IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 5 Ver. 8 (May. 2018), PP 88-96
www.iosrjournals.org

Anatomical Characteristics of Temporal Bone on Computerized Tomography

Dr. Osama A. Mabrouk Kheiralla, MD
Assistant Professor of Radiology - College of Applied Medical Sciences - Radiological Sciences Department – Imam Abdulrahman bin Faisal University- KSA.
Corresponding author: Dr. Osama A

Abstract: *The anatomical complexity of the temporal bone represents a challenge in the interpretation and diagnosis of different pathological conditions in this region. Computed Tomography (CT) play an important role in the diagnosis of temporal bone pathologies.High-resolution computed tomography (HRCT) is the modality of choice for imaging of bony lesions of temporal region. This article discusses the anatomical details of the temporal bone and the characteristic radiological findings of the temporal bone in Computed Tomography (CT) scan imaging.*

Key words: *Anatomy of the Temporal bone, Computed Tomography (CT) scan*

Date of Submission: 02-05-2018 Date of acceptance: 18-05-2018

I. Introduction

The anatomical complexity of the temporal bone represents a challenge in the interpretation of anatomical details and the diagnosis of different pathological conditions in this region. The understanding of the CT anatomy of the temporalbone is difficult due to complex structural relations that cannot be visualized ona single plane [1]. O Computed Tomography (CT) scan is a useful modality for imaging bony and some soft tissue lesions of the temporal bone.CT scans are more accurate in identifying many soft tissue abnormalities and are much less prone to artifacts [2].CT scanning offers the greatest structural definition of any currently available imaging modality [3, 4].The basic anatomical components of the temporal bones are depicted on axial and coronal CT images ***(Figure.1)***.

Familiarity with the detailed anatomical components of the temporal bone is mandatoryto proficiently interpretcomputed tomographic (CT) scan studies of the temporal bone. The thin-section scanning of highresolutionCT, which makes detaileddemonstration of the temporal boneanatomy a practical reality, has contributedto the diagnosis and postoperativeevaluation of middle ear diseases[5].CT scan allows multiplanar and noninvasive visualization of temporal bone.Advanced computed tomographic (CT) scan techniques have reached the ability of diagnosing small temporal bone tumors.

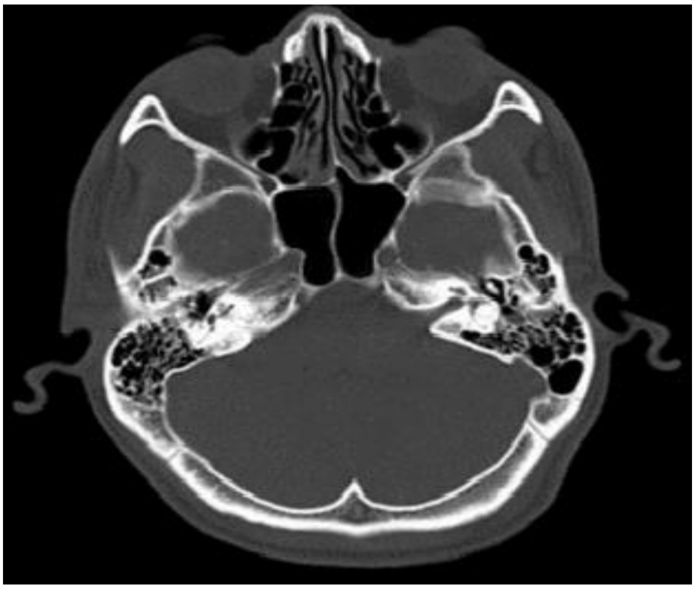

Figure1:*Axial CT scan demonstrating skull base and temporal bone.*

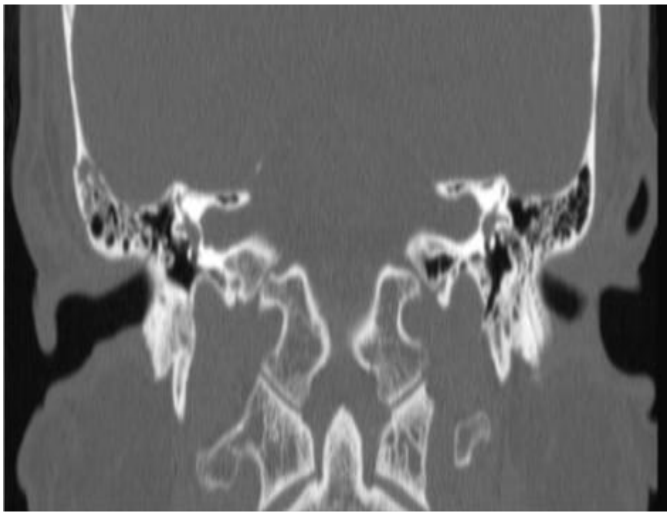

Figure2:*Coronal CT scan demonstrating details of temporal bone.*

Temporal boneanatomy:

Temporal bones are bilaterally symmetrical bonessituated at the base and sides of the skull;theyparticipate in the formation of the lateral portion the base of the cranial vault and lateral wall of the skull. Each temporal bone is composed of five parts: the petrous part, squamous part, the tympanic part, the mastoid and the styloid process***(Figure 3)***.

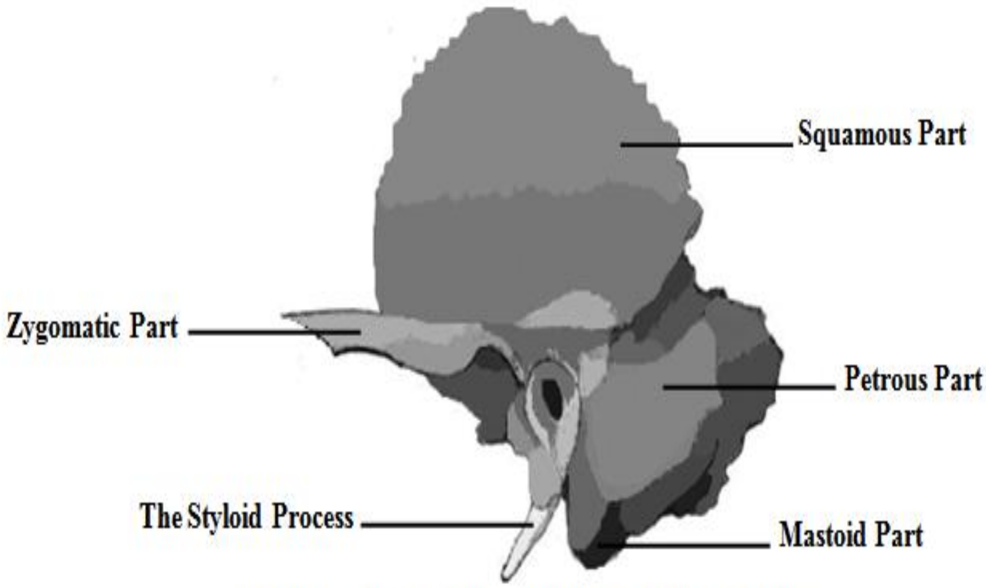

Figure.3: *The five main components of Temporal Bone.*

Temporal bone has got multiple intrinsic channels and fissures, and multiple extrinsic sutures that appear on CT images similar to fractures.Temporal bone houses several important structures such as the middle and internal ear apparatus including the cochlea, vestibule and the vestibulocochlear nerve (cranial nerve VIII), the facial nerve (cranial nerve VII), the internal carotid artery, and the jugular vein[6].

The petrous part is the medial part of the temporal bone; it is pyramidal in shape andof solid component to protect the internal soft structures of the acoustic meatus and vestibular apparatus. There are numerous openings in the inferior surface of the petrous part of the temporal bone such as the carotid canal for the passage of the internal carotid artery, and the jugular foramen for the passage of the internal jugular vein, 9^{th}, 10^{th} and 11^{th} cranial nerves.

The mastoid process is a conical bony projection, located posteriorto the petrous part; it is filled with air cells and lined with mucous membrane internally.

The squamous part is the superior part of the temporal bone, it is flat plate shaped and forms a portion of the lateral wall of the middle cranial fossa, the inferior portion of the squamous part of the temporal bonerepresents the glenoid fossa which articulates with the mandibular condyle to form the temporomandibular joint (TMJ). The squamous part contains a bony groove that houses the middle meningeal artery.

The zygomatic part arises anteriorly from the outer surface of the squamous part of the temporal bone to articulate with the zygomatic bone.

The tympanic part of the temporal bone is horseshoe-shaped surrounds the external auditory meatus, contributing in the formation of its anterior, posterior and inferior walls. The lateral border of tympanic part is attached to the cartilaginous part of the external acoustic meatus and medially it is attached to the petrous part of the temporal bone.

The styloid process is a needle-like projection from the inferior aspect of the petrous part of the temporal bone and runs downward and slightly anteriorly.The styloid process represents the anchor point for several muscles and ligamentsassociated with the tongue and larynx, they include: thestylohyoid ligament, thestylomandibular ligament, thestyloglossus muscle, thestylohyoid muscle andthestylopharyngeus muscle. The stylomastoid foramen is located posterior to the styloid process which forms a passage for the 7th cranial nerve and the stylomastoid artery.

During embryological development,the temporal bone undergo ossification from eight centers,one for the tympanic part, one for the zygomatic part, two for the styloid process and four for the petrous part and mastoid process. The squamous and tympanic parts undergo intramembranous ossification, while the temporal part, the petrous part and the styloid part undergo endochondral ossification. The mastoid process is absent in the newborn and develops with the traction force of the sternocleidomastoid muscle.

The external auditory meatus(ear canal) which is located within the tympanic part of the temporal bone is a sigmoid tube extendsfrom the tympanic membrane medially to the outer ear laterally; it measures about 2.5 cm in length and 0.7 cm in diameter. It is divided into two parts, a medial bony part represents theinner two thirds and an outer fibrocartilaginous part represents the outer one third it has a cartilaginous anterior and lower walls, and fibrous superior and back wall.

The middle ear have two components, the first one is the antrum; it is an air space in the petrous part of the temporal bone represents thecommunication between the mastoid cells posteriorly and the middle ear anteriorly, the second component of the middle ear isthe tympanic cavity, itis an air filled cavity within the petrous part of the temporal bone extending between the tympanic membrane laterally and the oval window of the inner ear medially,it contains the ossicular chain which is composed of three tiny bones known as the malleus, incus, and stapes***(Figure4,5)***.

The main function of the ossicles is to transfer the vibrations of the tympanic membrane into waves in the fluid of the inner ear.The roof of the middle ear is formed by a bony structure known as the tegmen tympani which separates the middle ear from the middle cranial fossa.The floor of the middle ear is mainly composed of a bonystructure covering the jugular bulb.

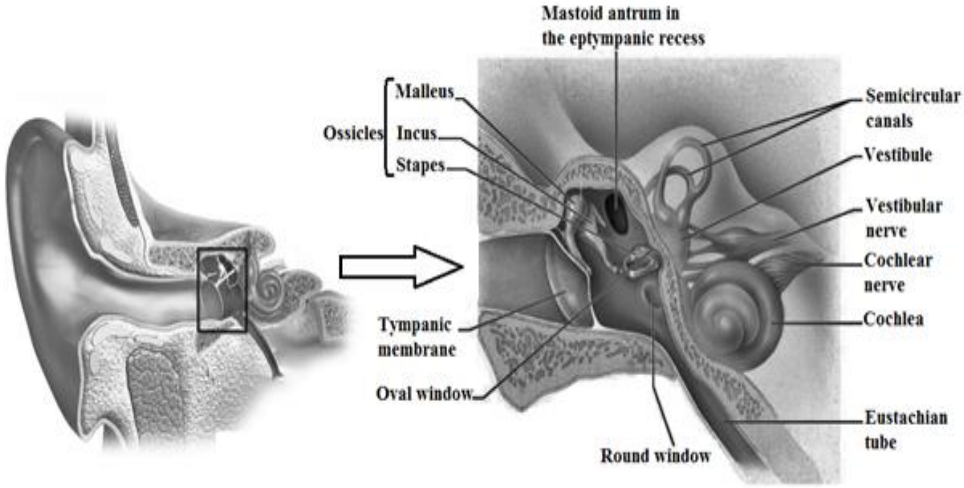

Figure4: *Anatomical illustration of the middle ear with its internal components.*

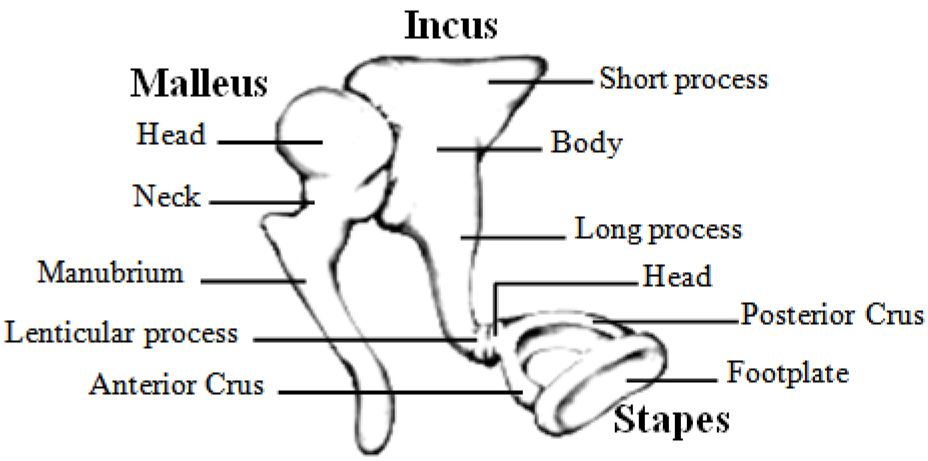

Figure.5: *Anatomical illustration of the ossicular chain which is composed of three tiny bones known as the malleus, incus, and stapes*

The inner ear is located within the petrous part of the temporal bone;it is composed of the bony labyrinth, which includes the cochlea anteriorly,the vestibule and the semicircular canalposteriorly.The inner ear consists of osseous and membra- nous labyrinths surrounded by dense compact bone called the otic capsule [7]. The cochlea is responsible for hearing while the vestibule and semicircular canal are responsible for balance.The cochlea isof spiral shape with 2.5-2.75 turns*(scalae),* the apical turn also known as vestibular duct*(scala vestibule)*abuts the oval window, the middleturn also known as the cochlear duct*(scala media)*houses the organ of Corti,the basal turnalso known as the tympanic duct*(scala tympani)*terminates at the round window, theseducts are separated from each other by interscalarseptae.The apical part of the cochlea is pointed anteroinferiorlyto the lateral direction; while the basal part rests close to the internal auditory canal. The cochlea is filled with aperilymph, vibrations that are coming from the middle ear through the oval window lead to the movement of the perilymph,Movement of the perilymph induces the movement of the basilar membrane and organ of Corti inside the cochlear duct; hair cells will sense this motion and convert itinto electrical signals that will communicated to auditory neurons which will transform the signals into nervepulses.The coronal projection is probably the best for visualizing the cochlea [8].

The vestibule is fluid-filledduct of oval shape anteroposteriorly, composed of two sacs the utricle which occupies the upper part of the vestibule and saccule which is located inferiorly.The vestibuleis important in maintaining balance,it is laterally connected to the footplate of the stapes through the oval window, and medially connected to the acoustic nerve, balance vibrations due to head tilting reach the vestibule from the stapes through the oval window, leading to polarization of hair cell within utricle and saccule of the vestibule, this polarization will be converted to nerve signal that pass to the brain through the vestibular nerve. The semicircular canals composed of three canals, anterior, posterior and lateral, each one of these canals detects motion in a single plane. Each canal is filled with endolymph. The actual hair cells sit in a small swelling at the base called the ampulla.

The Facial nerve:

Temporal bone CT is particularly useful in the evaluation of the caliber and the course of the IAC and bony facial nerve canal in the temporal bone [9]. The facial nerve has several functions; it is the motor nerve of facial expression and conveys special sensory (taste) information from the anterior two-thirds of the tongue and the interior of the mouth. and conveys general sensation from the external acoustic meatus and scalp, beside other functions likelacrimation and salivation.

The facial nerve can be divided into intracranial, intratemporal, and extracranial segments.The focus of this discussion is the intratemporal segment.The facial nerve emerges from the brain stem beneath the pons, it originates from three nuclei, the motor part of the facial nerve arises from the motor nucleus in the pons while the sensory part arises from solitary nucleus and parasympathetic part arises from the superior salivary nucleusin the pontine tegmentum***(Figure 6)***. Facial nerve travels through the cerebellopontine angle,to enter the temporal bone through the internal acoustic meatus,passing through the anterior superior quadrant of the internal acoustic meatus to enter the Fallopian canal, and then it passes anterolaterallybetween the cochlea (anteriorly) and vestibule (posteriorly), and runs posteriorly at the geniculate ganglion, where the three branches originate:

1- The greater superficial petrosal nerve
2- The lesser petrosal nerve
3- The external petrosal nerve

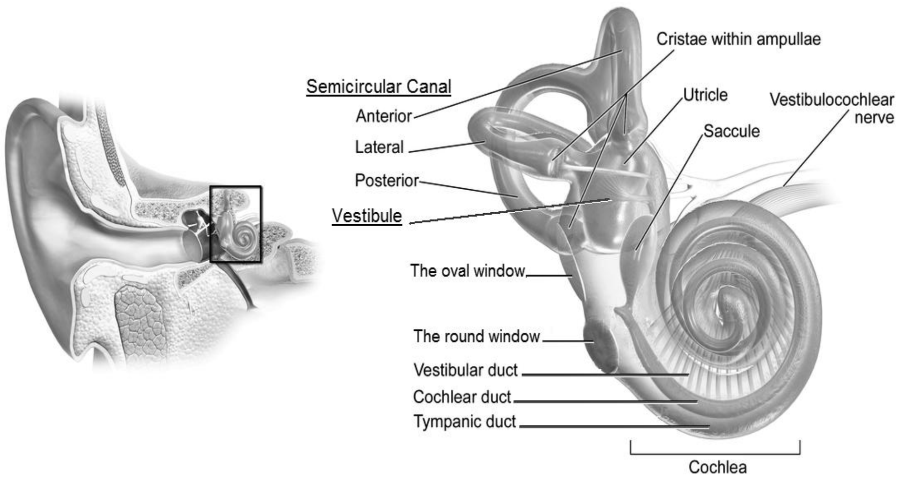

Figure 6:*Anatomical illustration the inner ear with its internal components*

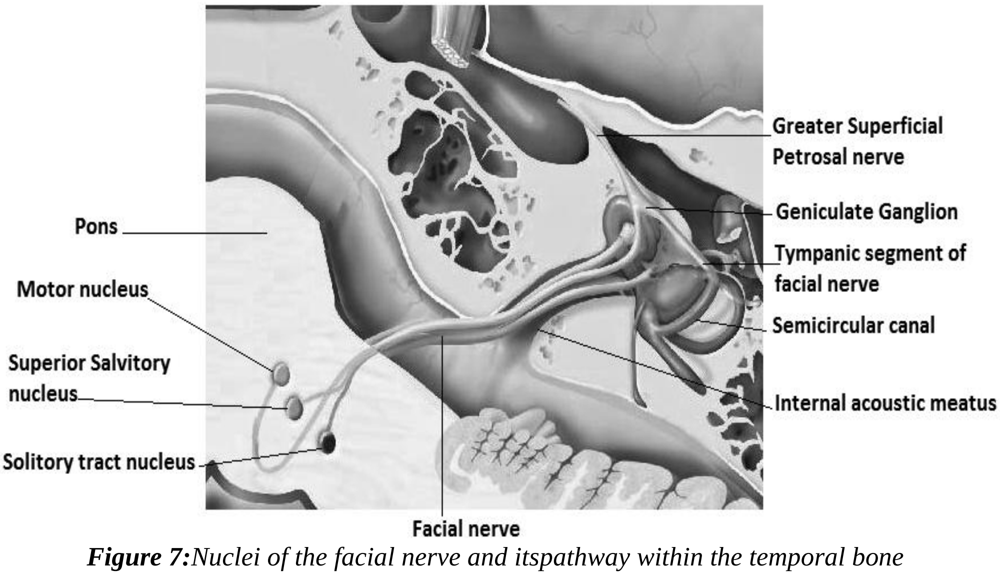

Figure 7:*Nuclei of the facial nerve and itspathway within the temporal bone*

From the geniculate ganglion, the facial nerve passes beneath the lateral semicircular canal in the medial wall of the middle ear cavity passing posterior to the cochleariform process, tensor tympani and oval window, after that it makes a second vertical turn distal to the pyramidal eminence downwards to the stylomastoid foramen, where it gives off three branches:

1- The tympanic branch to the stapedius muscle.
2- The Chorda tympani branch, it is the terminal branch of the nervusintermedius: carrying both secretomotorfibers to the submandibular gland and sublingual gland and taste to the anterior two thirds of the tongue
3- The pain fibers to the posterior part of the external acoustic meatus.

As the facial nerve exits the stylomastoid foramen, it passes between the posterior belly of the digastric muscle and the stylohyoid muscle and enters the parotid gland***(Figure 8)***.

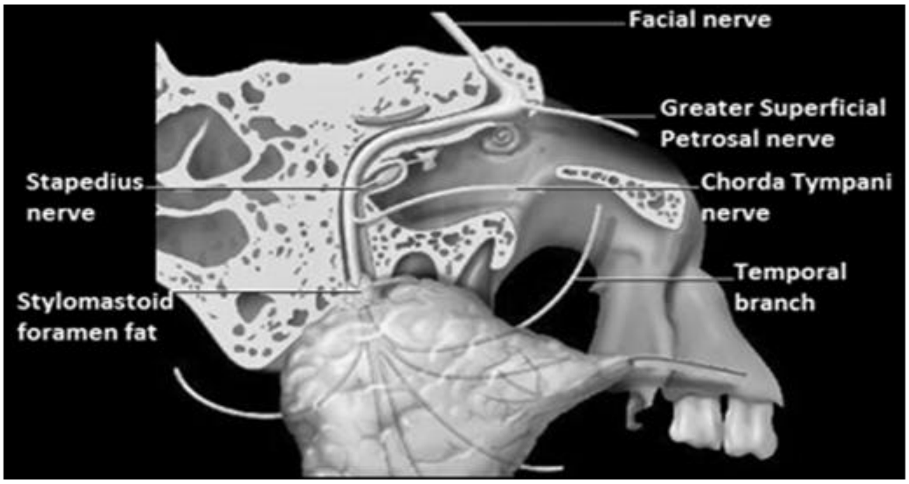

Figure 8: *The pathway of the facial nerve within the temporal bone*

CT scan imaging of the Temporal Bone:

The advent of high-resolution computed tomography (CT) scanning in the 1980s has revolutionized diagnostic imaging of the temporal bone. CT scanning offers the greatest structural definition of any currently available imaging modality.[1, 2]Computed tomography (CT) of the temporal bone is basically done in two acquisition techniques: Dual acquisition technique; it includes separate direct coronal and separate direct axial scans, the second technique is single axially acquired volume technique, in this technique single axial source data acquired from a multidetector row CT (MDCT) scanner and reformatted in coronal and sagittal planes, this technique is preferred because it provides adequate anatomical details while reducing radiation dose and motion artifact. However, in some cases, both techniques may be applied to provide superior image quality. CT scan imaging of the temporal bone is done in both axial and coronal views, these two views are mandatory for adequate and detailed study for temporal bone structure.

Axial images of the Temporal Bone:

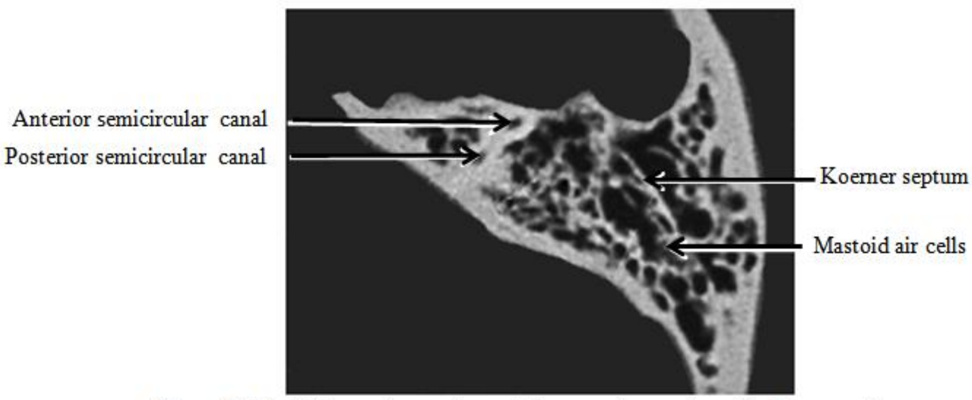

Figure 9: *Axial CT scan image through the superior portion of left temporal bone.*

Figure 9: isan axial section through the superiorportion of the left temporal boneshowing theposterior margin of the temporal bone forming the anterior margin of the posterior cranial fossa, at this level the Otic capsule appears as dense white bone within which, the anterior and posterior semicircular canal are found, mastoid air cells appear lateral to the otic capsule. The Koerner septum appears as a septum between squamous air cells and petrous air cells.

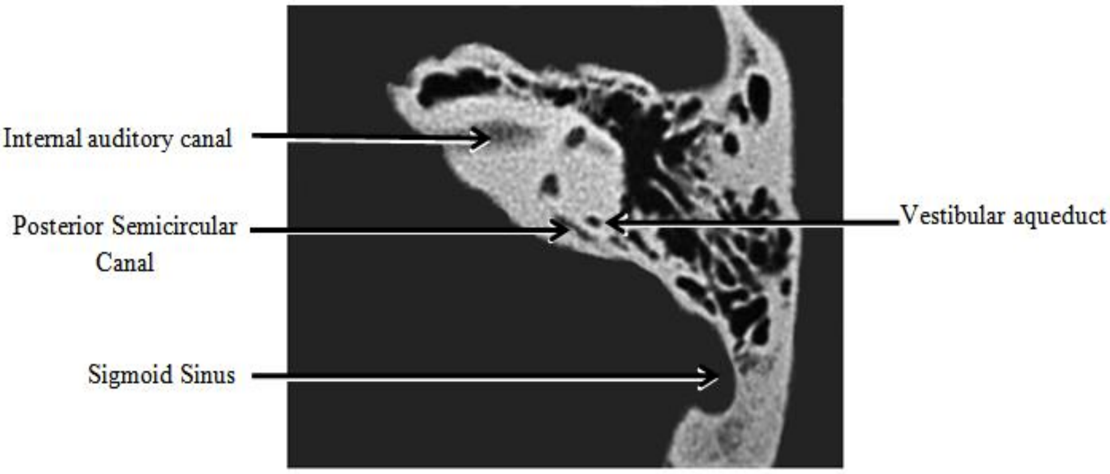

Figure 10:*Axial CT scan image through the left temporal bone at the level of sigmoid sinus*

Figure 10: is an axial CT scan section more inferior to the above one, at the level of sigmoid sinus where it indents the cerebellar plate posteriorly. The vestibular aqueduct appears coursing posterior to the posterior semicircular canal, superior semicircular canal appears located anteriorly. The superior aspect of the lateral semicircular canal appears lateral to the other semicircular canals. The facial nerve located withinthe superior portion of the internal auditory canal ***(Figure 10)***

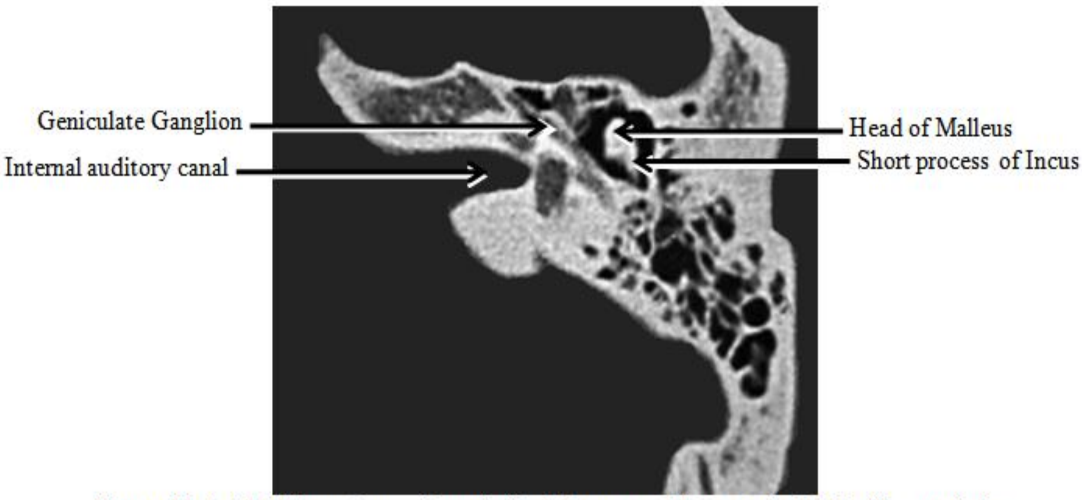

Figure 11:*Axial CT scan image through the left temporal bone at the level of the vestibule*

Figure 11: is an axial CT scan section through the left temporal bone, at the level of the horizontal and posterior semicircular canalsand the vestibule, at this level the ossiclesappear inside the tympanic cavity. Thefacial nerve appears coursing from the internal auditory canal andturns anteriorly as the labyrinthine segment where it ends at the geniculate ganglionthen it continues posteriorly as the tympanic segment

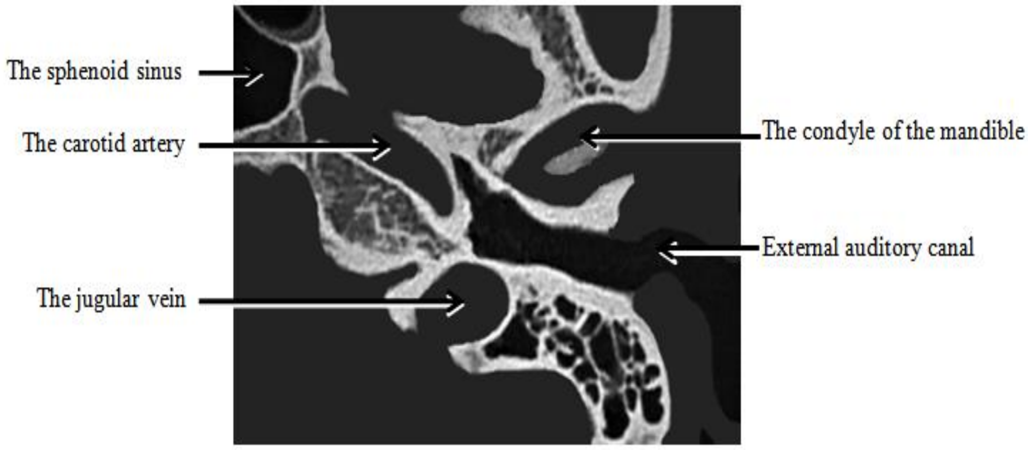

Figure 12:*Axial CT scan image through the left temporal bone at the level of the glenoid fossa*

Figure 12: demonstrates the most inferior axial CT scan section through the left temporal bone, at the level of the glenoid fossa, at this level the carotid artery appears orientedmedially and anteriorly, the jugular vein appears posterolateral to the carotid artery, the sphenoid sinusanteromedial to the carotid artery, the glenoid fossa appears anterior to the external auditory canal.***)***

Coronal images of the Temporal Bone:

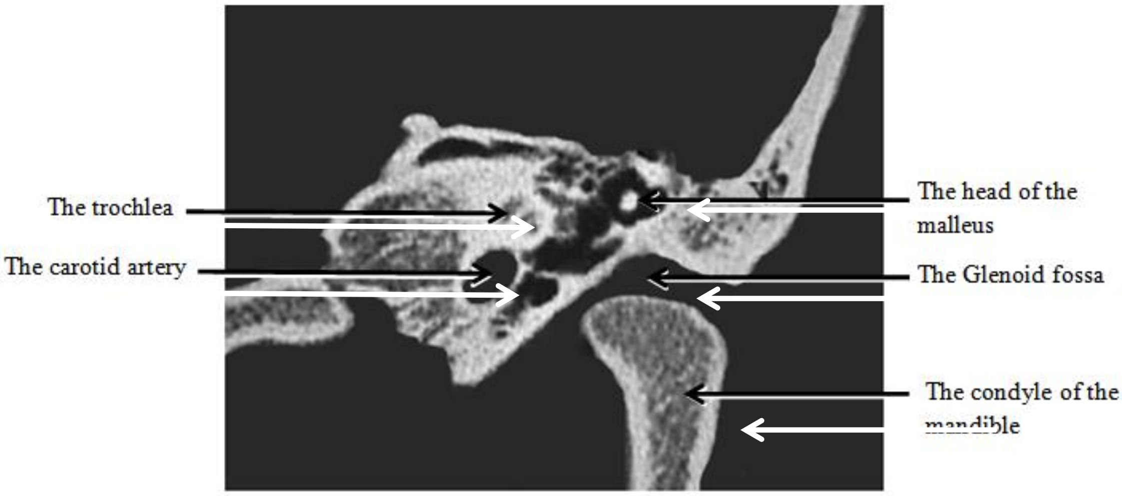

Figure 13:*Coronal CT scan image through the left temporal bone at the level of the glenoid fossa*

Figure 13: is a coronal CT scan image through the anterior part of the temporal bone demonstrating the carotid artery close to the trochlea (the basal turn); the head malleus appears inside the epitympanum. The Glenoid fossa represents the inferomedial margin of the mastoid air cells. In this image the tegmentempani appears separating the middle cranial fossa from space of the middle ear.

Figure 14: is coronal CT scan image more posterior that the previous one, through the internal auditory canal medially and the lateral semicircular canal appears lateral to it, and the facial nerve courses inferolateral tothe lateral semicircular canal and the ossicles appear inside the tympanic cavity, with the scutum represents the lateral boundary of the epitympanum.

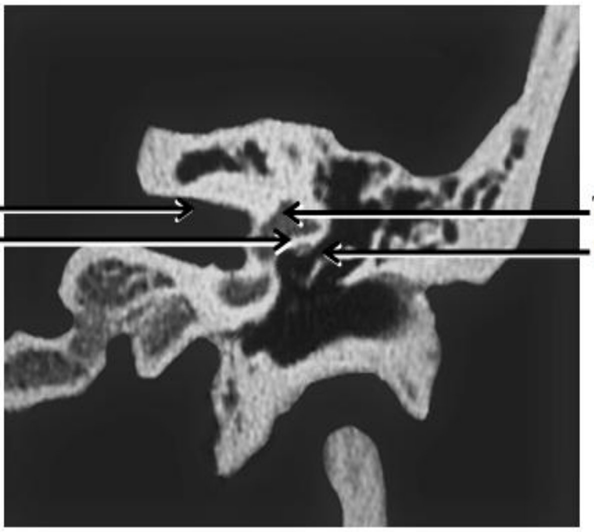

Figure 14:*Coronal CT scan image through the left temporal bone at the level of the glenoid fossa*

II. Conclusion

Temporal bone imaging is challenging andinvolves thorough understanding of temporal boneanatomy. CT scan is the best imaging modality to identifyanatomical details and minute structural components of temporal bone;it has the ability to clarifythe hidden parts of the temporal bone through its special algorithms and multiplanarreformatting technique.

References

[1]. Hanafee WN, Gussen A. **Correlation of basal projection tomography in clinical problems.**RadiolClin North Am I 974;1 2:419-429.
[2]. Virapongse C, Rothman SLG, Kier EL, Sarwar M. **Computed tomographic anatomy of the temporal bone.** AJR. 1982; 139:739-49.
[3]. Fujii N, Inui Y, Katada K. **Temporal bone anatomy: correlation of multiplanar reconstruction sections and three-dimensional computed tomography images.** *Jpn J Radiol*. 2010 Nov. 28(9):637-48.
[4]. Schwab SA, Eberle S, Adamietz B, Kuefner MA, Kramer M, Uder M, et al. **Comparison of 128-Section Single-Shot Technique with Conventional Spiral Multisection CT for Imaging of the Temporal Bone.***AJNR Am J Neuroradiol*. 2011 Jun 2.
[5]. Johnson OW, Voorhees RU, Lufkin RB, Hanafee W, Canalis R.**Cholesteatomas of the temporal bone: role of computed tomography.** Radiology 1983; 148:733-737.
[6]. Gunlock MG, Gentry LR,**Anatomy of the temporal bone.**Neuroimaging Clin N Am. 1998 Feb; 8(1):195-209.[PubMed] [Ref list]
[7]. Donaldson JS. **Normal anatomy ofthe inner ear.** OtolClin NorthAm 1975; 2:267-269.
[8]. Vignaud J, Juster M, Lenich H, Lichtenberg A, Korach G.**Radioanatomie de Ia cochlea.** ActaRadiol 1969; 9: 117- 122.
[9]. Sachin Gupta, Francine Mends, Mari Hagiwara, GirishFatterpekar, and Pamela C. Roehm, **"Imaging the Facial Nerve: A Contemporary Review,"** Radiology Research and Practice, vol. 2013, Article ID 248039, 14 pages, 2013. https://doi.org/10.1155/2013/248039.

Dr. Osama A "Anatomical Characteristics of Temporal Bone on Computerized Tomography."IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 17, no. 5, 2018, pp 88-96.