The Role of Multi-slice CT in Preoperative Assessment of Temporal Bone in Patients Prepared to Cochlear Implantation

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Presented By

Mostafa Salah Abdel-Moniem El Ghobashy

M.B.B.Ch.
Faculty of Medicine - Ain Shams University

Supervised By

Prof. Dr. Laila Ahmad Abdulrahman

Professor of Radiodiagnosis
Faculty of Medicine - Ain Shams University

Ass.Prof. Ahmed Mohamed Osman Bakry

Ass.Professor of Radiodiagnosis
Faculty of Medicine - Ain Shams University

Faculty of Medicine
Ain Shams University
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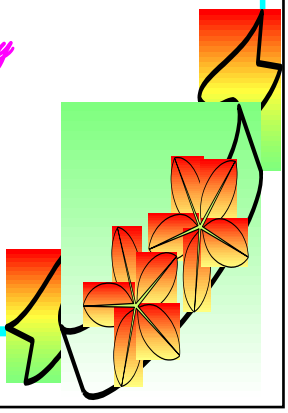
Mostafa Salah Abdel-Moniem El Ghobashy



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List of Abbreviations

CI	Cochlear implantation.
CHL	Conductive hearing loss.
CN	Cranial nerve**.**
ET	Eustachian tube.
EAC	External auditory canal.
IAC	Internal auditory canal
M	Month**.**
MDCT	Multi-detector computed tomography.
SCC	Semicircular canal.
SNHL	Sensori neural hearing loss
TT	Tegmen tympani
TM	Tympanic membrane.
Y	Year.
MSCT	Multi slice computed tomography
MPR	Multi planer reformat
IP-II	Incomplete partition type -I
LESA	Large endo lymphatic sac anomaly
LVAS	Large vestibular aqueduct syndrome
VA	Vestibular Aquiduct

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Introduction

The cochlear implant (CI) is a highly technological device that is surgically inserted in the cochlea of patients with severe to profound bilateral sensorineural hearing loss and that have not benefited from conventional sound amplification hearing aids ***(Barbosa et al., 2014).***

Cochlear implantation is the only United States Food and Drug Administration-approved treatment for children with marked bilateral sensorineural hearing loss. It provides auditory benefits that range from simple sound detection to substantial word understanding. Improved hearing through cochlear implantation has been demonstrated to enhance the rate of language acquisition, enable development of spoken language, and advance literacy in deaf children ***(Young et al., 2014).***

Candidates for the CI undergo preoperative assessment involving clinical, speech therapeutic, psychological and social criteria. During this stage, imaging of the cochlear region is paramount in defining the etiology of hearing loss, in locating findings that may contraindicate surgery, in helping to select the ear to be implanted, in adequately evaluating the anatomy for surgery, and - within limits - in predicting possible complications ***(Vlastarakos et al., 2010).***

In recent years, things started to change with the worldwide use of multi-slice spiral CT scanners in imaging of the temporal bone which provide better multi slice CT (MSCT) imaging of that complex part. The 3D multiplanar

reformatted images from conventional cross sectional CT data has been increasingly used to better demonstrate the anatomy and pathology of the temporal bone. 3D volume rendered CT images can aid in understanding the temporal bone. These images can be rotated in space and dissected in any plane allowing assessment of morphologic features of individual structures including the small ossicles of the middle ear and intricate components of the inner ear ***(Girish et al., 2006).***

During cochlear implant, there are key surgical steps which are influenced by anatomical variations between each patient. Pre-operative temporal bone CT scan can help us to determine if there are potential predictors of difficulties that may be encountered during the cortical mastoidectomy, facial recess approach and round window access in cochlear implant surgery ***(Park et al., 2015).***

MDCT plays a critical role in evaluation and management of different causes of hearing loss which require many therapeutic techniques including cochlear implantation. In general, most causes of hearing impairment including the external auditory canal, middle ear space including the ossicles, the mastoid and the petrous air cell system & the cochlea are best visualized with computed tomography scan of the temporal bone using bone algorithm and windowing techniques ***(Michele and Barry, 2008).***

Aim of the work

To evaluate the role of multi-slice CT in pre-operative evaluation of cochlear implant candidates.

Anatomy

Normal Temporal Bone:

The temporal bones comprise the lateral skull base, forming portions of the middle and posterior fossae. Each temporal bone is composed of five osseous parts: the squamous, mastoid, petrous, tympanic, and styloid portions **(Fig. 1).** Several intrinsic channels, intrinsic fissures, and extrinsic sutures are often apparent on C'I' images and can mimic fractures (pseudo fractures) (***Patel et al., 2012***).

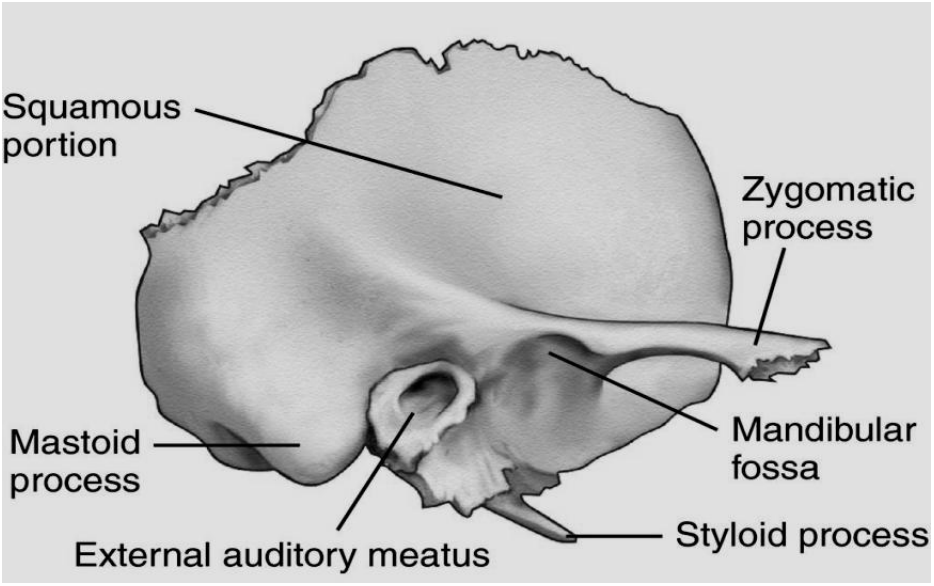

Fig.l: Temporal bone lateral surface. 3D bone surface reconstruction of the MDCT dataset. Note *three* portions (squamous, tympanic, and mastoid) of the temporal bone comprising its lateral surface (**Gray's Anatomy, 2000).**

Normal Anatomy of the ear

A-External Auditory Canal

The external ear lies lateral to the tympanic membrane. The external ear consists of the auricle, or pinna, and the external auditory canal **(EAC)** ***(Fatterpeckar et al., 2006).***

The external auditory canal (approximately 2.5 cm) forms an S- shaped curve as it extends from the auricle to the tympanic membrane. The medial two-thirds of the EAC are osseous and slightly narrower than the lateral third, which is cartilaginous. A somewhat more pronounced constriction, the isthmus, is seen at the bone-cartilage junction ***(Fatterpeckar et al., 2006***).

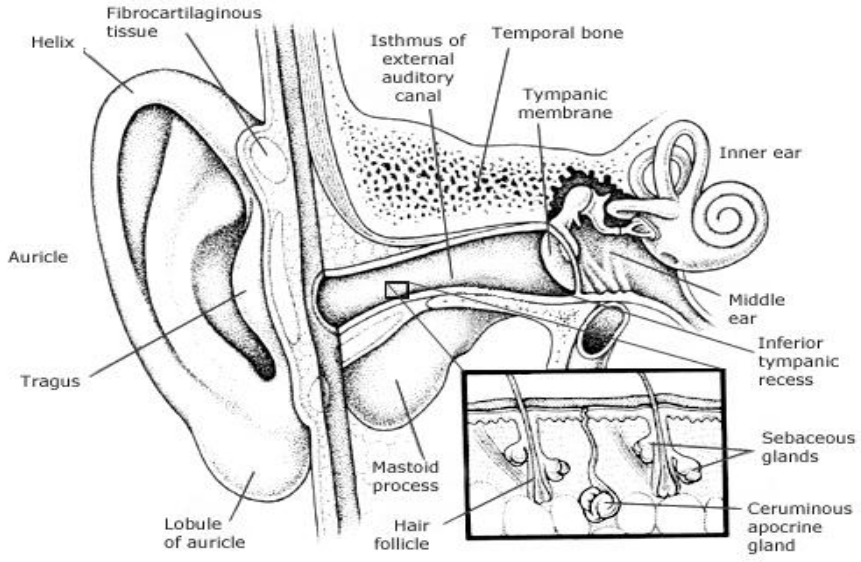

Fig. 2: Illustration of the anatomical structures of the auditory system. The outer ear includes the external auditory canal. The middle ear includes the tympanic membrane and three tiny bones. The inner ear contains the semicircular canals, cochlea, vestibule and the hearing nerves (***Ergon et al., 2014).***

By CT, the anterior and posterior walls are best visualized in the axial projection, while the coronal plane is well suited for visualization of the roof and the inferior wall ***(Fig. 3).*** Most medially, at the attachment of the tympanic membrane, the most postero-superior edge of the tympanic rim protrudes slightly into the canal, forming the posterior (greater) tympanic spine which can be visualized on the axial view as a sharp projection extending anteriorly at the junction of the middle ear and external canal (***Standring, 2008).***

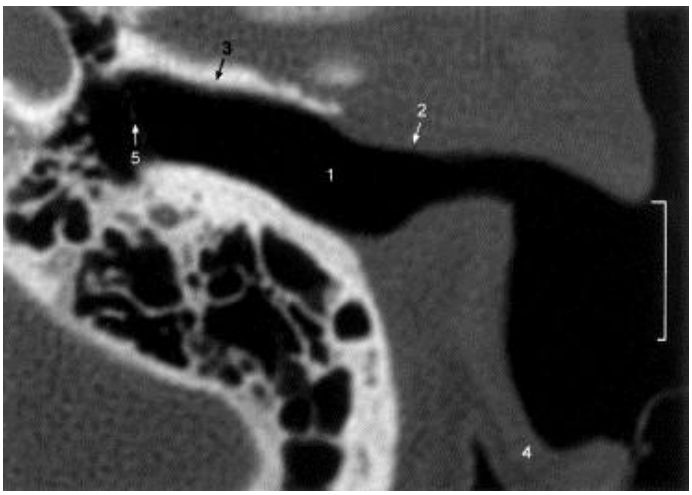

Fig. 3. Axial CT image at the level of the left temporo mandibular joint.
1-External auditory canal(EAC).
2-Cartilaginous portion of EAC, 3-bony portion of EAC, 4-pinna, 5-tympanic membrane. (***Ahuja et al., 2003).***

The tympanic membrane

The tympanic membrane (TM) transmits sound waves traveling through the EAC to the middle ear ossicles by way of mechanical vibration. Its outer circumference forms a fibro-cartilaginous ring that is fixed at the inner edge of the EAC in the tympanic sulcus. This sulcus is deficient