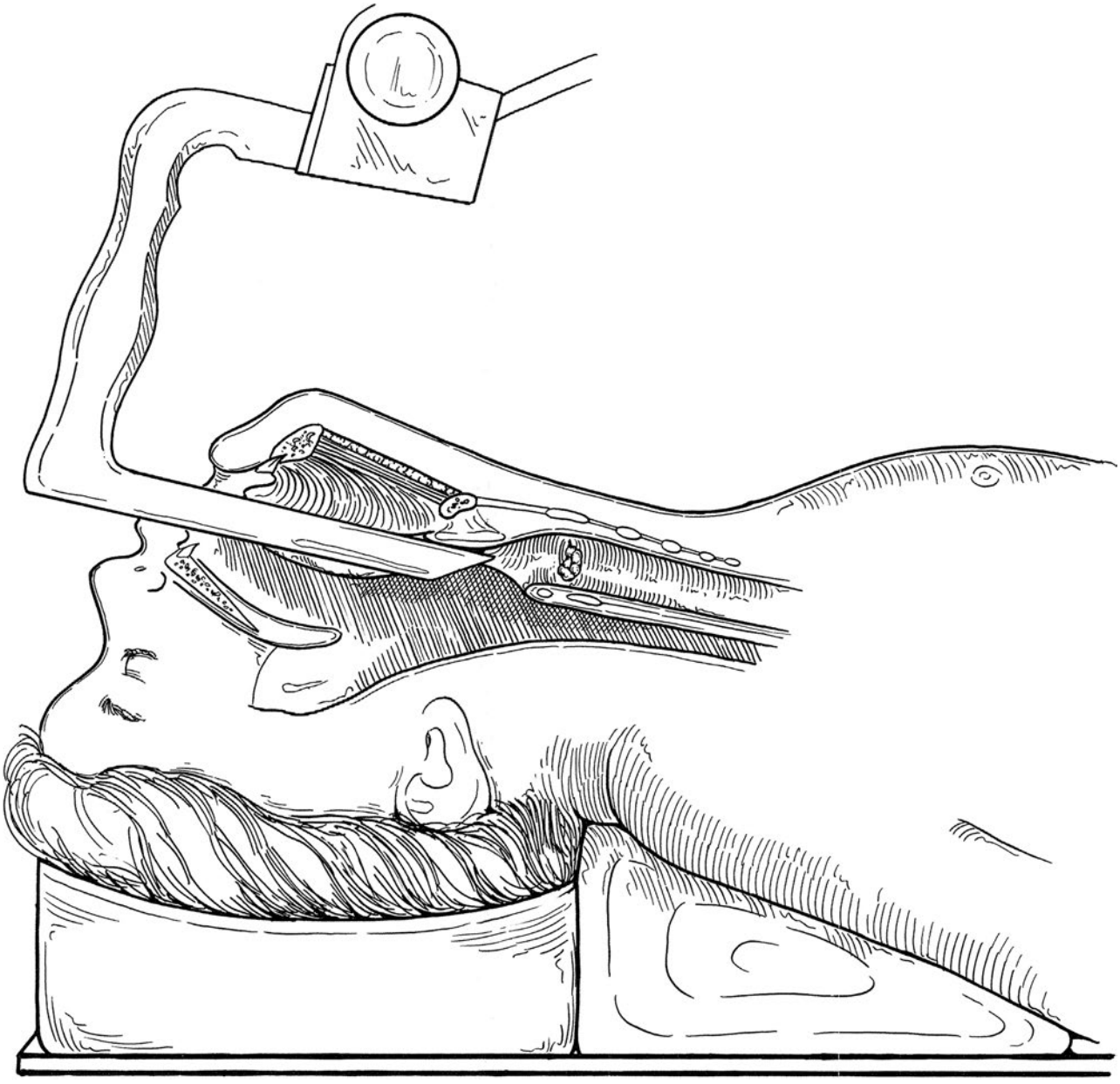
Diagnosis of laryngeal papillomas requires evaluation of the larynx and respiratory tract to determine extent of the disease, and a biopsy for pathological evaluation. Biopsy specimens are evaluated histologically and immunostained to determine the subtype of HPV present. Radiological imaging of the chest is sometimes indicated to rule out lung involvement.

Operative Technique

1. In children, laryngeal papillomas are excised in the operating room under general insufflation anesthesia with spontaneous ventilation. The operating room staff must wear and employ appropriate safety equipment to prevent both direct contact and inhalation of body fluids and/or fumes. Intravenous steroids can be administered prior to starting the case to reduce postoperative laryngeal edema.
2. A Jako or Lindholm laryngoscope of the appropriate length for the size of the child is positioned and suspended to expose the larynx and free the surgeon's hands (**Fig. 26.15a**). A dental guard can be used to minimize trauma to the maxillary incisors.
3. There are three different tools that can be used to excise laryngeal papillomas: CO_2 laser, KTP laser, and microdebrider.
4. CO_2 laser: Wet towels are draped around the laryngoscope to prevent damage from potential misfiring of the laser beam.
   a. The anesthesiologist is informed to reduce the oxygen concentration (typically below 30%) and to stop using inhalation anesthetics.
   b. A microscope equipped with a 400-mm lens is positioned to visualize the larynx. The CO_2 laser and micromanipulator are attached to the microscope.
   c. The laser beam is fired at individual papillomas with the tissue end-point of charring the papilloma. Care is taken to avoid damage to adjacent normal tissue (**Fig. 26.15b**).
   d. The charred tissue is then removed using a laryngeal suction that the surgeon holds in the dominant hand (**Fig. 26.15c**).
   e. The procedure is repeated on the next papilloma.
   f. Laser settings are dependent on the brand of laser used and should be determined in consultation with the vendor.
5. KTP laser: Wet towels are draped around the laryngoscope to prevent damage from potential misfiring of the laser beam.
   a. An operating microscope with a 400-mm lens is positioned to visualize the larynx. Alternatively, a telescope can be held in the nondominant hand to visualize the larynx.
   b. A 600-micron laser fiber is threaded through an appropriate-sized fiber delivery handpiece, which is then used to deliver the laser beam to individual papillomas.
   c. The laser beam is targeted at the base of the individual papilloma, with the tissue end-point of fulgurating the blood supply to the papilloma and the tissue itself.
   d. Charred tissue is then removed using a laryngeal suction that the surgeon holds in the nondominant hand (see **Fig. 26.15c**).
   e. Laser settings are dependent on the brand of laser used and should be determined in consultation with the vendor.
6. Microdebrider: An operating microscope with a 400-mm lens is positioned to visualize the larynx. Alternatively a telescope held in the surgeon's nondominant hand can be used to visualize the larynx.
   a. A microdebrider blade of appropriate length and curvature is placed down the laryngoscope and papillomas are sharply excised (**Fig. 26.15d**). The settings for the microdebrider are dependent on the brand of equipment used and should be discussed with the vendor.
7. The patient can be intubated at any time during the procedure with an appropriate-size endotracheal tube to obtain an airway and/or tamponade bleeding. Typically, however, the patient can be extubated at the end of the procedure.
8. Oxymetazoline-soaked cotton pledgets can also be placed on areas of bleeding to obtain hemostasis.
9. Adjunctive medical treatments can be administered via a laryngeal needle when the papillomas have been excised as appropriate.
10. The laryngoscope is removed at the end of the case, and the face, mouth, and teeth are examined for injury.

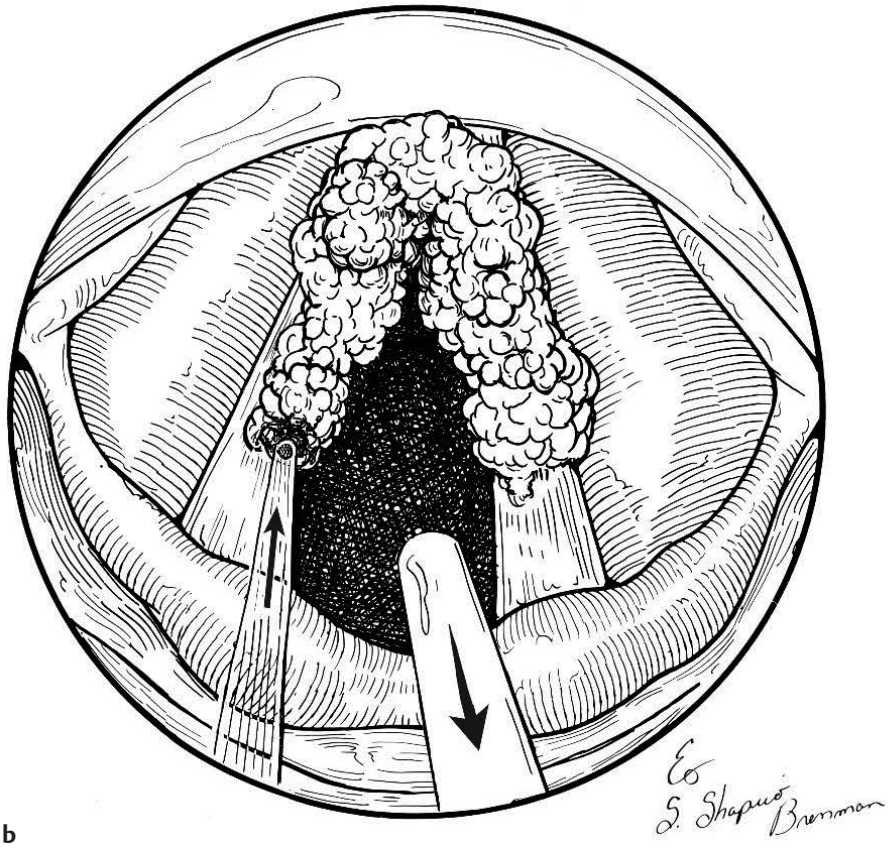
Complications

1. Laryngeal edema
2. Laryngeal stenosis
3. Hoarseness
4. Bleeding
5. Airway fire with laser use

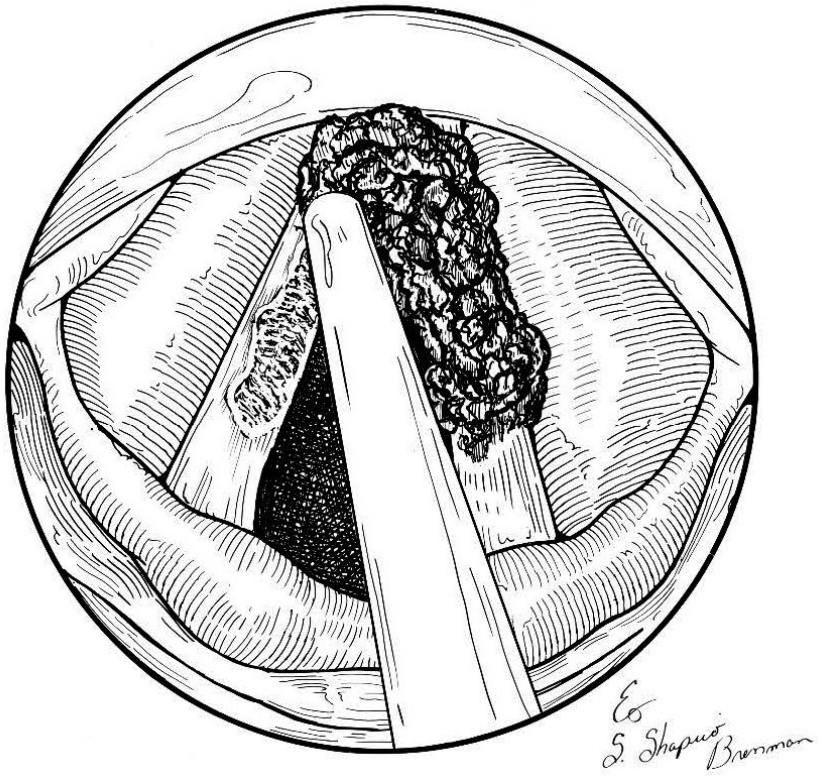


a

Fig. 26.15a

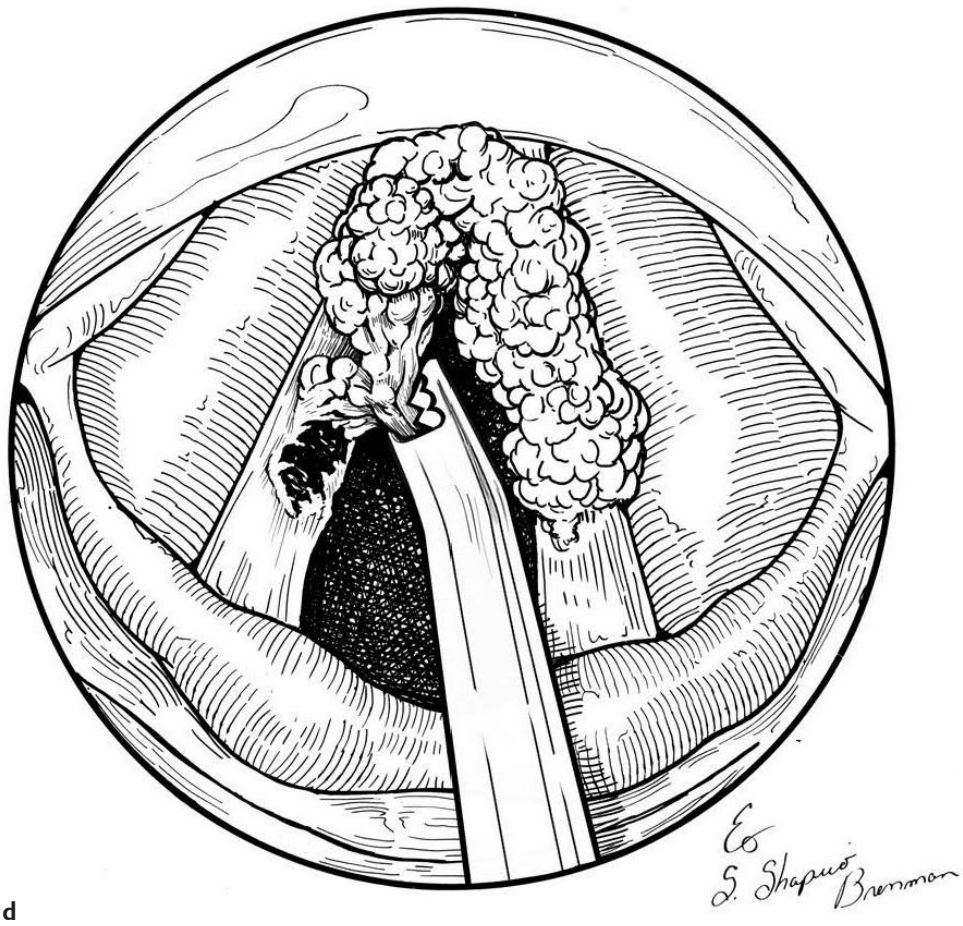


b



c

Fig. 26.15b,c



d

Fig. 26.15d

26-16 Excision of Subglottic Hemangioma

Ravindhra G. Elluru

Introduction

Subglottic hemangiomas are benign vascular tumors that arise within or under the epithelial lining of the subglottis. These tumors grow avidly in the months following birth, blocking the subglottic airway and causing respiratory distress. Subglottic hemangiomas are frequently, but not always, associated with cutaneous hemangiomas.

Indications

The indication for excision of a subglottic hemangioma is stridor and respiratory insufficiency. Excision of the subglottic hemangioma can be used either after failed medical management or as the initial treatment.

Preoperative Evaluation

Prior to excision, an endoscopy is performed to evaluate the extent of the hemangioma. In some cases an MRI of the chest may be needed to rule out extension of the hemangioma outside the airway lumen. A biopsy of the subglottic lesion should be performed in situations where the history and clinical exam do not lead to a clear diagnosis.

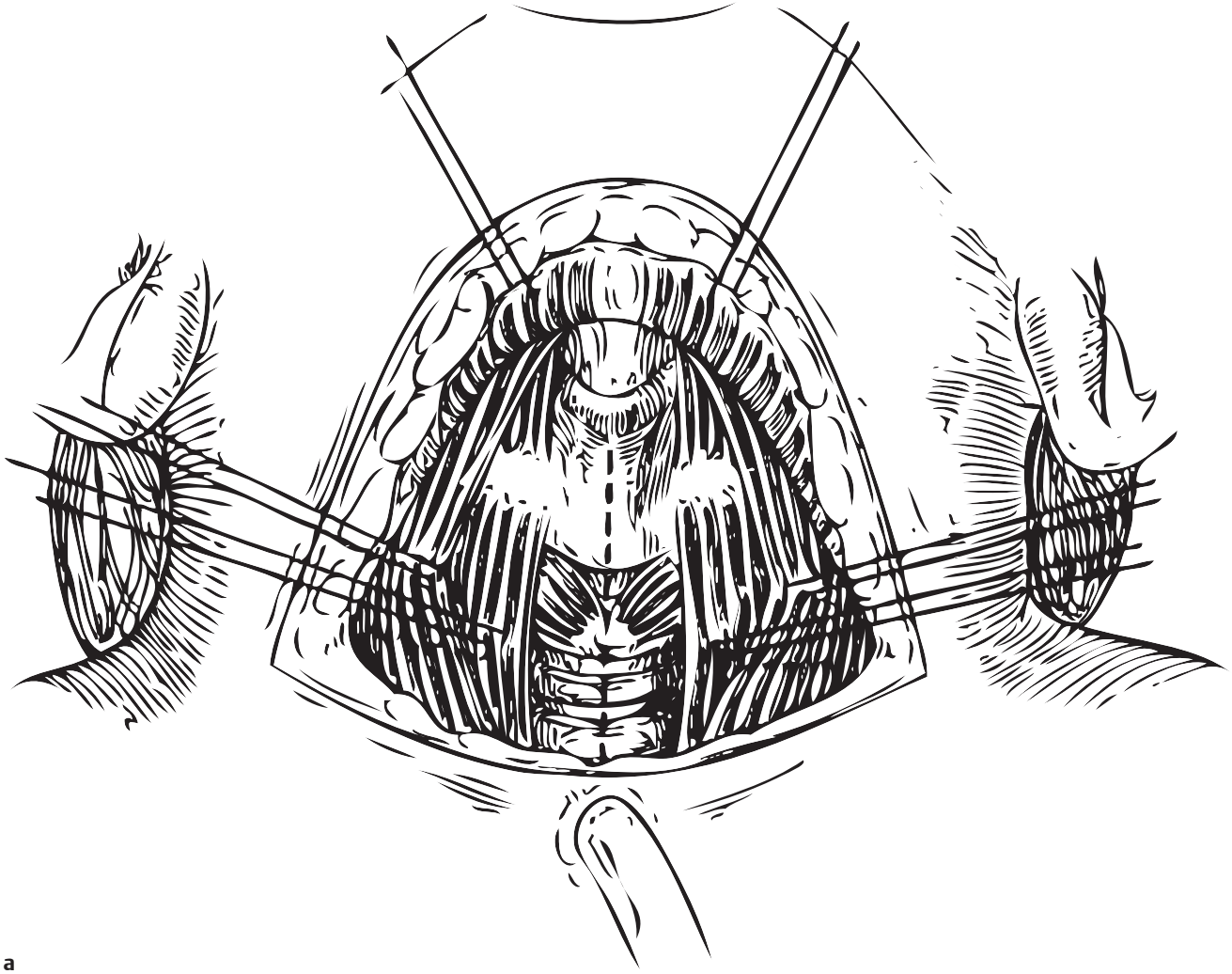
Operative Technique

1. There are two methods to excise a subglottic hemangioma: KTP laser ablation of the subglottic hemangioma, and open excision of the subglottic hemangioma.
2. In general, KTP lasers are used to treat small subglottic hemangiomas.
    a. Patients are typically given a preoperative dose of intravenous steroids.
    b. The larynx is suspended using a Jako or subglottis laryngoscope (see Section 26-4 for additional information).
    c. Wet towels are placed around the laryngoscope to protect the patient from any potential laser misfires.
    d. A microscope equipped with a 400-mm lens is used to visualize the subglottic hemangioma. Alternatively, a telescope can be inserted through the laryngoscope to visualize the subglottic hemangioma.
    e. A 600-micron laser fiber is threaded through a fiber delivery handpiece, which is then used to treat the subglottic hemangioma. The tissue end-point of laser treatment is to fulgurate the hemangioma, with the goal of opening the subglottic lumen.
    f. The surgeon should devise an approach to treating the subglottic hemangioma that minimizes loss of the mucosal lining.
    g. The settings for the laser are dependent on the brand of equipment used and should be discussed with the vendor.
    h. The surgeon uses a laryngeal suction or platform suction in the nondominant hand to suction smoke and any charred tissue.
    i. Oxymetazoline-soaked cotton pledgets on an alligator or cup forceps can be used to obtain hemostasis.
    j. Typically the patient is intubated after the procedure for 24 hours.
3. Open excision is generally used to treat larger subglottic hemangiomas.
    a. The surgical approach is somewhat similar to a laryngotracheoplasty with an anterior graft and is performed under general endotracheal anesthesia.
    b. A horizontal skin incision is made over the level of the cricoid ring, the platysmal muscle is divided, the strap muscles are separated along the midline raphe, and the thyroid isthmus is divided (**Fig. 26.16a**).
    c. The cartilaginous airway is skeletonized from the top of the thyroid cartilage to the first several tracheal rings (**Fig. 26.16b**).
    d. A vertical incision is made in the anterior midline of the cricoid ring and first several tracheal rings opening the airway. The thyroid notch is used as a landmark for the anterior midline. Two 4-0 Prolene stitches are placed through the cut edges of the cricoid ring to retract the airway open (**Fig. 26.16b**).
    e. The endotracheal tube is backed out of the airway, and a sterile endotracheal tube is placed through the tracheotomy to ventilate the patient and allow exposure to the subglottis.
    f. The mucosal lining over the hemangioma is elevated, and the underlying hemangioma are excised using the cartilaginous tracheal rings as the deep margin. The use of fine scissors and bipolar cautery are useful for this dissection (**Fig. 26.16c**).
    g. After the hemangioma is excised, the mucosal lining is gently laid back down against the tracheal cartilage rings.
    h. If the hemangioma occupies both sides of the subglottis, then the above step is repeated on the other half of the subglottis.
    i. A thyroid alar graft is often required to augment the dimensions of the subglottic lumen.
    j. The thyroid alar graft is obtained from the superior edge of the thyroid cartilage. A horizontal incision is made through the thyroid cartilage from the deepest level of the thyroid notch proceeding laterally to the desired length. A round knife is then used to elevate the cartilage off the underlying perichondrium (**Fig. 26.16d**).
    k. The patient is reintubated nasally, and the endotracheal tube that was placed through the tracheotomy is removed.

l. The thyroid alar graft is minimally carved to form a boat shape and is sewn between the cut edges of the cricoid ring with 4-0 PDS using horizontal mattress stitches (**Fig. 26.16e**). The remainder of the tracheotomy is closed using the same stitch to oppose the cut edges of the tracheal rings.
m. The wound is irrigated and fibrin glue may be applied to the closed vertical tracheotomy and graft.
n. The strap muscles are reapproximated with absorbable suture, and the skin is closed in two layers over a quarter-inch Penrose drain.
o. The patient is kept intubated for 2 to 4 days, after which the airway is examined in the operating room under general anesthesia. The patient is then reintubated with an endotracheal tube one-half size smaller and extubated the next morning.
p. The patient is kept on antibiotics for 7 days and reflux medication for 6 months after the procedure.

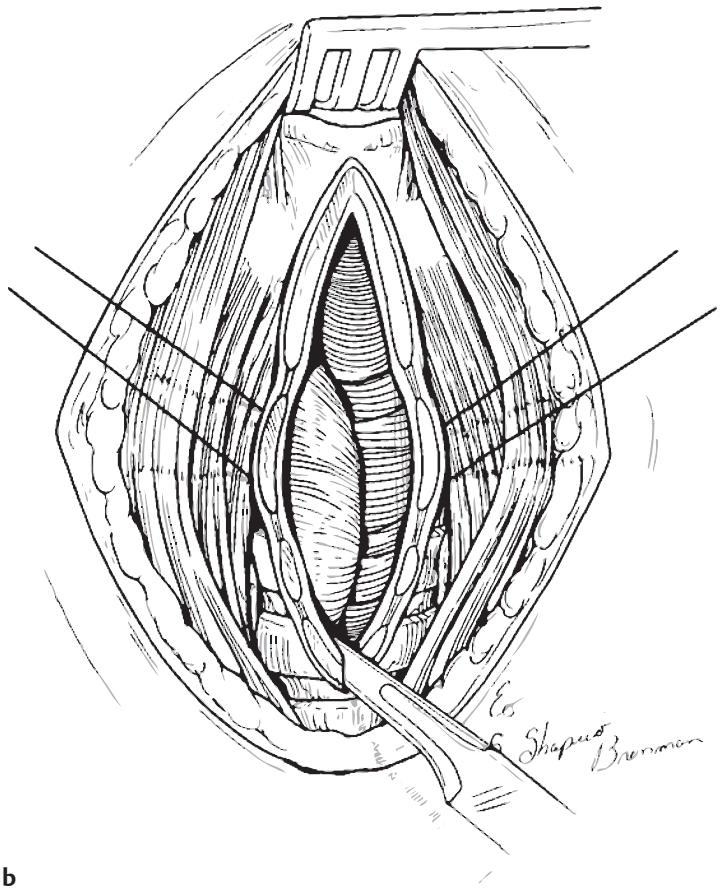
Complications

1. Incomplete excision with growth of the residual hemangioma
2. Subglottic stenosis
3. Scarring of the vocal folds with resultant hoarseness
4. Wound infection
5. Airway fire

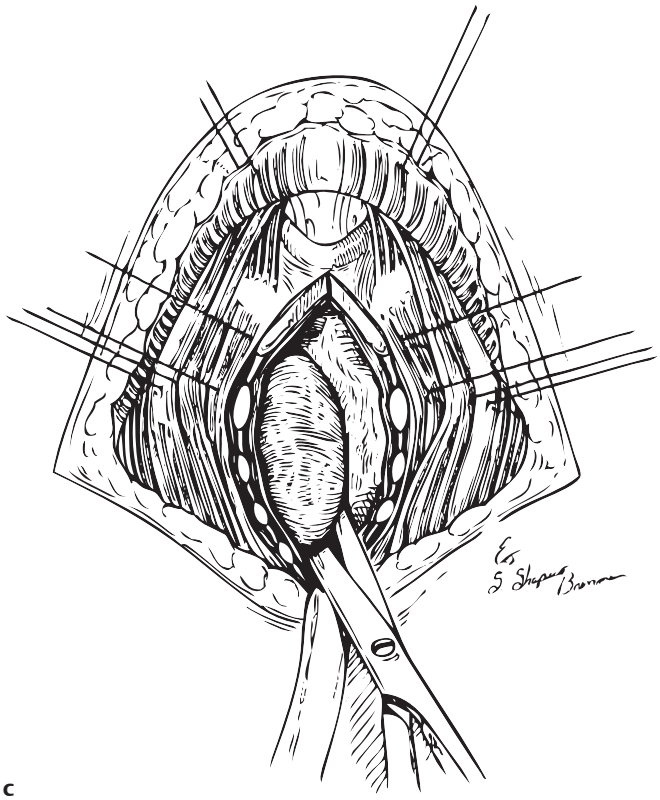


a

Fig. 26.16a

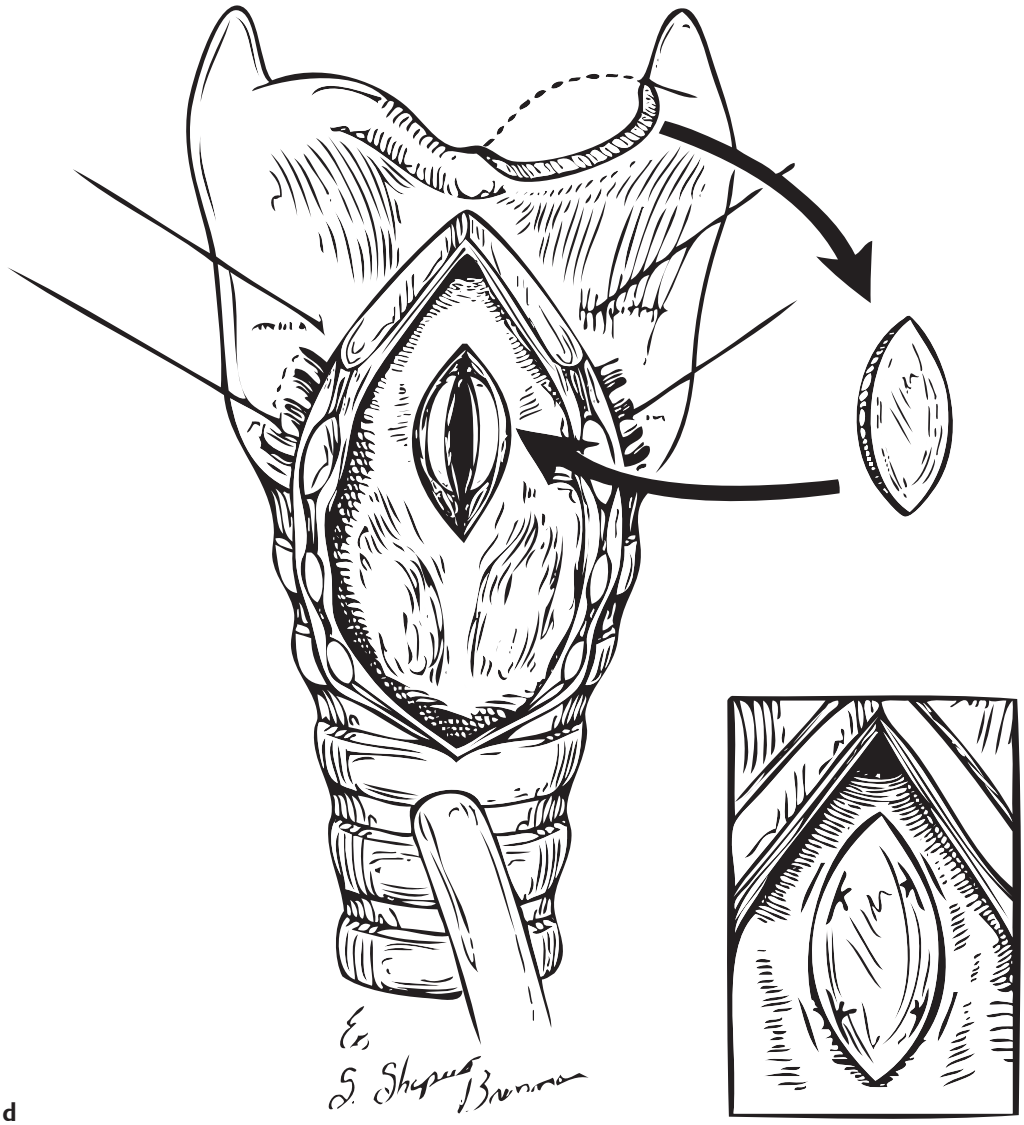


b

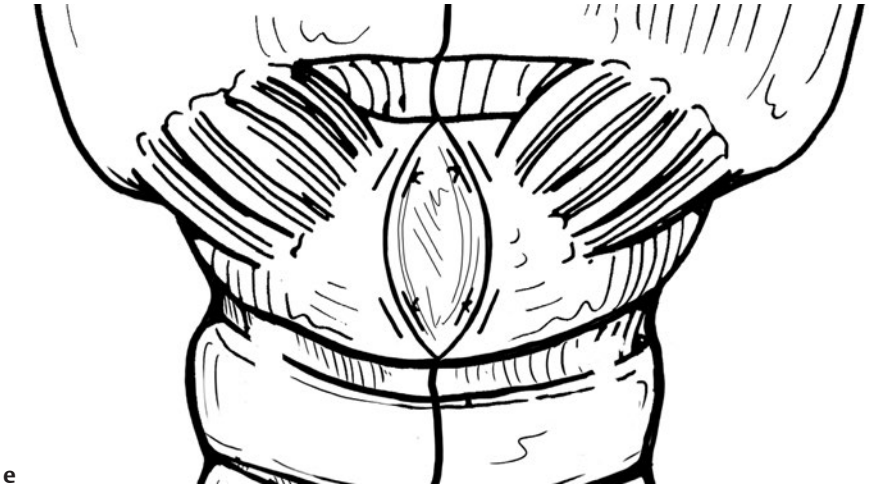


c

Fig. 26.16b,c



d



e

Fig. 26.16d,e

26-17 Laser Cordotomy and Arytenoidectomy

Ian N. Jacobs

Indications

Laser cordotomy is indicated in persistent bilateral vocal cord paralysis in a patient who is unable to be decannulated or one who has significant exertional dyspnea. It is often utilized when a small degree of posterior correction is required. When a greater airway enlargement is needed, a partial laser arytenoidectomy may also be performed as well.

Preoperative Evaluation

A flexible laryngoscopy of the patient while awake helps to assess the dynamics of laryngeal motion. No specific perioperative testing is needed, except for possibly evaluating the risk of aspiration.

Microlaryngoscopy and bronchoscopy are performed under a light plane of general anesthesia. The patient may be suspended and the arytenoid palpated to rule out fixation. In certain circumstances, laryngeal EMG may be performed.

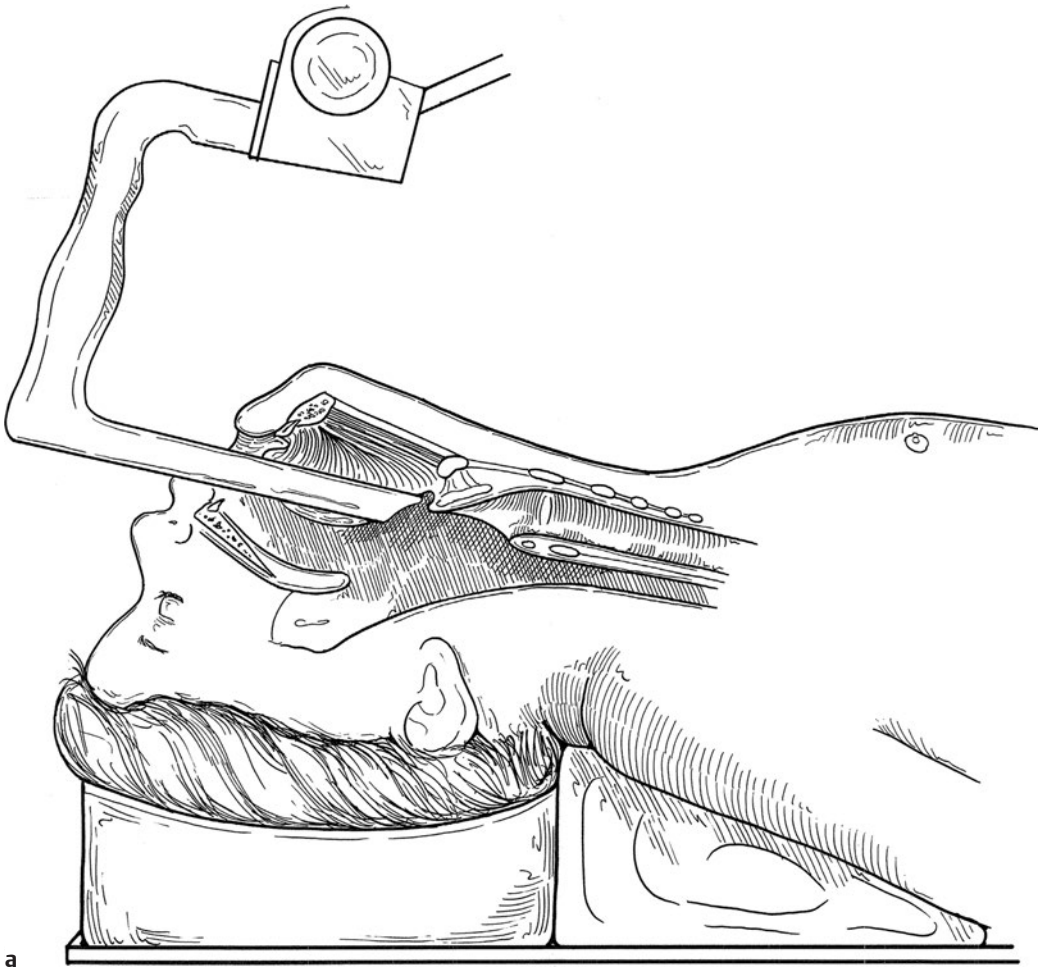
Operative Technique

A flexible laryngoscopy of the patient while awake helps to assess the dynamics of laryngeal motion. No specific perioperative testing is needed, except for possibly evaluating the risk of aspiration.

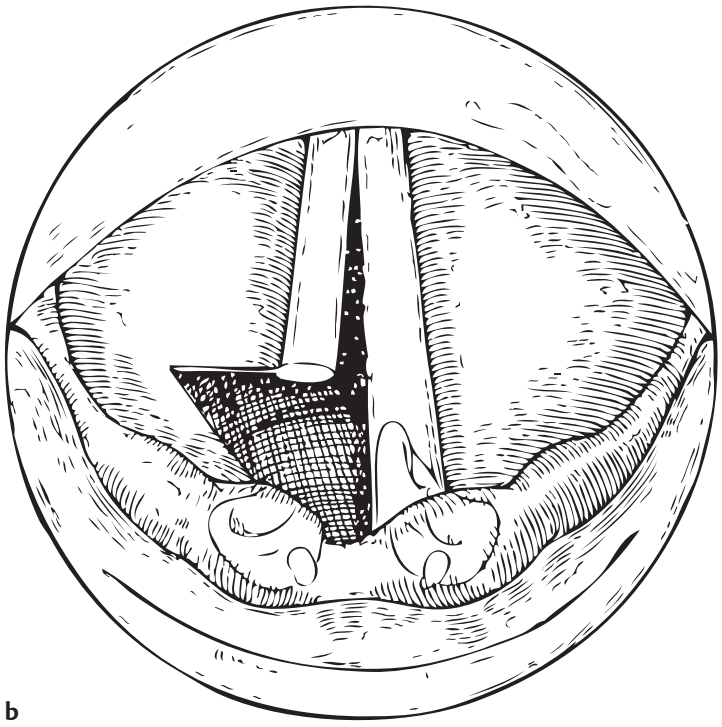
1. The procedure is performed under general anesthesia administered through the natural airway or tracheotomy tube.
2. A Lindholm laryngoscope is placed in the vallecula to expose the endolarynx (**Fig. 26.17a**).
3. Using a CO_2 laser on super-pulse, continuous mode, an incision is carried anteriorly to the vocal process and across the vocal fold laterally.
4. The incision is carried to the false vocal cord to create a large triangular gap that later fills in somewhat with soft tissue (**Fig. 26.17b**).
5. If laser arytenoidectomy is to be performed, the excision is enlarged to encompass a portion of the anterior arytenoids to create a large posterior glottic opening (**Fig. 26.17c**).
6. The patient is kept intubated for 1–3 days and extubated on humid air and steroids.
7. No antibiotics are given.
8. If the child has a tracheotomy then a repeat MLB is performed in 4–6 weeks.
9. If the posterior airway lumen is adequate, then a daytime capping trial is started.

Complications

1. Dysphonia
2. Aspiration
3. Recurrence of obstruction

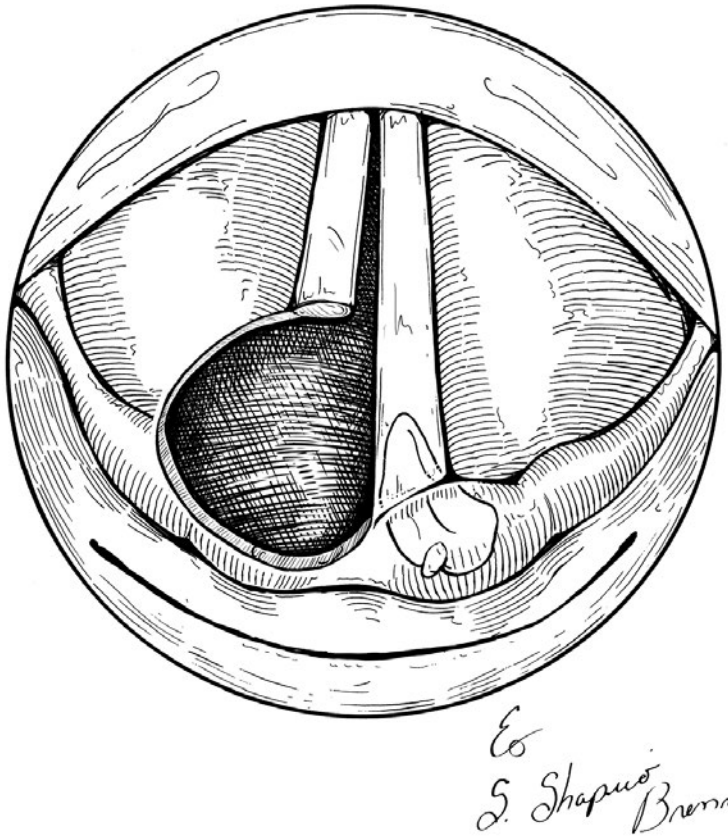


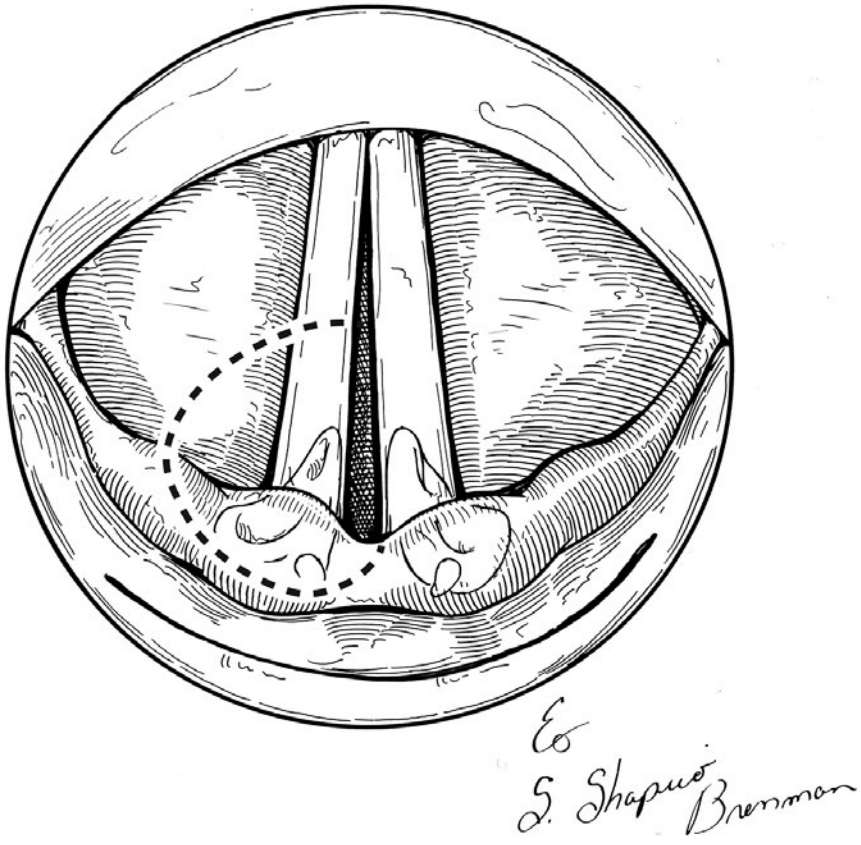
a



b

Fig. 26.17a,b





c

Fig. 26.17c

26-18 Supraglottoplasty

Ian N. Jacobs

Introduction

Laryngomalacia is the most common cause of stridor in children. The majority of patients with laryngomalacia are managed without surgery, while a small percentage have severe respiratory distress and require surgical intervention.

Indications

The main indications for surgery include severe stridor with significant oxygen desaturation, sleep apnea, or failure to thrive and weight loss.

Preoperative Evaluation

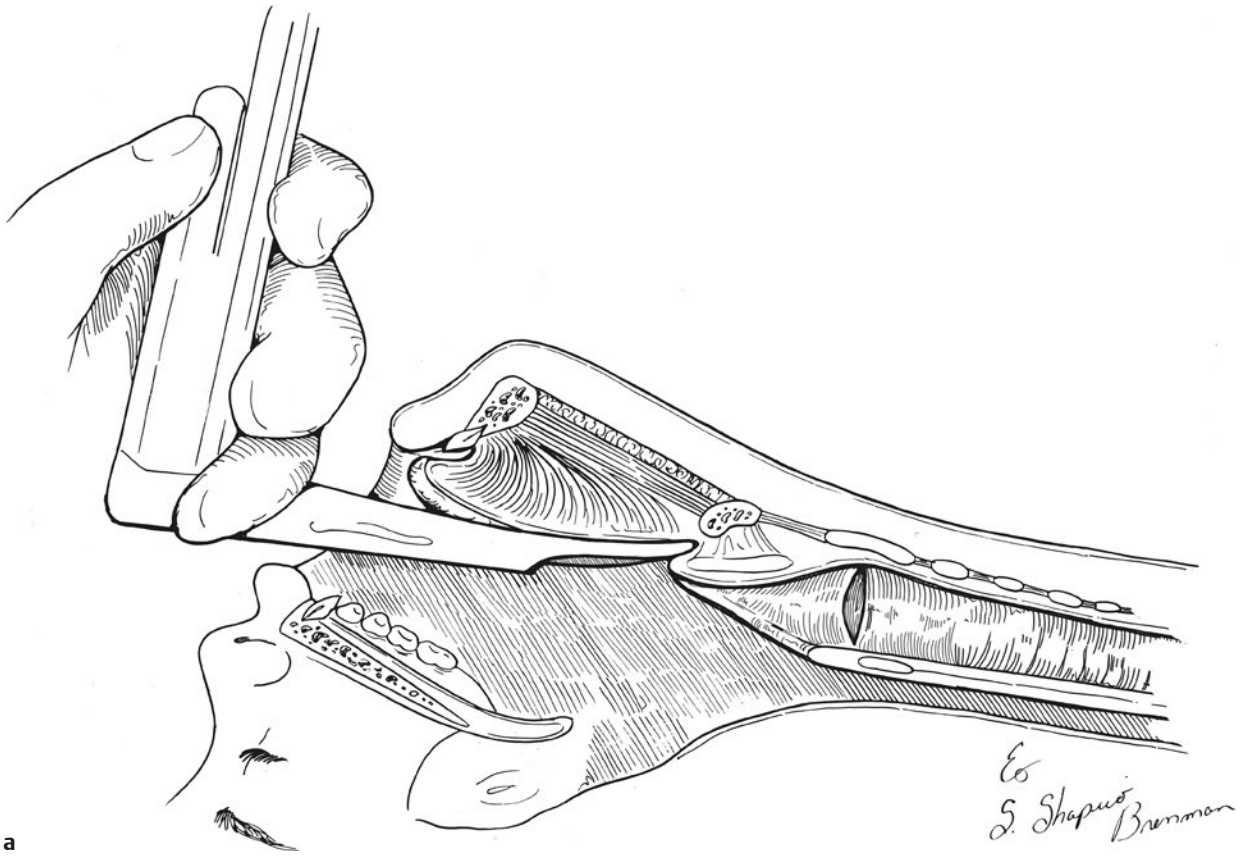
Typically, the history and physical examination include a flexible laryngoscopy in the office or at the bedside. This is done to confirm the diagnosis, rule out additional laryngeal pathology, and assess for inflammation (such as seen in reflux/regurgitation). Occasionally an anteroposterior/lateral plain neck film is ordered to look for gross subglottic pathology. Typically an extensive preoperative evaluation is not needed. Microlaryngoscopy and bronchoscopy are performed in the operating room to diagnose second airway lesions such as subglottic stenosis or tracheomalacia. The airway is examined while breathing spontaneously. The obstructive lesions are determined and the surgical plan is outlined during the endoscopy.

Operative Technique

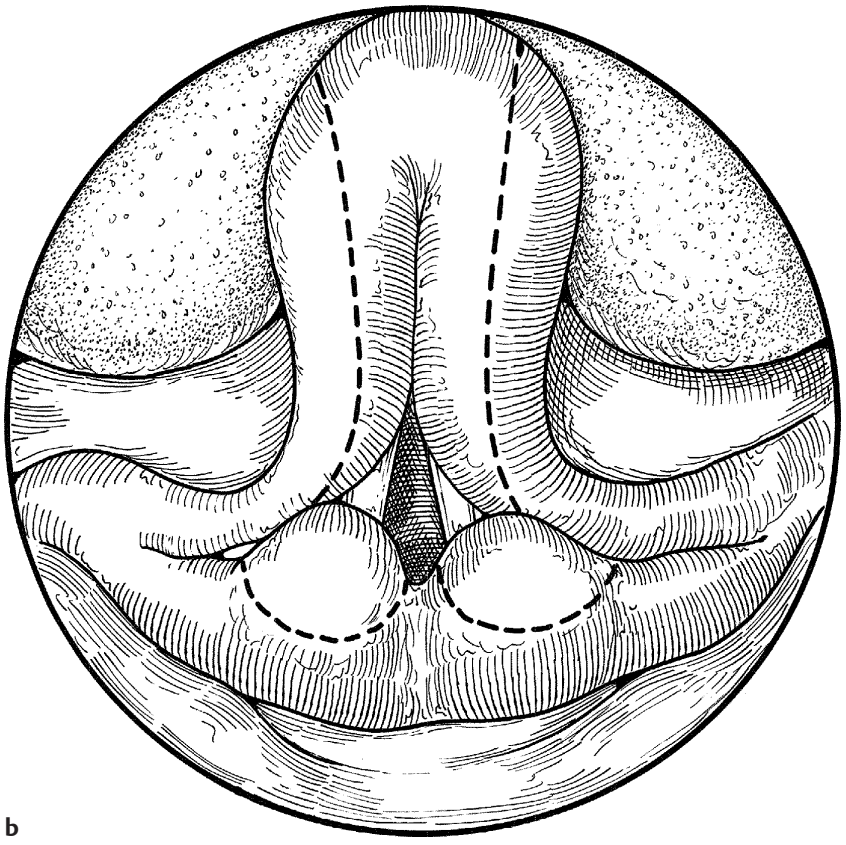
1. Flexible laryngoscopy is performed under spontaneous ventilation to determine the obstructive soft tissue and to delineate the type of laryngomalacia. The main pathologies are: short aryepiglottic folds, prolapsing and redundant cuneiform cartilage, and prolapsing epiglottis. The surgical strategy is directed at alleviating the most severe forms of obstruction.
2. The supraglottoplasty is performed under general anesthesia with spontaneous ventilation or insufflation technique.
3. A Lindholm laryngoscope is used to expose the supraglottic larynx and show all relevant structures including the cuneiforms and aryepiglottic folds (AEFs) (**Fig. 26.18a**).
4. The surgery is tailored to the pathology. Short AEFs are incised with either the CO_2 laser or microlaryngeal scissors, as indicated by the dotted line, and the redundant cuneiform tissue is excised with suction and laser or scissors (**Fig. 26.18b,c**).
5. The prolapsing epiglottis may be treated with the creation of scarring in the vallecula to the tongue base (**Fig. 26.18d**) or partially excised in a conservative manner (**Fig. 26.18b**). In severe cases, the epiglottis may need to be suspended with a suture to the base of tongue or hyoid bone.
6. The child can either be extubated in the operating room or remain intubated overnight. Steroids are continued for 48 hours.

Complications

1. Aspiration
2. Laryngeal edema
3. Supraglottic stenosis

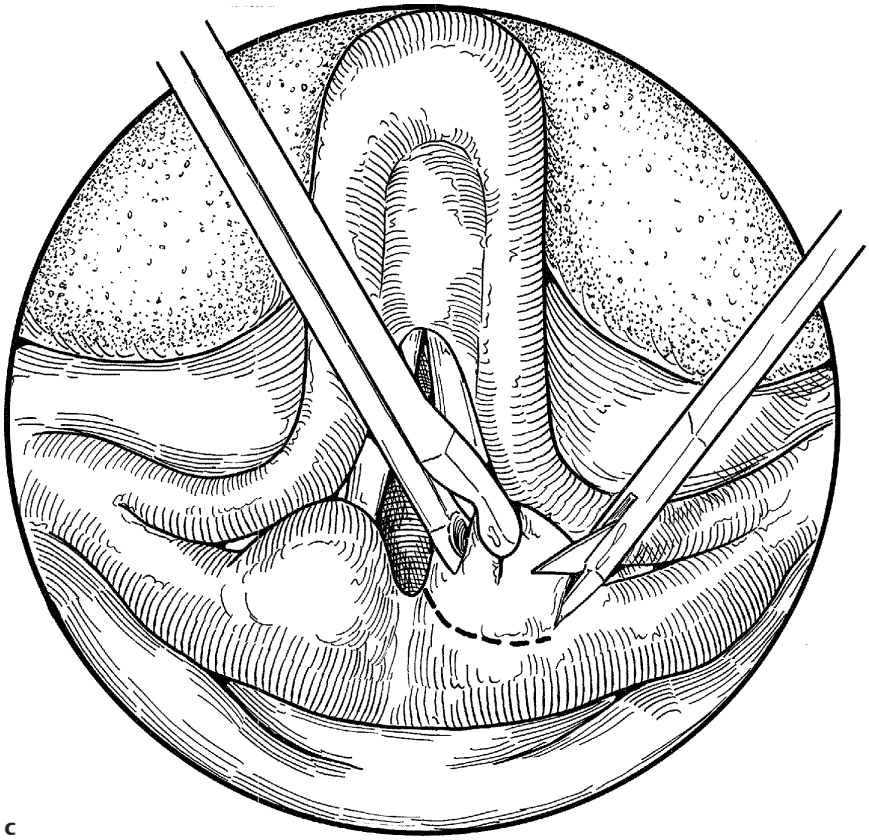


a

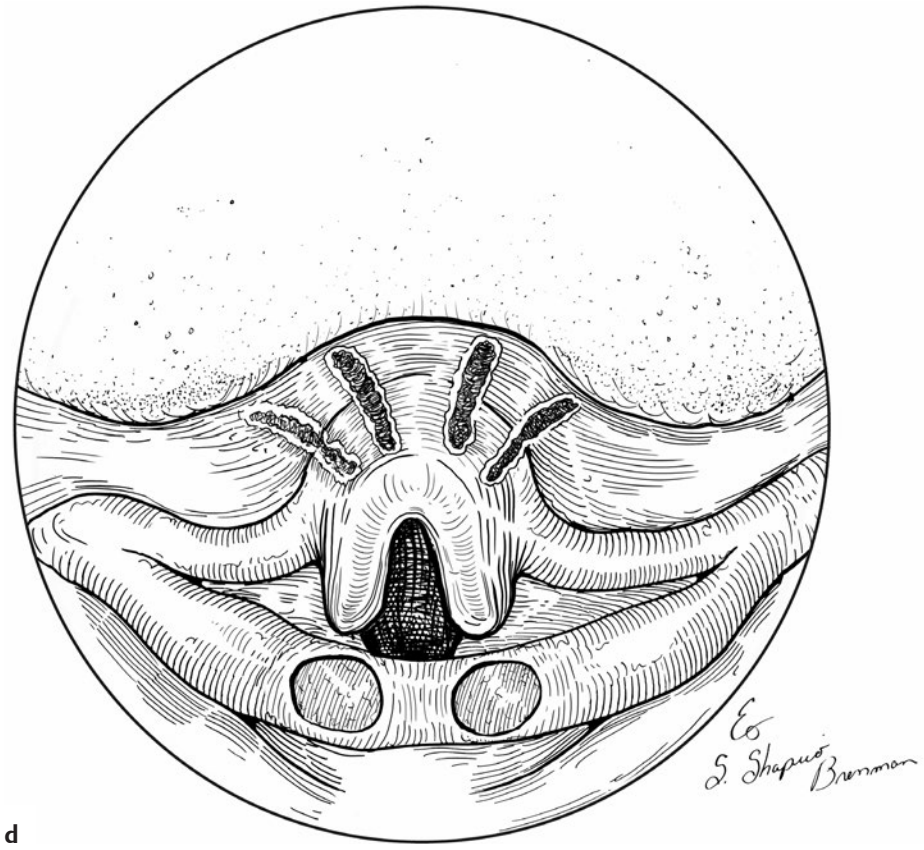


b

Fig. 26.18a,b



c



d

Fig. 26.18c,d

27 Neck

Lisa M. Elden

The neck distinguishes the head from the torso or trunk. Neck masses in children are common and usually represent cervical adenopathy that requires no intervention. However, in some instances, the nodes become large enough to cause suspicion of malignancy.

27-1 Lymph Node Excision

Introduction

Cervical adenopathy is common in children and usually requires no intervention. However, in some instances, the nodes become large enough to cause suspicion of a malignancy. In those instances, excisional (if possible) biopsy of an enlarged node is indicated.

Indications

The presence of a suspicious enlarged lymph node is the indication for excision of the mass.

Preoperative Evaluation

A computed tomography (CT) scan or magnetic resonance imaging (MRI) is helpful if the lymph node is large or if there are numerous nodes over the cervical region. A chest X-ray is indicated if there is suspicion of a malignant process in the neck. If there is a strong suspicion of a malignancy, the oncologist should be notified and prepared to perform a lumbar puncture and/or bone marrow aspirate if a malignancy is confirmed or suspected on frozen section evaluation of the node.

Operative Technique

1. An appropriate transverse skin crease overlying the lesion and approximately 1.5 cm below the margin of the mandible is selected. Care is taken to stay away from the course of the marginal mandibular nerve. One percent lidocaine with 1:100,000 epinephrine is injected to help in hemostasis.
2. An incision is made with a no. 15 scalpel through the skin and subcutaneous tissue (**Fig. 27.1a**).
3. The platysma muscle is incised using the cutting cautery to reduce bleeding (**Fig. 27.1b**).
4. Soft tissue overlying the node (or nodes) is gently dissected off using fine pick-ups and delicate scissors. A small gauze peanut may be helpful in this maneuver.
5. The node is gently grasped with fine forceps and dissected away from surrounding tissue with blunt and sharp dissection. Scissors are used to spread and then cut thin fibrous attachments. Every attempt is made to remove an intact node (**Fig. 27.1c**).
6. If a vascular pedicle is identified, this is clamped, cut, and tied with a 3-0 chromic suture (**Fig. 27.1d**).
7. If there is clinical suspicion of an infectious etiology for the node, a small piece is excised and sent for aerobic, fungal, and acid-fast cultures.
8. The node with its intact capsule is sent in a fresh state to the pathologist so that appropriate touch preps and stains may be performed.
9. A small rubber band drain is usually placed to prevent accumulation of fluid and/or blood in the dissected cavity. A safety pin or suture is attached to the distal end of the drain to prevent it from being lost in the wound. The drain is removed within 24 hours.
10. The wound is closed in layers. The skin is closed with subcuticular sutures, and Steri-Strips (3M) are applied to keep the wound edges approximated (**Fig. 27.1e**).

Complications

1. Hemorrhage from a major vessel
2. Marginal mandibular nerve injury

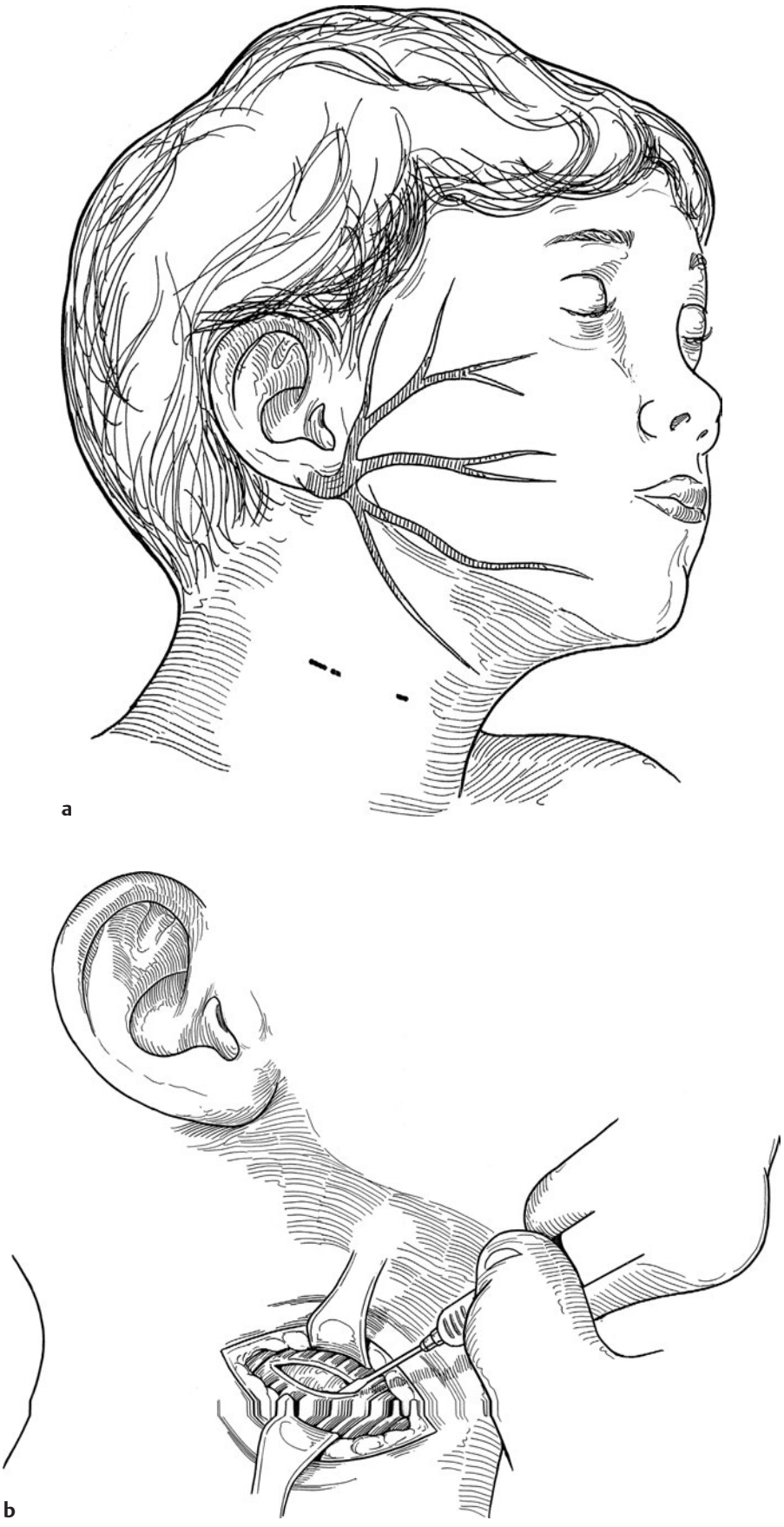
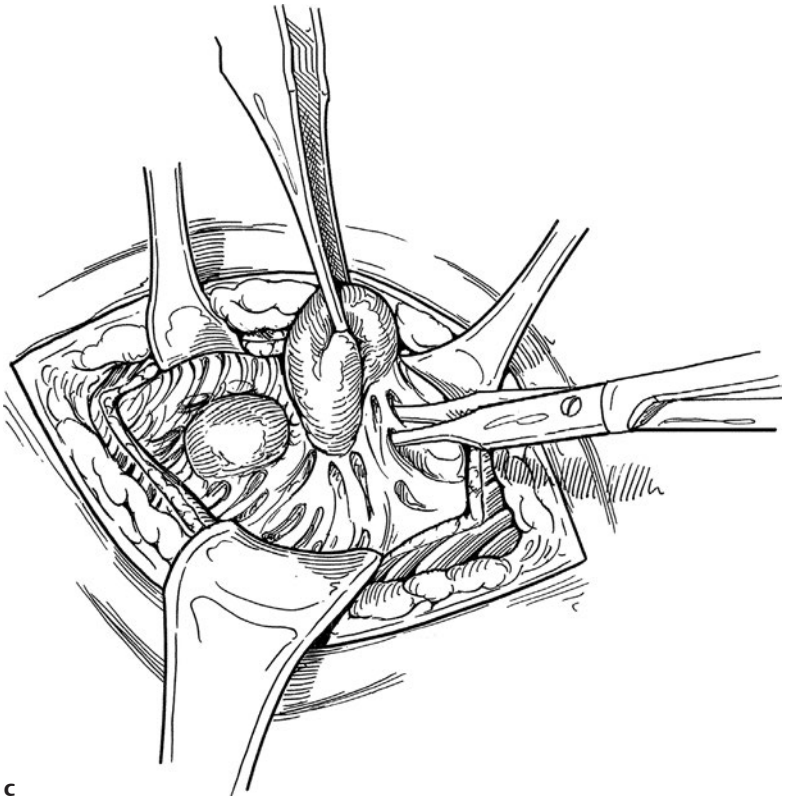
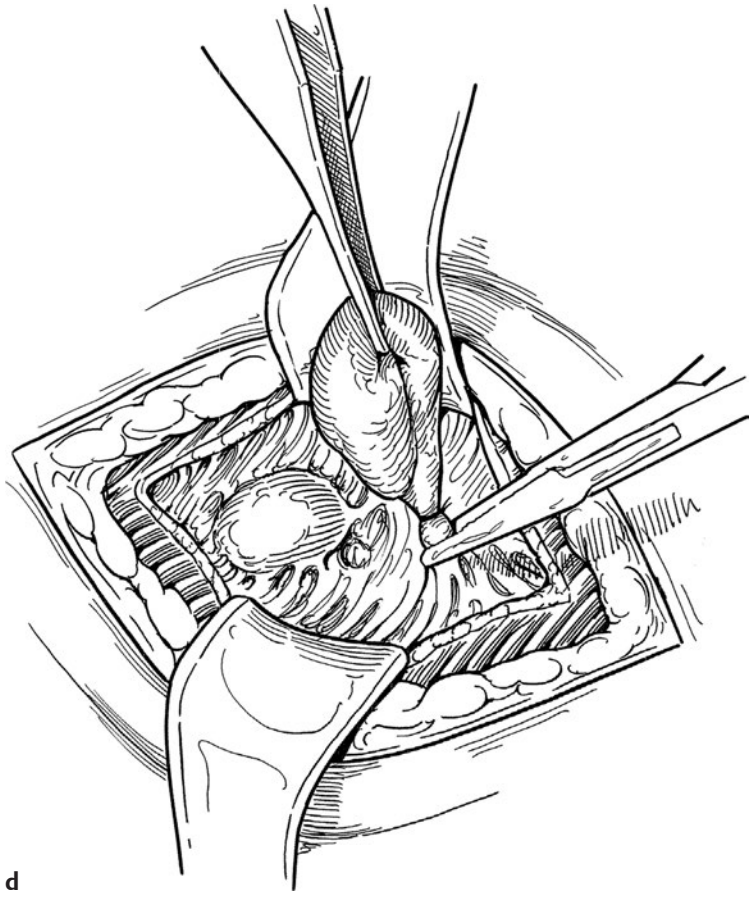


Fig. 27.1a,b

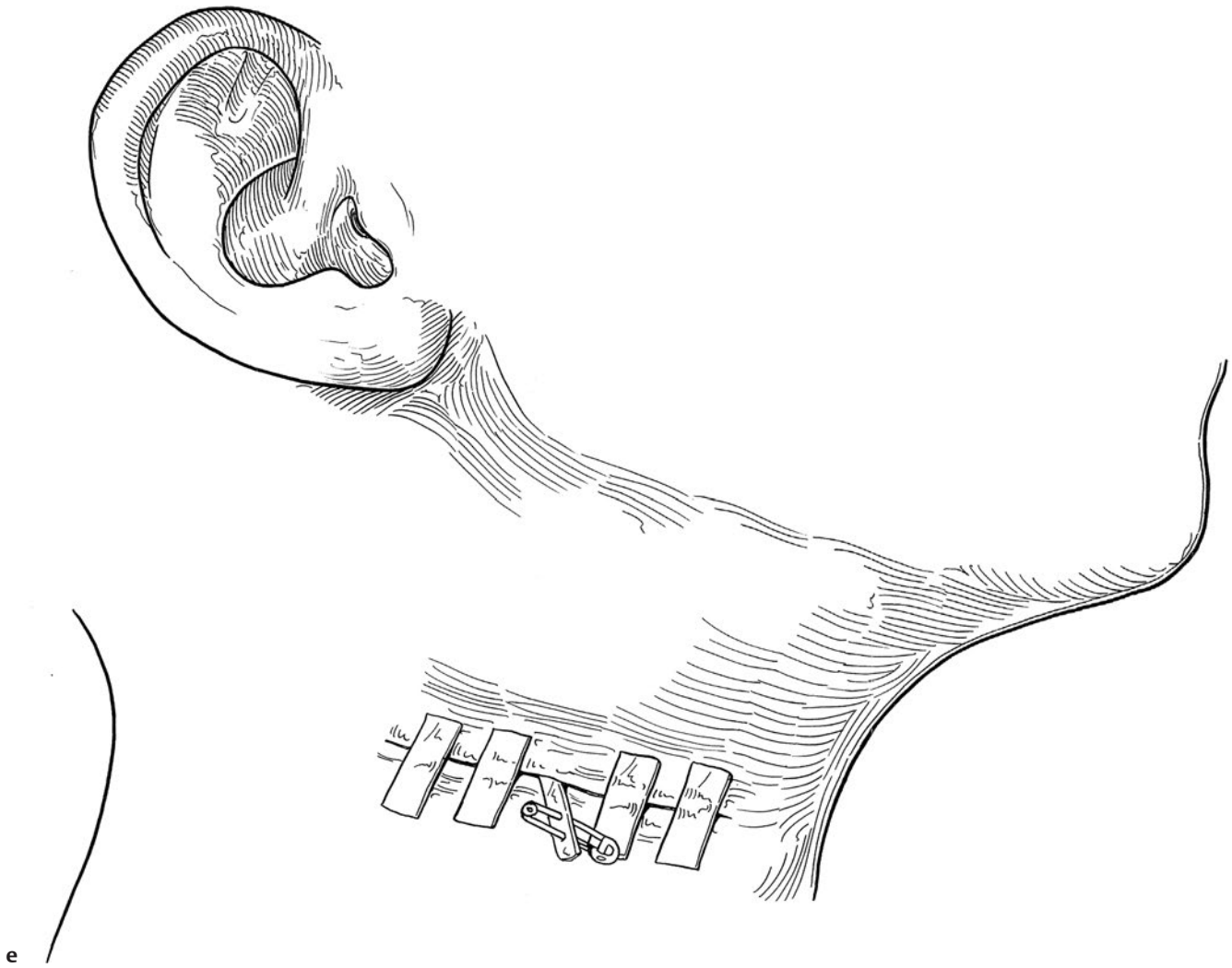


c



d

Fig. 27.1c,d



e

Fig. 27.1e

27-2 Excision of Thyroglossal Duct Cyst

Introduction

A cervical thyroglossal duct cyst may occur anywhere from the base of the tongue to the lower third of the neck. They usually lie close to the midline.

Indications

Excision of a thyroglossal duct cyst is indicated before it becomes infected. Once infected, excision is associated with a higher rate of recurrence.

Preoperative Evaluation

A thyroid ultrasound to establish the presence of thyroid tissue in its normal location should be done prior to surgery. If the thyroglossal duct cyst contains the child's only functioning thyroid tissue, thyroid replacement therapy will be required after excision.

Operative Technique

1. Excision of a thyroglossal duct cyst is performed under general anesthesia. One percent lidocaine with 1:100,000 epinephrine is injected to help with hemostasis.
2. The child is positioned supine on a shoulder roll with the neck extended (**Fig. 27.2a**).
3. A transverse incision is made over the cyst through the skin, subcutaneous tissues, and platysma muscle with a knife (**Fig. 27.2b**).
4. Subplatysmal flaps are elevated with a scissors to a level above the hyoid bone and inferiorly to expose the cyst while being careful not to enter it (**Fig. 27.2c**).
5. The cyst is dissected from its surrounding soft tissue attachments, including the thyrohyoid membrane (**Fig. 27.2d**).
6. If the tract enters the thyrohyoid membrane, it should be tied with suture, divided, and oversewn.
7. The cyst and its track usually extend to and are attached to the mid portion of the hyoid bone.
8. The hyoid bone is exposed laterally by cutting the overlying soft tissue with a knife or Bovie at the junction of the lesser and greater cornu (**Fig. 27.2e**).
9. The hyoid bone is cut on each side at the lesser cornu with a bone cutter or heavy scissors (**Fig. 27.2f**).
10. The superior and inferior muscle attachments to the hyoid bone are released with a knife or Bovie (**Fig. 27.2g**).
11. If a tract is present above the hyoid, it must be removed to prevent recurrence.
12. In some instances, it may be helpful for the assistant surgeon to break scrub to place the index finger of the left hand in the patient's vallecula, and the base of the tongue is depressed into the surgical field. The core of soft tissue and tract are removed by sharp dissection with a scissors up to the foramen cecum (**Fig. 27.2h**). Complete excision of the tract rarely requires entering the oropharynx. If the pharynx is entered, one or two sutures of 3-0 chromic are usually all that is required to close the mucosal defect.
13. The wound is closed in layers with 3-0 chromic sutures to obliterate the dead space (**Fig. 27.2i**). A Penrose drain is placed in the wound and the skin may be closed with interrupted 5-0 nylon or subcuticular 4-0 Vicryl (Ethicon) (**Fig. 27.2j**). A light gauze dressing is applied.
14. Intravenous postoperative antibiotics should be administered until the drain is removed, usually 24–36 hours.
15. Oral antibiotics are used for 10 days.

Complications

1. Seroma
2. Cyst recurrence

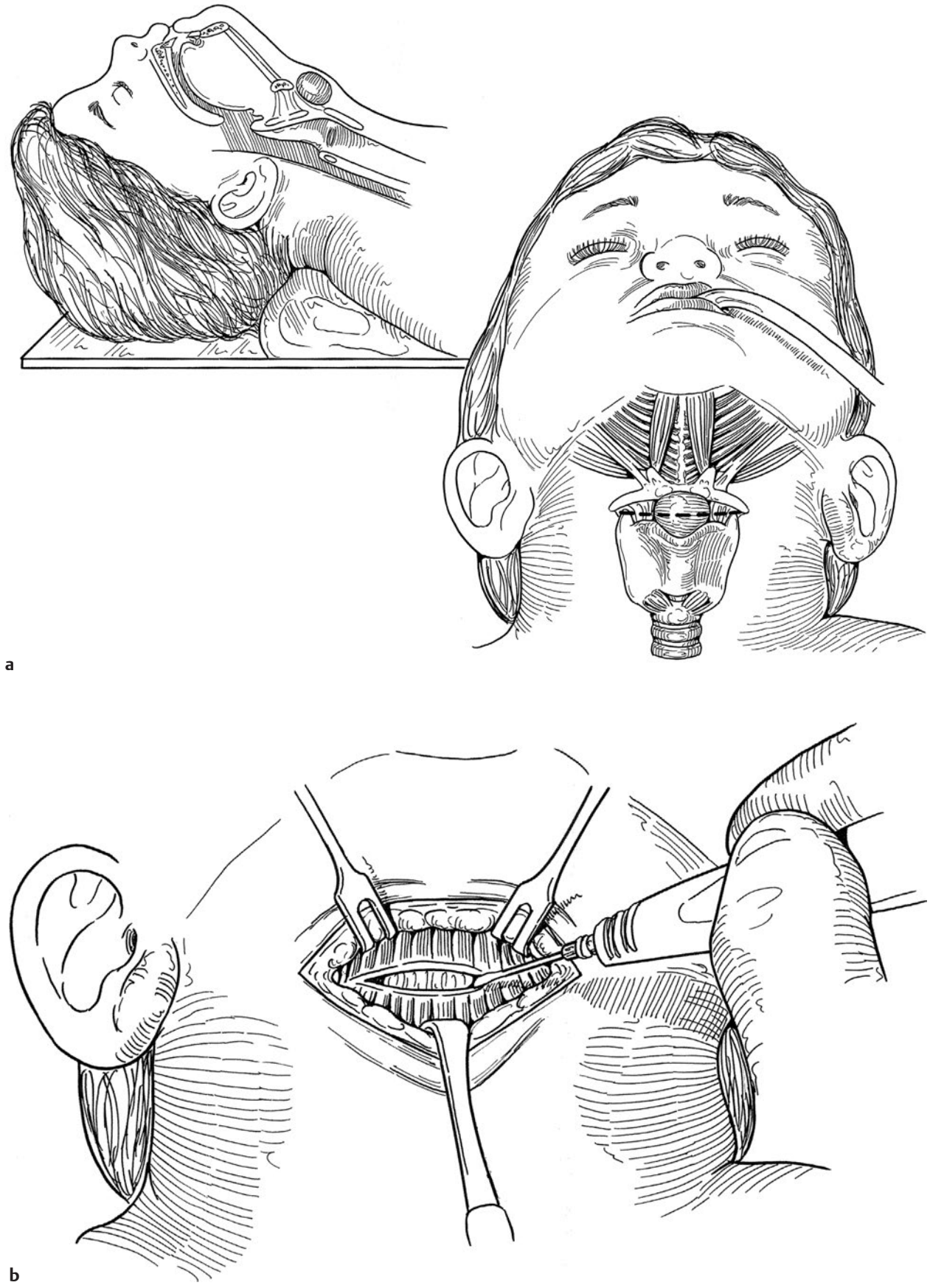
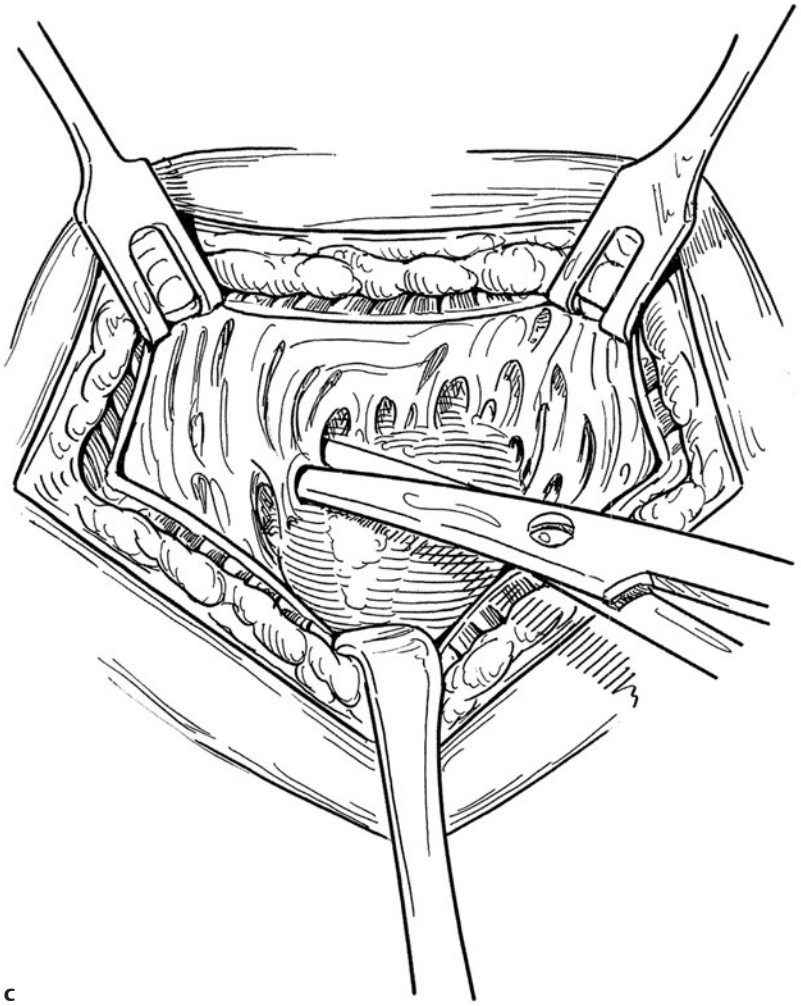
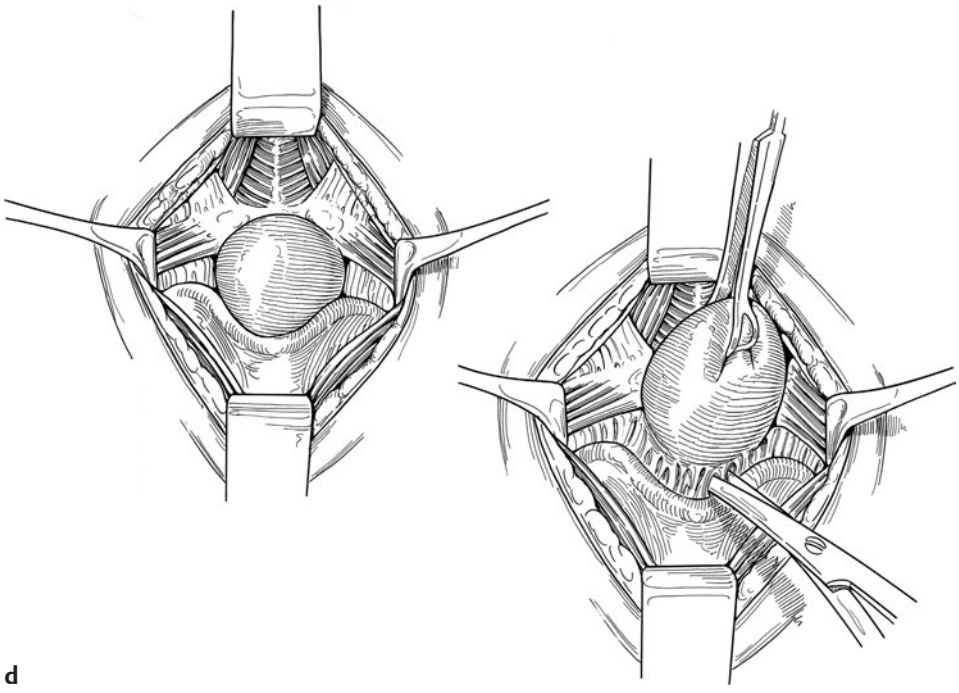


Fig. 27.2a,b

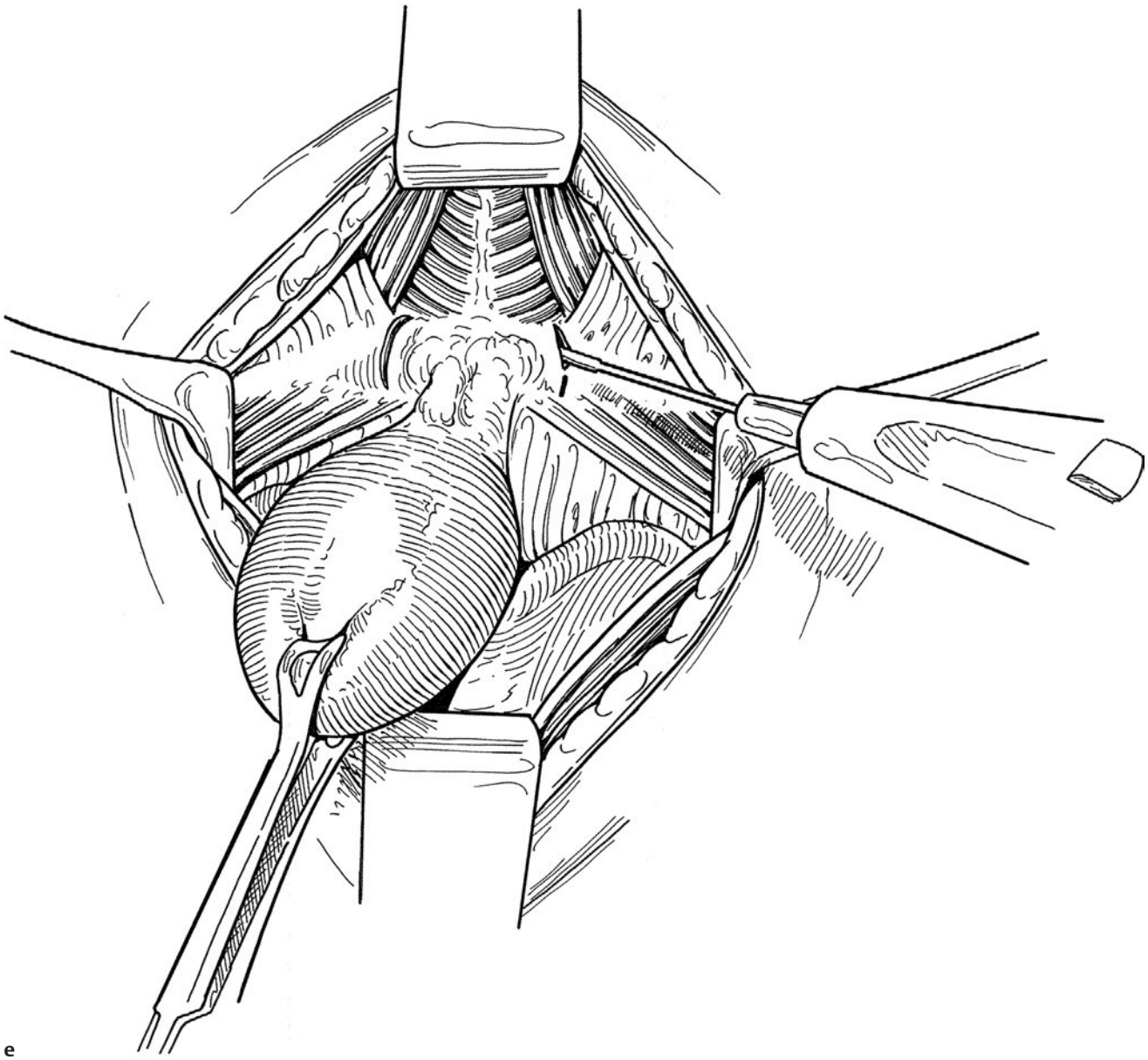


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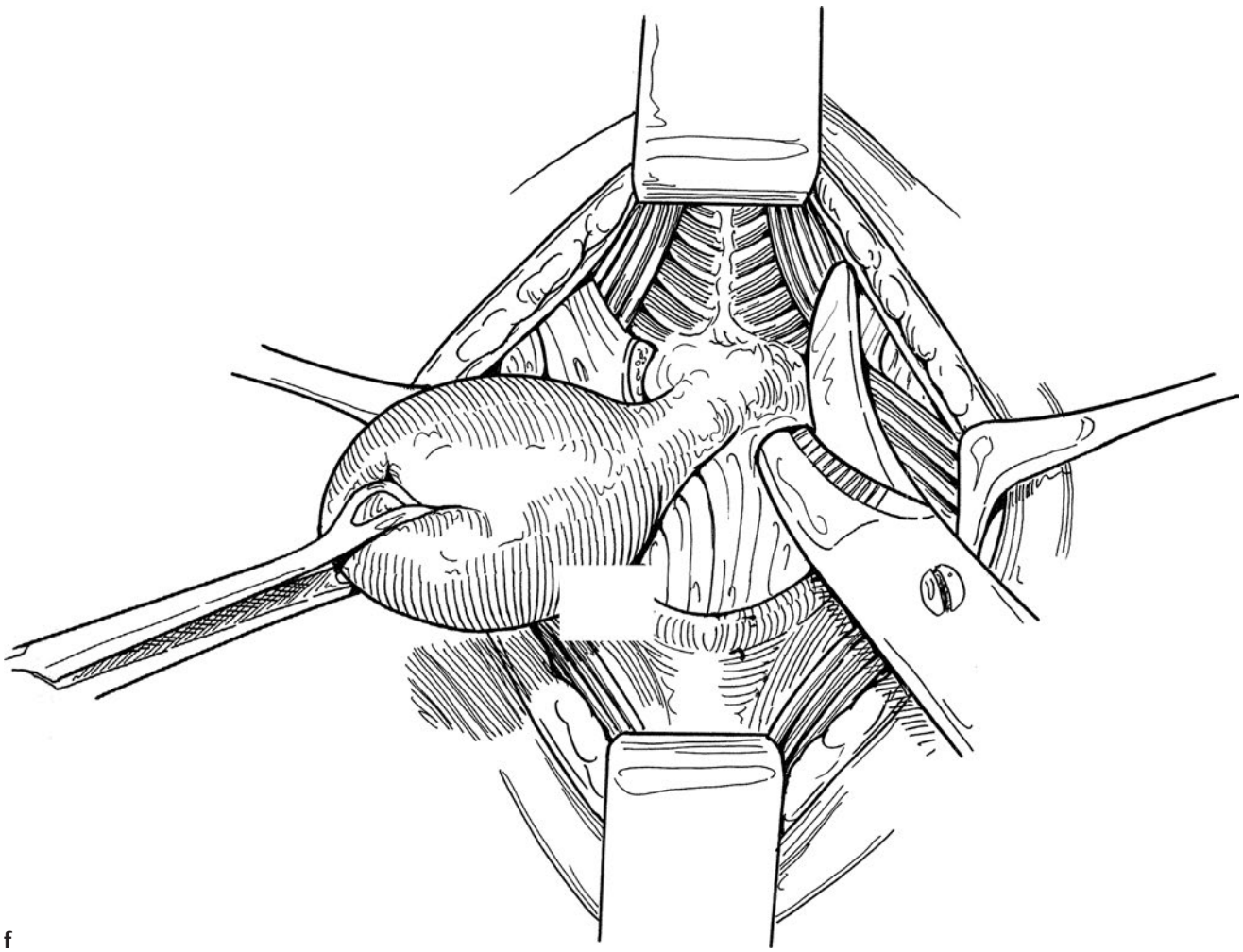
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Fig. 27.2c,d



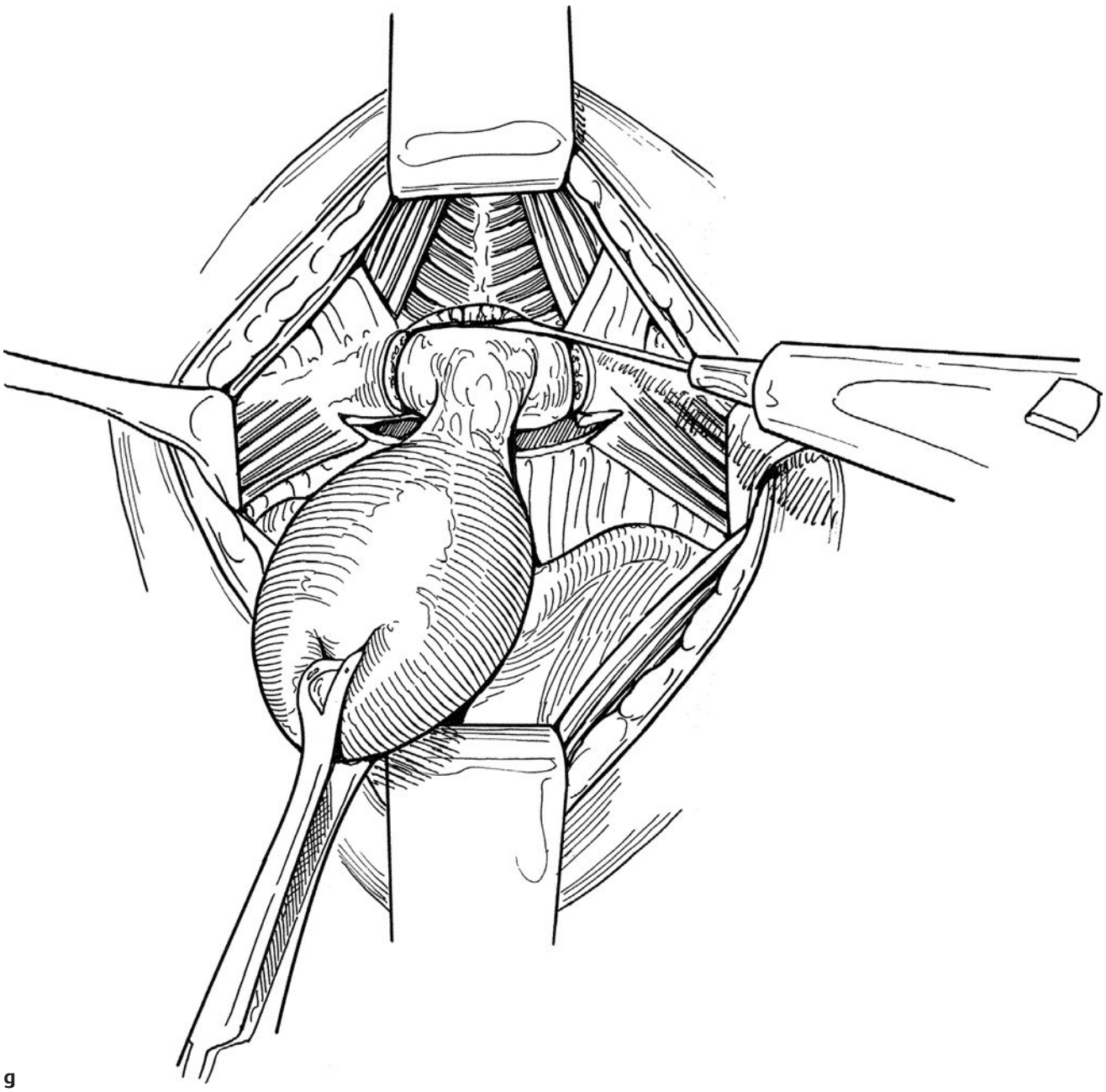
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Fig. 27.2e



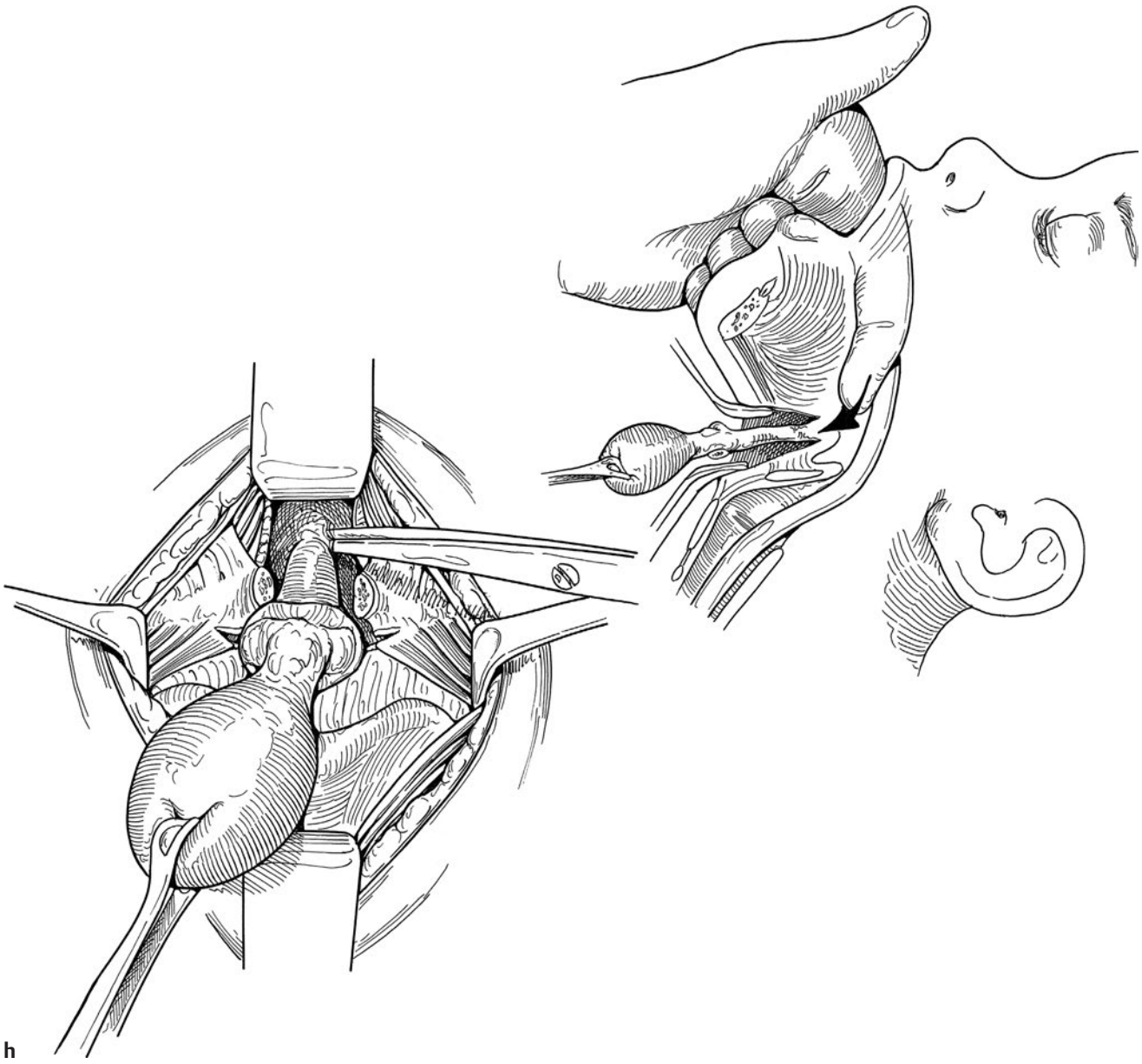
f

Fig. 27.2f



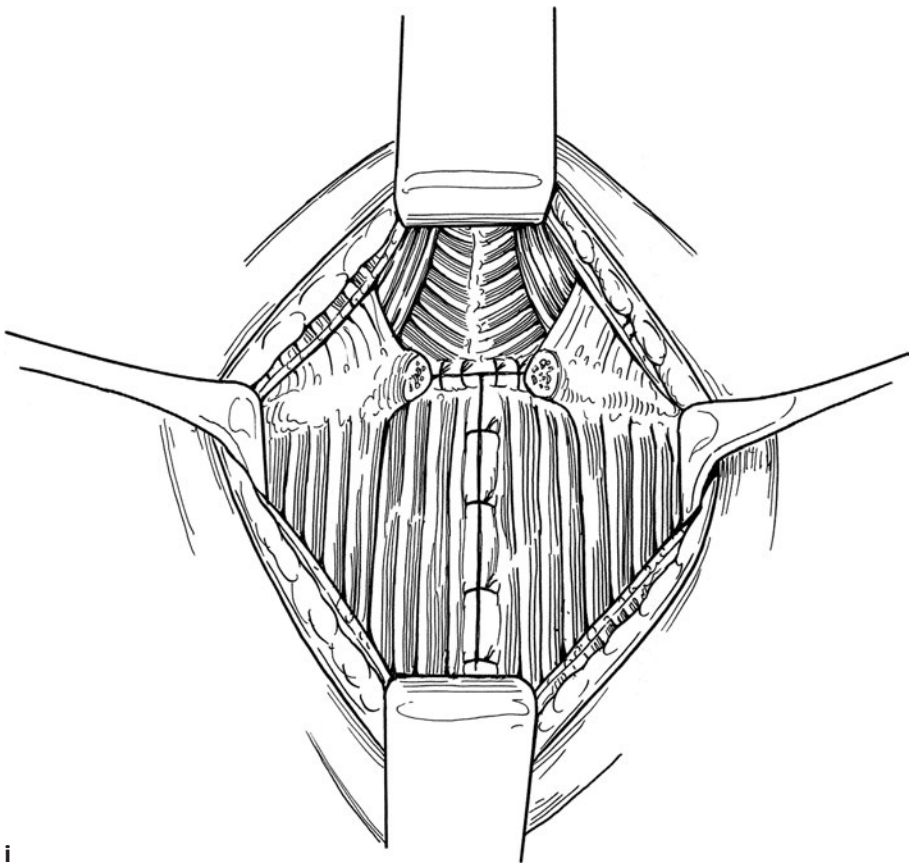
g

Fig. 27.2g



h

Fig. 27.2h



i



j

Fig. 27.2i,j

27-3 Excision of Branchial Cleft Cyst

Introduction

Branchial cleft anomalies are remnants of the branchial arch apparatus that did not disappear during embryologic development. Cysts occur as a result of persistence of epithelial remnants between branchial arches. These lesions usually present as soft swellings near the anterior border of the sternocleidomastoid muscle.

Indications

The presence of a branchial cleft cyst is the indication for surgical excision both to confirm the diagnosis and to prevent infection of the cyst.

Preoperative Evaluation

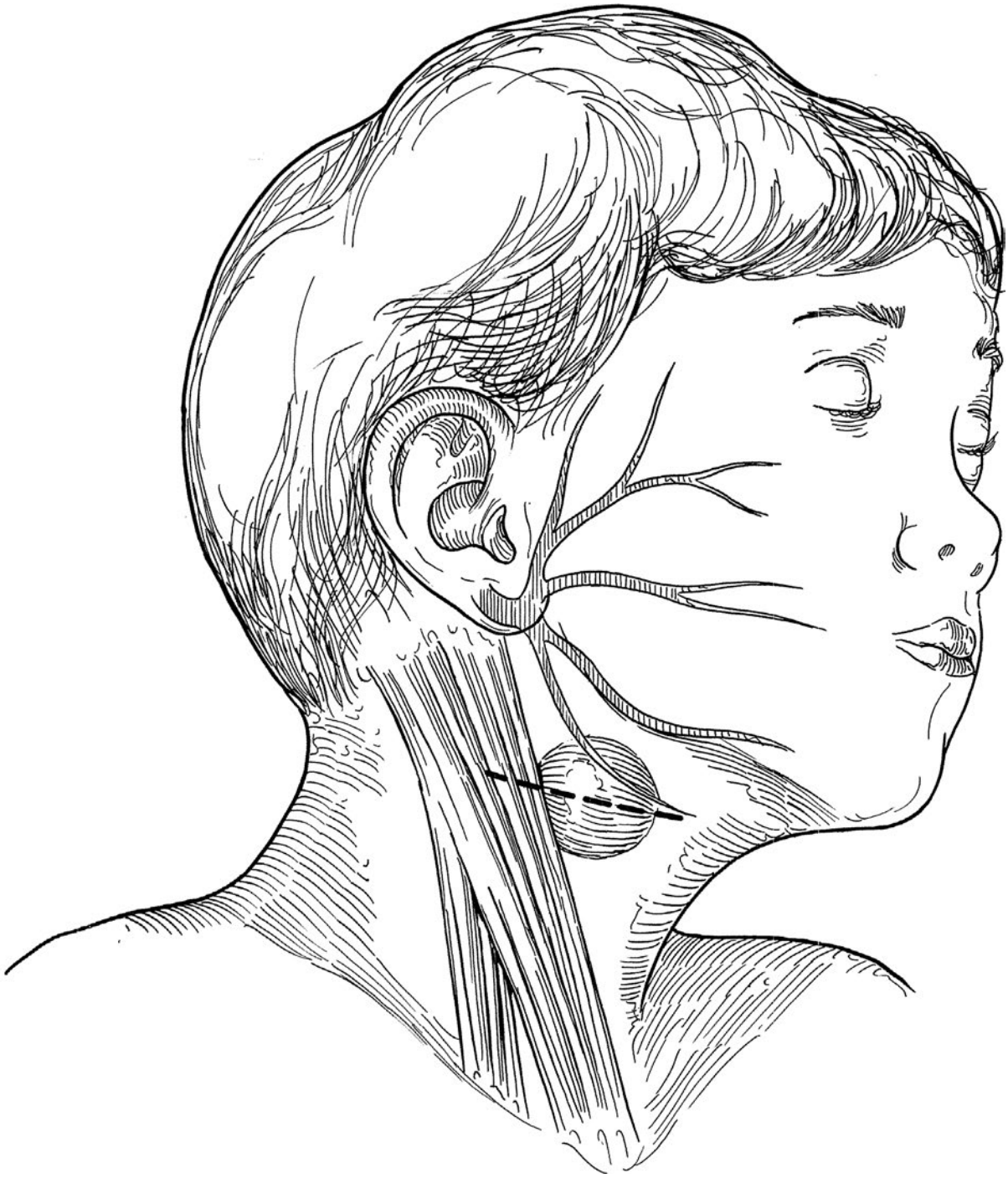
While clinical examination may suggest the diagnosis of branchial cleft cyst, radiographic studies such as ultrasound, CT, and MRI scans are helpful in confirming the diagnosis and determining the presence of an associated tract.

Operative Technique

1. A transverse skin crease overlying the lesion and 1.5 cm below the margin of the mandible is selected. Care is taken to stay away from the course of the marginal mandibular nerve. One percent lidocaine with 1:100,000 epinephrine is injected to help with hemostasis.
2. The skin incision is made with a no. 15 blade through the skin and subcutaneous tissues (**Fig. 27.3a**).
3. The platysma muscle is divided with a cutting cautery (**Fig. 27.3b**).
4. The tissues overlying the cyst are gently dissected away with fine forceps and small scissors. A small gauze peanut may be helpful in this maneuver.
5. The cyst is gently grasped with a Babcock clamp. Surrounding tissue is dissected free from the cyst using small scissors to spread between the cyst capsule and surrounding tissue and then to cut through thin fibrous attachments (**Fig. 27.3c**).
6. If a pedicle or fibrous tract is identified, it is followed as far cephalic as possible before it is clamped, cut, and tied with a 3-0 chromic suture. It is not necessary to trace the tract all the way through the carotid bifurcation and into the pharynx unless it extends to the tonsil (**Fig. 27.3d**).
7. A small rubber band drain is usually placed to prevent accumulation of fluid and/or blood in the dissected cavity. A safety pin or suture is attached to the distal end of the drain to prevent it from being lost in the wound. The drain is removed within 24 hours.
8. The wound is closed in layers. The skin is closed with subcuticular sutures, and Steri-Strips are applied to keep the wound edges approximated (**Fig. 27.3e**).
9. Antibiotics are not employed unless the cyst was clinically infected or the contents were spilled during the dissection.

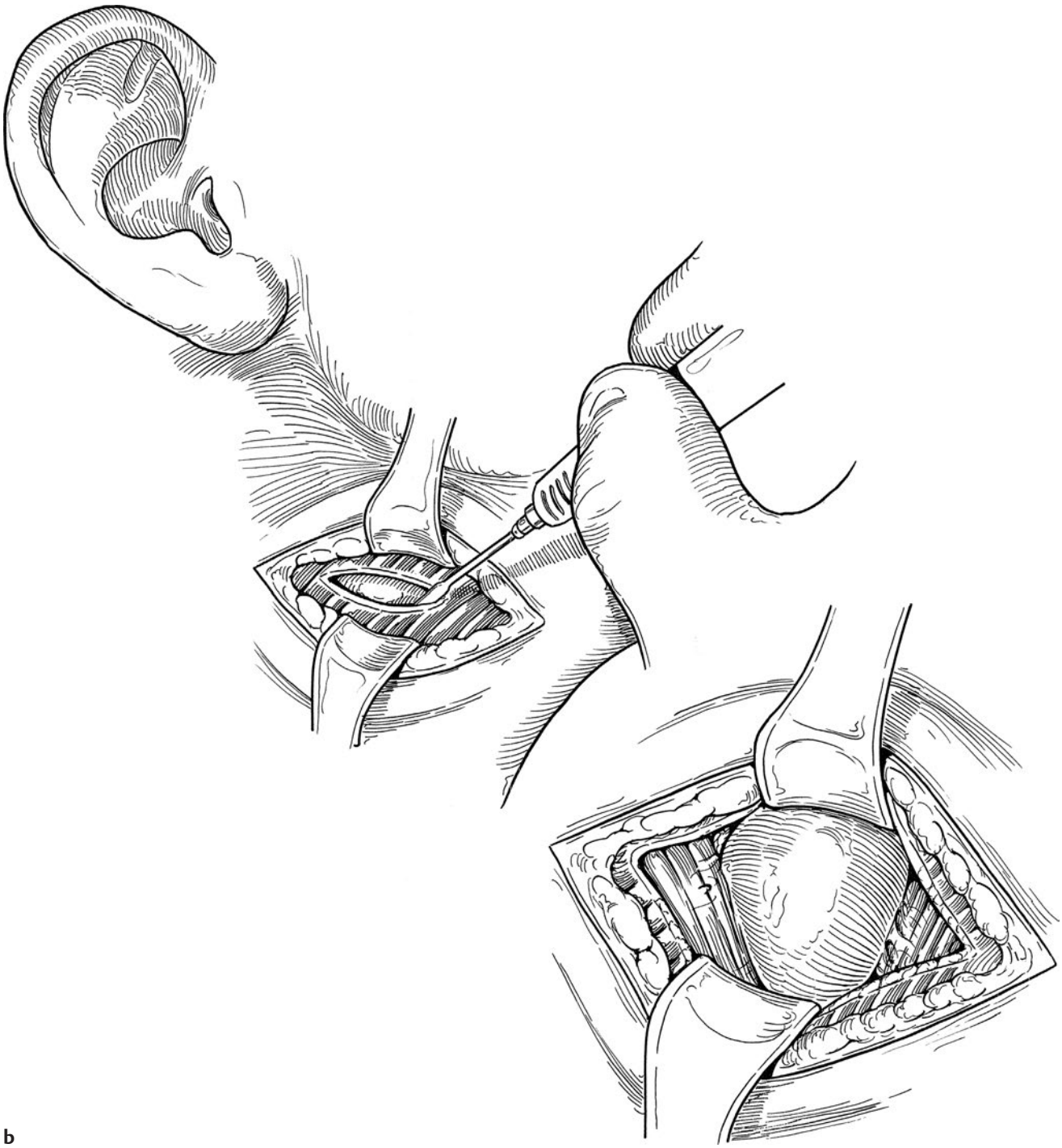
Complications

1. Recurrence of the cyst from incomplete excision
2. Marginal mandibular nerve injury



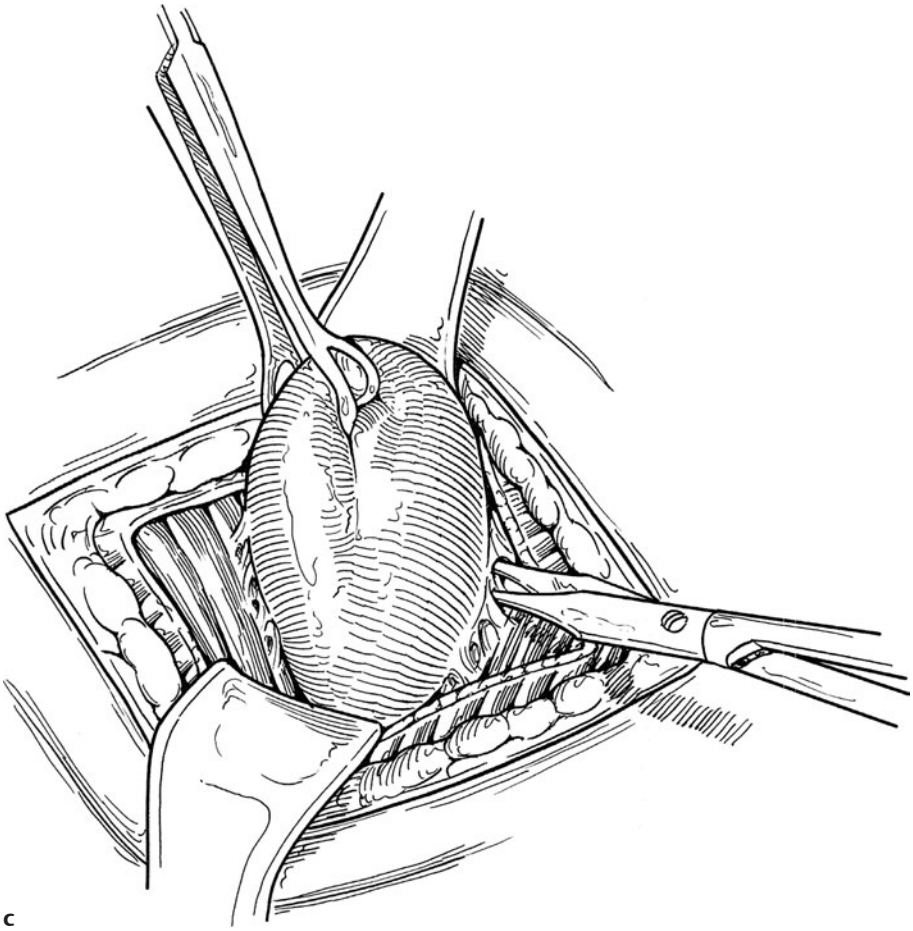
a

Fig. 27.3a

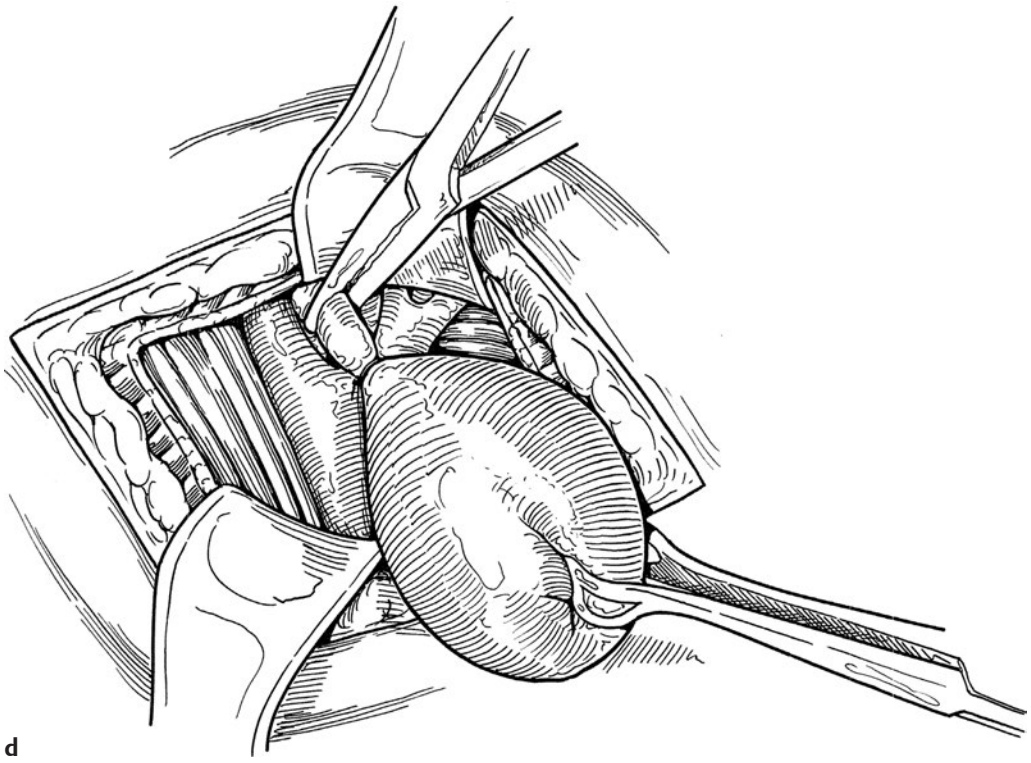


b

Fig. 27.3b

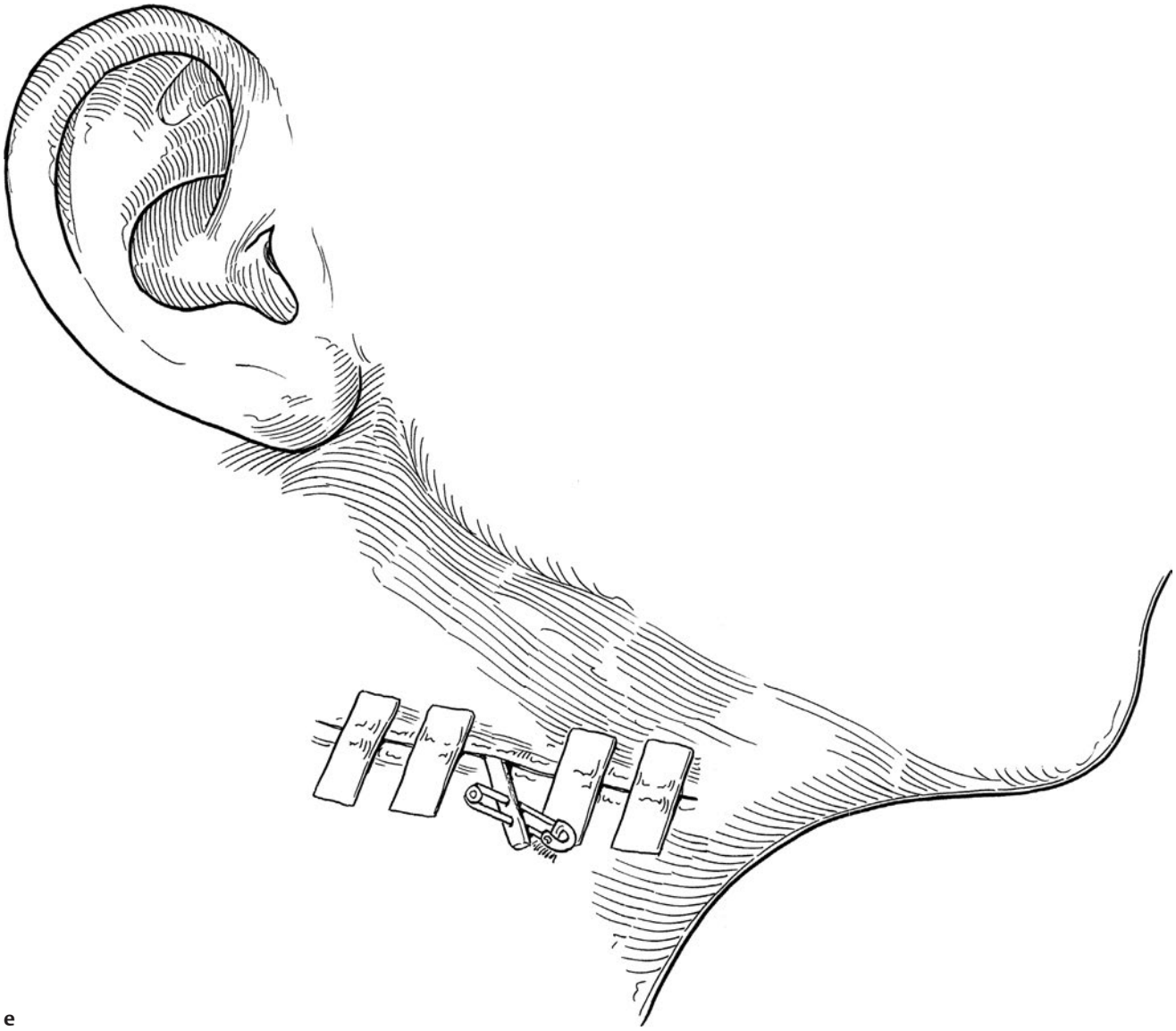


c



d

Fig. 27.3c,d



e

Fig. 27.3e

27-4 Excision of Branchial Cleft Sinus/Fistula

Introduction

Branchial cleft sinuses/fistulas are epithelial remnants of the branchial arch system that maintain a connection to either the skin, mucous membrane of the oral cavity or pharynx, or both. An external sinus tract usually presents at the anterior border of the sternocleidomastoid muscle. Internal sinuses present at the tonsillar fossa or the pyriform sinus. First branchial cleft sinuses present as external openings near the angle of the mandible and course near the branches of the facial nerve to end in the external auditory canal or middle ear.

Indications

The presence of a branchial cleft sinus/fistula is the indication for excision.

Preoperative Evaluation

CT or MRI scan of the lesion may help to delineate the extent of the tract. It is not necessary to inject radiopaque material into the fistula to visualize the tract. If a first branchial cleft sinus is suspected, an audiogram and a CT of the temporal bone are indicated preoperatively.

Operative Technique

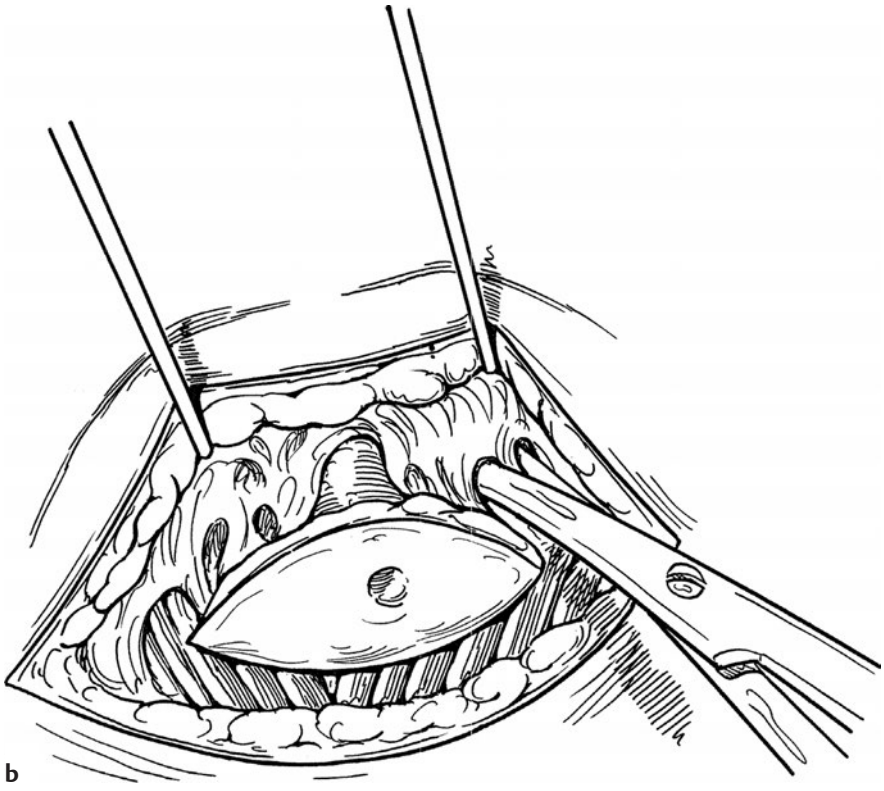
1. The area surrounding the external sinus (fistula) tract is injected with 1% lidocaine with 1:100,000 epinephrine.
2. A transverse elliptical incision is made encompassing the opening of the sinus tract (**Fig. 27.4a**).
3. Care is taken not to extend the superior limb of the incision too deeply where it may sever the tract.
4. Small blunt scissors are used to raise skin flaps superiorly and inferiorly (if necessary) staying superficial to the sinus tract (**Fig. 27.4b**).
5. The skin tract may be cannulated with a lacrimal probe, and then the distal end of the tract is grasped with an Allis clamp. Traction is maintained with the clamp as fibrous attachments to the tract are separated with the spreading of a small pair of blunt scissors and then cut (**Fig. 27.4c**).
6. The epithelial-lined sinus or fistula tract is followed superiorly as far as possible. Occasionally, a second, higher transverse incision (step ladder) is needed to permit complete dissection of long sinus tracts.
7. The most proximal end of the tract is clamped, cut, and tied with a 3-0 silk suture (**Fig. 27.4d**).
8. If the fistula tract has an internal opening into the pharynx (second or third branchial cleft sinus), this must be excised or ligated. In the case of a second branchial cleft fistula that drains into the tonsillar fossa, the involved tonsil is usually removed to allow complete excision of the fistula tract. Any defect in the wall of the pharynx (tonsillar fossa) must be closed with interrupted 3-0 chromic sutures.
9. If the fistula tract extends to the pyriform fossa (third branchial cleft sinus), the opening must be ligated with a 3-0 chromic suture.
10. If the lesion is a first branchial cleft sinus, the lesion must be approached through a parotidectomy incision. A superficial parotidectomy (see Section 29-2) is performed to identify and expose the trunk and branches of the facial nerve. Once this has been performed, the sinus tract can be dissected out to its termination in the external auditory canal or middle ear. If the sinus tract terminates in the external canal, the tract is transected at the entrance to the bony canal, and any epithelial remnants are removed with a curette. If the tract extends to the tympanic membrane or middle ear, a tympanoplasty (see Section 3-2) may be necessary to allow complete removal of the lesion and reconstruction of the tympanic membrane.
11. A small rubber band drain is usually placed to prevent accumulation of fluid and/or blood in the dissected cavity. A safety pin is attached to the distal end of the drain to prevent it from being lost in the wound. The drain is removed within 24 hours.
12. The wound is closed in layers. The skin incision (or incisions) is closed with subcuticular sutures, and Steri-Strips are applied to keep the wound edges approximated (**Fig. 27.4e**).
13. Antibiotics are not employed unless the tract was clinically infected or the contents were spilled during the dissection.

Complications

1. Recurrence of the cyst from incomplete excision of the tract
2. Marginal mandibular nerve injury
3. Facial nerve injury (first branchial cleft cyst)
4. Tympanic membrane perforation

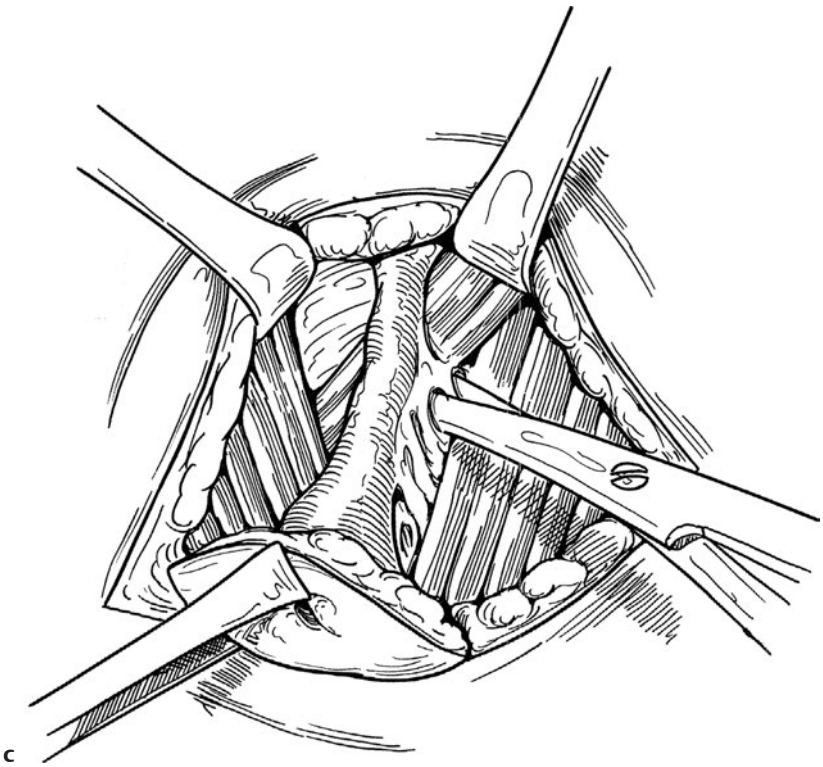


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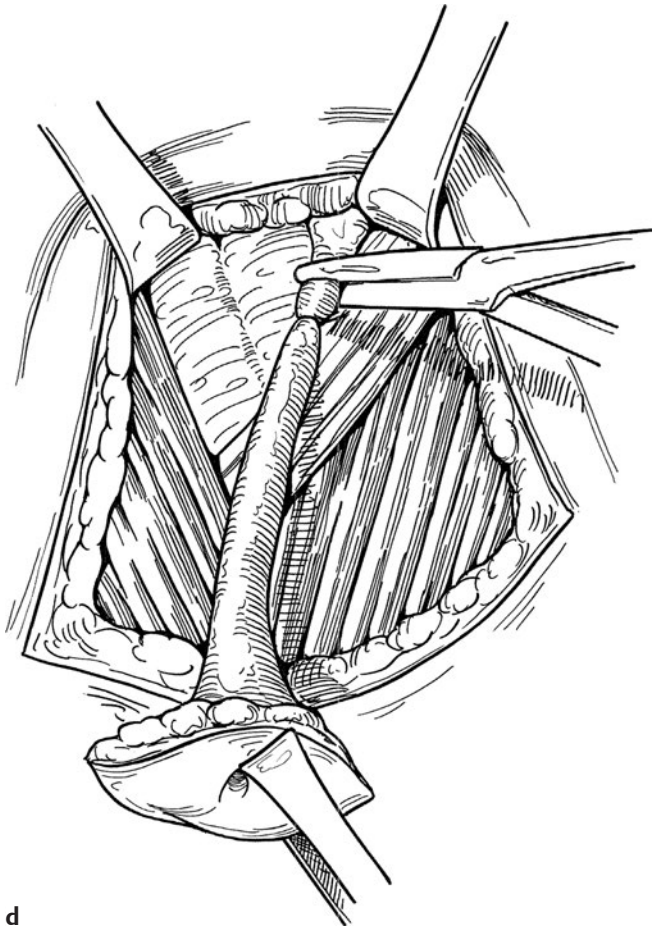


b

Fig. 27.4a,b

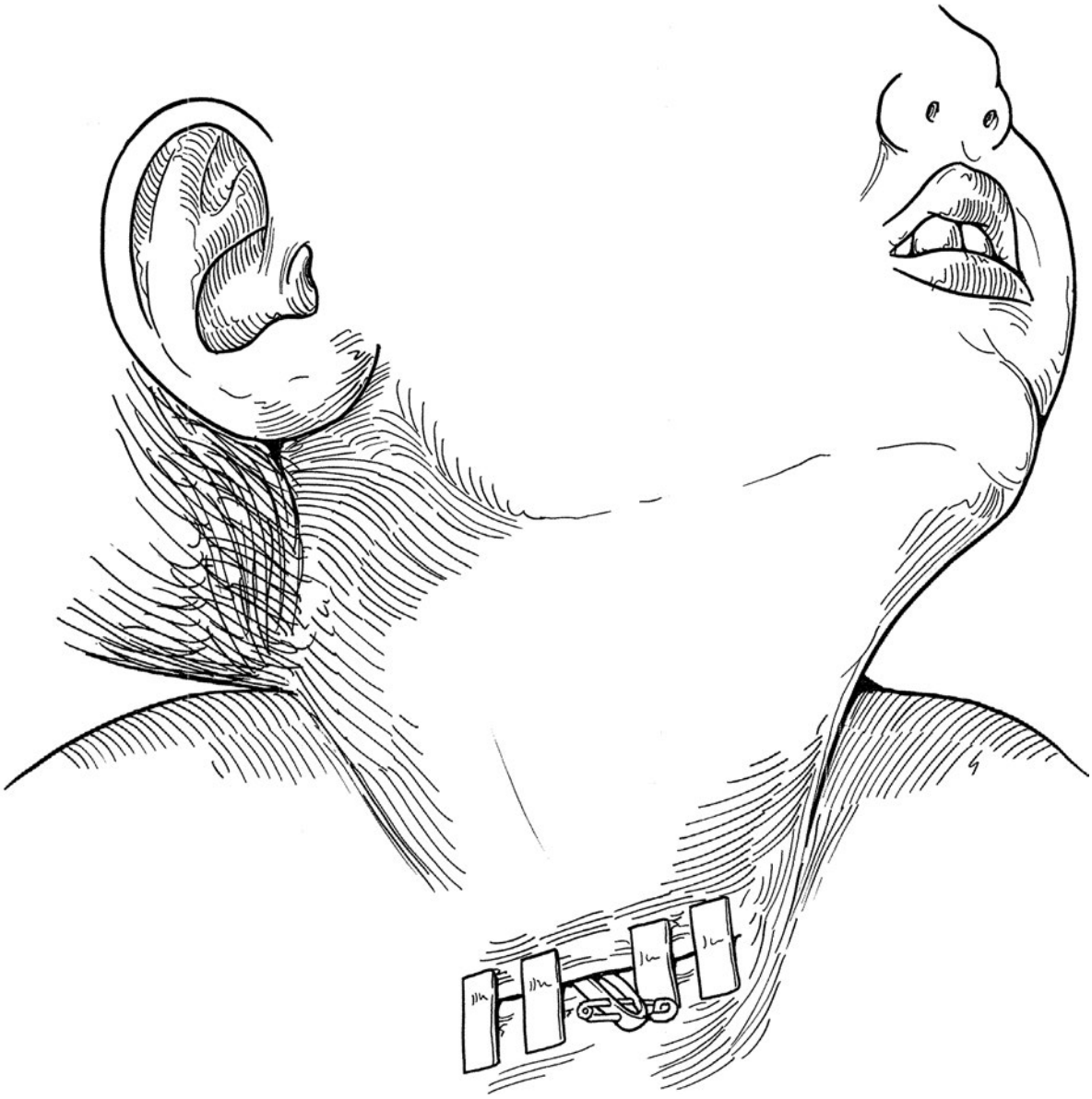


c



d

Fig. 27.4c,d



e

Fig. 27.4e

27-5 Drainage of Cervical Adenitis

Introduction

Purulent cervical adenitis is common in children and usually occurs concurrently with an upper respiratory infection.

Indications

The indication for drainage of a cervical adenitis is the loculation of pus in a cervical node. Intravenous antibiotics should also be administered.

Preoperative Evaluation

The preoperative evaluation of cervical abscess includes a CT scan or MRI to define the extent of the abscess.

Operative Technique

1. In older children, superficial cervical abscesses may be aspirated without any anesthetic (**Fig. 27.5a**). Local, injectable anesthetics are not helpful in acutely inflamed tissue. However, topical anesthetic creams may help decrease pain from the needle stick.
2. An 18-gauge needle is advanced into the abscess (**Fig. 27.5b**), and as much pus as possible is aspirated (**Fig. 27.5c**).
3. The needle should be gently moved back and forth to break septae and evacuate multiloculated pus (**Fig. 27.5d**).
4. Abscesses that do not respond to intravenous antibiotics and needle aspiration require incision and drainage under general anesthesia.
5. An incision is made into the abscess along the line of a skin crease (**Fig. 27.5e**).
6. Pus is evacuated from the abscess with a suction (**Fig. 27.5f**). Cultures are obtained.
7. The septae in the abscess cavity are broken with a cotton tip applicator, finger, or clamp (**Fig. 27.5g**).
8. The abscess is loosely packed with gauze to stop bleeding and allow it to drain (**Fig. 27.5h**).
9. No sutures are placed.
10. The packing is removed over 24–48 hours.
11. Antibiotics are administered based on culture findings (usually *Staphylococcus aureus*).

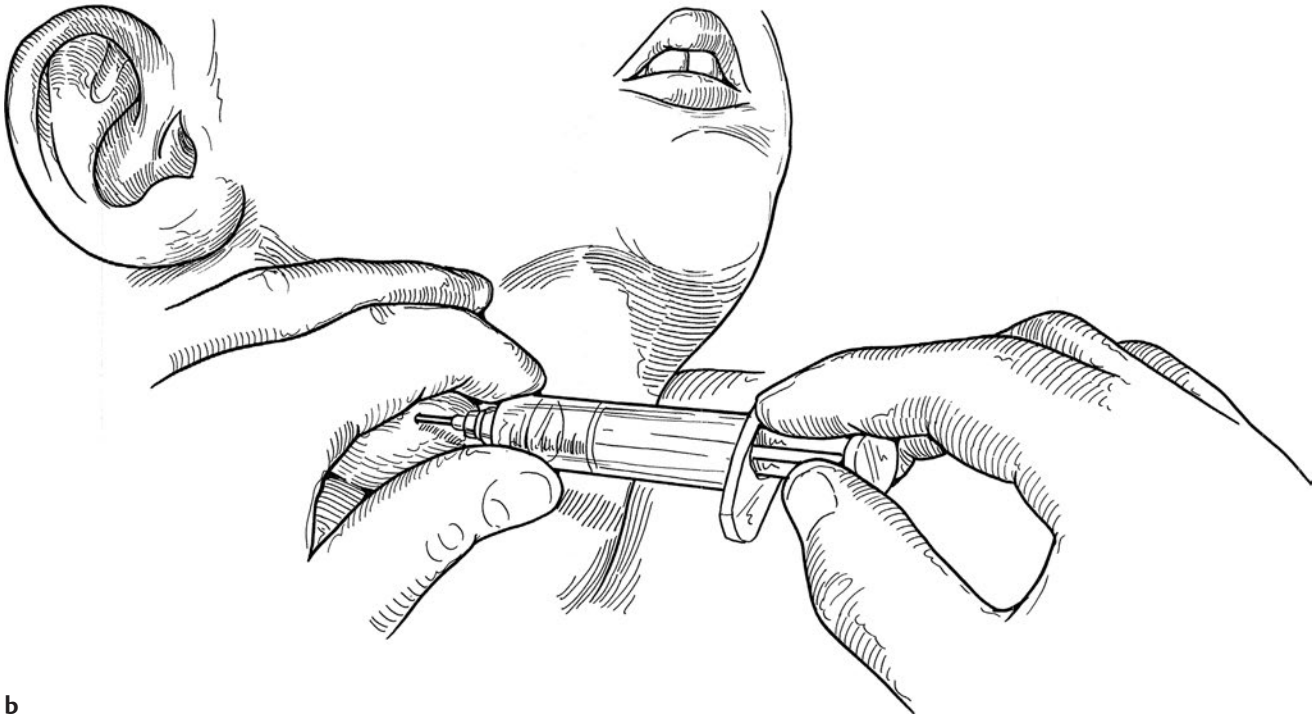
Complications

1. Recurrence of abscess
2. Marginal mandibular nerve injury

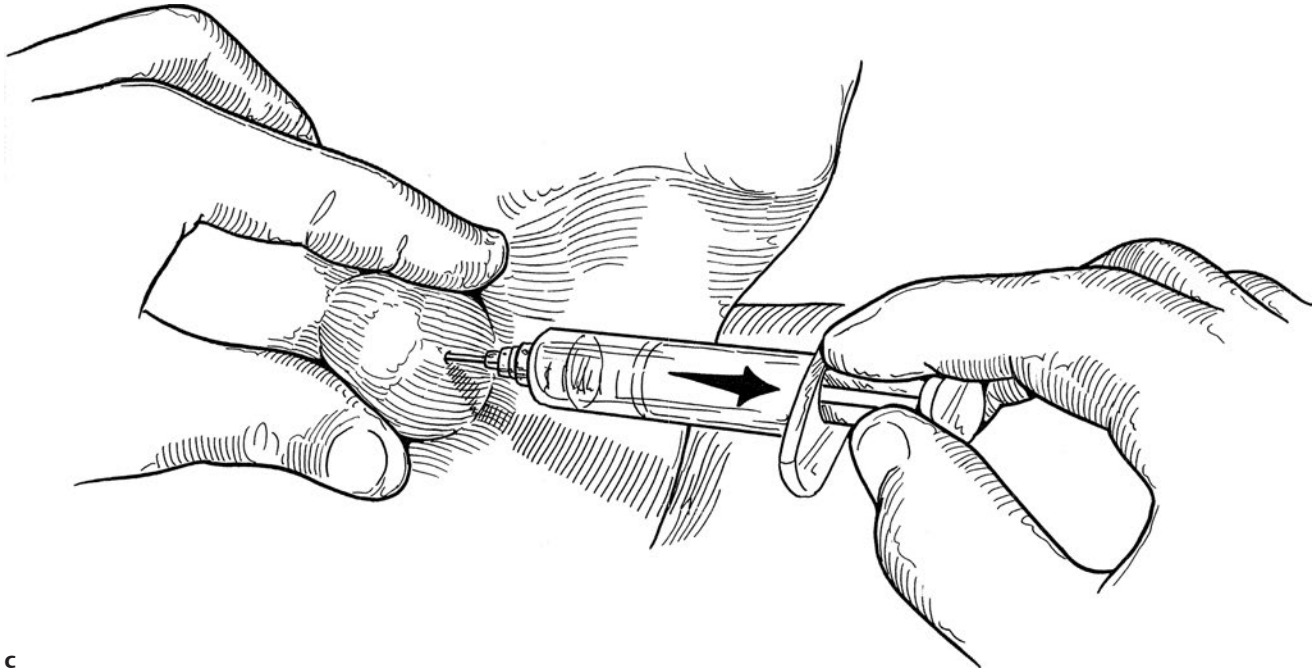


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Fig. 27.5a

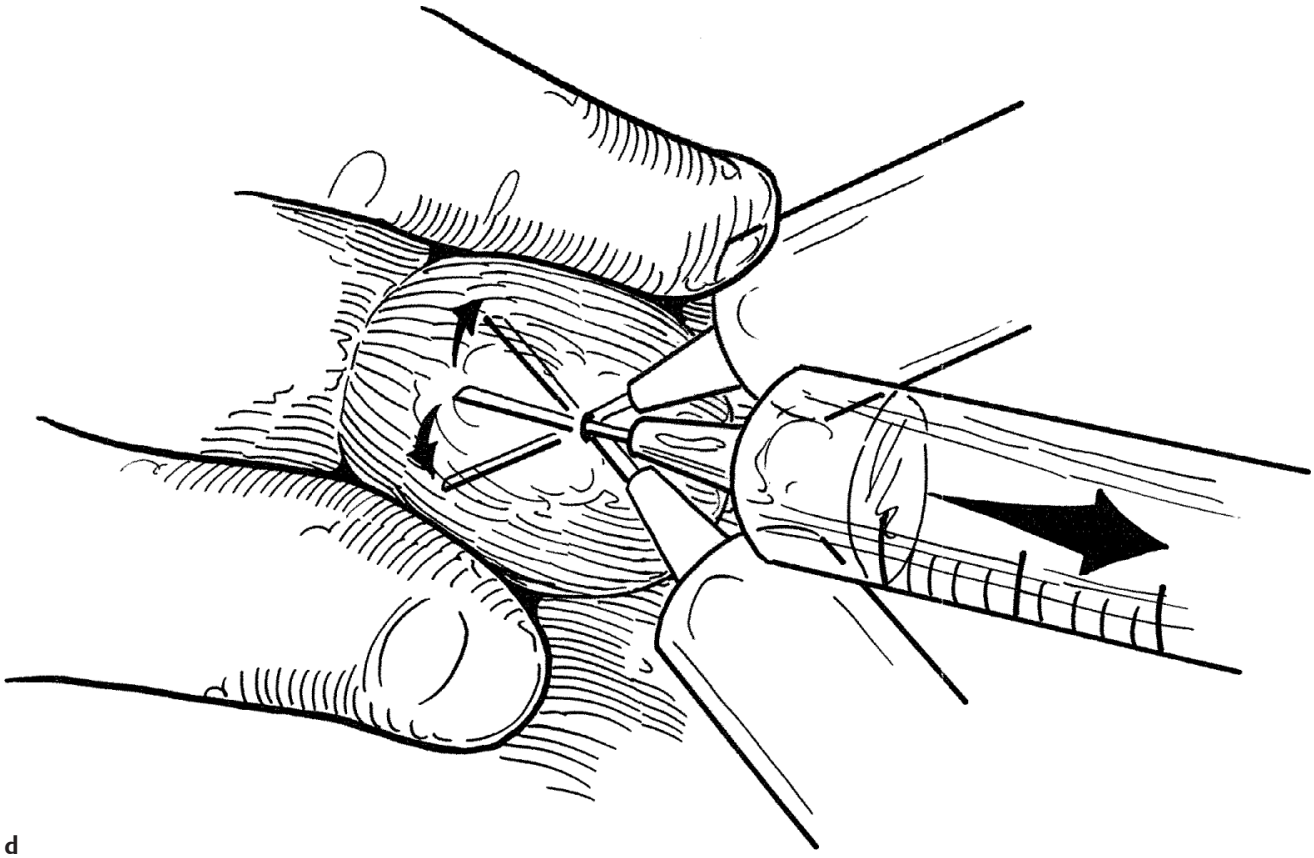


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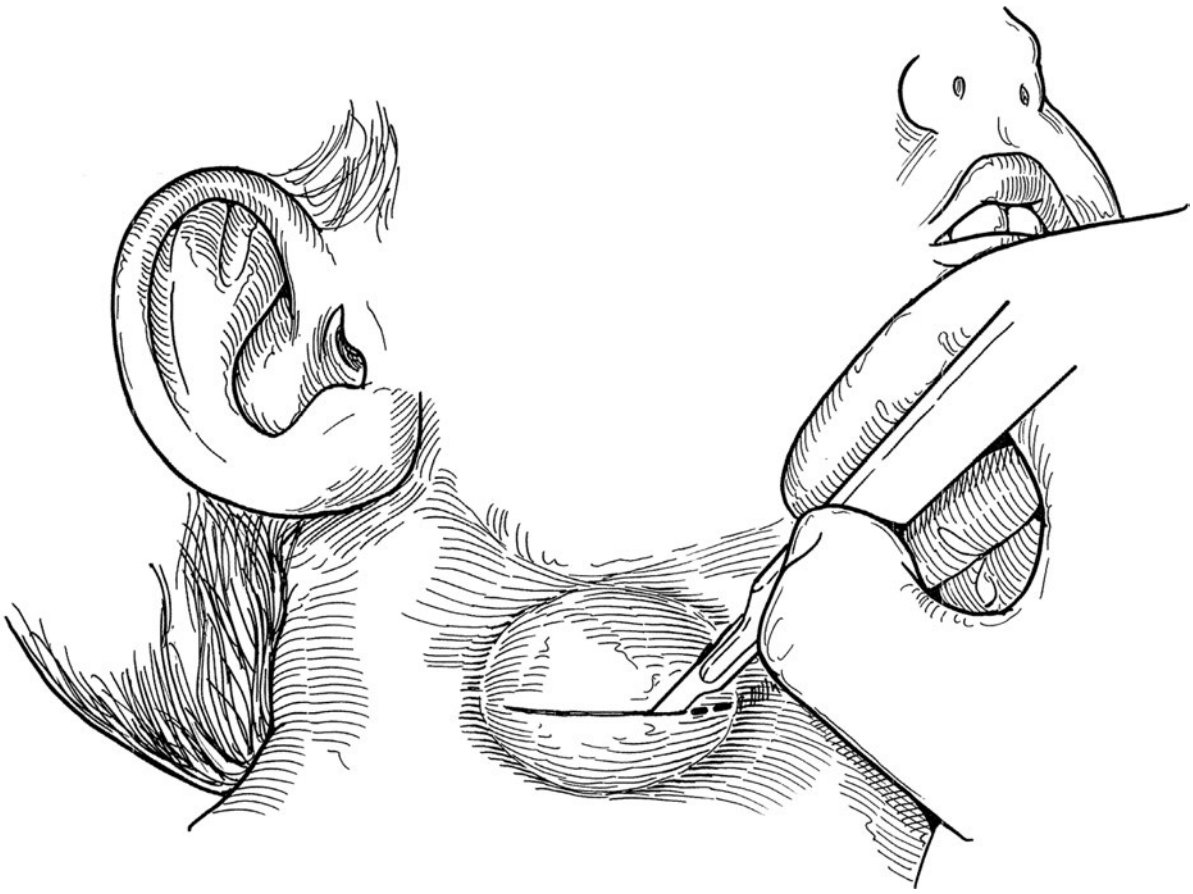
c

Fig. 27.5b,c

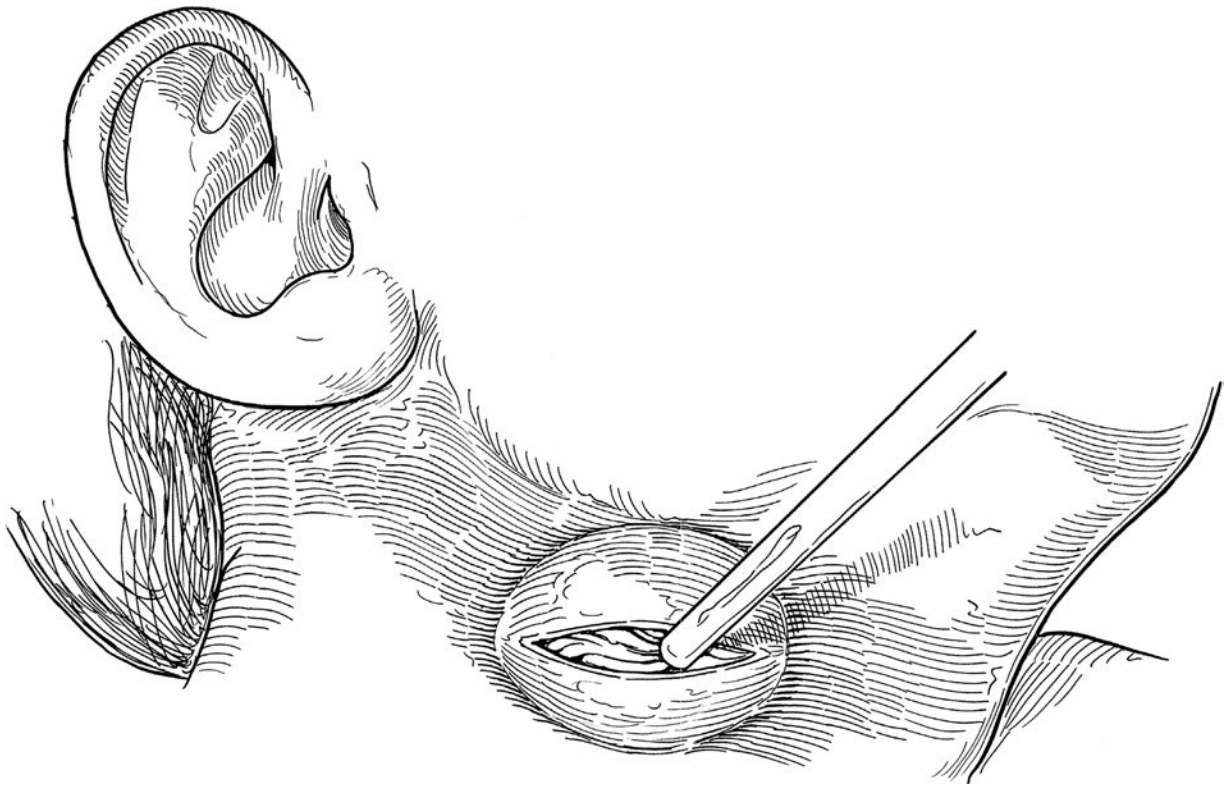


d

Fig. 27.5d

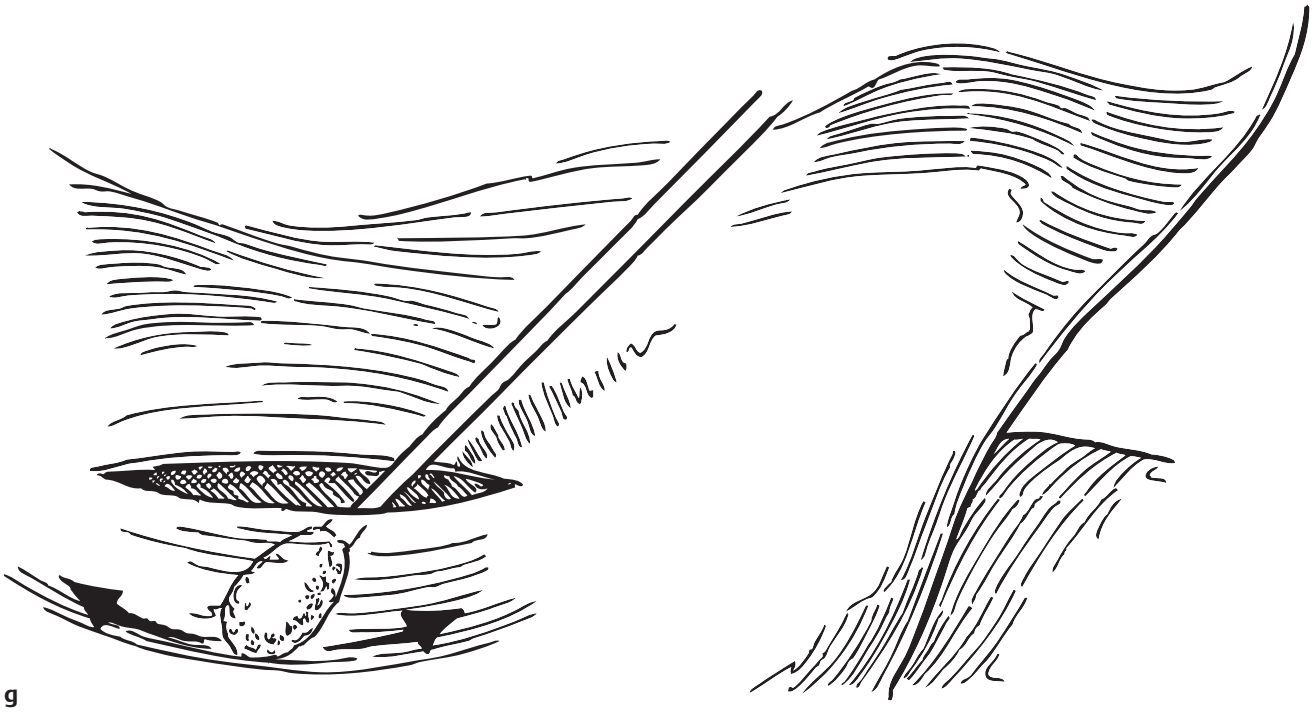


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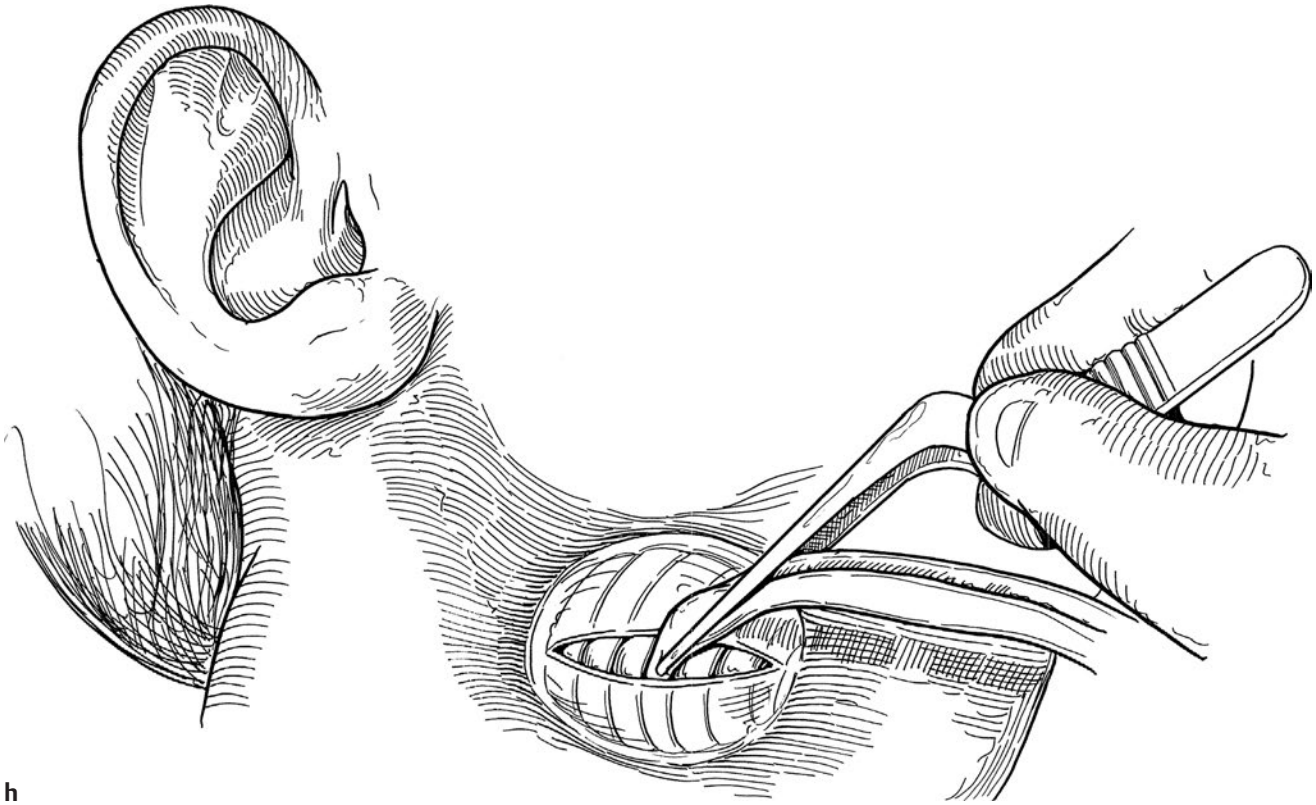


f

Fig. 27.5e,f



g



h

Fig. 27.5g,h

27-6 Curettage of Atypical Mycobacteria

Introduction

Atypical mycobacterial infection occurs uncommonly in children. It may involve any cervical lymph node, but most often presents at the lower border of the mandible in the posterior portion of the submandibular triangle. The overlying skin often has a deep red hue.

Indications

These infections usually do not respond to antitubercular medications. Surgical excision is the treatment of choice. While either total excision or curettage can be utilized in the management of these lesions, curettage is equally effective and usually allows a more cosmetically acceptable result, especially in larger lesions that may overlie the region where the marginal mandibular nerve courses.

Preoperative Evaluation

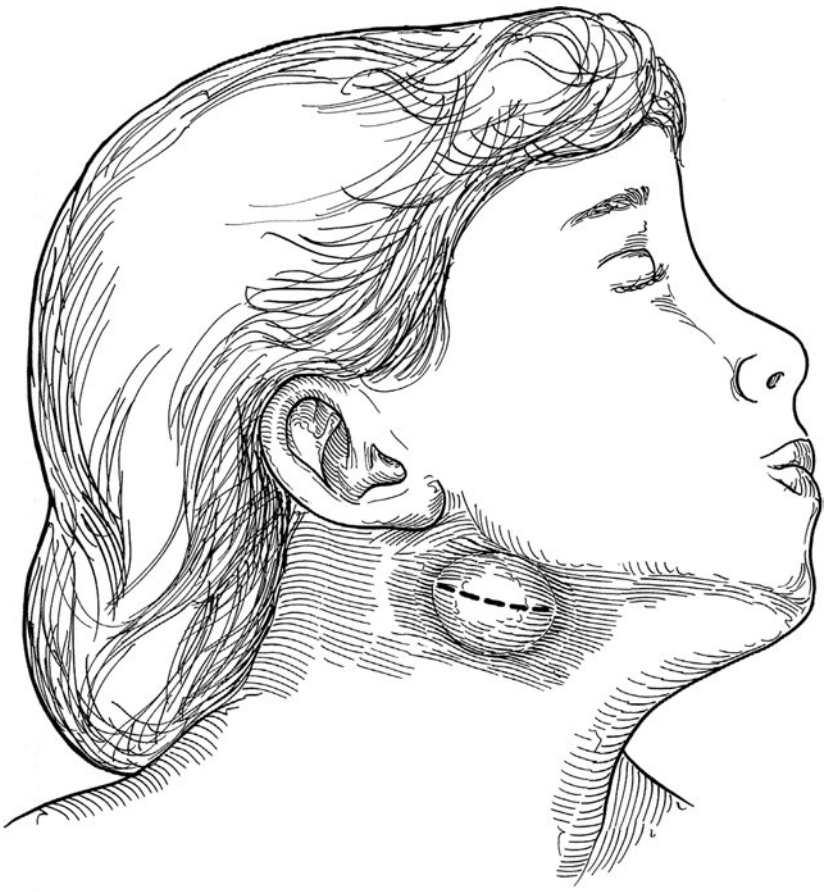
Inspection and palpation of the involved mass are usually sufficient. A CT or MRI scan will define the extent of the deep nodes involved. The surgeon may elect to utilize intraoperative facial nerve monitoring during the surgical procedure.

Operative Technique

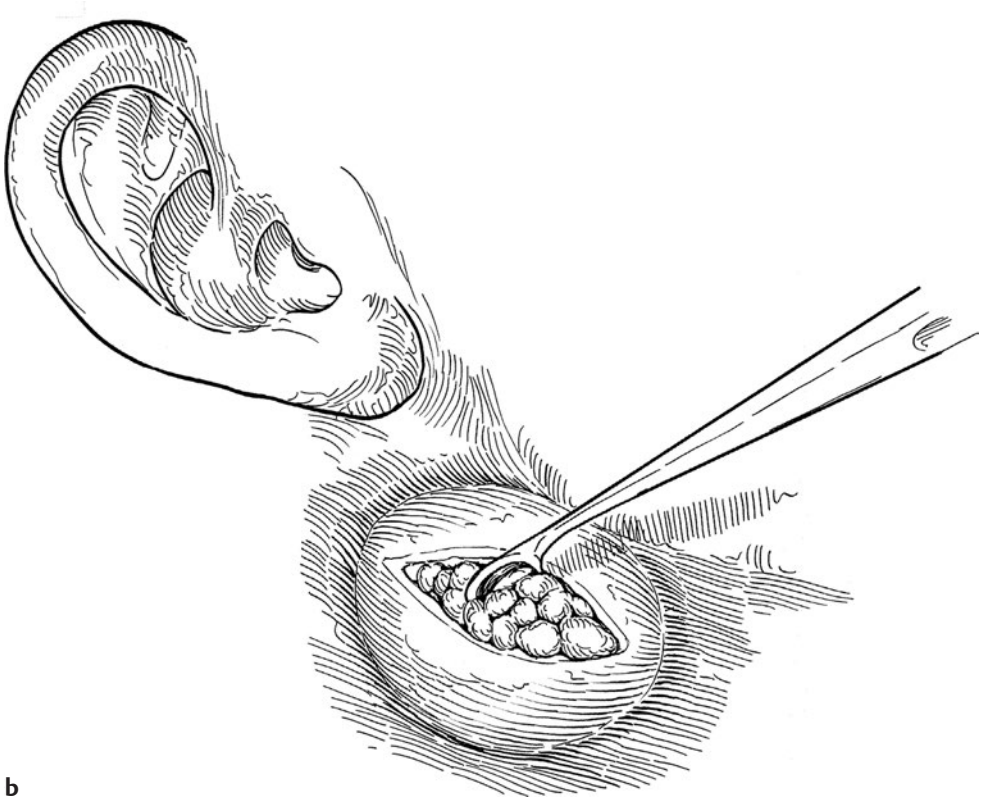
1. Curettage of atypical mycobacteria cervical adenitis is performed under general anesthesia.
2. An incision is made into the granulomatous abscess with a scalpel (**Fig. 27.6a**). The incision should be 2 cm below the edge of the mandible and in a skin crease. One percent lidocaine with 1:100,000 epinephrine may be injected subcutaneously at the site of the incision to aid in hemostasis.
3. The contents of the abscess are evacuated using a mastoid curette to clean out the granulomatous material (**Fig. 27.6b**).
4. Multiple nodes may be connected by granulomatous necrotic debris. These deeper nodes should be cleared out as well (**Fig. 27.6c**).
5. The skin incision is closed with interrupted 5-0 nylon suture. A rubber band drain is placed and removed in 24–36 hours (**Fig. 27.6d**).

Complications

Recurrence of infection.

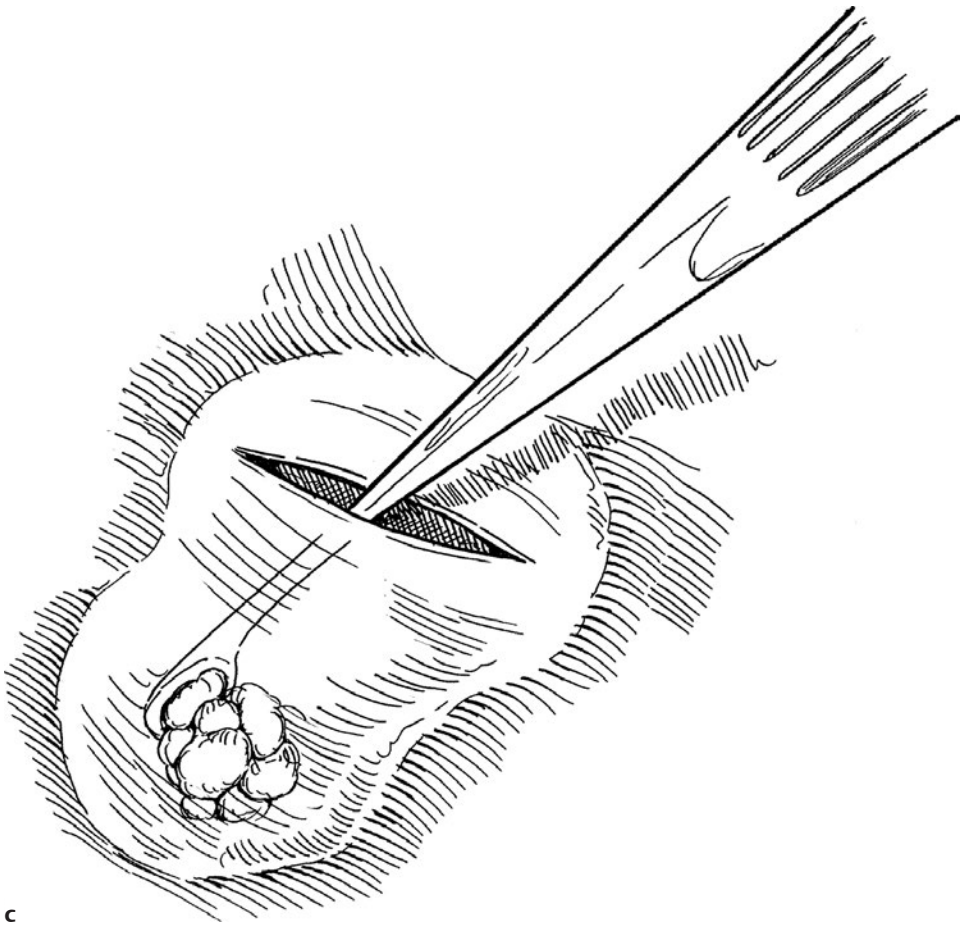


a

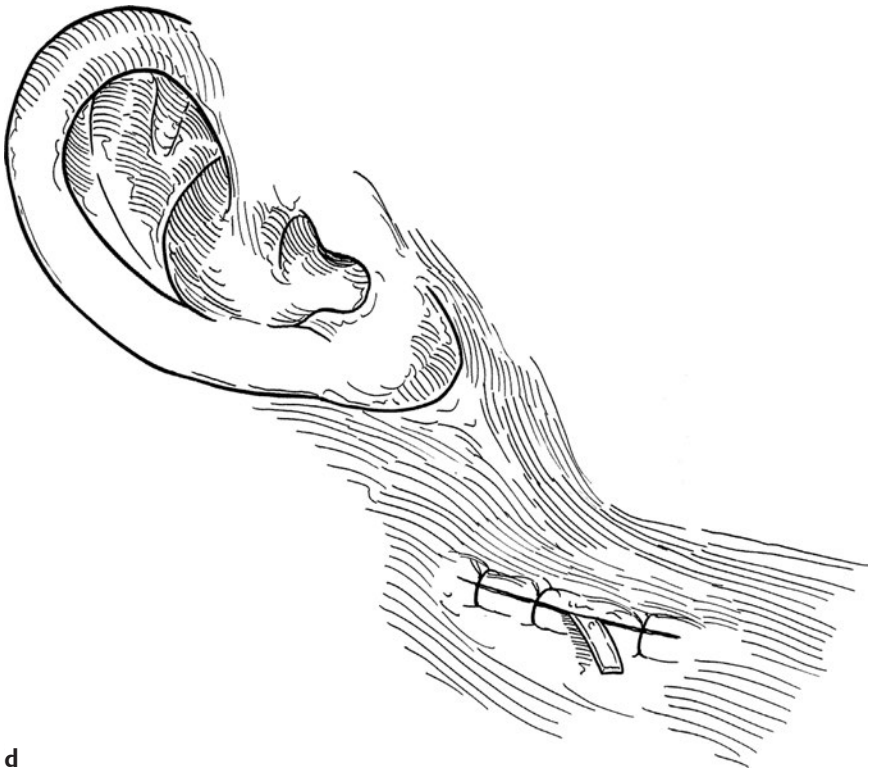


b

Fig. 27.6a,b



c



d

Fig. 27.6c,d

27-7 Thyroidectomy

Introduction

Thyroidectomy is an operation to excise one or both lobes of the thyroid gland. The most common indication for this procedure is the presence of a thyroid mass (suspicion of malignancy), which is rare in children.

Indications

Thyroidectomy is indicated in the treatment of possible malignant disease in the thyroid gland.

Preoperative Evaluation

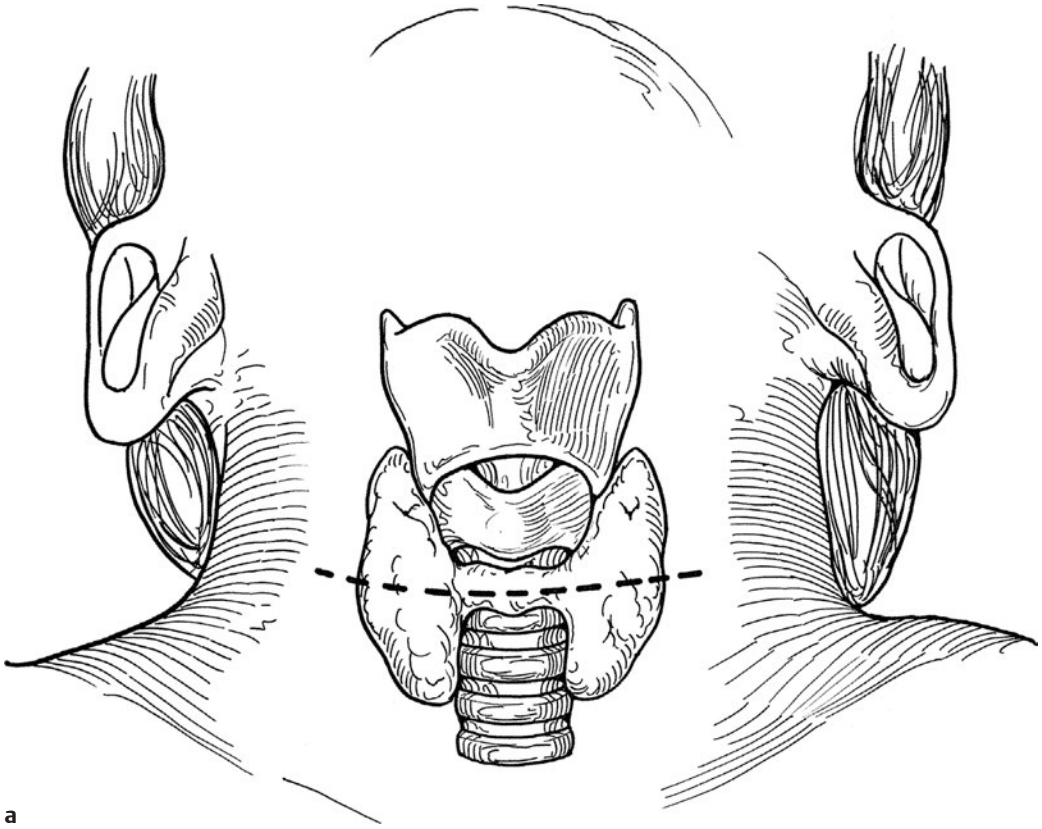
Thyroid ultrasound and MRI are helpful to define disease in the thyroid gland and adjacent structures. Thyroid function tests and a chest radiograph should be performed preoperatively.

Operative Technique

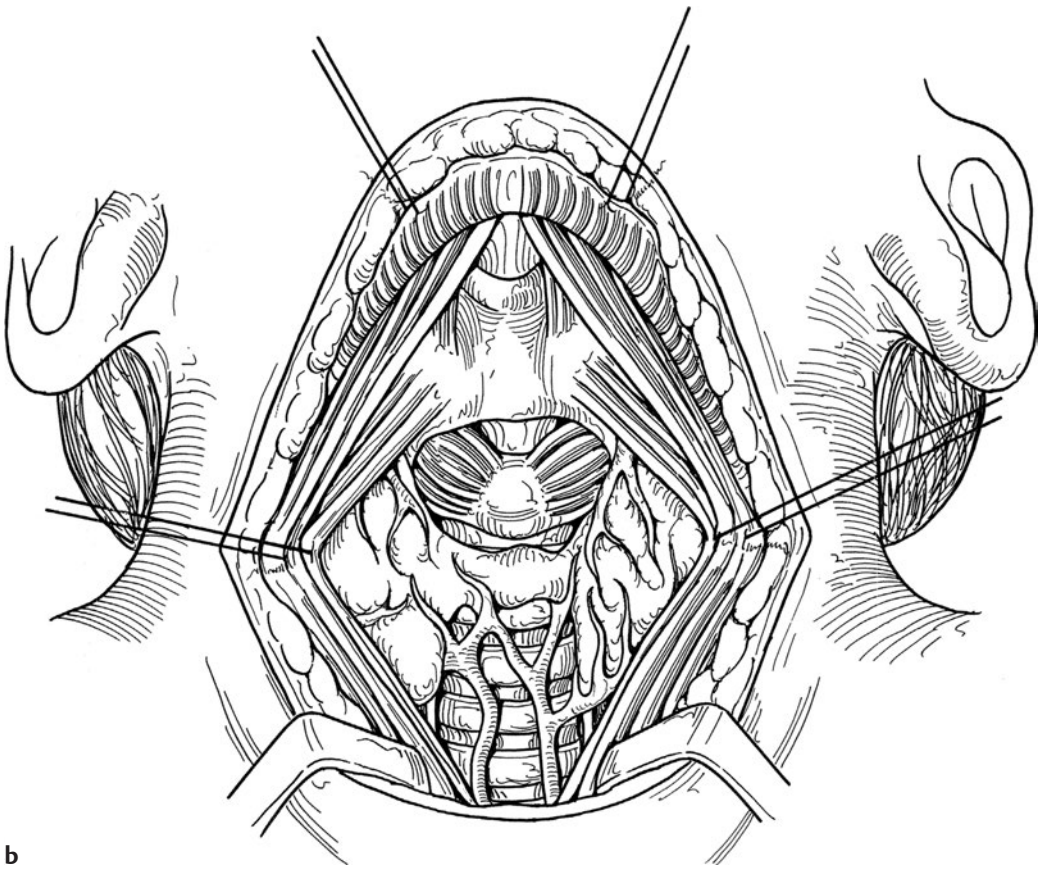
1. Thyroidectomy is done under general anesthesia with the patient on a shoulder roll and the neck extended (see Section 25-1).
2. A transverse incision is made in a skin crease in the lower neck after the area has been infiltrated with 1% lidocaine with 1:100,000 epinephrine to aid in hemostasis (**Fig. 27.7a**). The incision is carried through the subcutaneous tissue and the platysma muscle.
3. Inferior and superior subplatysmal skin flaps are elevated with scissors exposing the strap muscles over the thyroid gland (**Fig. 27.7b**).
4. The strap muscles are separated in the midline and retracted laterally (**Fig. 27.7b**).
5. Using a clamp spreading in a vertical plane, the recurrent laryngeal nerve is identified in the tracheoesophageal groove near the inferior portion of the thyroid lobe (**Fig. 27.7c**).
6. Protecting the recurrent nerve, the thyroid veins and arteries are divided as the thyroid is dissected from its surrounding attachments with a clamp and scissors (**Fig. 27.7d**). If a parathyroid gland is identified, it should be preserved, if possible. If the parathyroid gland is removed, it can be reimplanted into the sternocleidomastoid muscle.
7. The thyroid lobe is reflected medially and the isthmus is cut with a Bovie (**Fig. 27.7e**).
8. The thyroid isthmus may be oversewn with chromic sutures to ensure hemostasis.
9. If total thyroidectomy is required, the contralateral side is resected in a similar manner. In this instance, special care is taken to preserve at least one parathyroid gland.
10. The wound is closed with 4-0 Vicryl in the subcutaneous tissue and 4-0 interrupted subcuticular Vicryl in the skin (**Fig. 27.7f**).
11. A Penrose drain is placed in the wound under the flap and removed in 24–36 hours.

Complications

1. Recurrent laryngeal nerve injury
2. Hypoparathyroidism

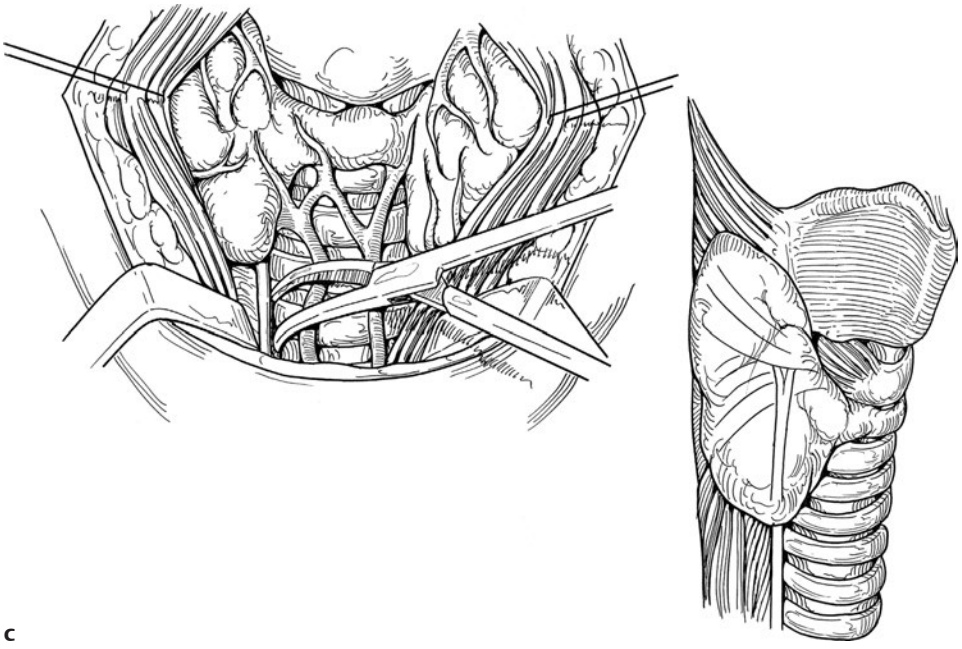


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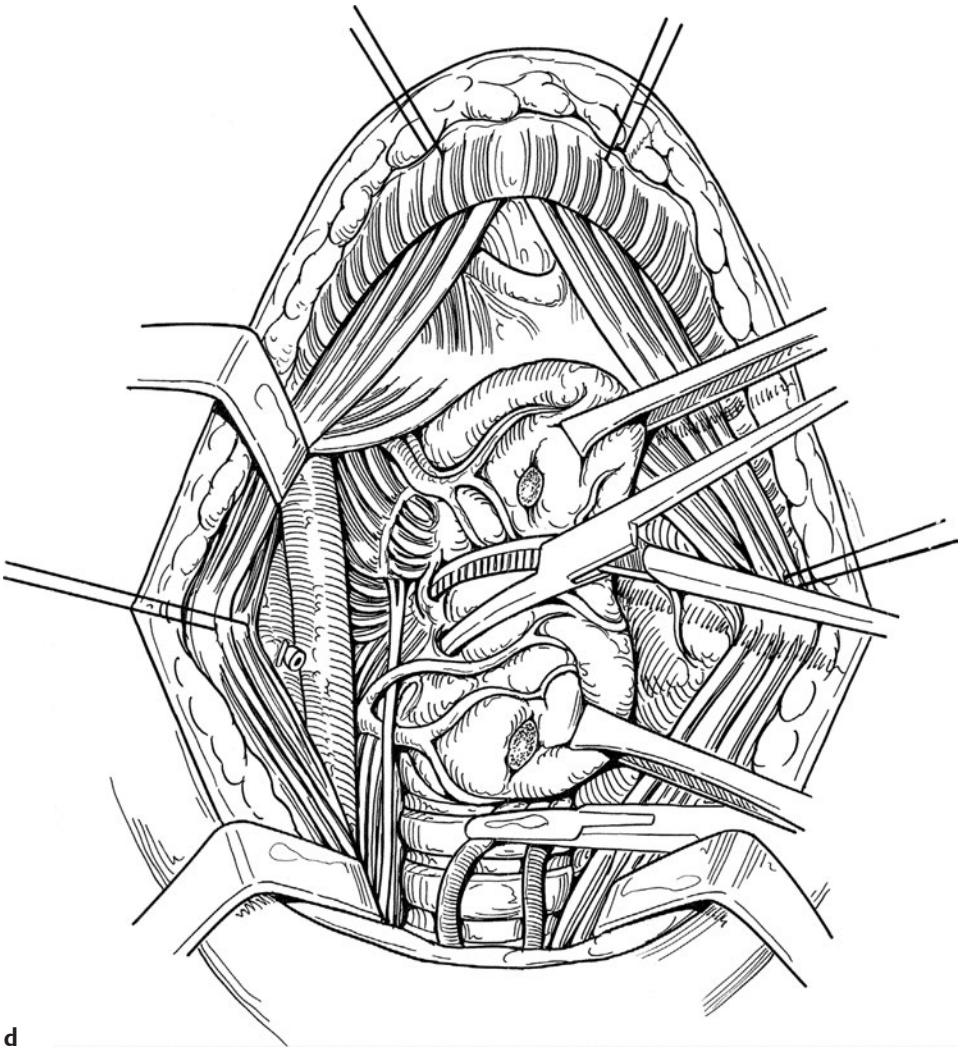


b

Fig. 27.7a,b

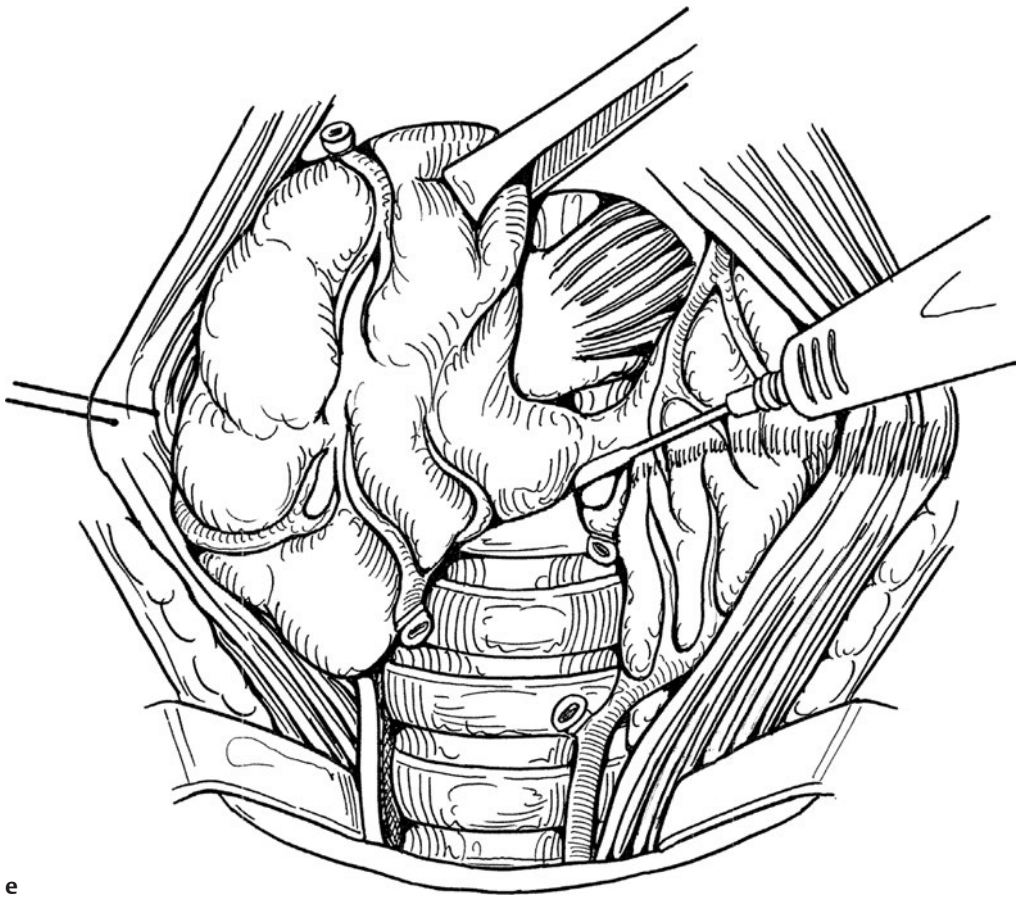


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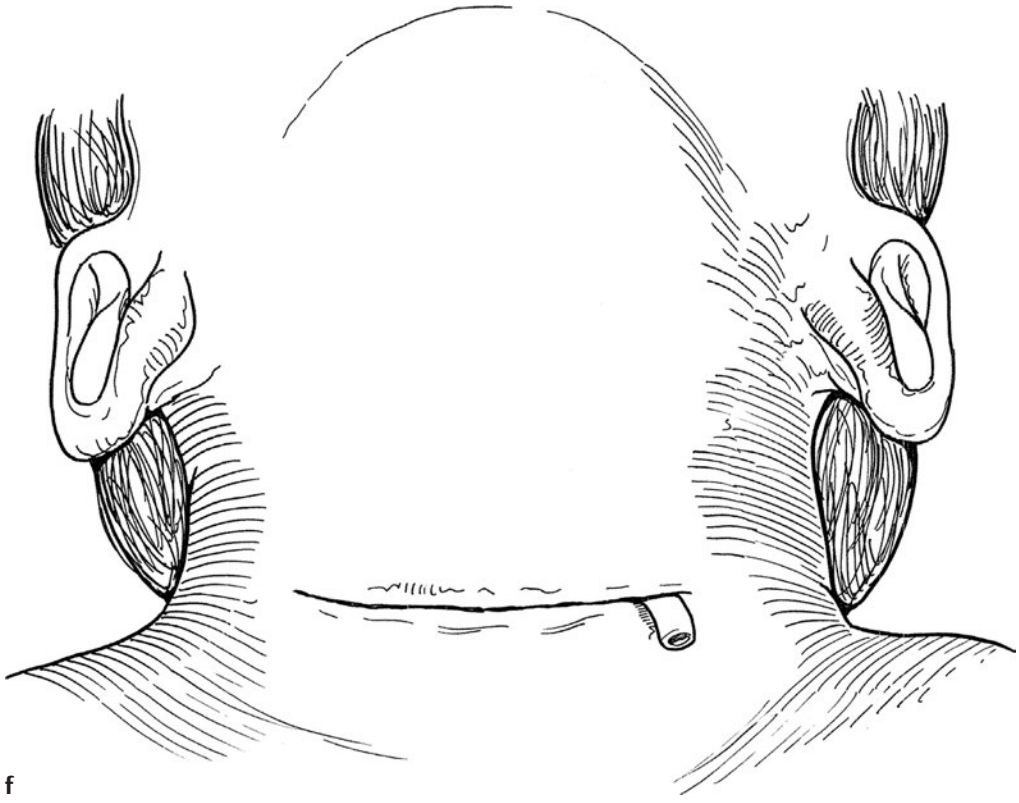


d

Fig. 27.7c,d



e



f

Fig. 27.7e,f

Section VI

The Salivary Glands

VI

28 Salivary Duct Surgery and Sialorrhea Surgery

Charles M. Myer III

Chronic sialorrhea is a significant social problem that makes it difficult for children to participate in group activities (e.g., play groups and school).

28-1 Parotid Duct Ligation

Introduction

Parotid duct ligation reduces salivary production and causes atrophy of the gland.

Indications

Parotid duct ligation is performed in neuromuscularly impaired children to help control drooling. The indications for the operation are based on the history and observance of drooling that is a problem both for the child and for his caregiver. It is usually performed bilaterally and simultaneously with either bilateral submandibular gland excision or bilateral submandibular duct ligation. Submandibular gland excision is described in Section 29-1.

Preoperative Evaluation

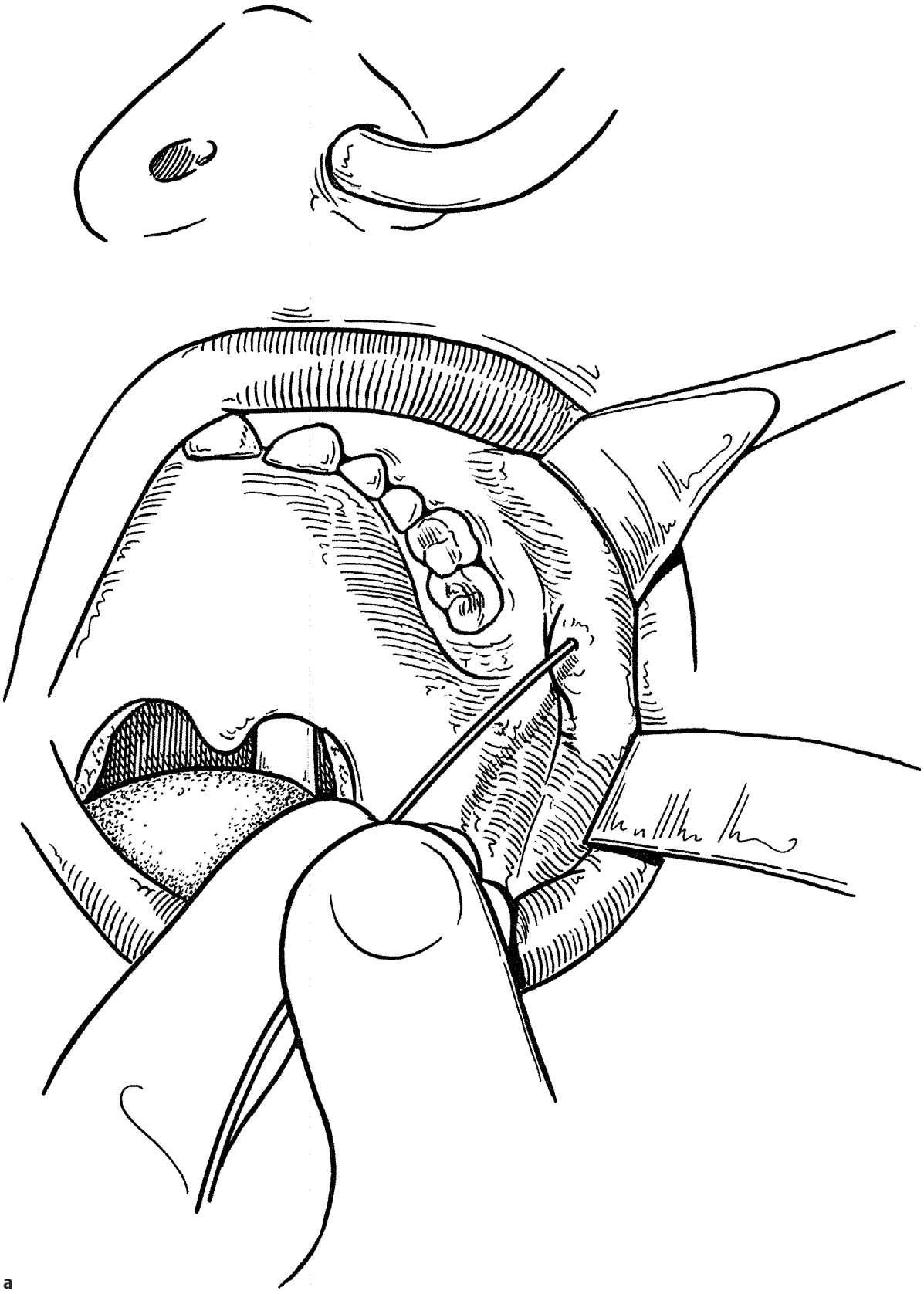
Preoperative radiographic studies are not helpful.

Operative Technique

1. Parotid duct ligation is performed utilizing general nasotracheal anesthesia. This provides good oral exposure.
2. A lacrimal probe is inserted into the parotid duct to stabilize the papilla (**Fig. 28.1a**). One percent lidocaine with 1:1000,000 epinephrine is injected into the mucosa surrounding the papilla.
3. An elliptical incision is made around the papilla (**Fig. 28.1b**).
4. The papilla is grasped with a clamp and traction is placed on the duct while dissecting the duct free from surrounding tissue with a scissors (**Fig. 28.1c**).
5. The duct is ligated twice with 3-0 silk suture and the papillary mucosa is excised by transecting the distal portion of the duct (**Fig. 28.1d**).
6. The duct is allowed to retract into the soft tissue of the cheek (**Fig. 28.1e**) and the oral mucosa is sutured loosely with 3-0 chromic suture (**Fig. 28.1f**).

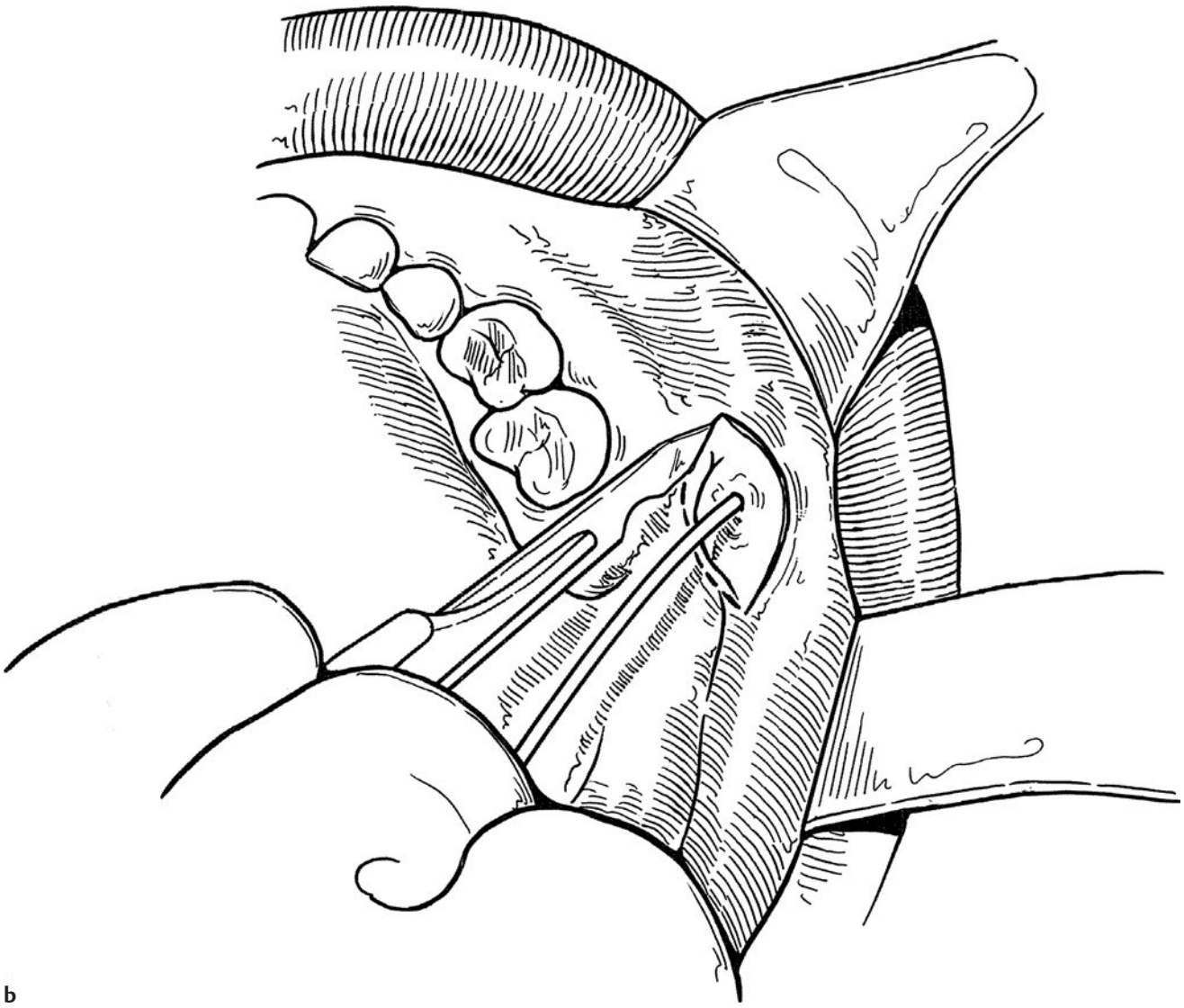
Complications

Temporary painful parotid swelling.



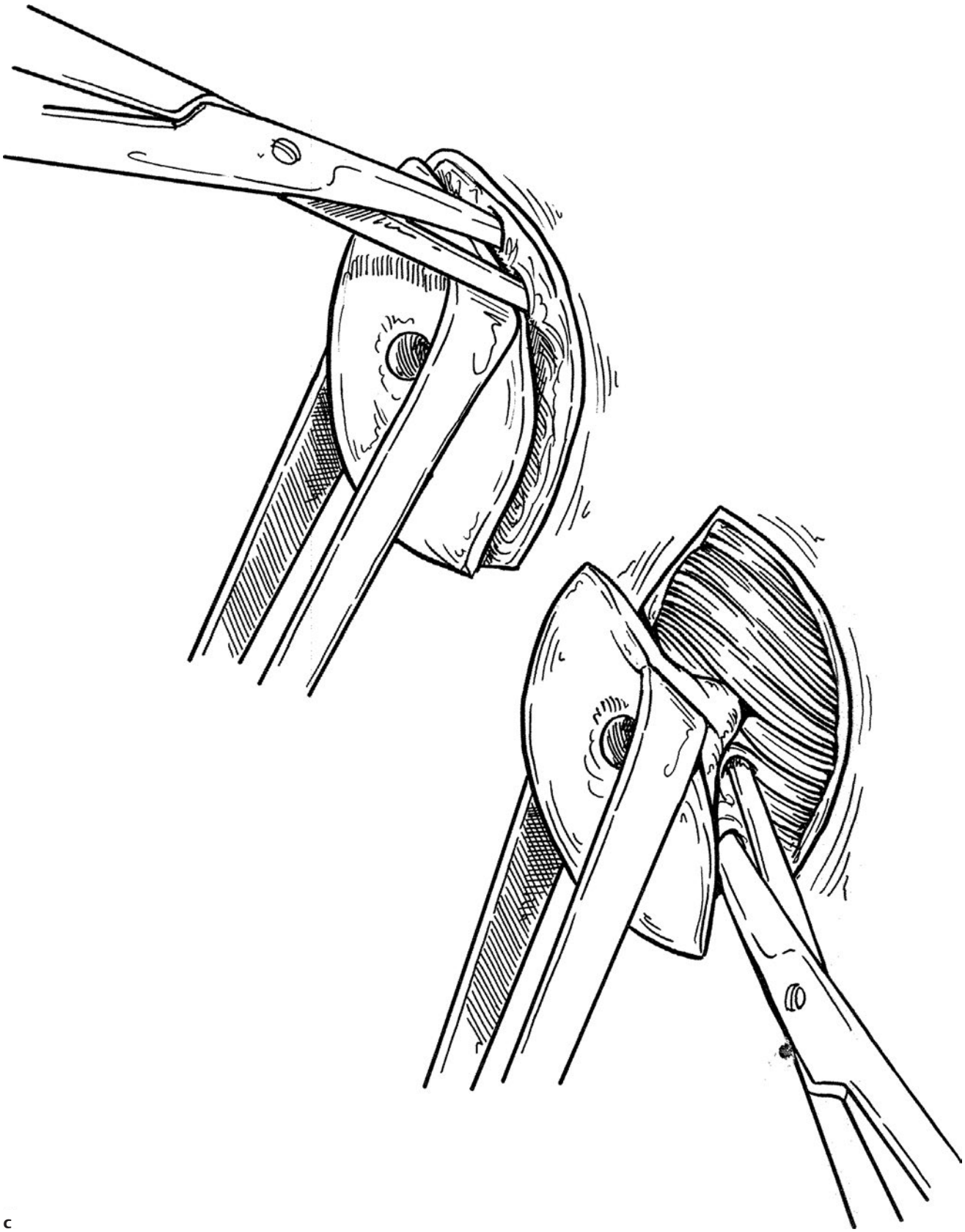
a

Fig. 28.1a



b

Fig. 28.1b



c

Fig. 28.1c

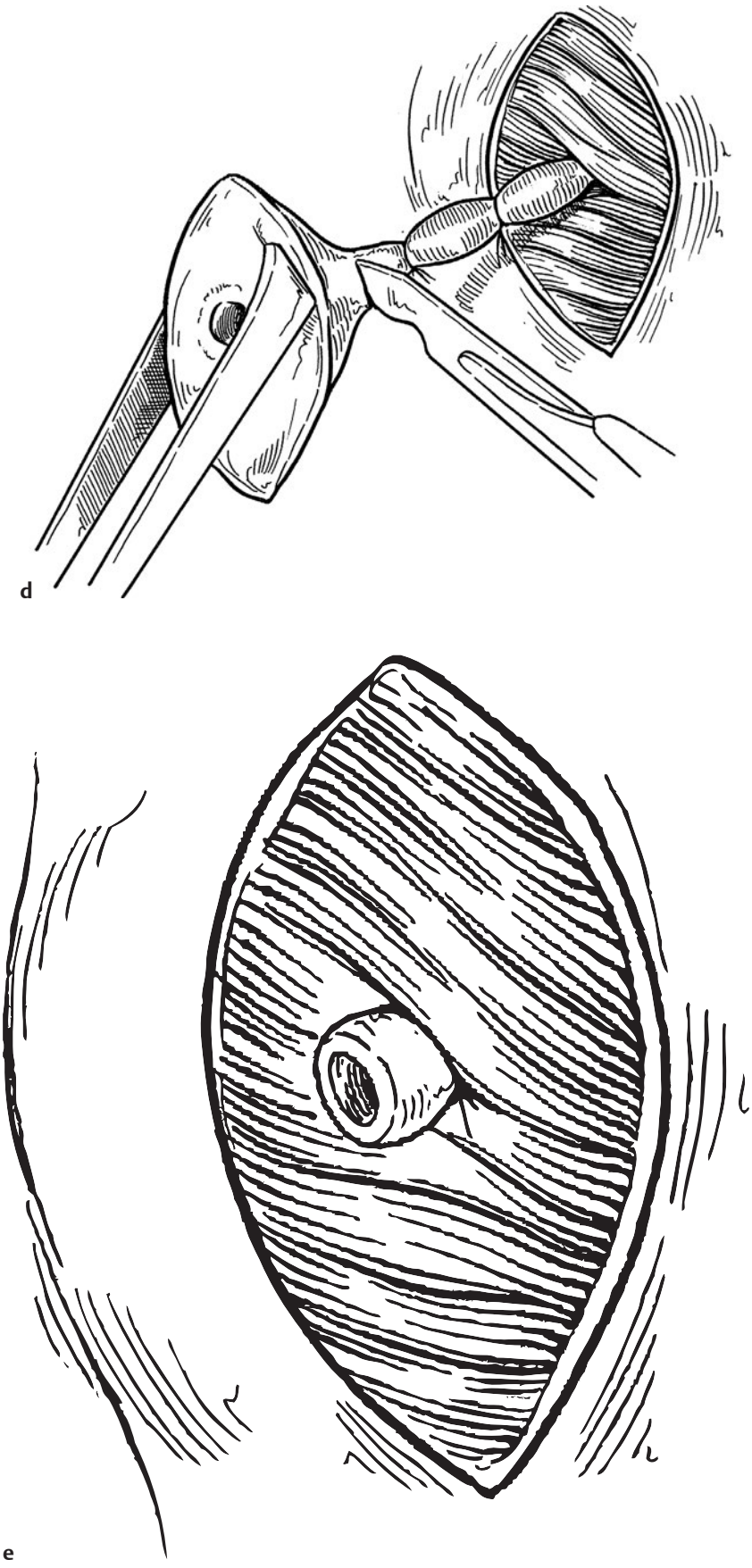
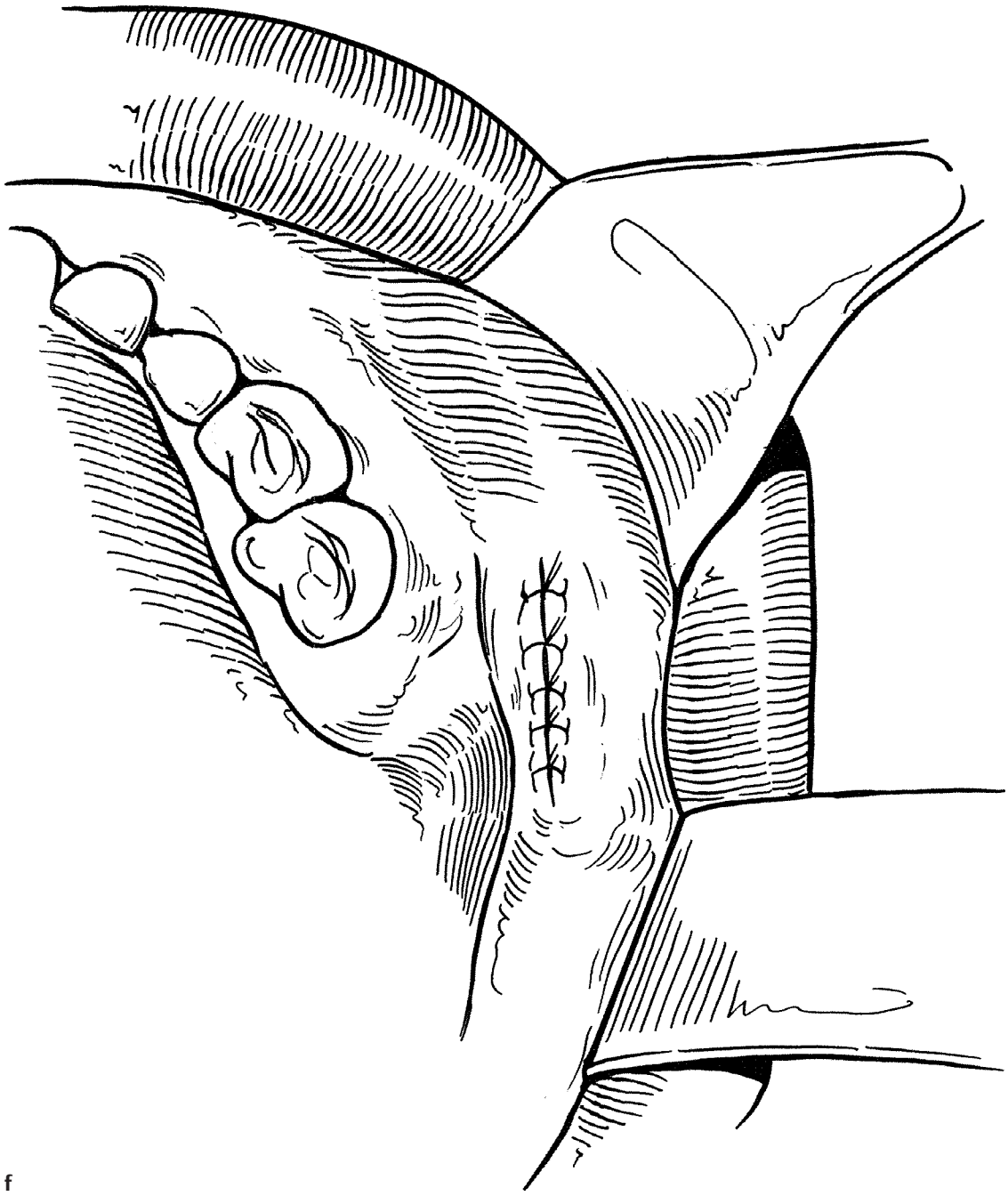


Fig. 28.1d,e



f

Fig. 28.1f

28-2 Removal of Distal Salivary Duct Stones (Submandibular and Parotid)

Introduction

Salivary duct stones usually present with acute painful swelling of the involved gland. Some degree of bacterial infection from chronic stasis is often present.

Indications

Removal of salivary duct stones is indicated in cases of chronic or intermittent salivary gland swelling secondary to a ductal stone.

Preoperative Evaluation

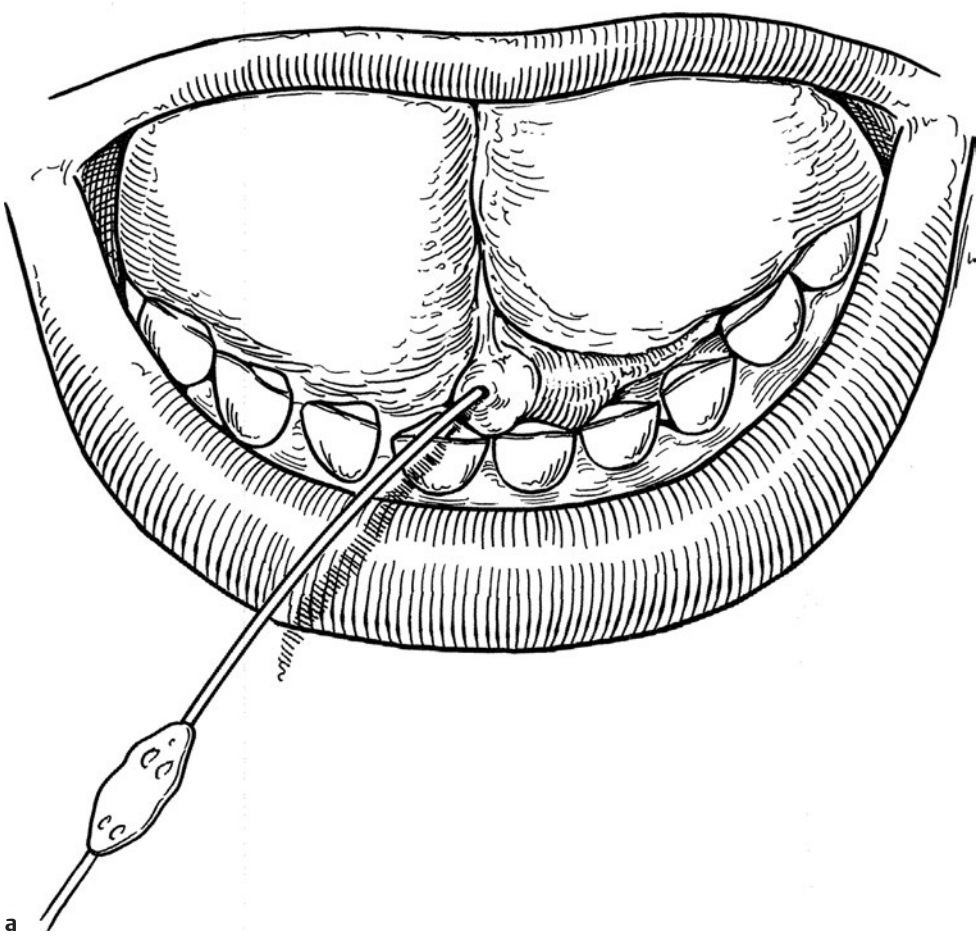
Inspection of the duct in the oral cavity may reveal a turbid discharge. The stone usually can be palpated by passing the index finger along the course of the duct intraorally. Standard radiographic films are rarely helpful because salivary duct stones are usually not calcified. Sialography or magnetic resonance imaging (MRI) may be useful to demonstrate the position of the stone but usually are not necessary.

Operative Technique

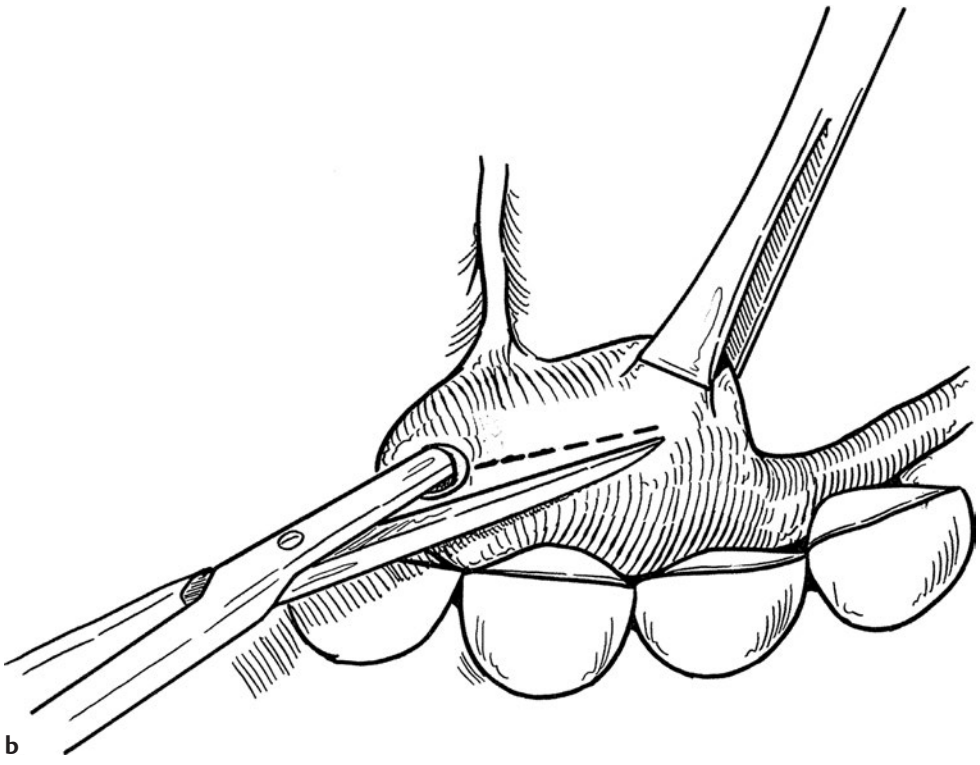
1. Stones near the papilla of the submandibular gland are removed utilizing general anesthesia and nasotracheal intubation to provide optimal intraoral exposure.
2. The duct is dilated with lacrimal probes (**Fig. 28.2a**).
3. The duct is cut by placing one blade of a sharp-pointed scissors in the dilated duct and closing the blades to open the duct in a slitlike manner (**Fig. 28.2b,c**).
4. The stone is expressed from the duct or removed with a curette (**Fig. 28.2d**).
5. The ductal incision is not closed. Salivary flow will keep this new, larger orifice open.
6. Stones near the orifice of the parotid duct are treated in the same fashion.

Complications

Stricture of the duct.

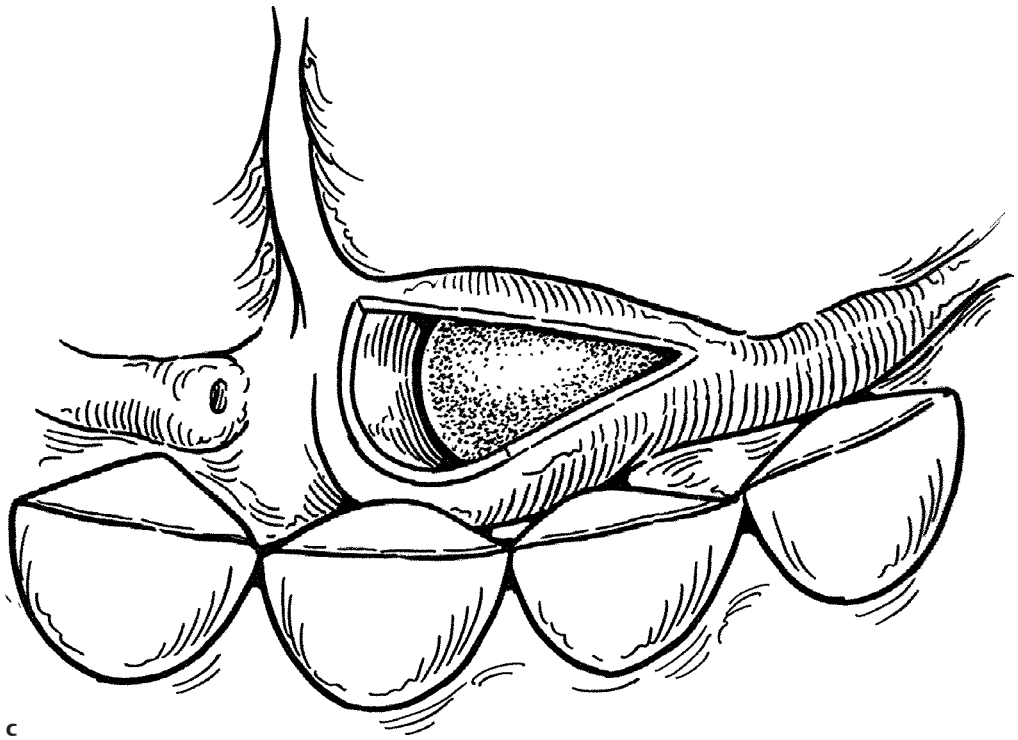


a

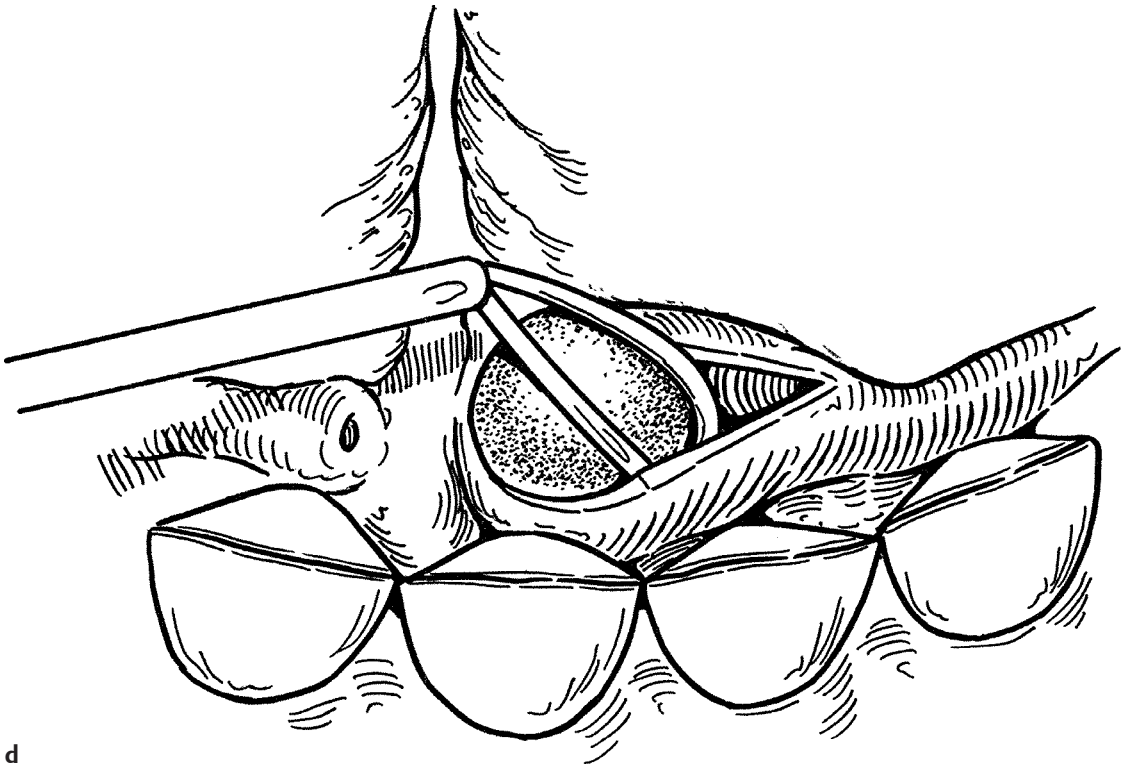


b

Fig. 28.2a,b



c



d

Fig. 28.2c,d

28-3 Removal of Submandibular Duct Stones (Proximal)

Introduction

Salivary duct stones usually present with acute painful swelling of the involved gland. Some degree of bacterial infection from chronic stasis is often present.

Indications

The presence of a salivary duct stone causing swelling and/or infection of the involved gland is the indication for surgical removal.

Preoperative Evaluation

Inspection of the duct in the oral cavity may reveal a turbid discharge. The stone usually can be palpated by passing the index finger along the course of the duct intraorally.

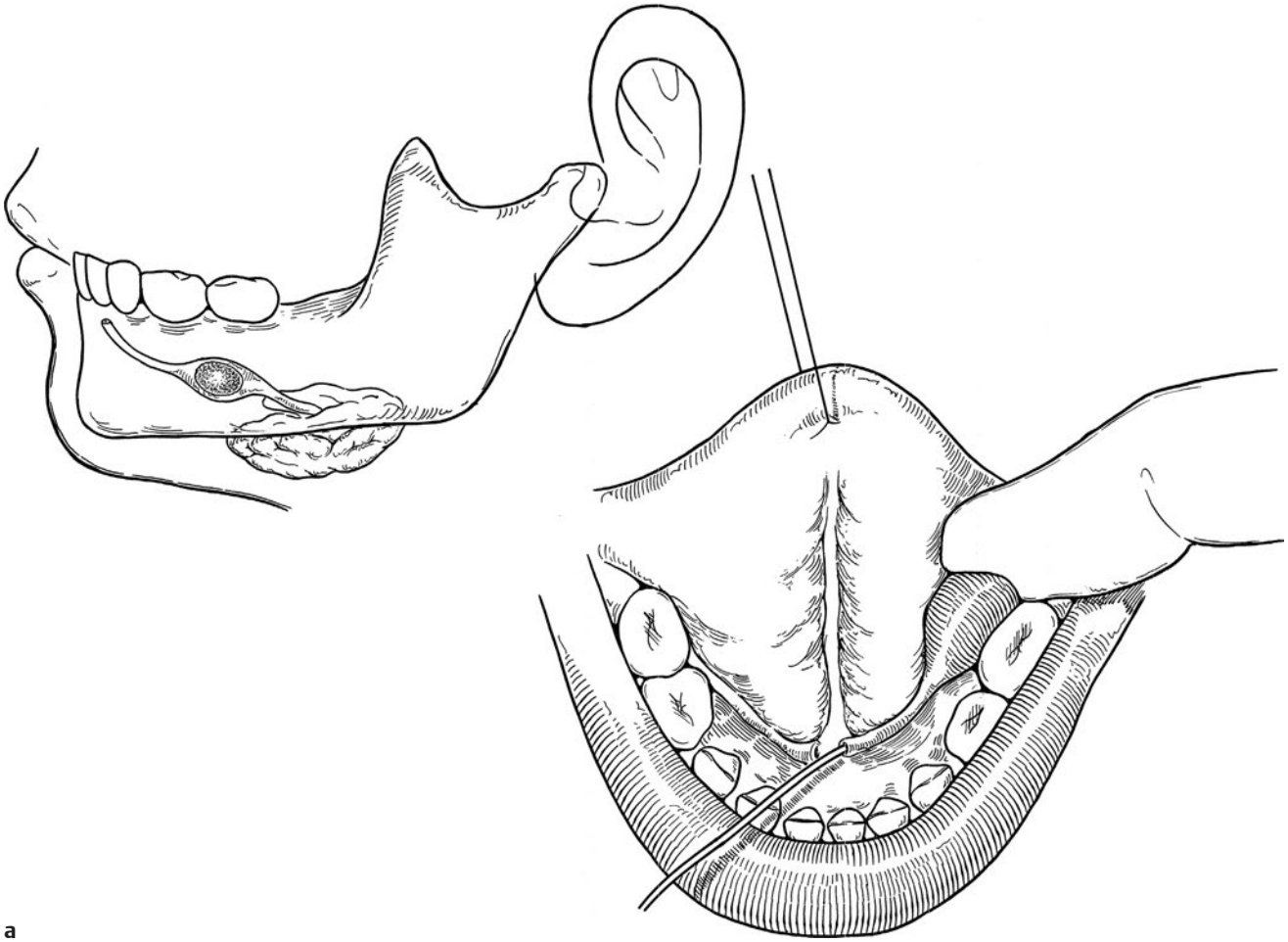
Standard radiographic studies are rarely helpful because salivary duct stones are usually not calcified. Sialography or magnetic resonance imaging (MRI) may be useful to demonstrate the position of the stone but usually are not necessary.

Operative Technique

1. Submandibular duct stones are removed utilizing general anesthesia and nasotracheal intubation for maximum exposure.
2. With a lacrimal probe in the duct and a finger in the floor of the mouth, the stone is located by palpation (**Fig. 28.3a**).
3. A silk suture is passed around the duct proximal to the stone to prevent the stone from slipping back into the gland (**Fig. 28.3b**).
4. The portion of the duct containing the stone is opened with a knife and the stone is removed (**Fig. 28.3b,c**).
5. The mucosal incision is closed loosely with 4-0 interrupted chromic sutures. It is not necessary to suture the duct since the obstruction has been relieved and attempts at closure of the duct can cause stenosis (**Fig. 28.3d**).
6. Alternatively, sialendoscopy could be utilized to facilitate stone removal after submandibular duct dilation as needed.
7. Submandibular duct stones that are deep within the proximal portion of the ductal system should be removed by resection of the involved gland (see Section 29-1).

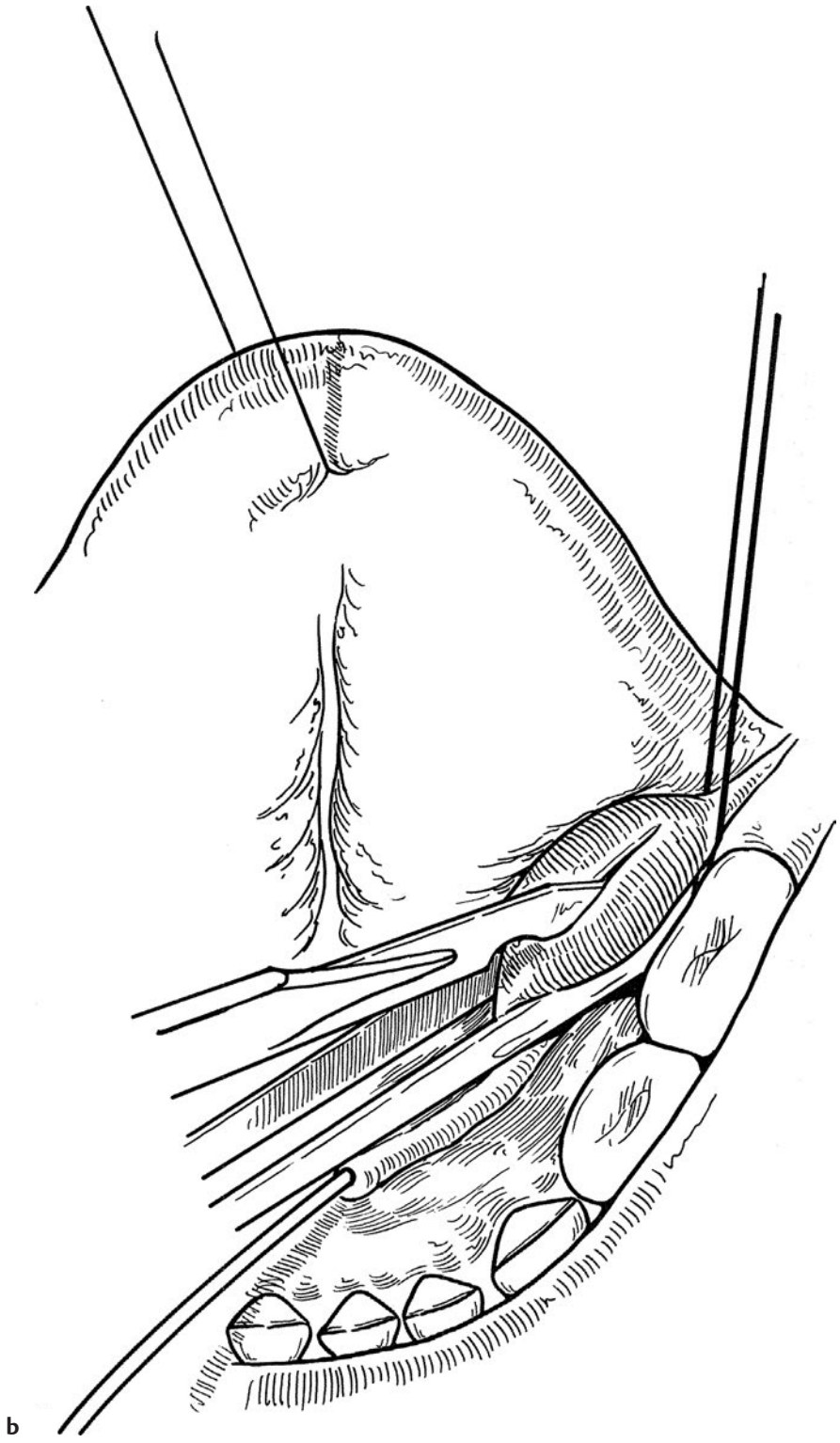
Complications

Stricture of the submandibular duct.



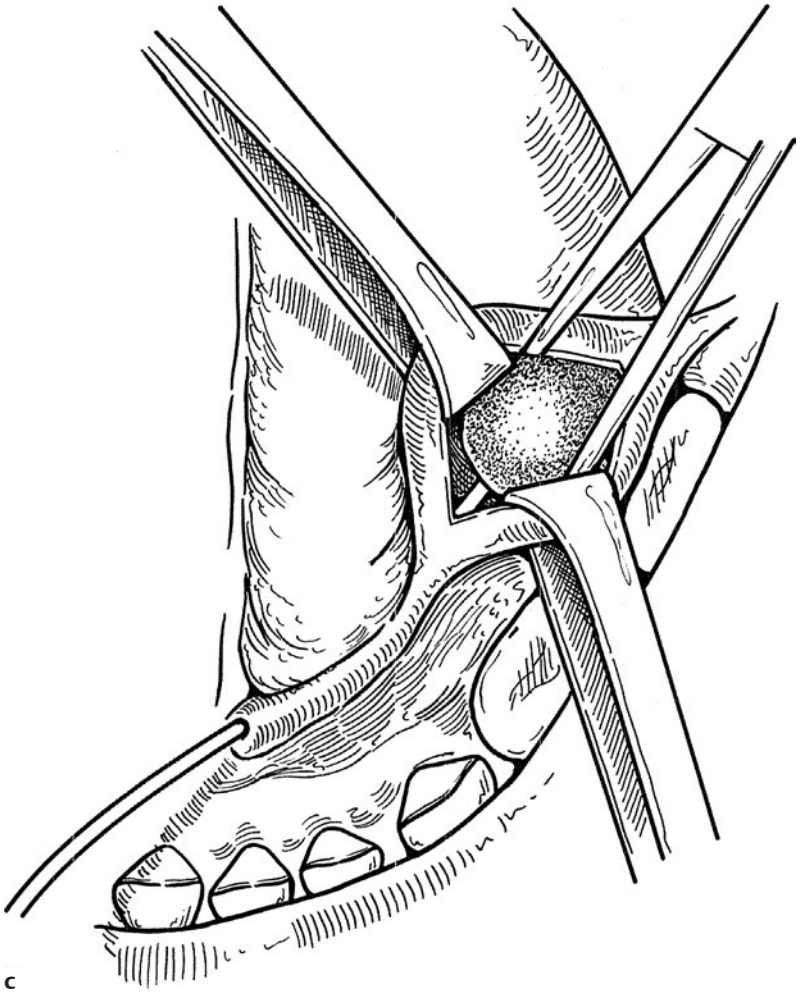
a

Fig. 28.3a



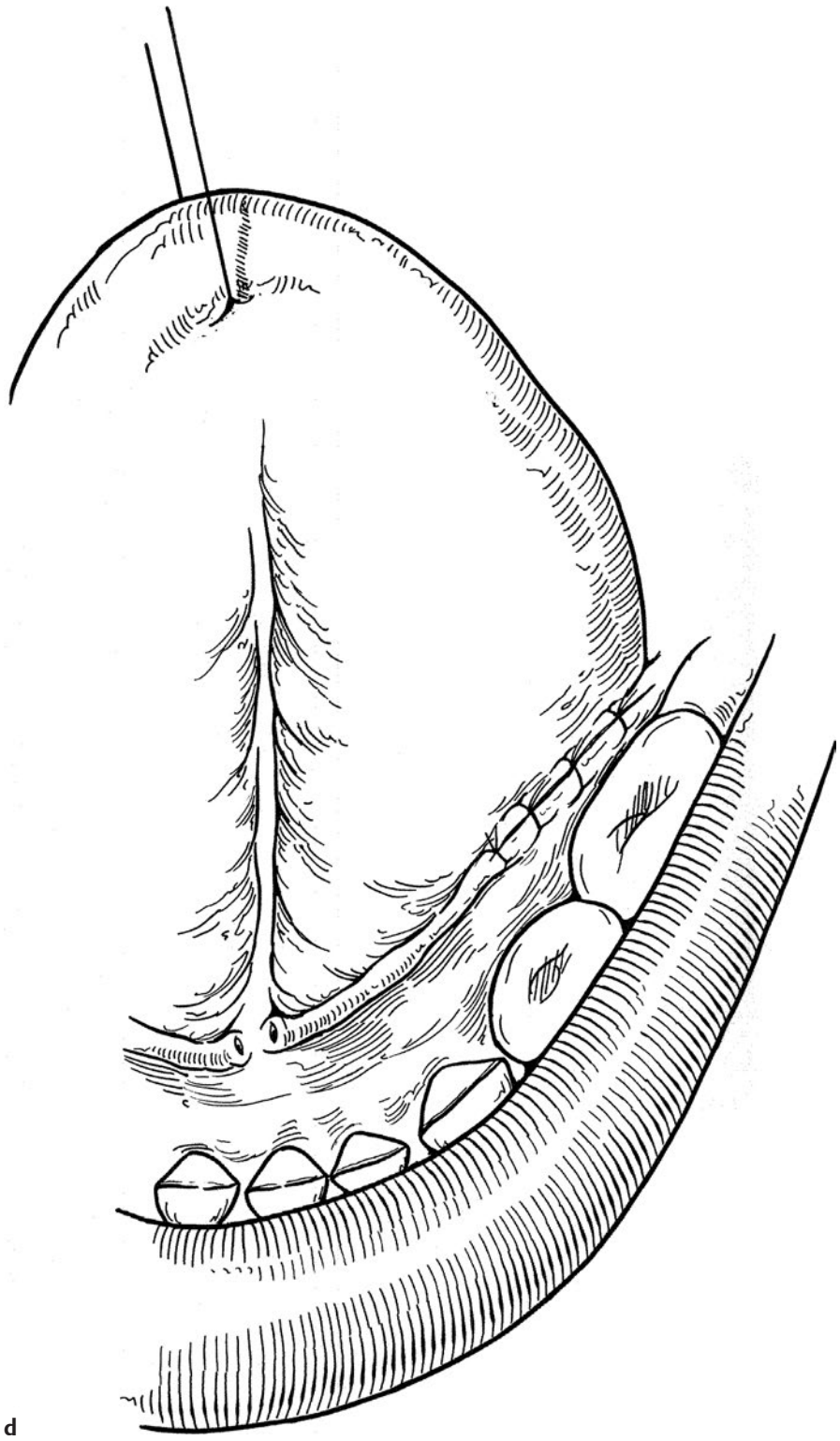
b

Fig. 28.3b



c

Fig. 28.3c



d

Fig. 28.3d

28-4 Removal of Parotid Duct Stones (Proximal)

Introduction

Salivary duct stones usually present with acute painful swelling of the involved gland. Some degree of bacterial infection from chronic stasis is usually present.

Indications

The presence of a salivary duct stone causing swelling and/or infection of the involved gland is the indication for surgical removal.

Preoperative Evaluation

Inspection of the duct in the oral cavity may reveal a turbid discharge. The stone can usually be palpated by passing the index finger along the course of the duct intraorally.

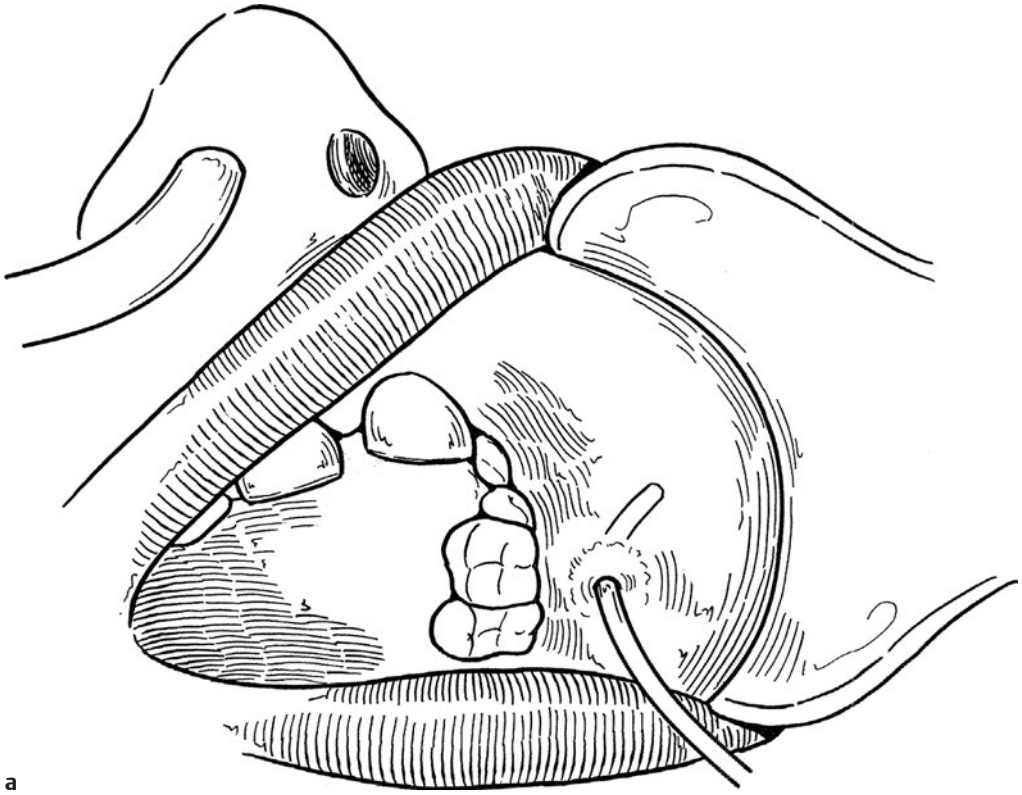
Standard radiographic studies are rarely helpful because salivary duct stones are usually not calcified. Sialography or magnetic resonance imaging (MRI) may be useful to demonstrate the position of the stone, especially proximal stones.

Operative Technique

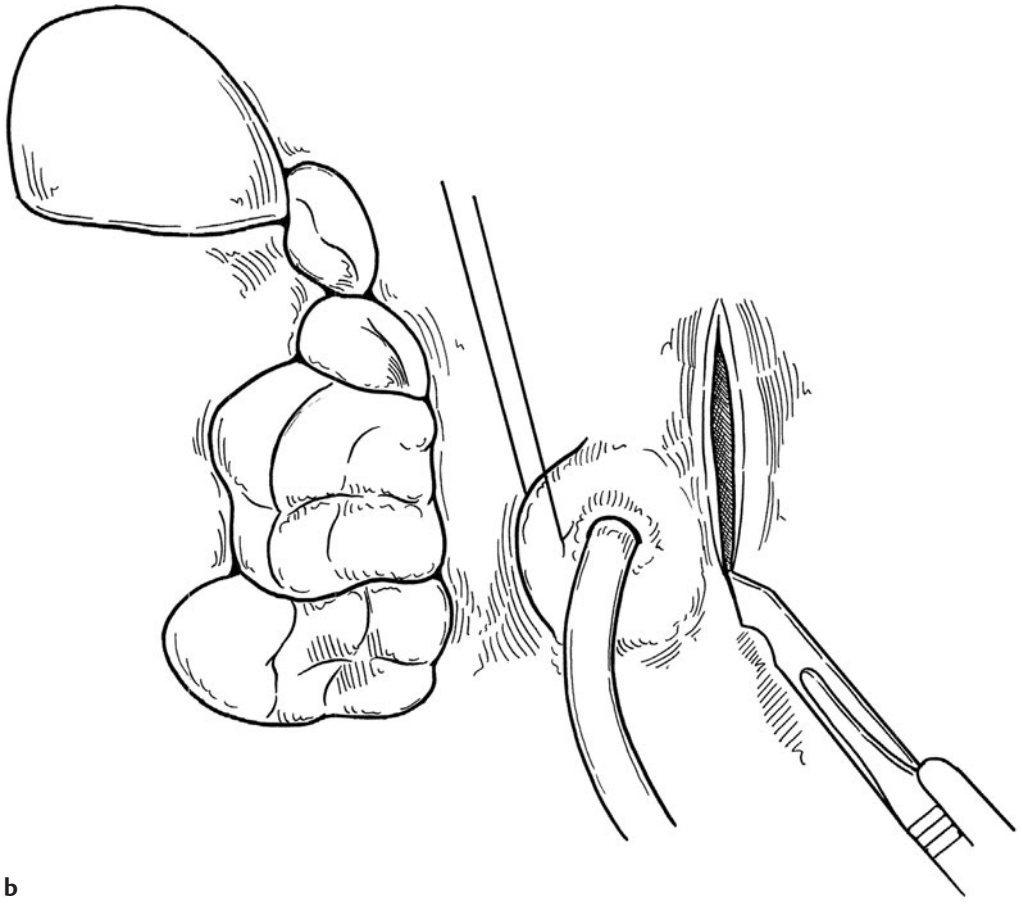
1. Parotid stones are removed utilizing general anesthesia and nasotracheal intubation for maximum exposure.
2. The parotid duct is cannulated with a polyethylene tube or lacrimal probe until the stone is palpated (**Fig. 28.4a**).
3. A suture is placed in the mucosa medial to the papilla to be used for traction (**Fig. 28.4b**).
4. A vertical incision is made along the lateral border of the papilla (**Fig. 28.4b**).
5. The course of the duct is followed by sharp and blunt dissection until the stone is reached (**Fig. 28.4c**).
6. The portion of the duct containing the stone is incised with a knife and the stone is removed (**Fig. 28.4d,e**).
7. The duct and mucosal incision are closed with 5-0 interrupted chromic suture (**Fig. 28.4f**). Parotid stones that are deep within the proximal portion of the ductal system should be removed with resection of the involved gland (see Section 29-2).
8. Alternatively, sialendoscopy could be utilized to accomplish stone removal after parotid duct dilation as needed.

Complications

Stricture of the parotid duct.

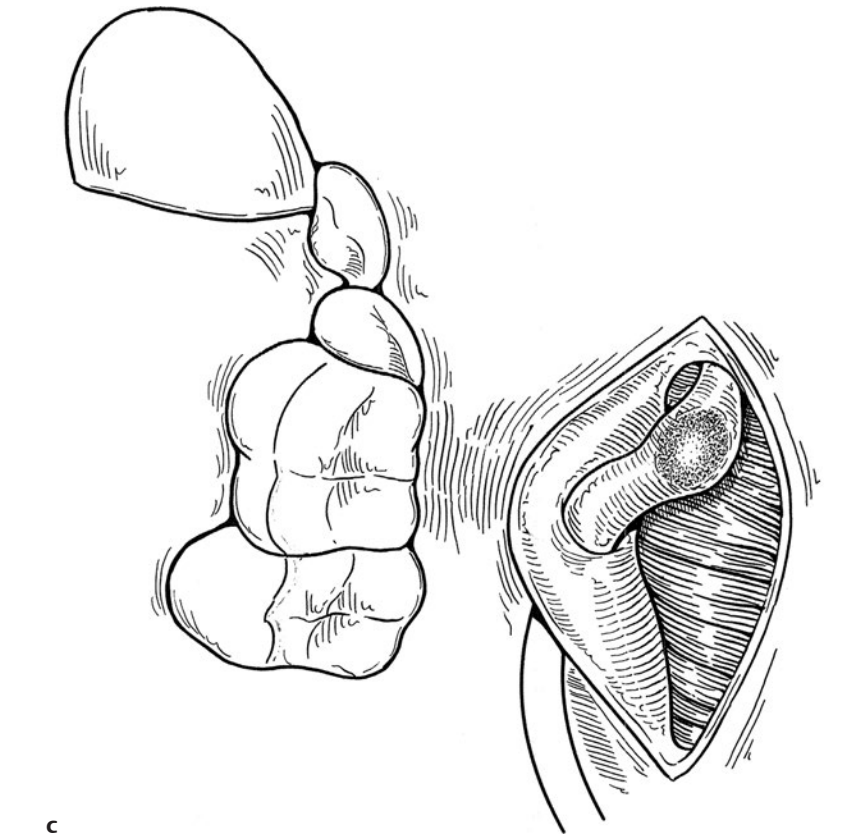


a

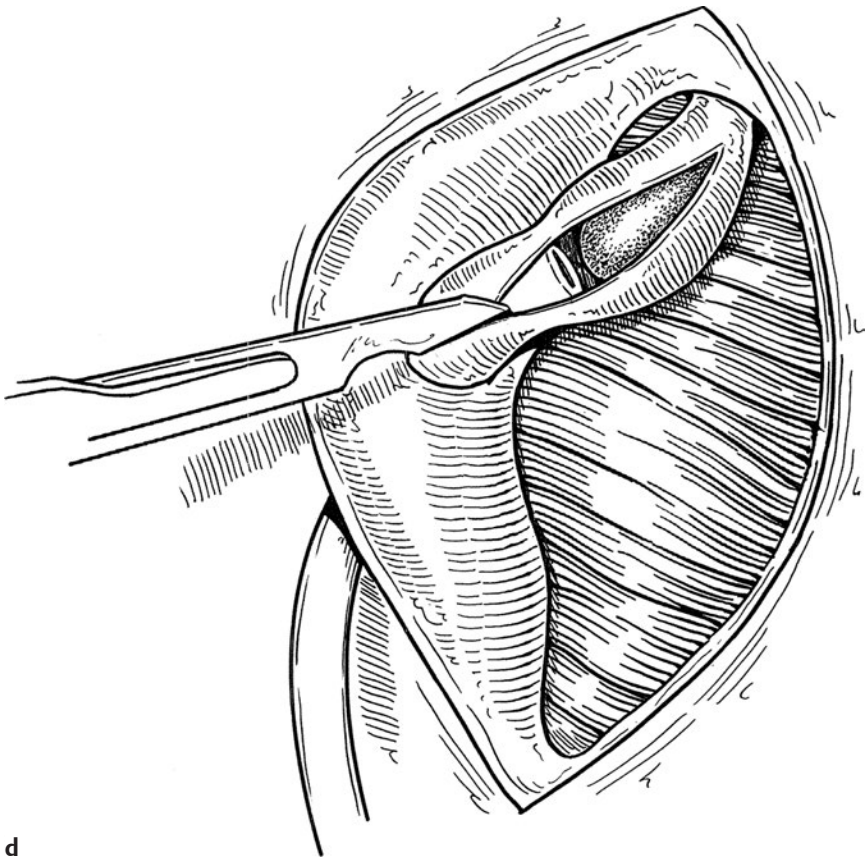


b

Fig. 28.4a,b

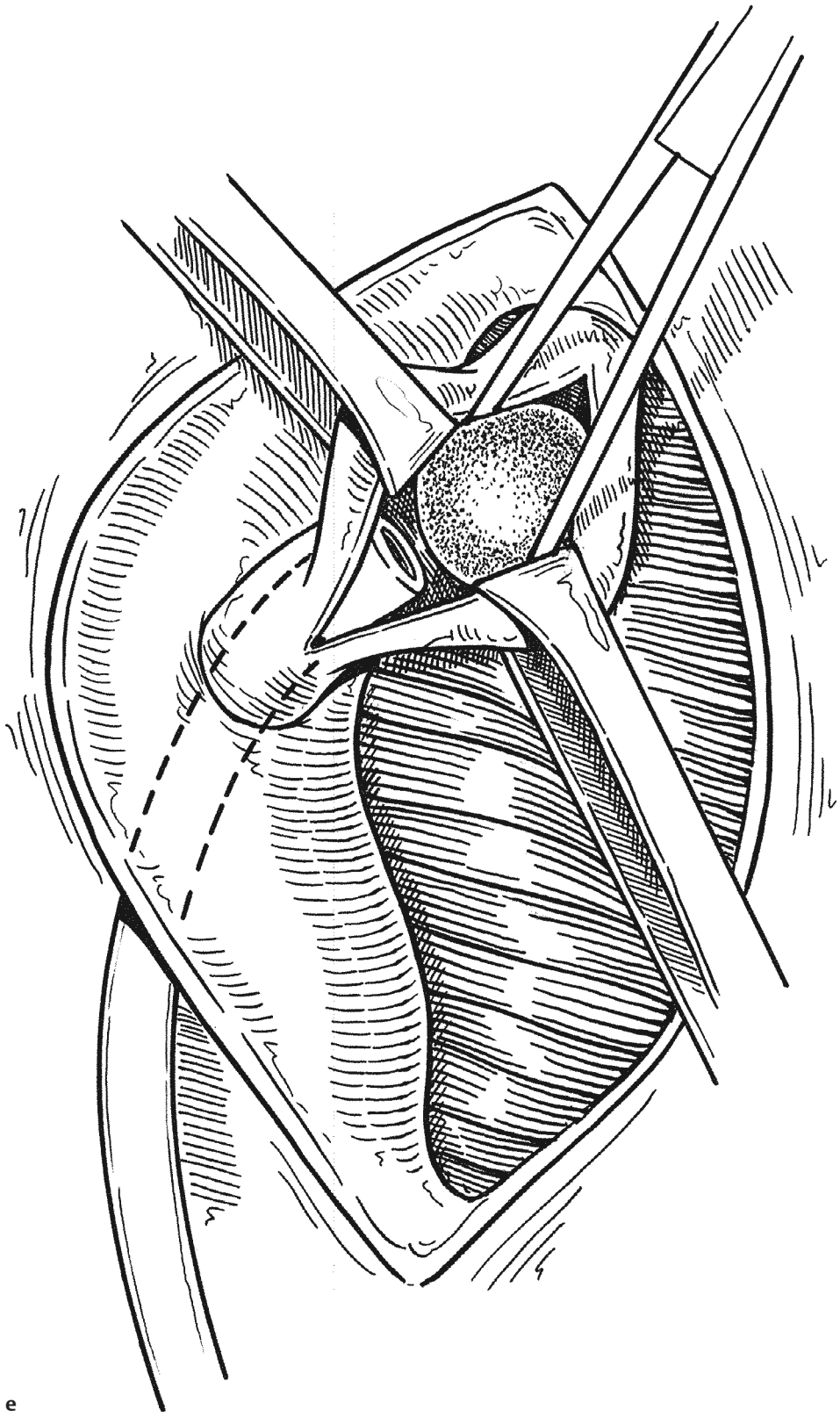


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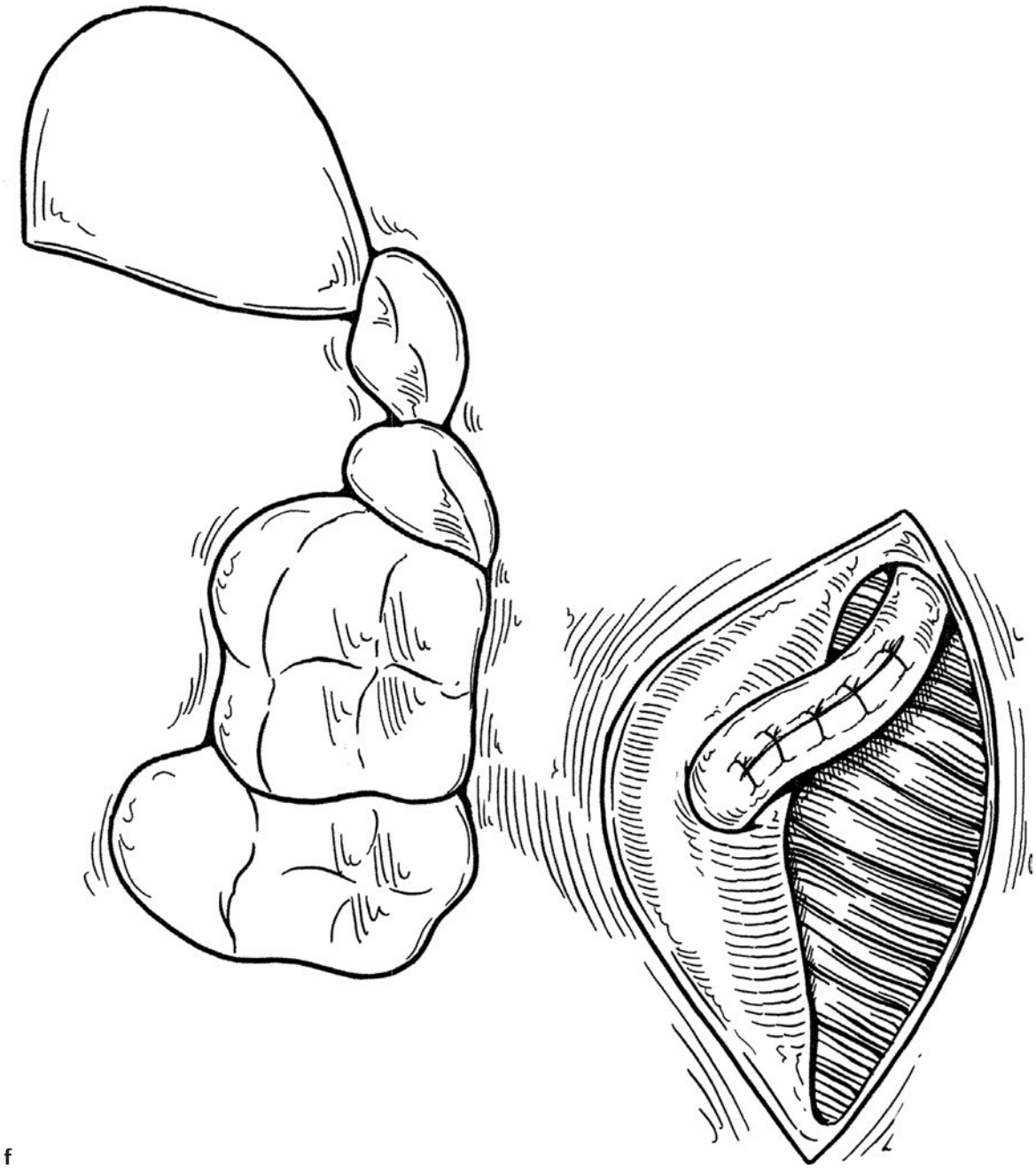
d

Fig. 28.4c,d



e

Fig. 28.4e



f

Fig. 28.4f

28-5 Parotid Duct Repair

Introduction

The parotid duct is vulnerable to injury whenever there is soft tissue trauma to the face (**Fig. 28.5a**).

Indications

Repair of the parotid duct is indicated when there is salivary flow out of a cheek wound. Deep wounds involving the masseter muscle should be explored for injury to the parotid duct.

Preoperative Evaluation

Facial nerve integrity should be assessed preoperatively. A sialogram may be helpful to demonstrate the cut duct and salivary leak.

Operative Technique

1. Wound exploration and ductal reanastomosis are best accomplished utilizing general anesthesia administered through a nasotracheal tube.
2. A polyethylene tube is passed into the distal duct through the papilla. The catheter exits the cut distal portion of the duct in the wound (**Fig. 28.5b**).
3. The proximal portion is then found and both ends are cut cleanly on an angle to increase the circumference of the anastomosis (**Fig. 28.5c**).
4. The proximal cut end is held with a 6-0 nylon suture, and the polyethylene tube is passed into that portion of the duct (**Fig. 28.5d**).
5. The ends of the duct are then sutured with 6-0 or 7-0 interrupted Vicryl suture (Ethicon) over the tube (**Fig. 28.5e**).
6. The polyethylene tube is secured by passing a 4-0 nylon or silk suture through the tube and suturing it to the adjacent oral mucosa. The end of the tube is cut to allow 5 mm to extend intraorally (**Fig. 28.5f**).
7. The facial wound is then closed using conventional plastic surgical techniques. Postoperative antibiotics and wound drainage are utilized.
8. The polyethylene tube is removed after 3 weeks.

Complications

1. Sialocutaneous fistula
2. Stricture of parotid duct

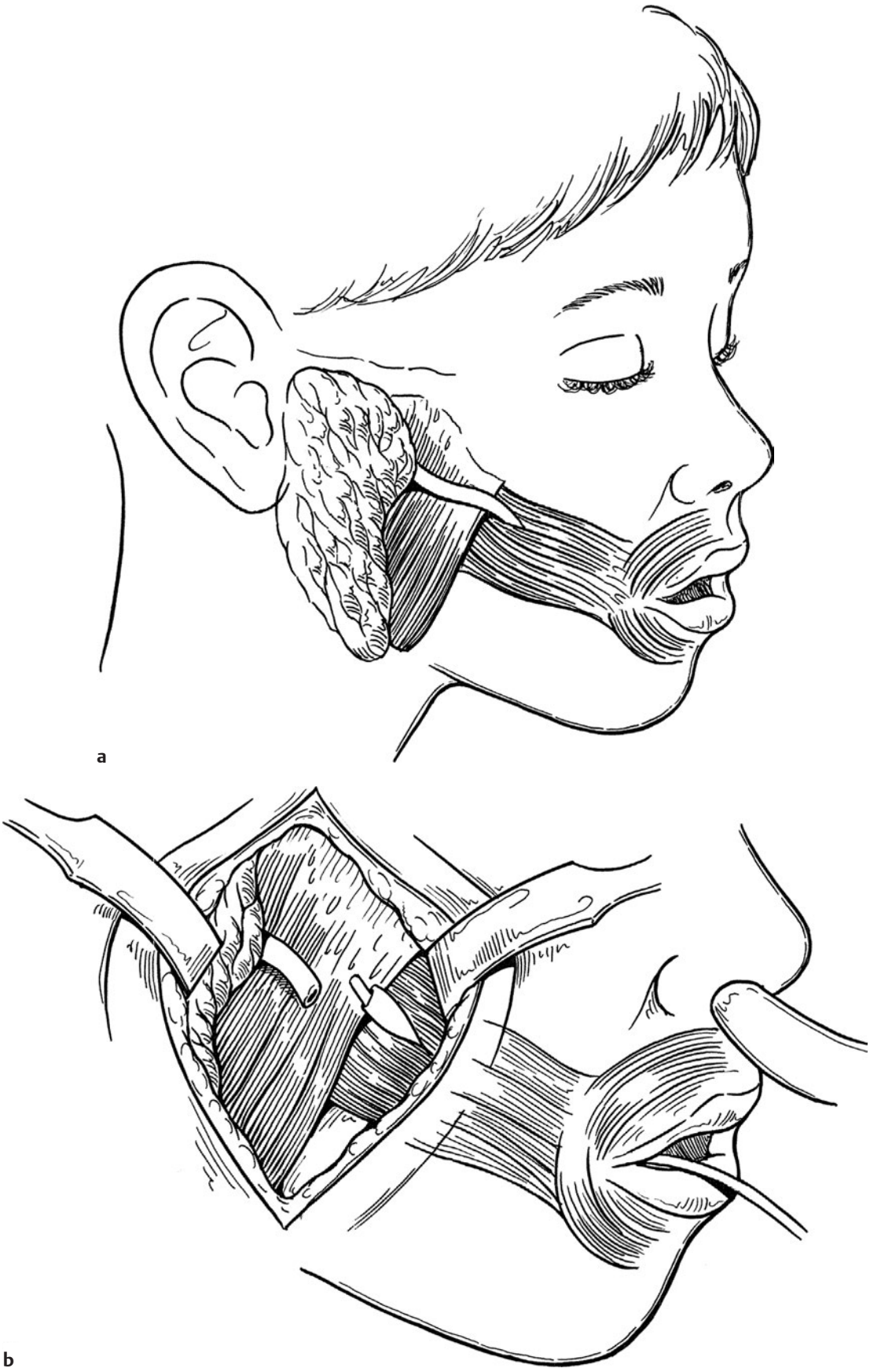
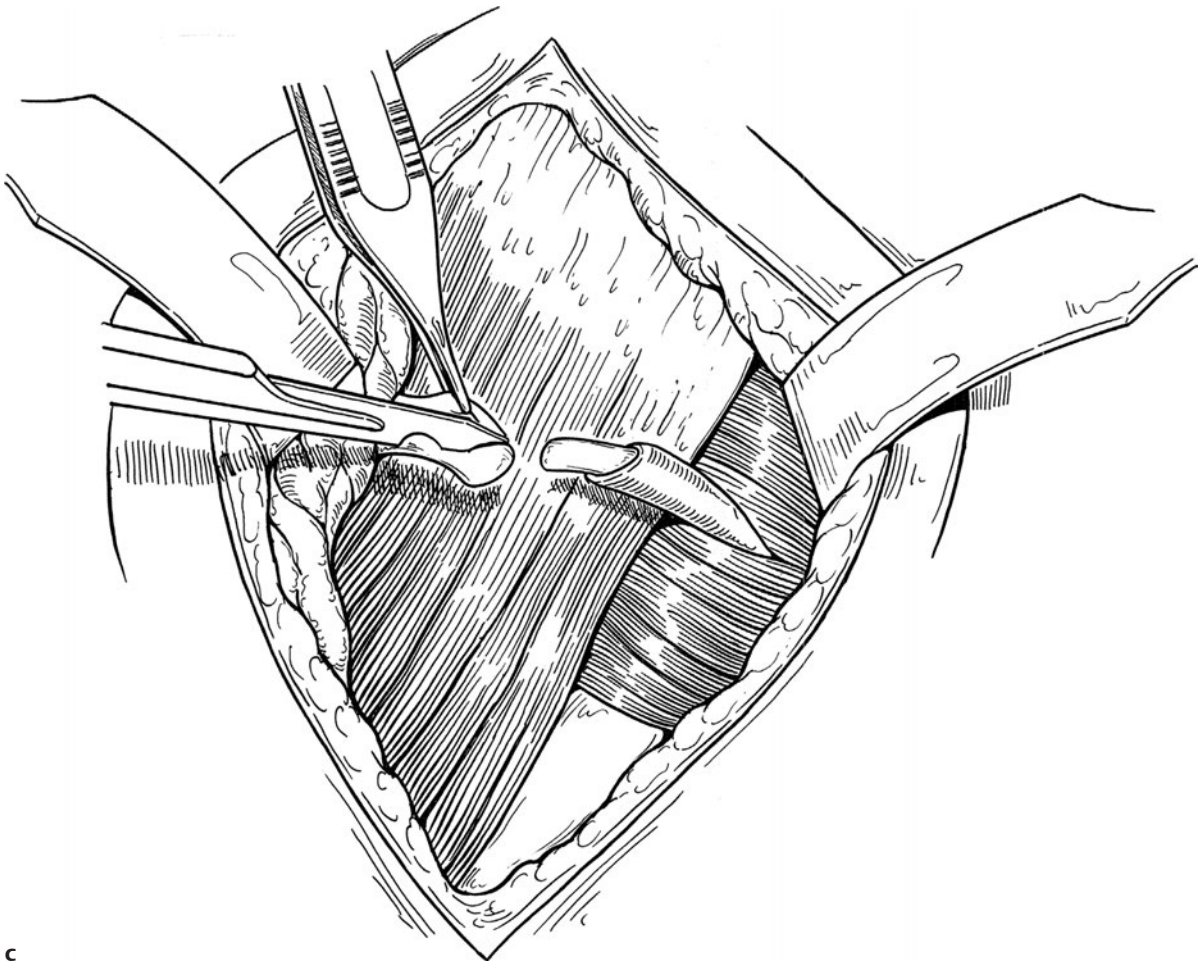
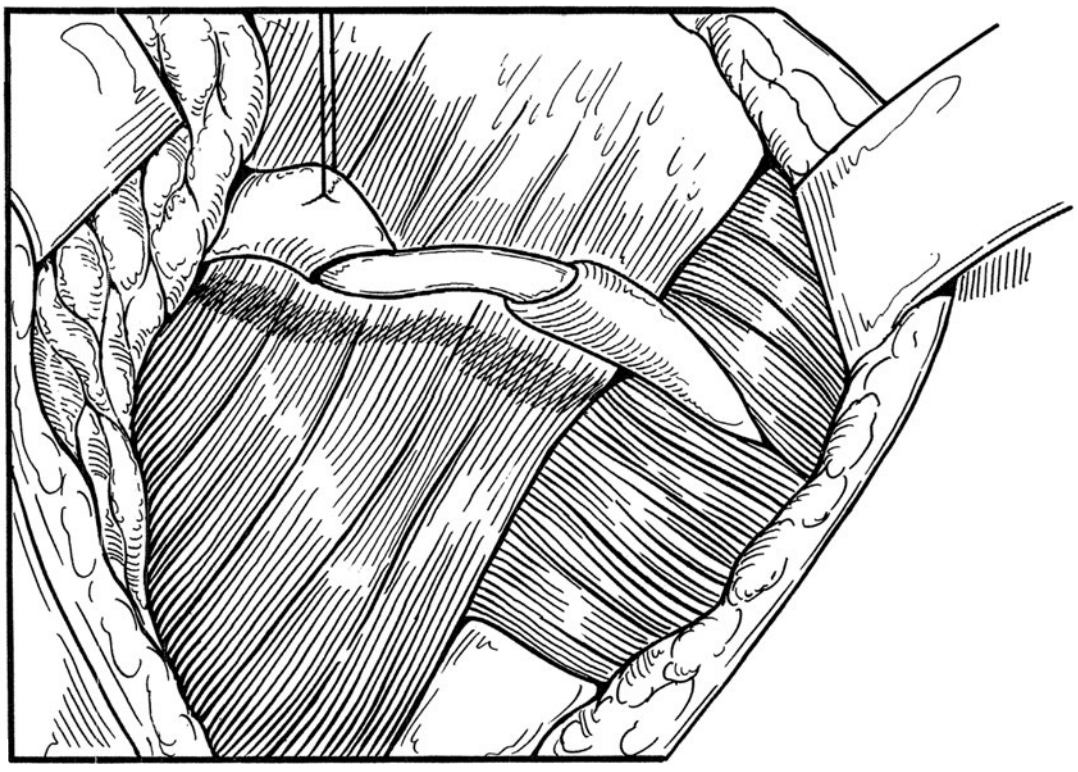


Fig. 28.5a,b

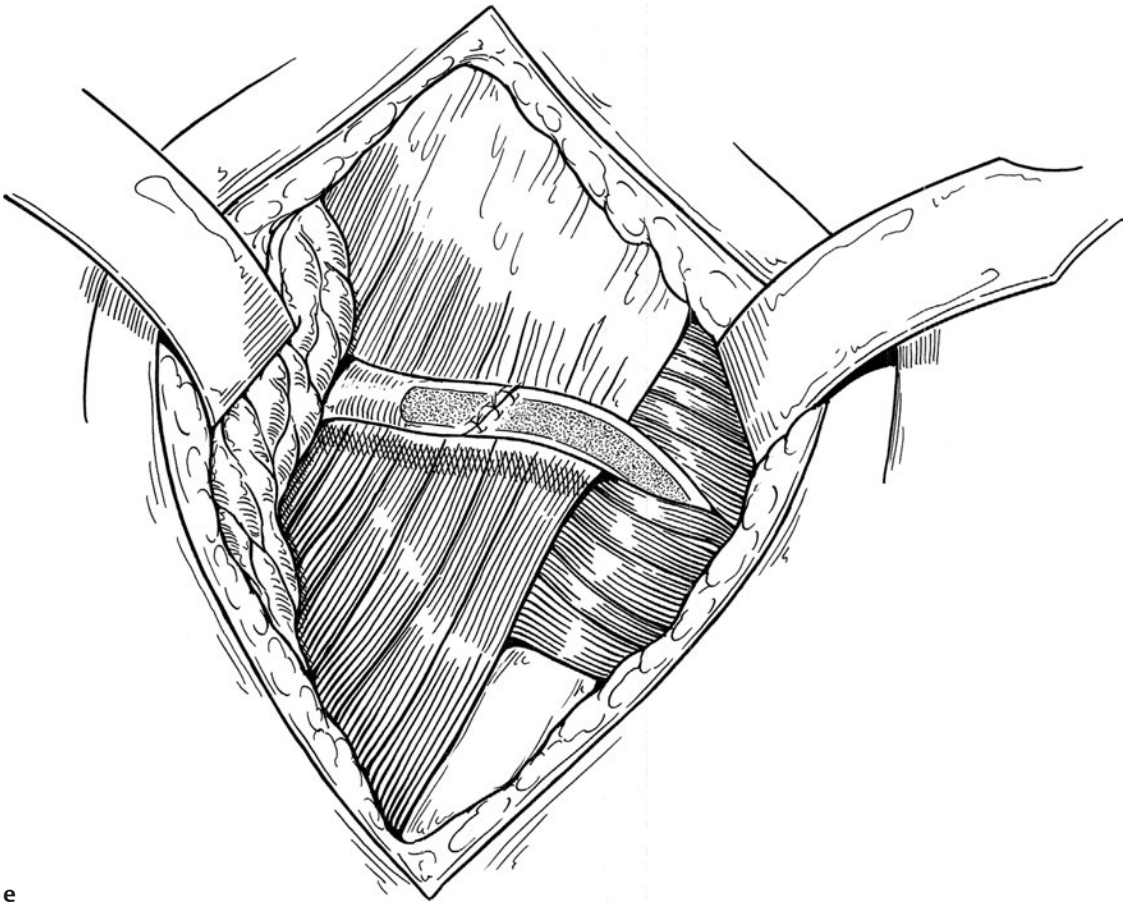


c

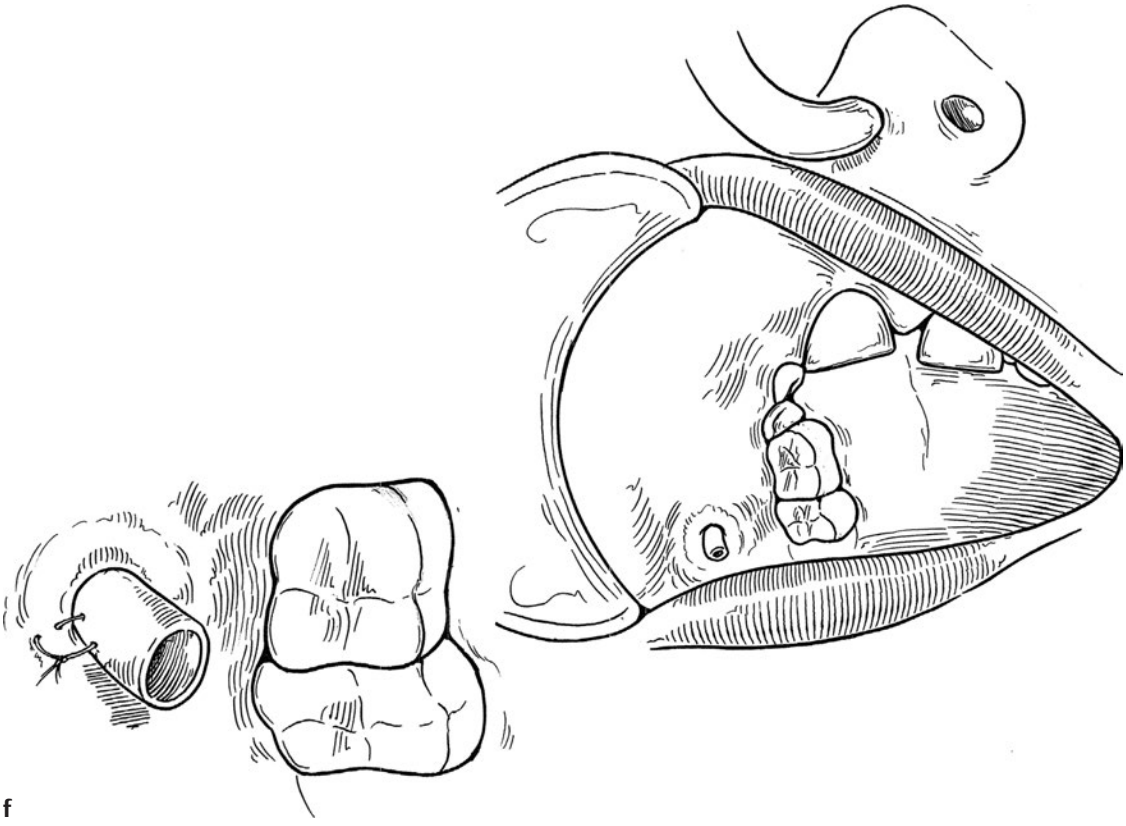


d

Fig. 28.5c,d



e



f

Fig. 28.5e,f

28-6 Submandibular Duct Repositioning

Introduction

Submandibular duct repositioning is one of the techniques used to decrease drooling. By repositioning the ducts into the posterior oral cavity, saliva is directed to the posterior oropharynx.

Indications

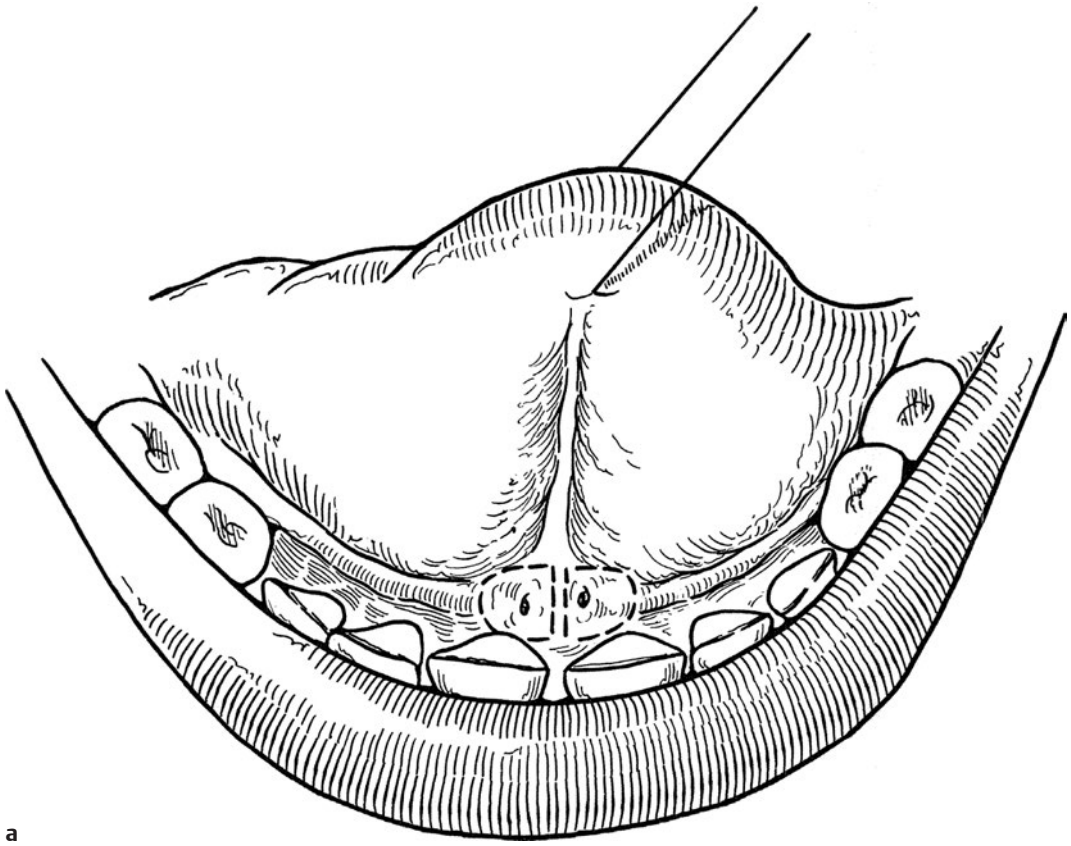
Submandibular duct repositioning is performed in neuromuscularly impaired children to help control drooling. The indications for the operation are based on the history and observance of drooling that is a problem both for the child and for her caregiver. It is usually performed bilaterally and simultaneously with bilateral parotid duct ligation. Alternately, the submandibular glands may be removed completely (see Section 29-1) or the submandibular ducts ligated.

Operative Technique

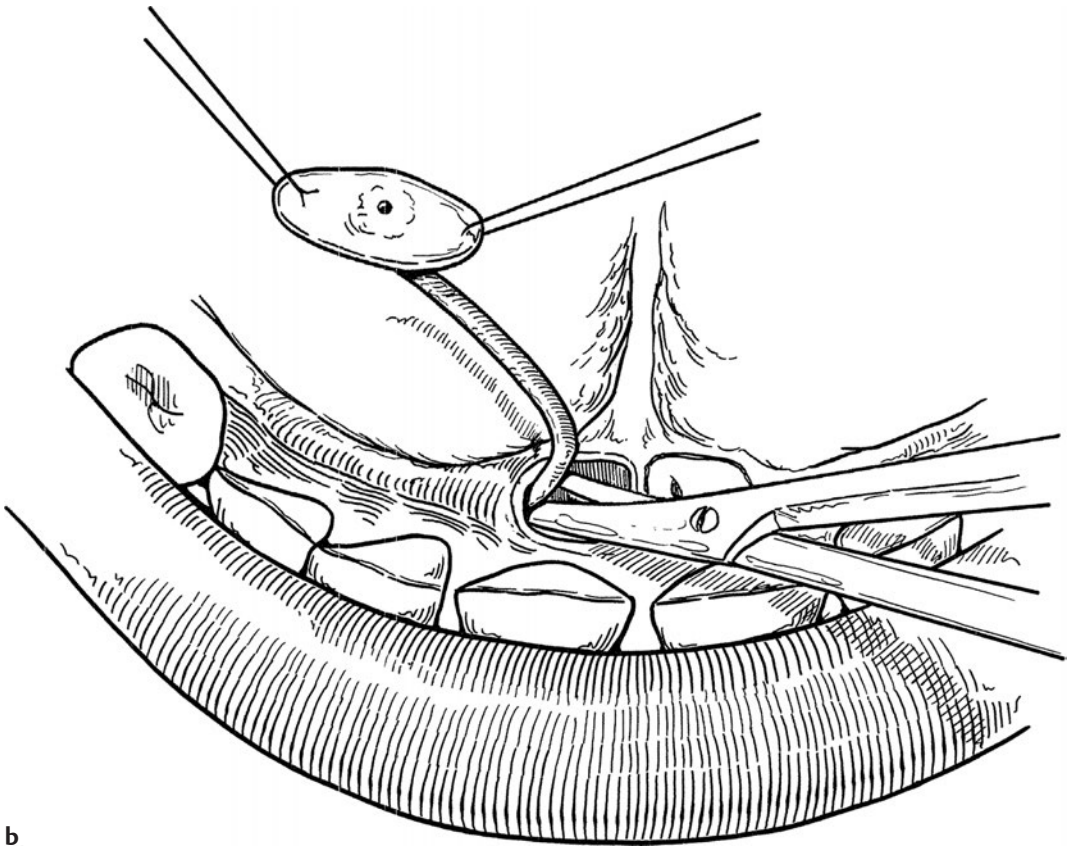
1. Submandibular duct repositioning is performed under general anesthesia administered through a nasotracheal tube.
2. The papillae of the submandibular ducts are released and separated by incising around the ducts with a knife (**Fig. 28.6a**).
3. With traction on the duct by using an atraumatic clamp or sutures, the duct is dissected from surrounding tissue attachments with a scissors (**Fig. 28.6b**).
4. A tunnel is made with a clamp to the posterior floor of the mouth. The mucosa of the mouth is cut with a knife down to the clamp (**Fig. 28.6c**).
5. The duct is delivered through the tunnel and the papilla is sewn in place with 3-0 chromic suture (**Fig. 28.6d**).
6. The surgical defect in the anterior floor of the mouth is closed with 3-0 chromic suture but can be left open to minimize the risk of ranula formation.

Complications

1. Submandibular duct stricture/kinking
2. Continued drooling
3. Ranula formation

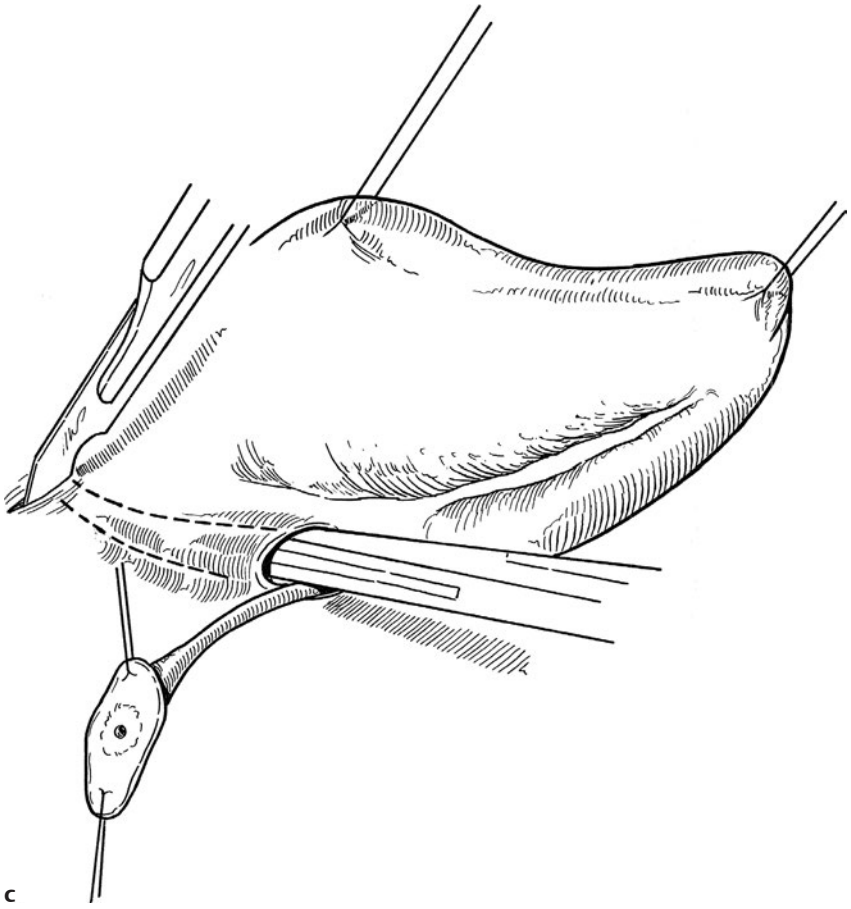


a

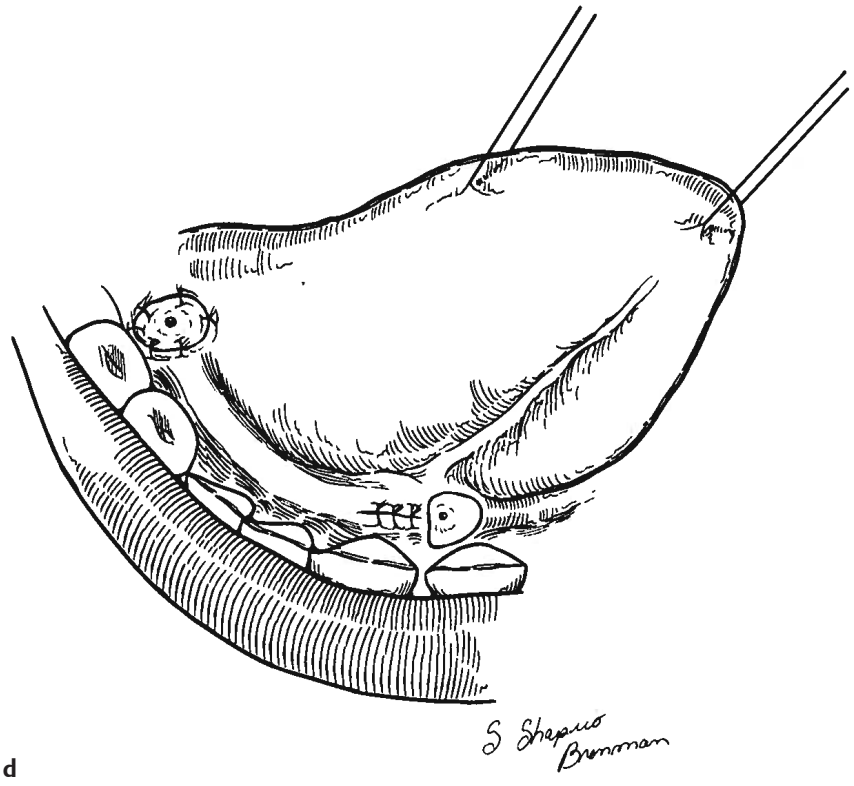


b

Fig. 28.6a,b



c



d

Fig. 28.6c,d

28-7 Repair of Papillary Salivary Duct Stricture (Parotid and Submandibular)

Introduction

Papillary salivary duct strictures occur as a result of chronic inflammation or intraoral trauma. These usually respond well to surgical correction. Strictures may also occur in the proximal portion of the duct distant from the papilla. These strictures may respond to interval dilatation with a lacrimal probe.

Indications

A papillary stricture that is causing recurrent swelling, pain, or infection of the associated gland is the indication for operative intervention.

Preoperative Evaluation

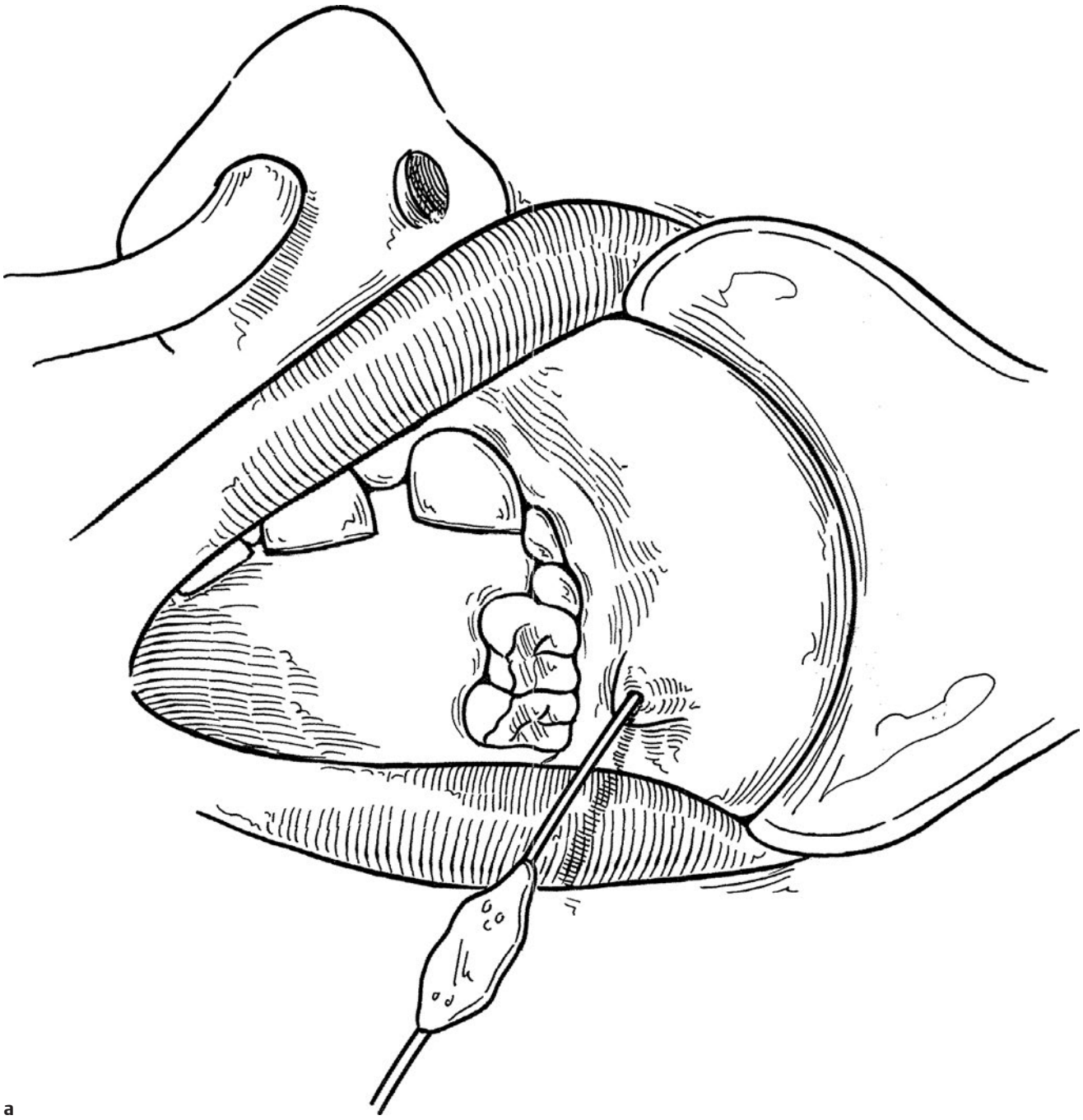
Sialography or sialendoscopy may be helpful to define the location and severity of the stricture. However, the stricture may preclude cannulation of the duct that is necessary for evaluation.

Operative Technique

1. Papillary ductal stricture is corrected utilizing general anesthesia administered through a nasotracheal tube.
2. The papilla is identified and the orifice is dilated with lacrimal dilators (**Fig. 28.7a**).
3. One blade of an iris scissors is inserted into the duct and the scissors are closed to create a slit posteriorly (**Fig. 28.7b,c**).
4. The edges of the duct are sutured to the edges of the mucosa with 5-0 Vicryl suture, creating a wider opening into the oral cavity (**Fig. 28.7d**).

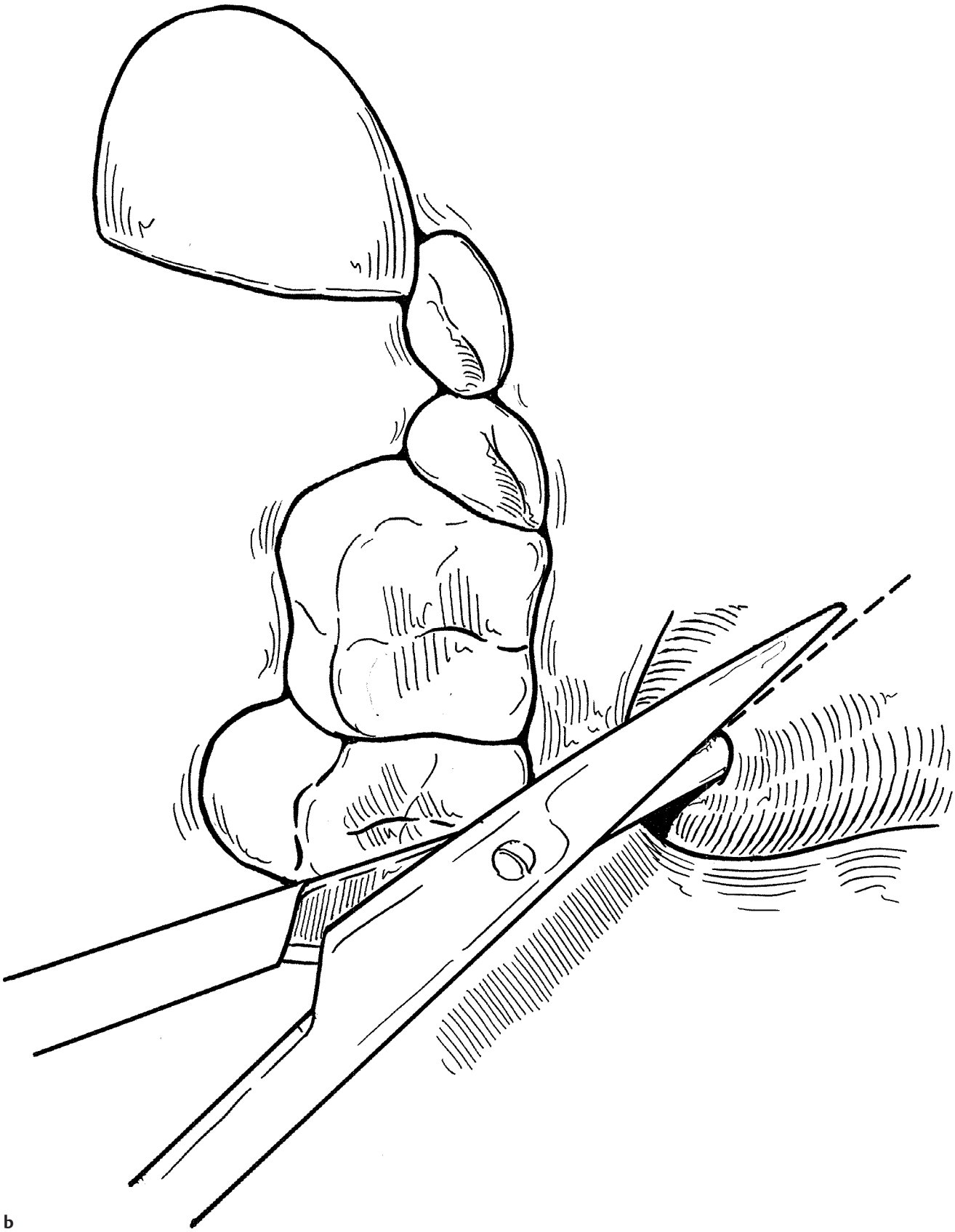
Complications

Restricture of the duct.



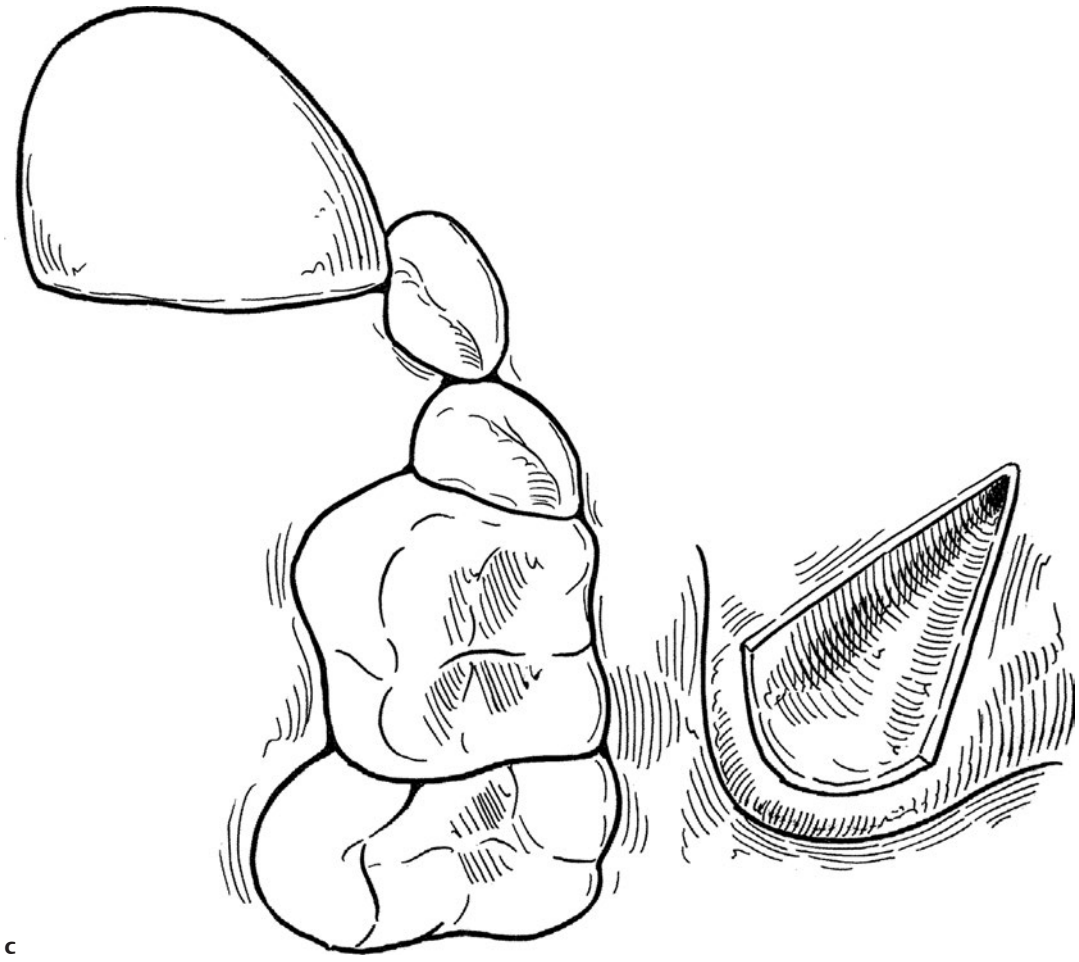
a

Fig. 28.7a

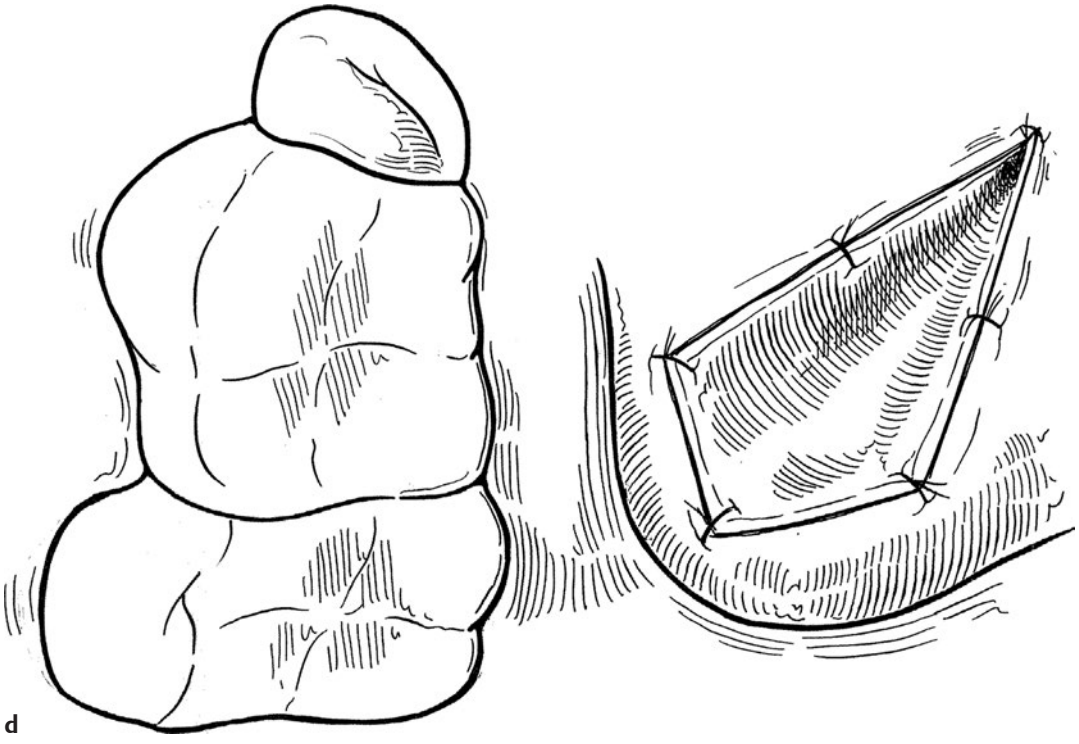


b

Fig. 28.7b



c



d

Fig. 28.7c,d

29 Salivary Gland Surgery

Charles M. Myer III

Salivary gland excision may be required to remove a gland damaged by chronic infection or with a mass that may be a tumor.

29-1 Submandibular Gland Excision

Indications

Submandibular gland excision is indicated in the treatment of chronic salivary gland infections, salivary gland stones, suspicion of neoplasm, and as an adjunct to surgical treatment for drooling.

Preoperative Evaluation

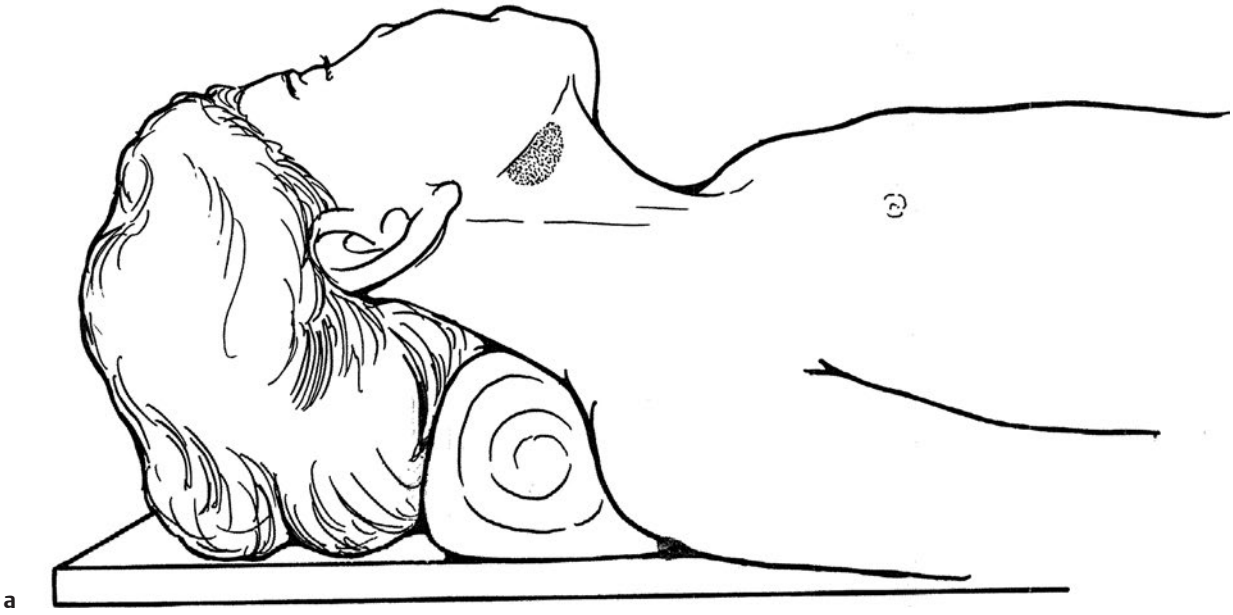
Palpation of the submandibular gland is usually sufficient to detect a mass. Sialography defines chronic inflammatory disease, stones, or strictures. Computed tomography (CT) or magnetic resonance imaging (MRI) is a more appropriate study to evaluate masses in the submandibular area. Fine needle aspiration (FNA) may be helpful. The surgeon may elect to utilize intraoperative facial nerve monitoring.

Operative Technique

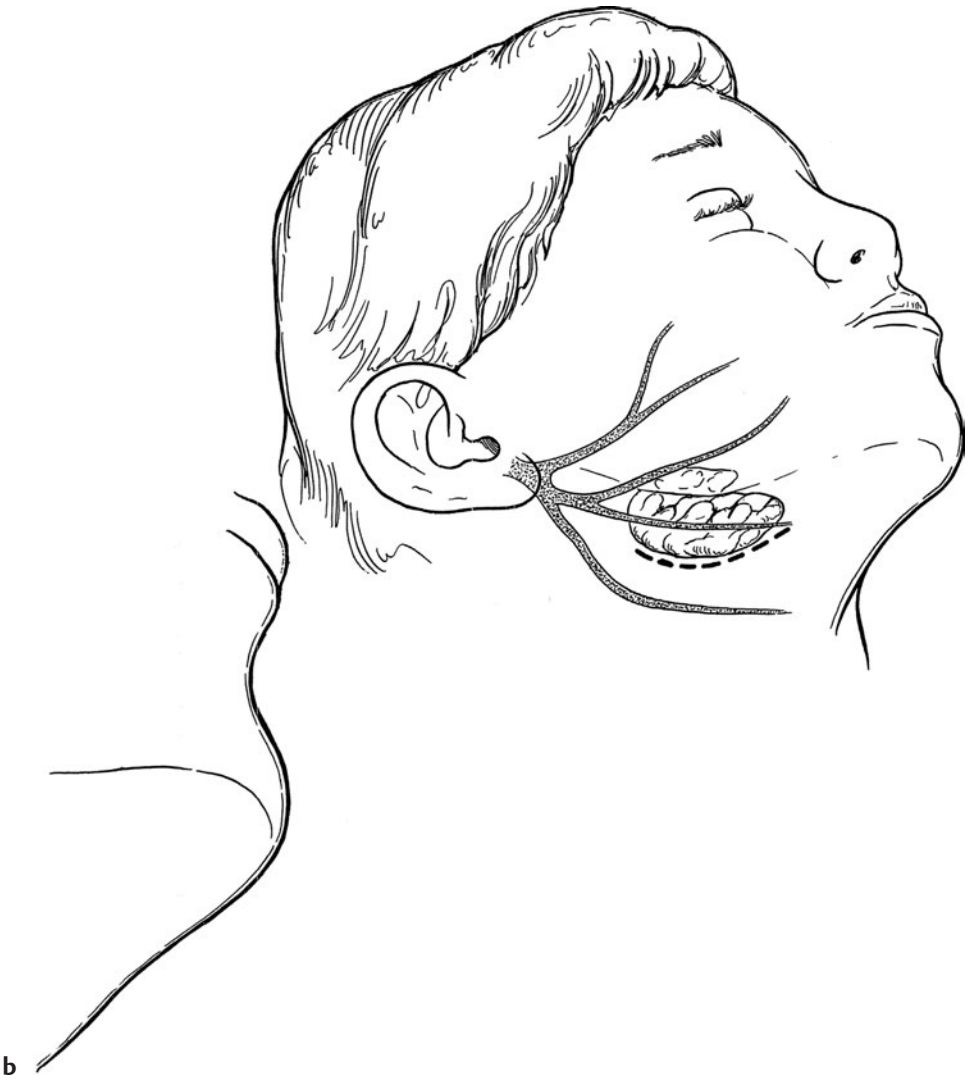
1. Submandibular gland excision is performed utilizing general endotracheal anesthesia.
2. The patient is positioned on a shoulder roll. The head is hyperextended and turned to the opposite side. This brings the submandibular gland into position (**Fig. 29.1a**).
3. One percent lidocaine with 1:100,000 epinephrine is injected in a skin crease near the lower border of the gland for hemostasis. This should be approximately 2 to 3 cm below the edge of the mandible to avoid the marginal mandibular branch of the facial nerve (**Fig. 29.1b**).
4. The platysma muscle is divided with a knife and minimal flaps are developed superiorly and inferiorly exposing the cervical fascia overlying the gland (**Fig. 29.1c**).
5. The cervical fascia is incised and the gland exposed (**Fig. 29.1d**). By staying deep to this fascia, injury to the marginal mandibular nerve, which lies between the platysma and the fascia of the gland, is avoided.
6. The facial artery and vein over the posterior aspect of the gland are divided (**Fig. 29.1e**) and elevated superiorly, further protecting the marginal mandibular nerve.
7. The submandibular gland is then mobilized by blunt and sharp dissection out of the digastric sling and off the hyoglossus muscle. The hypoglossal nerve deep to the gland is preserved and vessels are divided releasing the gland (**Fig. 29.1f**).
8. The mylohyoid muscle is then retracted anteriorly as the submandibular gland is retracted posteriorly (**Fig. 29.1g**). This stretches and exposes the duct, which should be double ligated with 3-0 silk and divided.
9. The gland is then retracted posterointeriorly and the submandibular ganglion and accompanying vein are transected with a knife, allowing the lingual nerve to retract up under the mandible and releasing the entire gland for removal (**Fig. 29.1h**).
10. The wound is closed in layers (platysma, subcutaneous tissue, and subcuticular chromic) and a small Penrose drain is placed in the wound (**Fig. 29.1i**). The drain is removed in 12 to 24 hours.

Complications

1. Marginal mandibular nerve injury
2. Hypoglossal nerve injury

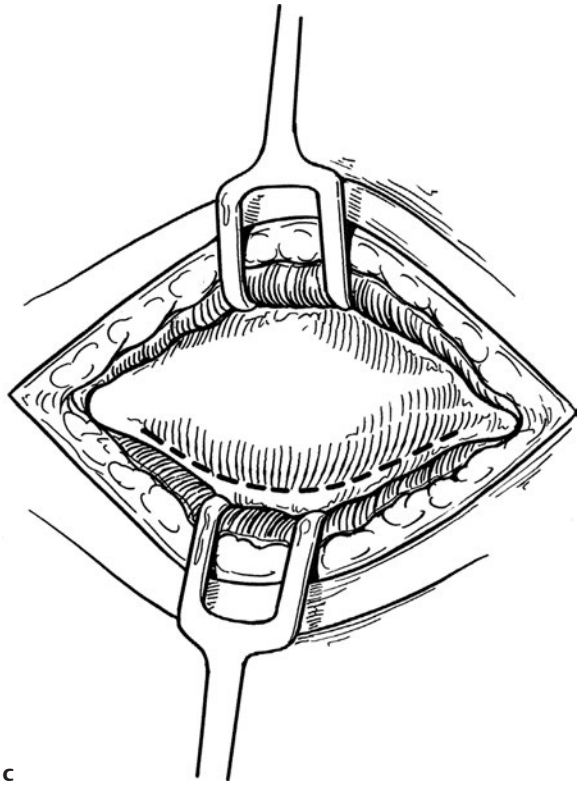


a

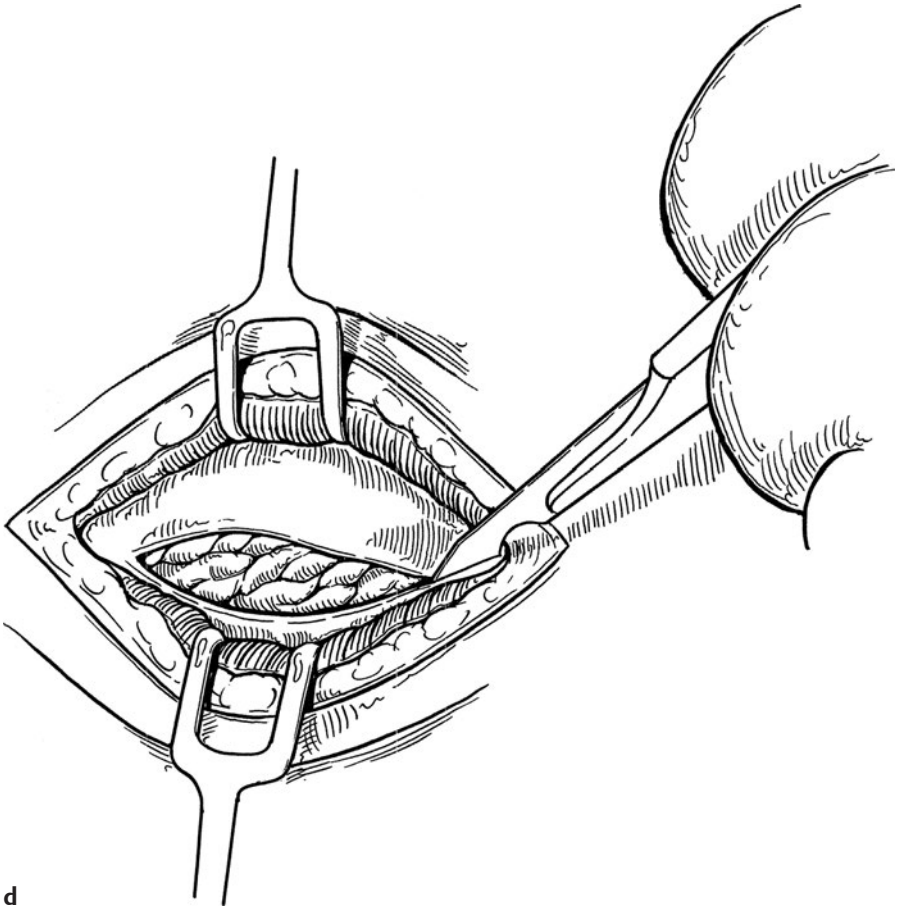


b

Fig. 29.1a,b

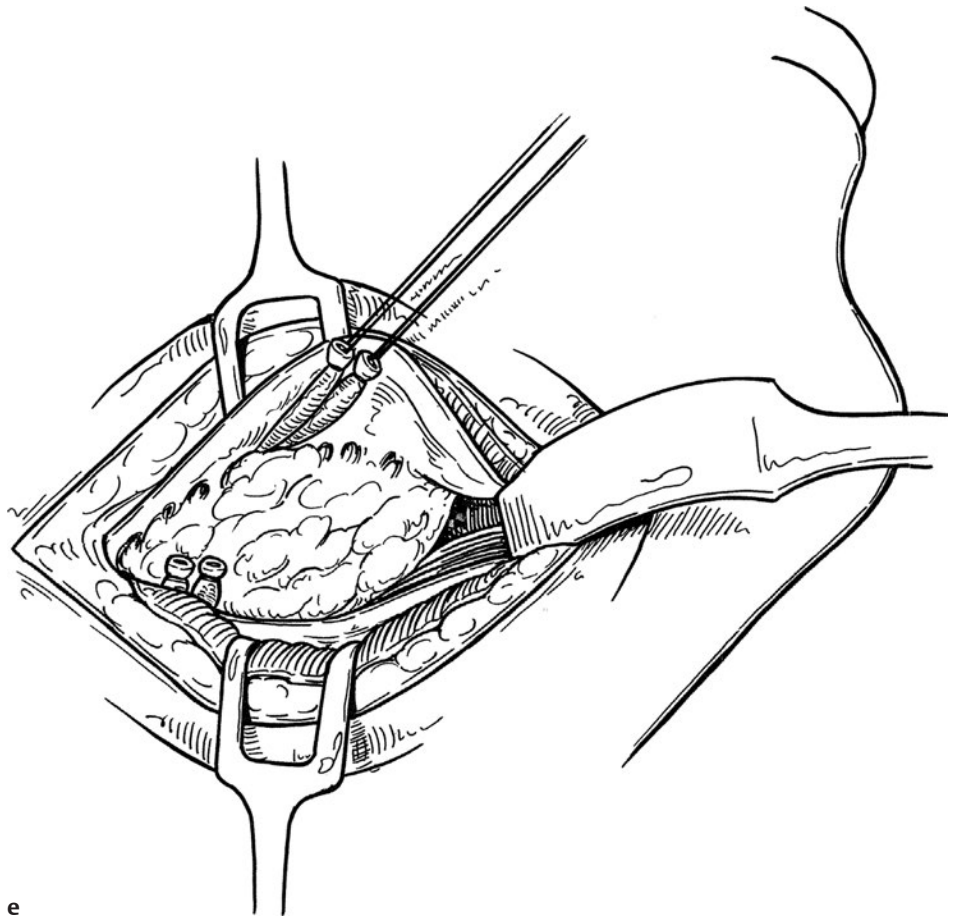


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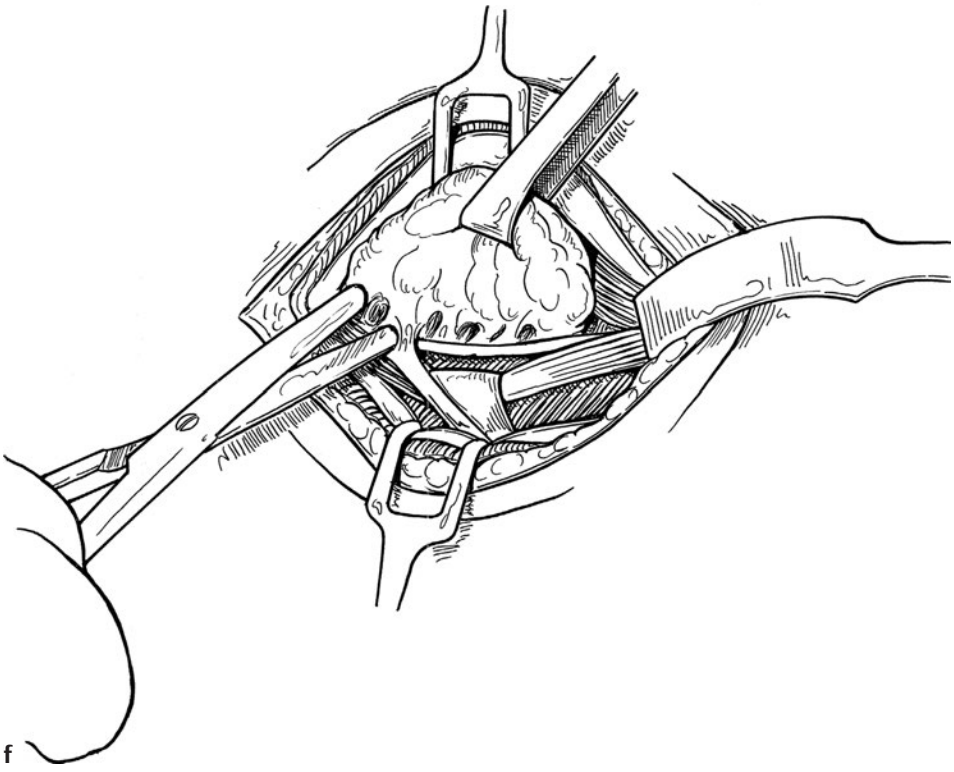


d

Fig. 29.1c,d

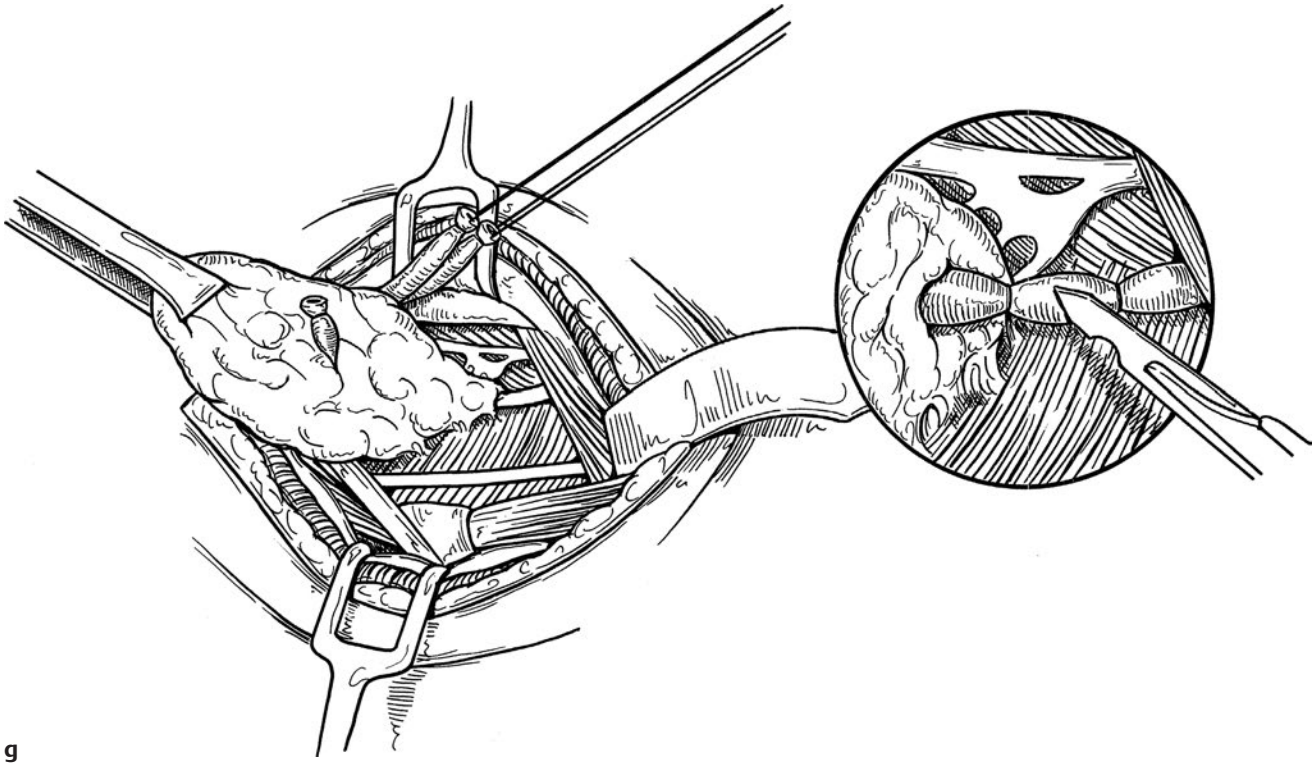


e

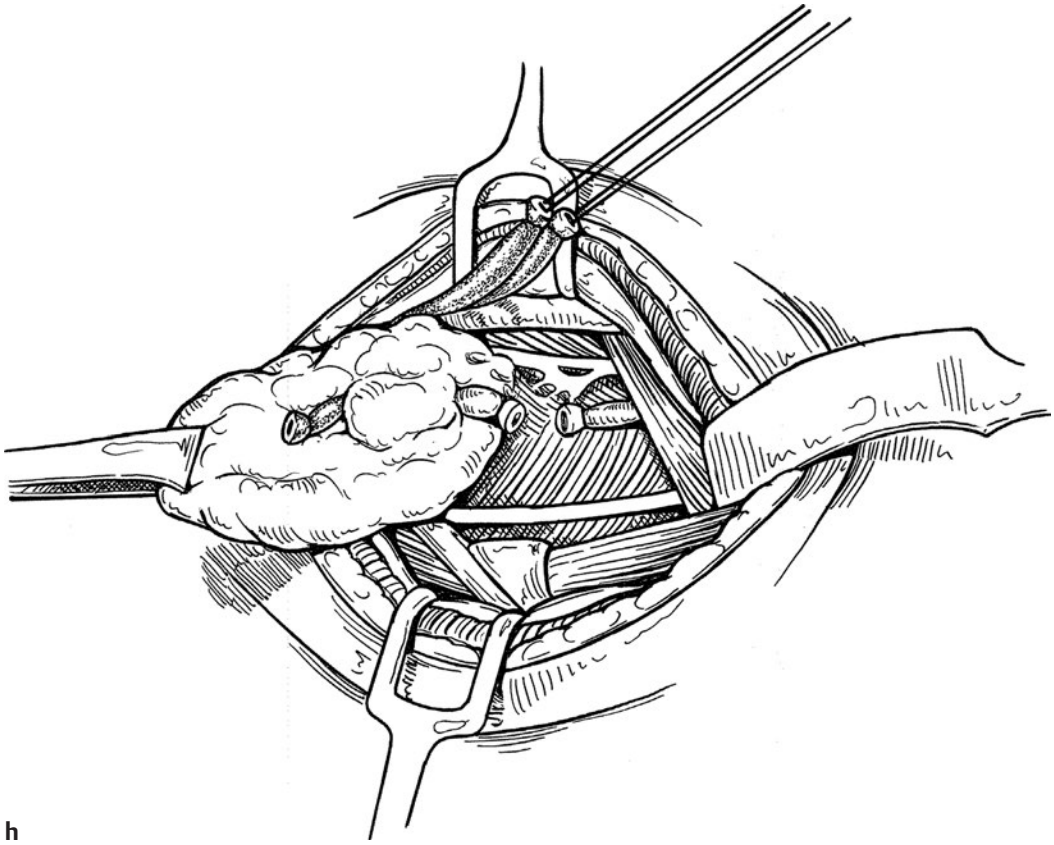


f

Fig. 29.1e,f



g



h

Fig. 29.1g,h



i

Fig. 29.1i

29-2 Parotidectomy

Introduction

Parotidectomy is most commonly performed in children to excise a mass (suspected neoplasm) in the parotid gland. Rarely, parotidectomy may be required to treat chronic inflammatory disease or stones.

Indications

A mass in the parotid gland and chronic and recurrent parotitis are indications for parotidectomy.

Preoperative Evaluation

Sialography, CT, or MRI may help define a mass in the parotid gland, but these studies do not have histologic specificity. An FNA may be appropriate in a cooperative patient. A suspected neoplasm must be removed for treatment and histologic diagnosis. The surgeon may elect to utilize intraoperative facial nerve monitoring.

Operative Technique

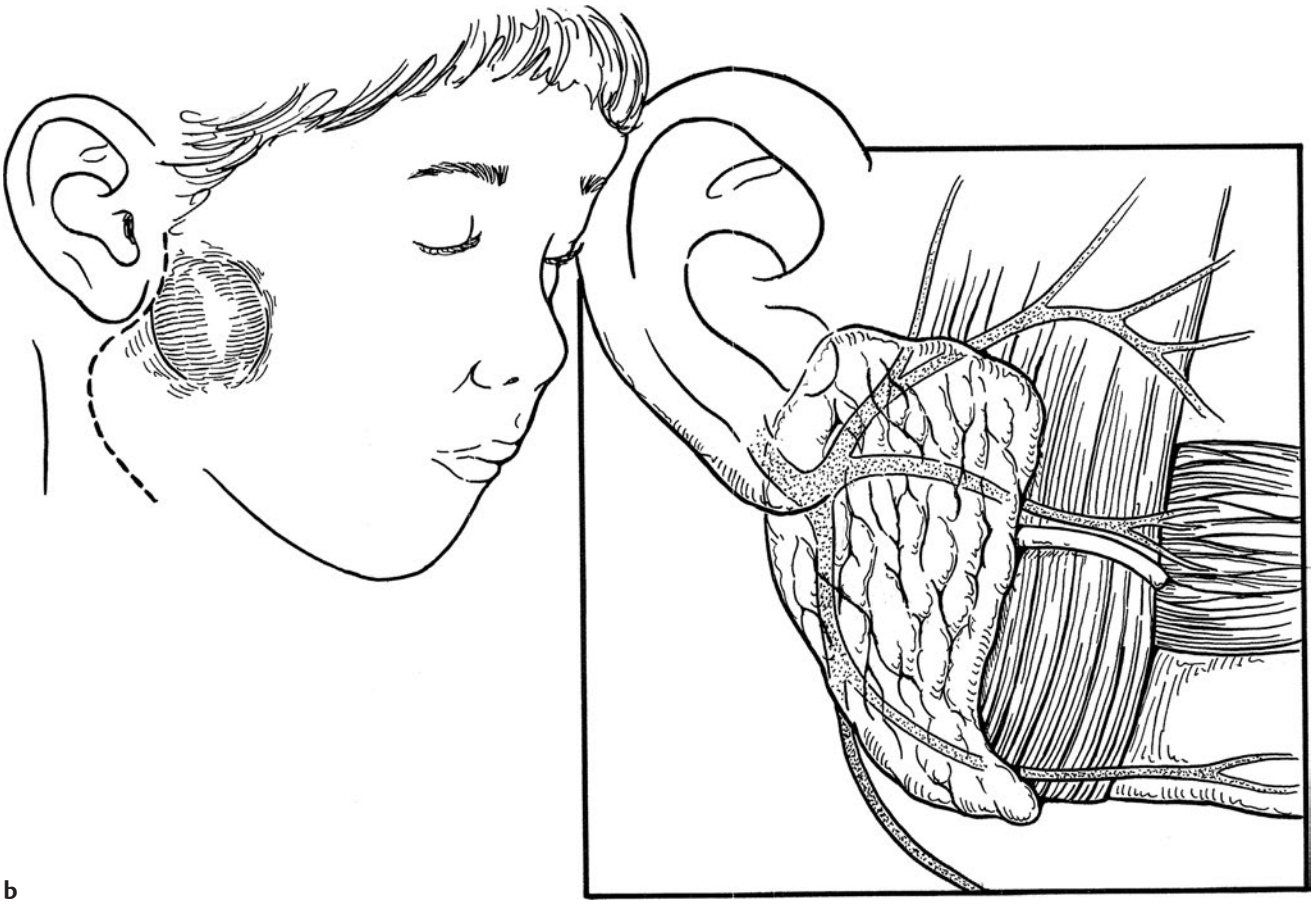
1. Parotidectomy is performed utilizing general endotracheal anesthesia without the use of any long-acting paralyzing agents. This permits intraoperative facial nerve monitoring and stimulation.
2. The patient is positioned on a shoulder roll with the neck slightly hyperextended and the head turned to the opposite side (**Fig. 29.2a**).
3. An incision is made starting in the preauricular line in front of the tragus. This is curved around the ear lobe, over the mastoid process, and continued onto the neck sufficiently below the mandible to avoid the marginal mandibular branch of the facial nerve (**Fig. 29.2b,c**).
4. The skin flap overlying the parotid gland is elevated with a scissors anteriorly in the plane of subcutaneous fat (**Fig. 29.2d**). The ear lobule is retracted posteriorly with a 2-0 silk suture. This exposes the parotid gland fascia over the gland (**Fig. 29.2e**).
5. The superficial fascia between the parotid gland and the sternocleidomastoid muscle is cut with a scissors (**Fig. 29.2f**).
6. Dissection along the anterior and inferior surface of the cartilaginous external auditory canal is carried out with a clamp spreading in the direction of the facial nerve (**Fig. 29.2g**).
7. As the parotid gland is retracted forward, the facial nerve is stretched across the line of dissection and can be found in the groove between the mastoid tip and the bony ear canal (**Fig. 29.2g**). The facial nerve in the child is more superficial than in an adult and the usually described bony and cartilaginous landmarks for finding the nerve in adults rarely apply in the child (**Fig. 29.2h**).
8. As the parotid gland is reflected forward, the facial nerve can often be detected with a gentle fingertip as it enters the gland from the stylomastoid foramen.
9. Sufficient care and time should be taken to find the trunk of the nerve before any further dissection of the parotid gland is carried out.
10. Once the glistening white facial nerve trunk is found, its presence should be confirmed by testing with a facial nerve stimulator (**Fig. 29.2i**).
11. Dissection is then carried out by using a clamp over the nerve. While elevating and opening the clamp to lift the parotid tissue from the facial nerve, the parotid tissue is cut with a knife or scissors. The nerve is kept in view at all times (**Fig. 29.2j**).
12. Once the nerve trunk, bifurcation, and branches beyond the mass are dissected free, the parotid tissue between the areas over the nerve is released by either blunt or sharp dissection (**Fig. 29.2k**).
13. The mass is then removed with a cuff of normal parotid gland.
14. If the parotid duct is exposed, it should be ligated to prevent leak of saliva (**Fig. 29.2l**).
15. No attempt is made to remove all remaining parotid tissue such as that in the region of the zygomatic temporal branch or tail of the parotid unless it is involved in the disease process.
16. When a mass or diseased tissue is present in the deep lobe of the parotid gland, this tissue is removed by sharp dissection from the masseter muscle as the branches of the facial nerve are gently retracted out of the way (**Fig. 29.2l**).
17. The branches or main trunk of the facial nerve are again tested to confirm integrity, and the wound is closed with 3-0 chromic in the subcutaneous tissue and 4-0 interrupted subcuticular chromic in the skin (**Fig. 29.2m**).
18. A Jackson-Pratt drain is placed in the wound and brought out inferiorly for suction drainage (**Fig. 29.2n**). Suction drains work well to prevent hematoma formation but can create a noticeable depression in the region of the excised gland. The drain is removed in 24 to 36 hours.

Complications

1. Facial nerve injury
2. Gustatory sweating (Frey's syndrome)
3. Salivary fistula

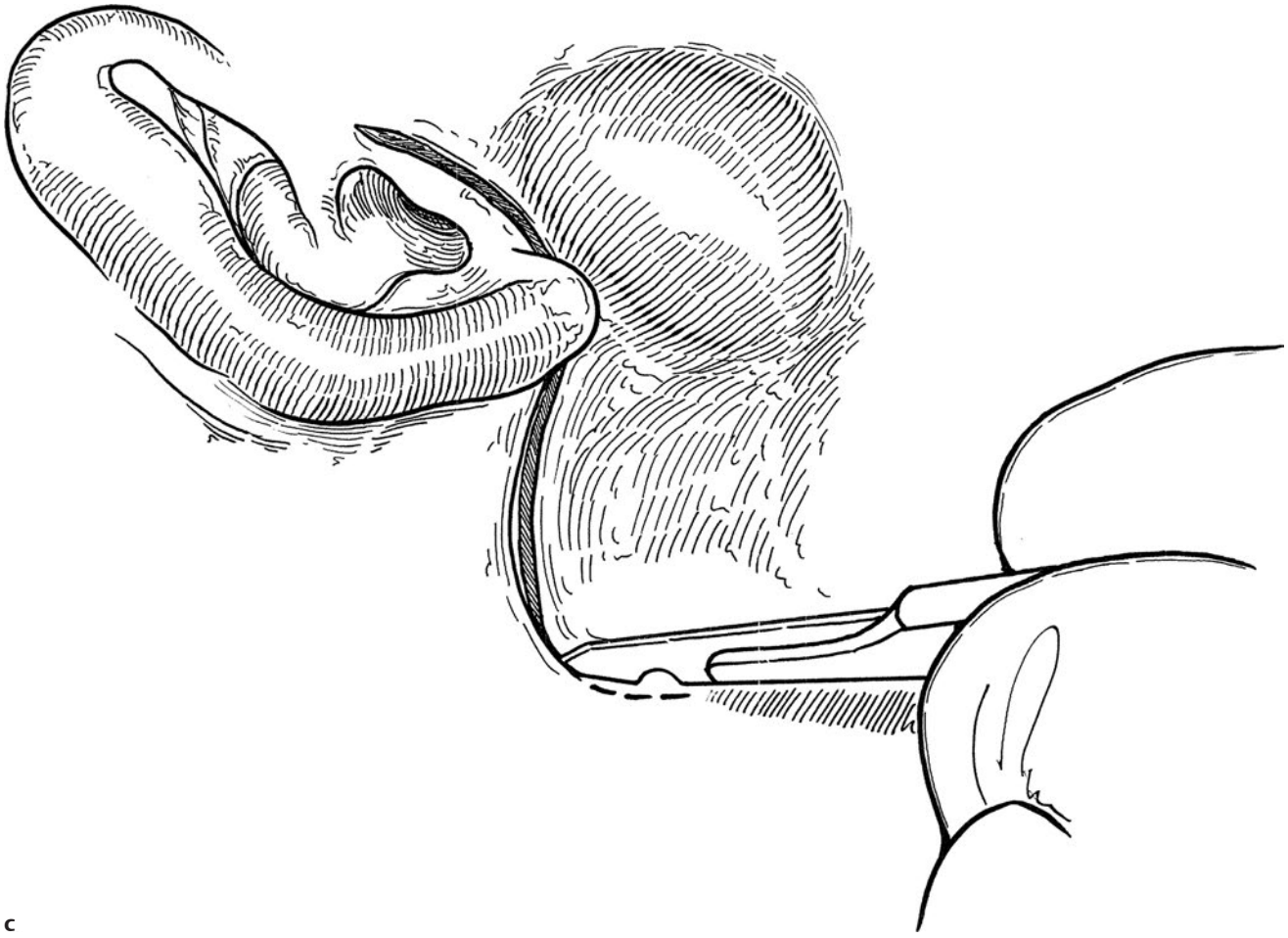


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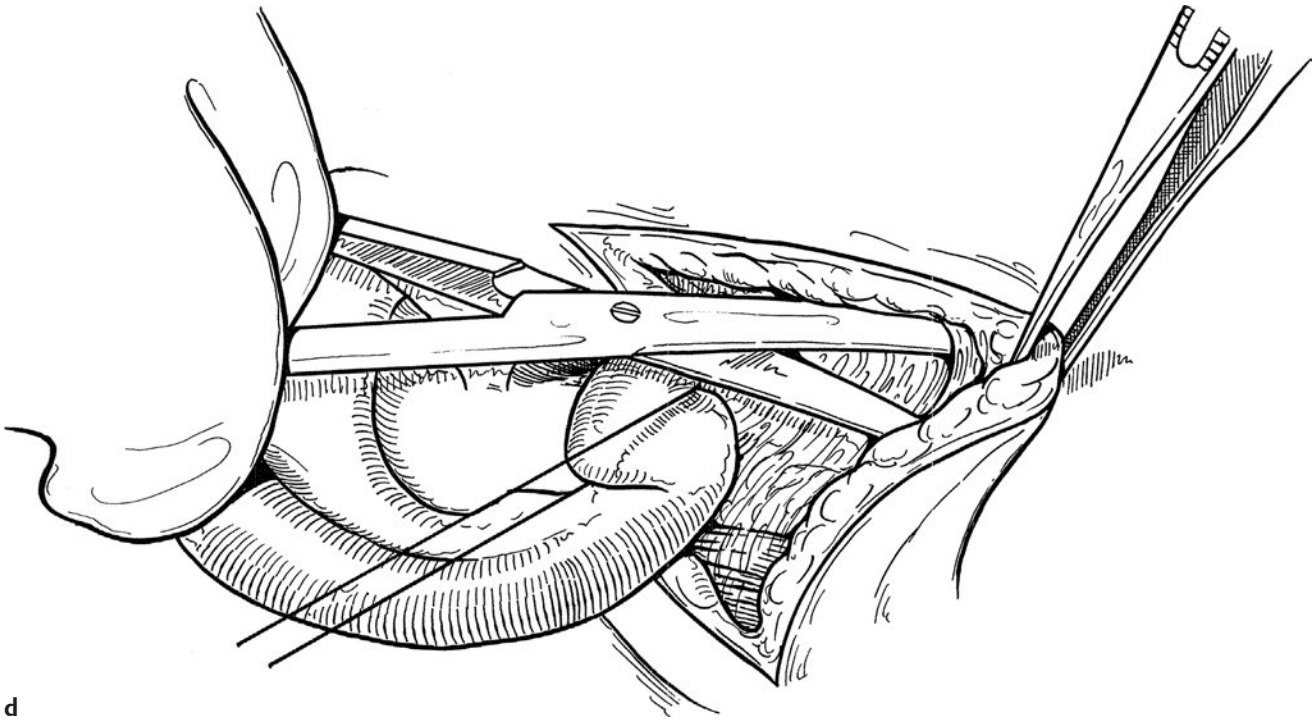


b

Fig. 29.2a,b

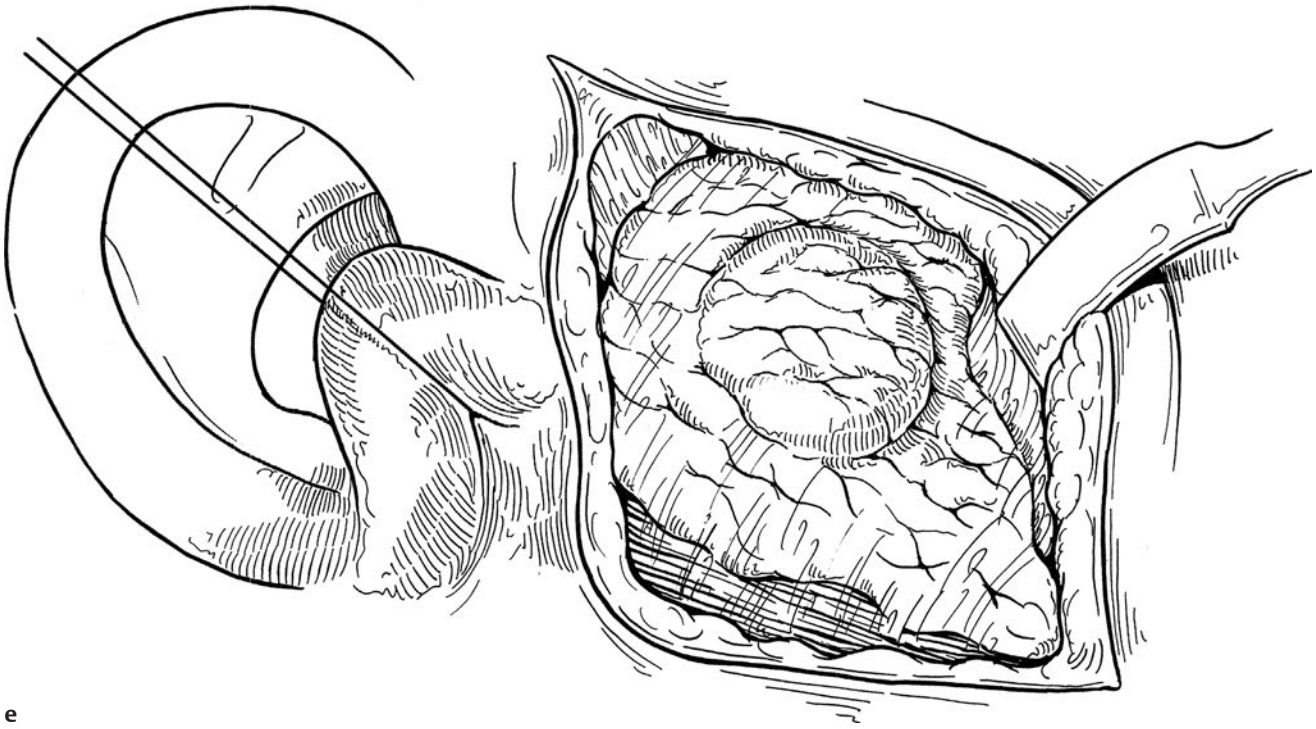


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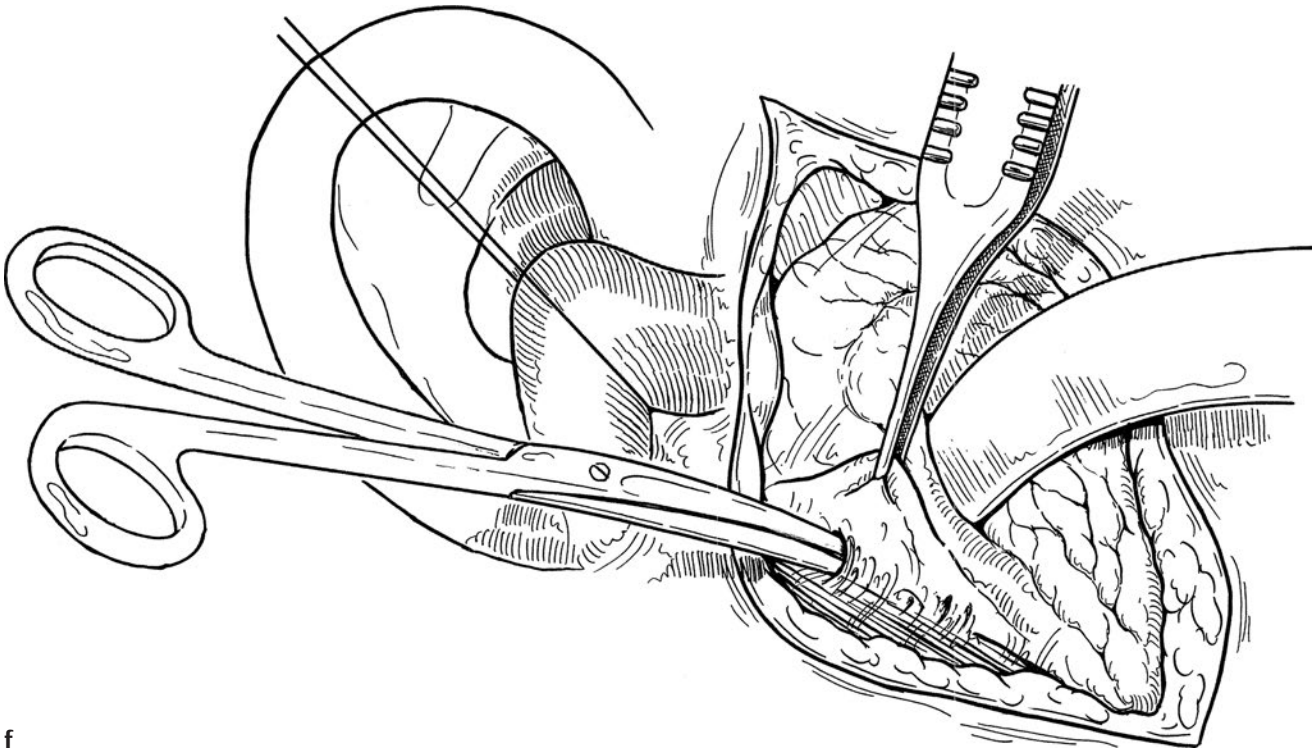


d

Fig. 29.2c,d

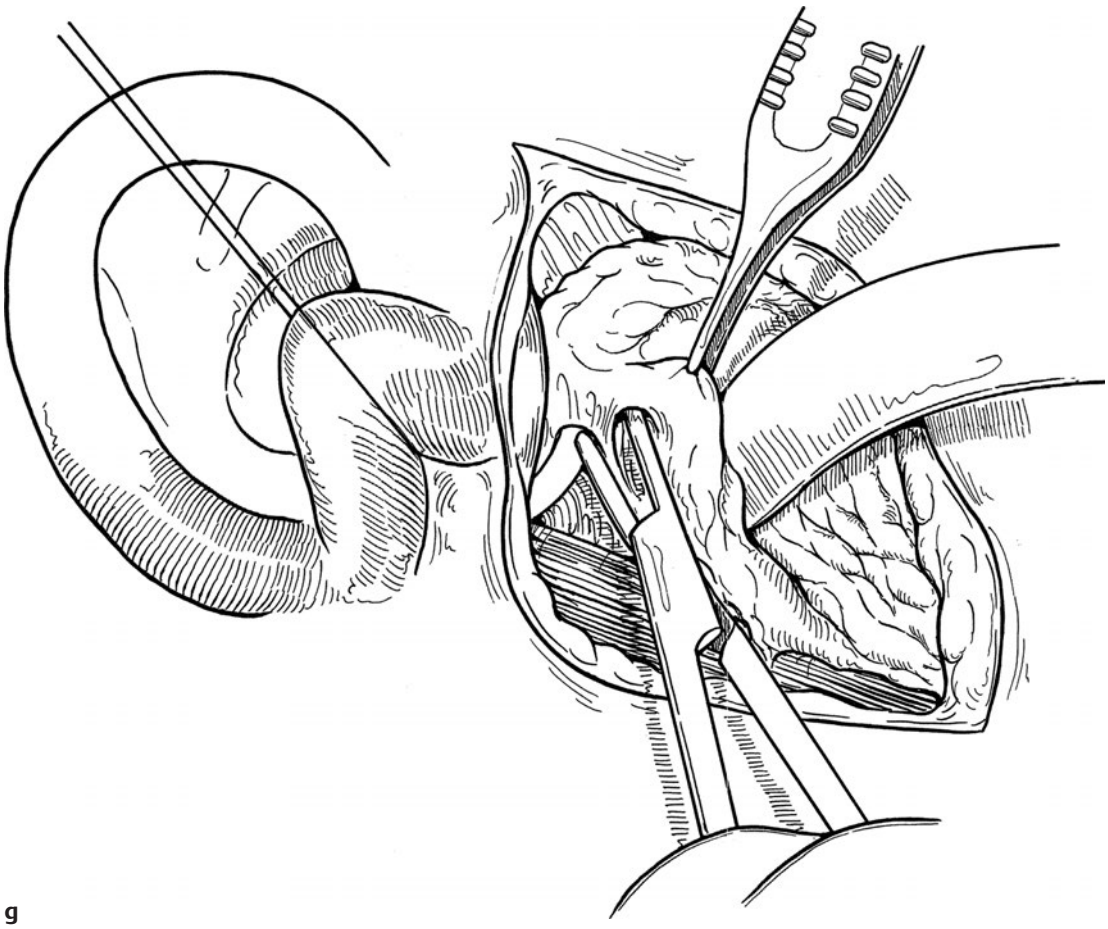


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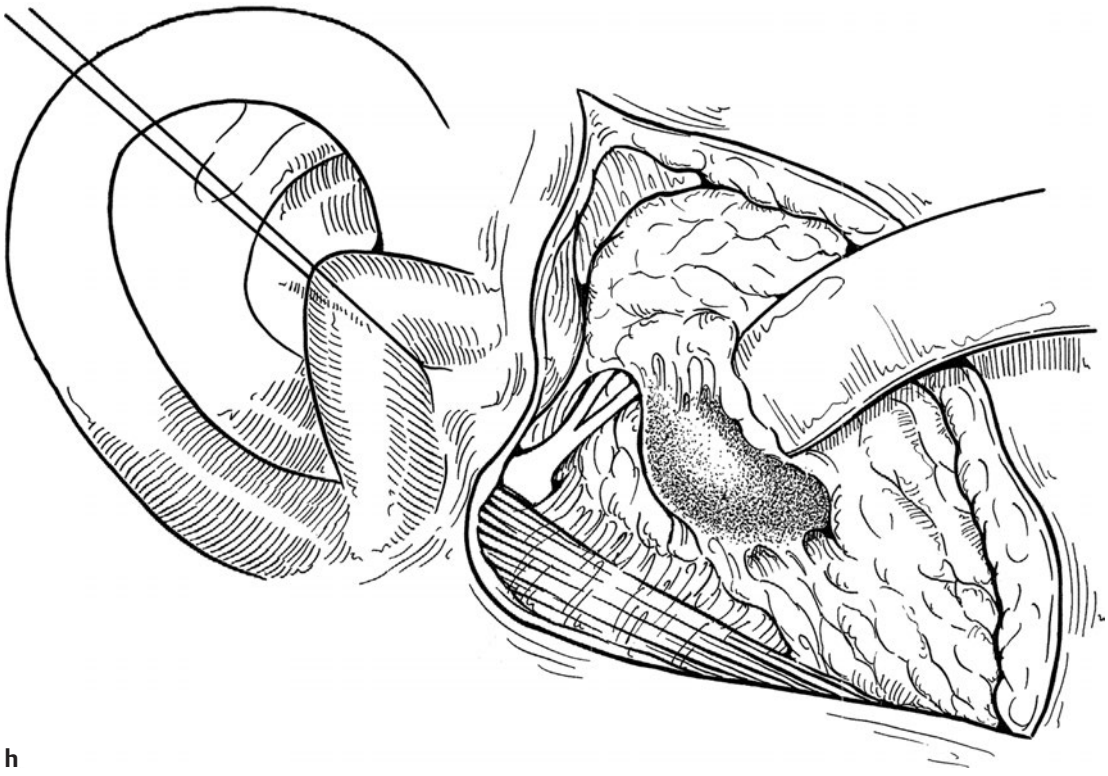


f

Fig. 29.2e,f

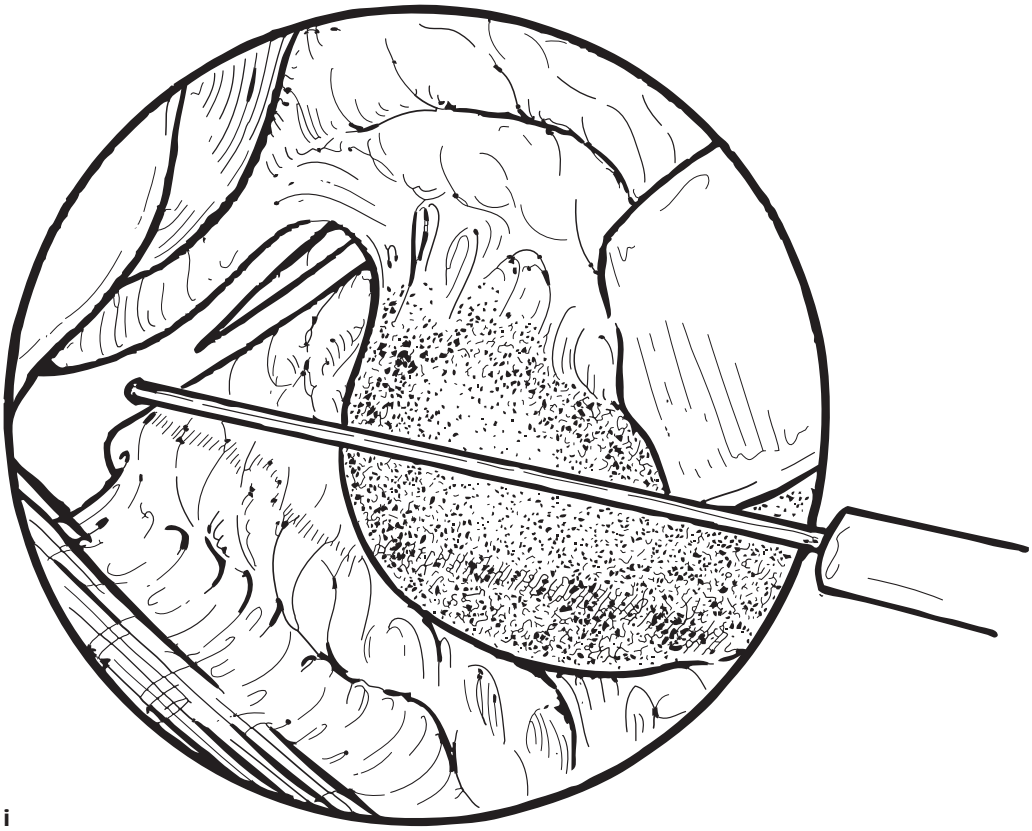


g

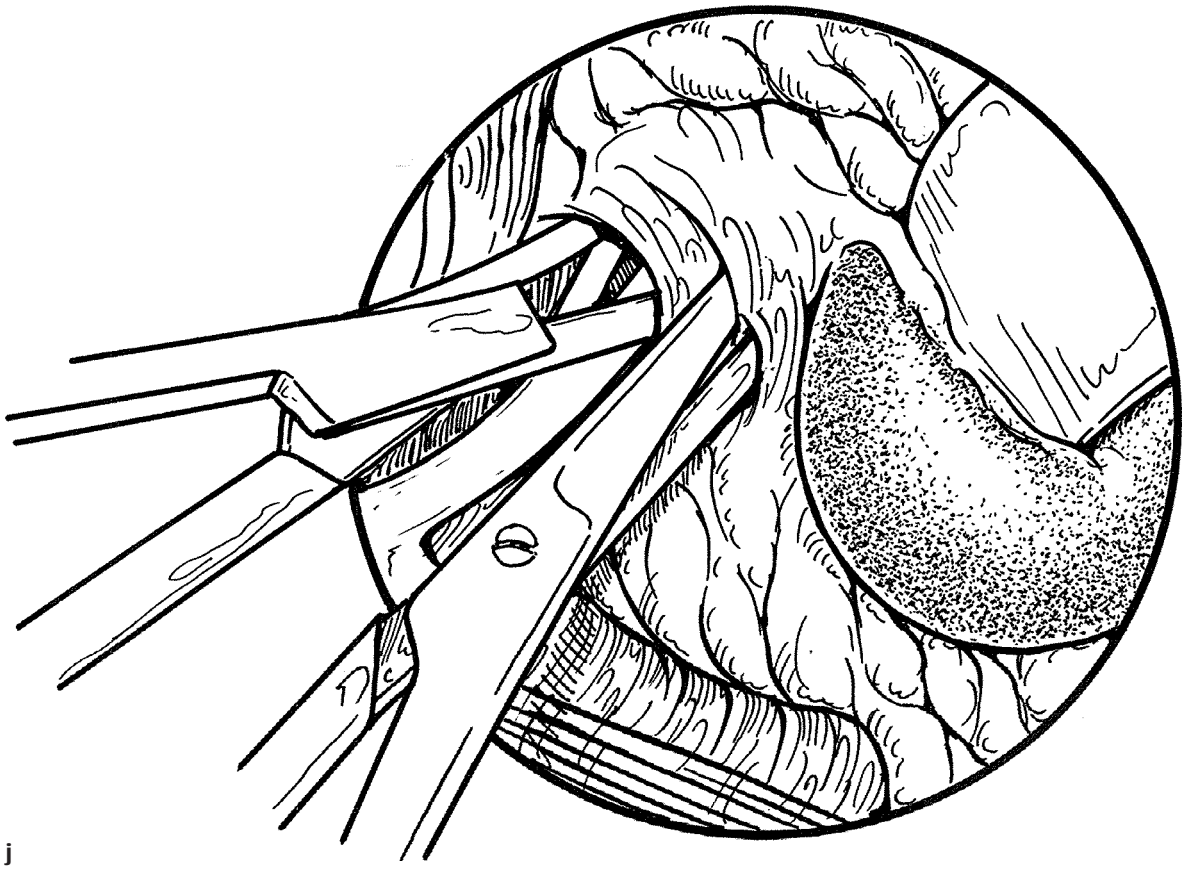


h

Fig. 29.2g,h

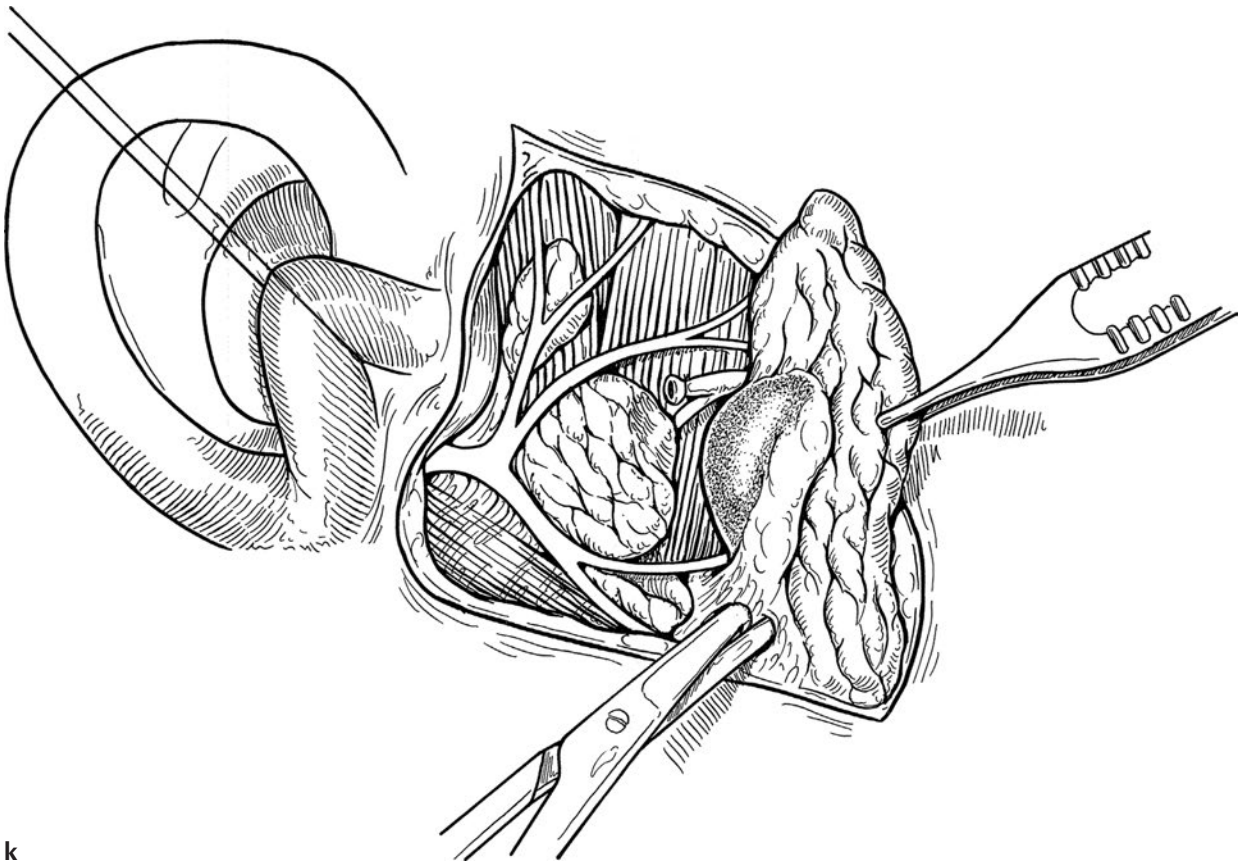


i

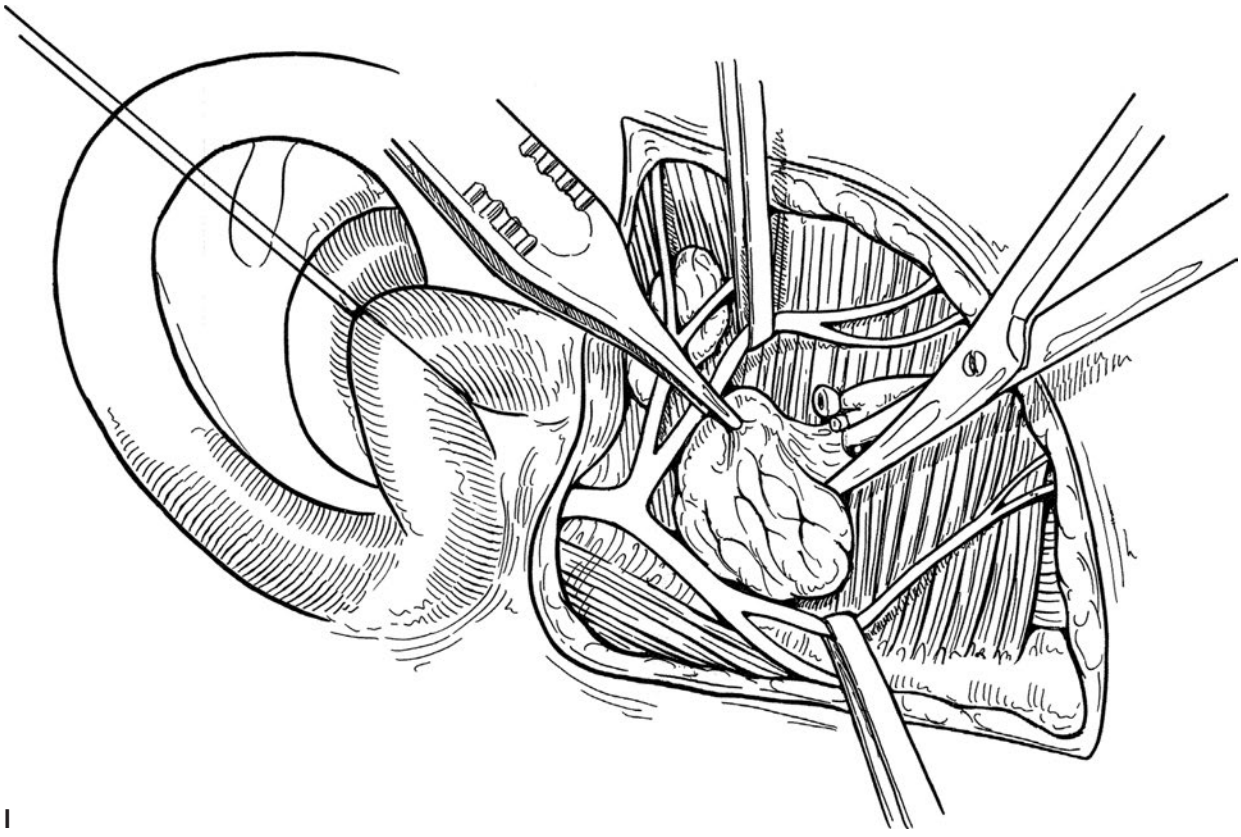


j

Fig. 29.2i,j

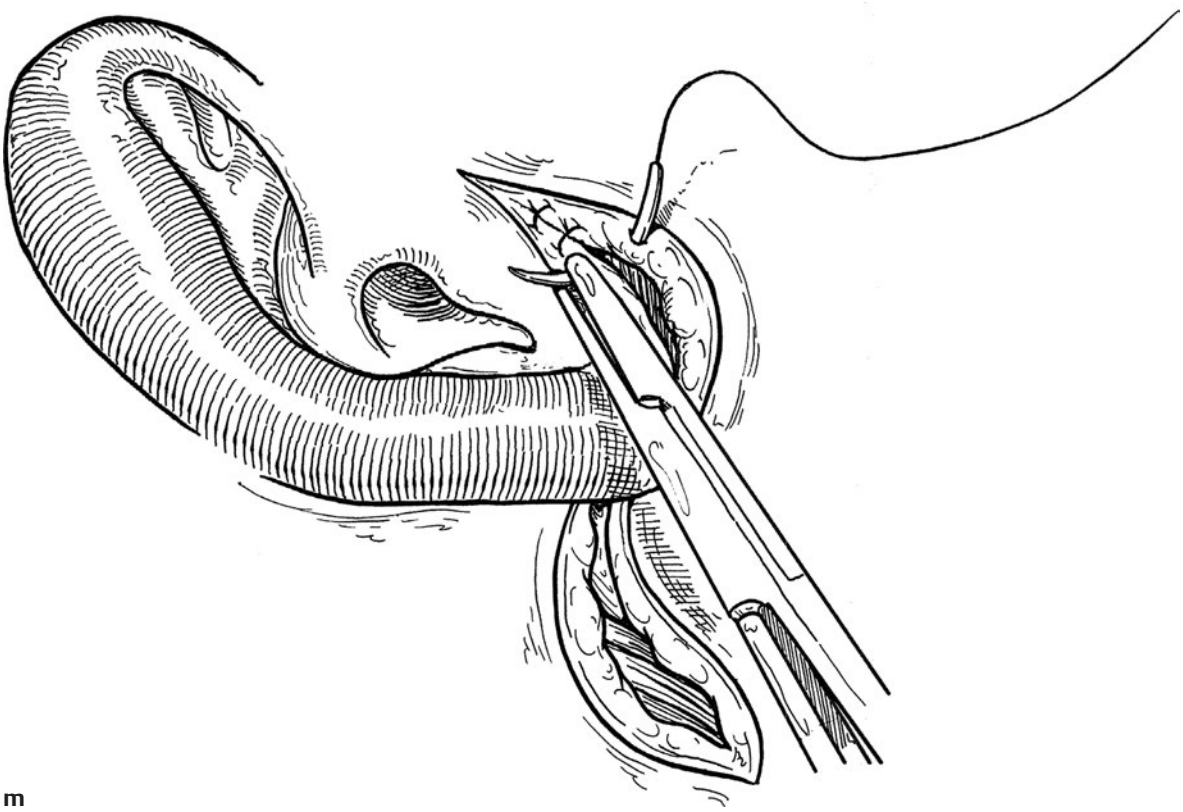


k

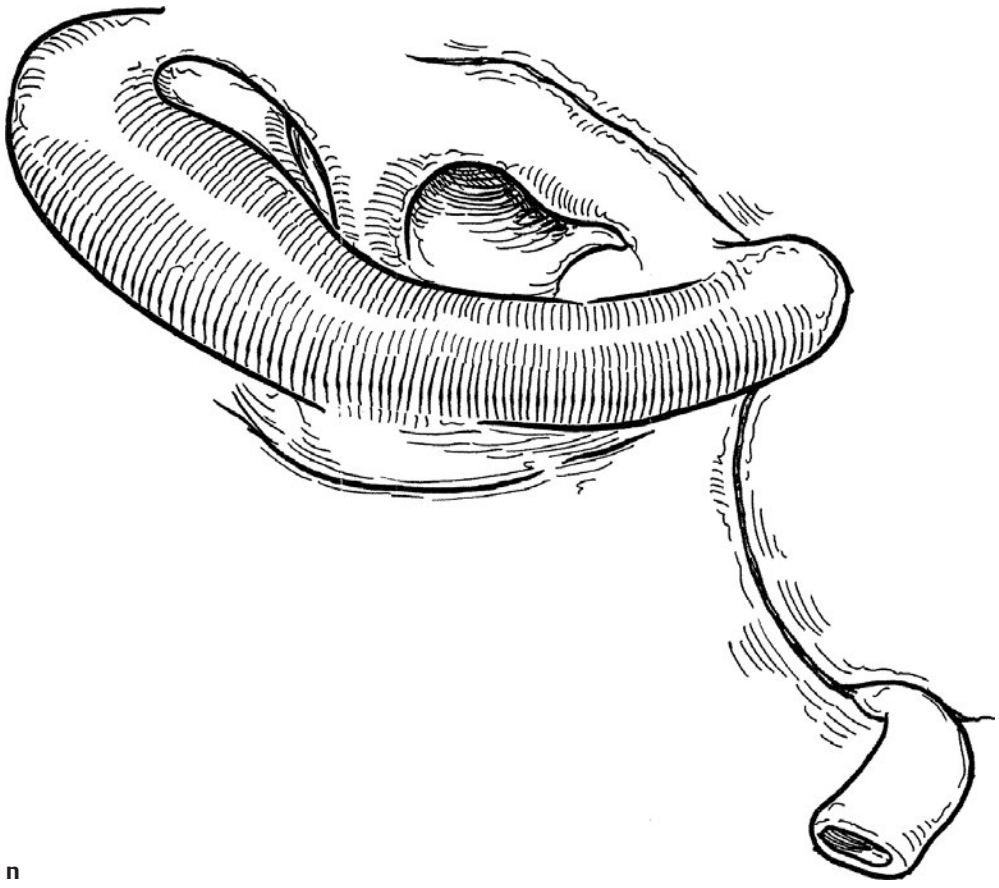


l

Fig. 29.2k,l



m



n

Fig. 29.2m,n

29-3 Marsupialization of Salivary Mucocele (Ranula)

Introduction

Ranulas and mucoceles develop from blocked minor (e.g., sublingual) salivary gland ducts. They usually present as a bluish, soft, fluctuant mass under the tongue (**Fig. 29.3a**).

Indications

The presence of a ranula is the indication for surgical treatment.

Preoperative Evaluation

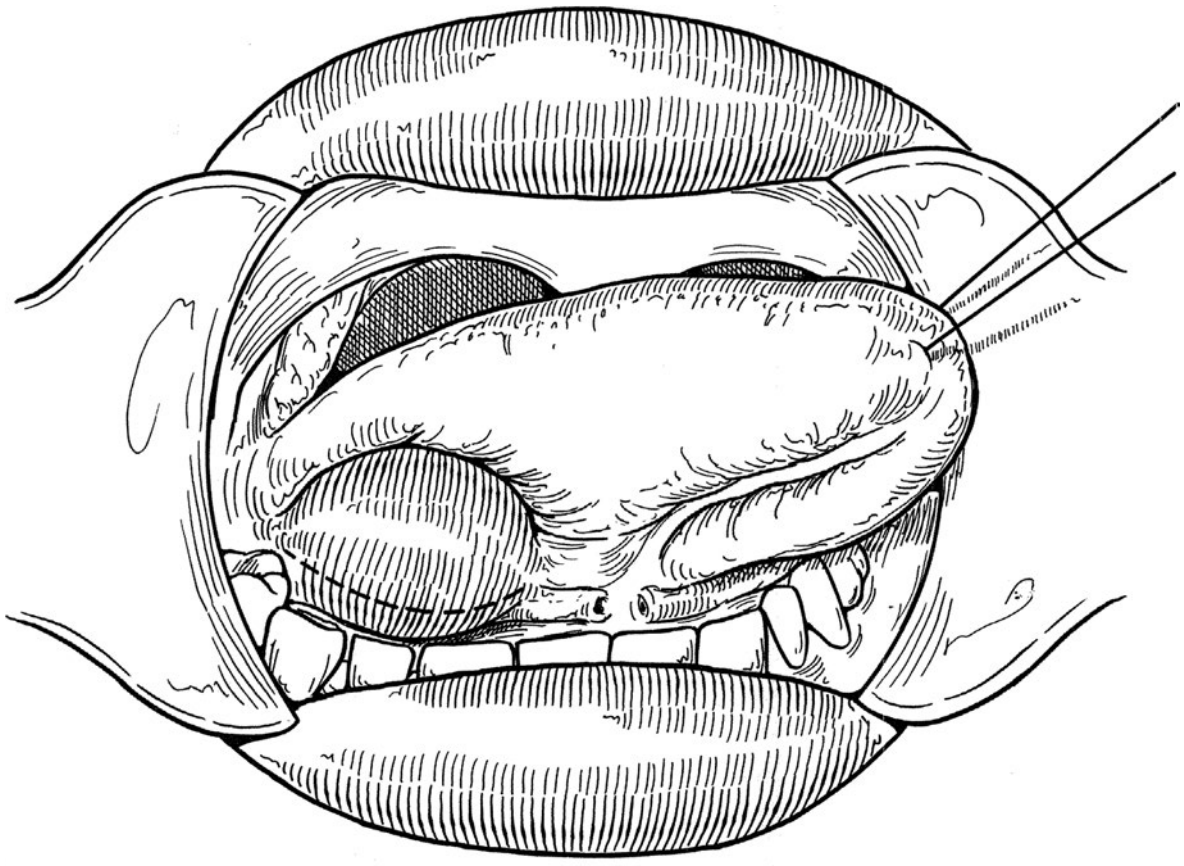
CT or MRI may be helpful to define the ranula, especially if it extends deep to the mylohyoid muscle. One usually relies on history and clinical examination alone.

Operative Technique

1. Marsupialization is performed utilizing general nasotracheal anesthesia for maximum exposure.
2. An incision is made into the lumen of the cyst along the floor of the mouth avoiding the submandibular duct (**Fig. 29.3a**). The mucoid contents of the cyst can be evacuated with a suction (**Fig. 29.3b**).
3. The redundant portions of the oral mucosa and cyst wall are excised, widely opening the cyst (**Fig. 29.3c**).
4. The mucosal edges of the floor of the mouth are sutured to the remaining cyst wall with 3-0 or 4-0 chromic suture (**Fig. 29.3d**).

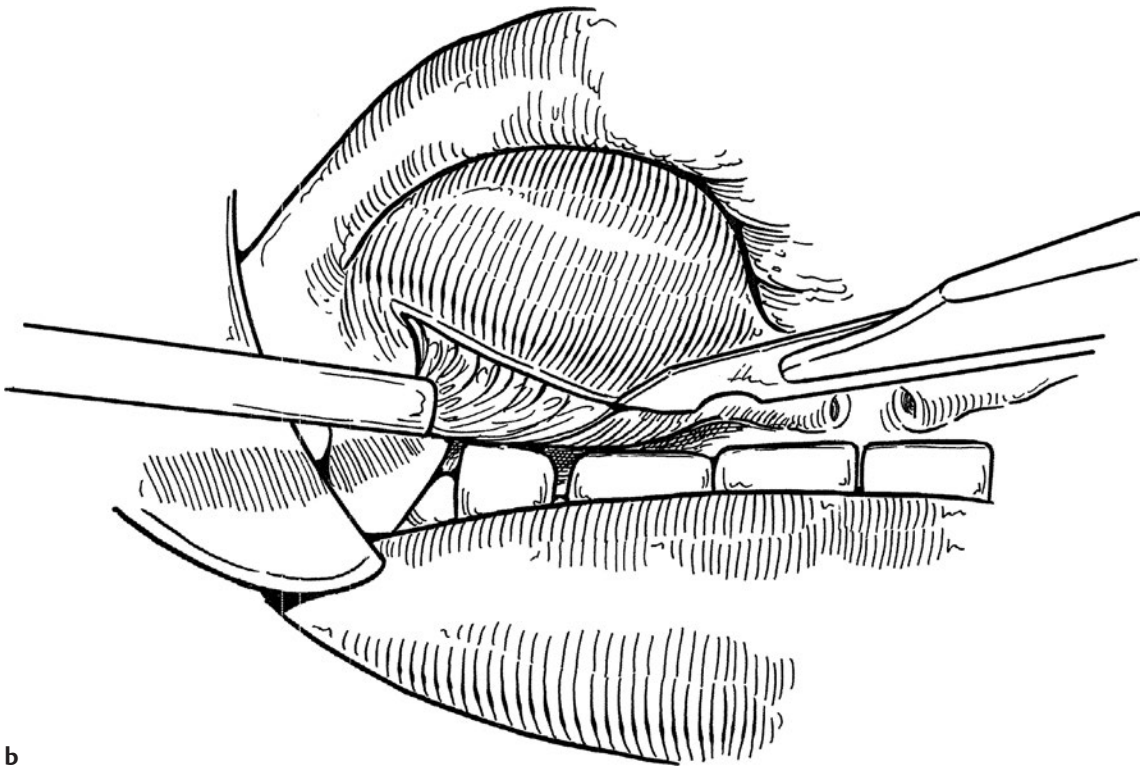
Complications

1. Recurrence of the ranula
2. Trauma to the submandibular duct

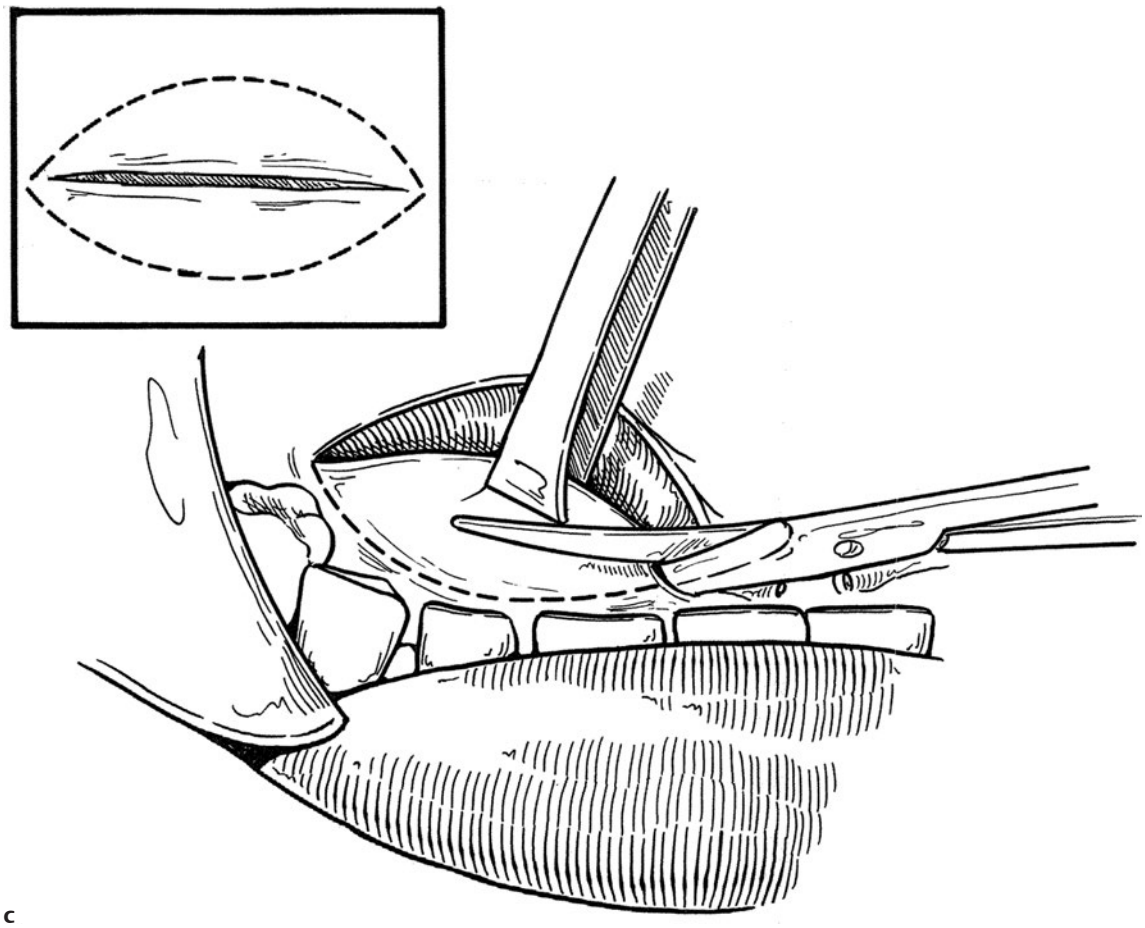


a

Fig. 29.3a

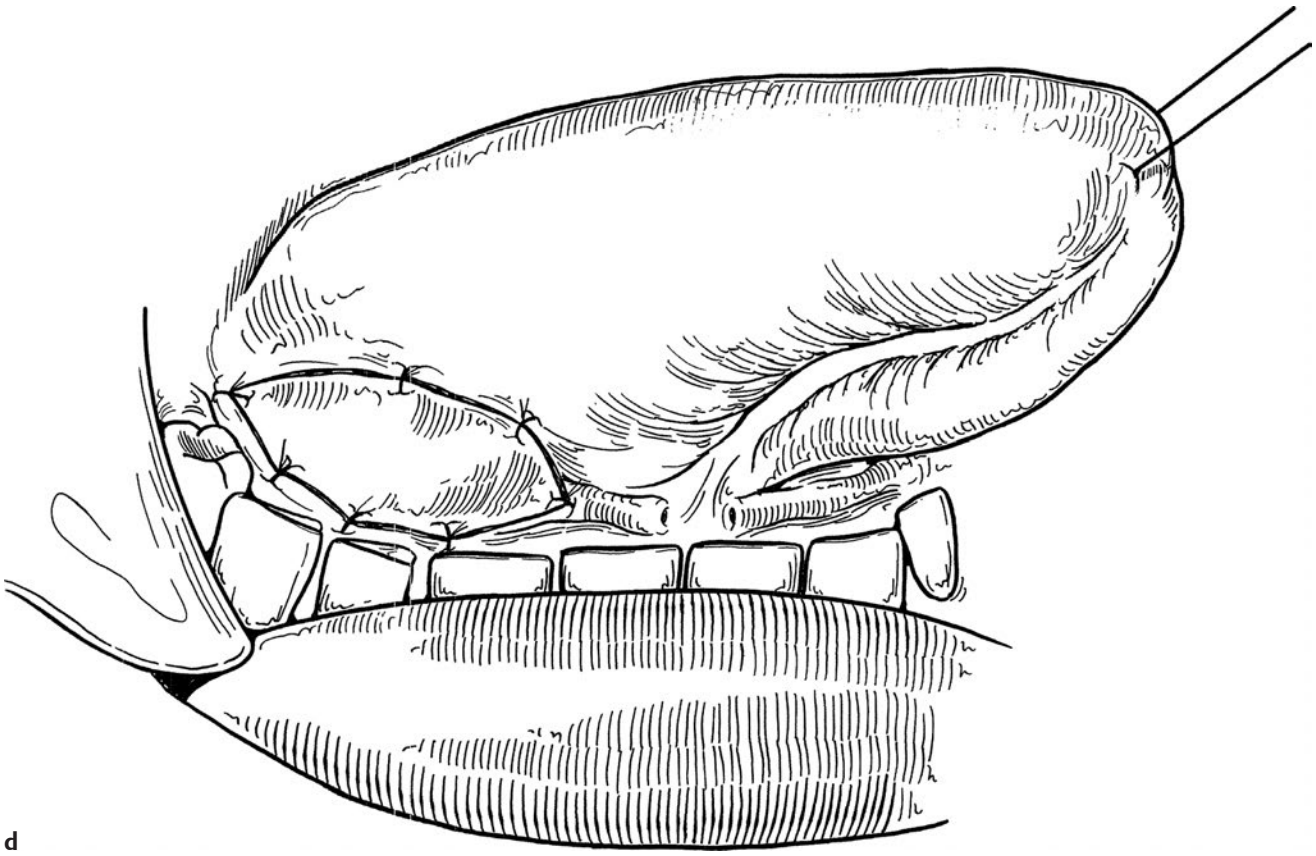


b



c

Fig. 29.3b,c



d

Fig. 29.3d

29-4 Ranula and Sublingual Gland Excision (Intraoral)

Introduction

Ranula is a cystic dilation of a sublingual salivary gland.

Indications

An enlarging or painful ranula should be removed.

Preoperative Evaluation

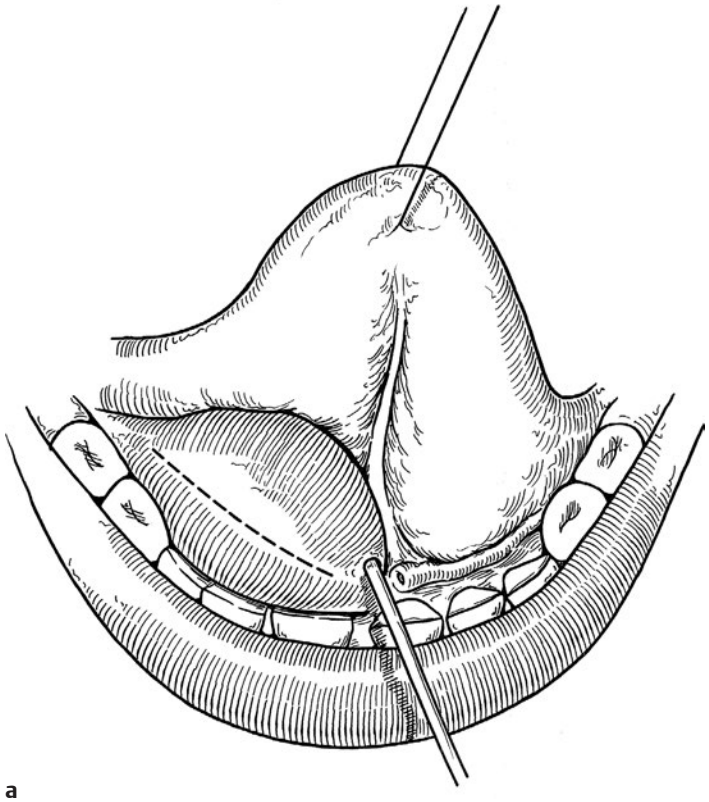
If a ranula is suspected to have an extension deep to the mylohyoid muscle, CT or MRI scan may be helpful to define its extent. Ranulas extending deep to the mylohyoid muscle should be removed through an external approach as described for submandibular gland excision (see Section 29-1). Alternatively, the sublingual gland can be removed and the plunging ranula aspirated, reserving the open procedure if this fails.

Operative Technique

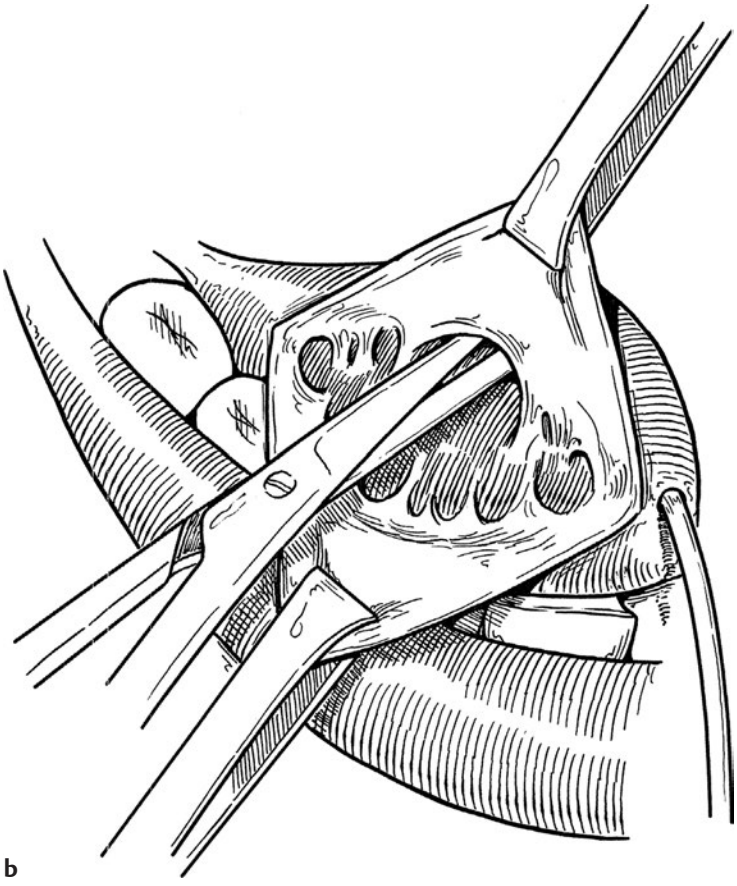
1. General anesthesia administered by nasotracheal tube is best for maximum exposure of the floor of the mouth.
2. The submandibular duct is cannulated with a polyethylene tube to aid in identification and protection of the duct during the dissection. The papilla may be dilated with lacrimal probes to permit the cannula to enter the duct (**Fig. 29.4a**).
3. A linear incision is made over the cyst along the course of the duct staying away from the duct itself (**Fig. 29.4a**).
4. Mucosal flaps are elevated superiorly and inferiorly by sharp and blunt dissection exposing the borders of the cyst (**Fig. 29.4b**).
5. The cyst is removed with attached sublingual salivary gland tissue by careful blunt and sharp dissection along the floor of the cyst (**Fig. 29.4c**) protecting the submandibular duct and lingual nerve, which lie on the floor of the mouth (**Fig. 29.4d**).
6. The mucosal incision is closed loosely with 3-0 chromic suture (**Fig. 29.4e**).

Complications

1. Submandibular duct stricture
2. Lingual nerve injury

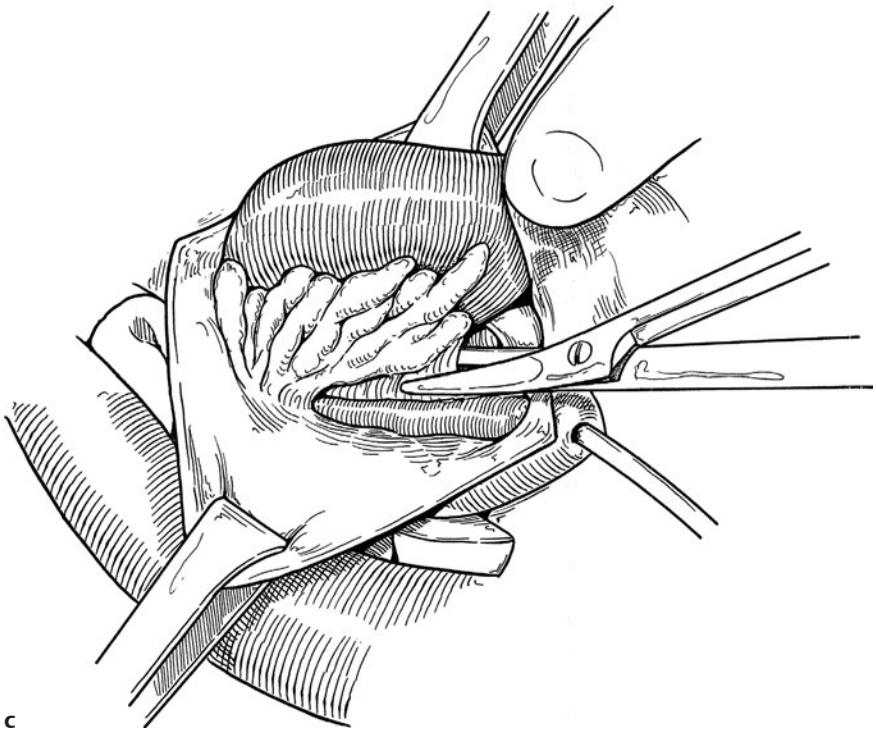


a

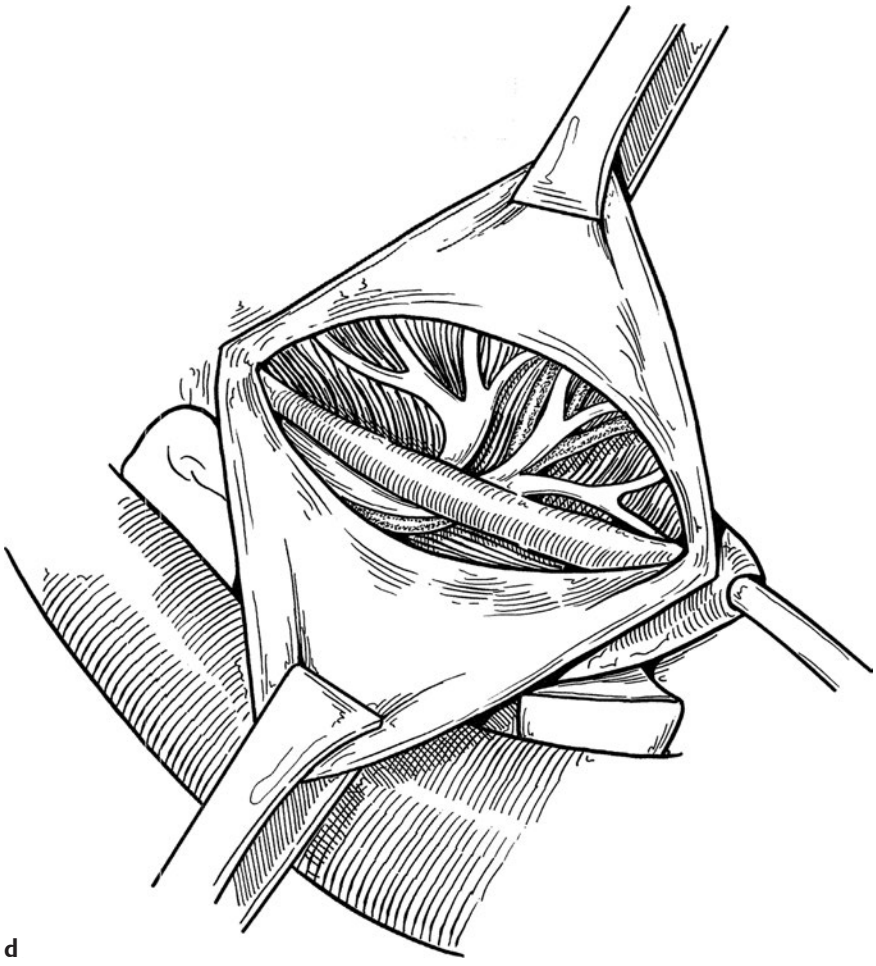


b

Fig. 29.4a,b

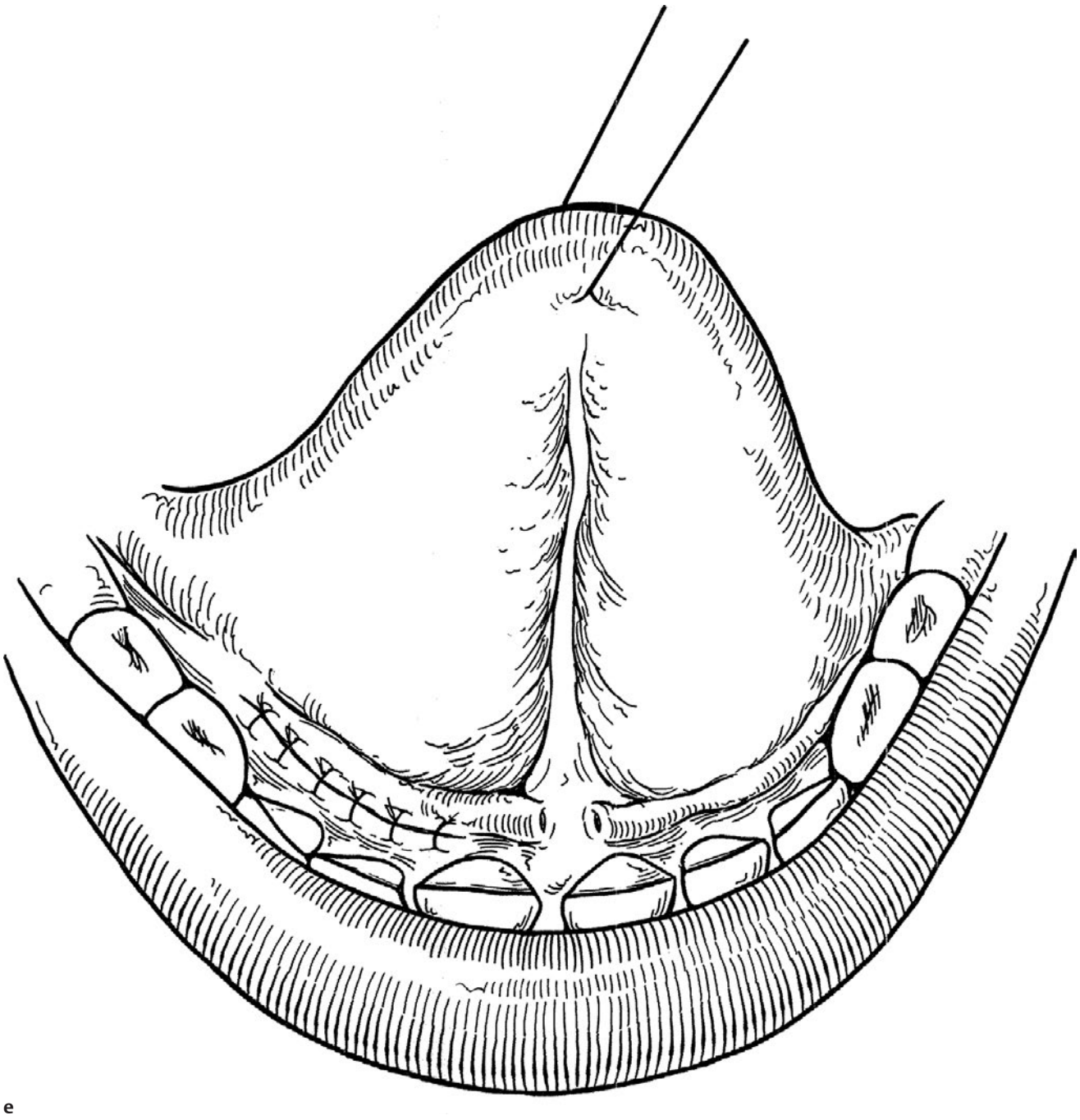


c



d

Fig. 29.4c,d



e

Fig. 29.4e

Section VII

Endoscopy

VII

30 Endoscopy

Steven E. Sobol

Endoscopic assessment of the nose and nasopharynx has become an integral part of the evaluation of patients with sinonasal disorders. Anterior rhinoscopy is simple to perform in most patients and is considered part of the basic head and neck examination. When distal pathology is suspected, pediatric endoscopes are often employed for the accurate evaluation of the patient's complaint. Moreover, recent technological advances have allowed for photographic and video documentation of pathology, facilitating discussion with the family and other practitioners.

30-1 Rhinoscopy

Indications

Anterior rhinoscopy is part of the basic head and neck physical examination.

Preoperative Evaluation

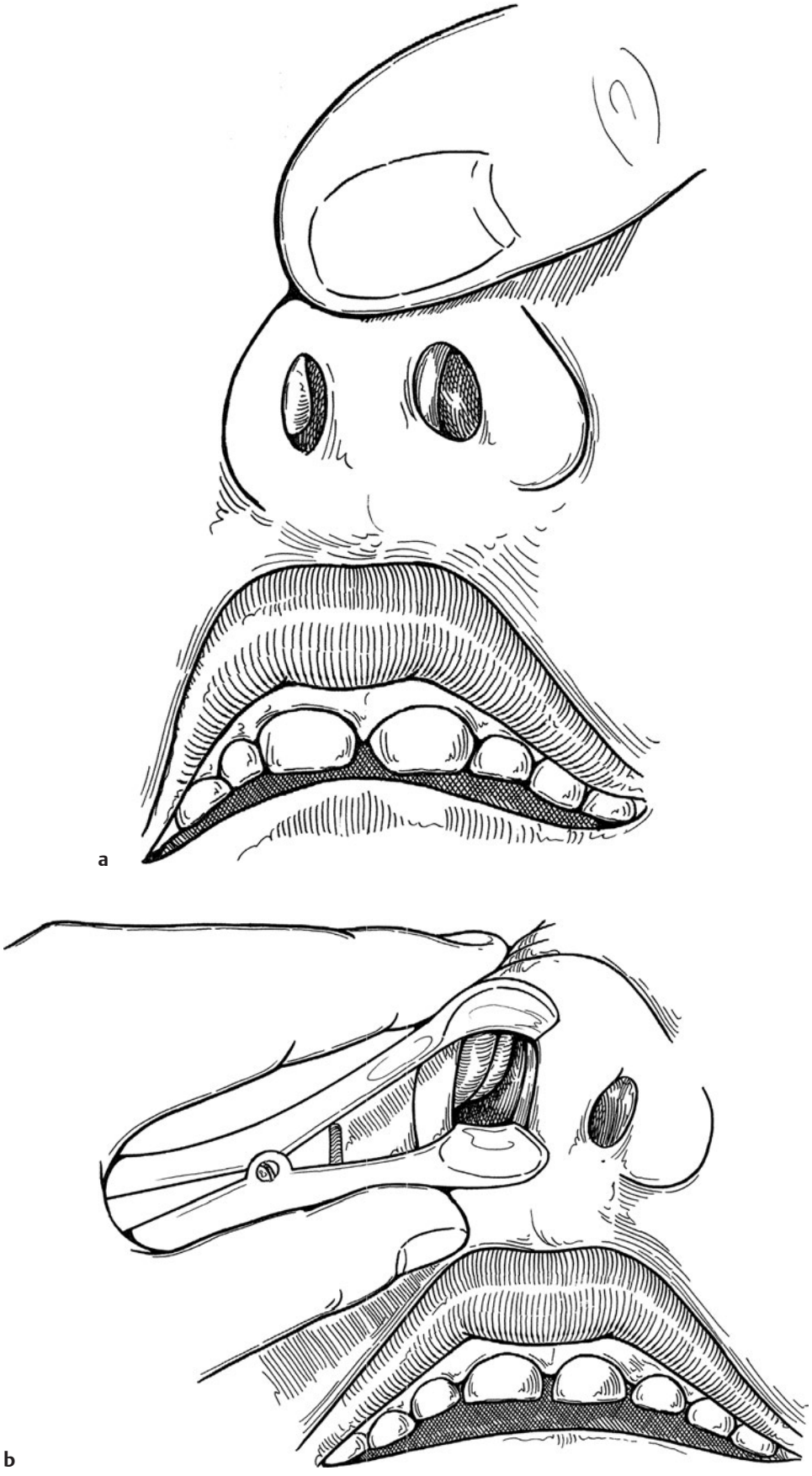
No specific evaluations are required for rhinoscopy.

Operative Technique

1. No anesthetic or vasoconstricting substance is necessary for limited anterior rhinoscopy.
2. The child is in the upright position seated in a chair or in the caretaker's lap.
3. The child's mobile nasal tip is gently elevated with the examiner's thumb as a directed light source is shined into the nasal cavity. In this way, the anterior nasal septum, nasal vestibule, and the inferior and, occasionally, the middle turbinate can be examined easily (**Fig. 30.1a**).
4. If redundant or collapsible tissue or nasal hairs prevent adequate visualization, a standard nasal speculum can be inserted gently into the nasal vestibule and the internal structures visualized.
5. Care must be taken to stabilize the instrument with the examiner's right forefinger on the patient's nasal tip so that the instrument will follow any movements of the child's head (**Fig. 30.1b**). An otoscope with a large speculum may be substituted for the nasal speculum.
6. If examination of the more posterior aspect of the nasal cavity is needed, posterior rhinoscopy can be performed utilizing a straight telescope. Topical anesthesia and vasoconstriction are obtained using cotton pledgets soaked in 4% cocaine (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used). The telescope can then be advanced into the nasal cavity to inspect the deeper aspects of the turbinates and the nasal septum (**Fig. 30.1c**). Rigid telescopes are available in different viewing angles so that the entire nasal cavity can be examined.
7. A flexible telescope may be inserted and angulated in different directions to view the entire nasal cavity (**Fig. 30.1d**).

Complications

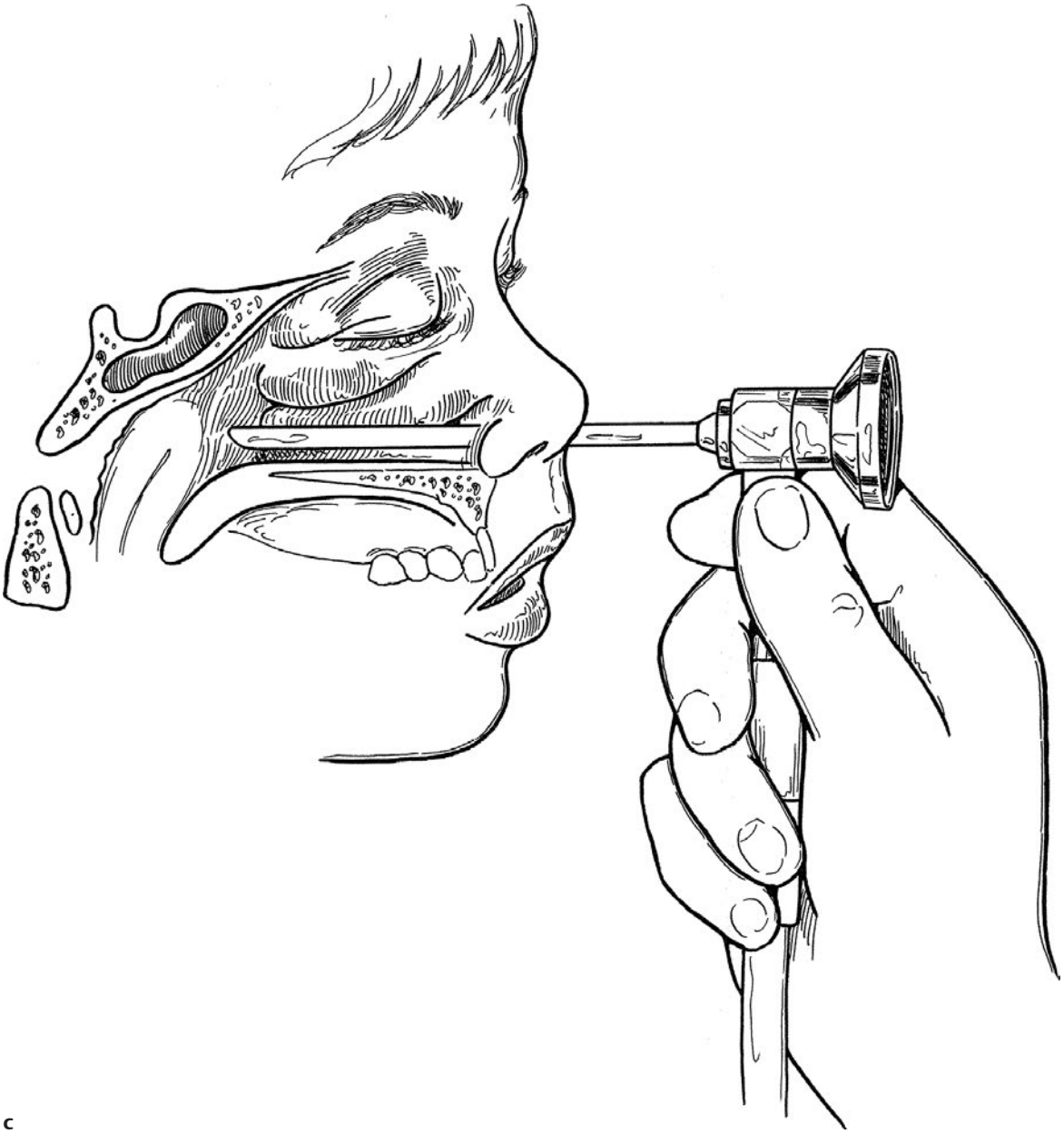
1. Epistaxis
2. Mucosal abrasion



a

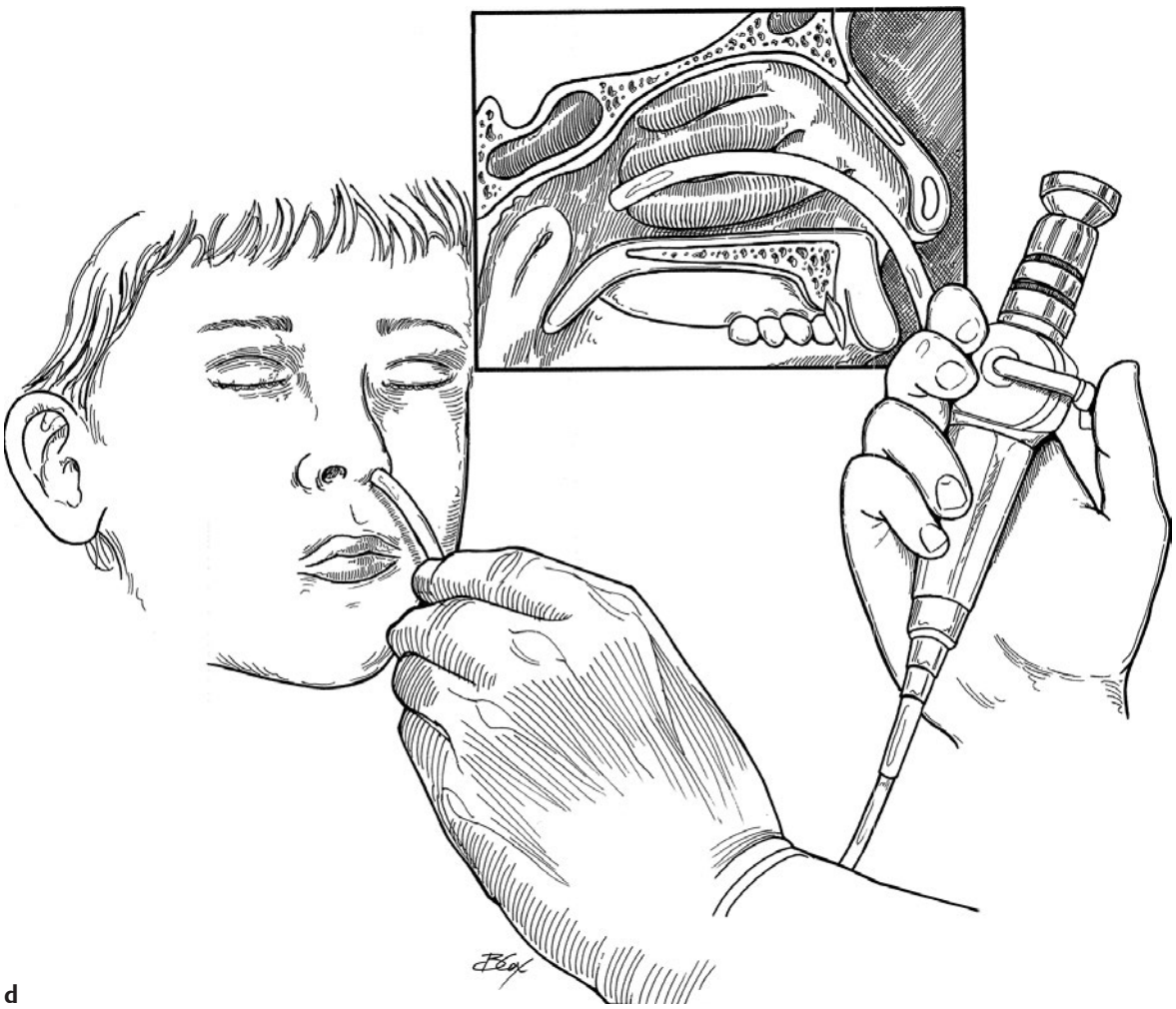
b

Fig. 30.1a,b



c

Fig. 30.1c



d

Fig. 30.1d

30-2 Nasopharyngoscopy (Mirror)

Indications

Nasopharyngoscopy is indicated when visualization of the nasopharynx is desired in order to assess for adenoid enlargement, a mass lesion, or velopharyngeal insufficiency. The utility of this technique is limited in young children and has largely been replaced by flexible fiberoptic nasopharyngoscopy.

Preoperative Evaluation

No specific evaluations are required for nasopharyngoscopy.

Operative Technique

1. The child is in the upright position seated in a chair or on the caretaker's lap.
2. The neck is flexed and the head extended in the sniffer's position.
3. The examiner faces the child and wears a headlight or head mirror with a focused light source beside the child's head.
4. The child is asked to open their mouth but not to protrude their tongue.
5. A tongue blade is used to depress the central portion of the tongue, taking care not to touch the more sensitive posterior aspects of the tongue.
6. A warmed or defogged nasopharyngeal mirror is gently inserted into the pharynx, behind the uvula, and angulated upward so that the examiner can view the entire nasopharynx (**Fig. 30.2**).
7. The child is asked to breathe through his/her nose or to pant like a puppy in order to allow the palate to relax and allow visualization of the nasopharynx.

Complications

None

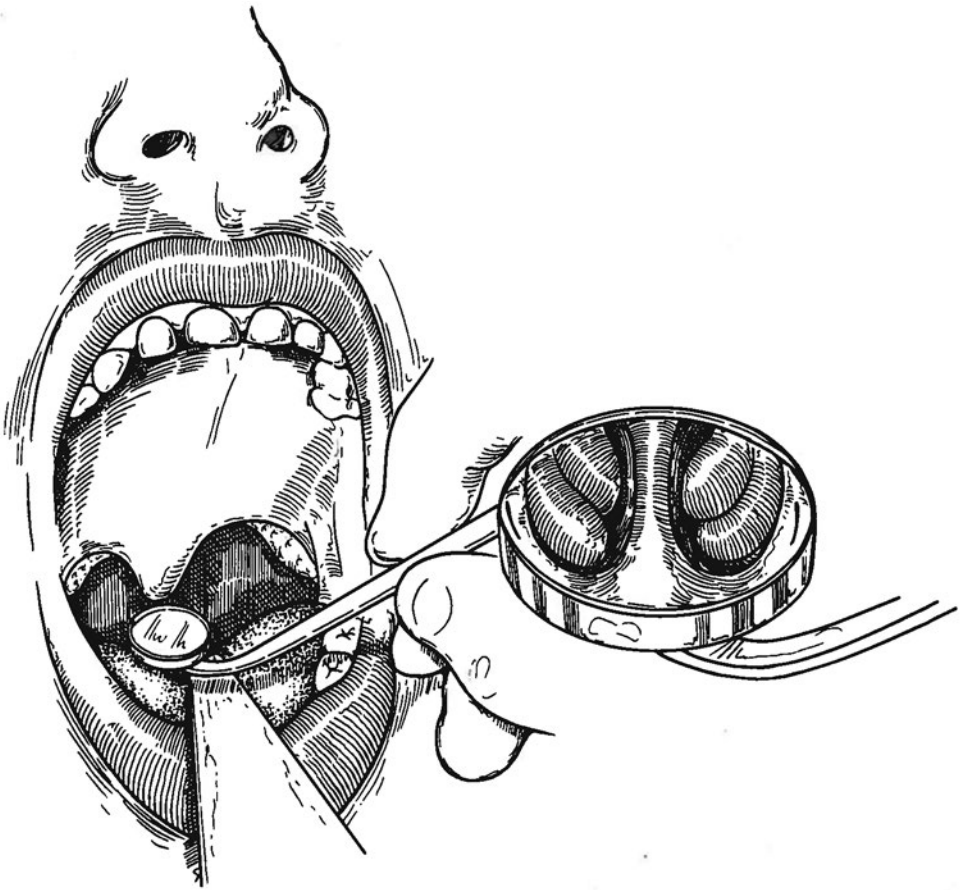


Fig. 30.2

30-3 Flexible Nasopharyngoscopy

Indications

Flexible nasopharyngoscopy is indicated when visualization of the nasopharynx is desired in order to assess for adenoid enlargement, a mass lesion, or velopharyngeal insufficiency. Dynamic velopharyngeal activity can be assessed using flexible nasopharyngoscopy without the impediment of a scope in the mouth. Additionally, the flexible scope is also used to evaluate the nasal cavity, including the septum, turbinates, and meati.

Preoperative Evaluation

No specific evaluations are required for nasopharyngoscopy.

Operative Technique

1. The child's position is the same as described above.
2. Flexible nasopharyngoscopy may be performed with or without topical anesthesia and/or vasoconstriction. Should topicalization be desired, a 1:1 solution of topical lidocaine (2%) and oxymetazoline may be used.
3. The flexible nasopharyngoscope is gently inserted along the floor of the nose or in the middle meatus area until the posterior aspect of the hard palate is identified (**Fig. 30.3**).
4. The telescope is deflected downward so that the adenoid pad can be identified and palatal closure monitored during phonation. Eustachian tube dynamics can also be observed.

Complications

1. Epistaxis
2. Mucosal abrasion

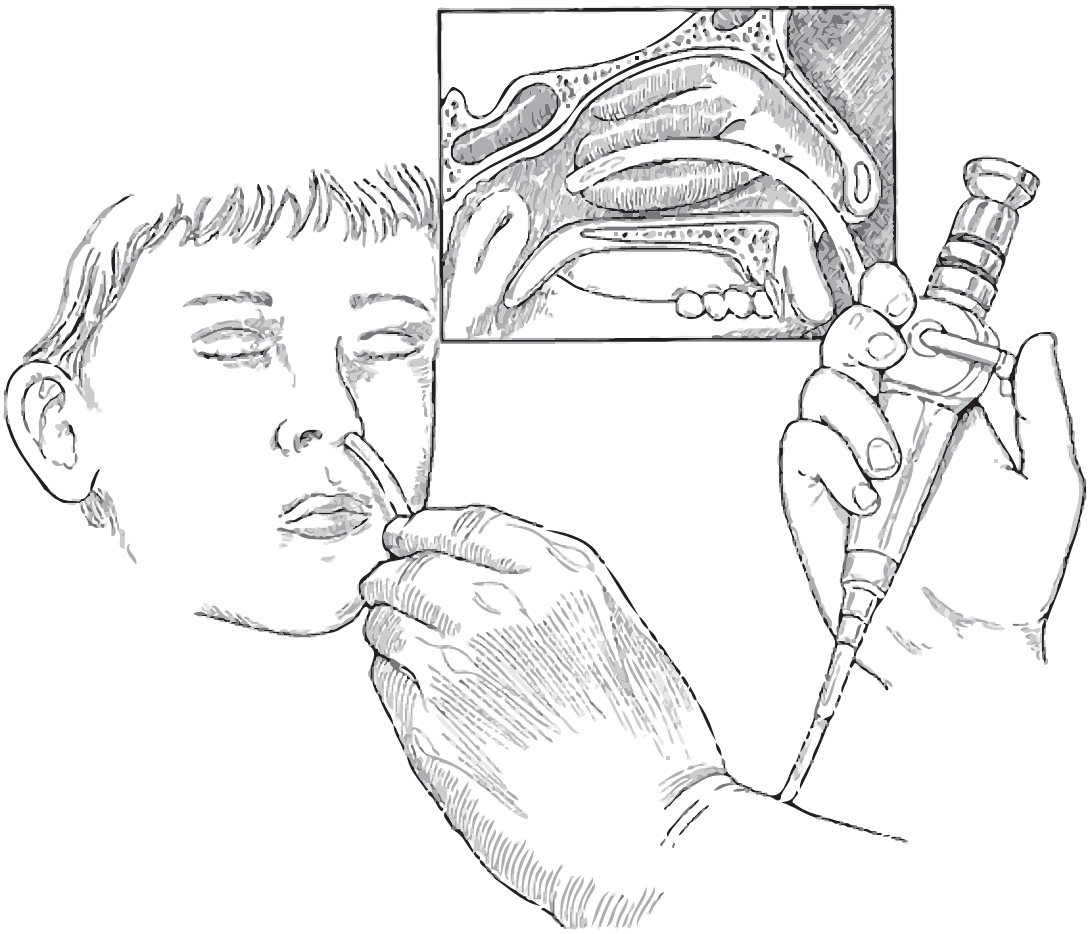


Fig. 30.3

31 Laryngoscopy

Steven E. Sobol

Laryngoscopy is a key skill that should be mastered by all otolaryngologists. As a diagnostic tool, laryngoscopy can be performed in the office with use of a mirror, rigid telescope, or flexible fiberoptic laryngoscope. Under general anesthesia, rigid laryngoscopes can be used with or without magnification, allowing for accurate diagnosis or manipulation of the larynx when necessary. There are currently a variety of laryngoscopes (both flexible and rigid) available to the otolaryngologist, each with specific features that may aid the surgeon in specific situations. This chapter reviews common techniques for laryngoscopy in the office and operating room setting.

31-1 Mirror Indirect Laryngoscopy

Indications

Mirror indirect laryngoscopy is considered to be part of the basic head and neck examination. It is indicated for patients manifesting with voice complaints or disorders that may manifest with laryngeal pathology. The utility of mirror examination is limited in young children and has largely been replaced by flexible fiberoptic laryngoscopy.

Preoperative Evaluation

No specific evaluations are required for mirror indirect laryngoscopy.

Operative Technique

1. The child is positioned in the upright position seated in a chair or on their caretaker's lap.
2. The child's head is extended and the neck flexed in the classic sniffer's position.
3. The examiner is facing the child using a headlight or head mirror with a focused light source beside the child's head.
4. The child is asked to open their mouth and protrude their tongue. The anterior portion of the tongue is grasped with a gauze sponge.
5. A warmed or defogged laryngeal mirror is gently inserted into the oral cavity and elevates the uvula and distal soft palate (**Fig. 31.1**). The warmed mirror should be touched to the examiner's hand prior to inserting it into the patient's mouth to prevent burning the oral mucosa.
6. The instrument is angulated until the examiner is able to obtain excellent visualization of the laryngeal and hypopharyngeal structure.
7. The child is asked to say "ee" so that active vocal cord adduction can be observed.
8. If the child begins to gag with the instrument in place, he/she is asked to pant like a puppy. This tends to relax the palate and allows completion of the examination.

Complications

Failure to accurately diagnose pathology

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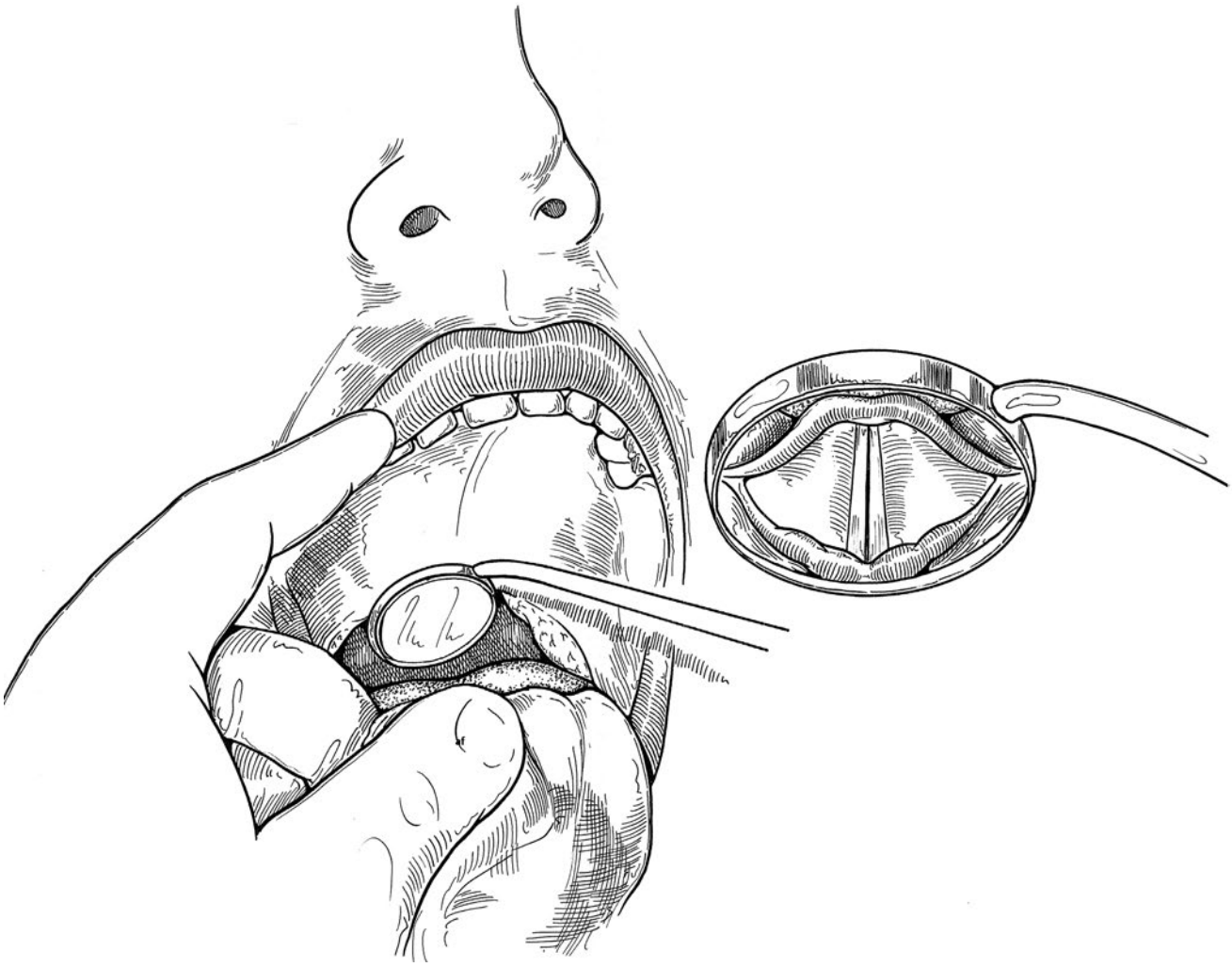


Fig. 31.1

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31-2 Rigid Telescopic Indirect Laryngoscopy

Indications

Rigid direct laryngoscopy is a useful technique to accurately assess vocal fold function. It is often used with stroboscopy for patients presenting with voice complaints or disorders that may have visible laryngeal pathology. Compliance with this procedure is limited in young children.

Preoperative Evaluation

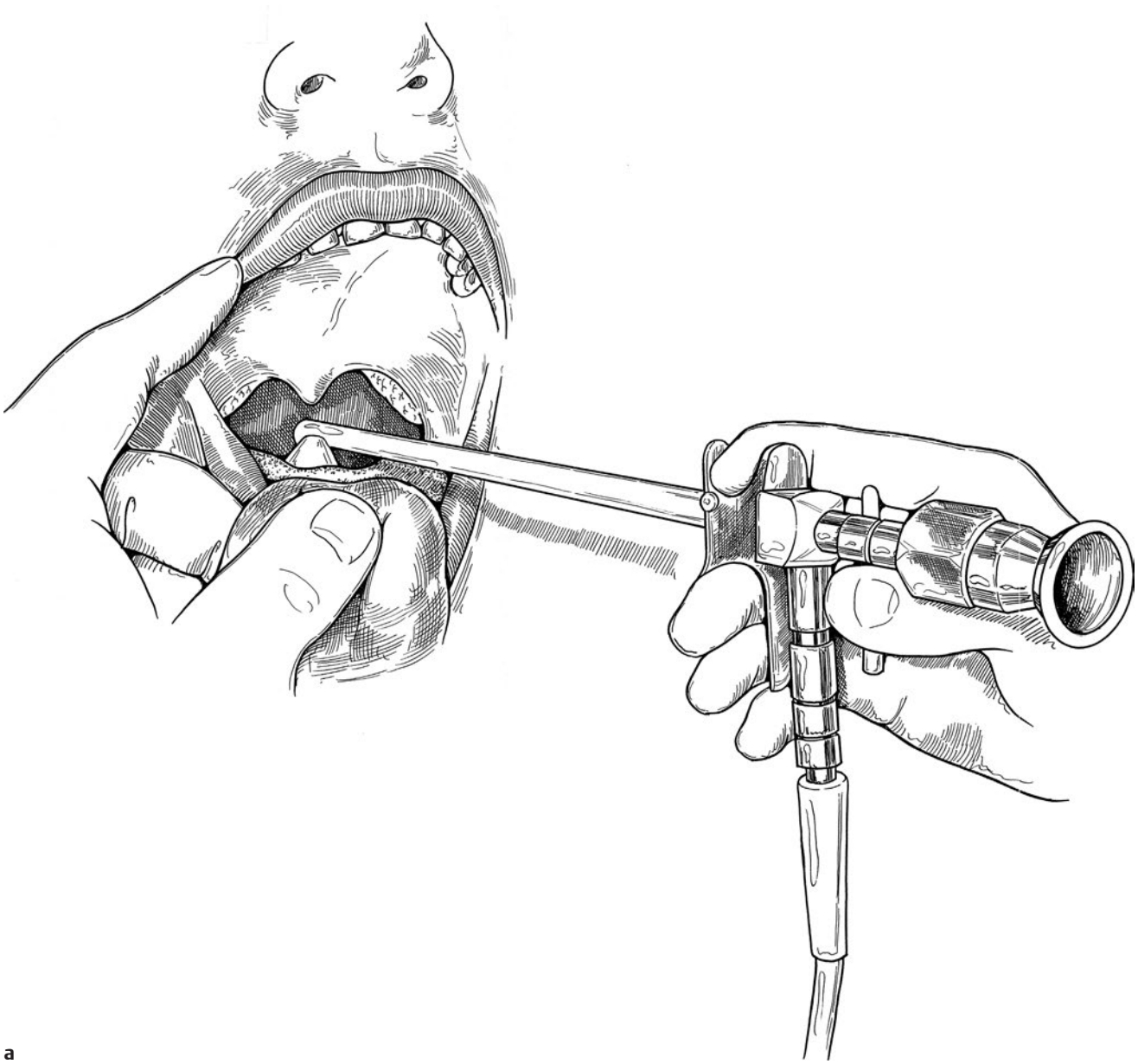
No specific evaluations are required for rigid direct laryngoscopy.

Operative Technique

1. This technique utilizes the same preparation as mentioned above.
2. The anterior tongue is grasped with a gauze sponge.
3. A defogged telescopic rod with a 90-degree viewing angle is inserted over the surface of the tongue, taking care not to touch the posterior tongue or posterior pharyngeal wall (**Fig. 31.2a**).
4. Visualization of the laryngeal and hypopharyngeal structures is obtained in the same manner as described for the mirror (**Fig. 31.2b**).
5. If the child begins to gag with the instrument in place, he/she is asked to pant like a puppy. This tends to relax the palate and allows completion of the examination.

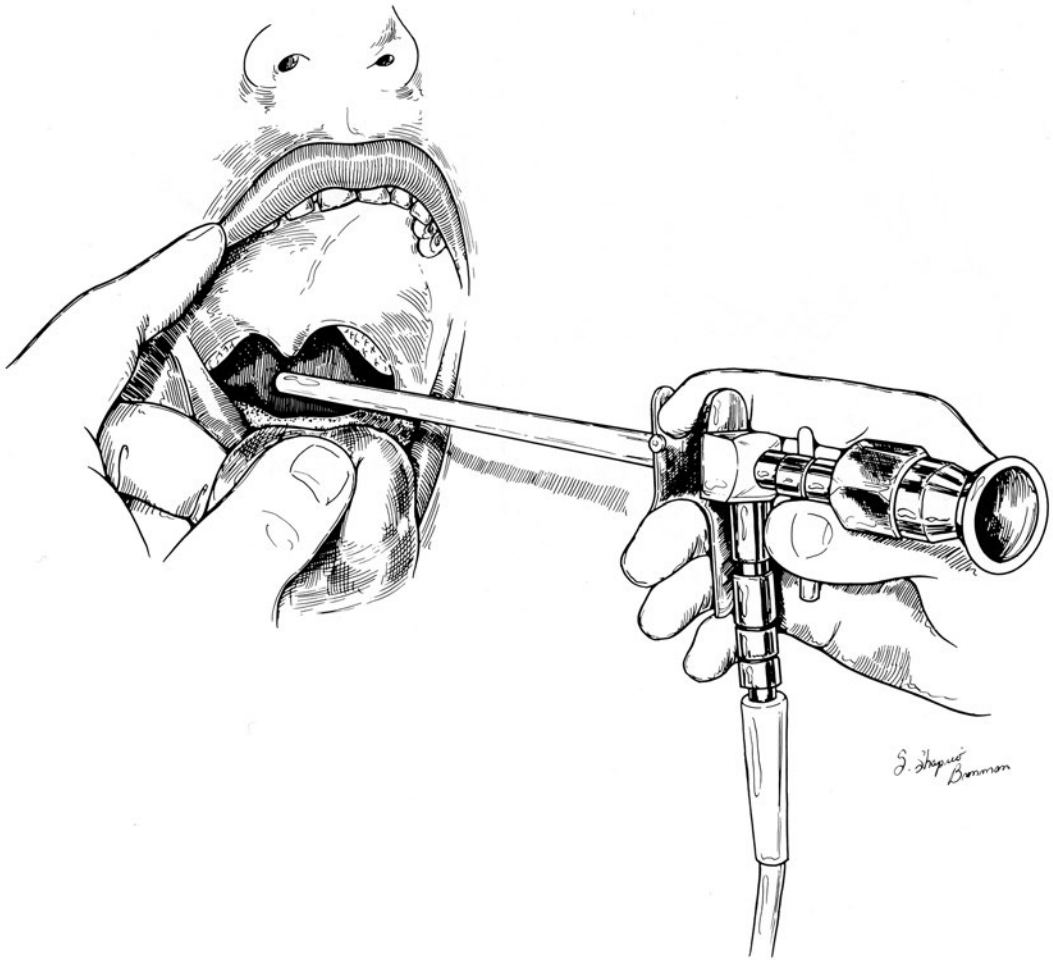
Complications

Failure to accurately diagnose pathology



a

Fig. 31.2a



b

Fig. 31.2b

31-3 Flexible Direct Laryngoscopy

Indications

Flexible direct laryngoscopy is the most commonly used office procedure to assess laryngeal function and pathology in children. Modern flexible laryngoscopes come in sizes as small as 2 mm and allow for excellent visualization of the larynx. The procedure is indicated for patients presenting with voice complaints or disorders that may have visible laryngeal pathology. Additionally, since flexible laryngoscopy does not require alteration of the oral cavity and pharynx by pulling the tongue forward, the procedure can be used to accurately assess the tongue base, hypopharynx, and vocal resonance.

Preoperative Evaluation

No specific evaluations are required for flexible direct laryngoscopy.

Operative Technique

1. The child is seated in the upright position of the caretaker's lap with the head extended and the neck flexed in the classic sniffer's position.
2. Flexible direct laryngoscopy may be performed with or without topical anesthesia and/or vasoconstriction. Should topicalization be desired, a 1:1 solution of topical lidocaine (2%) and oxymetazoline may be used.
3. The flexible laryngoscope is inserted into the anterior nares and passed posteriorly along the floor of the nose until the nasopharynx is visualized.
4. The scope is flexed inferiorly in the nasopharynx allowing for visualization of the tongue base, hypopharynx, and larynx.
5. The child is asked to say "ee" and laryngeal dynamics are assessed.
6. If aspiration is suspected, the patient may be asked to swallow a variety of food consistencies to assess for laryngeal penetration or pooling (functional endoscopic evaluation of swallowing [FEES]) (**Fig. 31.3**).

Complications

1. Failure to accurately diagnose pathology
2. Mucosal abrasion
3. Epistaxis

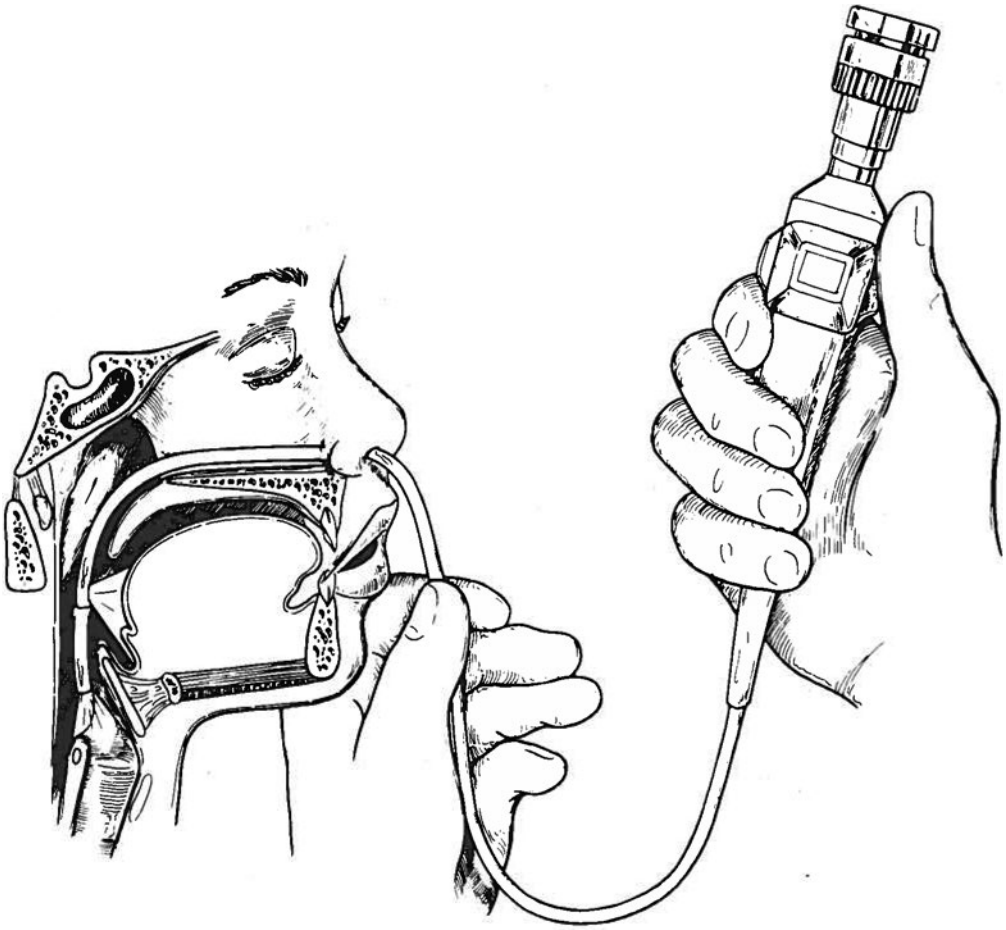


Fig. 31.3

31-4 Rigid Direct Laryngoscopy under General Anesthesia

Introduction

Rigid direct laryngoscopy is the most commonly used operative procedure to examine the larynx in children. There are a variety of different rigid laryngoscopes available, and the endoscopist should be familiar with the indications for each. Slotted laryngoscopes (Benjamin, Parsons, Jackson, etc.) allow for broad exposure of the larynx and are commonly used for diagnostic applications. These laryngoscopes can be suspended allowing for manipulation of the larynx, when necessary. Nonslotted laryngoscopes (i.e., Lindholm) offer a wide exposure of the larynx and are useful for microlaryngeal procedures. Anterior commissure scopes and subglottoscopes are occasionally necessary for difficult exposure.

Indications

The procedure is indicated for patients with suspected laryngeal pathology or as an adjunct to intubation in patients with difficult airways.

Preoperative Evaluation

Assessment of the patient's oral cavity and pharynx is essential for the selection of appropriate laryngoscopy equipment. For example, a patient with severe retrognathia may be better evaluated with an anterior commissure scope.

Operative Technique

1. The child is placed supine on the operative table with the head positioned as close as possible to the top of the bed.
2. The table is turned 90 degrees to the anesthesiologist and the endoscopist should take control of the mask.
3. The patient is placed into the sniffing position (**Fig. 31.4a**). In rare circumstances, a shoulder roll may be necessary in order to facilitate this position.
4. The depth of anesthesia should be controlled, allowing for assessment of spontaneous ventilation while minimizing the risk of laryngospasm.
5. A moist gauze or tooth guard should be placed in order to avoid injury to the oral cavity structures.
6. The mouth is widely opened facilitating insertion of the laryngoscope.
7. The laryngoscope is inserted along the right side of the mouth (**Fig. 31.4b**) and the tongue is swept over to the left.
8. The tip of the epiglottis is visualized (**Fig. 31.4c**) and the tip of the scope advanced into the vallecula (**Fig. 31.4d**).
9. The observer end of the scope is placed into the midline of the oral cavity and rotated posteriorly in order to bring the vocal cords into view.
10. If the epiglottis remains retroflexed, the tip of the laryngoscope may be advanced along the laryngeal surface of this structure (**Fig. 31.4e,f**) to the level of the false cords in order expose the true vocal cords. This technique is also preferred when an anterior commissure scope or subglottoscope is utilized.

Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma
4. Failure to diagnose pathology

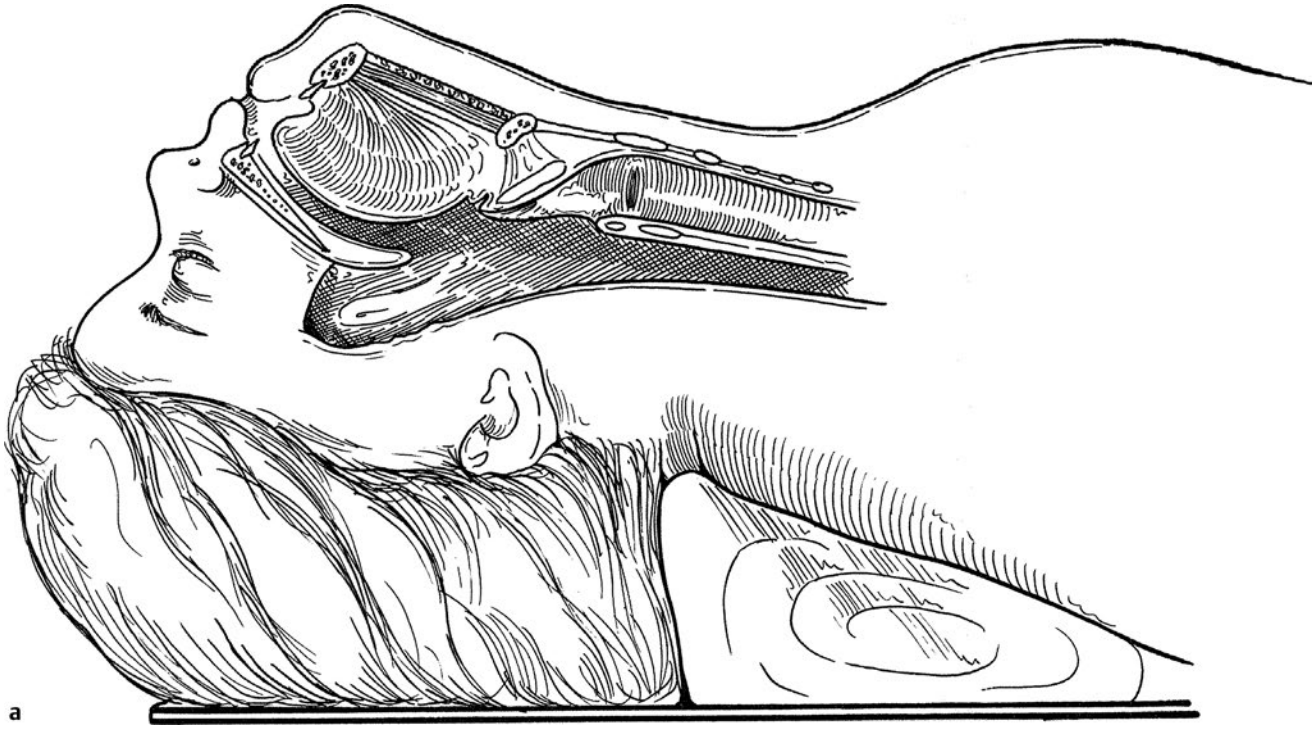
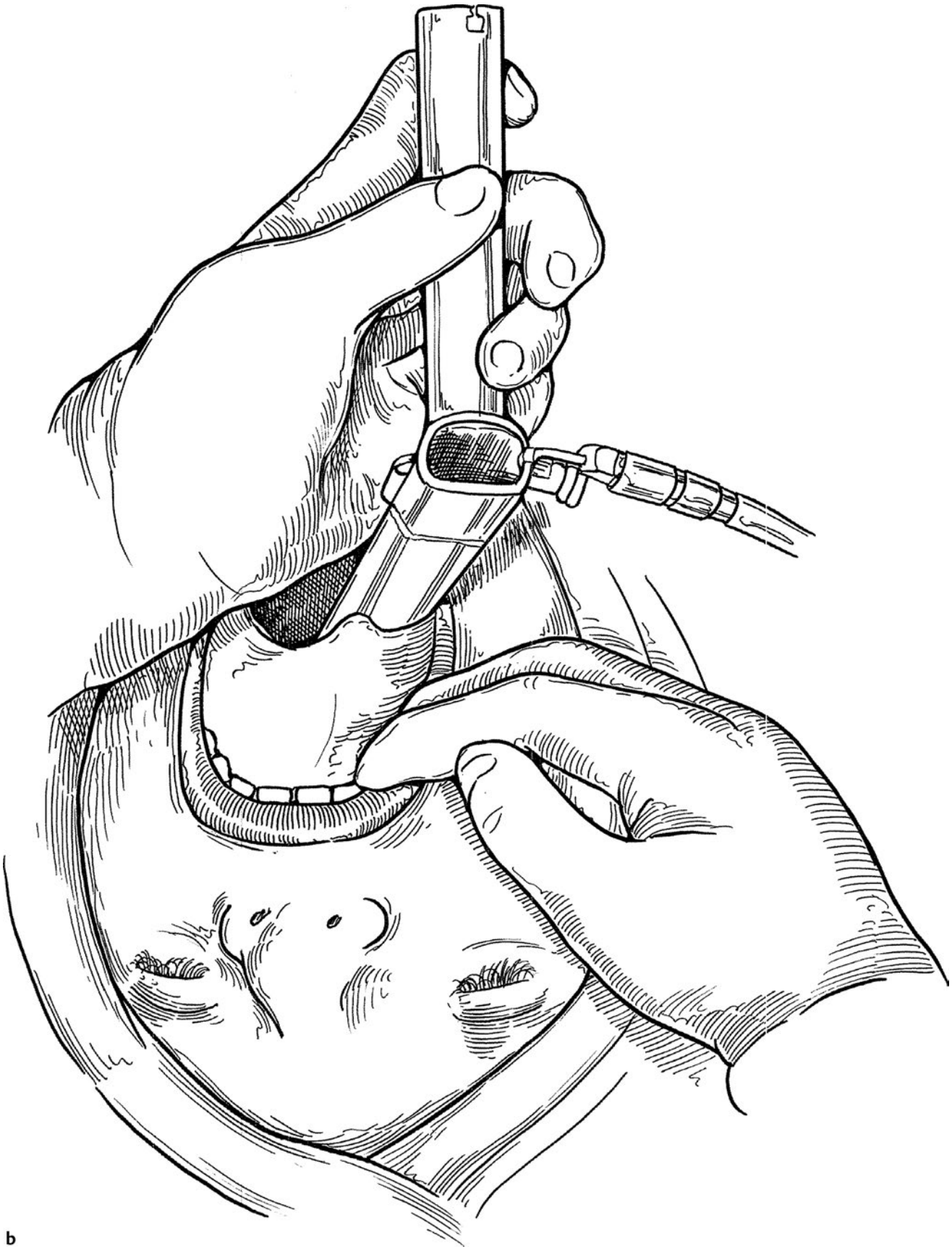
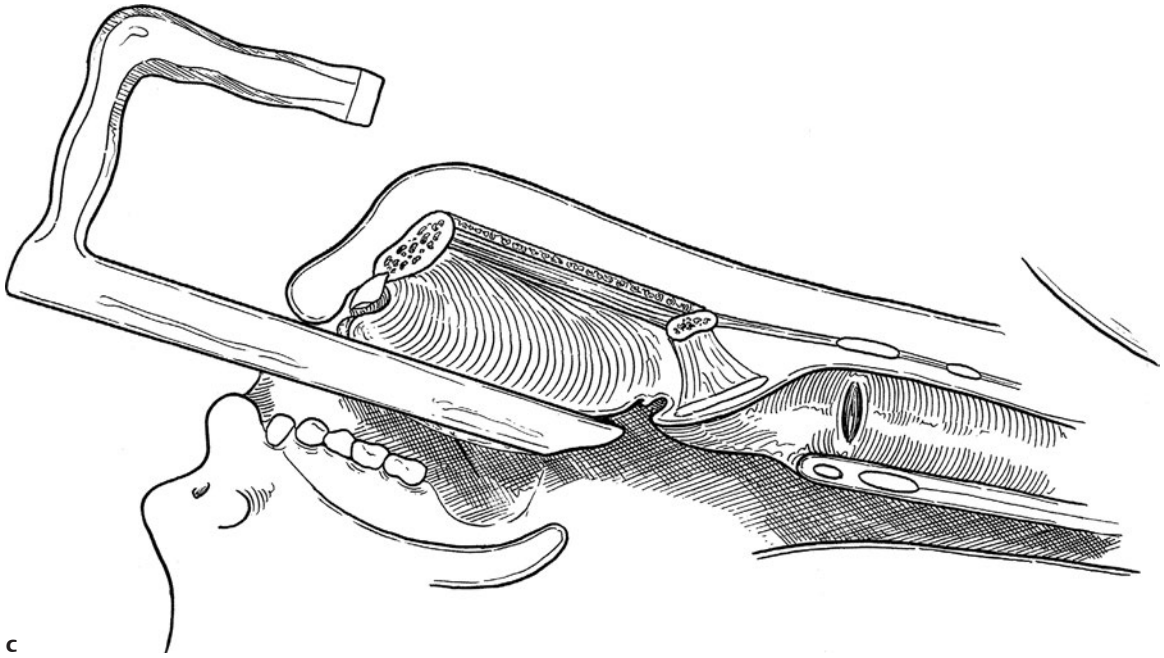


Fig. 31.4a

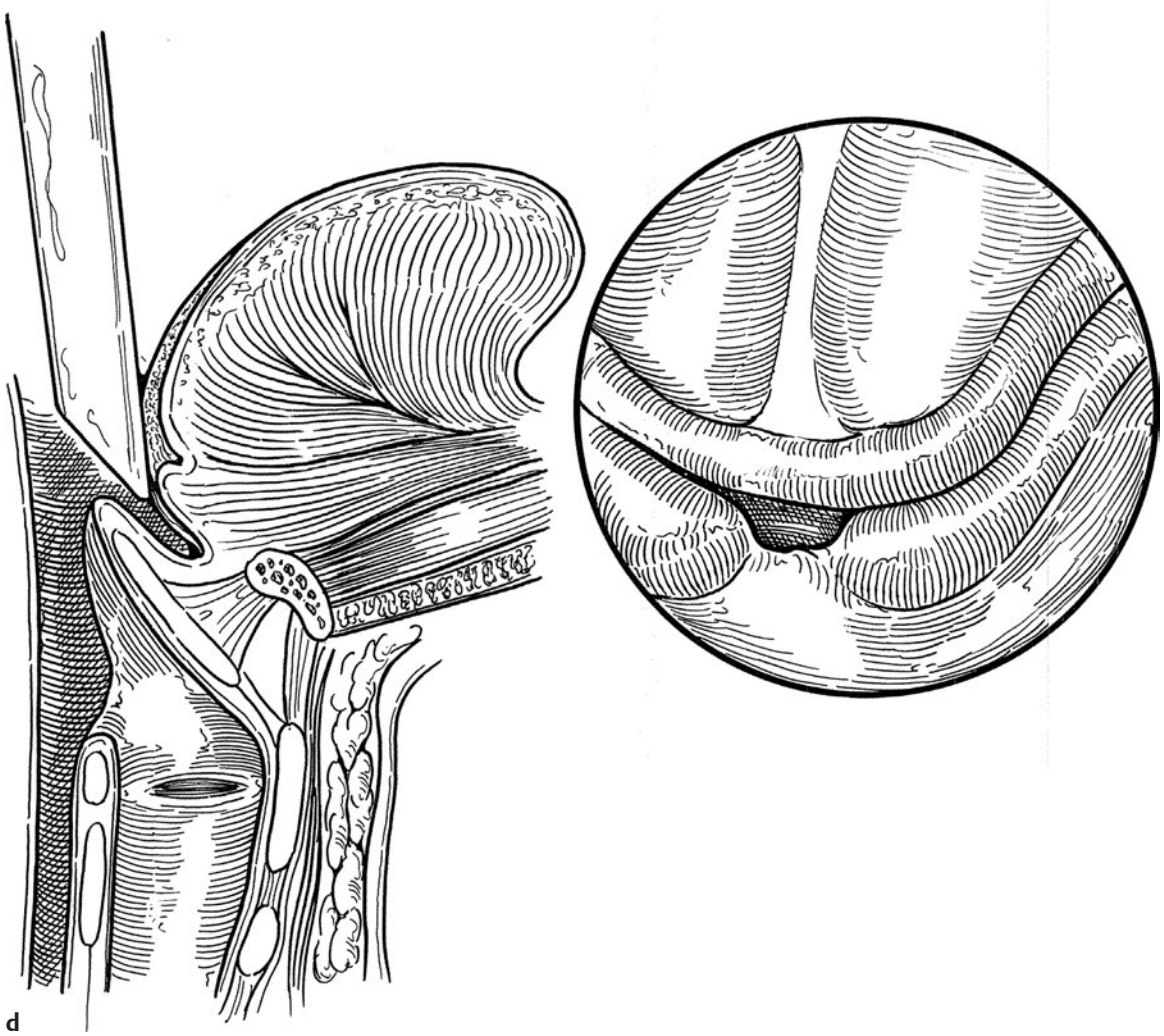


b

Fig. 31.4b



c



d

Fig. 31.4c,d

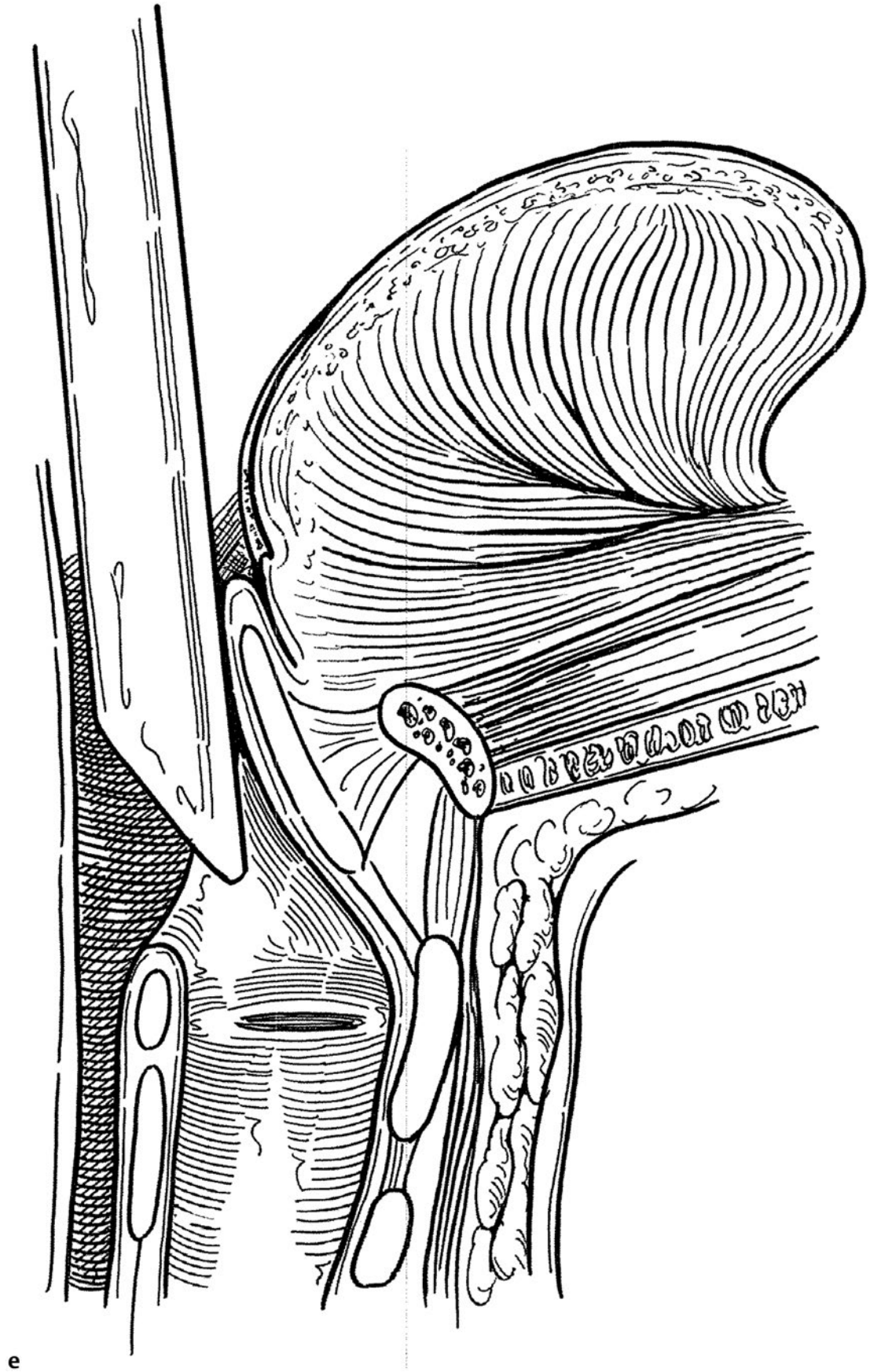
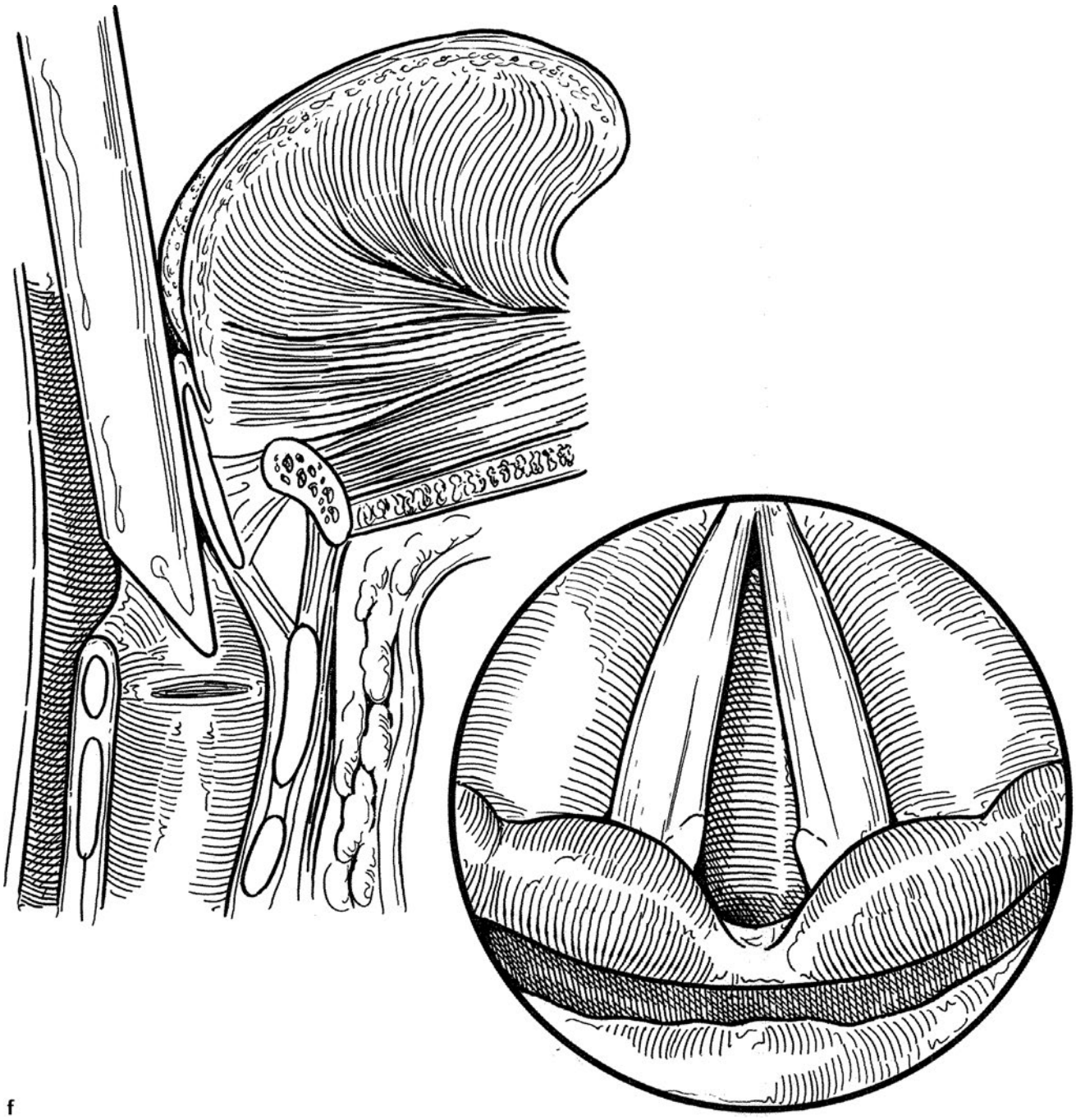


Fig. 31.4e



f

Fig. 31.4f

31-5 Microlaryngoscopy under General Anesthesia

Indications

The procedure is indicated for patients with suspected laryngeal pathology and allows for enhanced visualization of the larynx, which is magnified using an operating microscope or rigid telescope.

Preoperative Evaluation

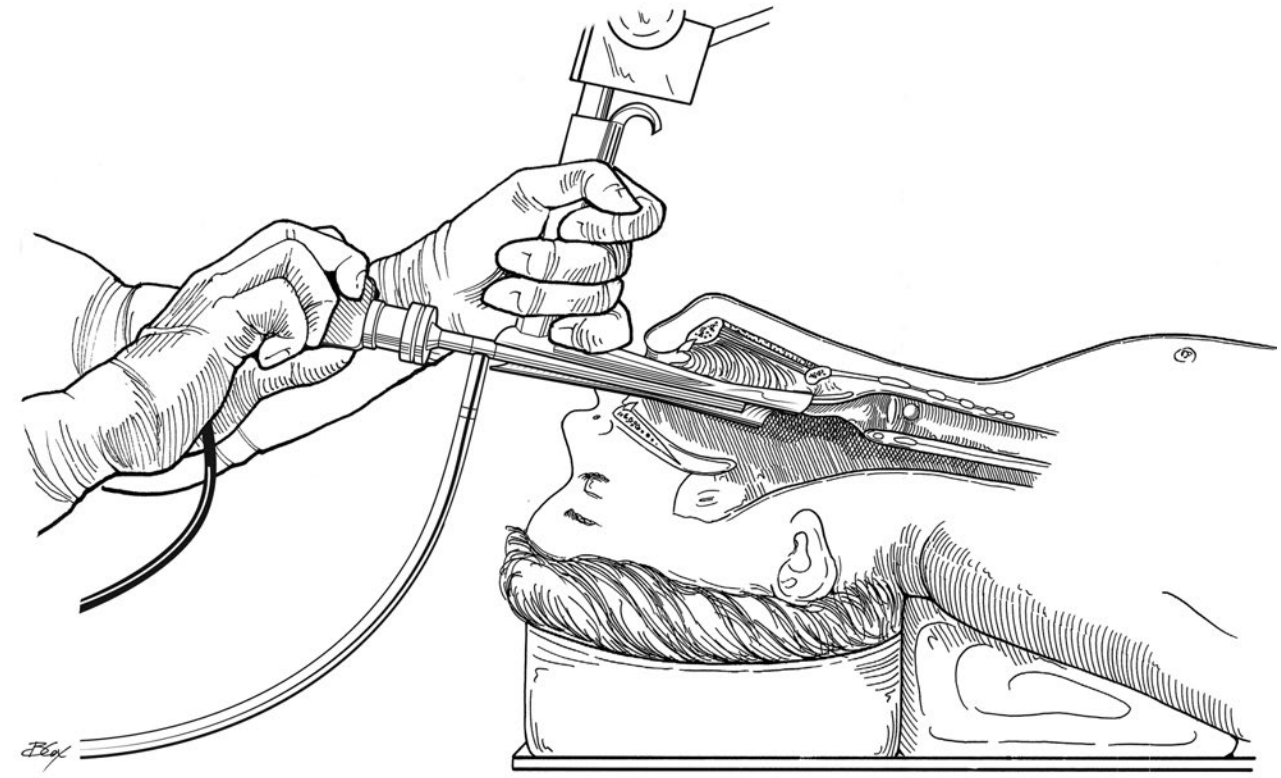
Assessment of the patient's oral cavity and pharynx is essential for the selection of appropriate laryngoscopy equipment.

Operative Technique

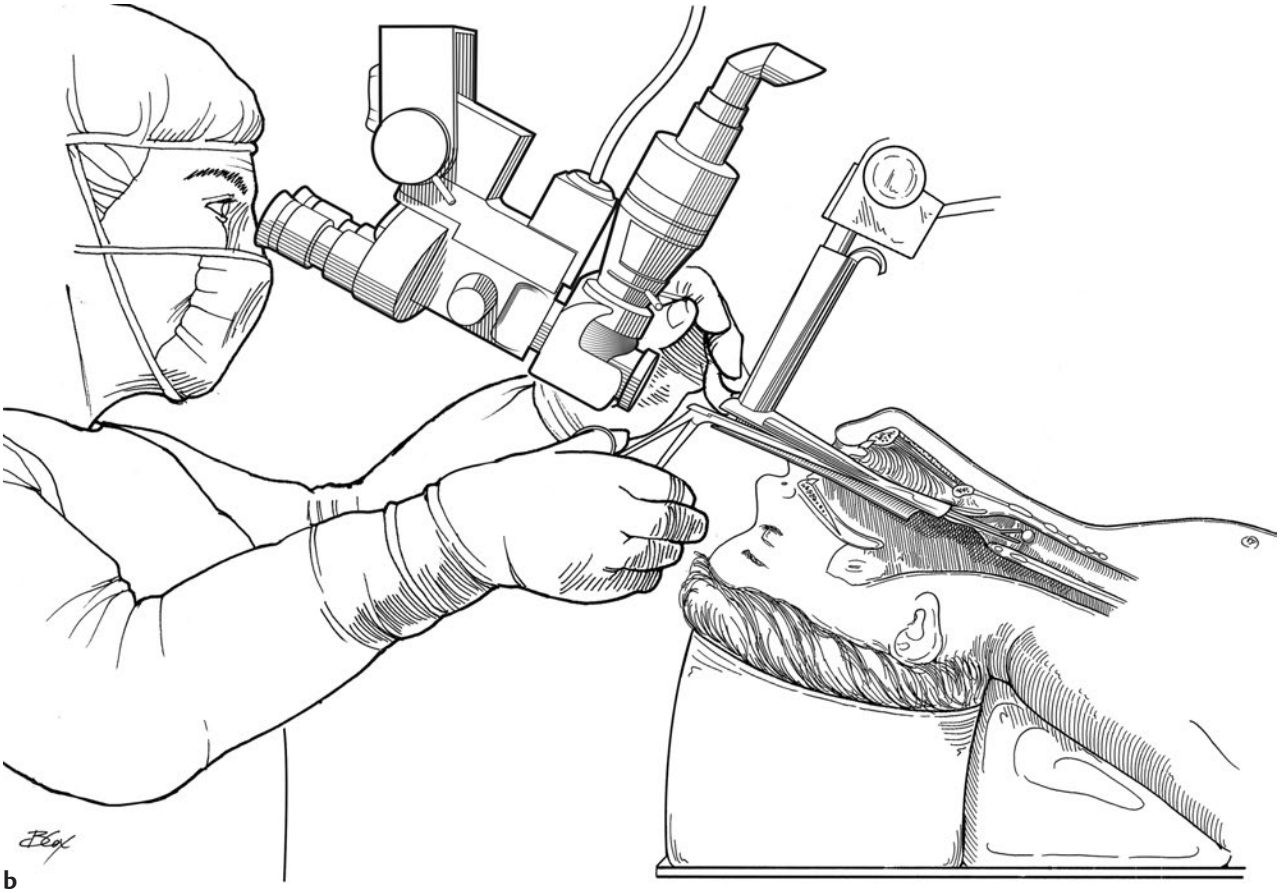
1. The child is placed supine on the operative table with the head positioned as close as possible to the top of the bed.
2. The table is turned 90 degrees to the anesthesiologist and the endoscopist should take control of the mask.
3. The patient is placed into the sniffing position. In rare circumstances, a shoulder roll may be necessary in order to facilitate this position.
4. The depth of anesthesia should be controlled, allowing for assessment of spontaneous ventilation while minimizing the risk of laryngospasm.
5. A moist gauze or tooth guard should be placed in order to avoid injury to the oral cavity structures.
6. The mouth is widely opened facilitating insertion of the laryngoscope.
7. The laryngoscope is inserted along the right side of the mouth and the tongue is swept over to the left.
8. The tip of the epiglottis is visualized and the tip of the scope advanced into the vallecula.
9. The observer end of the scope is placed into the midline of the oral cavity and rotated posteriorly in order to bring the vocal cords into view.
10. Topical anesthetic (2% lidocaine) should be applied to the larynx using an atomizer. In order to avoid potential systemic toxicity, the endoscopist should be aware of the maximum allowable dosage of topical lidocaine as it may be absorbed by the airway mucosa.
11. A rigid telescope (4 mm, 2.7 mm, 1.9 mm) attached to a camera head is inserted down the laryngoscope and used to visualize the magnified laryngeal structures (**Fig. 31.5a**). Foreign bodies may be visualized and removed.
12. Alternatively, if an operating microscope is to be utilized, the laryngoscope should be suspended using the appropriate suspension apparatus. Modern suspension bars allow for stabilization of the laryngoscope independent of bed movement.
13. The bed height and angulation should be altered to allow for direct laryngeal visualization by the endoscopist while seated in a comfortable, ergonomic position.
14. The lens of the operating microscope should be set to a focal length of 400 mm and positioned so that the view of the larynx is centered to effectively use laryngeal instruments (**Fig. 31.5b**—note foreign body being removed).

Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma
4. Failure to diagnose pathology



a



b

Fig. 31.5a,b

32 Intubation

Steven E. Sobol

Endotracheal intubation in children with mandibular hypoplasia (Pierre Robin sequence, Treacher Collins syndrome) as well as other craniofacial anomalies has provided a challenge to otolaryngologists and anesthesiologists alike. In addition to the small mandible, several other features of these patients contribute to the difficult intubation: macroglossia, glossoptosis, trismus related to temporomandibular joint abnormalities, and prominent maxillary or mandibular incisors. Most of the traditional techniques that have been described for intubation in problem cases are difficult or impossible to use in infants and young children with mandibular hypoplasia or craniofacial anomalies. We have developed a modification of the standard direct laryngoscopic procedure, utilizing the anterior commissure laryngoscope and an optical stylet in the task of exposing and intubating the larynx of a child with mandibular hypoplasia. This procedure may be used in older children with craniofacial malformations by using appropriately sized instruments.

32-1 Difficult Intubation (Rigid) for the Difficult Airway

Indications

A child with mandibular hypoplasia or other craniofacial anomaly in which standard intubation techniques are unlikely to be successful.

Preoperative Evaluation

Patency of the nasal airway, size of tongue, TMJ mobility, and presence of prominent teeth must be determined preoperatively.

Operative Technique

1. Infants in the first few weeks of life are usually not anesthetized prior to laryngoscopy and intubation. Awake intubation with continuous administration of oxygen is preferred.
2. In older patients, anesthesia is induced using 100% oxygen and an inhalational anesthetic agent or propofol with spontaneous ventilation preserved.
3. Muscle relaxants are best avoided in patients with difficult airway problems.
4. We have chosen to use a 9-cm (pediatric) Holinger anterior commissure laryngoscope for this procedure rather than the various anesthesia laryngoscopes or the Jackson standard laryngoscope. Its straight enclosed barrel design prevents the tongue from obscuring the view of the larynx as so often occurs with the other, more open instruments. In addition, its narrow profile throughout its entire length permits easier access to the laryngeal inlet and allows the barrel of the laryngoscope to slip more completely laterally into the oral commissure. Suctioning of excess secretions can be performed easily through this instrument using a straight laryngoscopic suction. Other techniques that utilize curved laryngoscopic blades, blind intubation, or flexible fiberoptic laryngoscopes do not allow such complete and easy clearing of pharyngeal secretions.
5. The dicta of Jackson regarding the position of the patient are still of prime importance. The patient is supine with the head elevated above the shoulders. The neck is flexed forward and the head extended at the atlanto-occipital joint to bring the axes of the mouth, pharynx, and larynx into alignment.
6. The laryngoscope is introduced into the mouth and advanced along the right side of the anterior two-thirds of the tongue (**Fig. 32.1a**, position a).
7. Instead of shifting the whole laryngoscope toward the midline in the traditional manner (**Fig. 32.1a**, position b), only the laryngoscope tip is directed toward the midline, while the proximal end is shifted far laterally into the oral commissure. This allows 20–30 degrees of additional anterior angulation of the blade (**Fig. 32.1b**, position a). This anterior

angulation is not possible with the laryngoscope in the standard midline position because of the bulky tongue, hypoplastic mandible, and the prominent maxilla or maxillary teeth common in these children (**Fig. 32.1b**, position b).

8. With the instrument approaching the larynx from the right side, the epiglottis is visualized and elevated with the tip of the laryngoscope.
9. Visualization of the larynx within the lumen of the laryngoscope may be facilitated by external pressure over the cricoid area in the posterior and lateral (toward the laryngoscope) direction.
10. With the larynx visualized, placement of an endotracheal tube requires a special sequence of maneuvers.
    a. The 15-mm adapter is removed from a tube of appropriate size and a water-soluble lubricant is placed on the outside of the tube to facilitate movement of the tube within the barrel of the laryngoscope.
    b. The tube is placed in the lumen of the laryngoscope and passed beyond the vocal cords.
    c. This step may be aided by the use of an optical stylet (2.7-mm diameter telescope, 27018A Karl Storz Endoscopy-America, Inc.) placed inside the endotracheal tube (**Fig. 32.1c**). (If a stylet is used, it should also be coated with a water-soluble lubricant to promote easy insertion into and removal from the endotracheal tube.)
    d. The proximal end of the endotracheal tube is grasped and stabilized in its position with a laryngeal alligator forceps as the laryngoscope is withdrawn (**Fig. 32.1d**).
    e. The 15-mm adapter is reinserted into the endotracheal tube and ventilation is commenced in the usual manner (**Fig. 32.1e**).
    f. Placement of the endotracheal tube in the trachea is confirmed by auscultation for bilateral air entry and observation of bilateral chest movement.

Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma

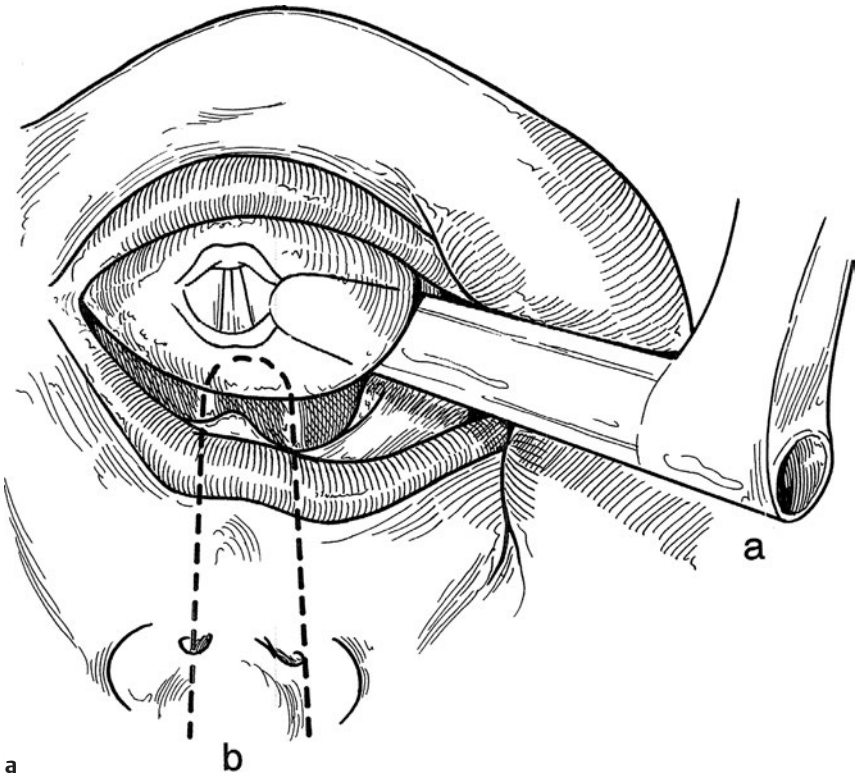
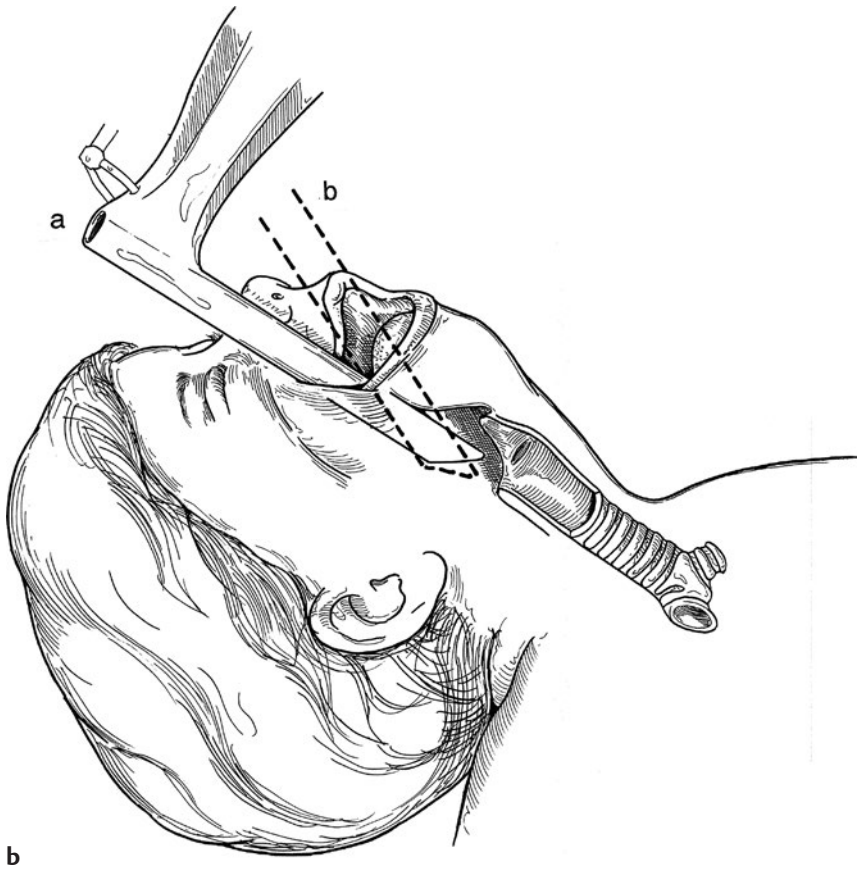
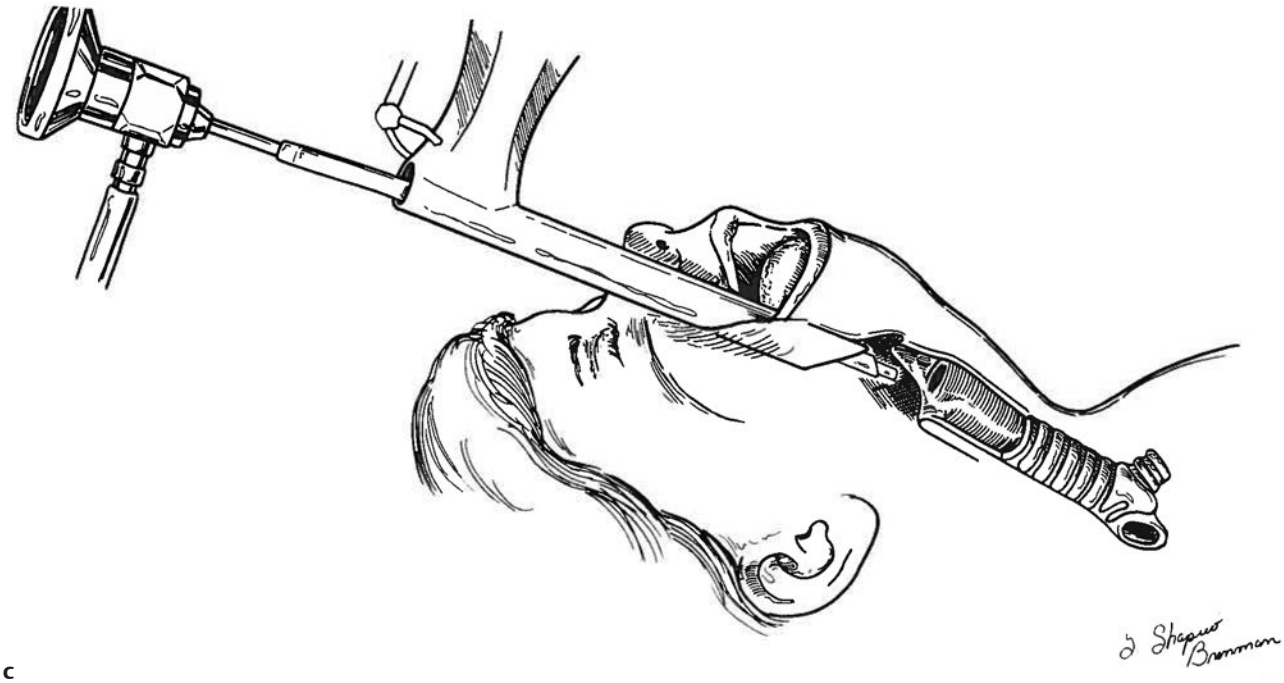


Fig. 32.1a

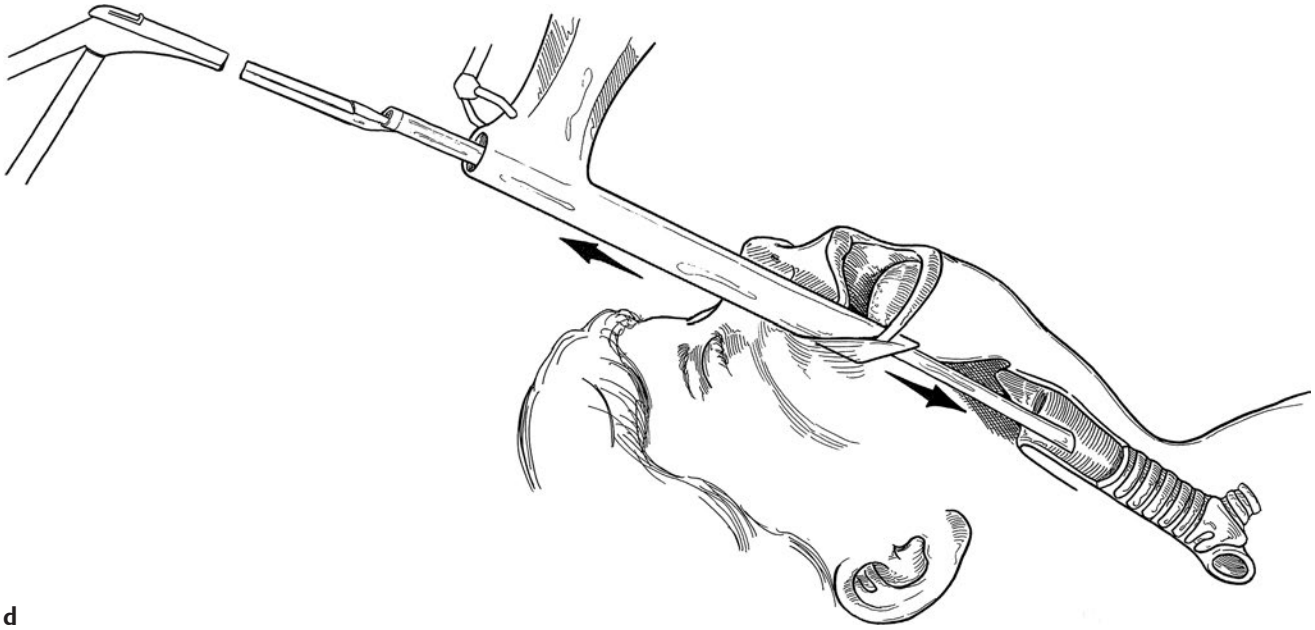


b

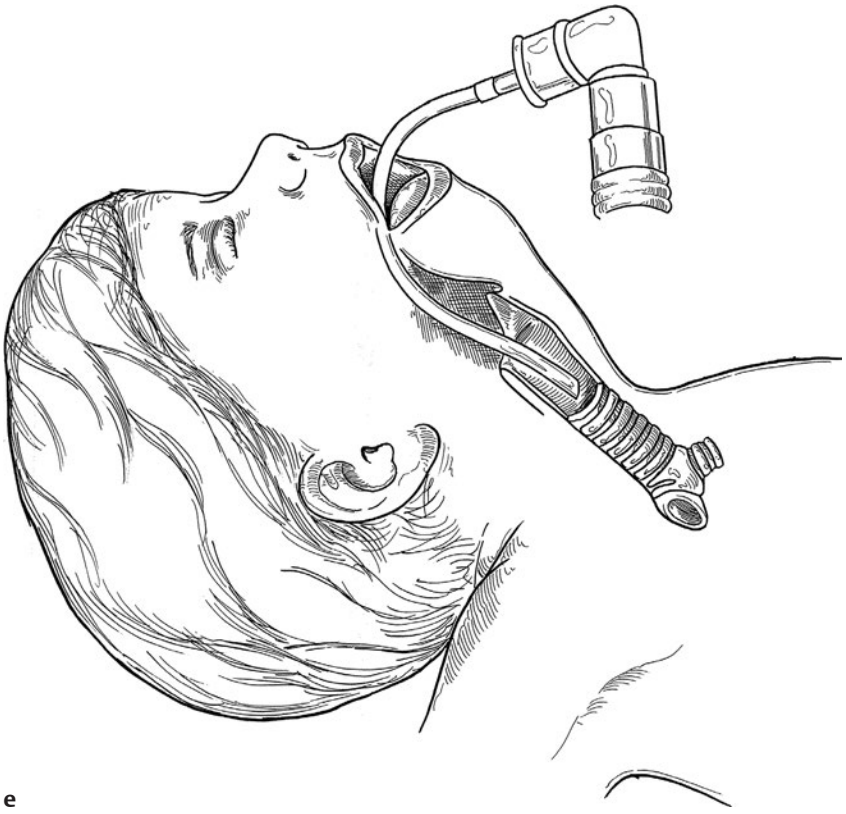


c

Fig. 32.1b,c



d



e

Fig. 32.1d,e

32-2 Difficult Intubation (Flexible) for the Difficult Airway

Indications

Flexible fiberoptic intubation is an excellent alternative to orotracheal intubation in children who are preoperatively assessed as having a difficult airway. The advantage of this technique is that it avoids manipulation of the pharynx and larynx with the exposure, decreasing the risk of laryngospasm and loss of the airway. The indications for this procedure are the same as those listed for rigid direct laryngoscopy and intubation. Relative contraindications include midface hypoplasia, nasal stenosis, and bleeding disorders that significantly increase the risk of epistaxis.

Operative Technique

1. If possible, the patient should be maintained in an upright position with spontaneous ventilation preserved. Sedation and anesthesia should be limited in order to prevent loss of spontaneous respiratory drive.
2. Topical anesthetic and vasoconstrictor agent is applied to the nasal cavity.
3. A flexible bronchoscope is threaded with an age-appropriate endotracheal tube.
4. The tip of the scope is advanced along the floor of the nasal cavity as with flexible laryngoscopy.
5. Once the larynx is visualized, the scope is advanced to the level of the glottis.
6. If possible, topical lidocaine is inserted through the side port in order to blunt the laryngeal reflexes. In order to avoid potential systemic toxicity, the endoscopist should be aware of the maximum allowable dosage of topical lidocaine as it may be absorbed by the airway mucosa.
7. The distal end of the scope is inserted between the vocal folds and advanced to the level of the distal trachea.
8. The endotracheal tube is advanced through the nasal cavity and into the airway (by an assistant) with the bronchoscope functioning as a stylet.
9. The position of the tube within the airway is confirmed using the bronchoscope by the endoscopist.

Complications

1. Loss of the airway
2. Epistaxis
3. Laryngospasm

33 Suspension Microlaryngoscopy

Lisa M. Elden

In the event of laryngeal pathology that requires microscopic manipulation and removal (laryngeal papilloma, vocal cord nodules, vocal cord web, etc.), it is necessary to place a laryngoscope and stabilize its position to allow for the instrumentation. This frees both of the surgeon's hands to accomplish the surgery.

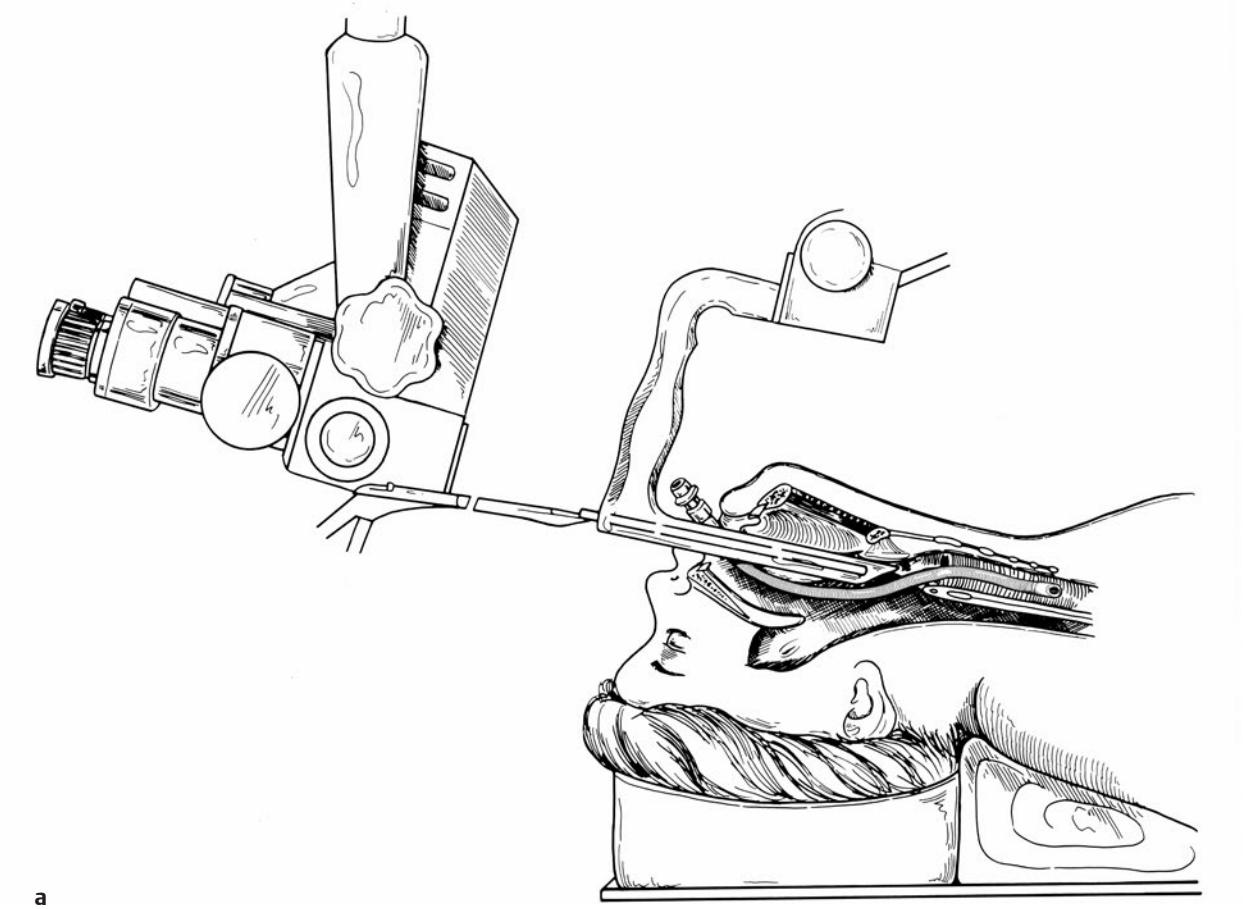
33-1 Suspension Microlaryngoscopy

Operative Technique

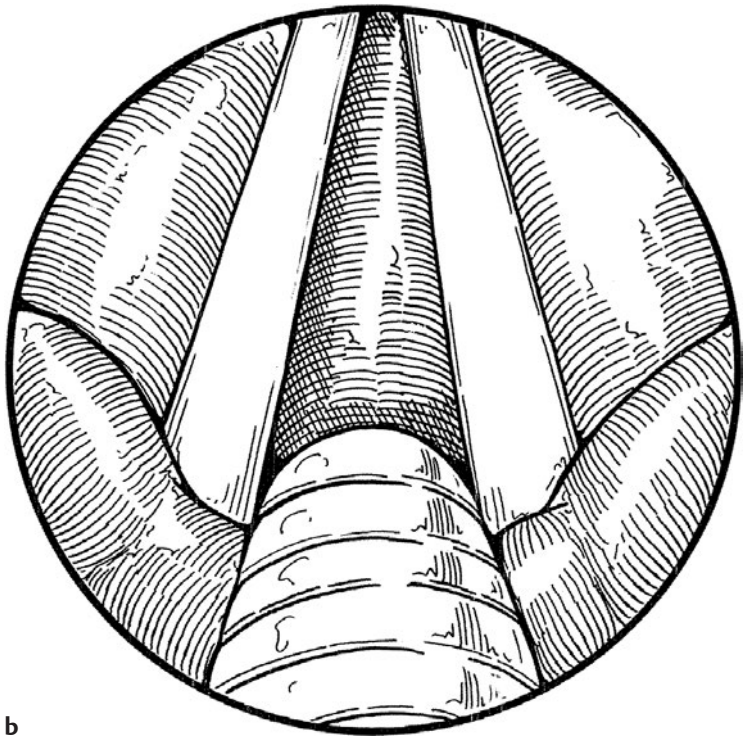
1. The child is supine on the operating room table.
2. The otolaryngologist first examines the airway as described in the laryngology section, and then intubates the larynx with a laser safe metal tube (if laser use is anticipated) or with a regular endotracheal tube (if laser is not required), which is taped to the left side of the mouth.
3. A roll is placed beneath the shoulders to allow for complete extension of the head on the neck.
4. The table is placed in reverse Trendelenburg position to allow for comfortable viewing of the larynx through the operating microscope.
5. The laryngoscope is then reintroduced as described previously.
6. When the larynx is adequately visualized, the observer's end of a self-retaining laryngoscope (Jako, Dedo, etc.) can be brought over to the midline so that minimal distortion of tissues is noted. A nonslotted laryngoscope should be used if a laser is to be used to avoid injury to local tissue, but a slotted laryngoscope may be used if a powered laryngeal shaver is used.
7. The laryngoscope is inserted deeply enough to view the entire anterior laryngeal structures (**Fig. 33.1a**).
8. The suspension apparatus is attached to the laryngoscope and then suspended from a Mayo stand or attached to the operating room table. This allows for movement of the entire table without disturbing the position of the laryngoscope.
9. The operating microscope is brought into place and the larynx is visualized utilizing a 400-mm lens (**Fig. 33.1b**). Instrumentation of the larynx can proceed with micro instruments and/or laser as indicated.
10. If a CO_2 laser is used, the patient's face must be covered with moist towels and the eyes with moist eye pads. No part of the patient's face can be exposed. Operating room personnel must wear protective eye wear.
11. If examination of the posterior commissure area is required and this area is obscured by the endotracheal tube, the tube is removed and ventilation is continued using a Venturi Jet ventilation device. The Venturi device is placed through one of the light carrier channels of the laryngoscope and positioned above the laryngeal inlet. When adequately positioned, chest wall movement can be seen after each jet of air, and the laryngoscopy may continue without any obstruction in the larynx (**Fig. 33.1c**).
12. A rigid suction instrument placed through one of the light carrier channels can aid in continuous smoke evacuation during laser procedures. This is possible because illumination for this procedure is provided by the operating microscope.
13. At the termination of the procedure, the patient may be re-intubated to recover from the anesthesia. This can be accomplished in one of two methods.
    a. The laryngoscope can be removed and the patient intubated in a normal manner.
    b. The child can be re-intubated even if a nonslotted laryngoscope is still in place.
        1. The appropriate endotracheal tube (without the anesthesia adapter) is placed through the laryngoscope and into the laryngeal lumen (**Fig. 33.1d**).
        2. The observer's end of the tube is grasped with an alligator forceps and gently advanced as the laryngoscope is withdrawn (**Fig. 33.1e**).
        3. The endotracheal tube is grasped at the level of the lips as it becomes visible as the laryngoscope is withdrawn.
        4. The laryngeal forceps are removed.
        5. The endotracheal tube adapter is placed on the end of the tube and adequate ventilation is resumed (**Fig. 33.1f**).

Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma

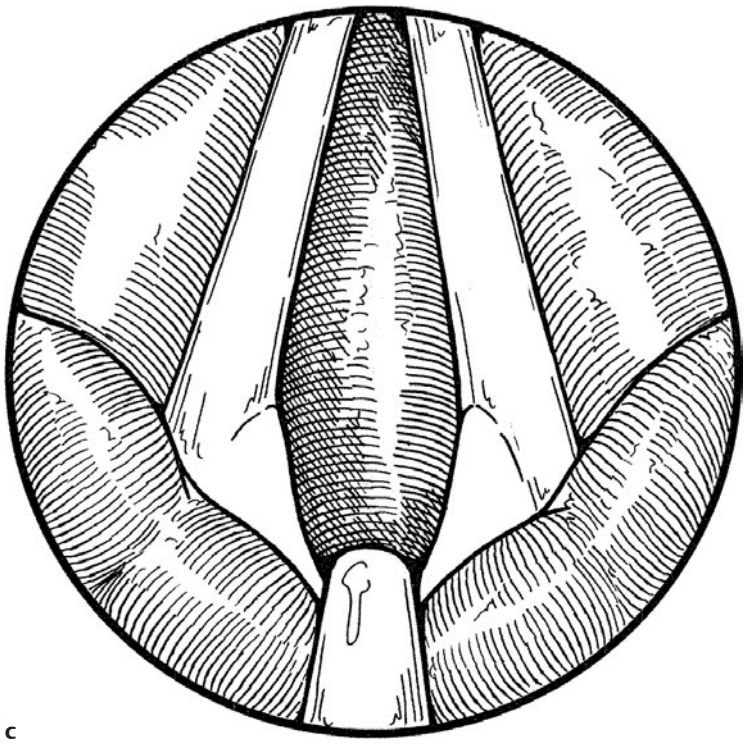


a

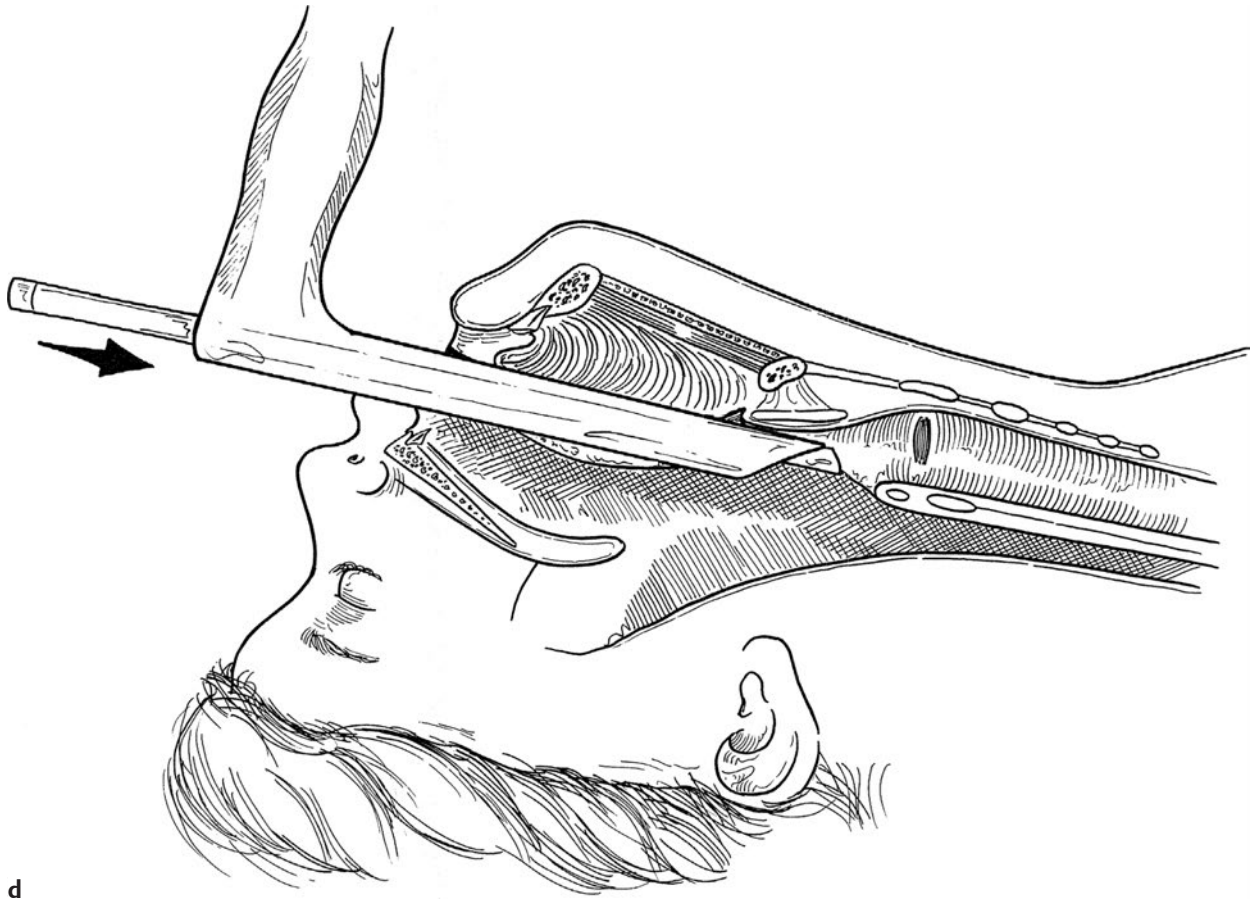


b

Fig. 33.1a,b

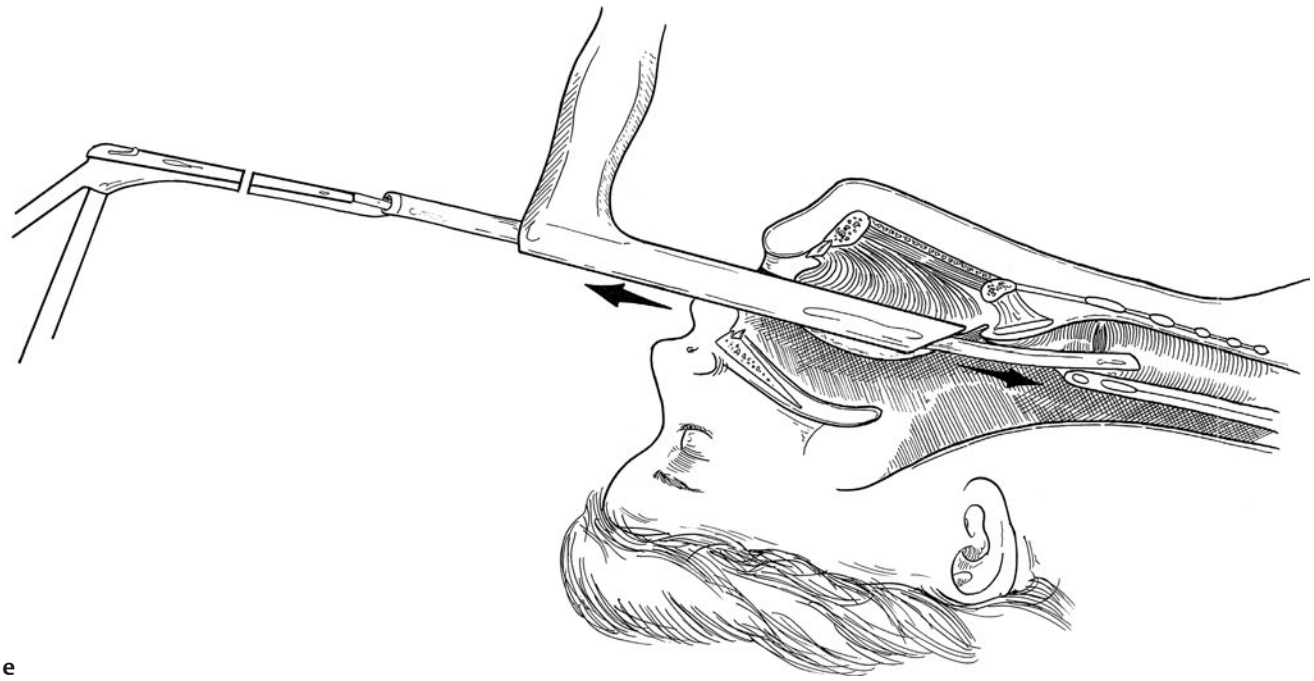


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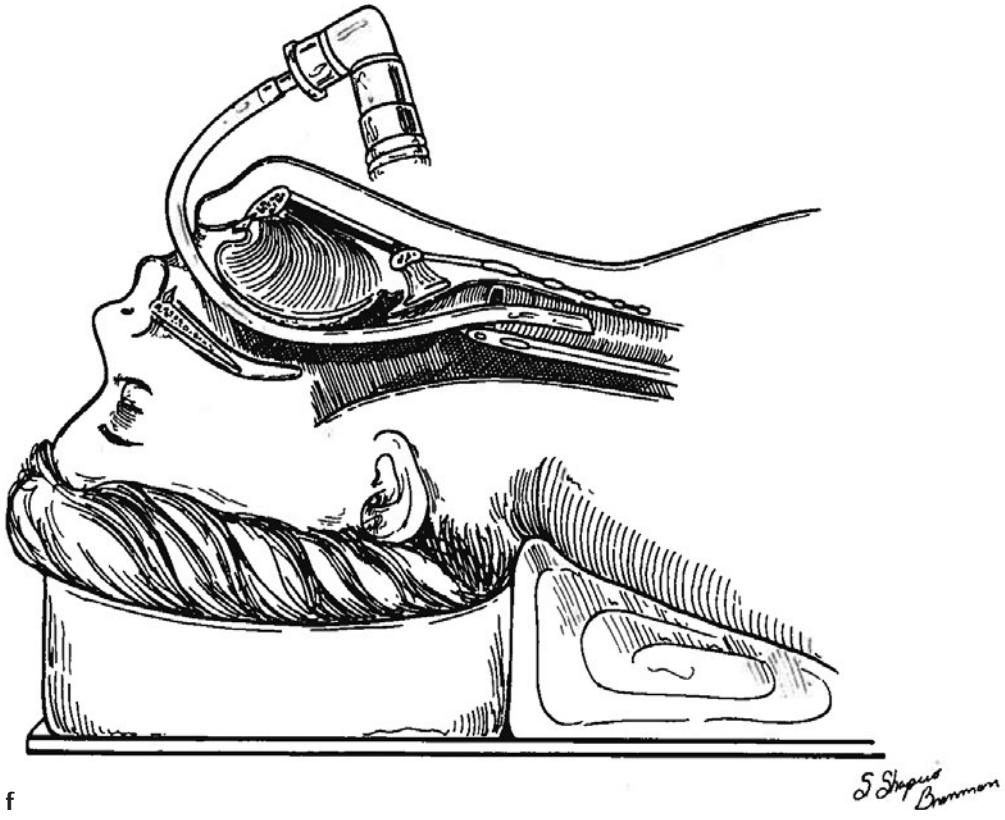


d

Fig. 33.1c,d



e



f

Fig. 33.1e,f

34 Bronchoscopy

Lisa M. Elden

Introduction

Bronchoscopy is the visual examination of the tracheobronchial tree. Both flexible and rigid instruments are available for this procedure. Rigid bronchoscopy permits instrumentation of the airway and allows for continued ventilation. Flexible bronchoscopy, while giving better visualization of the more distal bronchi, does not allow for easy foreign body removal and cannot be used to maintain an airway unless it is passed through or alongside of an endotracheal tube. However, the laryngeal lumen requirement for this arrangement precludes its use in small children. Direct laryngoscopy (either flexible or rigid) always precedes bronchoscopy.

Indications

Foreign body, lesions in the trachea or bronchi, or mucus plugging of the bronchi are indications for bronchoscopy.

Preoperative Evaluation

Anteroposterior and lateral chest radiographs may be helpful in the preoperative evaluation in the child undergoing bronchoscopy. Computed tomography (CT) may prove helpful in localizing the disease process. Indirect laryngoscopy is useful in the preparation for the endoscopic examination.

34-1 Flexible Bronchoscopy

Introduction

Flexible bronchoscopy is the procedure best suited to viewing respiratory dynamics of the trachea and bronchi and details of the distal airway.

Operative Technique

1. Flexible bronchoscopy occurs after successful flexible direct laryngoscopy has been performed.
2. As preparation is made to pass the bronchoscope through the vocal cords, the child is paralyzed or the anesthesia level is deepened sufficiently to prevent laryngospasm.
3. The bronchoscope is advanced into the subglottic space and then into the trachea and bronchi (**Fig. 34.1**).
4. Usually the anesthesiologist can maintain an adequate fit with the mask and adequate ventilation can be maintained. However, if the bronchoscope is too snug in the subglottic or laryngeal area, ventilation may be limited. In this case, the bronchoscope must be withdrawn periodically to the level of the laryngeal inlet so that adequate ventilation can be maintained.
5. The bronchoscope is advanced so that the right and left bronchi are inspected in an orderly manner.
6. The bronchoscope is withdrawn and ventilation maintained by the anesthesiologist utilizing a mask or endotracheal tube, depending on the situation.

Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma

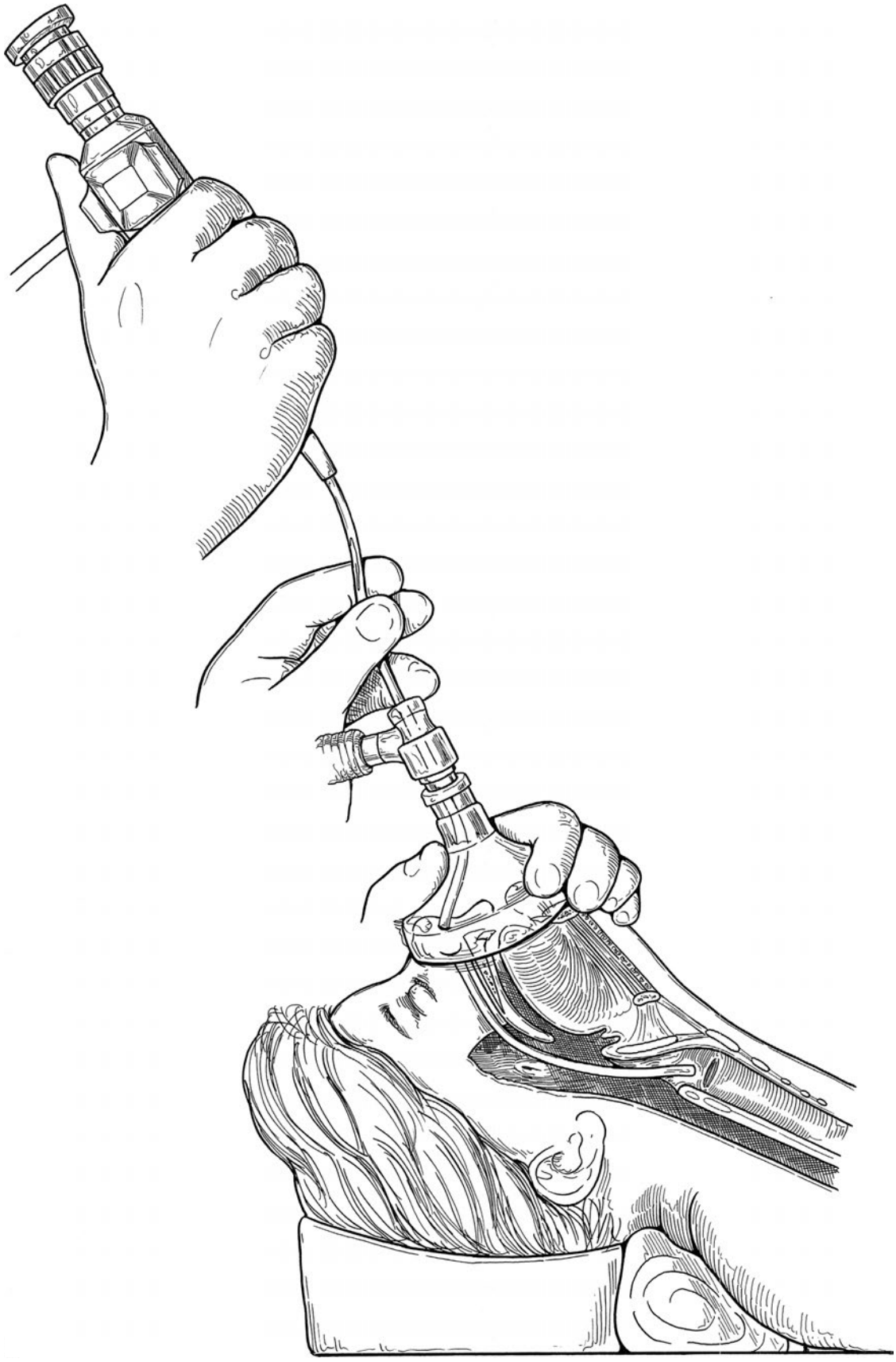


Fig. 34.1

34-2 Rigid Bronchoscopy

Introduction

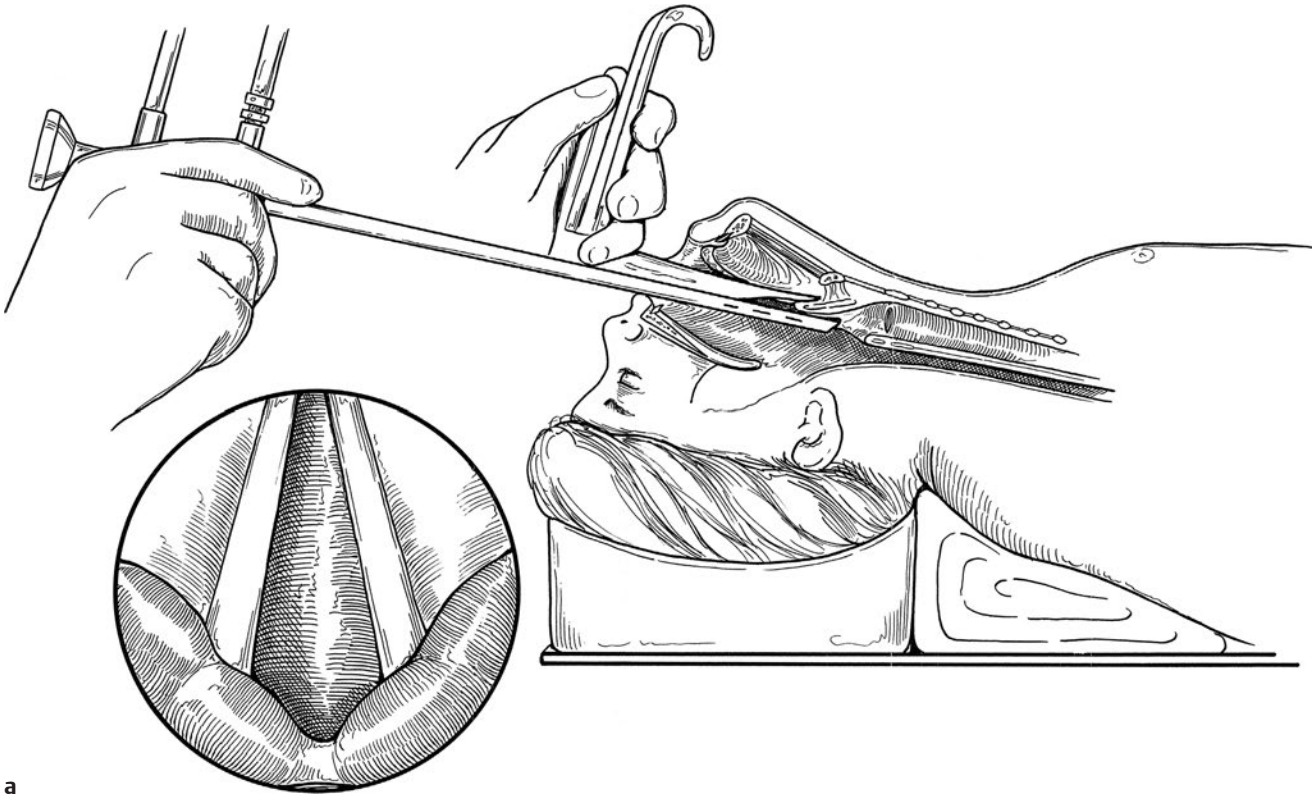
Rigid bronchoscopy is the technique of choice when management and/or manipulation of the airway is required.

Operative Technique

1. Direct laryngoscopy has already been performed utilizing the slide or open blade operating laryngoscope.
2. The laryngoscope is placed in the vallecula, holding up the posterior tongue so that the epiglottis and laryngeal inlet fall in the view of the scope. However, in some instances, it may be necessary to place the tip of the laryngoscope under the epiglottis to visualize the laryngeal inlet.
3. The bronchoscope is inserted with the examiner's right hand and advanced down the shaft of the laryngoscope until the laryngeal lumen is identified (**Fig. 34.2a**).
4. The bevel of the bronchoscope is kept in the anteroposterior direction so that it can be insinuated between the vocal cords (**Fig. 34.2b**). Occasionally, it is necessary to gently twist the bronchoscope to push the vocal cords apart to allow passage of the instrument.
5. As the instrument is passed below the subglottic space, the laryngoscope is removed and the anesthesiologist connects the tubing to the end of the bronchoscope. Adequate ventilation is ascertained by auscultating both lung fields to determine proper placement of the bronchoscope.
6. The bronchoscope is then advanced to the area of the carina to visualize both main stem orifices (**Fig. 34.2c**). The head is rotated to the right so that the left bronchus and its branches can be examined. The scope is withdrawn to the carina and the head is turned to the left so that the right bronchus and orifices can be examined in a similar manner.
7. At the termination of the procedure, the bronchoscope is withdrawn. The endotracheal tube is replaced by the anesthesiologist or the otolaryngologist so that the child may be awakened with an endotracheal tube in place.

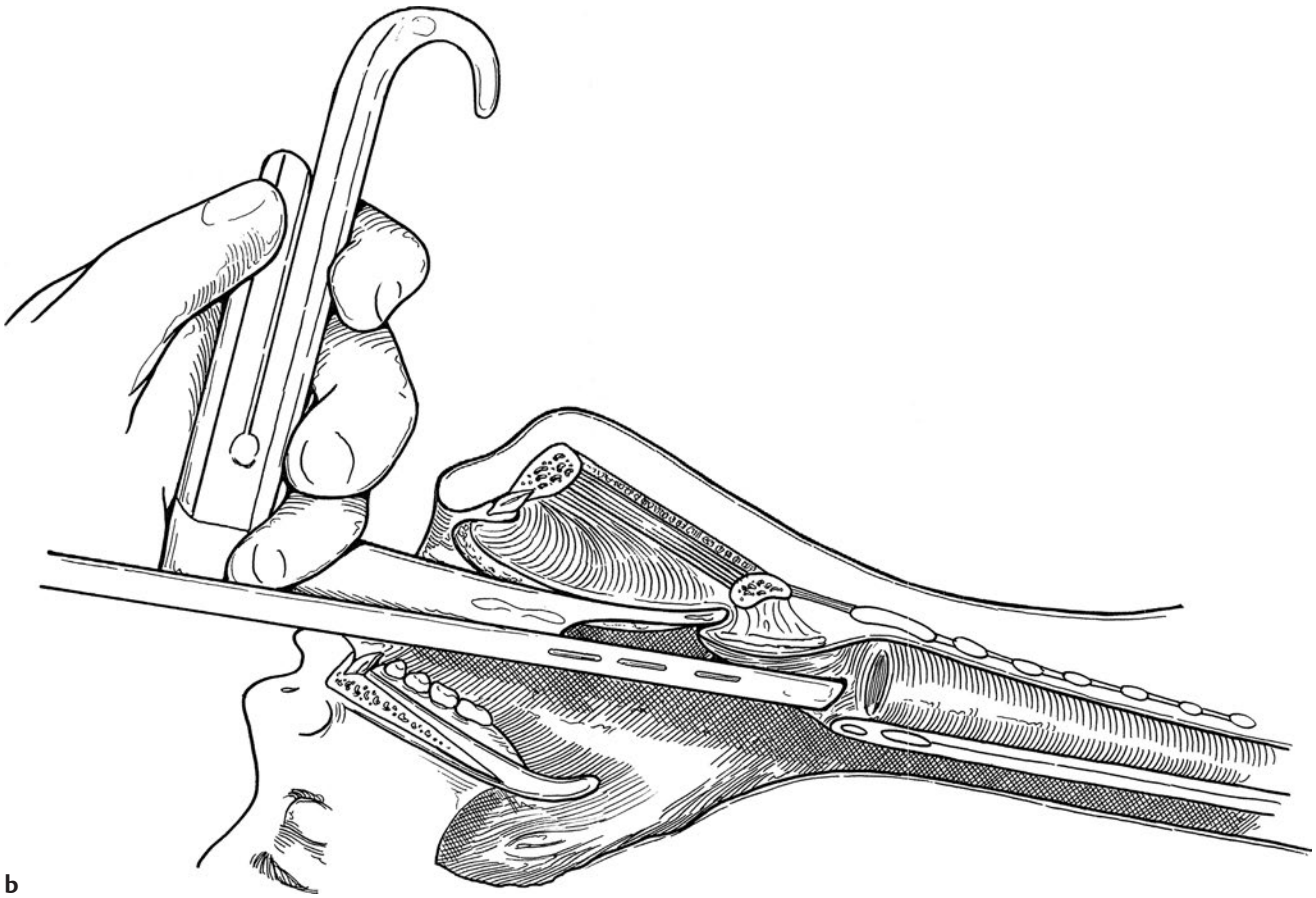
Complications

1. Laryngospasm
2. Glottic edema
3. Dental trauma

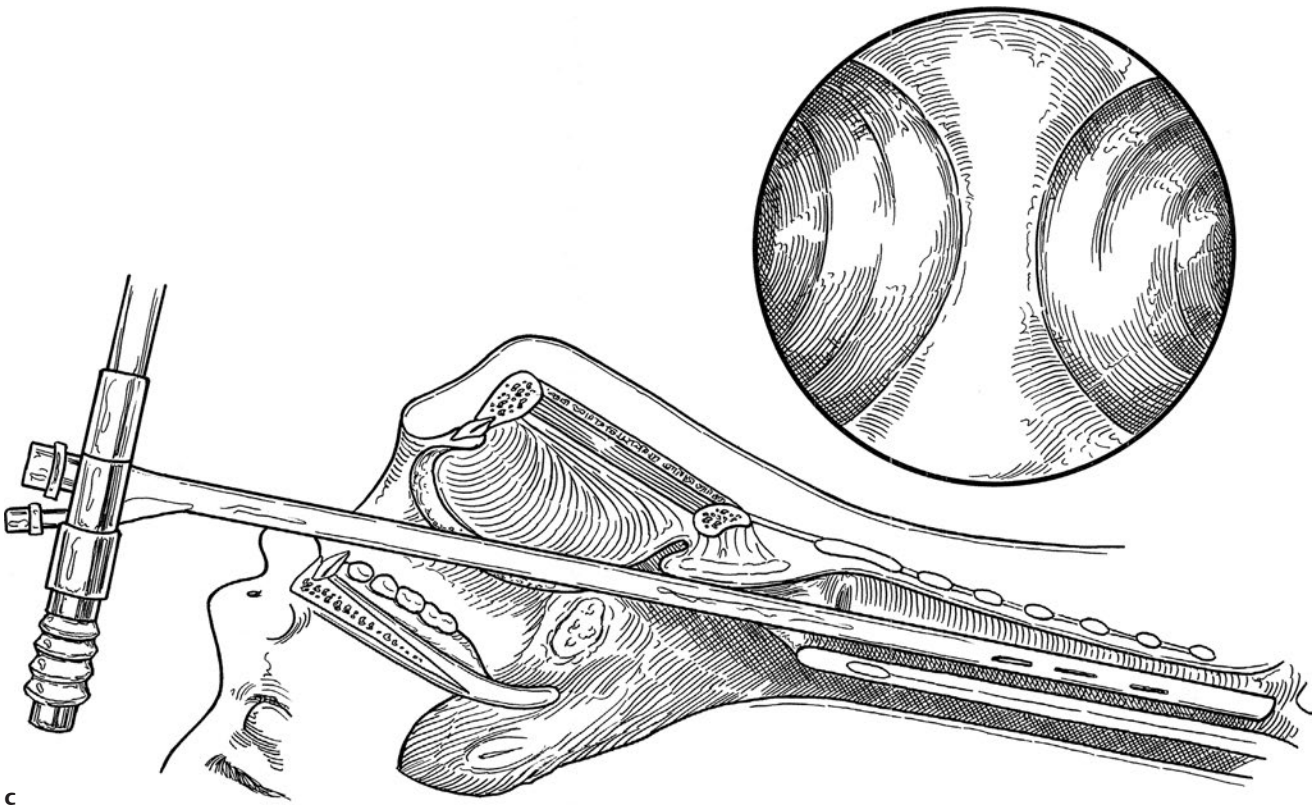


a

Fig. 34.2a



b



c

Fig. 34.2b,c

35 Esophagoscopy

Lisa M. Elden

Introduction

Esophagoscopy is the visual examination of the esophagus. Both flexible and rigid instruments are available for this procedure.

Indications

The presence or suspected presence of esophageal pathology (burn, stricture, fistula) or foreign body is the indication for esophagoscopy.

Preoperative Evaluation

Radiographic evaluation with plain film and/or contrast study is usually performed prior to esophagoscopy.

35-1 Flexible Esophagoscopy

Introduction

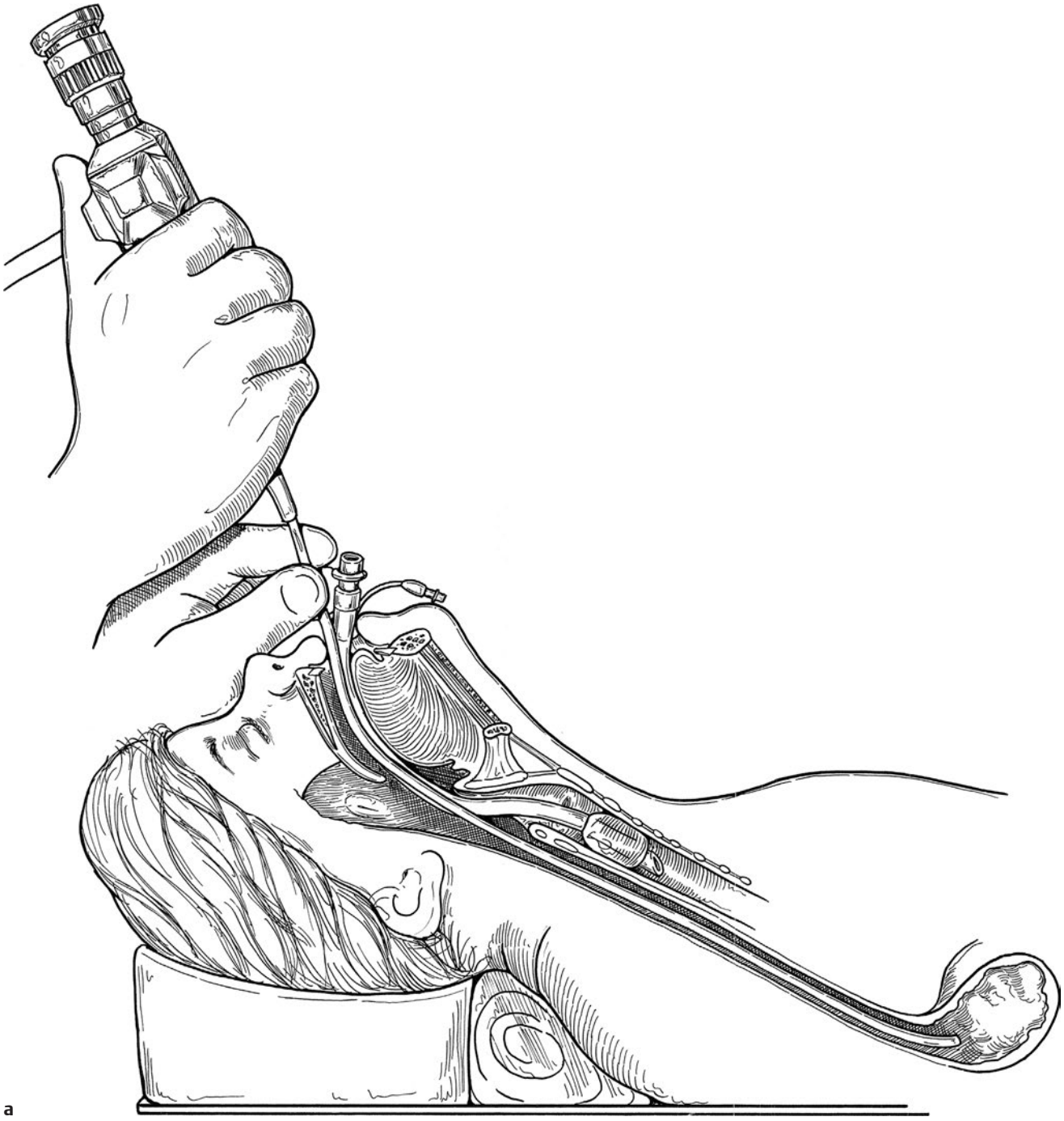
Flexible esophagoscopy has the advantage of being relatively atraumatic, but is less suitable than rigid esophagoscopy for foreign body removal or dilatation of other instrumentation of the esophagus. However, excellent examination of the mucosa can be obtained using this technique.

Operative Technique

1. The child is supine and under adequate endotracheal anesthesia.
2. After protecting the teeth with a mouthguard, the esophagoscope can be inserted into the mouth and advanced to the area of the esophageal inlet.
3. The flexible instrument is advanced through the esophagus (**Fig. 35.1a**) as the lumen is continually in view until the rugal folds are identified (**Fig. 35.1b**).
4. The esophagus is examined again as the instrument is withdrawn.

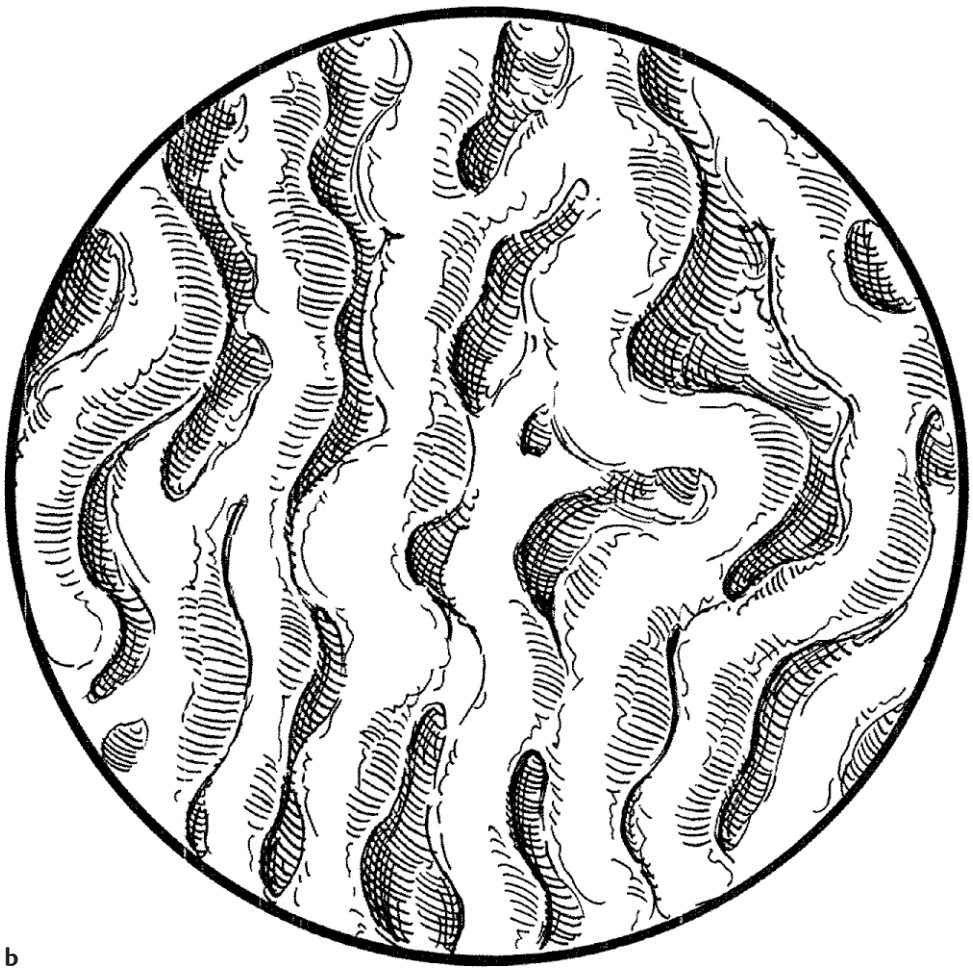
Complications

Esophageal perforation



a

Fig. 35.1a



b

Fig. 35.1b

35-2 Rigid Esophagoscopy

Introduction

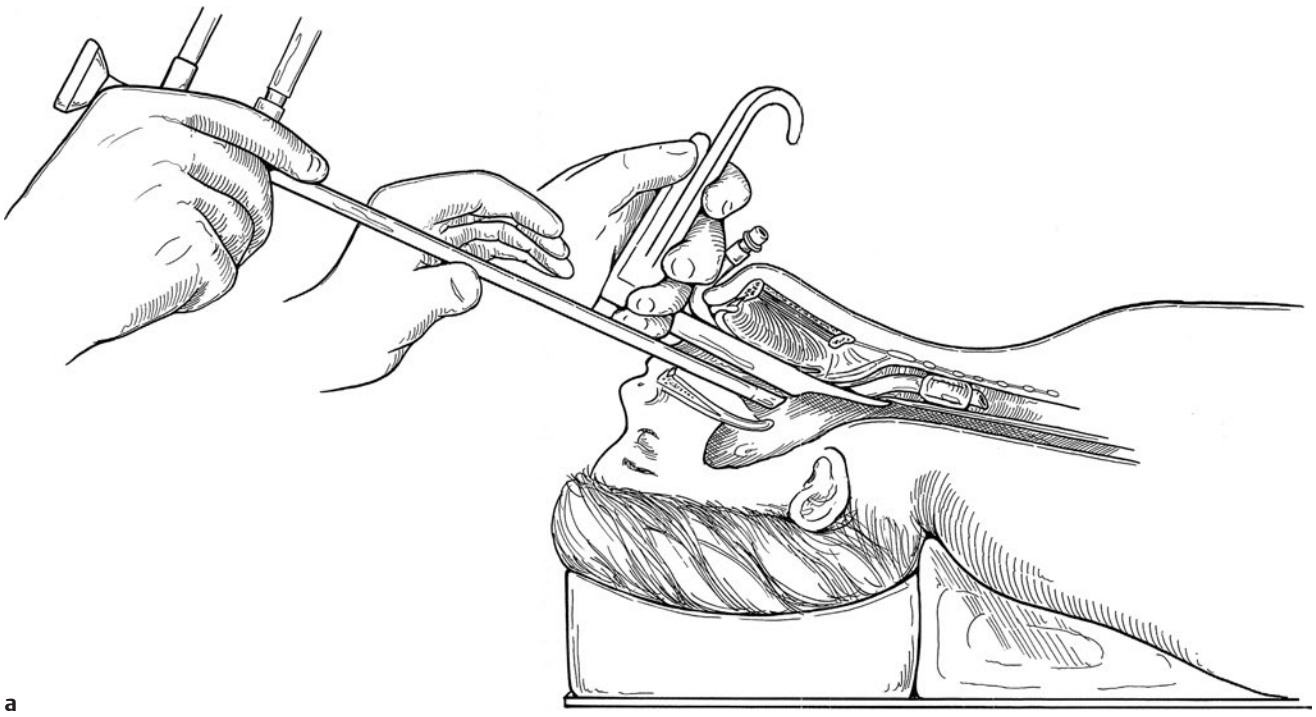
Rigid esophagoscopy is the procedure of choice in almost all cases because it allows for precise and gentle instrumentation of the esophagus.

Operative Technique

1. The child is supine and under adequate endotracheal anesthesia with the tube taped to the left side.
2. After protecting the upper teeth with a mouthguard, the slide or open blade operating laryngoscope is utilized as described in Chapter 31 in order to visualize the laryngeal structures.
3. The postcricoid area is identified and the esophagoscope is inserted (with the right hand) (**Fig. 35.2a**) to the level of the cricopharyngeus (**Fig. 35.2b**).
4. The laryngoscope is removed and the esophagoscope is gently advanced using both hands.
5. The surgeon's left hand rests on the child's mouth to guide the esophagoscope.
6. The esophagoscope is only advanced when an adequate lumen is identified.
7. Secretions are cleared from the esophagoscope utilizing long suction instruments.
8. Telescopic examination of the mucosa can be utilized, as necessary (**Fig. 35.2c**).
9. The esophagoscope is gently advanced to the area of the gastroesophageal junction (**Fig. 35.2d**).
10. The termination of the procedure is indicated by the appearance of gastric rugal folds in the distal end of the scope.
11. The esophagus is examined again as the instrument is withdrawn.

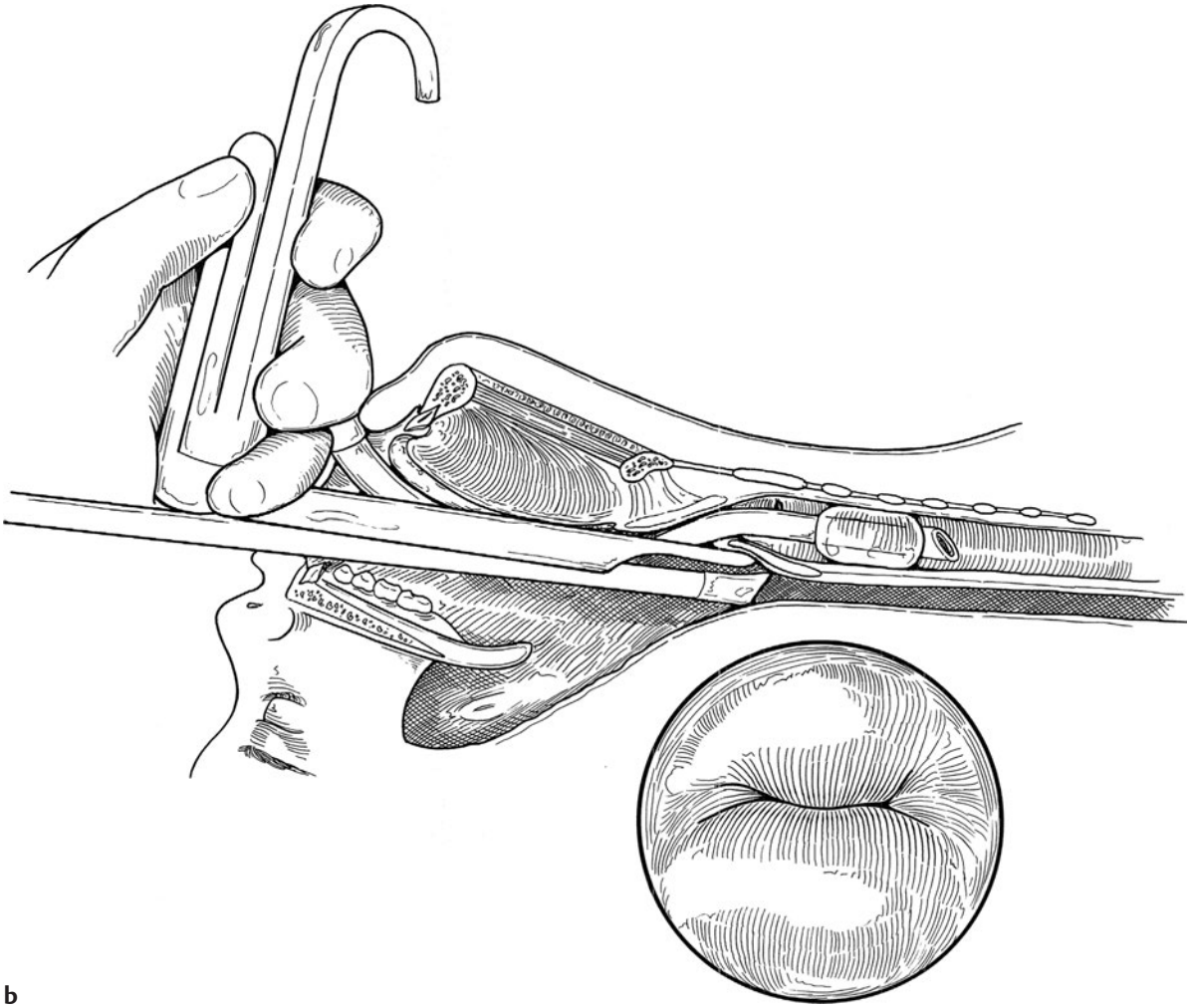
Complications

1. Dental trauma
2. Esophageal perforation

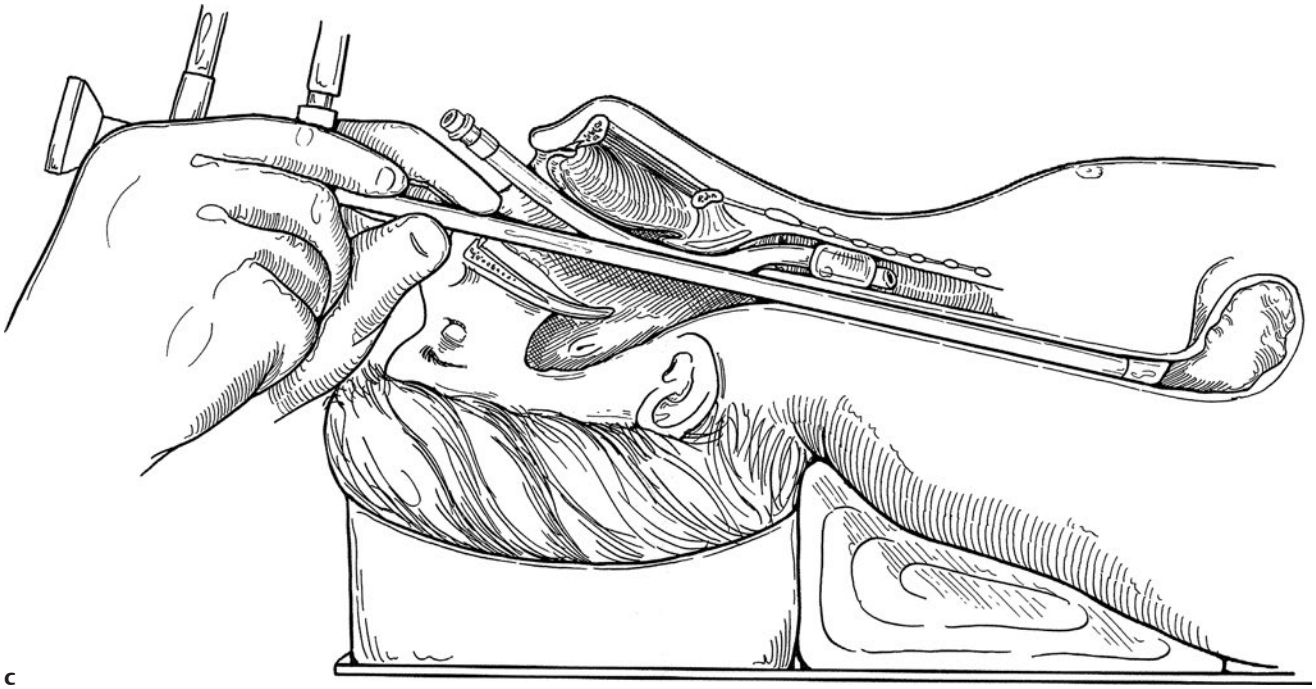


a

Fig. 35.2a

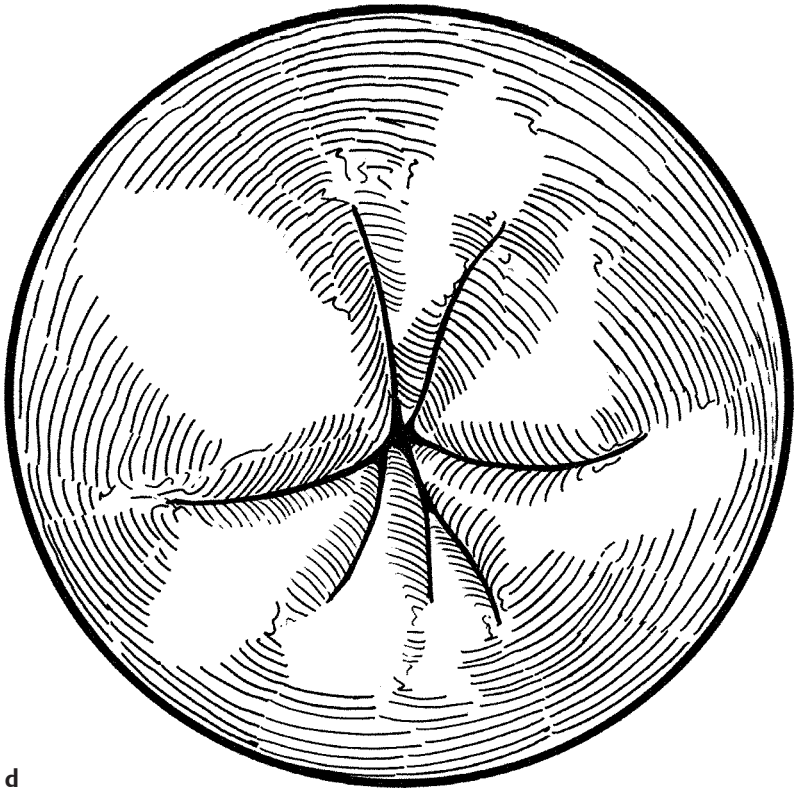


b



c

Fig. 35.2b,c



d

Fig. 35.2d

Section VIII

Facial Trauma

VIII

36 Facial Lacerations

Luv R. Javia

Facial lacerations are common in children as a result of their frequent falls and accidents. The majority of these injuries are superficial and require minimal care. However, some of these lacerations have deeper and/or associated injuries that must be detected and treated.

36-1 Repair of Facial Lacerations

Indications

A facial laceration through the dermis that is too large to approximate with wound tape (such as Steri-Strips [3M]) or tissue adhesive (e.g., octylcyanoacrylate or butylcyanoacrylate) should be sutured. Wounds that are under significant tension or dynamic stress or are irregular require suture placement.

Preoperative Evaluation

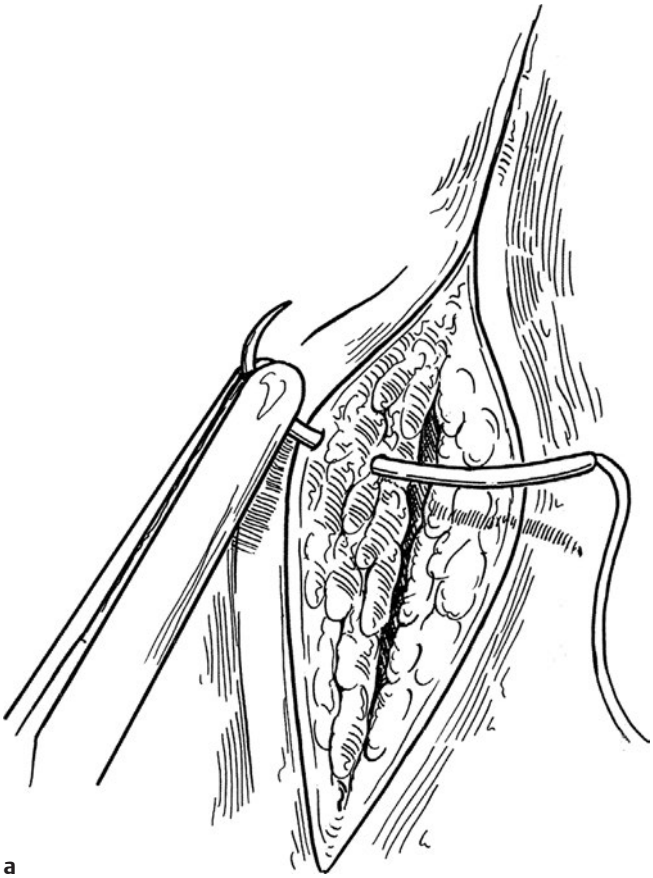
The presence of any associated injury must be determined and appropriate trauma protocols should be followed to stabilize the patient first. Facial radiologic imaging is indicated if fractures are suspected.

Operative Technique

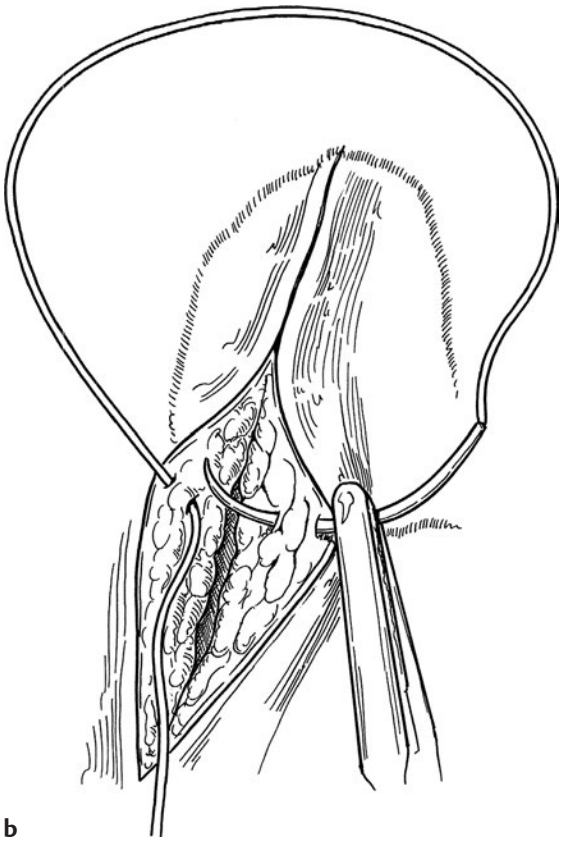
1. Lacerations should be anesthetized and cleansed of any foreign debris, and bleeding should be controlled.
2. Small lacerations that do not require deep tissue closure can be closed with wound tape or tissue adhesives. The tissue edges are approximated and held together with forceps or manual pressure as tape or adhesive is applied to the wound.
3. Small lacerations may be sutured using local anesthesia, but larger, complex lacerations of the head and neck are best closed utilizing sedation or even general anesthesia.
4. Subcutaneous absorbable sutures (4-0 or 5-0 Vicryl or Monocryl [Ethicon]) are useful to help close the deep lacerations, but should be kept to a minimum to reduce tissue reaction in the wound. It is helpful to start in the middle of the laceration to aid in lining up the edges correctly.
5. The skin is closed with interrupted buried subcuticular absorbable sutures when possible (**Fig. 36.1a,b,c**).
6. Attention is given to take a larger "bite" of the dermis and subcuticular tissue than the epidermis in order to evert the wound and bury the knot (**Fig. 36.1d**).
7. Wound tape or tissue adhesives are then applied to reduce skin tension (**Fig. 36.1c,e**).
8. If an interrupted subcutaneous closure is not possible, an interrupted closure with 5-0 or 6-0 fast-absorbing surgical gut (which usually do not need to be removed) or nylon can be used, again being careful to evert the wound edges (**Fig. 36.1e,f**).
9. Wound tape can be applied across the closure to reduce wound tension, if desired (**Fig. 36.1e**).
10. Facial sutures are removed at 3 to 4 days to prevent stitch marks. Neck sutures are removed in 4 to 6 days.

Complications

1. Widened/hypertrophic scar
2. Keloid
3. Uneven skin edges
4. Infection
5. Wound dehiscence



a



b

Fig. 36.1a,b

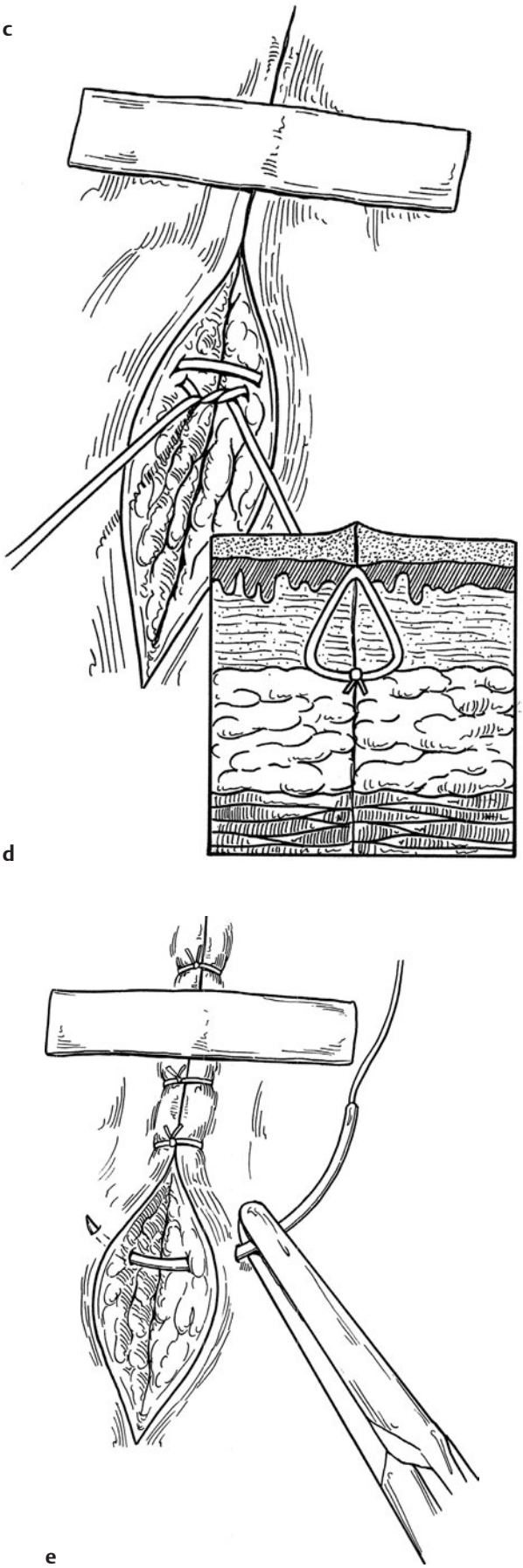


Fig. 36.1c,d,e

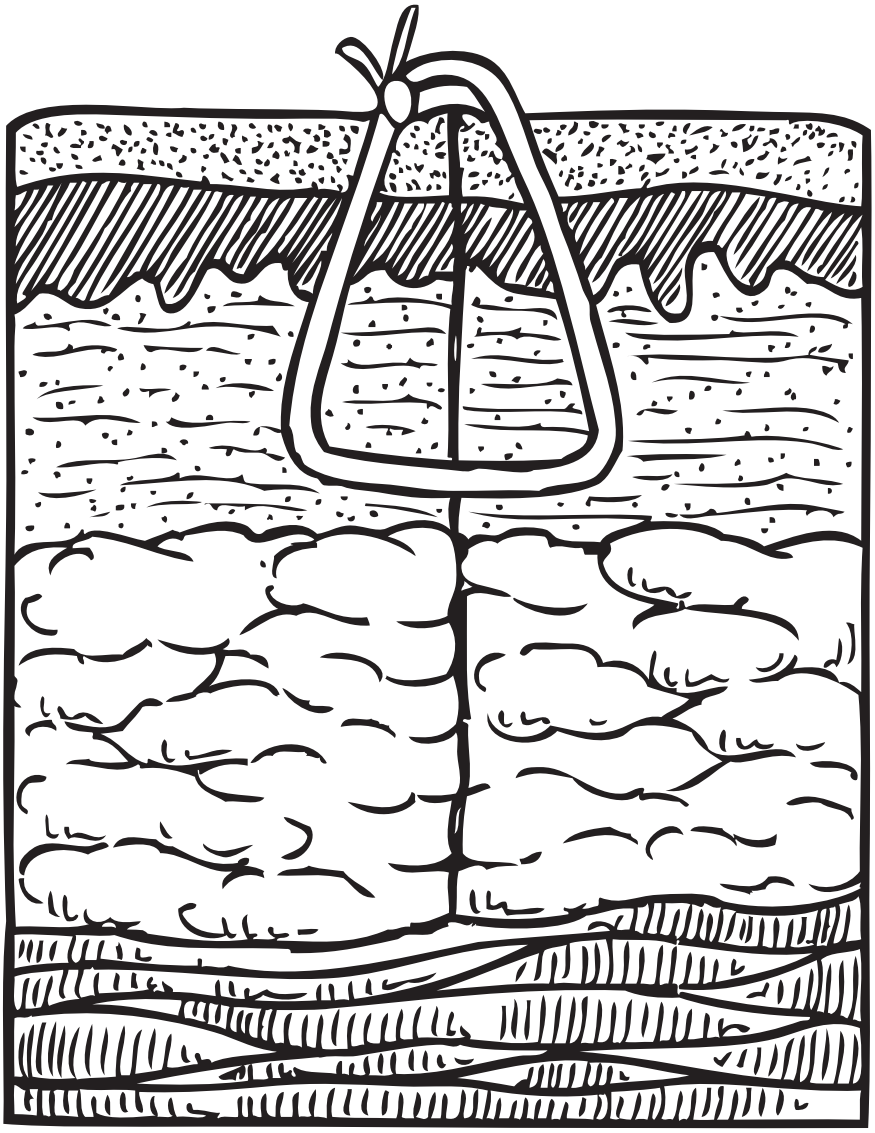
f 

Fig. 36.1f

37 Nasal Fractures

Luv R. Javia

Nasal fractures may occur at any age, but are uncommon in early childhood. They account for the second largest group of facial fractures because of the nose's prominent position on the face.

37-1 Treatment of Nasal Fractures

Indications

Reduction of nasal fractures is indicated if there is significant cosmetic or functional deformity. Nondisplaced fractures can be managed conservatively with observation and prevention of further injury as the nose heals. Displaced fractures (convex, concave, or comminuted) require reduction under general anesthesia.

Preoperative Evaluation

A complete examination of the nose and surrounding structures is necessary. Associated injuries to the orbit must be identified and treated. Inspection of the nose will usually reveal the nasal deformity. Palpation of the nose may detect bone irregularities (step-offs) on the nasal bones. However, if 30 to 60 minutes have passed, the edema over the bony structures may obscure the deformity.

If the patient is seen several hours after the injury and edema is present, the patient should be reexamined 4 to 7 days later to determine the presence of any nasal deformity after the acute edema has resolved.

Septal hematomas should be detected and treated immediately (see Section 10-1).

Nasal bone radiographs are occasionally helpful in identifying a fracture site, but only the clinical examination can determine if the cosmetic deformity present is sufficient to justify intervention (**Fig. 37.1a**).

Nasal fracture reduction is best carried out 4 to 7 days following the injury. This allows tissue edema from the injury to subside and permits a more precise reduction.

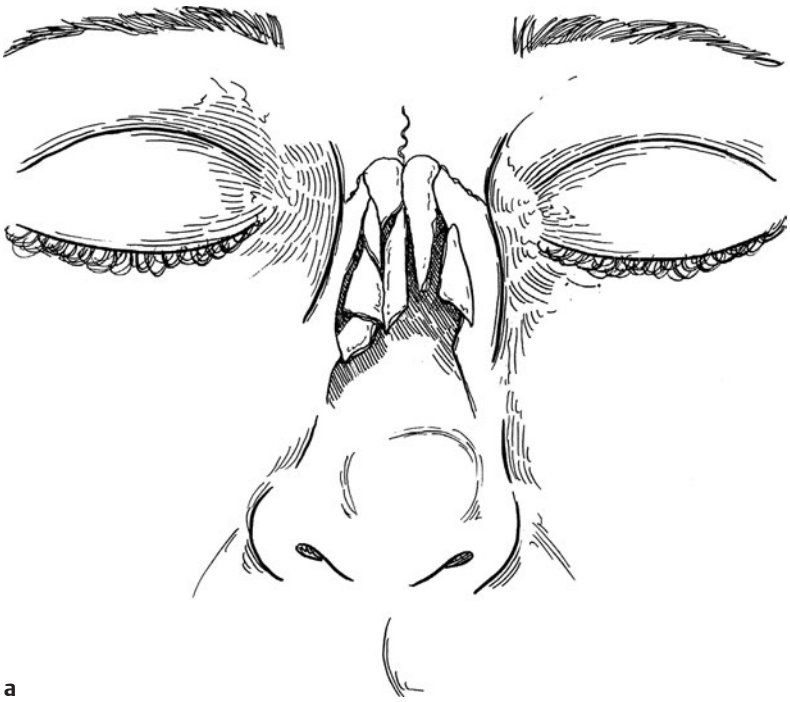
Deflection or fracture in the nasal septal cartilage may require further intervention in the future with a septoplasty or septorhinoplasty.

Operative Technique

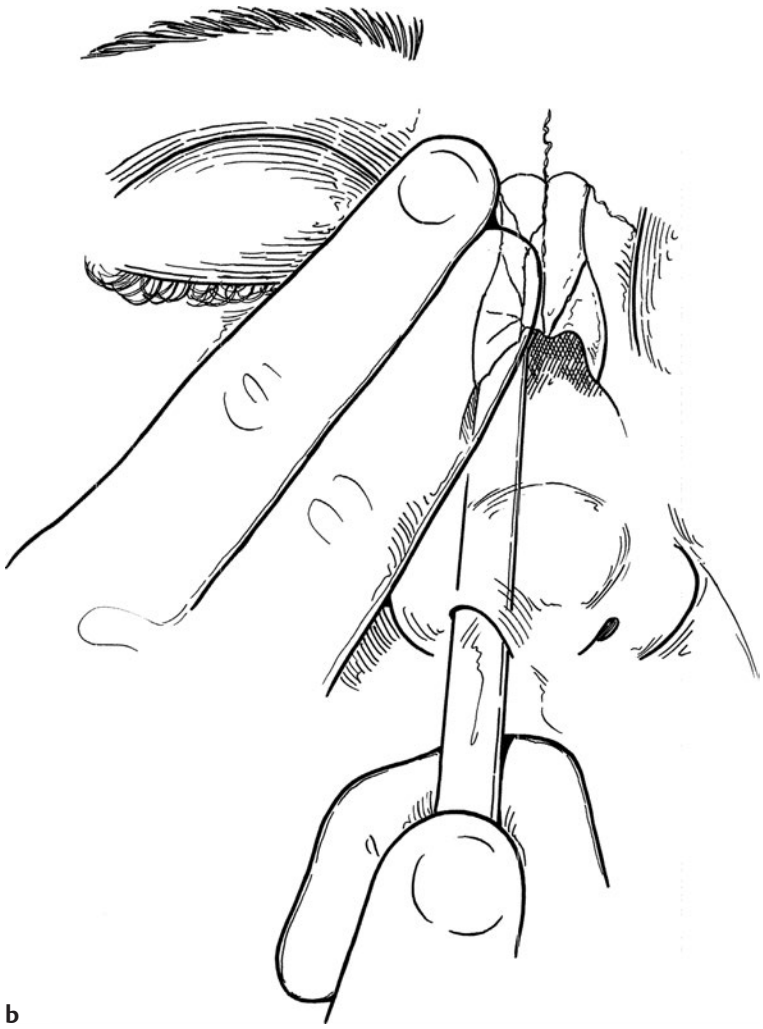
1. Nasal reduction in children is best accomplished under general anesthesia not only for the comfort of the child but also to protect the airway from bleeding that can ensue intraoperatively.
2. The nose is packed with 4% cocaine hydrochloride using neurosurgical pledgets for decongestion and hemostasis (alternately, any combination of a topical vasoconstrictor and local anesthetic may be used). In younger children, alternates to cocaine should be used.
3. A flat, blunt instrument (e.g., a Boies nasal fracture elevator) is placed external to the nose along its length toward the skull base to approximate a safe insertion depth to avoid skull base injury.
4. The Boies elevator is placed into the nose, and the depressed nasal bone is mobilized anterolaterally (**Fig. 37.1b**).
5. If the opposite nasal bone is displaced, it is reduced to its normal position manually or with the Boies elevator as described.
6. The fractured fragments are then gently replaced in their normal position by manual palpation (**Fig. 37.1c**).
7. Care is taken to make sure that the septum is in its normal midline position.
8. Gelfoam (Pfizer) or oxycel (Surgicel [Ethicon]) is then placed in the nose to support the fracture fragments, if necessary. This is rarely needed in young children.
9. An external nasal splint is then placed to prevent reinjury while the nose heals (**Fig. 37.1d**). This is removed after 5–7 days.

Complications

1. Cosmetic deformity secondary to inadequate reduction
2. Epistaxis
3. Cerebrospinal fluid leak due to aggressive/deep elevator placement



a

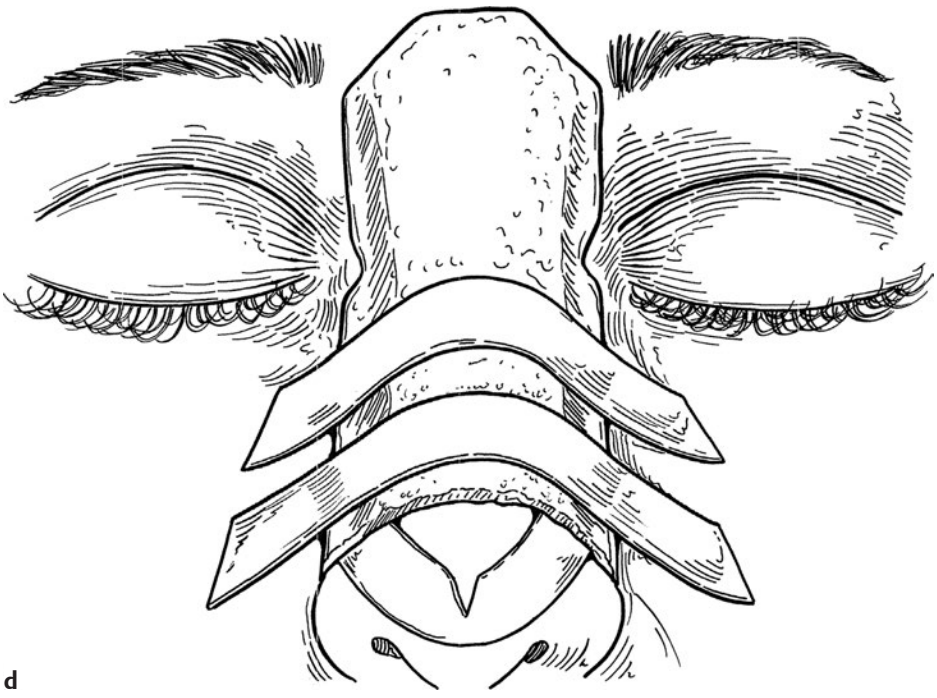


b

Fig. 37.1a,b



c



d

Fig. 37.1c,d

38 Zygomatic Arch Fractures

Luv R. Javia

Zygomatic arch fractures occur from direct trauma to the side of the face. The arch is most often fractured in two or three places; the fragments are usually depressed, causing a visible flat deformity of the cheek.

38-1 Treatment of Zygomatic Arch Fractures

Indications

If a zygomatic fracture results in a cosmetic deformity or trismus, operative intervention is required. If displacement or functional deficits are not present, soft diet and observation may be used for management. Treatment should be performed following resolution of facial edema at 3–5 days.

Preoperative Evaluation

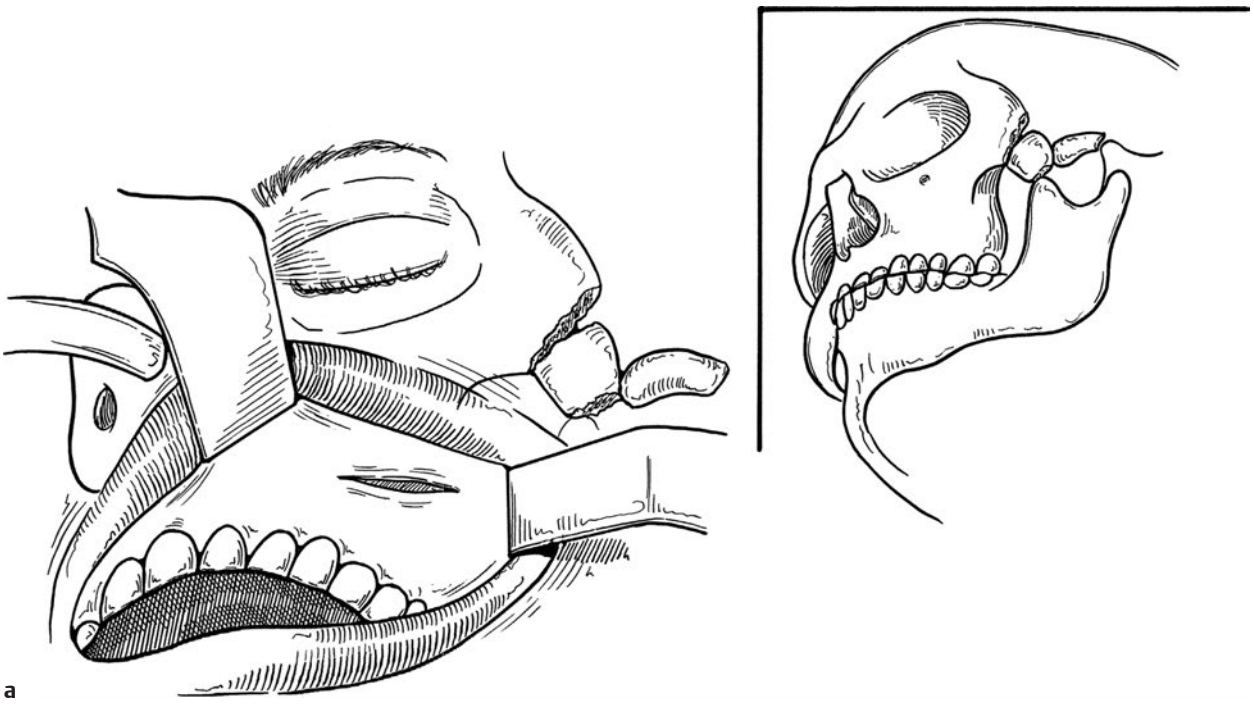
While plain film radiographs of the face can demonstrate the fracture, pediatric low-dose radiation computed tomography (CT) provides the best evaluation of the fracture and any associated injuries.

Operative Technique

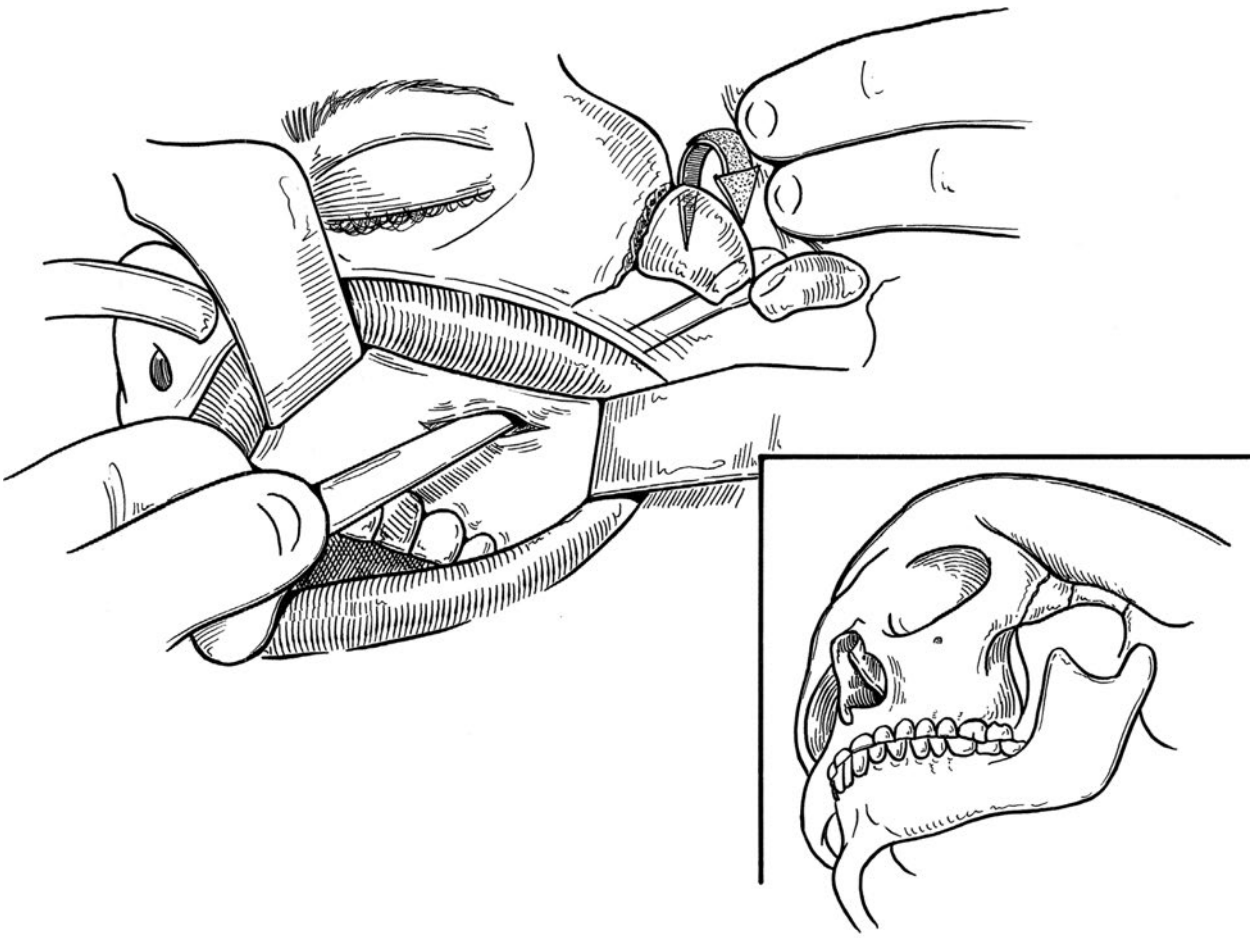
1. Zygomatic arch fractures are elevated in children utilizing general nasotracheal anesthesia.
2. One percent lidocaine with 1:100,000 epinephrine is injected at the incision site to aid in hemostasis. A small incision is made in the buccal mucosa lateral to the maxilla (**Fig. 38.1a**).
3. An elevator or bar is inserted under the zygoma. Using the maxilla as a fulcrum, the fracture is elevated into place (**Fig. 38.1b**). Careful attention should be paid to avoid injury to the infraorbital nerve as it exits the maxilla.
4. No splint is needed, and two or three chromic sutures are sufficient for closure of the intraoral incision (**Fig. 38.1c**).

Complications

1. Insufficient reduction
2. Wound infection

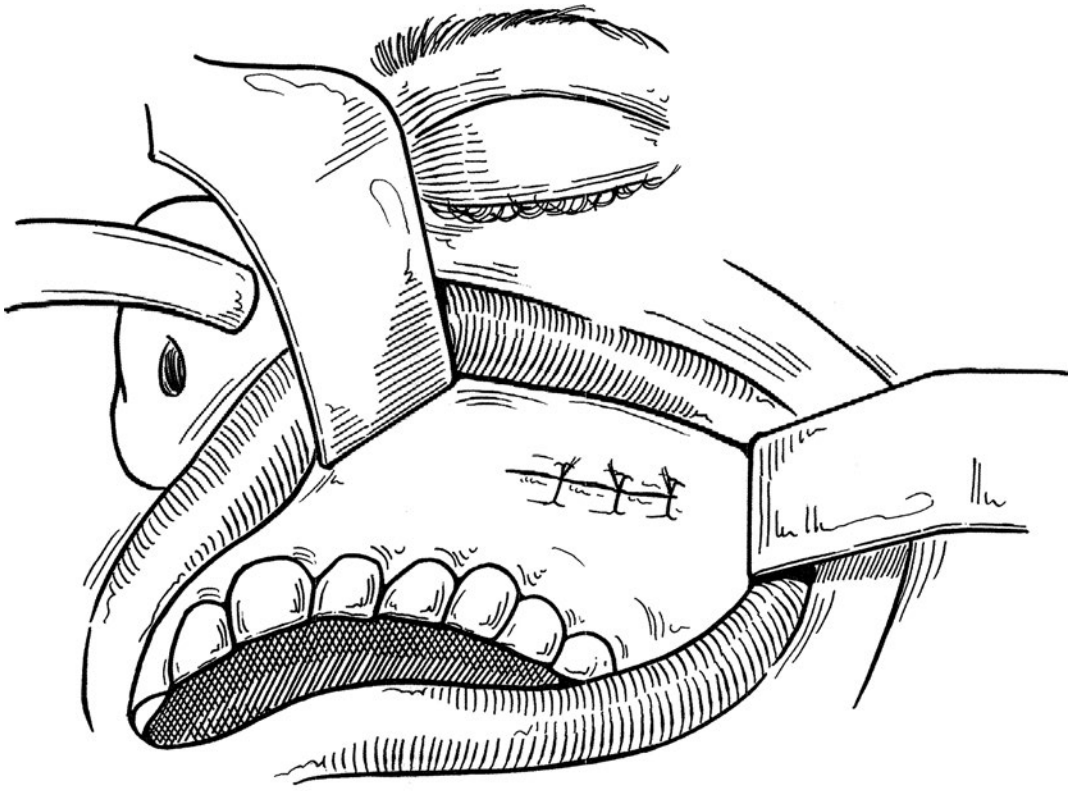


a



b

Fig. 38.1a,b



c

Fig. 38.1c

39 Malar Fractures

Luv R. Javia

Malar fractures usually occur as a result of direct trauma to the malar eminence (cheekbone). The malar bone fractures at its frontal, temporal, and maxillary attachments. The resulting fracture is often depressed and rotated.

39-1 Treatment of Malar Fractures

Indications

A depressed malar fracture with cosmetic deformity or functional consequence, such as diplopia, requires surgical intervention.

Preoperative Evaluation

Fracture step-offs can often be palpated along the inferior orbital rim and at the zygomatic frontal attachment. Infraorbital hypoesthesia may be present from injury to the infraorbital nerve. Pediatric low-dose radiation computed tomography (CT) of the facial bones is best to demonstrate the fracture and any associated injuries. Ophthalmologic evaluation should be obtained prior to surgical intervention. Fracture reduction should be carried out when the patient's general condition is stable and the edema has subsided (usually 3–5 days).

Fixation of fractures should be accomplished with plating technology. Titanium and resorbable plating systems are now widely available. If titanium plates are used, there is some controversy over whether they need to be removed. Proponents of removal believe that plates should be removed after 2–3 months, once healing has occurred, to prevent plate migration or skeletal growth alterations. Some believe that children younger than 10 years of age should be managed utilizing either titanium plates with subsequent removal or resorbable plates. Those older than 10 years of age should be treated similarly to adults with titanium plates not requiring removal. Others believe that removal of titanium plates is not an issue and recommend removal only in cases of infection, hardware failure, or tooth bud injury.

In the absence of displacement or functional deficits, conservative management can be instituted with soft diet and observation.

Operative Technique

1. Malar fractures are best reduced in children utilizing general anesthesia.
2. Corneal protection must be employed by performing a tarsorrhaphy suture with a 6-0 nylon or Prolene (Ethicon) suture through the gray line of the lid margins.
3. One percent lidocaine with 1:100,000 epinephrine is injected at the incision site to aid in hemostasis. No hair is shaved for the incision. The incision is made in the lateral eyebrow within the eyebrow itself paralleling and preserving the hair follicles (**Fig. 39.1a**). An upper blepharoplasty incision can also be employed to gain access to the lateral orbital rim as well (not shown).
4. For a subciliary approach, an incision is made through the skin just below the lash line after 1% lidocaine with 1:100,000 epinephrine is injected at the incision site to aid in hemostasis (**Fig. 39.1b**).
5. A dissection plane is developed with scissors inferior from the incision between the skin and the pretarsal portion of the orbicularis oculi just deep to it. This exposes the pretarsal and then the preseptal portions of the orbicularis oculi muscle (**Fig. 39.1c**).
6. Between the pretarsal and the preseptal portions of the muscle, a plane is dissected and carried inferiorly deep to the preseptal portion of the orbicularis oculi muscle. This dissection plane is between the preseptal portion of the orbicularis oculi muscle and the orbital septum. This is followed down onto the infraorbital rim (**Fig. 39.1d**).
7. Once the infraorbital rim is identified, the periosteum over the infraorbital rim can be incised sharply and the fracture can be visualized (**Fig. 39.1e**).
8. Alternatively, a transconjunctival approach can be performed instead of a subciliary approach (not shown).

9. The periosteum is elevated for a small distance to expose the fracture fragments (**Fig. 39.1f**).
10. The malar eminence is reduced and rotated into position by lifting the bone with an elevator inserted behind the zygoma from the frontal incision (**Fig. 39.1g**). The orbital floor is checked for fractures (see Section 40-1).
11. The fractures may be secured with titanium or resorbable minicompression plates, with at least two screws on either side of the fracture line. Resorbable plates require tapping prior to screwing in the plate (**Fig. 39.1h**).
12. The incisions are closed with 4-0 or 5-0 interrupted Vicryl sutures (Ethicon) in the periosteal layer. The brow skin incision is closed with a 4-0 or 5-0 subcuticular Monocryl (Ethicon). The subciliary skin incision is closed with a 5-0 or 6-0 interrupted or running fast-absorbing gut suture.
13. No dressings or splints are necessary.

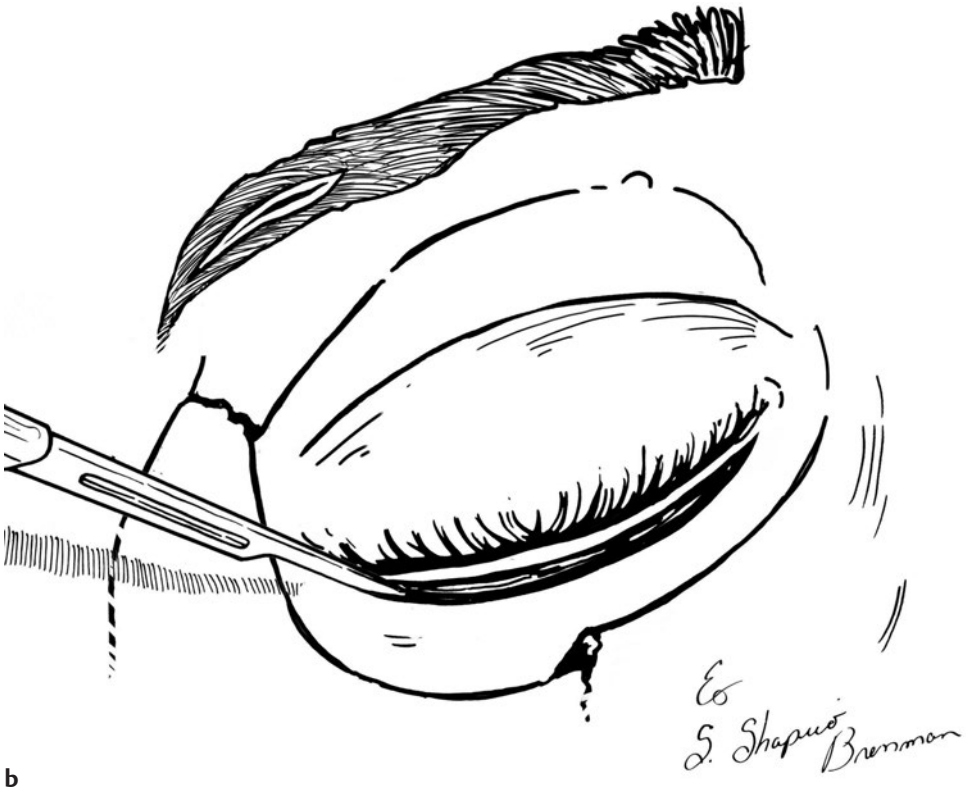
Complications

1. Insufficient reduction
2. Wound infection
3. Hardware failure
4. Osteomyelitis
5. Enophthalmos
6. Ectropion/entropion

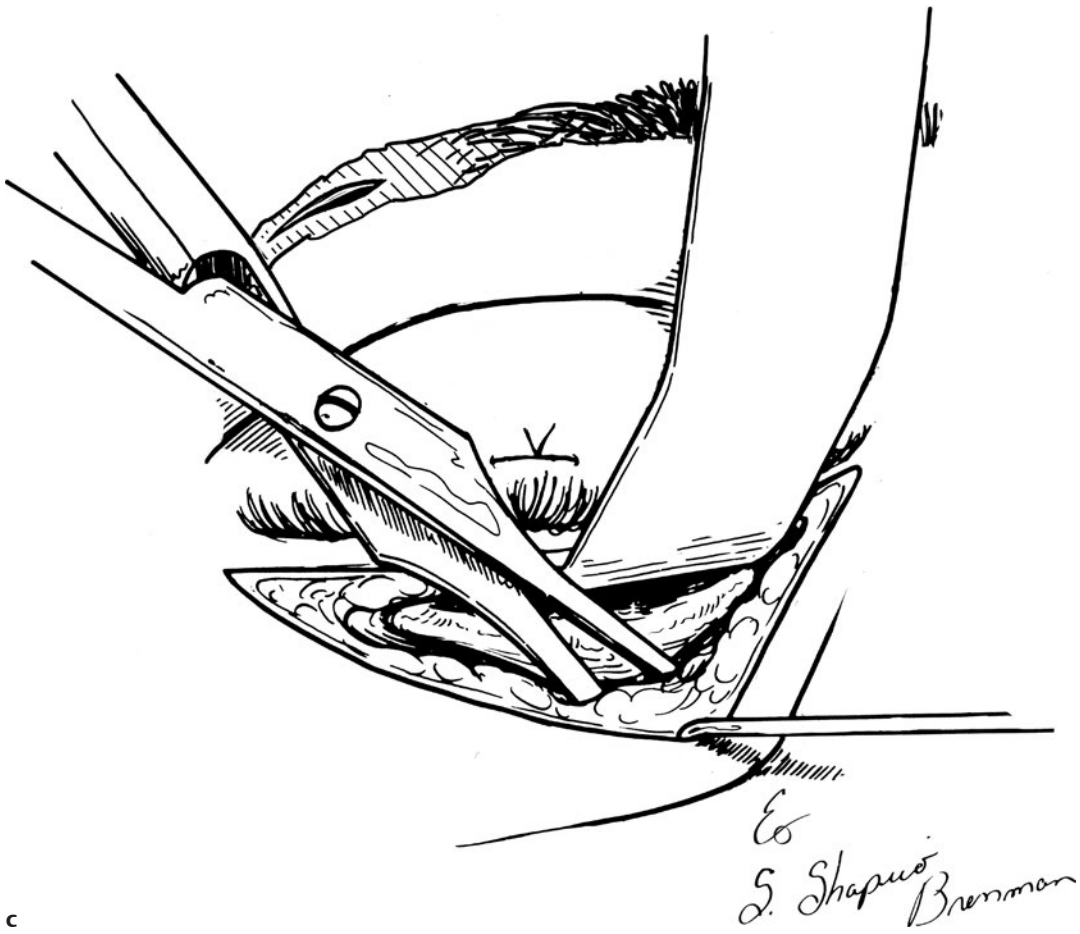


a

Fig. 39.1a

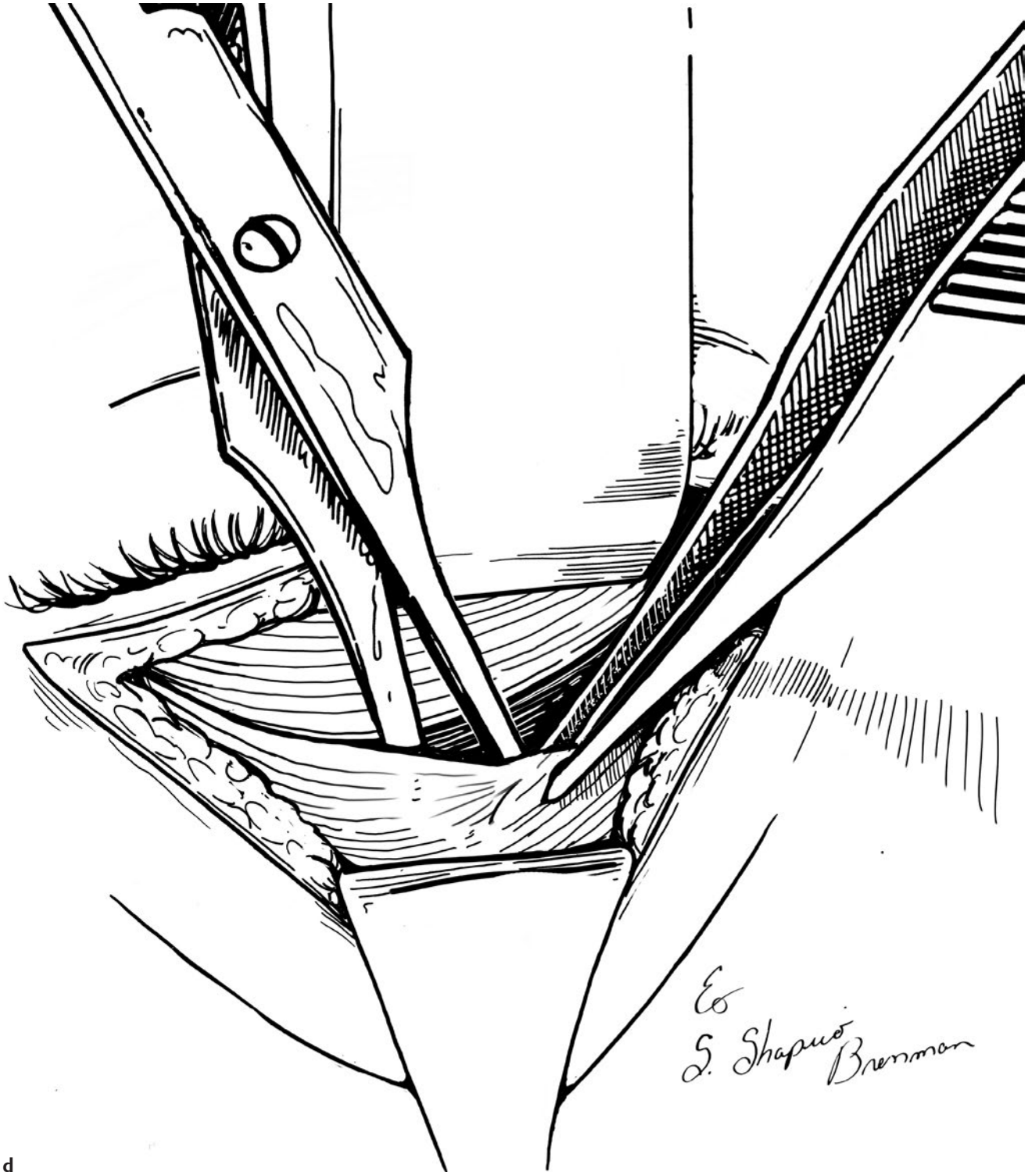


b



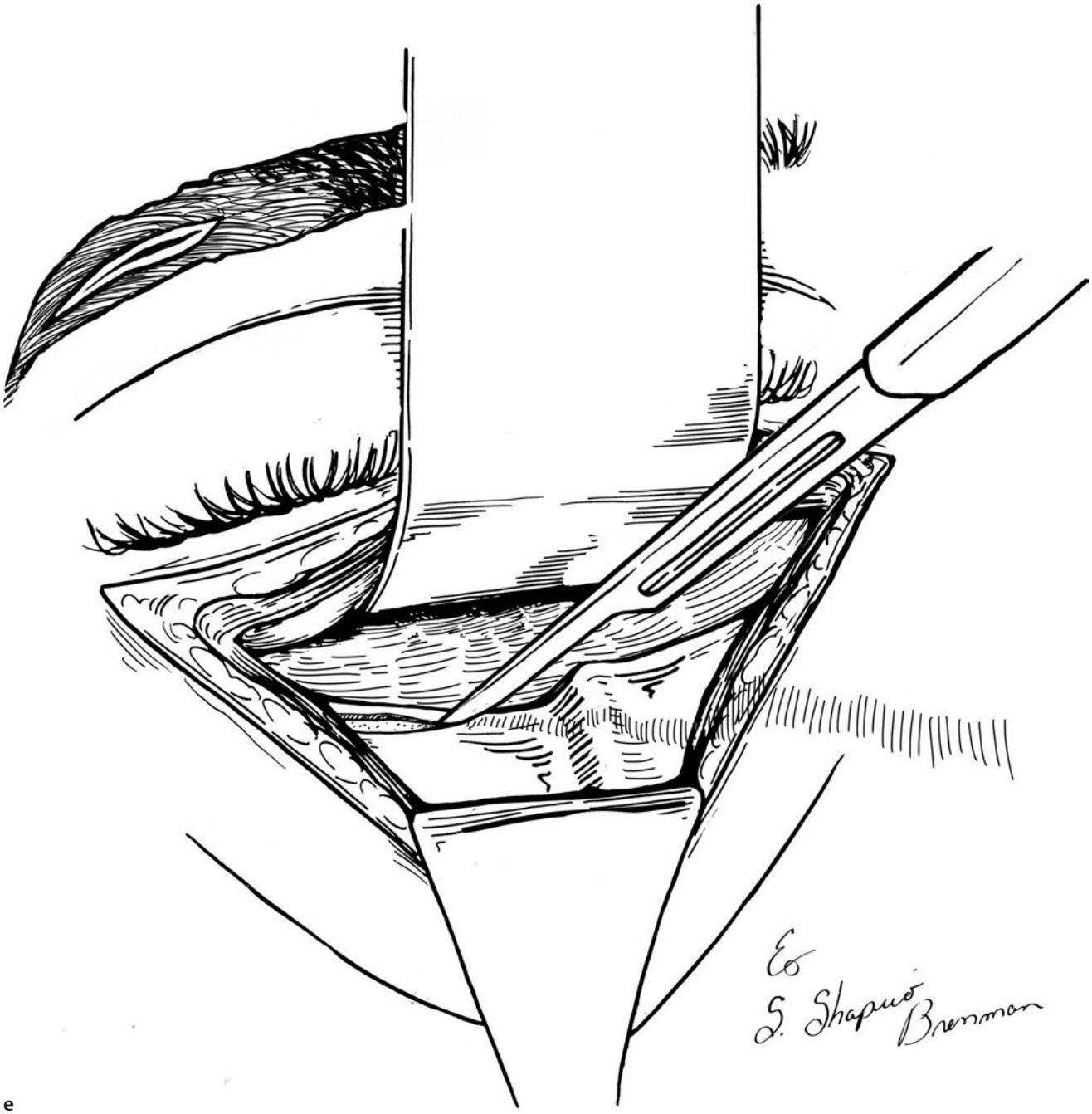
c

Fig. 39.1b,c



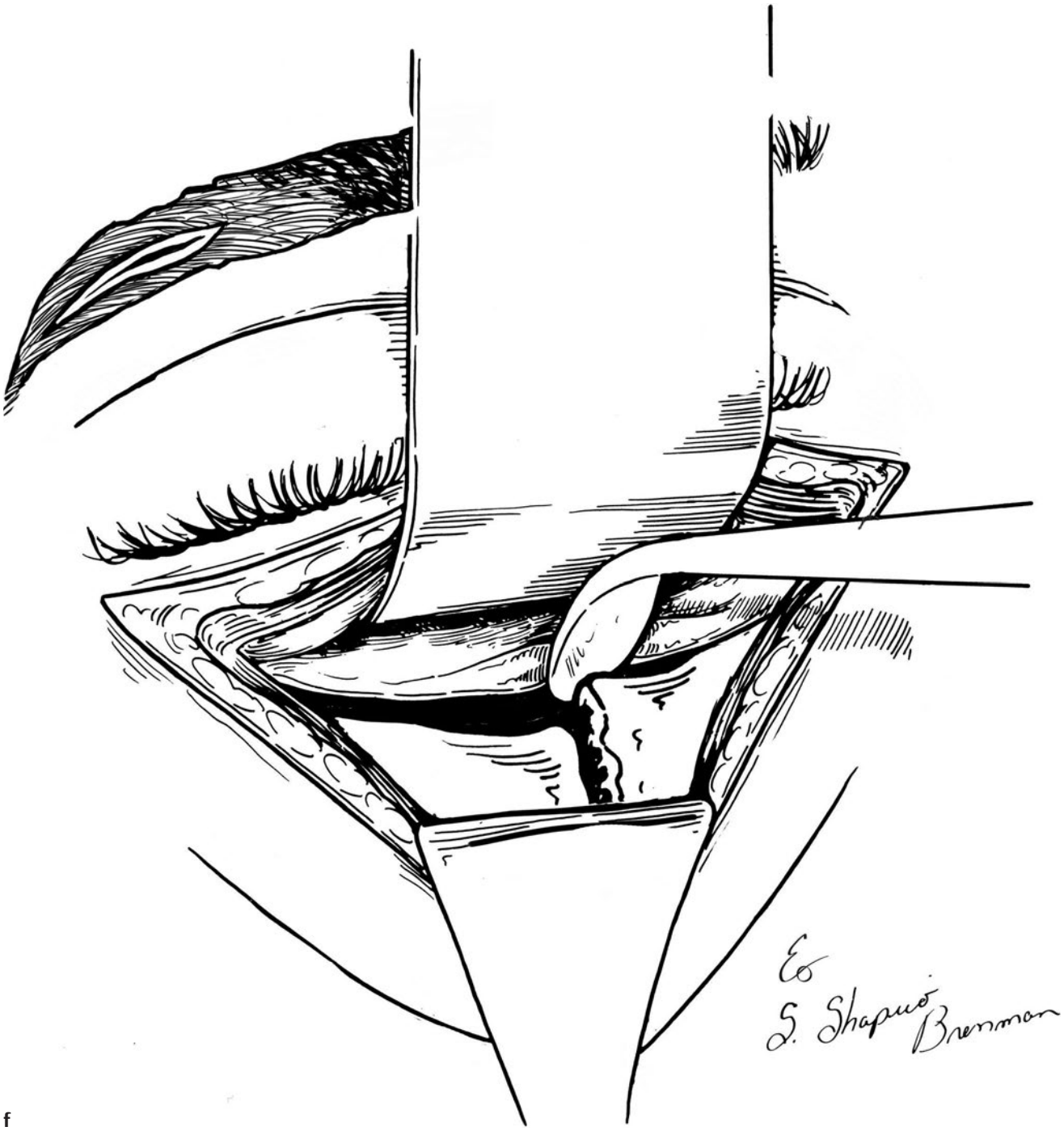
d

Fig. 39.1d



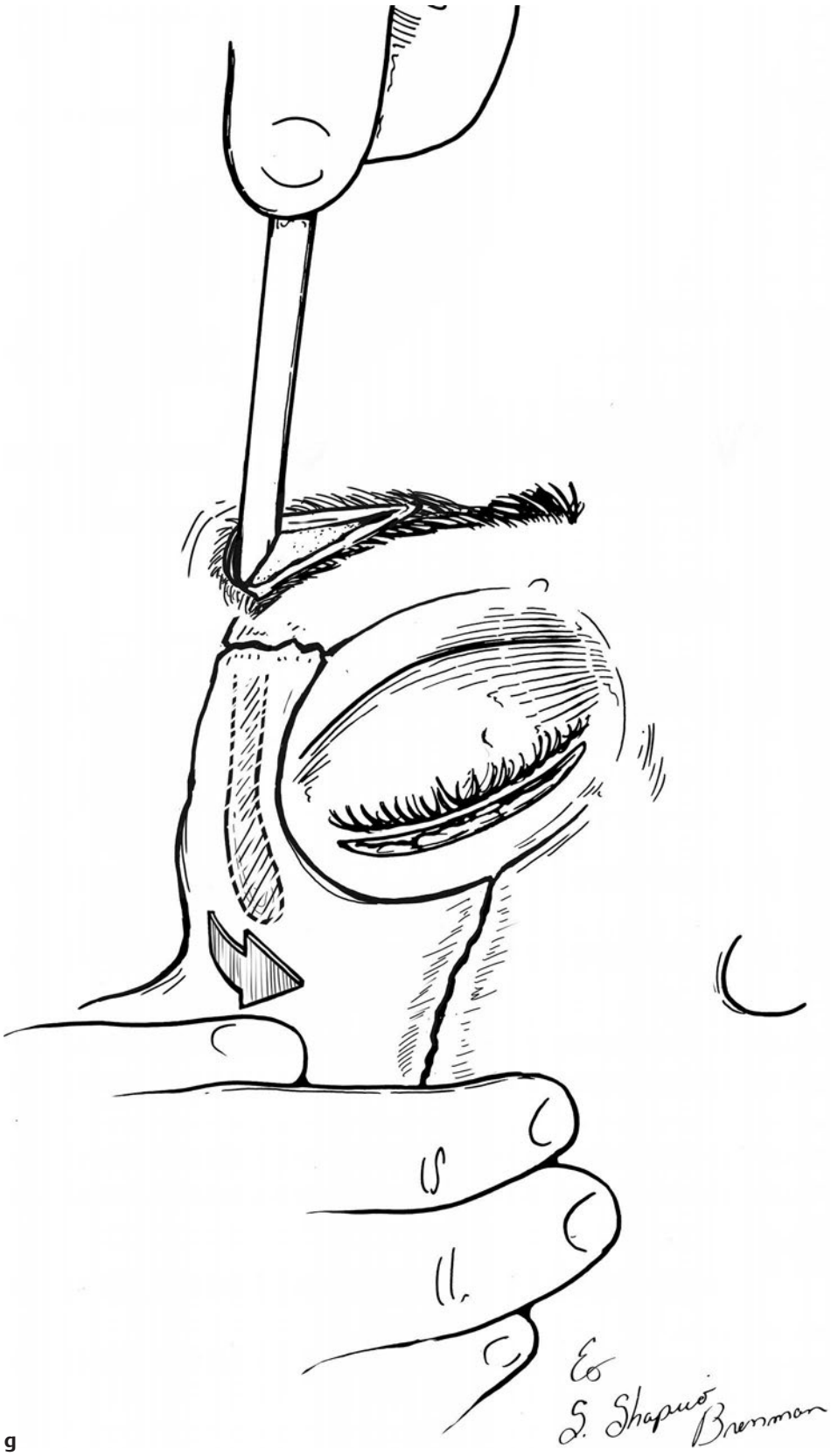
e

Fig. 39.1e



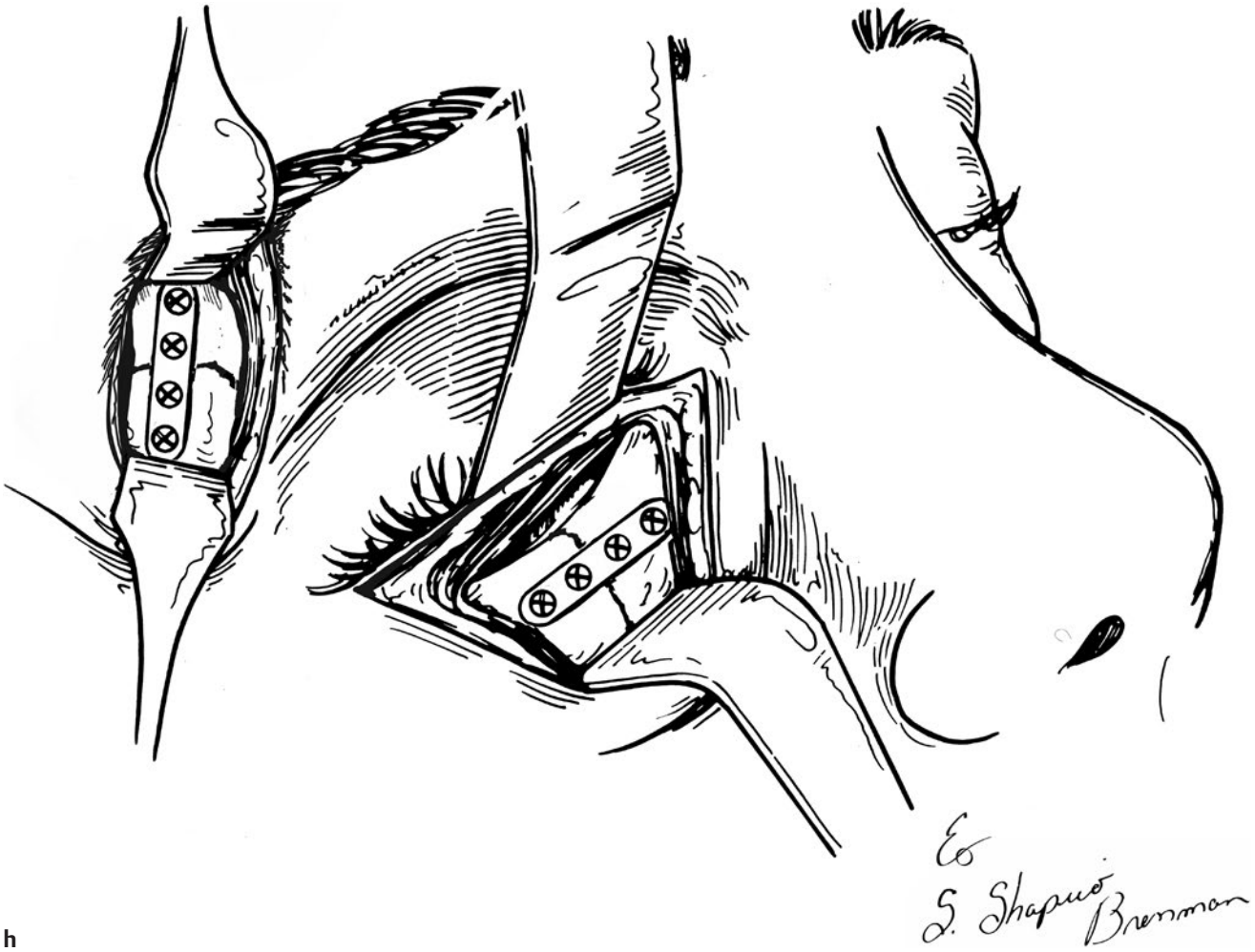
f

Fig. 39.1f



g

Fig. 39.1g



h

Fig. 39.1h

40 Orbital Fracture

Luv R. Javia

Direct trauma to the eye may transmit force to the floor of the orbit causing multiple fractures in the floor while the orbital rim remains intact. Herniation of fat and muscle through the bony defect may cause a restriction of upward gaze and resultant diplopia. It is necessary to have a high index of suspicion of orbital injury in children as they can often present white-eyed. Specifically, they may not have significant ecchymosis, edema, orbital rim step-off, or conjunctival hemorrhage.

Surgery should be performed within 48 hours and can lead to improvement of associated nausea, vomiting, and bradycardia, which is mediated by the oculocardiac reflex.

40-1 Treatment of Orbital Floor Fractures

Indications

Presence of an orbital floor fracture with enophthalmos and/or restriction of ocular mobility are indications for surgical exploration. Large floor defects > 1 cm^2 or 50% or more of the orbital floor are also an indication for repair as they will likely result in enophthalmos if uncorrected.

Medial orbital wall and orbital roof fractures are less common than orbital floor fractures but more proportionately common in children due to underpneumatized sinuses. These can be observed as long as entrapment, diplopia, enophthalmos, and a cerebrospinal fluid leak are not present.

Preoperative Evaluation

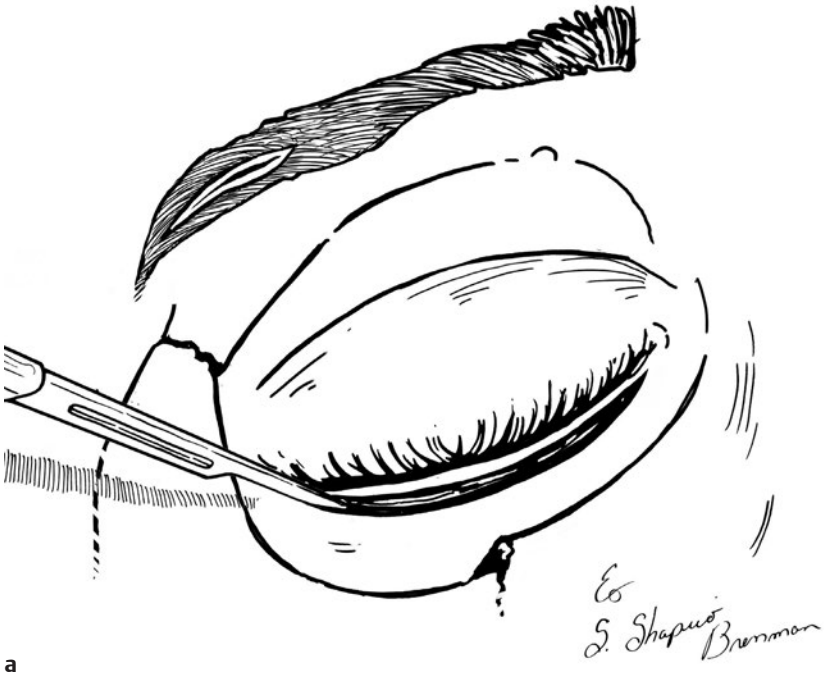
A careful examination of the eye to rule out ocular injury (e.g., hyphema) is essential. Plain radiographs may demonstrate the herniated orbital contents extending through the fracture into the maxillary sinus. However, pediatric low-dose radiation computed tomography (CT) provides the best definition of the fracture. Ophthalmology consultation is indicated prior to surgical intervention for evaluating visual acuity and trauma to the globe.

Operative Technique

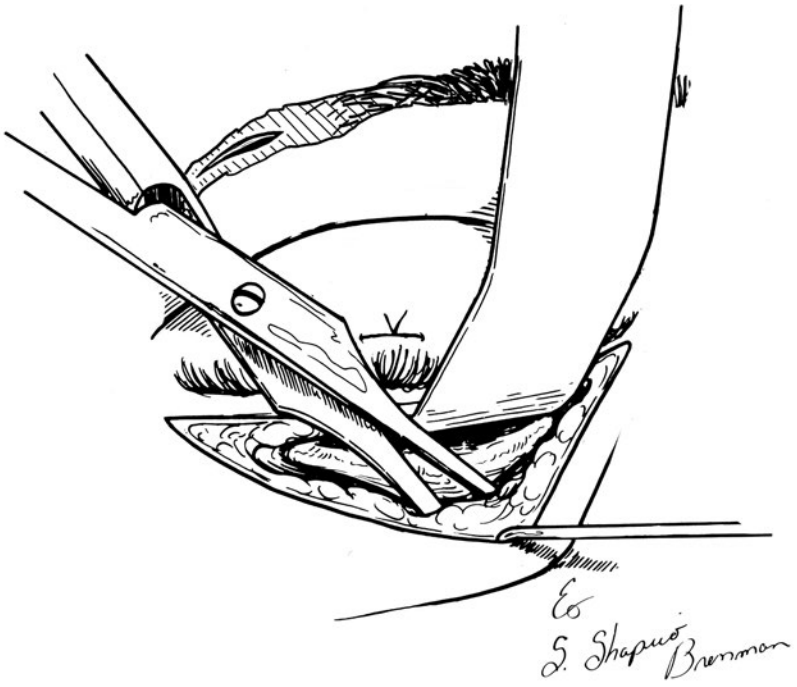
1. Orbital floor fractures are best reduced utilizing general anesthesia.
2. Corneal protection must be employed by performing a tarsorrhaphy suture with a 6-0 nylon or Prolene suture (Ethicon) through the gray line of the lid margins.
3. For a subciliary approach, an incision is made through the skin just below the lash line after 1% lidocaine with 1:100,000 epinephrine is injected at the incision site to aid in hemostasis (**Fig. 40.1a**).
4. A dissection plane is developed with scissors inferior from the incision between the skin and the pretarsal portion of the orbicularis oculi just deep to it. This exposes the pretarsal and then the preseptal portions of the orbicularis oculi muscle (**Fig. 40.1b**).
5. Between the pretarsal and the preseptal portions of the muscle, a plane is dissected and carried inferiorly deep to the preseptal portion of the orbicularis oculi muscle. This dissection plane is between the preseptal portion of the orbicularis oculi muscle and the orbital septum. This is followed down onto the infraorbital rim (**Fig. 40.1c**).
6. Once the infraorbital rim is identified, the periosteum over the infraorbital rim can be incised sharply and the fracture can be visualized (**Fig. 40.1d**).
7. Alternatively, a transconjunctival approach can be performed instead of a subciliary approach (not shown).
8. Orbital fat and muscle entrapped in the fracture are released with an elevator (**Fig. 40.1e**).
9. The depressed fracture fragments are lifted with an elevator (**Fig. 40.1f**).
10. A bone graft, titanium mesh, resorbable sheets, or high-density porous polyethylene implant is inserted along the orbital floor to protect the fractures and prevent reherniation of orbital contents (**Fig. 40.1g**).
11. Following repair, forced duction test should be performed to ensure that the implant is not causing any entrapment.
12. The incision is closed with 4-0 or 5-0 interrupted Vicryl sutures in the periosteum. The subciliary skin incision is closed with a 5-0 or 6-0 interrupted or running fast-absorbing gut suture (**Fig. 40.1h**).

Complications

1. Persistent diplopia
2. Enophthalmos
3. Wound infection
4. Hardware failure
5. Osteomyelitis
6. Ectropion/entropion

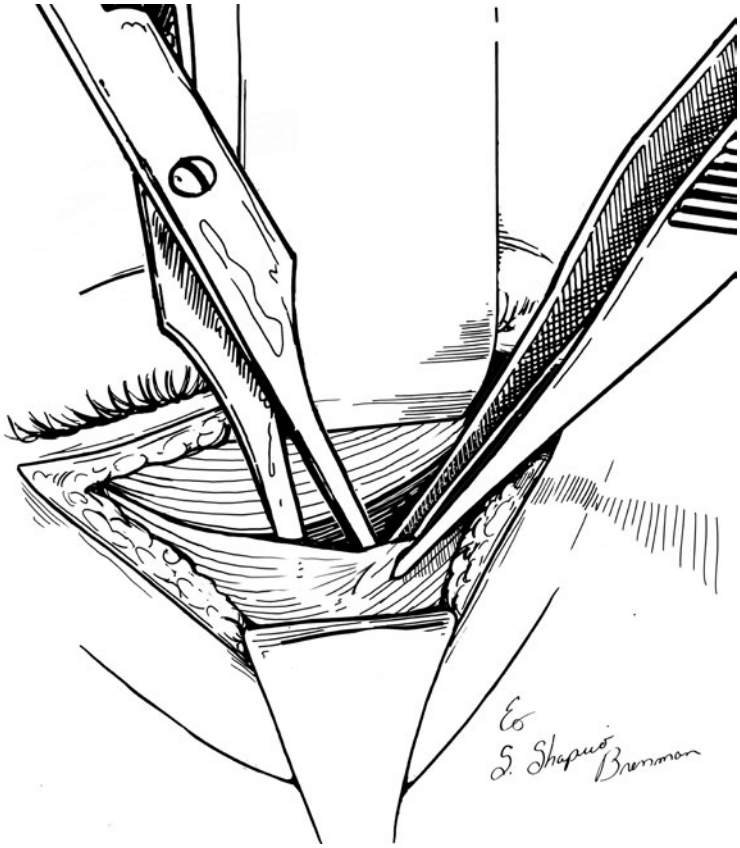


a

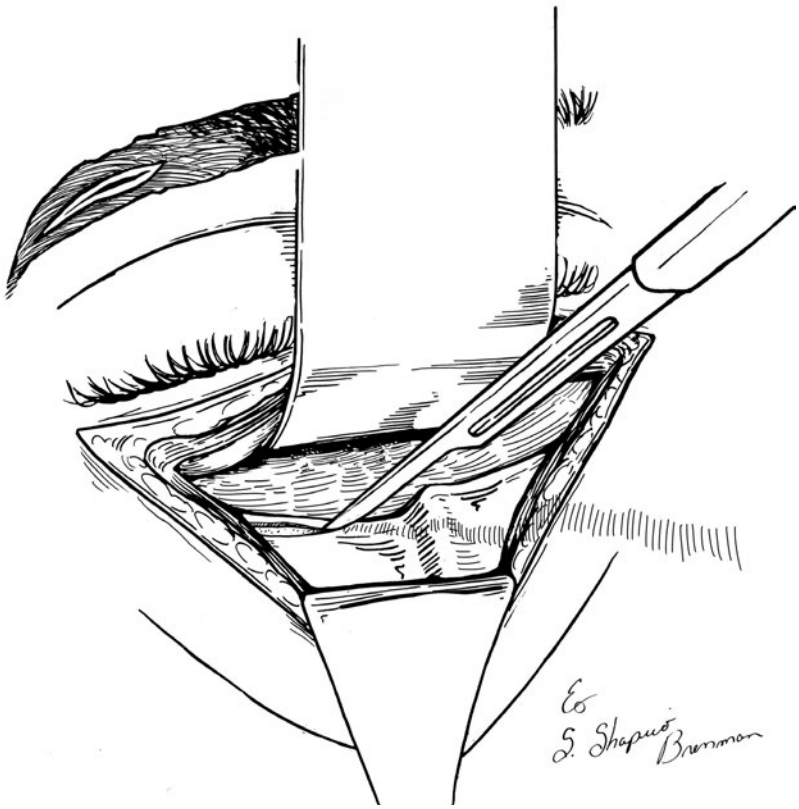


b

Fig. 40.1a,b

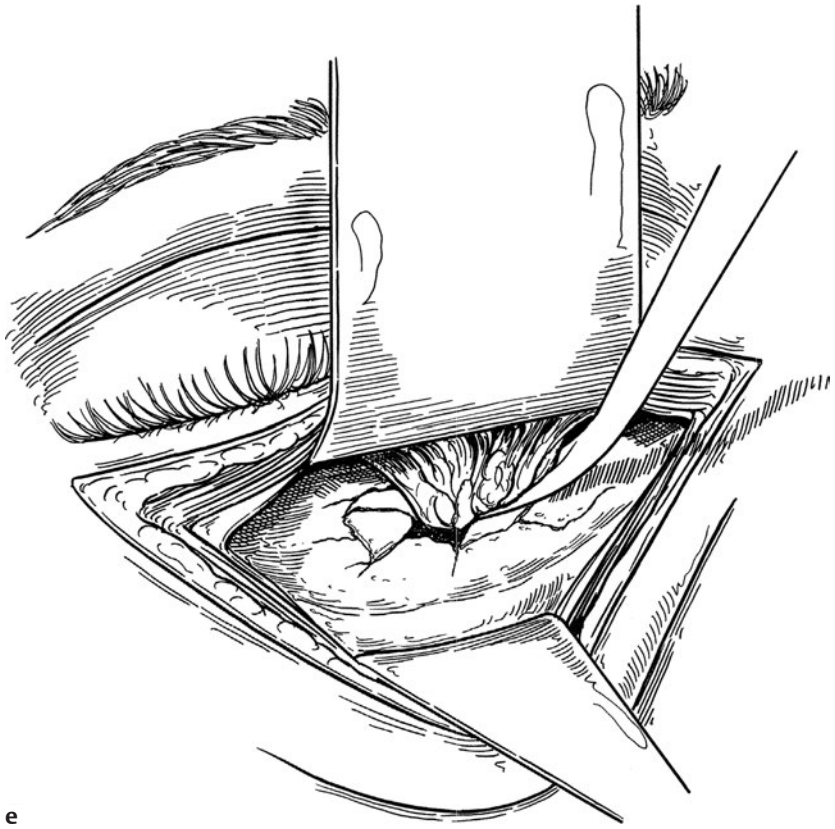


c

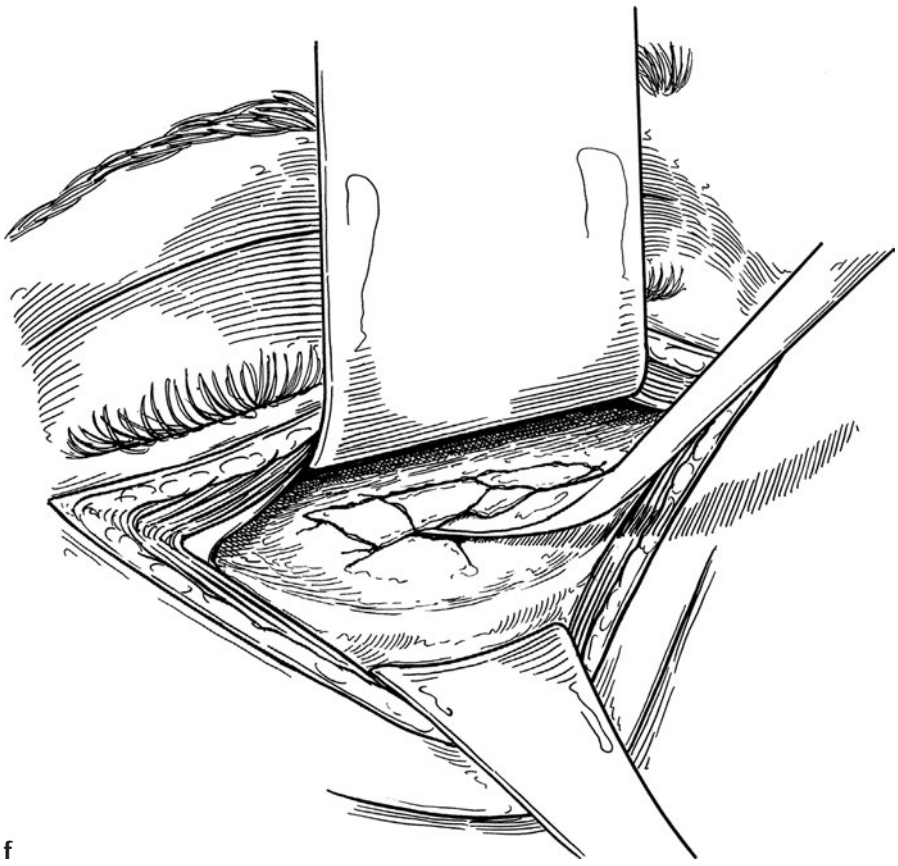


d

Fig. 40.1c,d

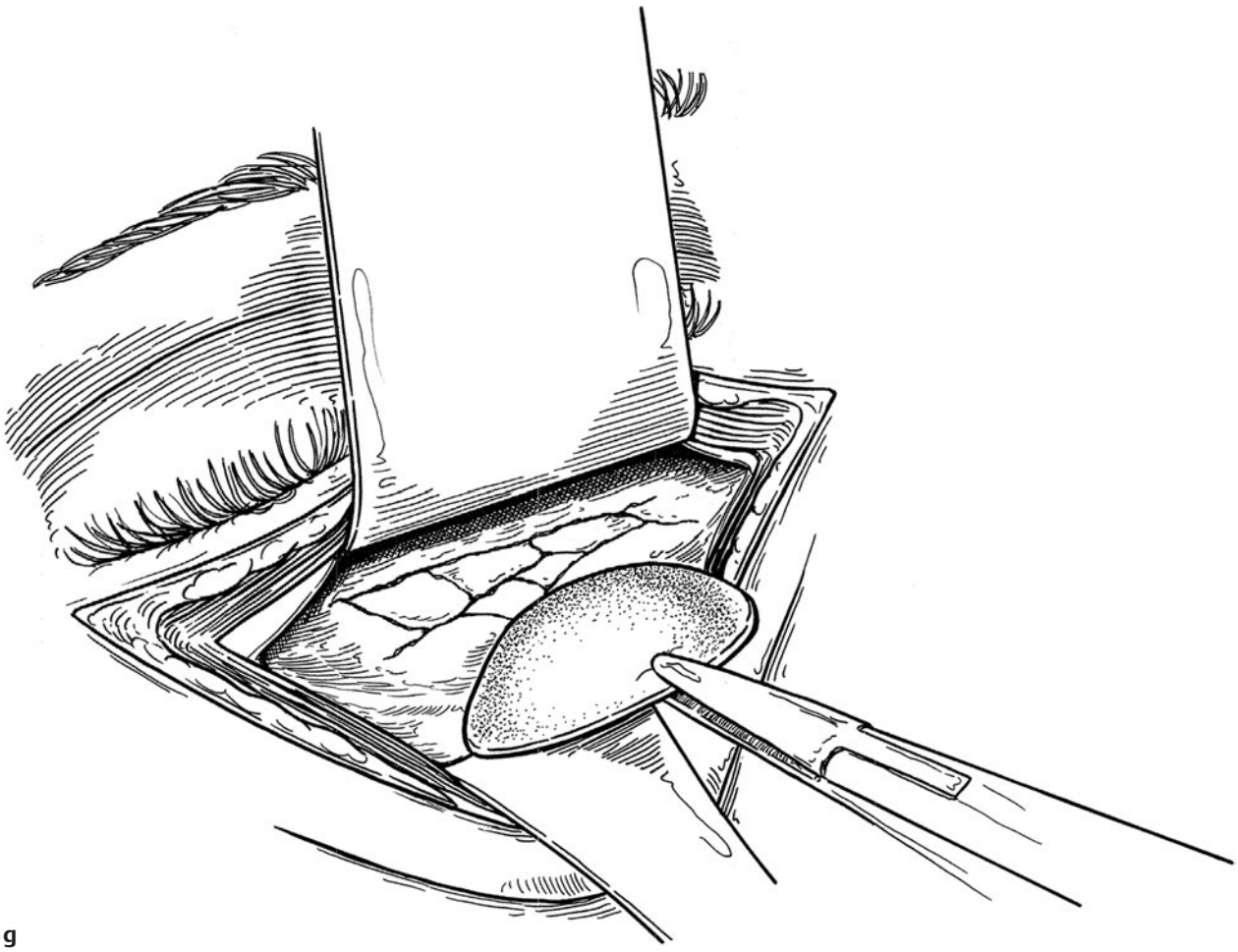


e

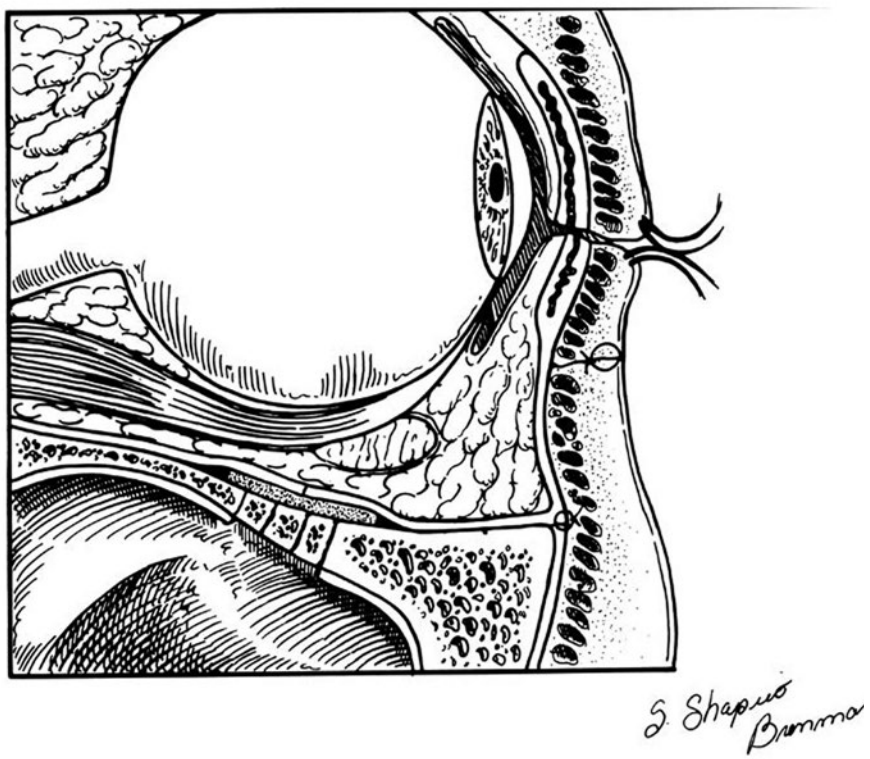


f

Fig. 40.1e,f



g



h

Fig. 40.1g,h

41 Midface Fractures

Luv R. Javia

Midface fractures are rare in children for a variety of reasons. In children, the midface occupies a relatively small portion of the head and is relatively small and flat as compared to the more prominent cranium. Also, the poorly developed paranasal sinuses result in crush or greenstick injuries rather than complete fractures. Additionally, pediatric bones are more elastic as compared to adult bones. Facial fat pads can provide additional protection to the underlying facial skeleton.

41-1 Treatment of Midface Fractures

Indications

A mobile/depressed midface requires open surgical treatment. Observation can be employed with nondisplaced fractures.

Preoperative Evaluation

Pediatric low-dose radiation computed tomography (CT) of the facial bones is the best study to define the fractures. Because the injuries are usually the result of severe trauma, associated injuries must be suspected. The airway may also be compromised. The injury is categorized by the location of the fracture: Le Fort I, II, or III (**Fig. 41.1a,b**). Location of the fracture is important to determine the stable site on the facial skeleton that is to be used for fixation and immobilization. The principles of management include restoration of midface projection and normal maxillomandibular occlusion. Additionally, vertical maxillary buttresses (anterior maxillary buttress, zygomaticomaxillary buttress, and pterygomaxillary buttress) need to be reestablished/stabilized.

These fractures are usually treated more conservatively than in adult patients. Intervention needs to be prompt in the pediatric population due to accelerated bone healing and greater osteogenic potential—preferably between 2 and 4 days after injury.

Minimally displaced fractures and most greenstick fractures without malocclusion can be treated conservatively with liquid to soft diet, restriction of activity, and analgesics. Minimally displaced fractures occurring during the period of tooth development require no treatment or brief maxillomandibular fixation (MMF). However, open reduction is indicated for severely/unstable displaced fractures, occlusal involvement, and orbital involvement.

Operative Technique

Maxillomandibular Fixation and Closed Reduction

1. Midface fractures are best reduced utilizing general anesthesia.
2. Arch bars or Ivy loops can be placed for MMF. Ivy loops are suggested by some for younger children with primary or mixed dentition. Some advocate for arch bars in only older kids with permanent dentition (> 11 years old). Please see Section 42-1 for details of placement of Ivy loops/arch bars.
3. The attachment of the suspension wire to the teeth can be accomplished utilizing an arch bar, bonded hooks, wire loops, or a dental plate. Assistance from a dentist or orthodontist can be very helpful in this step.
4. For children with minimally displaced fractures managed by closed reduction, a short 2–3 week period of MMF with elastics is usually sufficient.
5. MMF is released 2–3 weeks after reduction to prevent temporomandibular joint ankylosis.

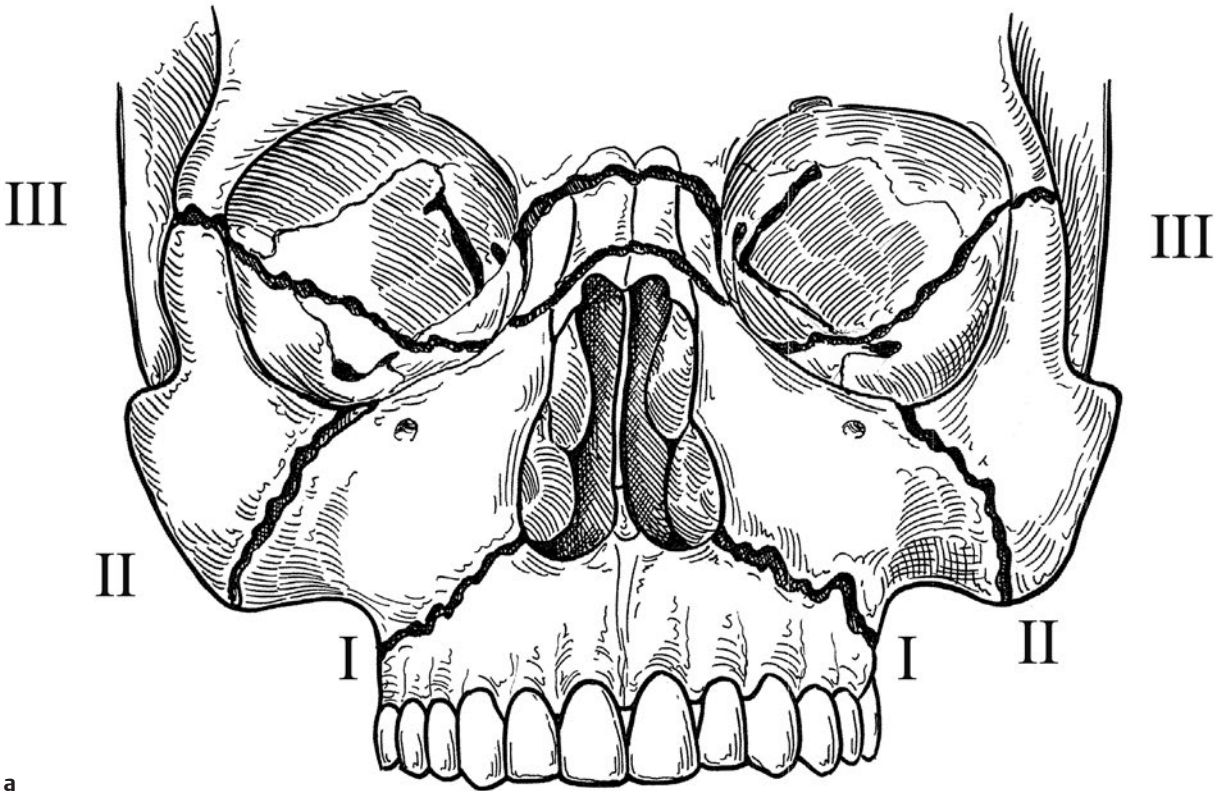
Open Reduction and Internal Fixation

1. Midface fractures are best reduced utilizing general anesthesia.
2. The patient is first placed into MMF to restore original occlusion.
3. Direct exposure of all fractures is required. Zygomaticofrontal process fractures can be exposed using an upper blepharoplasty or lateral eyebrow incision (see Section 39-1). Zygomaticomaxillary fractures can be exposed using a

subciliary or transconjunctival incision (see Section 39-1). Le Fort I fractures can be exposed through a sublabial incision, with careful attention paid to identify and preserve the infraorbital nerve as it exists its foramina (see Section 38-1).
4. Reduction and alignment of fractures is performed.
5. Internal fixation is performed using 1.5- or 2.0-mm resorbable miniplates and monocortical screws (**Fig. 41.1c**). Some centers use titanium plates. Some advocate for removal of the titanium plates after 2–3 months in children under 10 years old; however, this is a controversial topic (see Section 39-1). Unerupted tooth buds in children under 6 years of age should be preserved in the placement of screws on the maxilla.

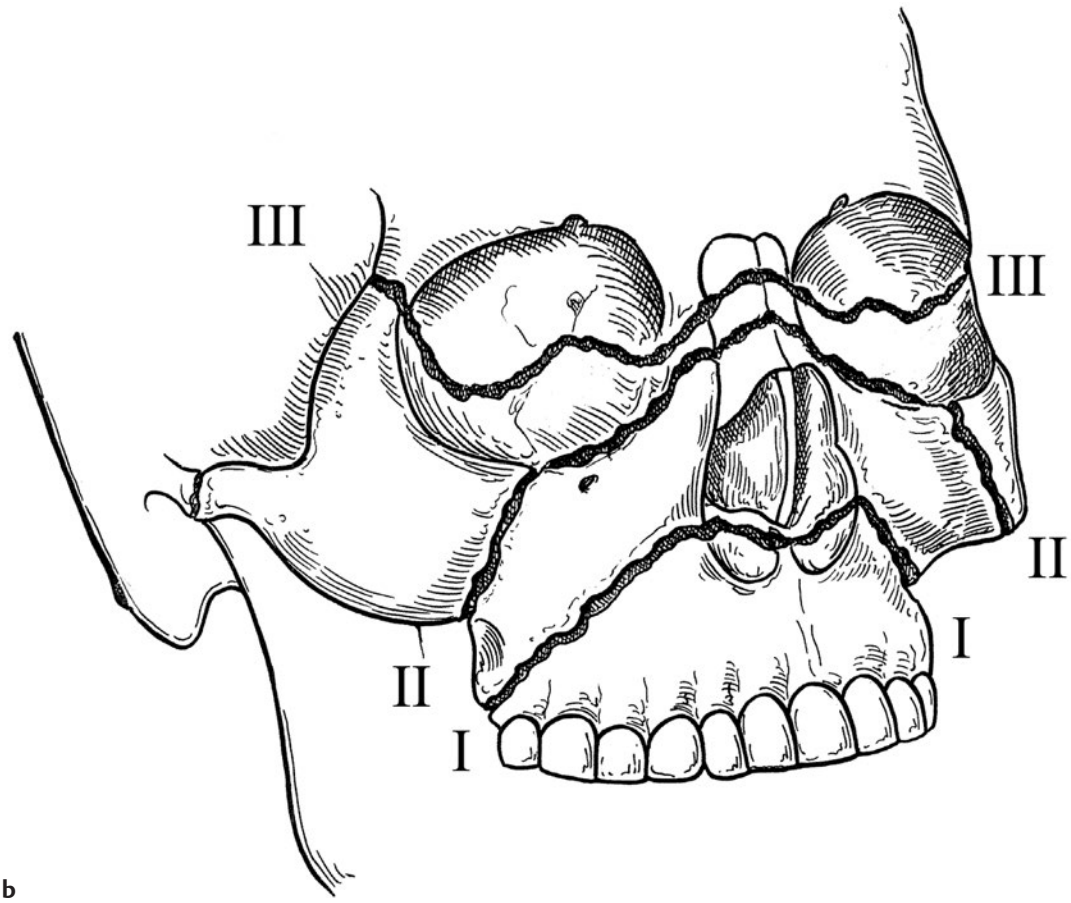
Complications

1. Persistent diplopia
2. Persistent enophthalmos
3. Infection
4. Hardware failure
5. Malunion/nonunion
6. Injury to unerupted teeth
7. Dental malocclusion

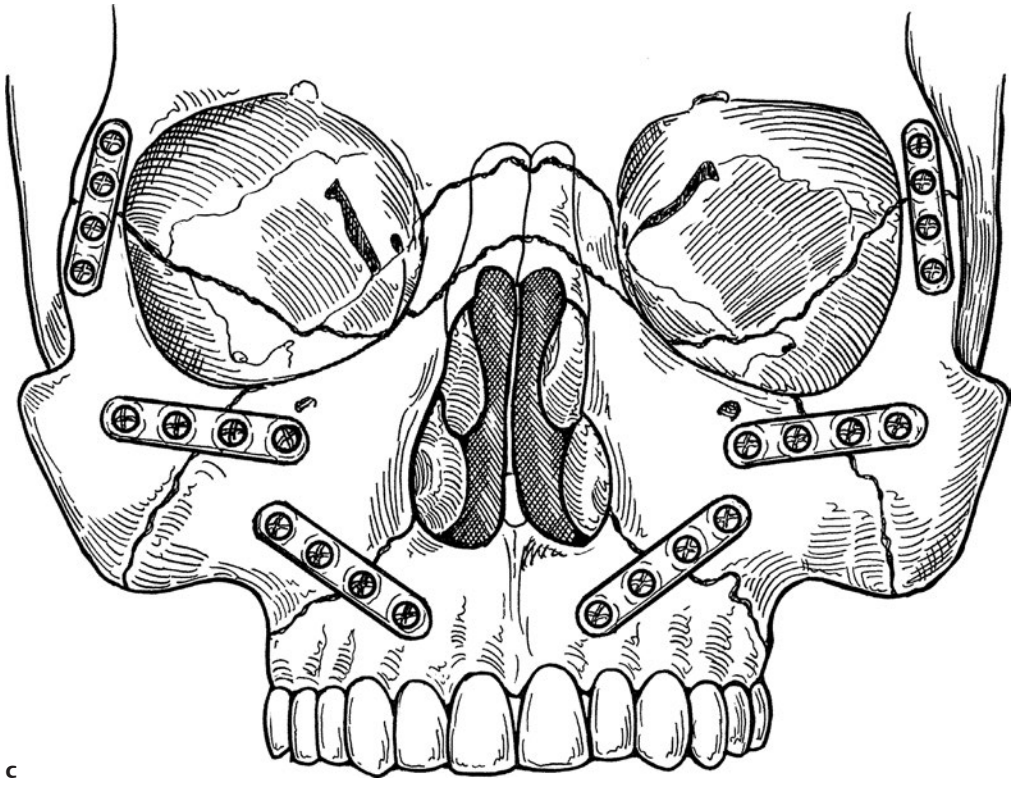


a

Fig. 41.1a



b



c

Fig. 41.1b,c

42 Mandibular Fractures

Luv R. Javia

Mandibular fractures are uncommon in children, and the incidence increases with age. They usually occur as a result of severe trauma and are often associated with other injuries. It is necessary to search for a possible second fracture site when one is found. The most common fracture site is the condyle.

42-1 Treatment of Mandibular Fractures

Indications

Mandibular anatomy and function have to be reestablished via reduction of fractures based on normal occlusion. As the pediatric population has greater osteogenic capacity and faster healing rates compared to adults, anatomical reduction must be done sooner and immobilization times should be shorter (2–3 weeks for children). Immobilization can be accomplished with maxillomandibular fixation (MMF), open reduction and skeletal fixation with miniplates, or a combination of the two.

Close observation, a liquid to soft diet, and analgesics are used to manage mandibular fractures without displacement and malocclusion. Condylar fractures are treated with observation or closed reduction with MMF (7–10 days) followed by physical therapy, the latter being indicated for displaced condylar fractures. However, some would advocate early mobilization without MMF for even displaced condylar fractures—this is a debated topic. Subcondylar fractures without malocclusion may also be managed conservatively.

Fractures in other parts of the mandible usually need surgical intervention. Displaced mandibular fractures should be reduced and immobilized with MMF or open reduction and miniplate application. For open reduction and miniplate fixation, the miniplate can be placed at the inferior border of the mandible with the screws directed away from developing tooth buds. Resorbable or titanium plates can be used. Some advocate that the titanium plates should be removed in 2–3 months after reduction, although this is controversial (see Section 39-1). For skeletal fixation, 1.5- or 2.0-mm miniplates should be used with at least two secure screw holes on either side of the reduced fracture. Screw holes are monocortical to avoid damaging unerupted teeth.

Preoperative Evaluation

Some degree of malocclusion and trismus usually accompany mandibular fractures; after 3–4 days, muscle spasms generally improve. Radiographs or low-dose radiation computed tomography imaging should be obtained to document the suspected fractures and to search for the frequent second fracture. Panoramic dental films are useful to determine dental fractures. Most mandibular fractures do not require immediate reduction. They should be managed as soon as the patient's general condition has stabilized (preferably within 48 hours).

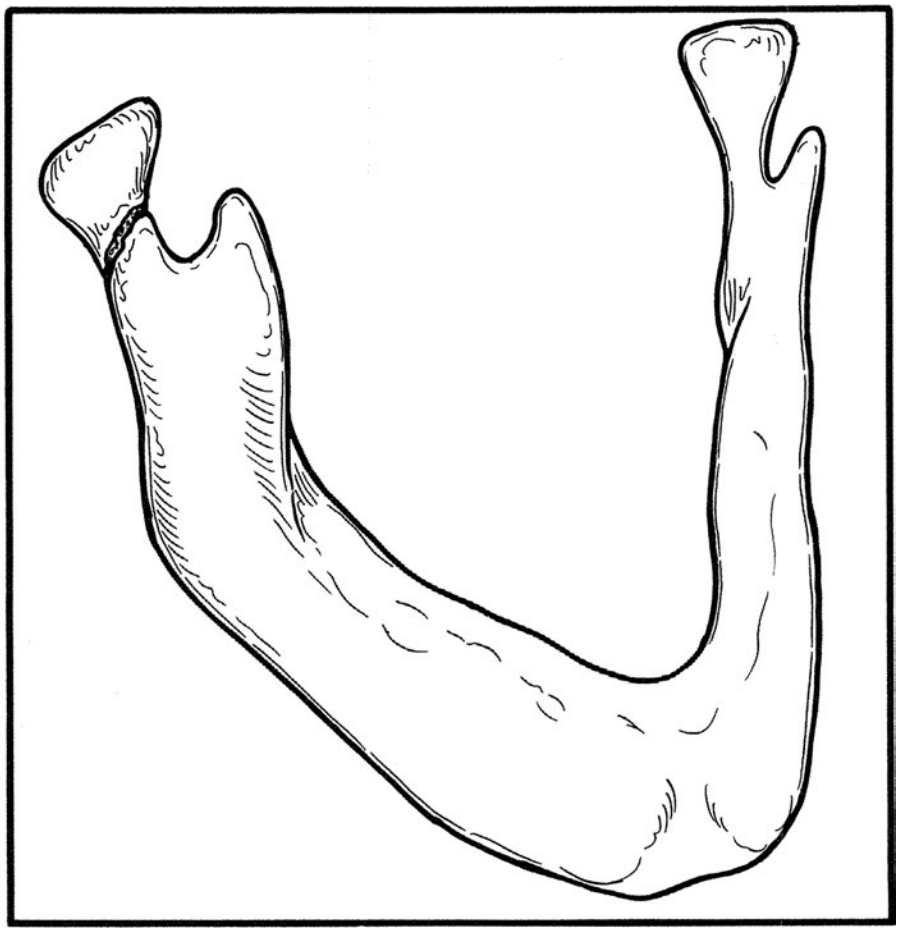
Operative Technique

1. Uncomplicated condylar and subcondylar fractures in children do not require reduction if occlusion is reasonably good (**Fig. 42.1a**). Soft diet should be used for approximately 4–6 weeks until the child can eat without pain. An immobilization dressing (Barton bandage) may help to reduce discomfort by restricting jaw motion (**Fig. 42.1b**) but some would advocate only a brief use as muscle spasms improve after 3–4 days and this would impede efforts at keeping the jaw mobilized.
2. Mandible fractures in children are best reduced and immobilized utilizing general anesthesia.
3. If a fracture is present and the fragments are not displaced, simple immobilization for 1 to 3 weeks will allow the fracture to heal.
4. When teeth are present, Ivy loops fashioned from 24- or 26-gauge stainless steel wire are utilized to immobilize the mandible and may be used to reduce the fracture as well. Because of the narrow neck on primary dentition, the wire loops may become loose or may gradually pull the tooth from its socket.
5. A 24- or 26-gauge stainless steel wire is bent around a suction approximately 2 to 3 mm in diameter (**Fig. 42.1c**).
6. The wire is grasped with a clamp or needle holder and twisted clockwise with a needle holder (**Fig. 42.1d**).
7. The trailing wires are then passed between two teeth (molars or premolars) at the gum line. One end is passed back around one tooth and the second end is passed back around the other tooth (**Fig. 42.1e**).

8. The ends of the wires are tightened by twisting clockwise with a needle holder (**Fig. 42.1f**).
9. The twisted ends of the wire are bent toward the gingiva to prevent buccal lacerations (**Fig. 42.1g**).
10. The loops on the mandible and maxilla are then wired together with 26-gauge wire to create maxillomandibular fixation (MMF), which immobilizes the mandible (**Fig. 42.1h**).
11. When permanent dentition is available for reduction and fixation, arch bars may be used (**Fig. 42.1i**).
12. A 24- or 26-gauge wire is passed around each of the premolars and molars. The wires are twisted and tightened with a needle holder to hold the arch bars in place on the maxillary or mandibular teeth (**Fig. 42.1i**).
13. The arch bars are secured together with rubber bands or 26-gauge wire to immobilize the mandible (**Fig. 42.1i**).
14. MMF should be removed in approximately 2–3 weeks to avoid ankylosis.
15. Severely displaced fractures may require open reduction and fixation with 1.5-/2.0-mm miniplates (resorbable or titanium).
16. An incision is made below the lower edge of the mandible, taking care to avoid the marginal mandibular division of the facial nerve (**Fig. 42.1j**). One percent lidocaine with 1:100,000 epinephrine is injected at the incision site to aid in hemostasis.
17. The platysma muscle is divided with a knife (**Fig. 42.1k**).
18. The inferior edge of the mandible is exposed by cutting through masseter muscle or periosteum as needed (**Fig. 42.1l**).
19. The periosteum is reflected with an elevator and a hole is drilled in the mandible on each side of the fracture. The fragments are reduced with forceps (**Fig. 42.1m**). The plate must be in a solid portion of the bone and close enough to the lower border of the mandible to avoid injury to the tooth buds (**Fig. 42.1m**).
20. The fracture may be stabilized utilizing miniplates (resorbable vs. titanium). Two screws are placed on either side of the fracture along the inferior border.
21. The wound is closed in layers with absorbable subcutaneous and subcuticular sutures. The wound is drained with a small Penrose drain if needed.
22. Postoperative antibiotics are given for 10 days. The drain is removed in 24–36 hours.

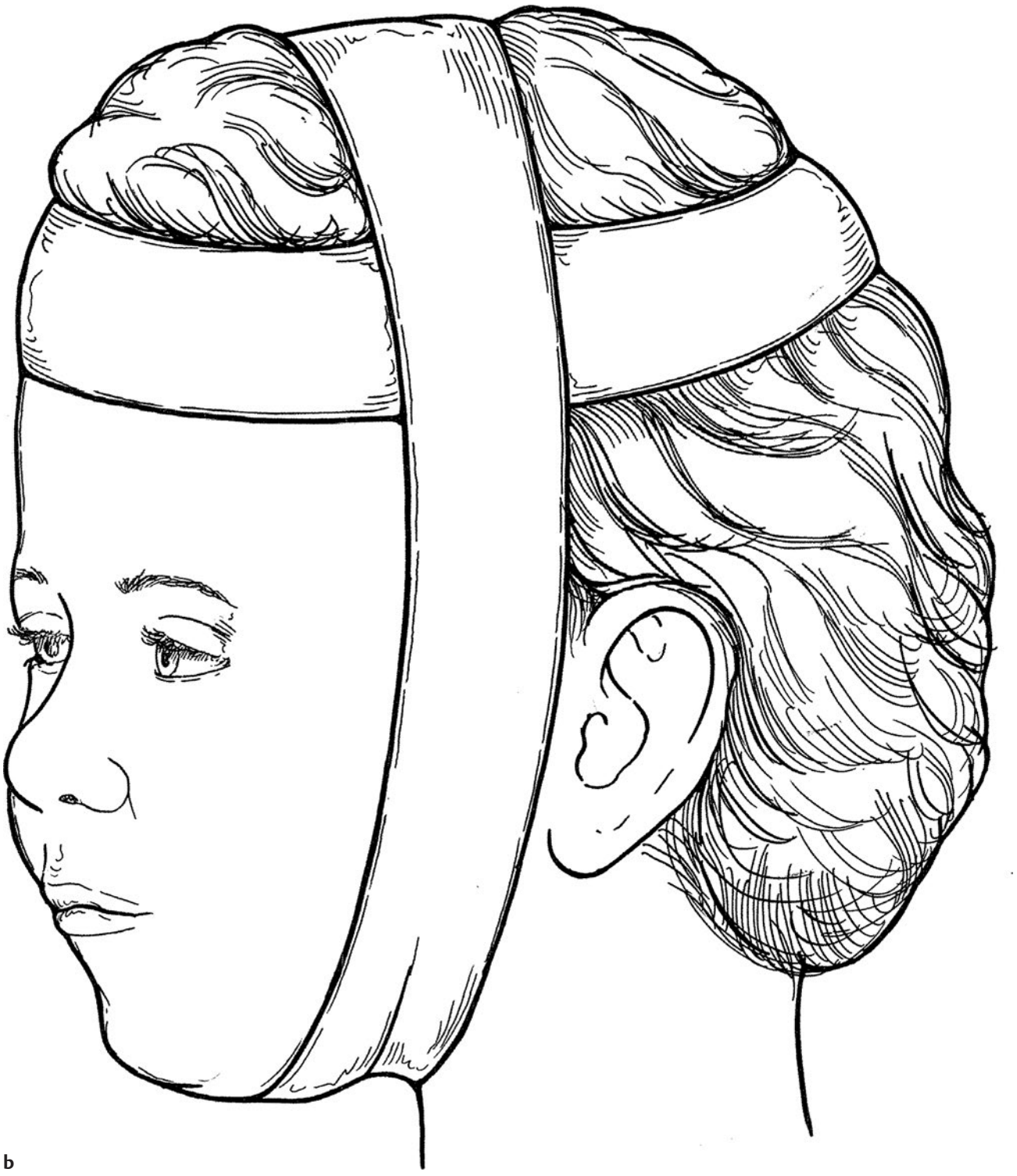
Complications

1. Malunion/nonunion
2. Osteomyelitis
3. Infected plates
4. Hardware failure
5. Loosened teeth/damage to permanent dentition or unerupted teeth
6. Reduced range of motion of the temporomandibular joint



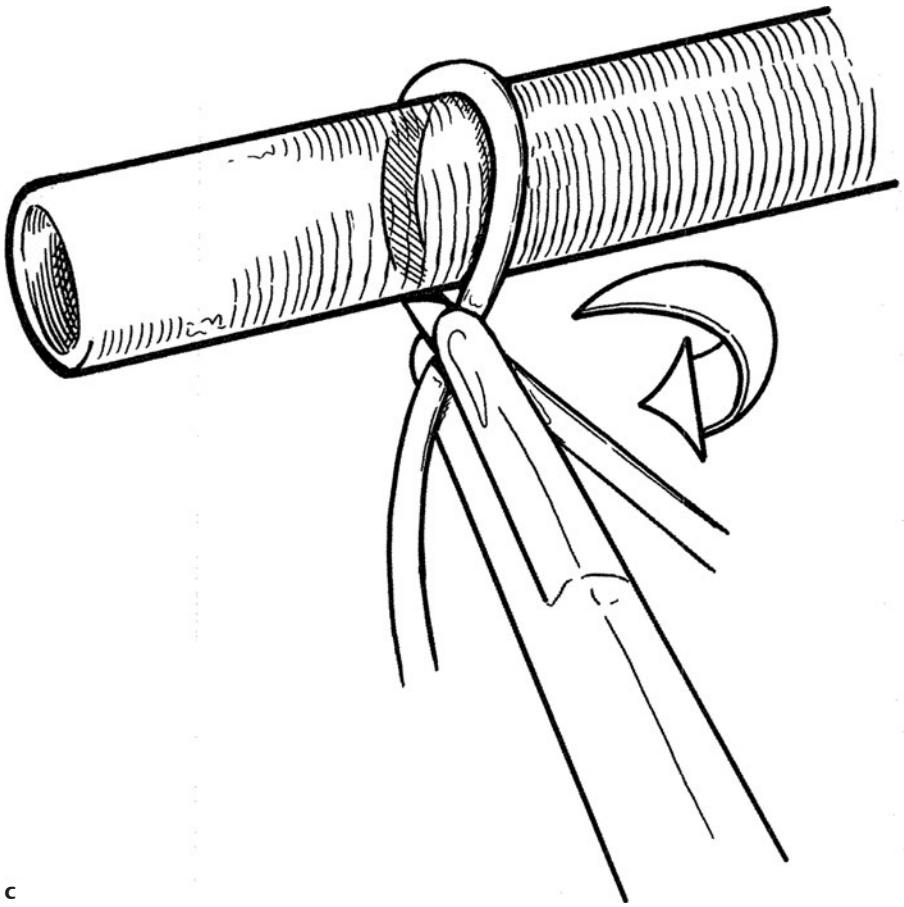
a

Fig. 42.1a



b

Fig. 42.1b

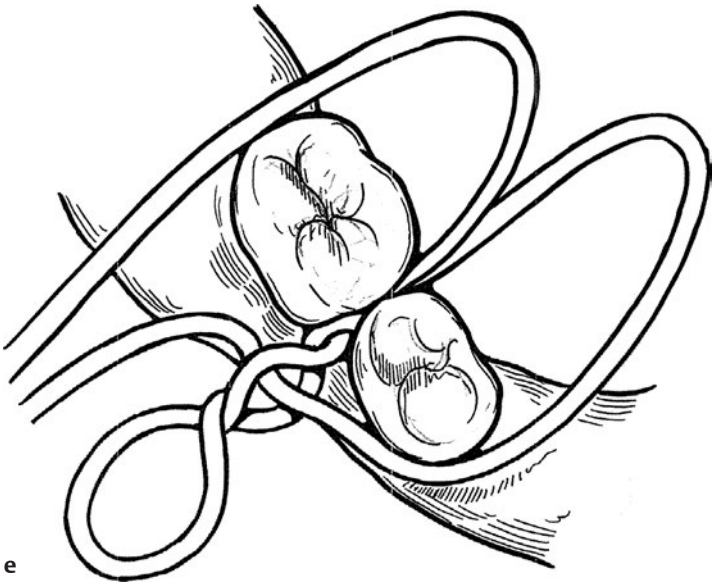


c

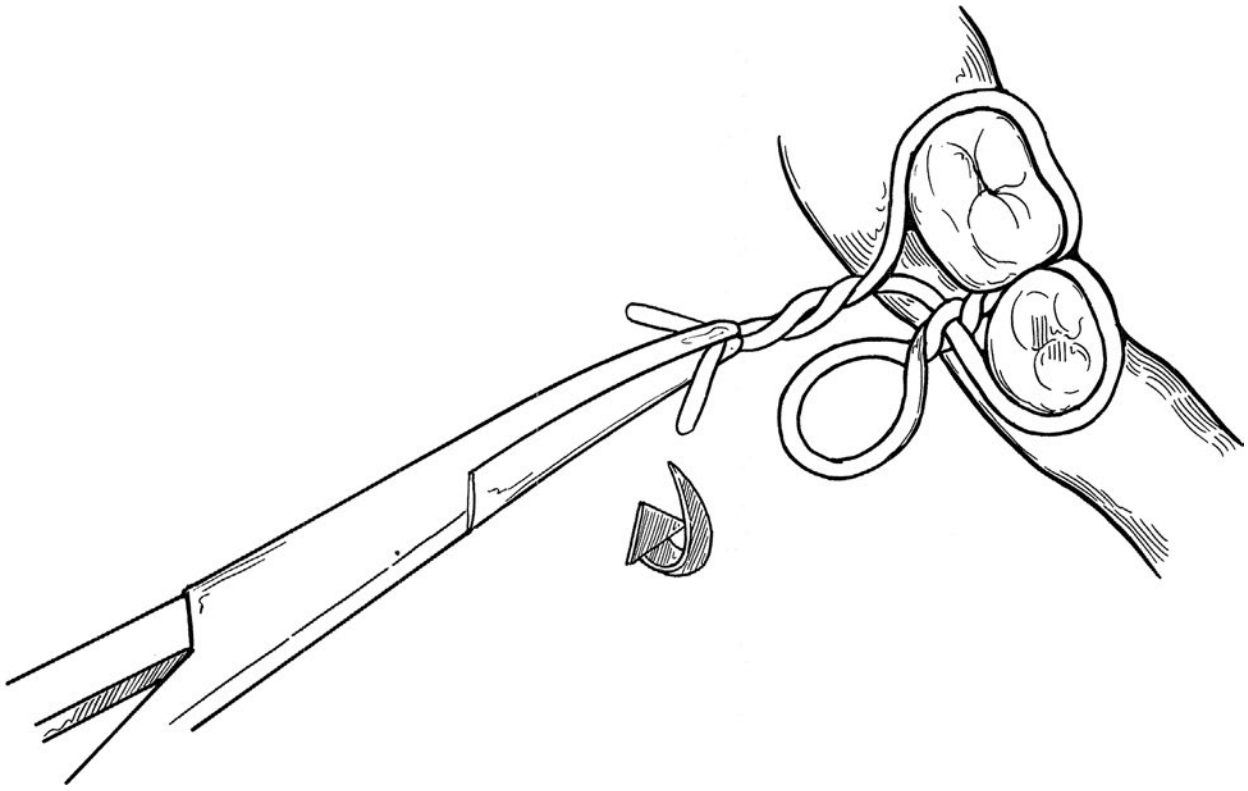


d

Fig. 42.1c,d

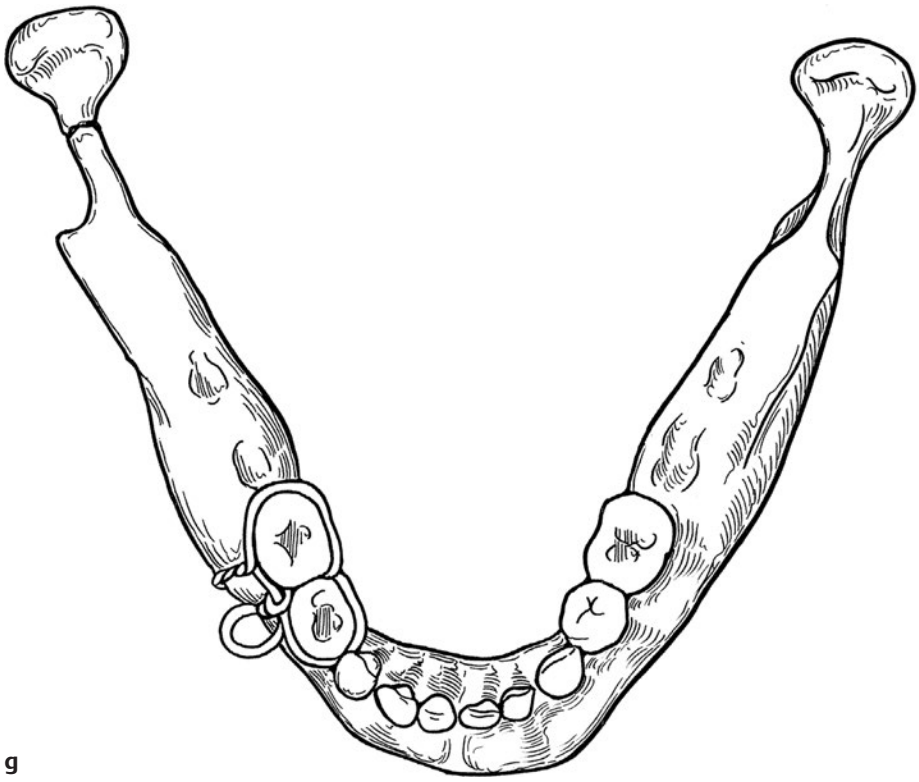


e

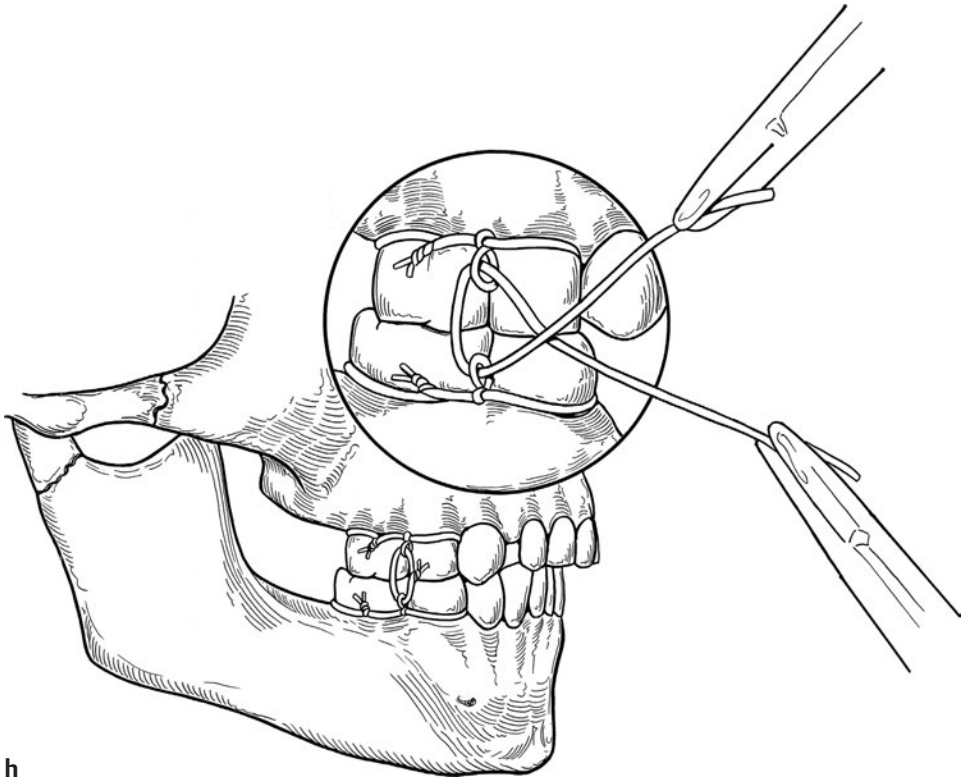


f

Fig. 42.1e,f

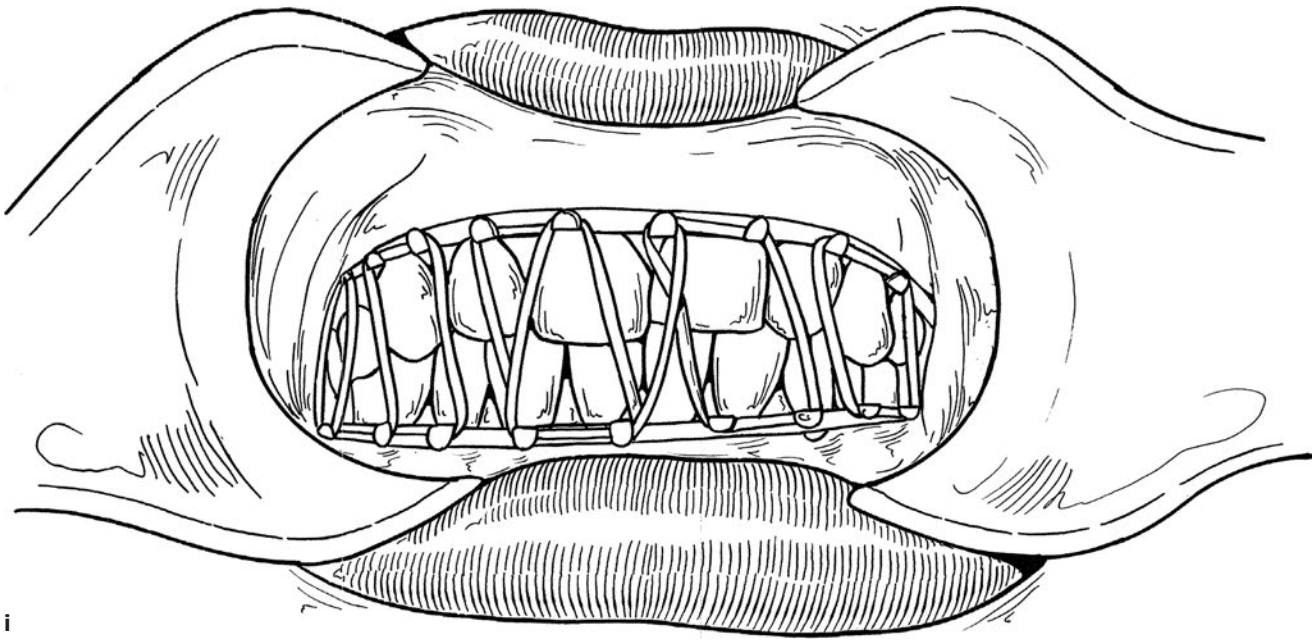


g

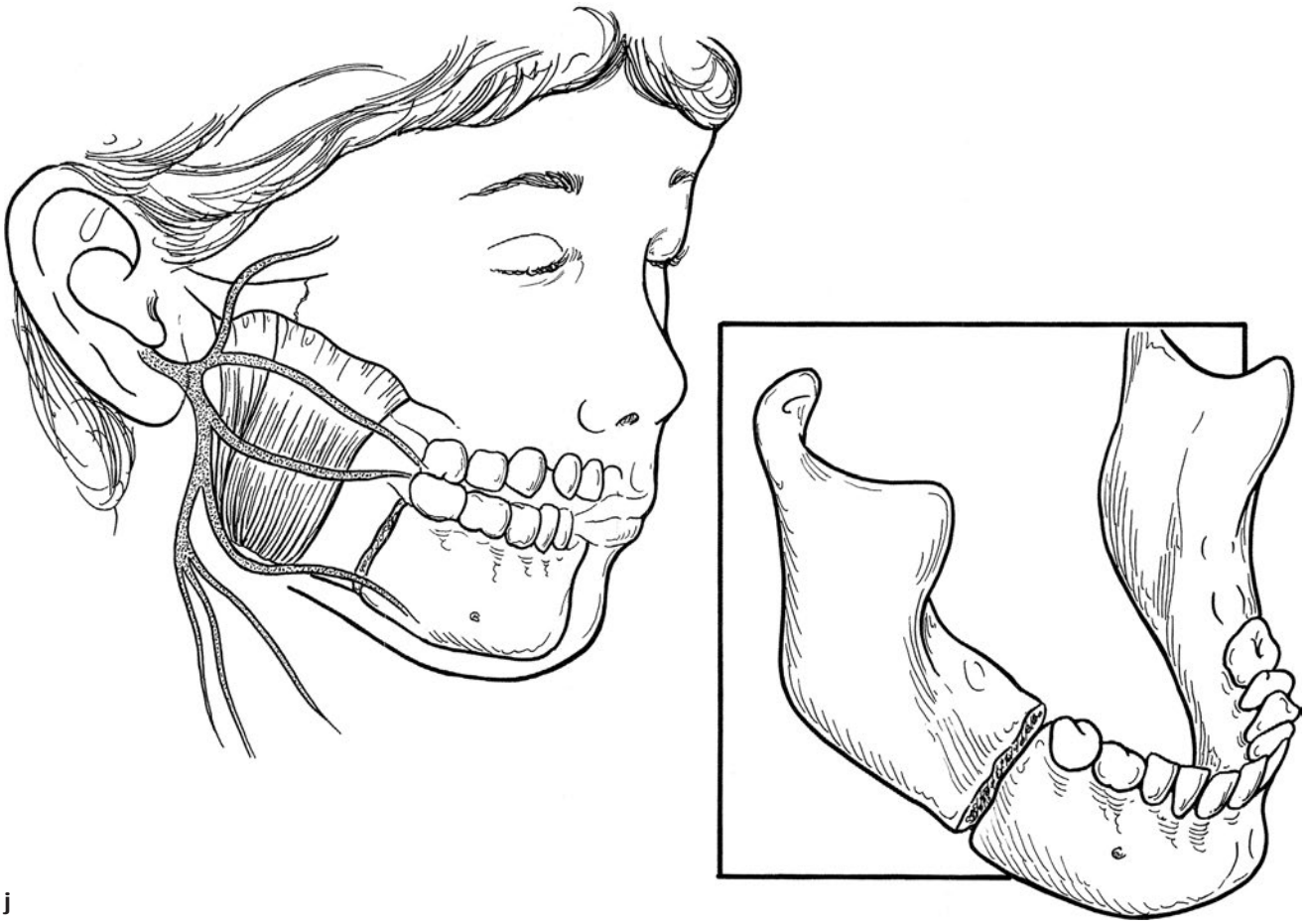


h

Fig. 42.1g,h

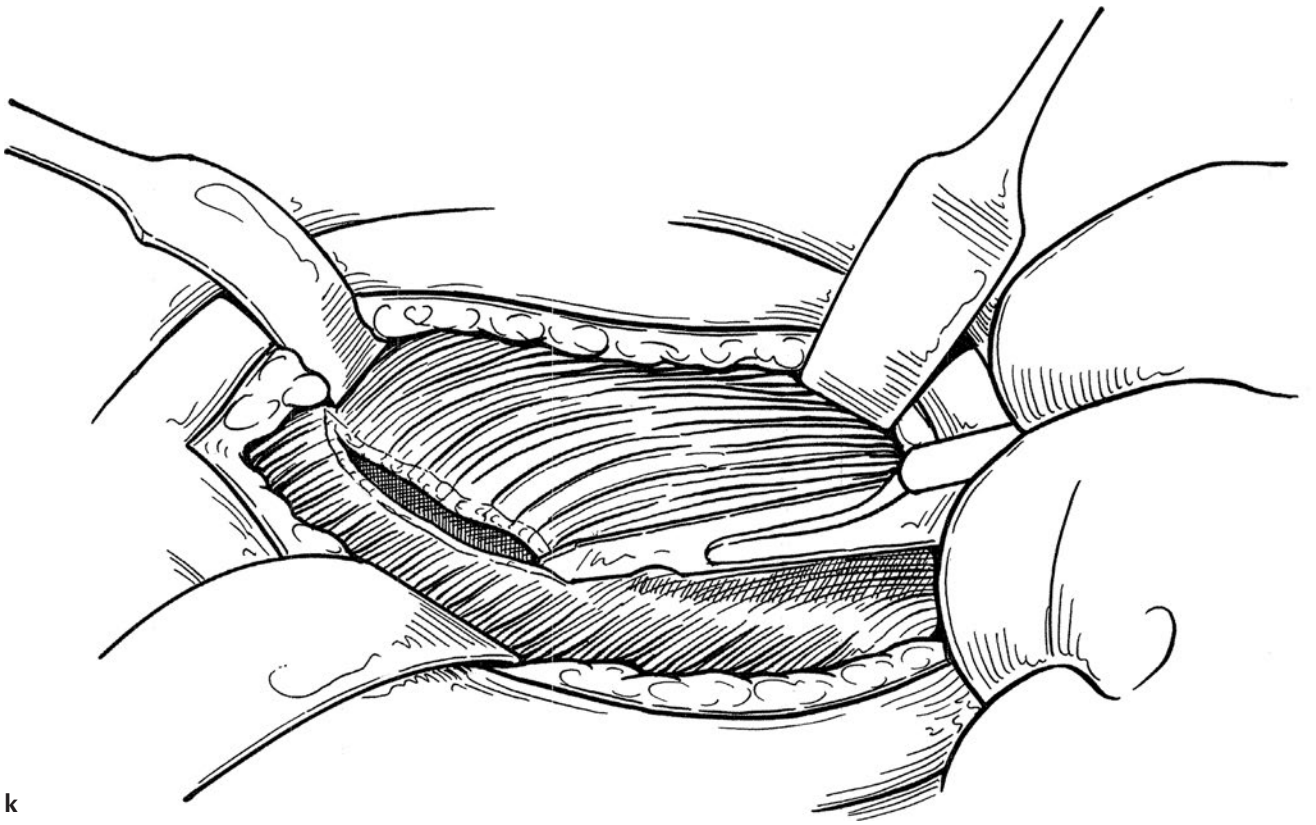


i

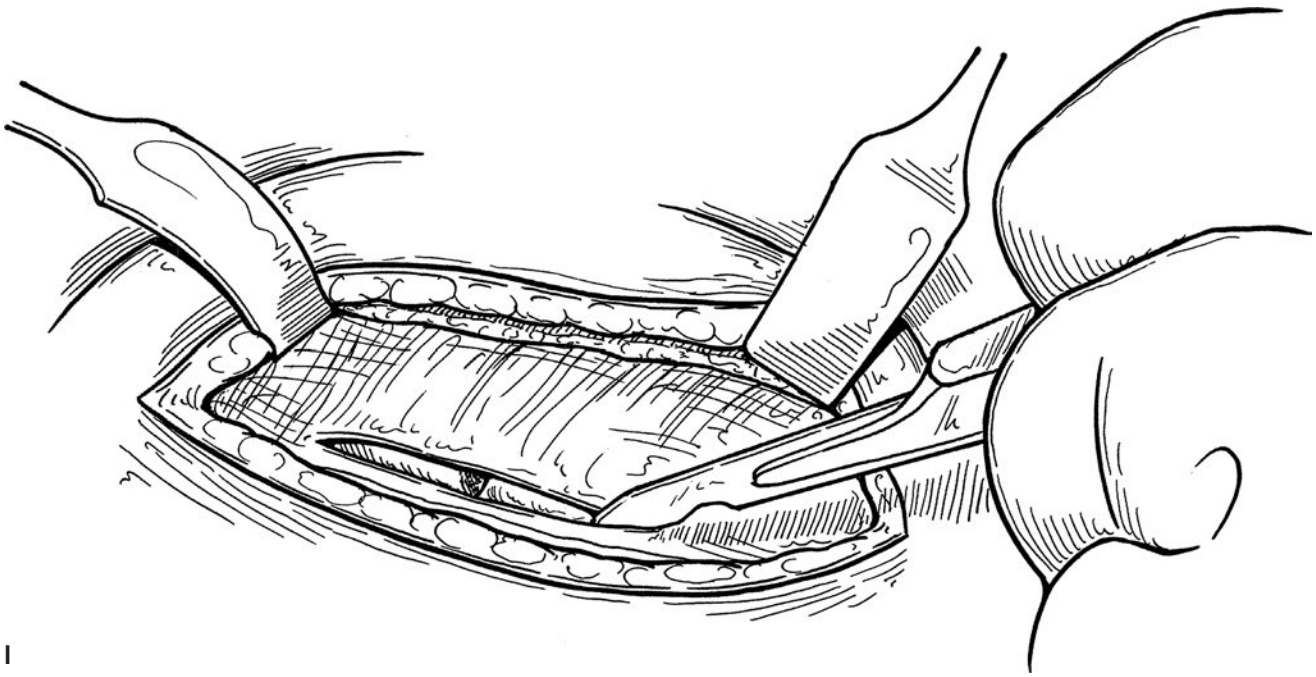


j

Fig. 42.1i,j

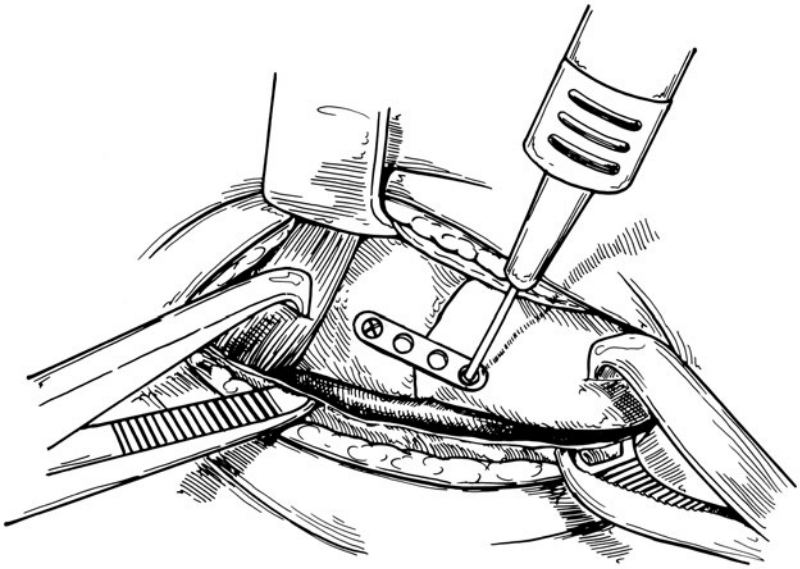


k



l

Fig. 42.1k,l



m

Fig. 42.1m

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