

Chung How Kau · Kenneth Abramovitch
Sherif Galal Kamel · Marko Bozic



Cone Beam CT of the Head and Neck

An Anatomical Atlas

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Preface

This book is dedicated to the memory of the three anonymous individuals whose cadaver dissections are the subject matter of this atlas. We are deeply respectful of and indebted to these anonymous individuals. They unknowingly have made a donation to science that will benefit students and clinicians in the imaging sciences. The handling of the cadaver donations that are displayed in this clinical atlas was managed with respect and driven by our scientific yearn for discovery; the discovery to benefit the current and next generation of clinicians and researchers. These donations will enrich the basic foundational knowledge base of human anatomy as depicted in cone beam CT imaging. The current effort made it possible to correlate the CBCT images with the actual physical image. This is a foundational knowledge base from which to build and make new discoveries. Future generations can then build on this foundational knowledge base to identify bone density states, tissue function profiles (atrophy, hypertrophy, etc) disease states (neoplasia, metaplasia, etc.). We trust that the boundaries have few limits.

These anonymous individuals did not know what value or impact their donation to science has made. But as shepherds, we have guided their donation to generate a high yield for the benefit of future scientific endeavors in the imaging sciences.

We have done all in our power to preserve, protect, and maintain the dignity of these individuals. We did not know them in life but studied them in

death. Whether they have been rich or poor, introverted or extraverted, domineering or submissive, powerful or shy, we honored their remains and dignified their gift.

To the three of you, our deepest thanks.

Chung H. Kau
Kenneth Abramovitch
Marco Bozic
Sherif K. Gala

Acknowledgments

The following people have been involved in the project without which this atlas would never have been completed:

1. Professor Mark Wong
2. Dr. Fen Pan
3. Dr. Hasmat Popat
4. Miss Jennifer Nguyen
5. Mr. Kurt E Clark
6. Dr. Nada Souccar

Contents

Introduction	1
Conventional Computed Tomography	2
CBCT	3
CBCT Data	4
CBCT Acquisition Systems	5
Uses of CBCT Technology.....	6
Diagnosis.....	6
Clinical Applications of the CBCT	7
Late Evaluation with CBCT	7
The Purpose of the Clinical Atlas.....	8
References	8
Axial	11
Coronal	31
Sagittal	47

Introduction

This pocket clinical atlas was produced to help dental and medical colleagues understand and correlate structures of the head and neck with cone beam computerized tomography (CBCT) imaging technology.

Methods used for radiographic evaluation and diagnosis have undergone enormous changes in the last 20 years. New technologies are being developed and are becoming readily available to the medical and dental field. The advancements in hardware and software have allowed the development of innovative methods for facial diagnosis, treatment planning, and clinical application.

CBCT was developed in the 1990s as an advancement in technology resulting from the demand for three-dimensional (3D) information obtained by conventional computed tomography (CT) scans. The development of CBCT technology reduces exposure by using lower radiation dose, compared with conventional CT [1–3]. As the demand for the technology increases, so has the market for custom built cranio-maxillofacial CBCT devices. The rates of increase for CBCTs have been increasing in number on the market over the last decade and a variety of applications to the facial and dental environments have been established [2].

Conventional Computed Tomography

CT technology was developed by Sir Godfrey Hounsfield in 1967 and there has been a gradual evolution to five generations of the system. First generation scanners consisted of a single radiation source and a single detector and information was obtained slice by slice. The second generation was introduced as an improvement and multiple detectors were incorporated within the plane of the scan. The third generation was made possible by the advancement in detector and data acquisition technology. These large detectors reduced the need for the beam to translate around the object to be measured and were often known as the “fan-beam” CTs. Ring artifacts were often seen on

the images captured distorting the 3D image and obscuring certain anatomical landmarks. The fourth generation was developed to counter this problem. A moving radiation source and a fixed detector ring were introduced. This meant that modifications to the angle of the radiation source had to be taken into account and more scattered radiation was seen. Finally the fifth (sometimes known as the sixth) generation scanners were the introduction to reduced “motion” or “scatter” artifacts. As with the previous two generations, the detector is stationary and the electron beam is electronically swept along a semicircular tungsten strip anode. Projections of the X-rays are so rapid that even the heart beat may be captured. This has led some clinicians to hail it as a 4D motion capture device [2, 4]. In 2007, the Toshiba “dynamic volume” scanner based on 320 slices is showing the potential to significantly reduce radiation exposure by eliminating the requirement for a helical examination in both cardiac CT angiography and whole brain perfusion studies for the evaluation of stroke [online reference, 1].

There are, however, limitations to these CT systems. They are expensive and require a lot of space. The 3D reconstruction is time consuming and so less cost efficient. Furthermore the radiation exposure to the patient has limited their usage to complex craniofacial problems and for specialized diagnostic information only.

CBCT

CBCTs for dental, oral, and maxillofacial surgery and orthodontic indications were designed to counter some of the limitations of the conventional CT scanning devices. The radiation source consists of a conventional low-radiation X-ray tube and the resultant beam is projected onto a flat panel detector (FPD) or a charge-coupled device (CCD) with an image intensifier. The FPD was shown to have a high spatial resolution [5]. The cone beam produces a more focused beam and much less radiation scatter compared with the conventional fan-

shaped CT devices [6]. This significantly increases the X-ray utilization and reduces the X-ray tube capacity required for volumetric scanning [7]. It has been reported that the total radiation is approximately 20% of conventional CTs and equivalent to a full mouth periapical radiographic exposure [8]. CBCT can therefore be recommended as a dose-sparing technique compared with alternative standard medical CT scans for common oral and maxillofacial radiographic imaging tasks [9]. The images are comparable to the conventional CTs and may be displayed as a full head view, as a skull view, or as localized regional views.

CBCT Data

The tube and the detector perform one rotation (180 or 360°) around the selected region. The resulting primary data are converted into slice data. The reconstructed slice data can be viewed in user-defined planes. The CT volume consists of a 3D array of image elements, called voxels. Each voxel is characterized with a height, width, and depth. Since the voxel sizes are known from the acquisition, correct measurements can be performed on the images. The spatial resolution in a CT image depends on a number of factors during acquisition (e.g., focal spot, size detector element...) and reconstruction (reconstruction kernel, interpolation process, voxel size). Image noise depends on the total exposure and the reconstruction noise. Increasing the current in the X-ray tube increases the signal-to-noise ratio, and thus reduces the quantum noise of the statistical nature of X-rays, at the expense of patient dose. The artifacts of CT imaging are the consequence of beam hardening, photon scattering, nonlinear partial volume effect, motion, stair step artifact, and others.

Most machines support the digital imaging and communications in medicine (DICOM) format export. The images can therefore be used for most if not all the (software) applications utilized by conventional CT [10].

The following is a summary of the additions and modifications of CBCT as compared with conventional CT, which make CBCT a more appealing alternative:

- Radiation dose is lower. This is mainly because of the lower effective tube current used for the CBCT: while the voltage of the source is approximately the same (90–120 kV), the current is roughly between 1 and 8 mA for the CBCT while e.g., for the multislice CT the current is around 80 mA but can also be as high as 200 mA.
- Detection systems are different (FPD or CCD with image intensifier).
- The resolution is higher; this is mainly due to lesser isotropic voxel size [11].
- There is less artifacts caused by metallic structures but because of lower dose there is more noise and detailed information about soft tissues is lost [10].
- CBCT is less expensive and smaller.

CBCT Acquisition Systems

In 2005, four main CBCT devices were reported in the literature and it was expected that many companies were to enter the market [2]. In July 2008, there were 16 manufacturers of CBCT devices producing 23 different models. There are various classifications of devices but CBCT devices may be divided to fit into four subcategories based on the need of the clinician: and one field of view of the scan (FOV)

- Dentoalveolar (FOV less than 8 cm)
- Maxillo-mandibular (FOV between 8 and 15 cm)
- Skeletal (FOV between 15 and 21 cm)
- Head and neck (FOV above 21 cm)

The important differences besides the clinical classification are the radiation dose, size and weight, time needed for the reconstruction, voxel size, scanning time etc. Furthermore the differences in prices, software, and warranty are important considerations.

Uses of CBCT Technology

Radiographic evaluation and diagnosis have undergone enormous changes in the last 20 years. The important differences between the devices are their FOV, the irradiation dose, size and weight, time needed for the reconstruction, voxel size, scanning time, price, software and warranty. The use of CBCT has many applications. The indications for the CBCT imaging has not been clearly established yet. However, CBCT imaging may be used for the following reasons:

1. Diagnosis
2. Clinical application
3. Clinical evaluation of treatment outcomes

Diagnosis

Common uses of CBCT technology in the head and neck is for impacted teeth evaluation [13], implant treatment planning [14], evaluations of the temporomandibular joint (TMJ) [15], simulations for orthodontic and surgical planning, diagnosis of dento-alveolar pathology, evaluation of the nasal/paranasal sinuses, and pharyngeal airways [16]. Furthermore, craniofacial anomalies, for example cleft patients and those undergoing combined orthodontic and maxillofacial therapy, benefit greatly from CBCT imaging as the technology provides more information than conventional images [17]. There has been a debate on the routine use of technology in orthodontics and further studies are needed [18]. It has also been proven that CBCT is accurate to identify apical periodontitis [19]. A recently suggested CBCT-aided method for determination of root curvature radius allows a more reliable and predictable endodontic planning, which reflects directly on a more efficacious preparation of curved root canals [20]. CBCT provides better diagnostic and quantitative information on periodontal bone levels in three dimensions than conventional radiography [21]. CBCT can also

be used for maxillofacial growth and development assessment and dental age estimation [22].

Clinical Applications of the CBCT

CBCT provides information for 3D models made by rapid prototyping. The obtained 3D models can serve as a matrix that enables precise planning of operations such as for mini-implant positions in anatomically complex sites [23]. A recent study that included phantoms and human cadavers showed that intraoperative CBCT quantifiably improved surgical performance in all excision tasks and significantly increased surgical confidence. Such intraoperative imaging in combination with real-time tracking and navigation should be of great benefit in delicate procedures in which excision must be executed in close proximity to critical structures [24]. Another study included 179 patients undergoing facial surgery and intraoperative CBCT was used. The acquisition of the data sets was uncomplicated, and image quality was sufficient to assess the postoperative result in all cases [25].

Late Evaluation with CBCT

CBCT is also a tool for the evaluation of surgical and orthodontic treatment. There have not been a lot of papers published but they are increasing in their number as the CBCT is becoming more readily available. CBCT was successfully used to compare the anteroposterior positions of the cleft-side piriform margin and alar base with those of the noncleft side in 52 postoperative unilateral cleft lip patients with no alveolar bone graft [26]. CBCT can be used in combination with 3D soft tissue data obtained with stereo photogrammetry, structured light systems and laser acquisition systems for diagnostic, treatment planning and posttreatment evaluation purposes [27]. Evaluation of the nasal and paranasal sinuses and of the pharyngeal airway is also becoming more relevant.

The Purpose of the Clinical Atlas

The purpose of this clinical atlas is to provide every dental or medical colleague with the platform to observe and understand images from the Cone Beam Technology. Great care has been put into the dissection of the cadavers and the reproductions of the slice sections both on the human specimens and the CBCT image.

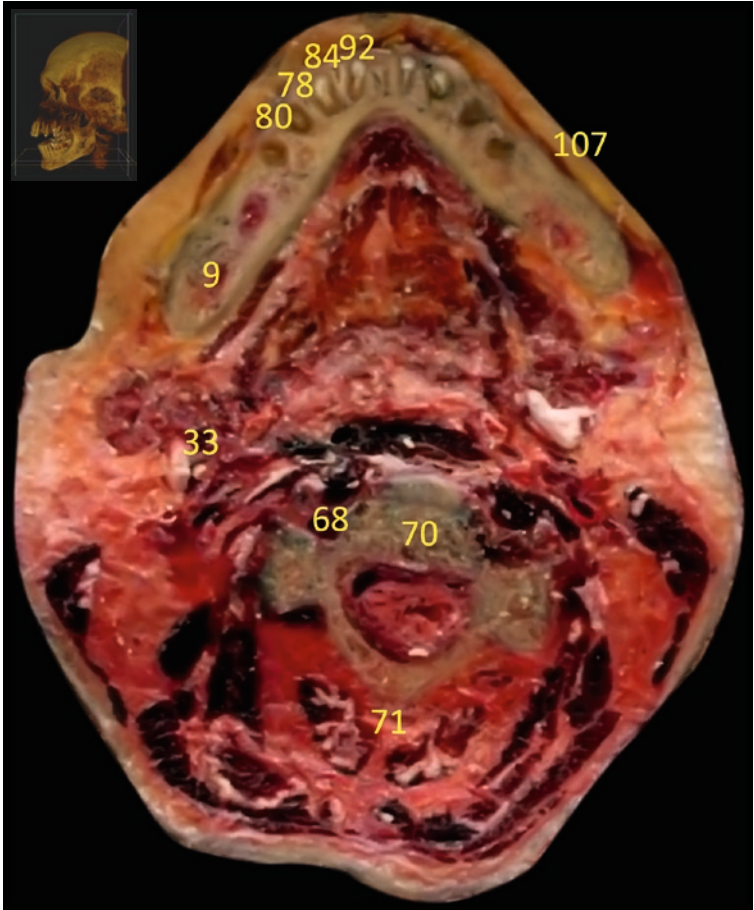
It is hoped that this will serve as a reference for all who are working in the area of CBCT imaging of the head and neck.

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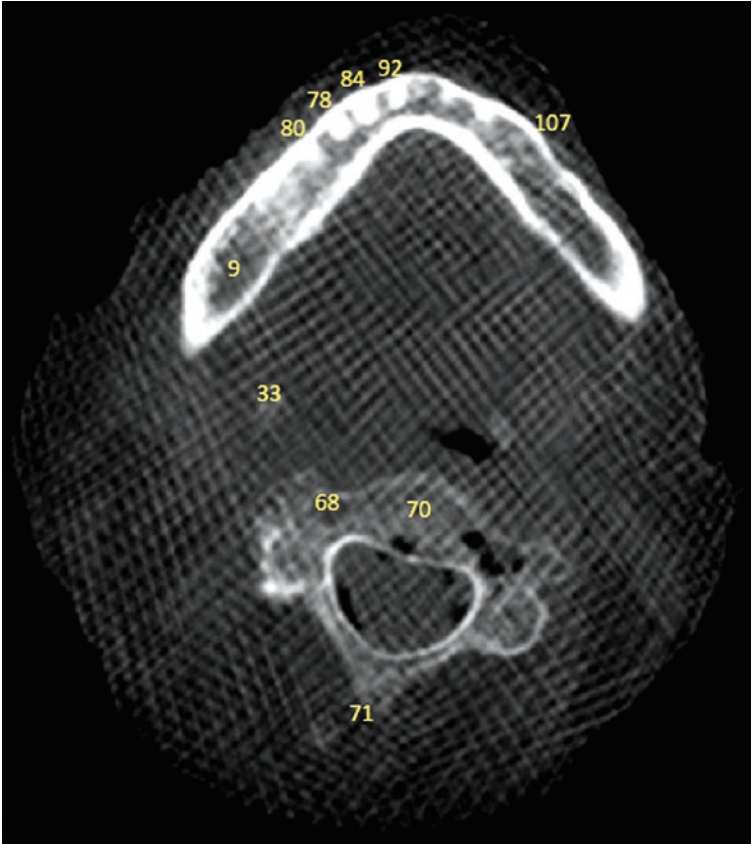
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Axial

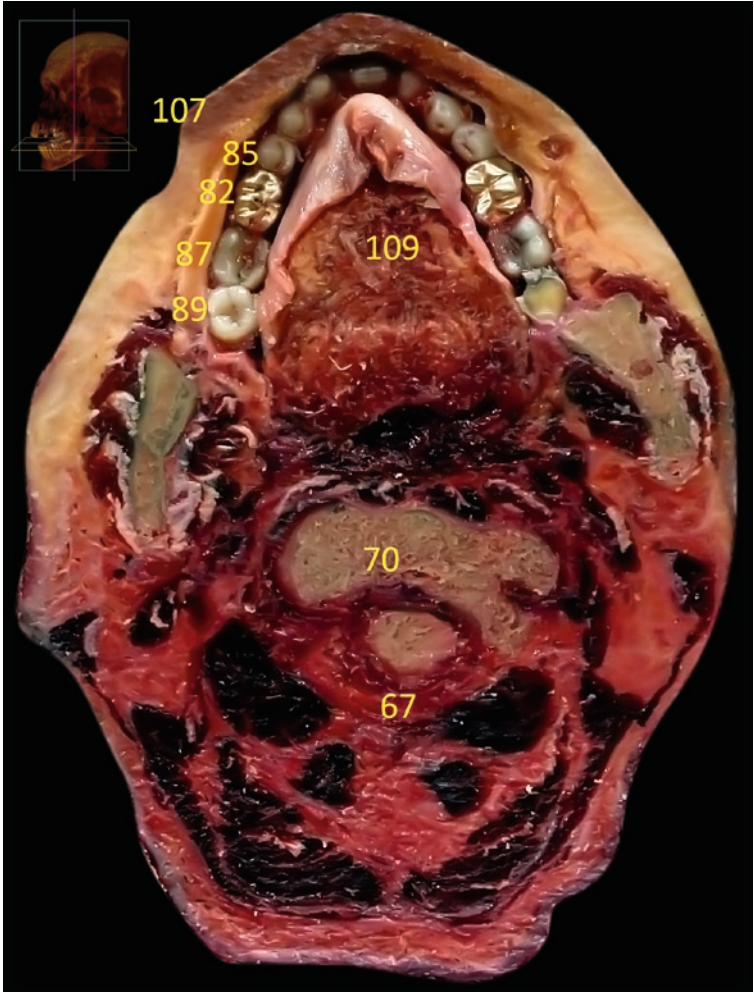


9 – Mandible-body
33 – Temporal bone-styloid process
68 – C2 Axis-transverse process
70 – C2 Axis-body
71 – C2 Axis-spine

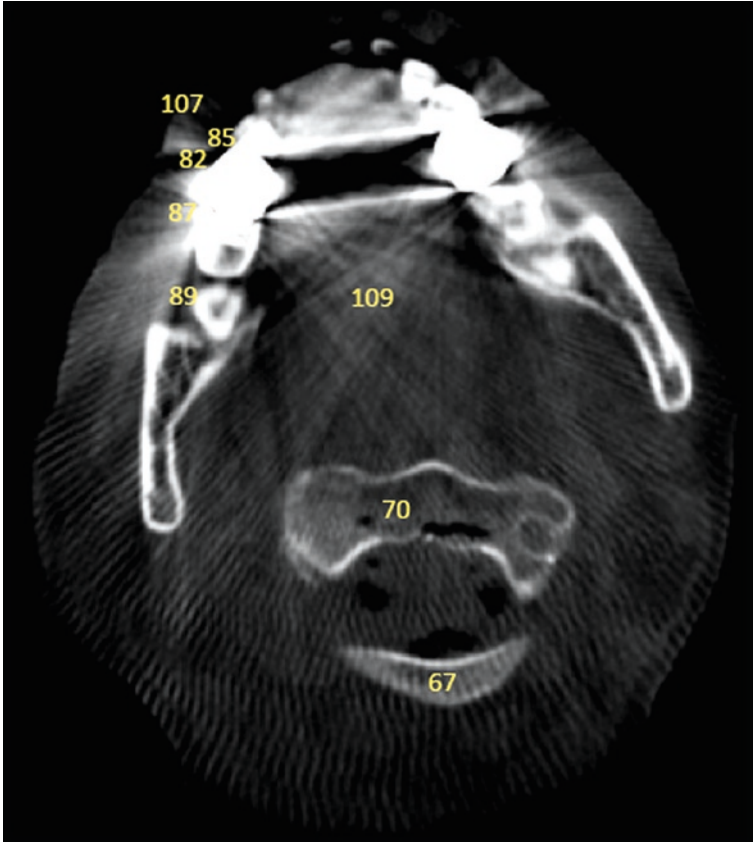
78 – Mandibular cuspid (Root)
80 – Mandibular first bi-cuspid (Root)
84 – Mandibular lateral incisor teeth (Root)
92 – Maxillary central incisor teeth (Root)
107 – Face



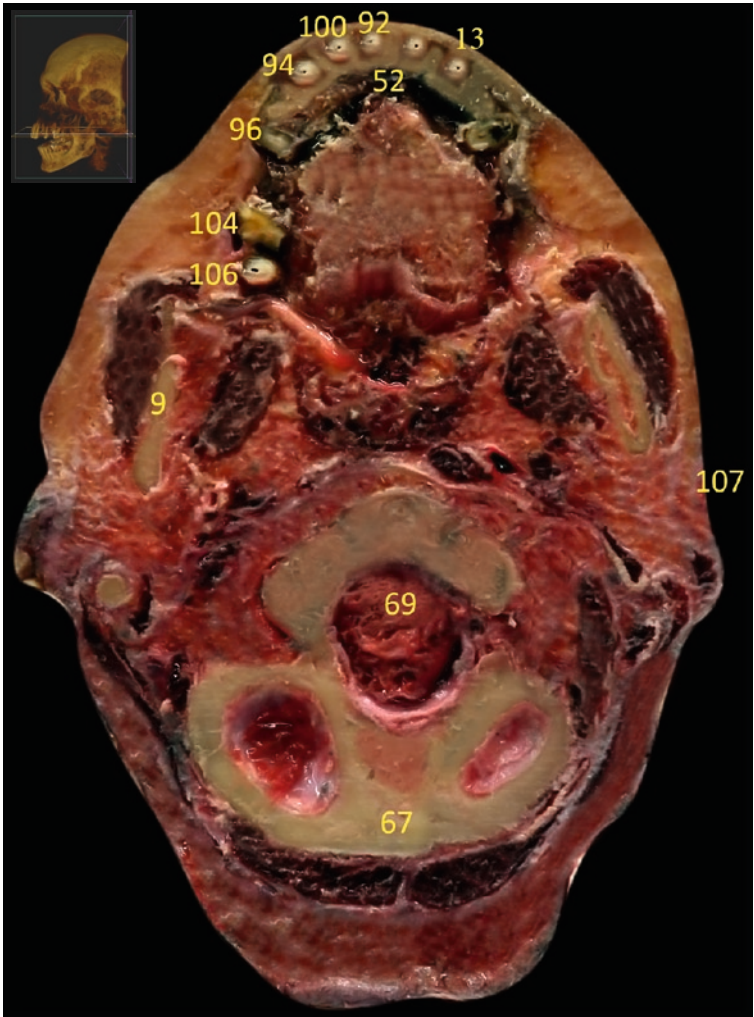
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33 – Temporal bone-styloid process	80 – Mandibular first bi-cuspid (Root)
68 – C2 Axis-transverse process	84 – Mandibular lateral Incisor teeth (Root)
70 – C2 Axis-body	92 – Maxillary central incisor teeth (Root)
71 – C2 Axis-spine	107 – Face



67 – C1 Atlas-posterior arch/ tubercle	87 – Mandibular second molar (Crown)
70 – C2 Axis-body	89 – Mandibular third molar (Crown)
82 – Mandibular first molar (Root)	107 – Face
85 – Mandibular second bi-cuspid (Crown)	109 – Tongue

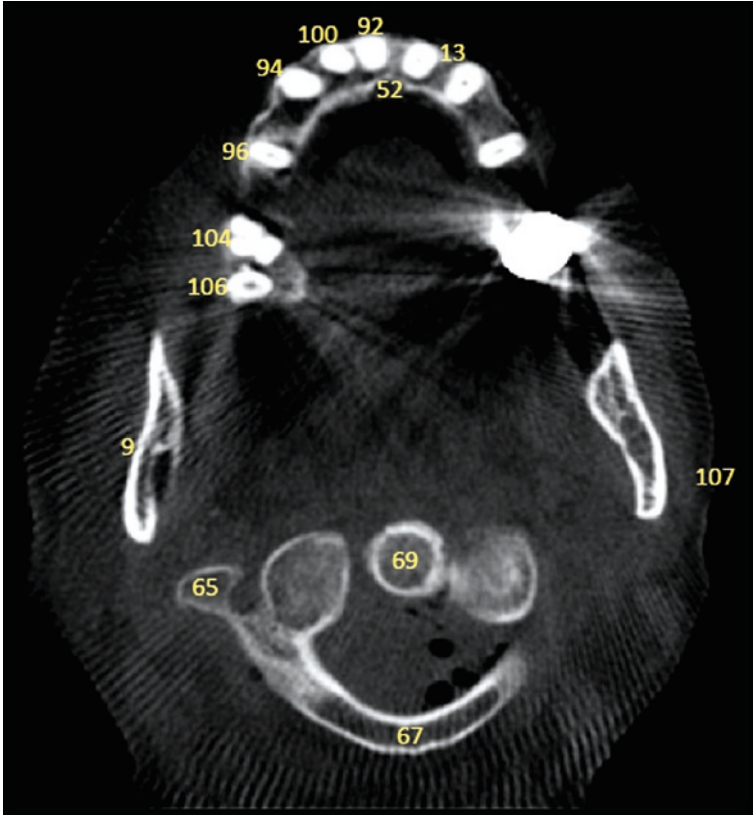


67 – C1 Atlas-posterior arch/ tubercle	87 – Mandibular second molar (Crown)
70 – C2 Axis-body	89 – Mandibular third molar (Crown)
82 – Mandibular first molar (Root)	107 – Face
85 – Mandibular second bi-cuspid (Crown)	109 – Tongue

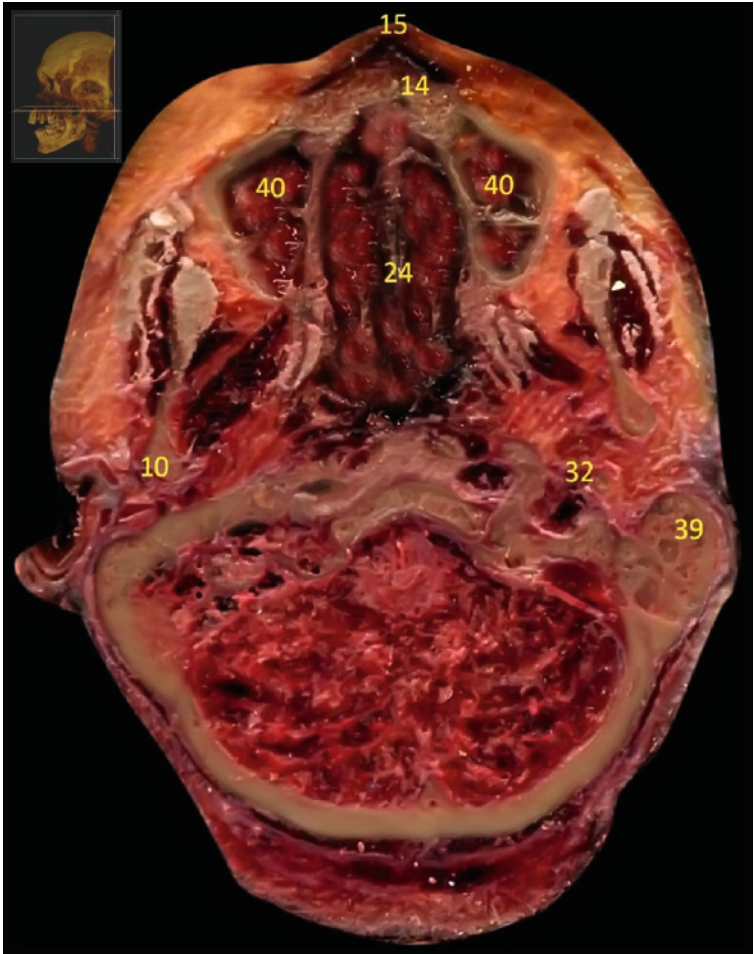


- 9 – Mandible-body
- 13 – Maxilla-alveolar bone
- 52 – Incisive canal
- 65 – C1 Atlas-body
- 67 – C1 Atlas-posterior arch/tubercle
- 69 – C2 Axis-dens
- 92 – Maxillary central incisor teeth (Root)

- 94 – Maxillary cuspid (Root)
- 96 – Maxillary first bi-cuspid (Root)
- 100 – Maxillary lateral incisor teeth (Root)
- 104 – Maxillary second molar (Root)
- 106 – Maxillary third molar (Root)
- 107 – Face



- 9 – Mandible-body
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- 100 – Maxillary lateral incisor teeth (Root)
- 104 – Maxillary second molar (Root)
- 106 – Maxillary third molar (Root)
- 107 – Face



10 – Mandible-condyle

14 – Maxilla-anterior

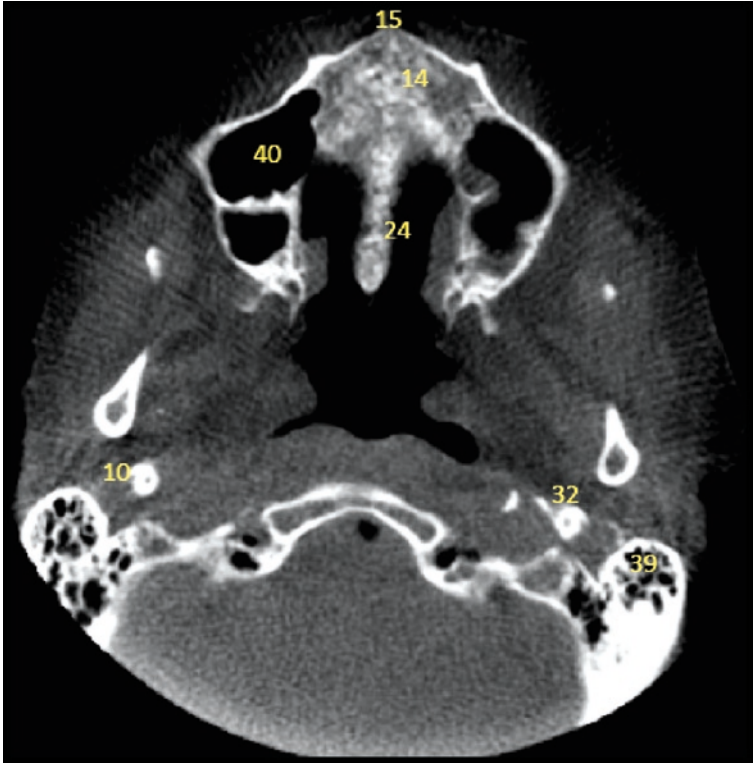
15 – Maxilla-anterior nasal spine

24 – Palatine bone-vomer

32 – Temporal bone

39 – Mastoid air cells

40 – Maxillary sinus



10 – Mandible-condyle

14 – Maxilla-anterior

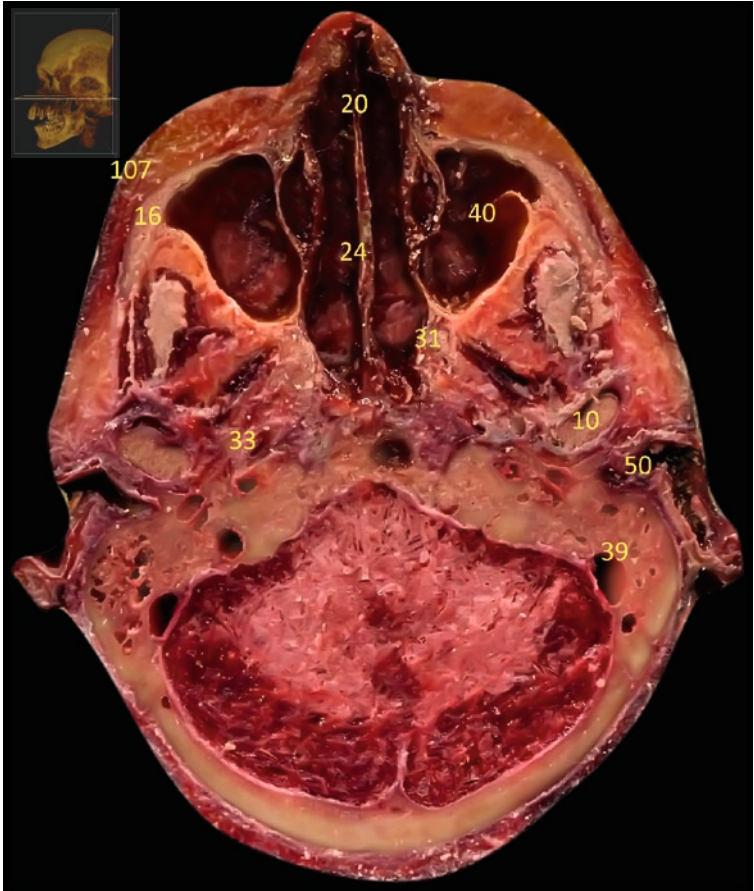
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24 – Palatine bone-vomer

32 – Temporal bone

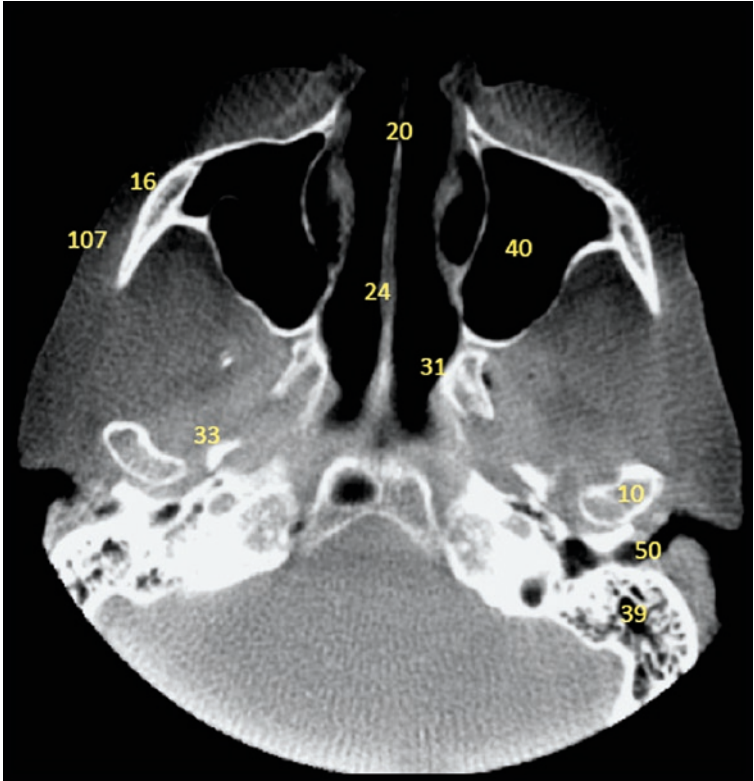
39 – Mastoid air cells

40 – Maxillary sinus



- 10 – Mandible-condyle
- 16 – Maxilla-zygomatic process
- 20 – Nasal septum
- 24 – Palatine bone-vomer
- 31 – Sphenoid bone

- 33 – Temporal bone-styloid process
- 39 – Mastoid air cells
- 40 – Maxillary sinus
- 50 – Auricular canal
- 107 – Face

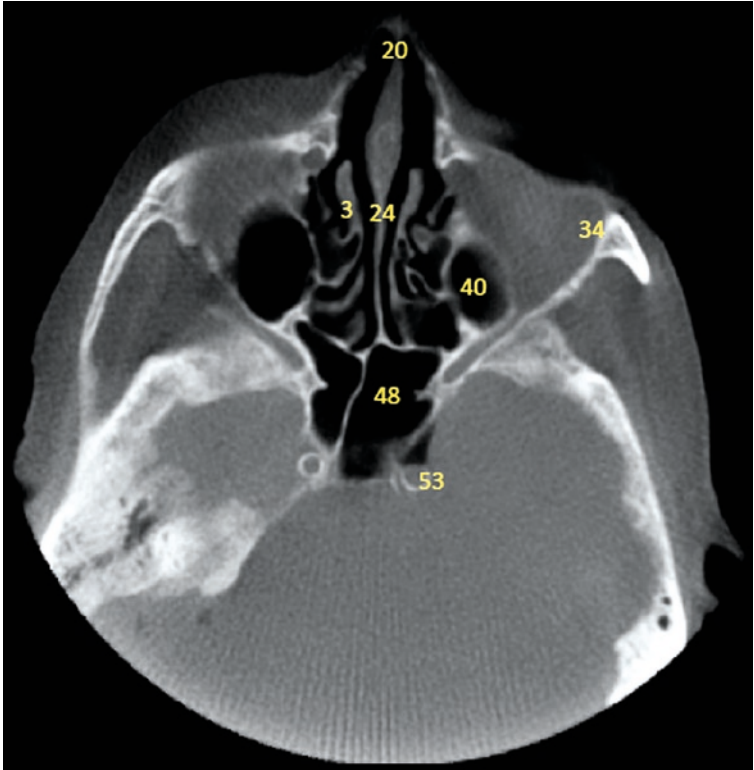


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|-----------------------------------|------------------------------------|
| 10 – Mandible-condyle | 33 – Temporal bone-styloid process |
| 16 – Maxilla-zygomatic process | 39 – Mastoid air cells |
| 20 – Nasal septum | 40 – Maxillary sinus |
| 24 – Palatine bone – <i>vomer</i> | 50 – Auricular canal |
| 31 – Sphenoid bone | 107 – Face |



3 – Concha-superior
20 – Nasal septum
24 – Palatine bone-vomer
34 – Zygoma

40 – Maxillary sinus
48 – Sphenoid sinus
53 – Internal carotid artery



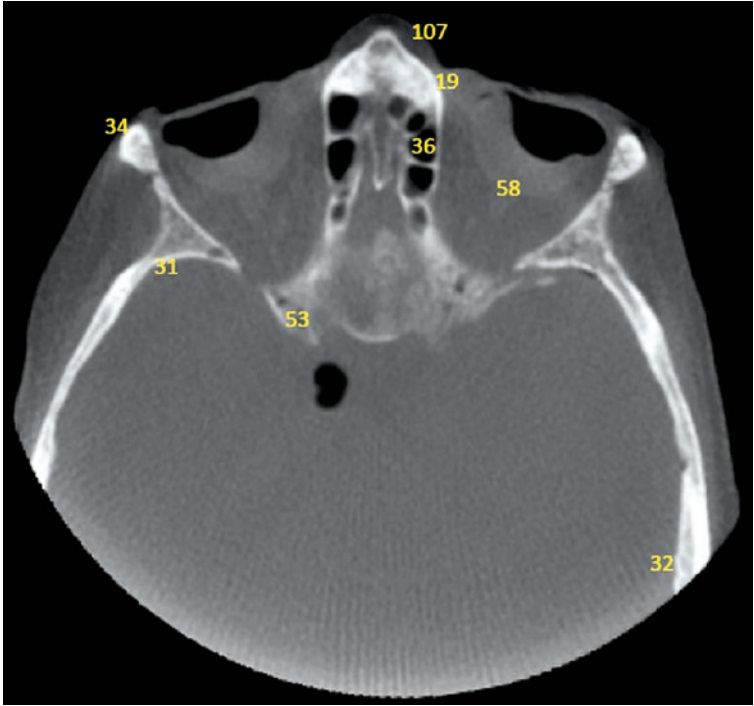
3 – Concha-superior
20 – Nasal septum
24 – Palatine bone-*vomer*
34 – Zygoma

40 – Maxillary sinus
48 – Sphenoid sinus
53 – Internal carotid artery



19 – Nasal bone
31 – Sphenoid bone
32 – Temporal bone
34 – Zygoma

36 – Ethmoid sinus
53 – Internal carotid artery
58 – Orbit
107 – Face

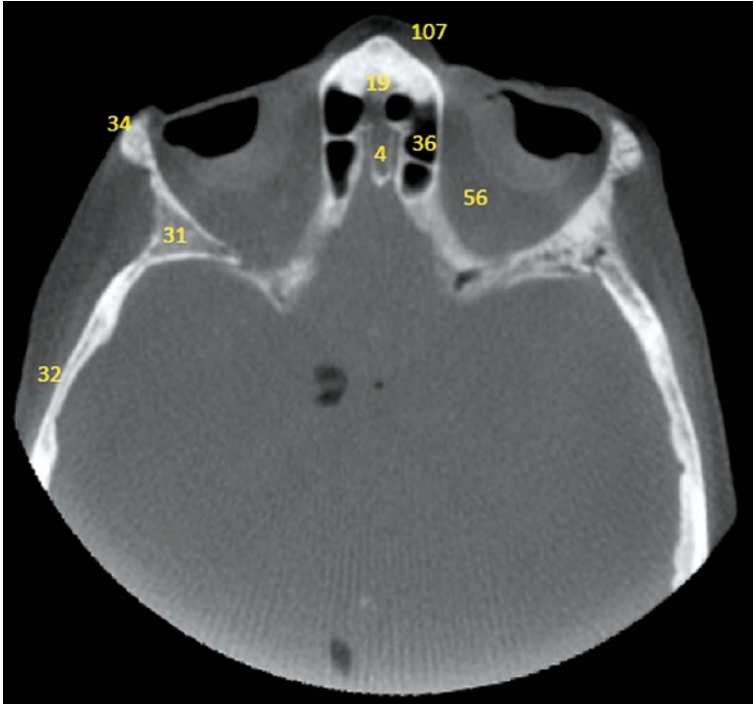


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|--------------------|------------------------------|
| 19 – Nasal bone | 36 – Ethmoid sinus |
| 31 – Sphenoid bone | 53 – Internal carotid artery |
| 32 – Temporal bone | 58 – Orbit |
| 34 – Zygoma | 107 – Face |



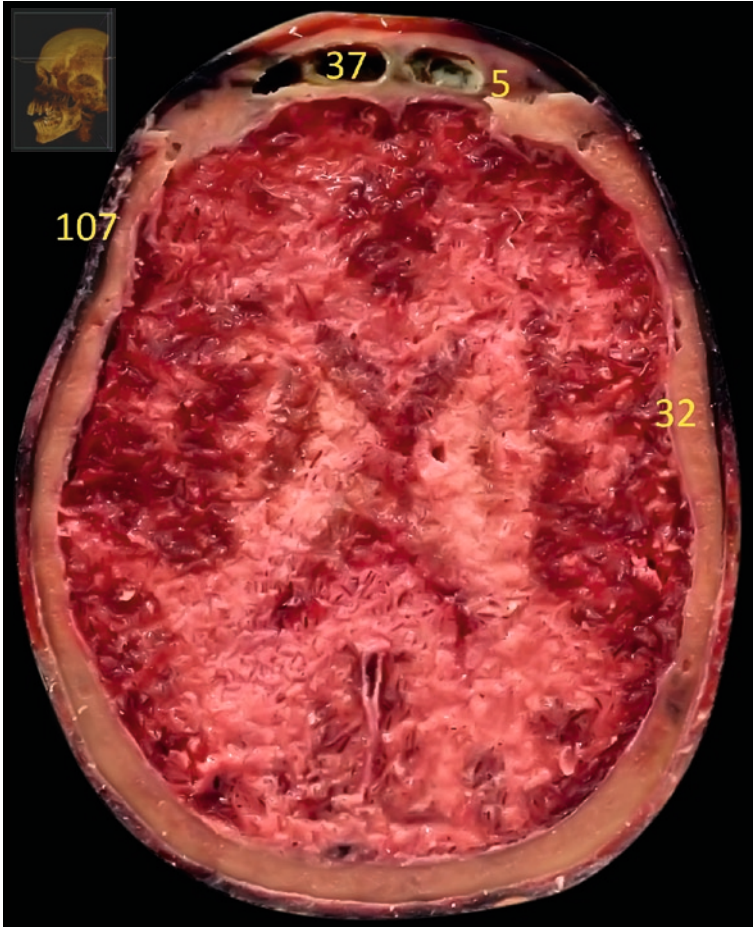
4 – Ethmoid bone-*crista galli*
19 – Nasal bone
31 – Sphenoid bone
32 – Temporal bone

34 – Zygoma
36 – Ethmoid sinus
56 – Optic nerve canals
107 – Face



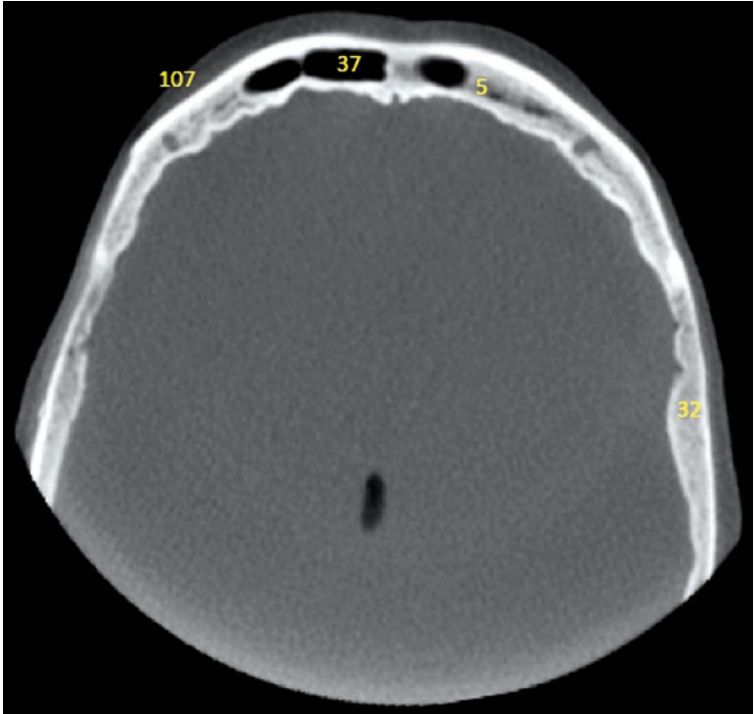
4 – Ethmoid bone-*Crista galli*
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31 – Sphenoid bone
32 – Temporal bone

34 – Zygoma
36 – Ethmoid sinus
56 – Optic nerve canals
107 – Face



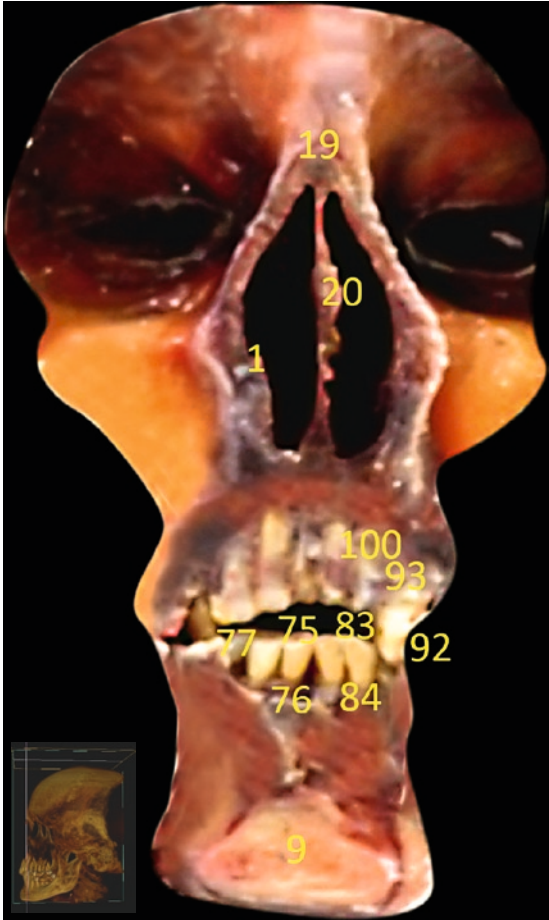
5 – Frontal bone
32 – Temporal bone

37 – Frontal sinus
107 – Face

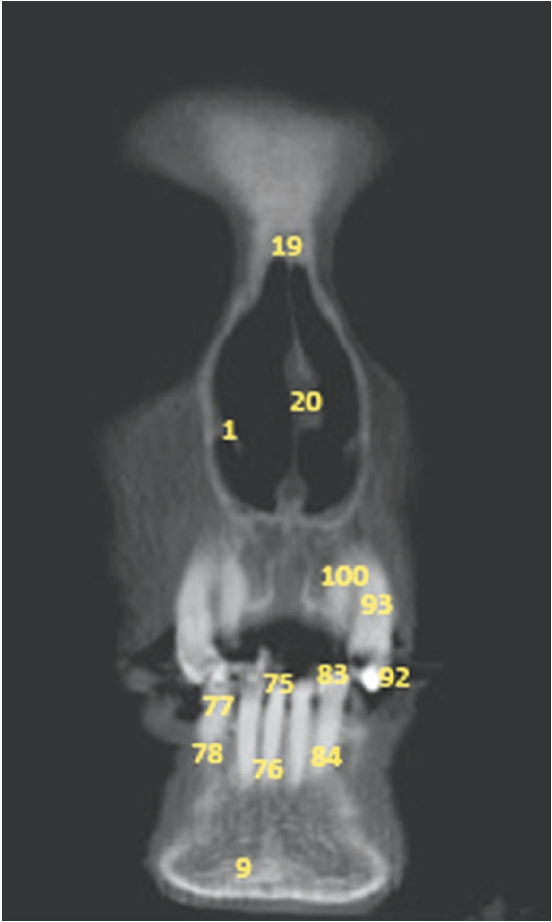


5 – Frontal bone	37 – Frontal sinus
32 – Temporal bone	107 – Face

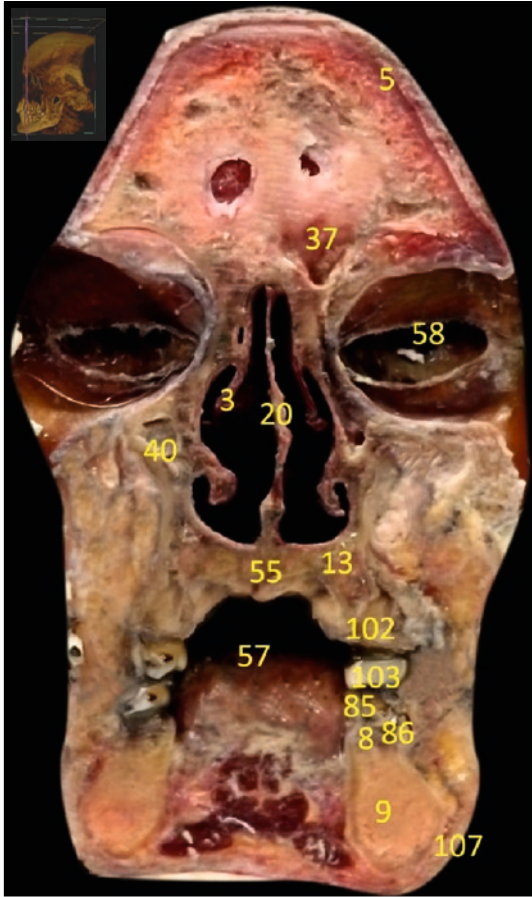
Coronal



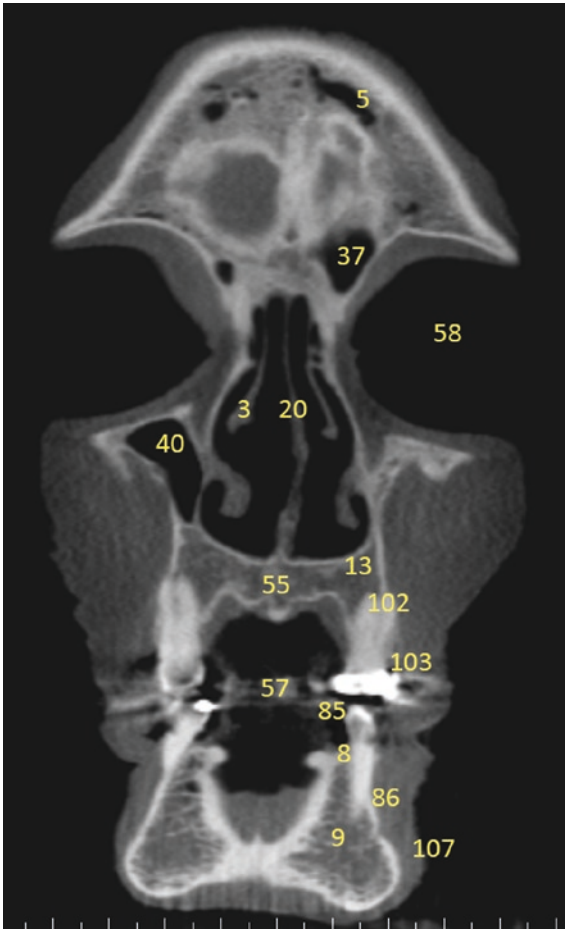
- | | |
|---|---|
| 1 – Concha-inferior | 77 – Mandibular cuspid (Crown) |
| 9 – Mandible-body | 83 – Mandibular lateral incisor teeth (Crown) |
| 19 – Nasal bone | 84 – Mandibular lateral incisor teeth (Root) |
| 20 – Nasal septum | 94 – Maxillary cuspid teeth (Root) |
| 75 – Mandibular central incisor teeth (Crown) | 93 – Maxillary cuspid (Crown) |
| 76 – Mandibular central incisor teeth (Root) | 100 – Maxillary lateral incisor teeth (Root) |



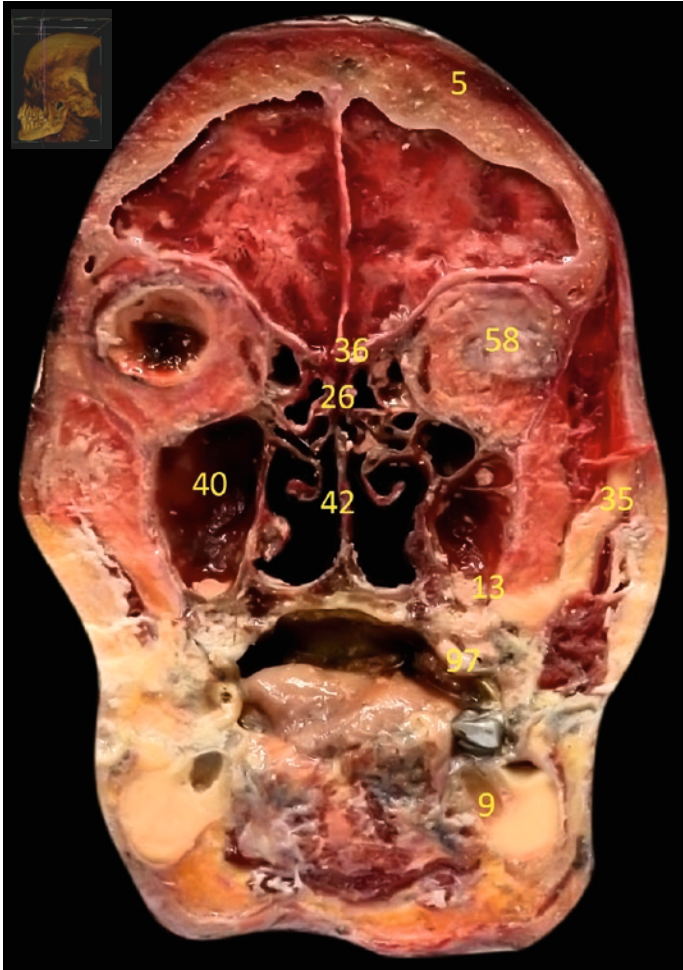
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|---|---|
| 1 – Concha-inferior | 77 – Mandibular cuspid (Crown) |
| 9 – Mandible-body | 83 – Mandibular lateral incisor teeth (Crown) |
| 19 – Nasal bone | 84 – Mandibular lateral incisor teeth (Root) |
| 20 – Nasal septum | 94 – Maxillary cuspid teeth (Root) |
| 75 – Mandibular central incisor teeth (Crown) | 93 – Maxillary cuspid (Crown) |
| 76 – Mandibular central incisor teeth (Root) | 100 – Maxillary lateral Incisor teeth (Root) |



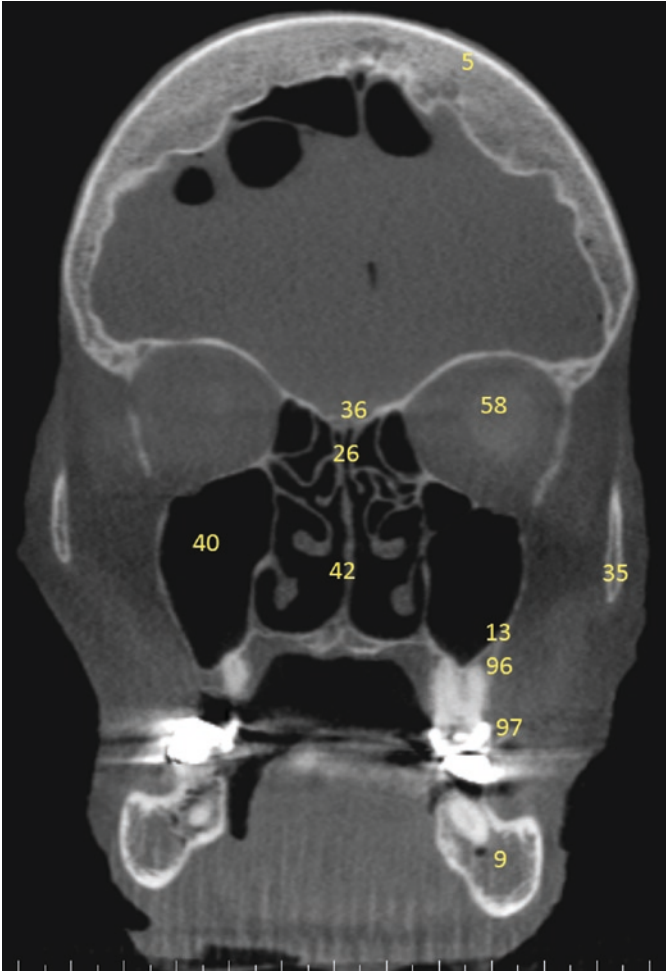
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|----------------------------|--|
| 3 – Concha-superior | 55 – Mid palatal suture |
| 5 – Frontal bone | 57 – Oral cavity |
| 8 – Mandible-alveolar bone | 58 – Orbit |
| 9 – Mandible-body | 85 – Mandibular second bi-cuspid (Crown) |
| 13 – Maxilla-alveolar bone | 86 – Mandibular second bi-cuspid (Root) |
| 20 – Nasal septum | 102 – Maxillary second bi-cuspid (Root) |
| 37 – Frontal sinus | 103 – Maxillary second molar (Crown) |
| 40 – Maxillary sinus | 107 – Face |



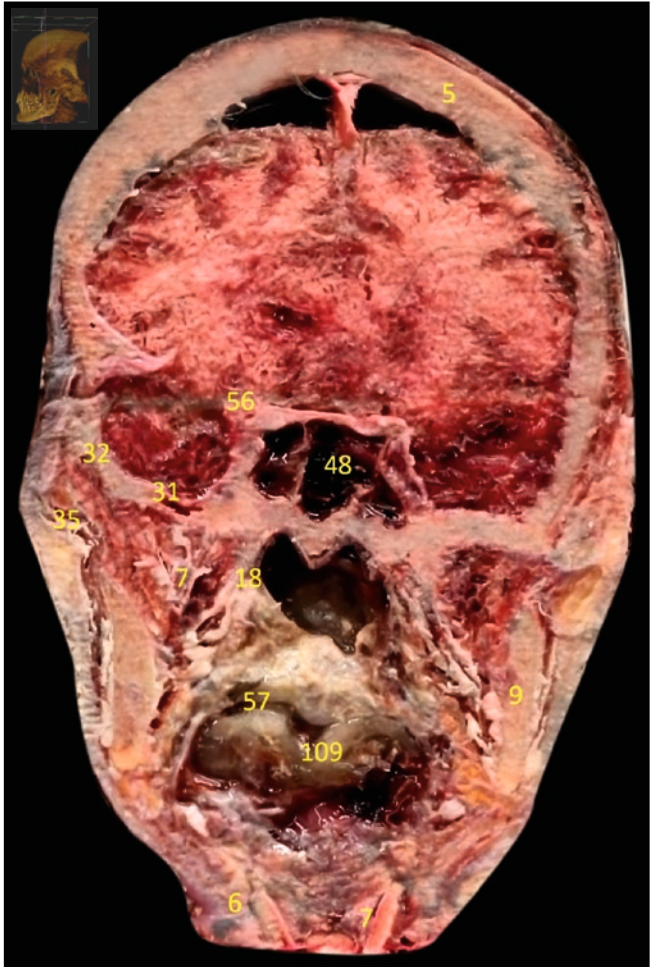
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|----------------------------|--|
| 3 – Concha-superior | 55 – Mid palatal suture |
| 5 – Frontal bone | 57 – Oral cavity |
| 8 – Mandible-alveolar bone | 58 – Orbit |
| 9 – Mandible-body | 85 – Mandibular second bi-cuspid (Crown) |
| 13 – Maxilla-alveolar bone | 86 – Mandibular second bi-cuspid (Root) |
| 20 – Nasal septum | 102 – Maxillary second bi-cuspid (Root) |
| 37 – Frontal sinus | 103 – Maxillary second molar (Crown) |
| 40 – Maxillary sinus | 107 – Face |



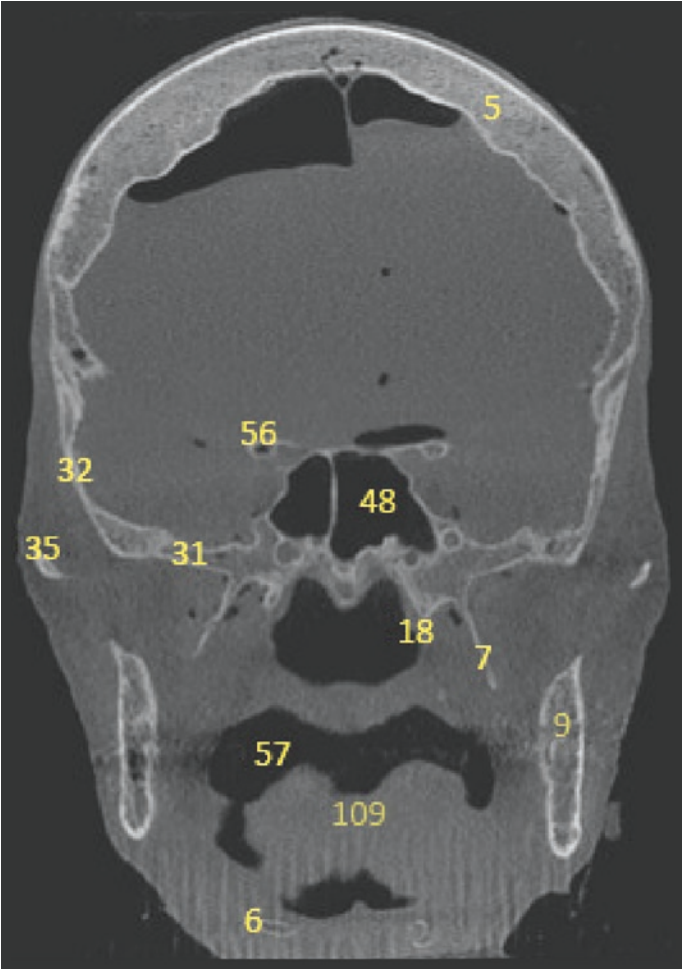
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|---|---------------------------------------|
| 5 – Frontal bone | 36 – Ethmoid sinus |
| 9 – Mandible-body | 40 – Maxillary sinus |
| 13 – Maxilla-alveolar bone | 42 – Nasal septum |
| 26 – Perpendicular plate of the ethmoid sinus | 58 – Orbit |
| 35 – Zygomatic arch | 96 – Maxillary first bi-cuspid (Root) |
| | 97 – Maxillary first molar (Crown) |



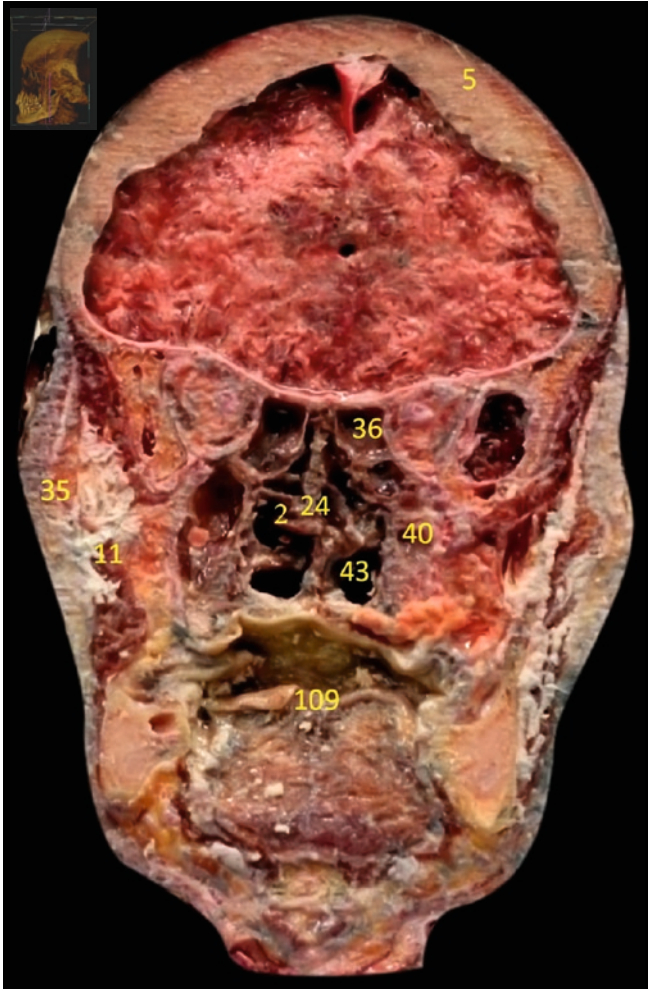
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|---|---------------------------------------|
| 5 – Frontal bone | 36 – Ethmoid sinus |
| 9 – Mandible-body | 40 – Maxillary sinus |
| 13 – Maxilla-alveolar bone | 42 – Nasal septum |
| 26 – Perpendicular plate of the ethmoid sinus | 58 – Orbit |
| 35 – Zygomatic arch | 96 – Maxillary first bi-cuspid (Root) |
| | 97 – Maxillary first molar (Crown) |



- | | |
|-----------------------------|-------------------------|
| 5 – Frontal bone | 32 – Temporal bone |
| 6 – Hyoid | 35 – Zygomatic arch |
| 7 – Lateral pterygoid plate | 48 – Sphenoid sinus |
| 9 – Mandible-body | 56 – Optic nerve canals |
| 18 – Medial pterygoid plate | 57 – Oral cavity |
| 31 – Sphenoid bone | 109 – Tongue |

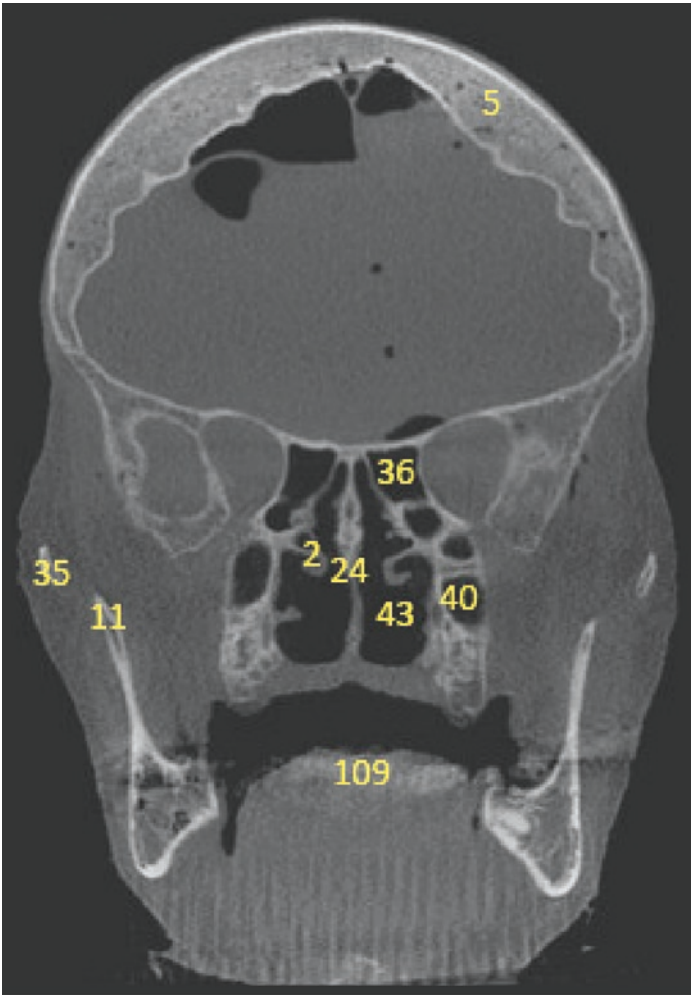


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|-----------------------------|-------------------------|
| 5 – Frontal bone | 32 – Temporal bone |
| 6 – Hyoid | 35 – Zygomatic arch |
| 7 – Lateral pterygoid plate | 48 – Sphenoid sinus |
| 9 – Mandible-body | 56 – Optic nerve canals |
| 18 – Medial pterygoid plate | 57 – Oral cavity |
| 31 – Sphenoid bone | 109 – Tongue |



2 – Concha-middle
5 – Frontal bone
11 – Mandible-coronoid process
24 – Palatine bone-vomer
35 – Zygomatic arch

36 – Ethmoid sinus
40 – Maxillary sinus
43 – Nasal sinus
109 – Tongue

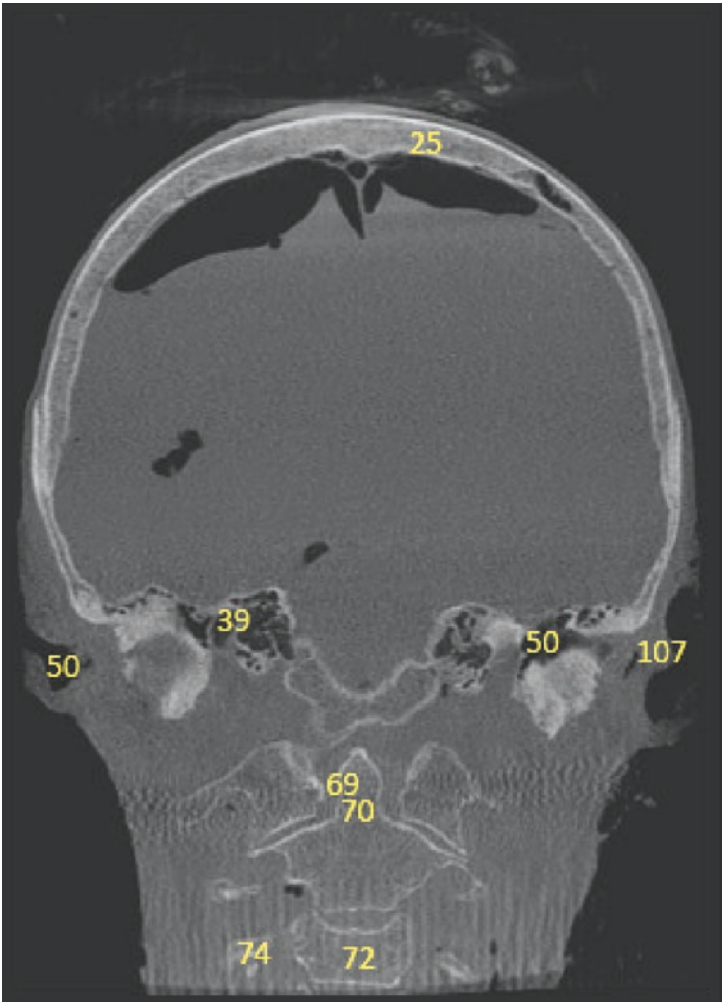


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|----------------------------------|----------------------|
| 2 – Concha-middle | 36 – Ethmoid sinus |
| 5 – Frontal bone | 40 – Maxillary sinus |
| 11 – Mandible-coronoid process | 43 – Nasal sinus |
| 24 – Palatine bone- <i>vomer</i> | 109 – Tongue |
| 35 – Zygomatic arch | |



25 – Parietal bone
39 – Mastoid air cells
50 – Auricular canal
69 – C2 Axis-dens

70 – C2 Axis-body
72 – C3-body
74 – C3-transverse process
107 – Face

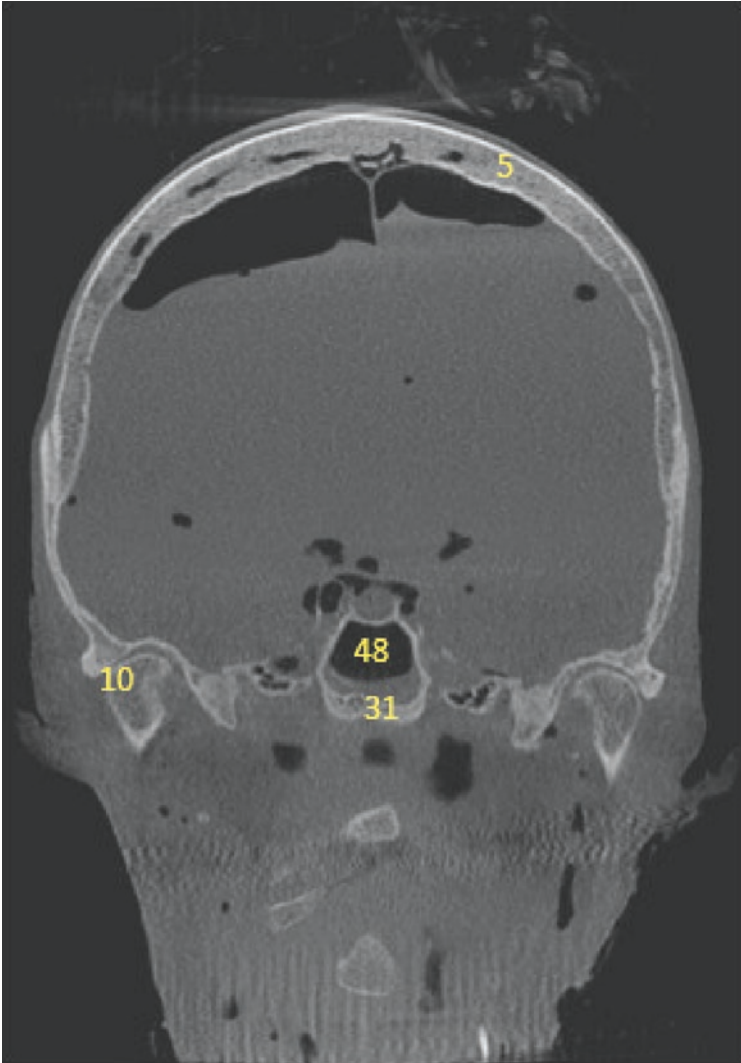


25 – Parietal bone	70 – C2 Axis-body
39 – Mastoid air cells	72 – C3-body
50 – Auricular canal	74 – C3-transverse process
69 – C2 Axis-dens	107 – Face



5 – Frontal bone
10 – Mandible-condyle

31 – Sphenoid bone
48 – Sphenoid sinus



5 – Frontal bone	31 – Sphenoid bone
10 – Mandible-condyle	48 – Sphenoid sinus

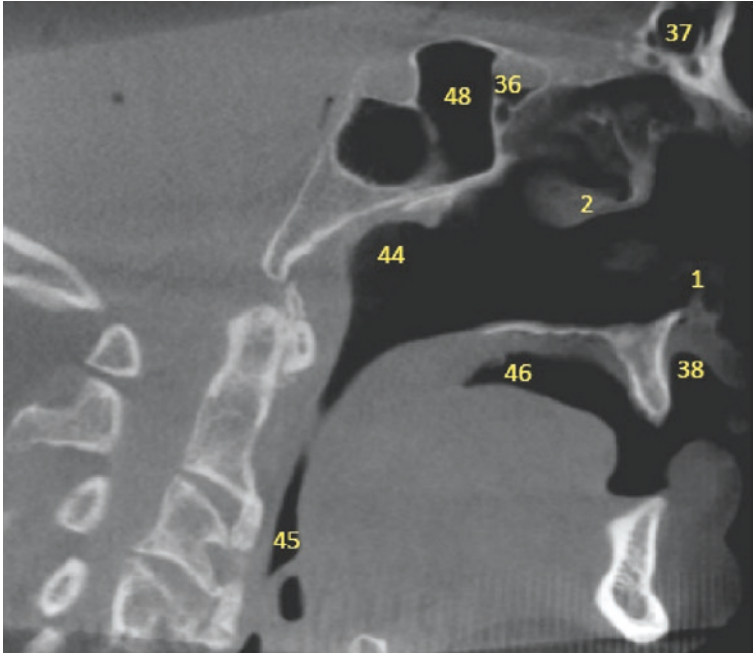
Sagittal

Mid-Sagittal: Airspaces



- 1 – Concha-inferior
- 2 – Concha-middle
- 38 – Mandibular vestibule
- 36 – Ethmoid sinus
- 37 – Frontal sinus

- 44 – Nasopharyngeal airspace
- 45 – Oropharyngeal airspace
- 46 – Palatoglossal airspace
- 48 – Sphenoid sinus

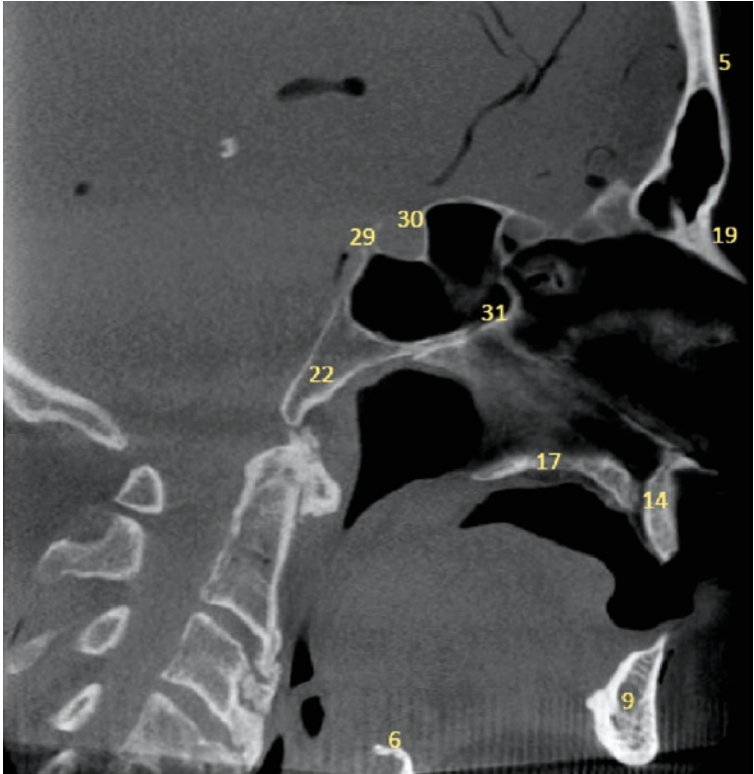


- 1 - Concha-inferior
- 2 - Concha-middle
- 36 - Ethmoid sinus
- 37 - Frontal sinus
- 38 - Mandibular vestibule
- 44 - Nasopharyngeal airspace
- 45 - Oropharyngeal airspace
- 46 - Palatoglossal airspace
- 48 - Sphenoid sinus

Mid-Sagittal at Midline



- | | |
|-------------------------------|-------------------------------------|
| 5 – Frontal bone | 19 – Nasal bone |
| 6 – Hyoid | 22 – Occiput-clivus |
| 9 – Mandible-body | 29 – Sphenoid bone-dorsum sella |
| 14 – Maxilla-anterior | 30 – Sphenoid bone-tuberculum sella |
| 17 – Maxilla-palatine process | 31 – Sphenoid bone |



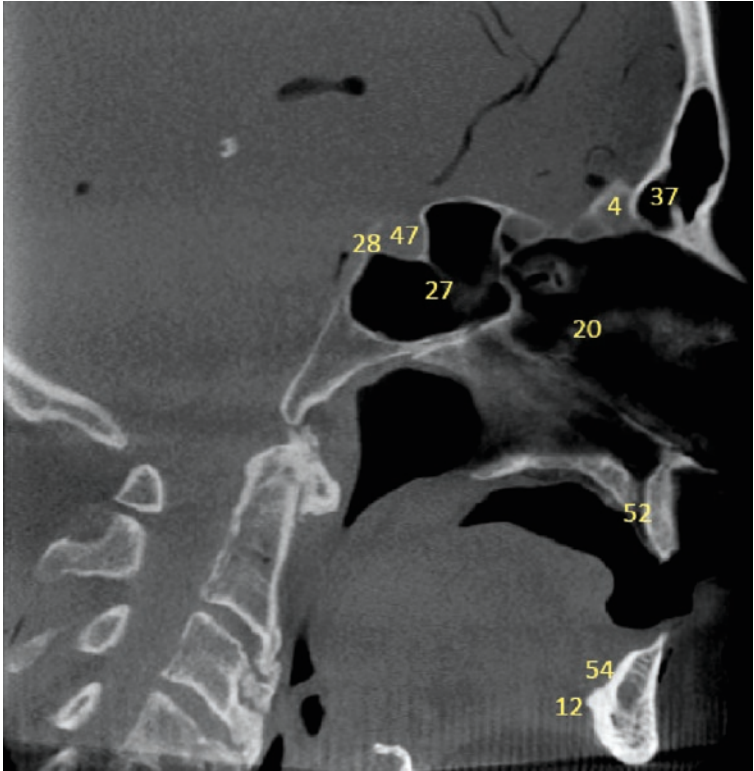
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|-------------------------------|-------------------------------------|
| 5 – Frontal bone | 19 – Nasal bone |
| 6 – Hyoid | 22 – Occiput-clivus |
| 9 – Mandible-body | 29 – Sphenoid bone-dorsum sella |
| 14 – Maxilla-anterior | 30 – Sphenoid bone-tuberculum sella |
| 17 – Maxilla-palatine process | 31 – Sphenoid bone |

Mid-Sagittal Osteology



4 – Ethmoid bone-*crista galli*
12 – Mandible-*genial tubercle*
20 – Nasal septum
27 – Septum in sphenoid sinus
28 – Sphenoid-posterior clinoid process

37 – Frontal sinus
47 – Pituitary fossa
52 – Incisive canal
54 – Lingual foramen



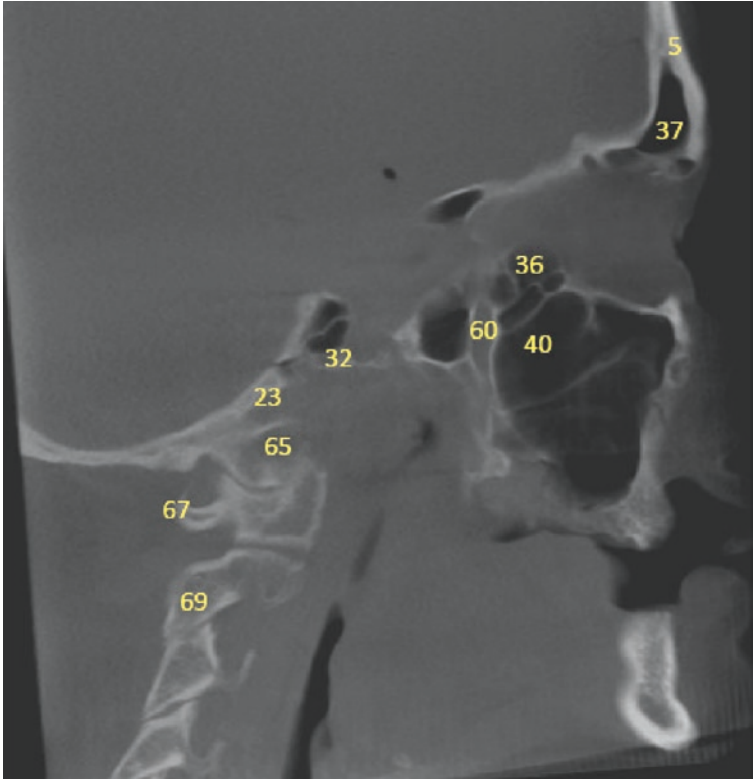
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|---|----------------------|
| 4 – Ethmoid bone- <i>crista galli</i> | 37 – Frontal sinus |
| 12 – Mandible-ge-nial tubercle | 47 – Pituitary fossa |
| 20 – Nasal septum | 52 – Incisive canal |
| 27 – Septum in sphenoid sinus | 54 – Lingual foramen |
| 28 – Sphenoid-posterior clinoid process | |

2.5 cm from Mid-Sagittal



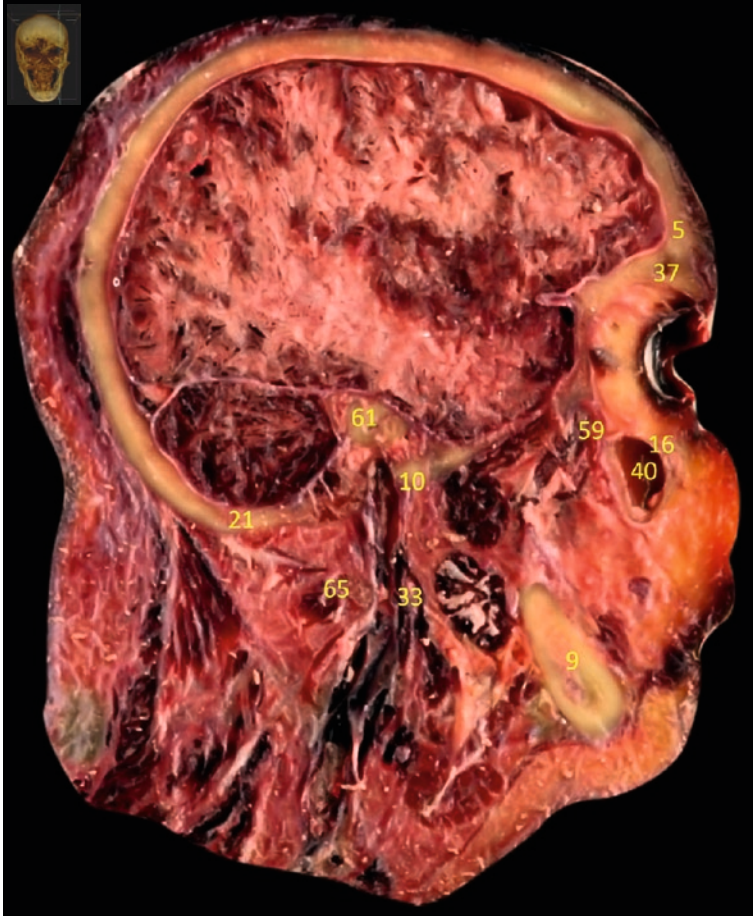
- 5 – Frontal bone
- 23 – Occiput-condylar process
- 32 – Temporal bone
- 36 – Ethmoid sinus
- 37 – Frontal sinus
- 40 – Maxillary sinus

- 60 – Pterygomaxillary fissure
- 65 – C1 Atlas-body
- 67 – C1 Atlas-posterior arch/tubercle
- 69 – C2 Axis-dens

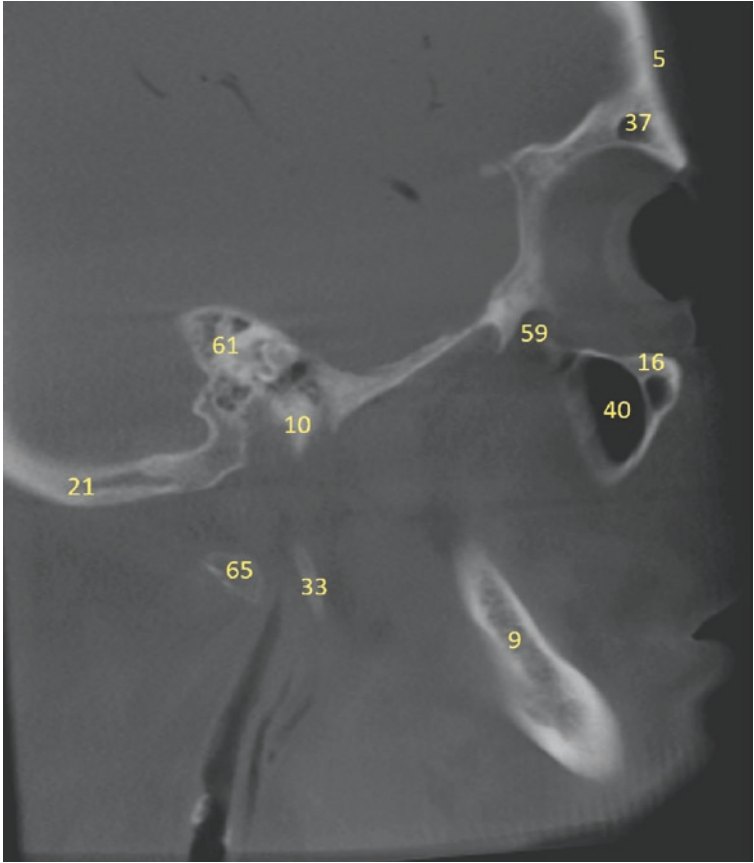


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|-------------------------------|---------------------------------------|
| 5 – Frontal bone | 40 – Maxillary sinus |
| 23 – Occiput-condylar process | 60 – Pterygomaxillary fissure |
| 32 – Temporal bone | 65 – C1 Atlas-body |
| 36 – Ethmoid sinus | 67 – C1 Atlas-posterior arch/tubercle |
| 37 – Frontal sinus | 69 – C2 Axis-dens |

5 cm from Mid-Sagittal (S2)

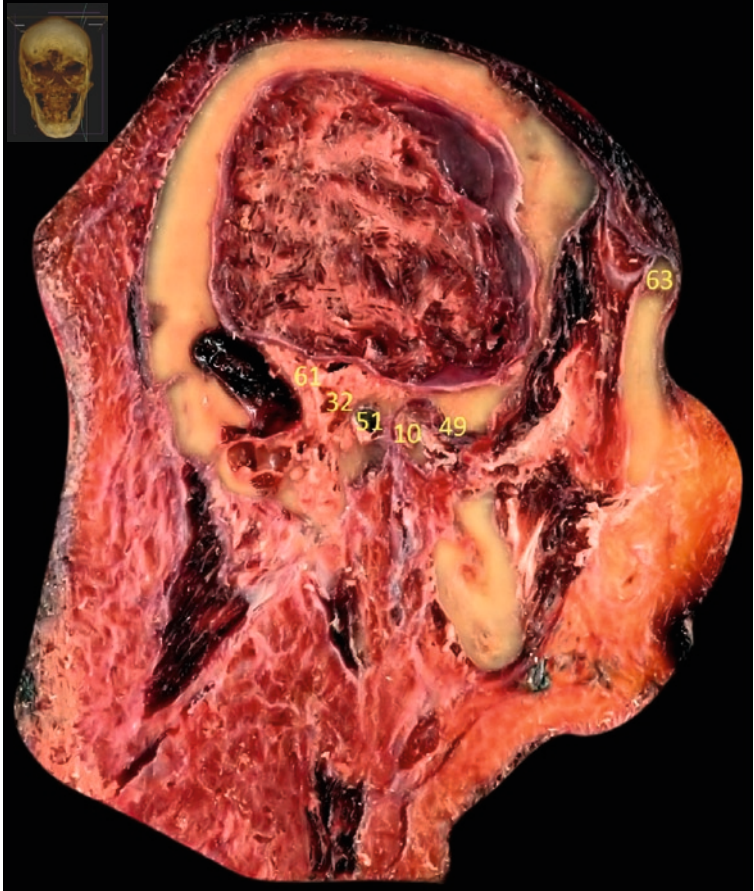


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|------------------------------------|----------------------------------|
| 5 – Frontal bone | 37 – Frontal sinus |
| 9 – Mandible-body | 40 – Maxillary sinus |
| 10 – Mandible-condyle | 59 – Orbital fissure |
| 16 – Maxilla-zygomatic process | 61 – Temporal bone-petrous ridge |
| 21 – Occiput | 65 – C1 Atlas-body |
| 33 – Temporal bone-styloid process | |



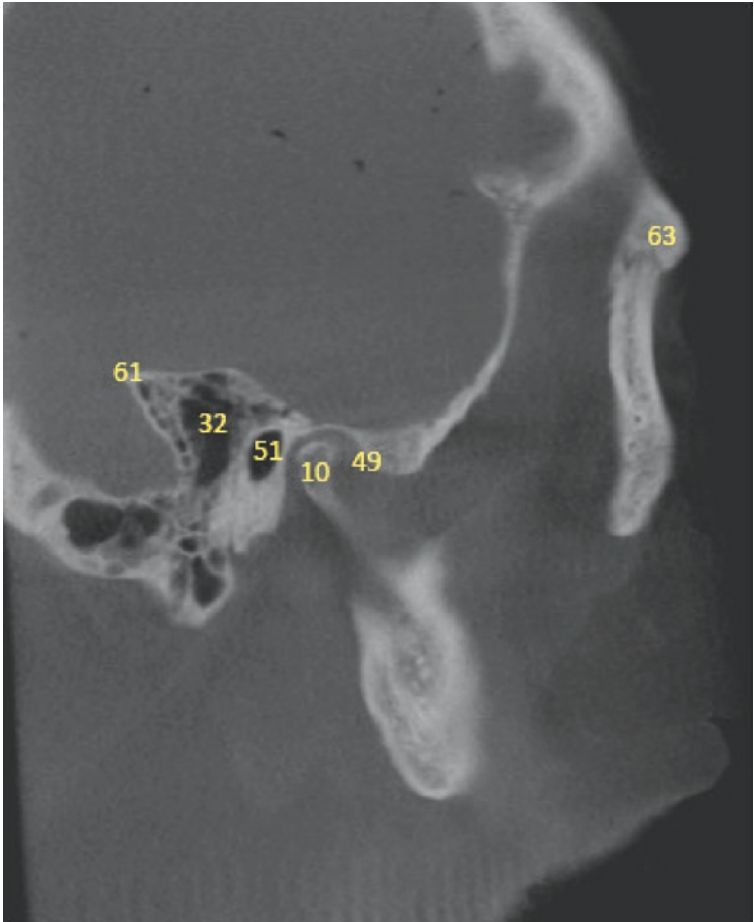
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|------------------------------------|----------------------------------|
| 5 – Frontal bone | 37 – Frontal sinus |
| 9 – Mandible-body | 40 – Maxillary sinus |
| 10 – Mandible-condyle | 59 – Orbital fissure |
| 16 – Maxilla-zygomatic process | 61 – Temporal bone-petrous ridge |
| 21 – Occiput | 65 – C1 Atlas-body |
| 33 – Temporal bone-styloid process | |

7.5 cm from Mid-Sagittal



10 – Mandible-condyle
32 – Temporal bone
49 – Articular eminence

51 – External acoustic meatus
61 – Temporal bone-petrous ridge
63 – Zygomaticofrontal suture



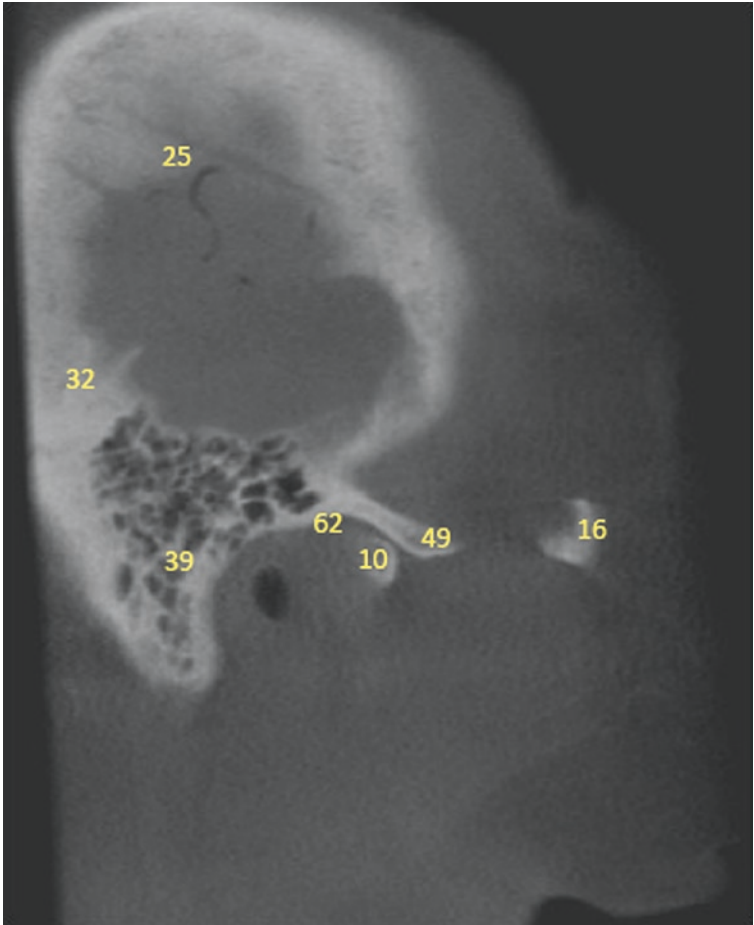
10 – Mandible-condyle	51 – External acoustic meatus
32 – Temporal bone	61 – Temporal bone-petrous ridge
49 – Articular eminence	63 – Zygomaticofrontal suture

10 cm from Mid-Sagittal



10 – Mandible-condyle
16 – Maxilla-zygomatic process
25 – Parietal bone
32 – Temporal bone

39 – Mastoid air cells
49 – Articular eminence
62 – Temporal fossa



10 – Mandible-condyle
16 – Maxilla-zygomatic process
25 – Parietal bone
32 – Temporal bone

39 – Mastoid air cells
49 – Articular eminence
62 – Temporal fossa

Master Legends

1. Concha - Inferior
2. Concha - Middle
3. Concha - Superior
4. Ethmoid bone - Crista galli
5. Frontal Bone
6. Hyoid
7. Lateral pyterygoid plate
8. Mandible - alveolar bone
9. Mandible - body
10. Mandible - condylar process
11. Mandible - coronoid process
12. Mandible - Genial tubercle
13. Maxilla - Alveolar bone
14. Maxilla - anterior
15. Maxilla - Anterior nasal spine
16. Maxilla - zygomatic process
17. Maxilla- Palatine process
18. Medial pyterygoid plate
19. Nasal Bone
20. Nasal Septum
21. Occiput
22. Occiput - Clivus
23. Occiput -Condylar process
24. Palatine bone - Vomer
25. Parietal Bone
26. Perpendicular plate of the ethmoid sinus
27. Septum in Sphenoid Sinus
28. Sphenoid - Posterior Clinoid Process
29. Sphenoid bone - Dorsum Sella
30. Sphenoid bone - Tuberculum Sella
31. Sphenoid bone
32. Temporal Bone
33. Temporal bone - Styloid process

34. Zygoma
35. Zygomatic arch
36. Ethmoid Sinus
37. Frontal Sinus
38. Mandibular vestibule
39. Mastoid Air cells
40. Maxillary Sinus
41. Maxillary Vestibule
42. Nasal septum
43. Nasal Sinus
44. Nasopharyngeal airspace
45. Oropharyngeal airspace
46. Palatoglossal airspace
47. Pituitary fossa
48. Sphenoid Sinus
49. Articular eminence
50. Auricular Canal
51. External acoustic meatus
52. Incisive canal
53. Internal Carotid artery
54. Lingual foramen
55. Mid palatal suture
56. Optic nerve canals
57. Oral cavity
58. Orbit
59. Orbital fissure
60. Pterygomaxillary fissure
61. Temporal Bone - petrous ridge
62. Temporal fossa
63. Zygomaticofrontal suture
64. Zygomaticotemporal suture
65. C1 Atlas - body
66. C1 Atlas - anterior arch/tubercle
67. C1 Atlas - posterior arch/tubercle
68. C2 Axis - Transverse process
69. C2 Axis - Dens

Master Legends

70. C2 Axis - Body
71. C2 Axis - spine
72. C3 - Body
73. C3 - spine
74. C3 - transverse porcess
75. Mandibular Central Incisor Teeth (Crown)
76. Mandibular Central Incisor Teeth (Root)
77. Mandibular Cuspid (Crown)
78. Mandibular Cuspid (Root)
79. Mandibular first bi-cuspid (Crown)
80. Mandibular first bi-cuspid (Root)
81. Mandibular first molar (Crown)
82. Mandibular first molar (Root)
83. Mandibular Lateral Incisor Teeth (Crown)
84. Mandibular Lateral Incisor Teeth (Root)
85. Mandibular second bi-cuspid (Crown)
86. Mandibular second bi-cuspid (Root)
87. Mandibular second molar (Crown)
88. Mandibular second molar (Root)
89. Mandibular third molar (Crown)
90. Mandibular third molar (Root)
91. Maxillary Central Incisor Teeth (Crown)
92. Maxillary Central Incisor Teeth (Root)
93. Maxillary Cuspid (Crown)
94. Maxillary Cuspid (Root)
95. Maxillary first bi-cuspid (Crown)
96. Maxillary first bi-cuspid (Root)
97. Maxillary first molar (Crown)
98. Maxillary first molar (Root)
99. Maxillary Lateral Incisor Teeth (Crown)
100. axillary Lateral Incisor Teeth (Root)
101. Maxillary second bi-cuspid (Crown)
102. Maxillary second bi-cuspid (Root)
103. Maxillary second molar (Crown)
104. Maxillary second molar (Root)
105. Maxillary third molar (Crown)

- 106. Maxillary third molar (Root)
- 107. Face
- 108. Lips
- 109. Tongue