ROLE OF HIGH RESOLUTION CT OF THE TEMPORAL BONE IN ATTICO-ANTRAL DISEASE

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M.D IN **RADIODIAGNOSIS**

By

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UNDER THE GUIDANCE OF

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APRIL– 2012

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I hereby declare that this dissertation entitled ***"ROLE OF HIGH RESOLUTION CT OF THE TEMPORAL BONE IN ATTICO-ANTRAL DISEASE"*** *is a bonafide and genuine research work carried out by me under the guidance of* **DR.PURNIMA HEGDE, M.D. (RD)** Professor, Department of Radiodiagnosis, Sri Devaraj Urs Medical College, TAMAKA, KOLAR.

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INTRODUCTION

Attico-antral disease is one of the commonest causes of deafness. Attico-antral disease is an inflammatory disease of the middle ear cleft characterized by the formation of a cholesteatoma inside the ear with potentially fatal complications. Cholesteatoma are cyst-like, expansile lesions of the temporal bone lined by stratified squamous epithelium that contain desquamated keratin. Atticoantral disease, in which the perforation is located in the attic region of tympanic membrane, and is typically associated with the development of cholesteatoma. Cholesteatoma is associated with a higher risk of major complications, e.g. brain abscess and other intracranial infection.

Cholesteatoma is traditionally diagnosed by otoscopic examination and treated by explorative surgery. Conventional radiography does not permit a detailed study of middle ear and mastoid. High resolution computed tomography (HRCT) has completely replaced conventional multidirectional tomography in evaluation of the temporal bone. HRCT has high resolution, multiplanar reconstructions and 3D reconstructions provide global information of middle ear structures. This gives surgeon better information and plays a major role in pre-operative evaluation and post-operative follow up of the patients with attico-antral disease.

Barring any medical contraindications, treatment of a suspected cholesteatoma is by surgical exploration and eradication of disease with tympanomastoidectomy operation. HRCT scan can delineate location and extent of disease. There exists an apparent resistance among otologists universally to HRCT scanning prior to mastoid surgery. Knowledge of disease extent and information on degree of mastoid pneumatization aid in planning the surgical approach. It serves as road map to assist the surgeon during surgery.

AIMS & OBJECTIVES

1) To assess the usefulness of HRCT scan in attico-antral disease in depicting the status of the middle ear structures.

2) To correlate HRCT findings of temporal bone with surgical findings in attico-antral disease with respect to the following parameters:

- Presence or absence of cholesteatoma.
- Extent of cholesteatoma.
- Status of ossicular chain.
- Integrity of the facial canal.
- Detection of erosions or dehisence in the bony labyrinth.
- Detection of erosions or dehisence in the dural or sinus plates.

HISTORIC PERSPECTIVE

Attico-antral disease is an inflammatory disease of the middle ear cleft characterized by the formation of cholesteatoma with potentially fatal complications. Atticoantral disease, in which the perforation is located at the attic region of tympanic membrane and is typically associated with the development of cholesteatoma.

Cholesteatoma has been known for more than 300 years in the medical literature; still its precise detection with the use of cross-sectional imaging techniques remains challenging.[1] Joseph-Guichard Duverney, a French anatomist, was the first to describe a temporal bone lesion in 1683, probably representing a cholesteatoma.[2] In 1838, this pathology was named “cholesteatoma” (Greek: chole + stear =fat; oma= tumor) by the German anatomist/pathologist Johannes Muller. However, this term is incorrect because the lesion does not contain fat and is not of a neoplastic nature.

The diagnosis of cholesteatoma at first presentation is mainly based on clinical suspicion and otoscopic examination. Cholesteatoma is treatable cause of deafness if diagnosed early in the course of the disease and further complications can be prevented. Due to lack of imaging in those days, early detection was not possible. Initially, plain radiography was obtained to look for middle ear structures, but due to overlapping of structures it could not provide much information. The Stenvers view, a long-axis projection of the petrous portion of the temporal bone, was used to depict the round window and posterior semicircular canal, as well as other structures.[3] The Poschl view, a short-axis view of the petrous pyramid, was used to optimally visualize the superior semicircular canal, anterior wall of the cochlea, and vestibular aqueduct.[4, 5]

Temporal bone imaging became a specialized area of radiologic study with the advent of polytomography during the late 1950s and early 1960s. Thick sections with poor resolution and increased radiation dose was a drawback.

CT was invented in 1972 by British engineer Godfrey Hounsfield of EMI Laboratories, England and by South Africa-born physicist Allan Cormack of Tufts University, Massachusetts. Hounsfield and Cormack were later awarded Nobel Peace Prize for their contributions to medicine and science. HRCT has the advantage of producing images with higher contrast and a better spatial resolution. High resolution CT (HRCT), a modification of routine CT, provides a direct visual window into the temporal bone providing minute structural details.[6] HRCT images are obtained with thin sections (1-2 mm) and special bony algorithm for high details.[7] HRCT scanning excels in the evaluation of bone and air space anatomy and disorders of temporal bone. Newer high resolution multi-detector spiral imaging system can generate nearly isotropic voxels for multi-planar reconstruction, making direct imaging in several planes unnecessary.[8]

HRCT and MRI are currently the most widely used imaging modalities and have largely replaced the other modalities for evaluating middle ear pathologies. The role of imaging is to document disease early, delineate its extent and associated complications and to provide the surgeon with a detailed road map for planning surgical procedure.

Cholesteatoma whether congenital or acquired, can only be treated by surgical resection. The goals of surgical management include the eradication of disease, restoration of hearing, and to the extent possible, maintenance of normal anatomic configuration.

There is no single surgical method in treating cholesteatoma. The site, extent of cholesteatoma, the extent of bone involvement/erosion and mastoid pneumatization guides the surgeon in choosing the type of surgery which may range from simple extraction of cholesteatoma to radical mastoidectomy.[9]

Surgical methods include:[10]

a) Atticotomy : Transcanal

b) Simple mastoidectomy

c) Canal wall up procedures (intact wall)

d) Canal wall down procedures–Radical or modified radical mastoidectomy.

REVIEW OF LITERATURE

Cholesteatoma are cyst-like, expansile lesions of the temporal bone lined by stratified squamous epithelium that contain desquamated keratin. They most frequently involve the middle ear and mastoid, but they may develop anywhere within the pneumatized portions of the temporal bone.[11] Cruveilhier first described aural cholesteatoma as a “pearly tumor” of the temporal bone.[10] Schuknecht gave a more appropriate description, keratoma, however it is rarely used.[11]

In Virchow’s description of the pathology of aural cholesteatoma in 1864, he noted that the cholesteatoma extended through the bone to the external auditory canal, sometimes, also, into the cranial cavity.” Since that time, clinicians and investigators have studied the pathophysiology of bone resorption from this disease. Although much progress has been made in the understanding of the resorptive process, the actual sequence of events and their relative importance are unknown.[10]

Studies specific to COM with cholesteatoma reveal an annual incidence ranging between 6 and 12 per 100,00.[12,13,14] The current literature suggests that 10% of cholesteatomas are bilateral.[13]

Today the use of conventional radiography is limited to the evaluation of mastoid pneumatization. The high resolution computed tomography (HRCT) of temporal bone provides exquisite bony details and excellent demonstration of soft tissue density within the air spaces of the mastoid, external auditory canal and middle ear but very limited identification of the type of substance producing the abnormal density. Magnetic resonance (MR) is more sensitive than HRCT in the early identification of soft tissue pathologic changes in the temporal bone . However bony structures cannot be imaged by MR. For this reason , HRCT remains the study of choice for assessment of middle ear pathology.[15]

Middle ear cholesteatoma is a distinct clinical entity with characteristic findings that may be suggested by high resolution CT imaging. These findings should alert the clinician to the possibility of cholesteatoma, which will guide in the surgical approach and treatment plan.[16]

The history of surgery for middle ear cholesteatoma is of an evolution of techniques to meet the challenges of inaccessible disease. Routine CT scanning prior to all surgery of cholesteatoma can only be justified if it can be shown that clinical management is influenced.[17]

HRCT is the imaging technique of choice in case of a clinically suspected cholesteatoma. Typical HRCT findings associated with cholesteatoma include a sharply marginated expansile soft-tissue lesion, retraction of the tympanic membrane, scutum blunting , and erosion of the tympanic tegmen and ossicles.[18]

High resolution thin section computed tomography has widely replaced conventional techniques for temporal bone imaging. The most significant use of computed tomography lies in evaluation of cases of chronic suppurative otitis media. High resolution CT of temporal bone has been implicated as a mode of diagnosing cholesteatoma, demonstrating ossicular chain, analysing labyrinthine fistula and detecting bony defects in facial canal.[19]

The ability of HRCT scanning to depict accurately the status of structures of the temporal bone represents a major advance in delineating pathology prior to surgical exploration of ears with cholesteatoma. This imaging technique provides information concerning location and extent of disease as well as possible anatomic variations and complications that may be encountered. There is excellent correlation between CT scan and surgical findings in patients with cholesteatoma.[20]

The advent of High resolution CT scans has brought about significant enhancement in pre-operative assessment of temporal bone pathology and fine anatomical details.[21] The principal merit of CT scan of the temporal bone lies in its inherent ability to depict pathology which is not clinically evident.[19] The HRCT scan is a valuable and useful investigative tool prior to cholesteatoma surgery.[21]

The CT finding of abnormal soft tissue density associated with bone erosion was highly correlated with surgical findings of cholesteatoma. By contrast, total absence of abnormal soft tissue on CT essentially excluded cholesteatoma.[22] HRCT is valuable for detection of early erosive changes suggestive of cholesteatoma.[16]

There is good to excellent radio-surgical correlation in cholesteatoma for most middle ear structures except for the integrity of the facial canal. The scan alerts the surgeon to potential surgical dangers and complications of disease. High resolution CT scan is an important investigative tool prior to cholesteatoma surgery.[21]

Using the high contrast and special resolution of modern high resolution CT, this has become the method of choice in the investigation of cholesteatomas of the middle ear.[23]

Newer high resolution multidetector spiral imaging system can generate nearly isotropic voxels for multiplanar reconstruction, making need for multiple series with direct imaging in several planes unnecessary.[24]

Koster O et al (1985) [23] conducted a study in 30 patients with cholestatoma of middle ear to assess the value of high-resolution CT in diagnosing acquired cholesteatoma of the middle ear. They found that the extent of the soft tissue process can be demonstrated by CT, but differentiation of the cholesteatoma from the accompanying inflammatory changes is not possible. They also pointed that the typical complications such as destruction of the auditory ossicles, the bony labyrinth, the facial canal, the lateral wall of the attic and the superior and inferior walls of the tympanic cavity are clearly demonstrated by HRCT.

Sandeep Berry et al (1998) [25] conducted a study in 30 patients with unsafe chronic suppurative otitis media and showed that CT scan is highly sensitive for soft tissue density mass in the middle ear and mastoid, dural plate exposure, sinus plate erosion, facial canal and stapes integrity, moderately sensitive for malleus and incus integrity and least sensitive for lateral canal fistulae.

N W C Chee et al (2001) [21] conducted a study to assess the value of preoperative high resolution computed tomography in cholesteatoma surgery. Out of 36 cases, 30 cases (83.3%) had all, of the following radiological features: (a) a nondependent tissue mass, (b) a location typical for cholesteatoma and (c) bony erosion. The radiosurgical agreement was excellent for the erosions of malleus (kappa statistics, k=0.83), stapes (0.94) and semicircular canals (0.8), good for the incus (0.62) and tegmen (0.65), but poor for the facial nerve canal (0.3).

Park MH et al (2010) [26] performed a study to evaluate the usefulness of Hounsfield unit (HU) to better distinguish cholesteatoma from other inflammatory conditions in the mastoid ad antrum before primary mastoid surgery. Out of 82 patients enrolled, forty-one patients were pathologically diagnosed with cholesteatoma, whereas the others were diagnosed with inflammatory granulation.

HU was calculated as 42.68 +/- 24.42 in the cholesteatoma group and 86.07 +/- 26.50 in the non-cholesteatoma group. The differences between the 2 groups were statistically different (Student t test, $P < .01$). By applying the HU, the sensitivity (51.2%-80.5%), specificity (80.5%-87.8%), positive predictive value (72.4%-86.8%), and negative predictive value (62.3%-81.8%) to diagnose cholesteatoma improved. An improved diagnosis of cholesteatoma was achieved after adjusting for the HU.

ANATOMY

EMBRYOLOGY

The embryologic development of the ear is a multistage and anatomically complex process. The outer ear structures develop from the first branchial cleft and the first and second branchial arches during the 6th through 12th weeks of intrauterine life. The external auditory canal (EAC) initially develops as a solid core of epithelium, termed the meatal plate, which migrates toward the first pharyngeal pouch and subsequently hollows out during the 2nd through 7th months of intrauterine life. The eustachian tube and tympanic cavity arise from the first pharyngeal pouch between 10 and 30 weeks gestation. The tympanic membrane is derived from three germ cell layers, including ectoderm from the first branchial groove and mesoderm and endoderm from the first branchial pouch. The ossicular chain and supporting ligaments arise from the first and second branchial arches.

The membranous portion of the inner ear arises from neuroectoderm (otic placode) in the 4th week of gestation. The otic placode invaginates, forming the otic pit, and subsequently forms the otic vesicle (otocyst). The otocyst divides into the dorsal and ventral pouches (pars superior and inferior, respectively), which are the precursors to the utricle, semicircular canals, cochlear duct, and saccule. The bony labyrinth (otic capsule) develops from mesenchyme around the membranous labyrinth between 4 and 8 weeks gestation, continues to grow between 8 and 16 weeks gestation, and ossifies by the 24th week of gestation.[2]

ANATOMY

The anatomy of the temporal bone is complex and in many circumstances confusing. The temporal bones are situated at the sides and base of the skull. Each consists of the following five parts: Squamous, mastoid, petrous, tympanic, and styloid process.[8]

Squamous Portion: It forms the anterolateral and upper part of the bone. It forms the lateral wall of the middle cranial fossa. It articulates with the sphenoid bone anteriorly and with the parietal bone superiorly. The anteriorly projecting zygomatic process articulates with the zygoma of the maxillary bone.[47]

Mastoid Portion: The mastoid process is hollowed to form a number of spaces, the mastoid cells, that vary greatly in size and number. In the upper and anterior part of the process, these cells are large and irregular, toward the middle part they diminish in size, and those in the apex of the process frequently are small. In addition to these cells a large, irregular cavity, the tympanic antrum, occurs and is situated at the upper and anterior part of the mastoid portion of the bone. The antrum communicates with the epitympanum (attic), situated anteroinferiorly and medially by way of the narrow5 channel, the aditus ad antrum. The inner or intracranial surface of the mastoid presents a deeper groove, the sigmoid sulcus, that lodges part of the transverse sinus.[8]

Petrous Portion: The petrous part of the temporal bone is pyramidally shaped and contains the inner ear structures. It extends from the mastoid part posteriorly to the angle between the occipital and sphenoid bones anteriorly. Its antero-superior surface contributes to the floor of the middle cranial fossa and is marked by the arcuate eminence denoting the location of the superior semicircular canal, the tympanic tegmen overlying the tympanic cavity, and the trigeminal impression for the fifth cranial nerve. The posterior surface of the petrous pyramid lies in a vertical plane and forms the anterolateral wall of the posterior cranial fossa. The meatus of the internal auditory canal is located on the posterior surface at the midpoint between the base and apex of the petrous pyramid. Slightly postero-inferior to the internal acoustic meatus is a small slit that leads to the vestibular aqueduct. The aqueduct transmits the endolymphatic duct and sac. Located at the apex of the petrous pyramid are the internal carotid artery, the hiatus for the lesser superficial petrosal nerve, and the semicanal for the tensor tympani muscle. A ridge of bone separates the jugular bulb from the more anteriorly located canal for the internal carotid artery. The sigmoid sinus curves into the postero-lateral part of petrous portion.[46]

Styloid process: The styloid process arises just lateral to the posterior aspect of the jugular fossa. The stylomastoid foramen for the facial nerve lies posterior to the styloid process.[46]

Tympanic Portion: The tympanic bone forms the inferior, anterior, and part of the posterior wall of the bony external auditory canal. At the medial end of the tympanic bone is a narrow groove, the tympanic sulcus, for the attachment of the tympanic membrane.[46]

External ear:

External Auditory Canal: The external auditory canal is approximately 2.5 cm in length. Its lateral one-third is formed by elastic cartilage oriented in an upward and backward fashion. The medial two-thirds of the external auditory canal is osseous and is oriented in a downward and forward direction.[46]

Tympanic membrane: is the medial boundary of the external auditory canal, separating the canal from the middle ear. The tympanic membrane is oriented obliquely so that the inferior and anterior walls of the external auditory canal are longer. Major part of membrane is taut, referred to as the pars tensa, except for a small triangular lax superior part referred as pars flaccida. The most medial point of the roof of the external auditory canal is known as scutum.[8]

Middle Ear: The middle ear, or tympanic cavity, is an irregular, laterally compressed space within the temporal bone. The middle ear is traversed by the ossicular chain connecting the lateral and medial walls. The tympanic cavity consists of three parts:

a) tympanic cavity proper (mesotympanum) - opposite the tympanic membrane,

b) attic (epitympanum) - above (cranial to) the level of the membrane, and

c) hypotympanum, - inferior and medial extension occurring below (caudal to) the level of the tympanic membrane.[8]

- **Roof or Tegmental Wall**: Tegmen tympani separates the middle ear cavity from the middle cranial fossa. In children this may be unossified and may allow direct passage of infection from the middle ear to the epidural space of the middle cranial fossa.
- **Floor or Jugular Wall**: It is usually a very thin plate of cortical bone that separates the cavity from the internal jugular vein. Occasionally the bone may be dehiscent with the jugular bulb present within the hypotympanum.[8]
- **Mastoid or Posterior Wall**: The mastoid or posterior wall is wide above and below and presents the aditus ad antrum (entrance to the tympanic antrum), the pyramidal eminence, and the incudal fossa. Aditus ad antrum is a large,

irregular aperture that leads posteriorly from the epitympanic recess to the mastoid antrum. Pyramidal eminence is situated immediately behind (dorsolateral to) the oval window and in front of (ventral or medial to) the vertical (mastoid) portion of the facial canal. There are two important recesses in the posterior wall, the sinus tympani and the facial recess. They may be the sites of occult extension of disease within the middle ear.[8,7]

- **Carotid or Anterior Wall**: Corresponds to the carotid canal, from which it is separated by a thin plate of cortical bone. At the upper part of the anterior wall are the orifice of the semicanal for the tensor tympani muscle and the tympanic orifice of the eustachian tube.[8]
- **Medial or Labyrinthine Wall**: It separates inner ear from the middle ear cavity. Posteriorly and superiorly, is the prominence produced by the anterior limb of the lateral semicircular canal. Below this and extending more anteriorly is the prominence of the facial canal. Immediately below the mesotympanic facial canal is the laterally directed oval window niche. Below the oval window lies the promontory, a convexity that bulges into the tympanic cavity and represents a portion of the otic capsule over the basal turn of the cochlea. Below and behind the back part of the promontory is the round window niche.[8]

Contents of the tympanic cavity:

Auditory Ossicles: Three small bones span the width of the tympanic cavity**,** the malleus, the incus, and the stapes. The malleus consists of a head, a neck, the manubrium, and the anterior and lateral processes. The head lies within the epitympanum. The manubrium is attached to the tympanic membrane. The lateral process abuts the tympanic membrane immediately below the pars flaccida. The incus, the largest of the auditory ossicles, consists of a body, short process, long process, and lenticular process. The body of the incus rests in the epitympanum in association with the head of the malleus. The short process of the incus extends posteriorly, occupying the posterior incudal recess (fossa incudis).[46]

From its articulation with the incus, the stapes passes almost horizontally (but slightly cephalad) across the tympanic cavity to meet the wall of the labyrinth at the oval window. The stapes resembles a stirrup and consists of a head, a neck, two crura, and a base.[8]

Ligaments and muscles: Ossicles are connected with the walls of the tympanic cavity by ligaments, three for the malleus and one each for the incus and stapes. Important muscles include tensor tympani and stapedius.

Facial nerve : After its origin in the medulla, the facial nerve proceeds forwards and laterally in the posterior fossa into the internal auditory meatus, in conjunction with the nervus intermedius (sensory component of the facial nerve) and the acoustic nerve. The first or the internal auditory segment is 7 to 8 mm in length and lies superior to the cochlear nerve passing above the crista falciformis. The second or the labyrinthine segment of the nerve (3-4mm) passes forward and laterally within its own bony channel, the Fallopian canal. This is the narrowest part of the facial canal and extends from the internal auditory canal to the geniculate ganglion. When the nerve reaches a point just lateral and superior to the cochlea, it angles sharply forward, nearly at right angles to the long axis of the petrous temporal, to reach the geniculate ganglion. At the ganglion, the direction of the nerve reverses itself, executing a hairpin bend so that it runs posteriorly. This is the 'first genu' of the facial nerve. The third or the tympanic segment (12.0mm) extends from the geniculate ganglion to the second genu of the facial nerve. Here it lies above the oval window and below the bulge of the lateral semicircular canal. At the level of the sinus tympani, the nerve changes direction at the 'second genu'. The fourth or the mastoid segment (15-20mm) extends from the second genu to the stylomastoid foramen. Here the nerve assumes a vertical position, dropping downward in the posterior wall of the tympanic cavity and the anterior wall of the mastoid to exit at the base of the skull from the stylomastoid foramen.[8,47]

Inner Ear:

Vestibule: The central portion of the cavity of the bony labyrinth is the vestibule. The vestibule is continuous anteriorly with the cochlea and posteriorly with the semicircular canals. The vestibule has two other openings, the oval window (for the footplate of the stapes) and the vestibular aqueduct.[8]

Semicircular Canals: The three semicircular canals are continuous with the vestibule. Each of the canals makes about two thirds of a circle and measures about 1mm in cross-sectional diameter. The nonampulated ends of the superior and posterior semicircular canals join to form the bony common crus. The superior and posterior semicircular canals are both arranged in a vertical orientation at approximately right angles to one another. The superior canal is directed anterolaterally at an angle of about 45° to the midsagittal plane, and the posterior canal is directed posterolaterally at a corresponding angle. The anterior limb of the lateral semicircular canal lies in the plane higher than the posterior limb, making an angle of about 30° with the horizontal.[8]

Cochlea: The cochlea is a conical structure, its base facing the internal auditory canal and its apex or cupola directed anteriorly, laterally, and slightly downward. The cochlea consists of a bony canal wound around a conical central core called the modiolus. The canal winds through slightly more than 21⁄2 turns. The first turn bulges toward the tympanic cavity, and this elevation on the medial wall of the tympanic cavity is known as the promontory. The openings in or near the first portion of the cochlear canal include the round window, which is covered by the secondary tympanic membrane; the oval window (actually an opening of the vestibule), which is covered by the footplate of the stapes; and the cochlear canaliculus, which leads via a small canal to the subarachnoid space, opening on the inferior surface of the petrous portion of the temporal bone.[8]

ANATOMICAL VARIANTS AND CONGENITAL ABNORMALITIES

ANOMALIES OF THE MIDDLE EAR

These anomalies may also be found in association with a variety of syndromes, the more common of which are Goldenhar and Treacher-Collins syndromes.[48] Depending on the source, either the incus or stapes are the ossicles most frequently malformed or absent.[48,49] A rare anomaly of the malleus is congenital fixation of the head to the lateral epitympanic wall called the malleus bar.[50,51] The facial nerve course is often anomalous in the presence of ossicular chain anomalies as the ossicles develop from the first and second branchial arches and the nerve develops from the second arch. The most common facial nerve anomalies noted to occur in patients with congenital middle ear malformations without stenosis or atresia of the EAC are displacement and wide bony dehiscence of the tympanic segment.[48]

Lastly, other anomalies that may occur within the middle ear include an absent stapedius muscle and/or tendon, absence or elongation of the pyramidal eminence, and hypoplasia of the tympanic cavity.[52]

VASCULAR ANOMALIES

- ✓ Aberrant petrous internal carotid artery
- ✓ High jugular bulb / Dehiscent jugular bulb
- ✓ Jugular diverticulum

NORMAL VARIANTS

- ✓ Dehiscent facial nerve
- ✓ Aberrant internal carotid artery
- ✓ Jugular bulb variants
- ✓ Persistent stapedial artery
- ✓ Anterior and wider sigmoid sinus
- ✓ Size of mastoid antrum
- ✓ Presence of korner's septum –bony demarcation between mastoid and temporal squamae
- ✓ Deep posterior wall recesses – facial canal recess and sinus tympani
- ✓ Low lying middle cranial fossa

PATHO-PHYSIOLOGY OF CHOLESTEATOMA FORMATION

"Cholesteatoma" is a well-demarcated non-neoplastic lesion in the temporal bone, which is commonly described as "skin in the wrong place." [28]

Multiple theories were developed concerning the pathophysiology of both congenital and acquired cholesteatomas. Which one is the most plausible is a matter of long-standing debate and still remains unclear. [29,30,31]

The most plausible explanation for the development of congenital cholesteatomas is the postpartum persistence of a fetal epithelial thickening medial to the malleus neck. This lesion is a distinct squamous cell nest with unknown function, which usually involutes to become normal endothelium. Lack of involution, for unknown reasons, can be the precursor of congenital cholesteatoma,[32] which may form in the intra-uterine or early post natal period. Congenital cholesteatomas can be associated with EAC atresia or, rarely, with first branchial cleft remnants.

Acquired cholesteatomas may develop by various etiopathogenic mechanisms:

1) The "migration theory" postulates relocation of squamous epithelium from the margin of a perforated or retracted TM into the middle ear, forming a cholesteatoma.[33]

2) The "basal hyperplasia theory" assumes an inflammation associated proliferation of basal cells breaking through the basement membrane, thus giving rise to a cholesteatoma.[34]

3) The "post surgery/post traumatic theory" claims iatrogenic implantation of epidermal elements into the middle ear cavity.[35]

4) According to the “retraction pocket theory,” there is poor ventilation of the mastoid-cave and the middle ear as a result of eustachian tube dysfunction. This leads to an increased negative pressure in the tympanic cavity, resulting in retraction of the TM with invagination of part of it, usually the pars flaccida. Chronic retraction pockets may facilitate hyperplastic epidermal in-growths into the middle ear with consecutive development of granulation tissue and bone erosion. On the basis of this mechanism, cleft palate[36] and poorly pneumatized mastoids (underdeveloped or as a consequence of chronic inflammation) [37] are associated with a higher risk for cholesteatoma formation. The developing cholesteatoma may cause secondary perforation in the tympanic membrane.

5) The “metaplasia theory” is based on the identification of mucous glands in the inflamed connective tissue taken from cholestematous ears.[38] However, various studies[39,40] revealed that acquired cholesteatomas originate from the squamous epithelium (ectoderm) of the EAC and the bordering TM, rather than from metaplasia of the cuboidal epithelium (endoderm) of the middle ear.

Classification based on pathogenesis

Cholesteatomas can be classified as either congenital or acquired,[41] though the origins are indistinguishable with histology and imaging. Only the location of the lesion, the clinical history of the patient, and the otologic status of the tympanic membrane (TM) give some hints for differentiating these two types of cholesteatomas

- “Congenital cholesteatomas” develop from embryonic epithelial rests and can be located everywhere in the temporal bone: in the middle ear, in the mastoid, in the petrous apex, in the squama of the temporal bone, within the TM, or in the EAC. Furthermore, the same histologic entity can arise in other areas of the skull, in the extracranial soft tissues, or in an intracranial extra-axial location, where it is referred to as “epidermoid cyst.” Middle ear congenital cholesteatomas represent approximately 2% of all middle ear cholesteatomas.

- Acquired cholesteatomas are further subdivided and are uniquely localized in the middle ear.

“Primary acquired cholesteatomas” (80% of all middle ear cholesteatomas) develop behind an apparently intact TM, usually in the region of the pars flaccida.

“Secondary acquired cholesteatomas” (18% of all middle ear cholesteatomas) grow into the middle ear through a perforated TM, usually through the pars tensa and sometimes the pars flaccida.

Classification based on location in the tympanic cavity in relation to the tympanic membrane

On the basis of their site of origin, middle ear cholesteatomas can be classified as the following:

- “Pars flaccida (attic) cholesteatomas” are located at the upper one-third portion of the TM filling the Prussak space. On the basis of their pathogenesis, they are mostly acquired cholesteatomas resulting from a chronic infection with formation of granulation tissue behind an apparently intact TM (primary acquired) or through a perforation of the TM (secondary acquired).[41] Congenital cholesteatomas may be present in this location as well. Initially, pars flaccida cholesteatomas are usually located lateral to the ossicles.

- “Pars tensa (sinus) cholesteatomas” develop most often through a defect of the lower two-thirds portion of the TM (pars tensa) and most often are localized in the facial recess and sinus tympani of the tympanic cavity and in the mastoid region.[42] On the basis of their pathogenesis, they are either secondary acquired or congenital cholesteatomas.

Special groups of cholesteatomas

- “Mural cholesteatomas” are extensive lesions in the middle ear/mastoid, which drain their cystic contents through the TM into the EAC and leave the matrix behind. Due to enzymatic activity, the cavity grows continuously and resembles a mastoidectomy cave with no history of surgery; hence, the name of the process,“automastoidectomy.”[43,44]

- “EAC cholesteatomas,” because of their particular age distribution (in older populations), peculiar etiology, and distinct clinical signs and differential diagnosis, represent another special group of cholesteatomas. They are subdivided into idiopathic and secondary EAC cholesteatomas.[45] The typical location of an idiopathic EAC cholesteatoma is the floor of the EAC with a characteristic bilateral occurrence. The location of secondary EAC cholesteatoma depends on the site of the inducing factor.

IMAGING MODALITIES FOR TEMPORAL BONE

PLAIN RADIOGRAPH

Stenvers view : is obtained with the patient facing the film and the head slightly flexed and rotated 45º toward the side opposite the examination. The radiographic beam is angulated 14º caudad. The long axis of the petrous pyramid is parallel to the plane of the film, and the entire pyramid, including its apex, is well visualized. This view shows the entire pyramid, arcuate eminence, internal auditory canal, porus acusticus, horizontal and vertical semicircular canals, vestibule, cochlea, mastoid antrum, and mastoid tip.

Schuller view : is a lateral view of the mastoid, obtained with the sagittal plane of the skull parallel to the film and with 30º-cephalocaudal angulation on the radiographic beam. This view shows the degree and extent of mastoid pneumatization, the status of the trabecular pattern, and the position of the lateral sinus.

Prior to the advent of CT, multiplanar imaging using pluridirectional tomography was routine. Many different obliquities were used to generate a perfect cross-sectional image through a particular part of the temporal bone anatomy. Indeed, coronal and sagittal images were routine. Axial images were more difficult to achieve because of the awkward patient position needed for the basal view. Oblique planes carried names such as Poschl, Guillen, Stenvers, and so on, named after the people who described them. Each plane was designed to optimize visualization of a certain structure.

HIGH RESOLUTION COMPUTED TOMOGRAPHY

HRCT is the imaging technique of choice in case of a clinically suspected cholesteatoma. HRCT, due to its excellent spatial resolution, has a high sensitivity with a high NPV when it shows a free middle ear or mastoid. However, specificity is low in the case of a mass lesion because it may correspond to granulation tissue, secretion, cholesterol granuloma, or neoplasm. Still, the location of the mass and the absence or presence of bony erosions give some hints to the pathology of the lesion.

Prior to the advent of CT, multiplanar imaging using pluridirectional tomography was routine. Now, with the introduction of multidetector spiral CT scanners, an entire volume of the temporal bone is examined with one pass of the scanner in one plane. The volume is organized based on the isotropic voxel and spatial resolution is the same in any plane, be it the plane of acquisition or a reconstructed plane.[8] Recent developments in software technology have made it possible to rapidly generate 3D volumes from conventional 2D data. These volume-rendered (VR) images can be sectioned in any plane and rotated in space, allowing 3D insight into the anatomy of the temporal bone.

Typically, a high-resolution matrix should be used (512 × 512), with thin sections (0.6 to 1.5 mm) and a field of view of 15 to 20 cm. CT images are usually acquired or displayed in axial and coronal planes. For axial imaging, sections are made in a plane rotated 30° superior to the anthropologic base line (the line intersecting the inferior orbital rim and the EAC). Scans produced in this plane display the temporal bone structures to good advantage.[8] Advent of Multidetector CT with submillimeter section thickness provided the opportunity to replace direct coronal scanning with coronal reconstruction of image data from axial scanning.

Acquisition of a data set in isotropic voxels allows reconstructions in any plane without a significant loss in resolution.[53] Oblique reconstructions in 3D volumetric CT give radiologists the opportunity to visualize the anatomic structures of the middle and inner ear (the ossicular chain, stapedial footplate – oval window complex, round window, cochlea, vestibular aqueduct, and bones of the superior semicircular canal and facial nerve canal) in greater detail and may help increase the accuracy of CT for the diagnosis of diseases of the middle and inner ear. [53]

HRCT FINDINGS IN CHOLESTEATOMA

Clinical examination and otoscopy are used to diagnose cholesteatoma. CT can determine its extent by revealing the combination of a soft tissue mass and bone erosion with 80% specificity. Unfortunately, cholesteatoma sac, associated granulation tissue, mucosal oedema and effusion may be indistinguishable on CT.

Although cholesteatoma is said to show a lower attenuation than granulation tissue, the difference is subtle and enhanced MRI may be more reliable in differentiation.[17]

The imaging signature of cholesteatoma is bone erosion associated with a nonenhancing soft-tissue mass, and it is the bone destruction that makes these lesions particularly dangerous. Cholesteatomas may erode the scutum, ossicles, tegmen tympani, and bony labyrinth.[54] Correlating the site of the tympanic membrane perforation and the radiographic findings, basically two patterns of radiographic findings can be observed in the study of cholesteatomas.[55]

1. **Pars Flaccida Cholesteatomas (primary acquired) –**

Erosion of the scutum is the classic finding with retraction of tympanic membrane.[55,56] A soft-tissue mass lies in the epitympanum lateral to the ossicles with increased distance between the lateral epitympanic wall and the ossicles. This increase is due to medial displacement of the ossicles and to erosion of the lateral epitympanic wall.[55] When the cholesteatoma is limited to the anterior portion of the epitympanum, the adjacent aspect of the malleus head is eroded and has a concave, rather than a convex, outline. If the cholesteatoma extends into the posterior epitympanum, the body of the incus will be eroded. The long process of the incus is usually spared in pars flaccida cholesteatomas, unless the cholesteatoma sac is large and extends into the posterior middle ear.[55] Widening of the aditus is often an important imaging diagnostic finding when the lesion extends posteriorly.[57,58]

2. Pars Tensa Cholesteatoma (secondary acquired) -

Cholesteatoma of the pars tensa are more difficult to diagnose than pars flaccida lesions because the lateral epitympanic wall may be intact. The pars tensa cholesteatoma is easiest to diagnose on axial CT, in contrast to the early Prussak'stype cholesteatoma, which is best seen on coronal images.[8] In early cases, bony erosion is limited to the long process of the incus.[55] The pars tensa cholesteatoma tends to extend initially toward the medial wall of the middle ear and comes into contact early with the otic capsule over the lateral semicircular canal. As a result, fistulous formation to the lateral semicircular canal is more commonly seen in pars tensa cholesteatoma.[8] The malleus head and incus bodies are displaced laterally by the soft-tissue mass of the cholesteatoma sac. The malleus head is usually displaced but intact while the displaced incus body is often eroded. [55] Ossicular erosive changes occur, in order of decreasing frequency, in the long process incus, crura of stapes, body of the incus, and manubrium.[59]

Ossicular destruction occurs in 75% of pars flaccida cholesteatomas and in as many as 90% of pars tensa cholesteatomas. The long process of the incus, by virtue of its limited ligamentous support and poor blood supply, is the most common segment of the ossicular chain eroded by both varieties of acquired cholesteatoma.[8]

Labyrinthine fistula is a potentially serious complication of cholesteatoma, with an incidence of 5% to 10%. In order of decreasing frequency, fistulas occur in the lateral semicircular canal, superior ampulla, posterior canal, and promontory of the cochlea. The diagnosis of fistula can be made when the mass is in direct apposition to the lumen of the labyrinth.[8,60]

The facial nerve canal can be eroded; thus, it must be carefully evaluated on imaging. The most common site of facial nerve compression is the tympanic segment, which lies inferior to the lateral semicircular canal in the middle ear. Involvement of the tympanic segment of the nerve is best seen in coronal and 20° coronal oblique sections. Mastoid segment erosions are seen in sagittal and axial sections.[55]

Bony erosion may also occur at several other strategic locations. Especially ominous is the involvement of the tegmen tympani and sigmoid sinus plate. Erosion of the tegmen usually occurs in large cholesteatomas. MR imaging is recommended when defects occur at these sites because there could be associated epidural invasion by cholesteatoma, increasing the potential for development of meningitis, cerebritis, or abscess should the lesion become infected.[8]

The radiologic detection of the extent of a cholesteatoma beyond the limits of the mesotympanum and epitympanum depends on the recognition of soft-tissue and bony changes in the aditus, the antrum, the mastoid, and the petrous pyramid. Enlargement of the aditus is best seen in axial CT, and indicates extension of the cholesteatoma posterosuperiorly. When the cholesteatoma extends into the mastoid antrum, a mass is visible that partially or completely fills the lumen. As the cholesteatoma erodes the air cells that line the walls of the antrum, the contour becomes smooth. Further extension of the cholesteatoma results in enlargement of the antral cavity. Further extension of the cholesteatoma into the mastoid causes progressive destruction of the trabecular pattern and formation of a large, smoothwalled cloudy cavity.[55]

HRCT findings in mimics of cholesteatoma

a) Granulation tissue:

Granulation tissue is probably the most common cause of debris in the middle ear. On CT, a soft-tissue density is seen, with no ossicular displacement or bone erosion.[8] The CT density of middle ear debris is not histologically specific.[61] Holotympanic debris in the absence of TM alteration or significant conductive hearing deficit quite likely represents granulation tissue or fluid.[62] In the presence of TM retraction and conductive deficit, the possibility of inflammatory ossicular fixation should be considered, especially when there is associated calcification or ossification.

When fluid or inflammatory tissue in the middle ear cavity surrounds the cholesteatoma, the mass is obscured. Since the densities of cholesteatoma, inflammatory tissue and fluid are very similar in CT, Contrast-enhanced, T1-weighted MR images may be used in separating typical granulation tissue, which enhances, from cholesteatoma, which does not.[8,55]

b) Cholesterol granulomas :

In CT the granuloma appears as a nonspecific soft tissue mass when the middle ear is aerated. Unfortunately, the middle ear mucosa is usually inflamed, and the contour of the mass cannot be discerned. The bony walls of the middle ear are intact, but the ossicles are often eroded by the granulomatous process. A more precise assessment of the type and size of the mass are accomplished with MRI. A cholesterol granuloma appears as a well-defined soft-tissue mass of high signal intensity in both T1 and T2 sequences. In the T1-weighted images the mass can be distinguished from surrounding fluid or edematous mucosa that has a low signal.[55]

c) Chronic mastoiditis:

HRCT findings in chronic mastoiditis are opacification of the mastoid antrum and air cells with varying degrees of change in the mastoid trabeculae. Mastoid inflammation produces thickening of some trabeculae secondary to reactive new bone formation. In the initial stages, the air cells are opacified & fewer than normal and the residual trabeculae are thickened. Later as the chronic inflammatory process continues, the air cells are obliterated and the mastoid appears partially or completely sclerotic.[55]

MAGNETIC RESONANCE IMAGING

MR imaging provides complementary information due to the different pulse sequences, leading to a better tissue differentiation. The MR imaging signal-intensity characteristics of cholesteatomas are not specific, usually hypointense or isointense on T1WI and hyperintense on T2WI compared with brain tissue. Sometimes, cholesteatomas have lower signal intensity on T2WI or on constructive interference in steady state/FIESTA images than the surrounding granulation tissue; however, they may also be indistinguishable on these sequences.

On contrast-enhanced T1WI, differentiation may be possible,[63] because granulation tissue shows contrast enhancement, whereas cholesteatoma does not. However, in a temporal bone having already undergone surgery, standard MR imaging sequences may not accurately detect cholesteatomas. [64]

Studies have shown that diffusion weighted single-shot spin-echo echo-planar sequences can be useful in the diagnosis of cholesteatomas. [65,66.67] Irrespective of their type (congenital or acquired), cholesteatomas appear to have high signal intensity on DWI, attributed partly to restricted water diffusion (probably due to the oily consistency of the contained fluid) and predominantly to the T2 shinethrough effect of the lesion as revealed by calculated apparent diffusion coefficient values.[68] A limitation of spin-echo DWI in the detection of a residual/recurrent cholesteatoma is mainly attributed to the presence of magnetic susceptibility inhomogeneities at air/bone interfaces at the skull base,[69] especially at the tympanic tegmen. these artifacts can be reduced by parallel imaging techniques as well as multishot EPI and FLASH sequences.[70]

Single-shot turbo spin-echo DWI allows the use of a higher imaging matrix and thinner (2 mm) sections and is associated with fewer susceptibility artifacts. This sequence allows detection, in an ear that has not undergone surgery, of a cholesteatoma as small as 2 mm.[71] The most recent method for the diagnosis of recurrent cholesteatoma is the multishot fast spin-echo DWI-PROPELLER technique.

Improvement in MR imaging techniques in diagnosing cholesteatoma with the use of delayed contrast-enhanced, T1-weighted MR images[72,73] and echo-planar diffusion-weighted (DWI) MR images.[74,75] Several reports have discussed the appearance of acquired cholesteatoma on late postgadolinium T1-weighted MR images and on EPI-DWI images. [74,75] On EPI-DWI, cholesteatomas demonstrate a hyperintensity probably based on a T2 shinethrough effect. However, a major limitation of the EPI-DWI images still seems to be the important susceptibility artifact at the skull base (among other artifacts), the low resolution, and relatively thick sections, [76,77] thus causing a size limit for detection on EPI-DWI of approximately 5 mm. [78,79]

Single-shot TSE-DWI uses a 180° radio-frequency refocusing pulse for each measured echo, which explains the reduction of the susceptibility artifact. It allows the use of a higher imaging matrix and thinner sections (2 mm).[80]

Imaging features of complications of cholesteatoma

- Labyrinthine fistula is the most frequent complication associated with middle ear cholesteatoma, with a prevalence of 5%–10%. The CT finding of a dehiscent lateral semicircular canal support the diagnosis. A dehiscence on the cochlear promontory represents an uncommon location for labyrinthine fistula.

- A fistula of the oval window might be suspected on HRCT when a stapes fragment is dislocated toward the vestibulum.

- Facial palsy may result from direct inflammatory effects, compression atrophy, very rarely from the presence of an inflammatory neuroma, and most often from erosion of the tympanic segment of the facial canal. However, bony dehiscence of the tympanic segment of the facial canal is a common variant present in 25%–57% of cases. Perineural extension of a cholesteatoma along the facial nerve may also occur, in which case MR imaging is important.

- Sensorineural hearing loss develops by cholesteatomatous involvement of the internal auditory canal. Total hearing loss may occur in the presence of a labyrinthine fistula causing labyrinthitis, which can be diagnosed byMRimaging showing enhancement of the membranous labyrinth. In these cases, CT is useful for demonstrating labyrinthine ossification ensuing in complicated or untreated cases.

- Erosion of the sigmoid sinus plate and consecutive thrombosis, tympanic tegmen erosion and subsequent intracranial invasion, recurrent bacterial meningitis, and intracranial abscess are rare complications, which require an urgent imaging.

- A bony defect of the tympanic tegmen or the anterior wall of the epitympanum should raise the suspicion of an encephalocele or cholesteatoma extension in the middle cranial fossa, and MR imaging is recommended.

MATERIALS & METHODS

Source & method of collection of data:

Over a period of 18 months, patients with clinical diagnosis of Attico-antral disease in the department of Otorhinolaryngology of Sri R.L. Jalappa Hospital and Research Center who were referred to department of Radio-diagnosis were examined by HRCT of temporal bone.

A total of 30 patients were studied. HRCT temporal bone was performed by using SIEMENS EMOTION 16slice CT machine in axial plane and coronal images were reformatted. Findings of HRCT temporal bone were recorded. Findings of mastoid exploration surgery were recorded. Report of HRCT of temporal bone was correlated with surgical findings and tabulated using percentages.

Inclusion criteria:

1. All patients who are diagnosed clinically with attico-antral disease.
2. Age-15 years and above.

Exclusion criteria:

1. Patients with previous surgery of middle ear and mastoid.
2. Patients with history of RTA.
3. Pregnant women.

Technique for HRCT study:

Routine lateral topogram of the skull base was initially taken in all patients in the supine position. The axial view was performed with the patients in the supine position and the coronal images were reformatted. Contiguous axial 0.6 mm thickness images were obtained from top of the petrous apex to the inferior tip of the mastoid, and coronal images were obtained from the anterior margin of the petrous apex to the posterior margin of the mastoid.

The axial CT examinations were performed at 120 Kv and 240 mAs, the field of view was approximately 18 cm with an imaging matrix of 512 X 512 pixels and the slice increment was the same as slice thickness. Images were evaluated in both soft tissue and bone algorithm.

HRCT findings were noted according to the proforma. Intraoperative findings of mastoid exploration surgery were recorded and were taken as standard for determination of sensitivity and specificity of HRCT scan for various study variables. The data were analyzed using descriptive statistic tools like proportions.

RESULTS

During the period of 18 months of the study, 30 patients with clinical diagnosis of attico antral disease were studied, out of which 14 were female and 16 were male (Chart - 1), predominantly in age group of 21-30years(Chart - 2).

1) **Presence or absence of cholesteatoma** : Of the 30 cases studied, 27 (90%) patients had imaging findings of cholesteatoma whereas 3 (10%) patients had no findings suggestive of cholesteatoma. Surgery showed cholesteatoma in 26 (86.6%) patients and no cholesteatoma in 4 (13.3%) patients (Table - 5 & Chart - 5).

2) **Extent of Cholesteatoma :**

- Epitympanum was involved in 29 (96.6%) patients in HRCT and 30 (100%) patients at surgery. (Table – 6)

- Aditus was involved in 26 (86.6%) patients at both HRCT and at surgery. (Table – 7)

- Mastoid antrum was involved in 24 (80%)patients in HRCT and 25 (83.3%) patients at surgery. (Table – 8)

- Facial recess was involved in 18 (60%) patients in HRCT and 14 (46.6%) patients at surgery. (Table – 9)

- Sinus tympani was involved in 14 (46.6%) patients in HRCT and 10 (33.3%) patients at surgery. (Table – 10)

- Extension beyond middle ear cleft was seen in 4 (13.3%) patients in HRCT and 5 (16.6%) patients at surgery. (Table – 12, 13)

- Hypotympanum was involved in 2 (6.6%) patients in HRCT and 4 (13.3%) patients at surgery. (Chart - 6).

3) Status of ossicular chain :

- Erosion of malleus noted in 25 (83.3%) patients in both HRCT and surgery.(Tables – 14)

- Incus erosion was seen in 17 (56.6%) patients in HRCT and 20 (66.6%) patients at surgery. (Tables – 15)

- Stapes erosion was seen in 10 (33.3%) patients in HRCT and 15 (50%) patients at surgery (Table –16 & Chart - 7).

4) Integrity of facial canal:

- Tympanic segment of facial canal was the most commonly involved, showing erosion in 10 (33.3%) patients in HRCT and 12 (40%) patients at surgery. (Table – 18)

- Labyrinthine segment of facial canal showed erosion in 4 (13.3%) patients in HRCT and 3 (10%) patients at surgery.

- Mastoid segment of facial canal showed erosion in 1 (3.3%) patient in HRCT and 4 (13.3%) patients at surgery. (Table – 19)

5) Detection of erosions in bony labyrinth :

- Lateral SCC was the most commonly involved in bony labyrinth seen in 4 (13.3%) patients in both HRCT and surgery. (Table – 20)

- Posterior SCC erosion was seen in 1(33.3%) patient in both HRCT and surgery . Superior SCC erosion was not seen in any of the patients in our study (Table – 21).

6) Detection of erosions in dural / sinus plate :

- Erosion of dural plate was seen in 6 (20%) patients in HRCT whereas 9 (30%) patients showed dural plate erosion at surgery.

- Erosion of sinus plate was seen in 4 (13.3%) patients in HRCT and 3 (10%) patients at surgery (Tables – 22, 23 & Chart - 9).

Sensitivity, specificity, positive predictive value and negative predictive values of various parameters were calculated (Table – 24).

OBSERVATIONS

Table 1: Gender distribution of study population

Gender	No. of patients	Percentage
Male	16	53.33
Female	14	46.67
Total	**30**	**100**

Chart 1: Gender distribution of study population.

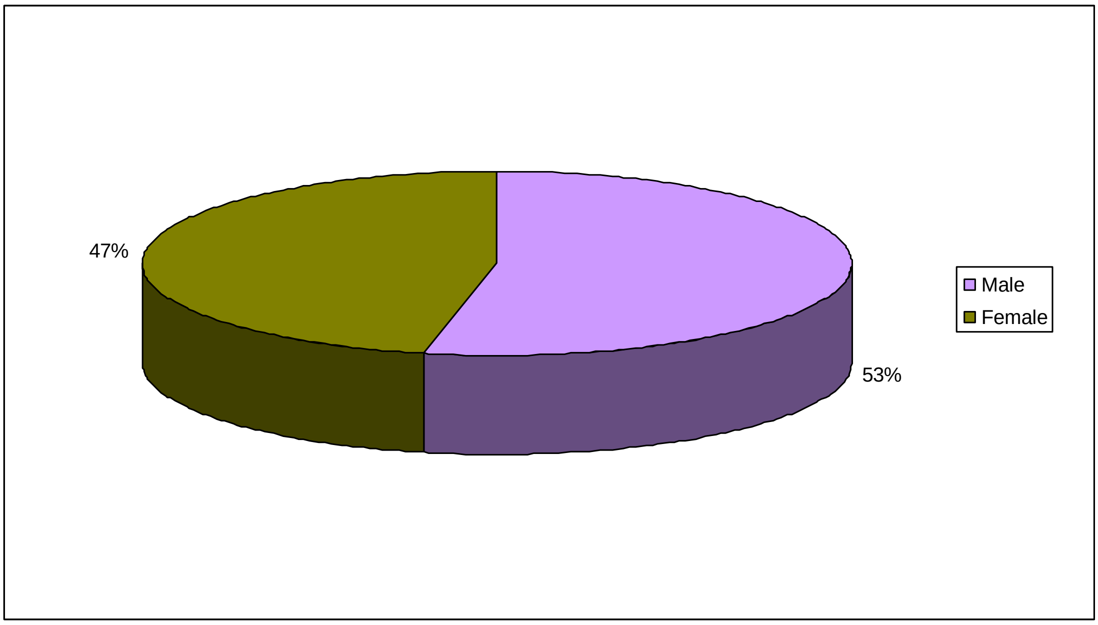


Table 2: Age distribution of study population.

Age (yrs.)	No. of patient	Percentage(%)
11-20	09	30
21-30	10	33.33
31-40	04	13.33
41-50	06	20
51 and above	01	3.33
Total	**30**	**100**

Chart 2: Age distribution of study population

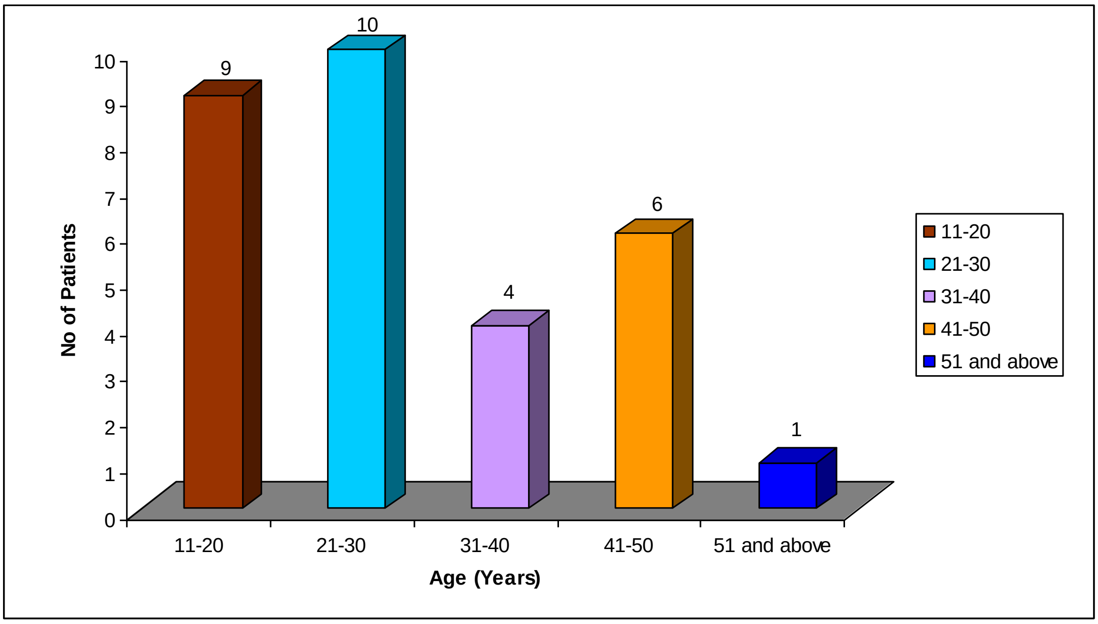


Table 3: Frequency of clinical symptoms of study population.

Clinical features	No. of patients	Percentage
Ear discharge	27	90
Ear ache	25	83.33
Hearing loss	20	66.67
Facial weakness	6	20
Giddiness,vomiting, others	5	16.66

Chart 3: Frequency of clinical symptoms of study population

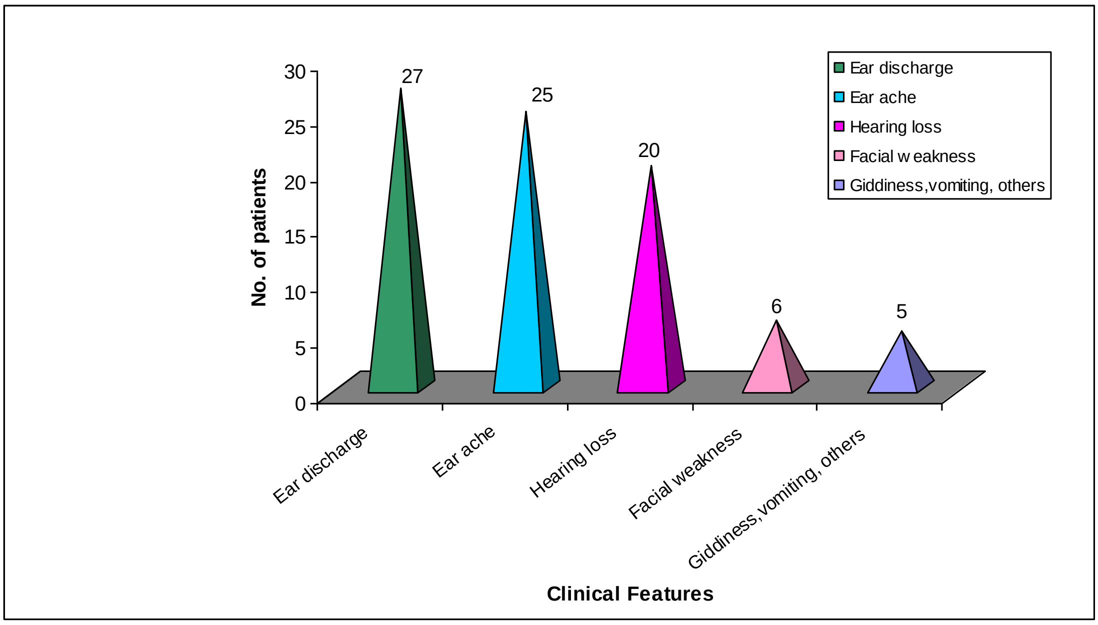
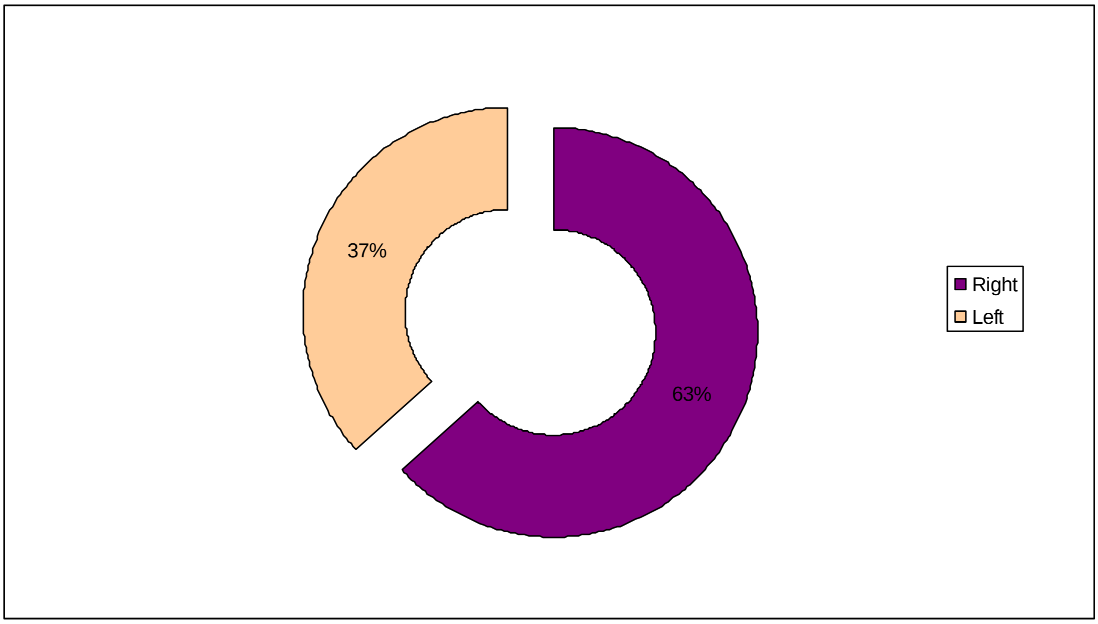


Table 4: Distribution of cholesteatoma with respect to side.

Side	Frequency	Percentage
Right	19	63.33
Left	11	36.67
Total	30	100

Chart 4: Distribution of cholesteatoma with respect to side.



	DISEASE				
TEST	**Present**	**n**	**Absent**	**n**	**Total**
Positive	True positive	a	False positive	c	a+c
Negative	False negative	b	True negative	d	b+d
Total		a+b		c+d	a+b+c+d

Table 5: Distribution with respect to presence or absence of cholesteatoma.

Out of 30 cases studied, HRCT showed findings of cholesteatoma in 27 cases. Surgically cholesteatoma was present in 26 cases. The findings were correlated with surgical outcome by diagnostic statistics.

HRCT FINDINGS	**SURGICAL FINDINGS**	
	Cholesteatoma	No Cholesteatoma
Cholesteatoma	24	3
No Cholesteatoma	2	1

Chart 5: Distribution with respect to presence or absence of cholesteatoma.

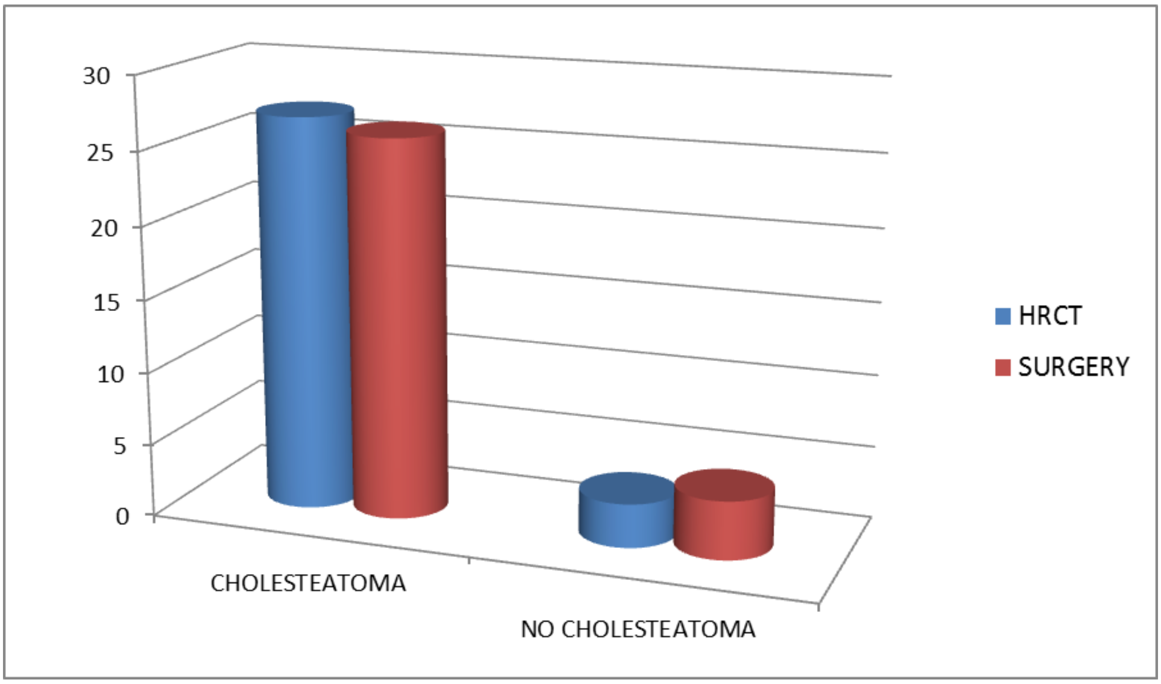


Table 6: Distribution with respect to involvement of epitympanum

HRCT FINDINGS	SURGICAL FINDINGS - EPITYMPANUM	
	Involved	Not Involved
Involved	29	0
Not Involved	0	1

Table 7: Distribution with respect to involvement of aditus

HRCT FINDINGS	SURGICAL FINDINGS - ADITUS	
	Involved	Not Involved
Involved	25	1
Not Involved	1	3

Table 8: Distribution with respect to involvement of mastoid antrum

HRCT FINDINGS	SURGICAL FINDINGS - ANTRUM	
	Involved	Not Involved
Involved	24	0
Not Involved	1	5

Table 9: Distribution with respect to involvement of facial recess

HRCT FINDINGS	SURGICAL FINDINGS – FACIAL RECESS	
	Involved	Not Involved
Involved	13	5
Not Involved	1	11

Table 10: Distribution with respect to involvement of sinus tympani

HRCT FINDINGS	SURGICAL FINDINGS – SINUS TYMPANI	
	Involved	Not Involved
Involved	8	6
Not Involved	2	14

Table 11: Distribution with respect to involvement of hypotympanum

HRCT FINDINGS	SURGICAL FINDINGS – HYPOTYMPANUM	
	Involved	Not Involved
Involved	8	6
Not Involved	2	14

Table 12: Distribution with respect to involvement of eustachian tube

HRCT FINDINGS	SURGICAL FINDINGS – EUSTACHIAN TUBE	
	Involved	Not Involved
Involved	2	0
Not Involved	1	27

Table 13: Distribution with respect to involvement beyond middle ear cleft

HRCT FINDINGS	SURGICAL FINDINGS – BEYOND MIDDLE EAR	
	Involved	Not Involved
Involved	4	0
Not Involved	1	25

Chart 6 : Distribution with respect to extent of cholesteatoma.

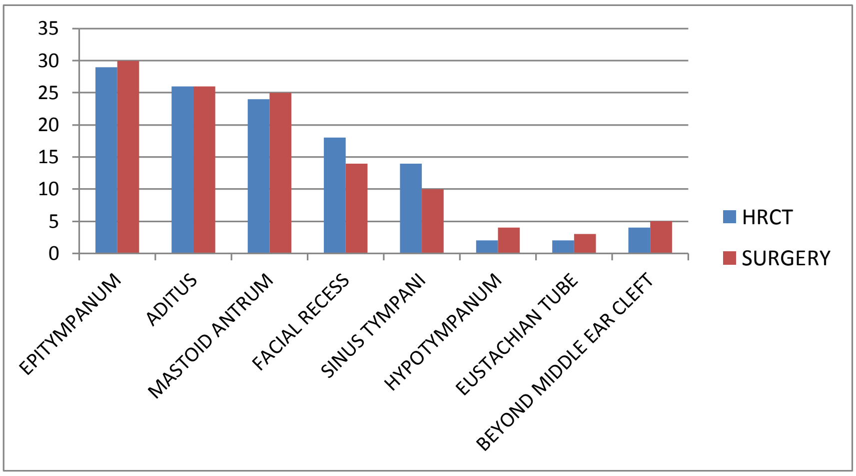


Table 14: Correlation of status of malleus on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – MALLEUS	
	Eroded	Intact
Eroded	21	4
Intact	4	1

Table 15: Correlation of status of incus on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – INCUS	
	Eroded	Intact
Eroded	16	1
Intact	4	9

Table 16: Correlation of status of stapes on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – STAPES	
	Eroded	Intact
Eroded	10	0
Intact	5	15

Chart 7 : Distribution with respect to erosion of ossicles

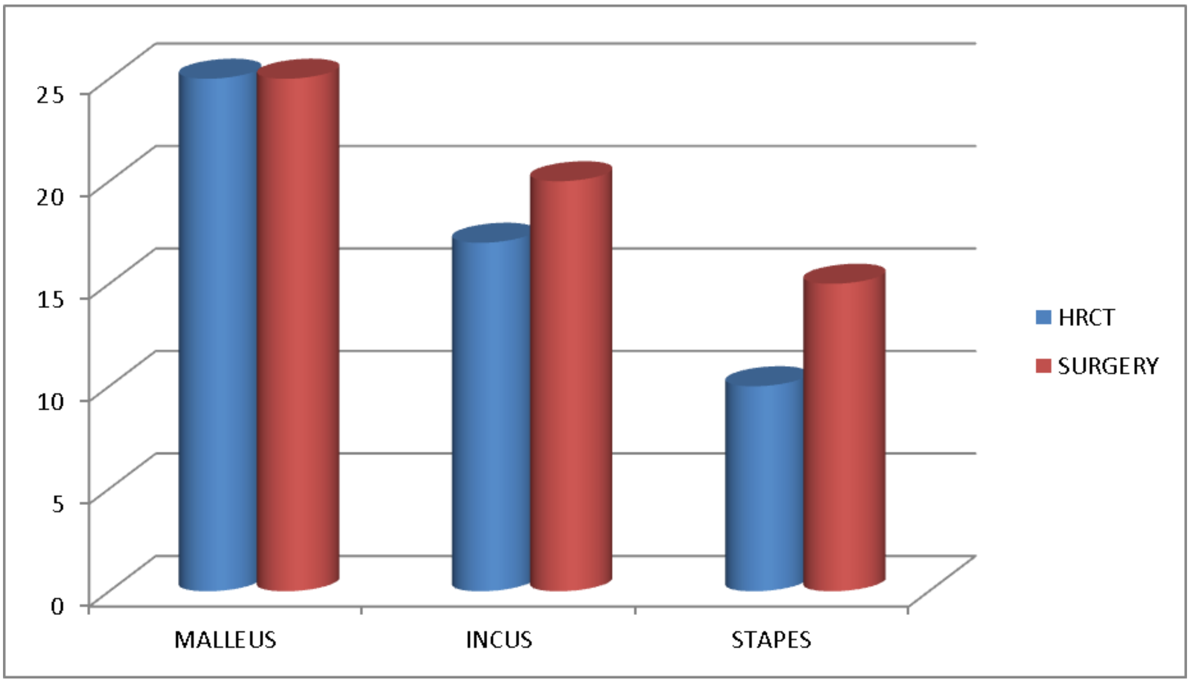


Table 17: Correlation of status of labyrinthine segment of facial canal on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – LABYRINTHINE SEGMENT	
	Eroded	Intact
Eroded	2	2
Intact	1	25

Table 18 : Correlation of status of tympanic segment of facial canal

HRCT FINDINGS	**SURGICAL FINDINGS – TYMPANIC SEGMENT**	
	Eroded	Intact
Eroded	8	2
Intact	4	16

Table 19 : Correlation of status of mastoid segment of facial canal

HRCT FINDINGS	**SURGICAL FINDINGS – MASTOID SEGMENT**	
	Eroded	Intact
Eroded	1	0
Intact	3	26

Chart 8 : Distribution with respect to integrity of facial canal

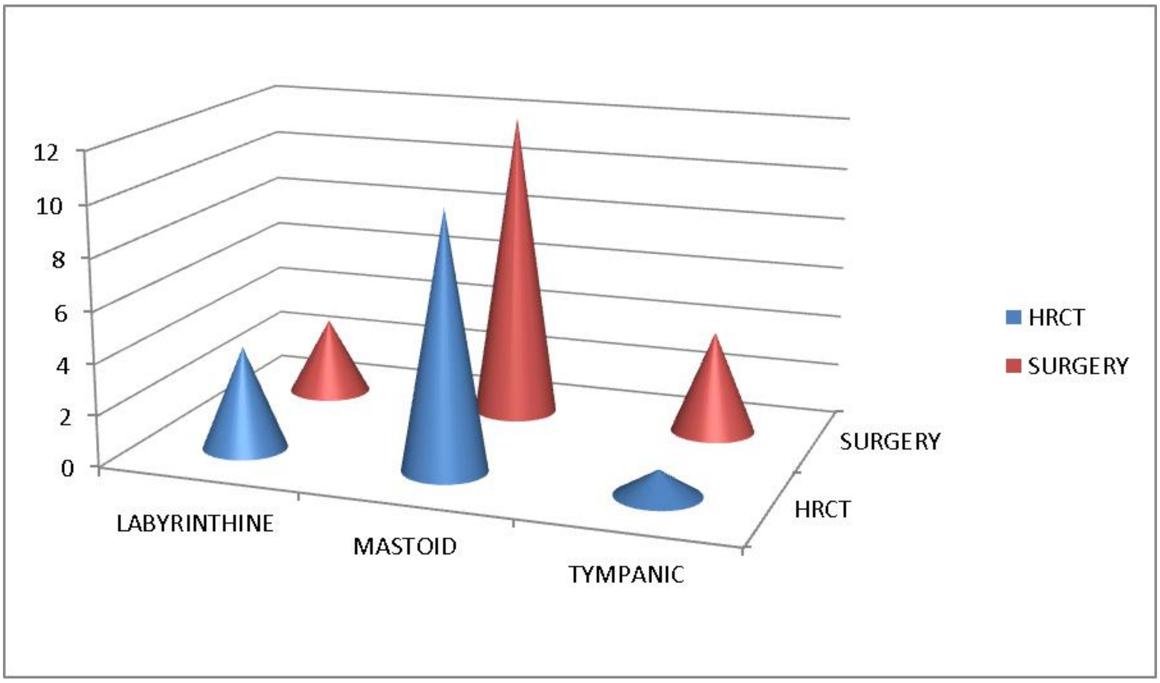


Table 20 : Correlation of status of lateral semi-circular canal

HRCT FINDINGS	SURGICAL FINDINGS – LATERAL SCC	
	Eroded	Intact
Eroded	3	1
Intact	1	25

Table 21 : Correlation of status of posterior semi-circular canal

<table>
<tr><th rowspan="2">HRCT FINDINGS</th><th colspan="2">SURGICAL FINDINGS – POSTERIOR
SCC</th></tr>
<tr><td>Eroded</td><td>Intact</td></tr>
<tr><td>Eroded</td><td>1</td><td>0</td></tr>
<tr><td>Intact</td><td>0</td><td>29</td></tr>
</table>

Table 22 : Correlation of status of dural plate on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – DURAL PLATE	
	Eroded	Intact
Eroded	6	0
Intact	3	21

Table 23 : Correlation of status of sinus plate on HRCT with operative findings

HRCT FINDINGS	SURGICAL FINDINGS – PSINUS PLATE	
	Eroded	Intact
Eroded	3	1
Intact	0	26

Chart 9 : Distribution with respect to integrity of dural and sinus plates

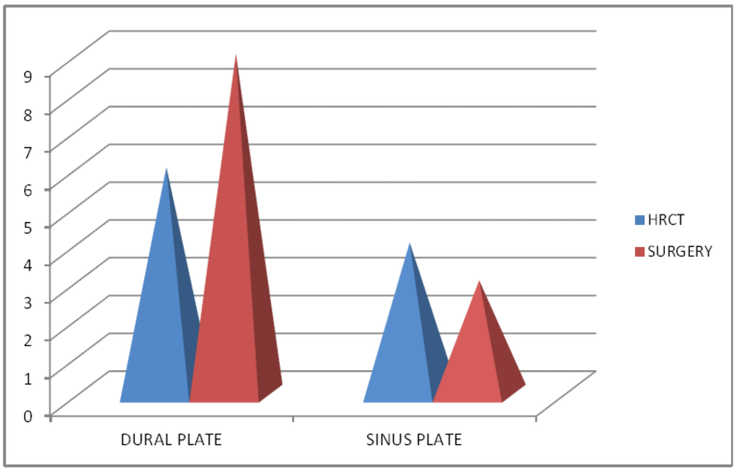


Table 24 : Sensitivity and specificity of HRCT with surgical findings.

EXTENT OF CHOLESTEATOMA	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
EPITYMPANUM	100	100	100	100
ADITUS	96.1	75	96.1	75
MASTOID ANTRUM	96	100	100	93.3
FACIAL RECESS	92.8	68.7	72.2	91.6
SINUS TYMPANI	80	70	57.1	87.5
HYPOTYMPANUM	50	100	100	92.8
EUSTACHIAN TUBE	66.6	100	100	96.4
BEYOND MIDDLE EAR CLEFT	80	100	100	96.1

Continued…

Status of ossicles	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
MALLEUS	84	20	84	20
INCUS	80	90	94	69
STAPES	66	100	100	75

Integrity of facial canal	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
LABYRINTHINE SEGMENT	66.67	92.59	50	50
TYMPANIC SEGMENT	66.6	88.8	80	80
MASTOID SEGMENT	25	100	100	89.6

Erosions of bony labyrinth	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
LATERAL SCC	75	96.1	75	96.1
POSTERIOR SCC	100	100	100	100
SUPERIOR SCC	100	100	100	100

Erosions of dural/sinus plate	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PREDICTIVE VALUE
DURAL PLATE	66.6	100	100	87.5
SINUS PLATE	100	96.2	75	100

FIGURES & LEGENDS

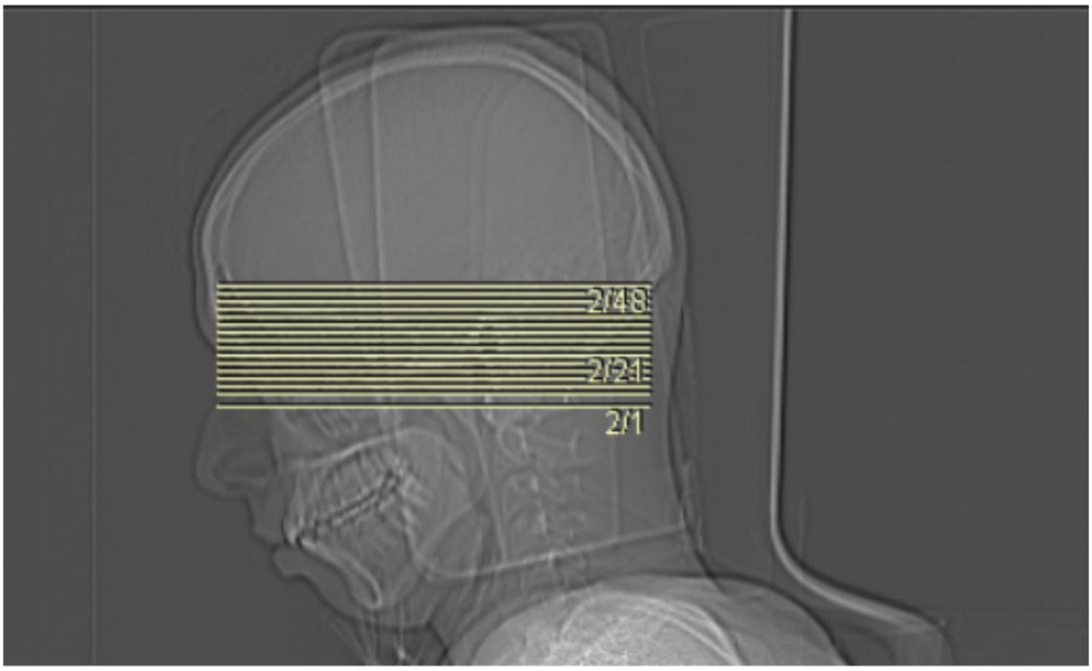


Figure 1 : Topogram of HRCT temporal bone

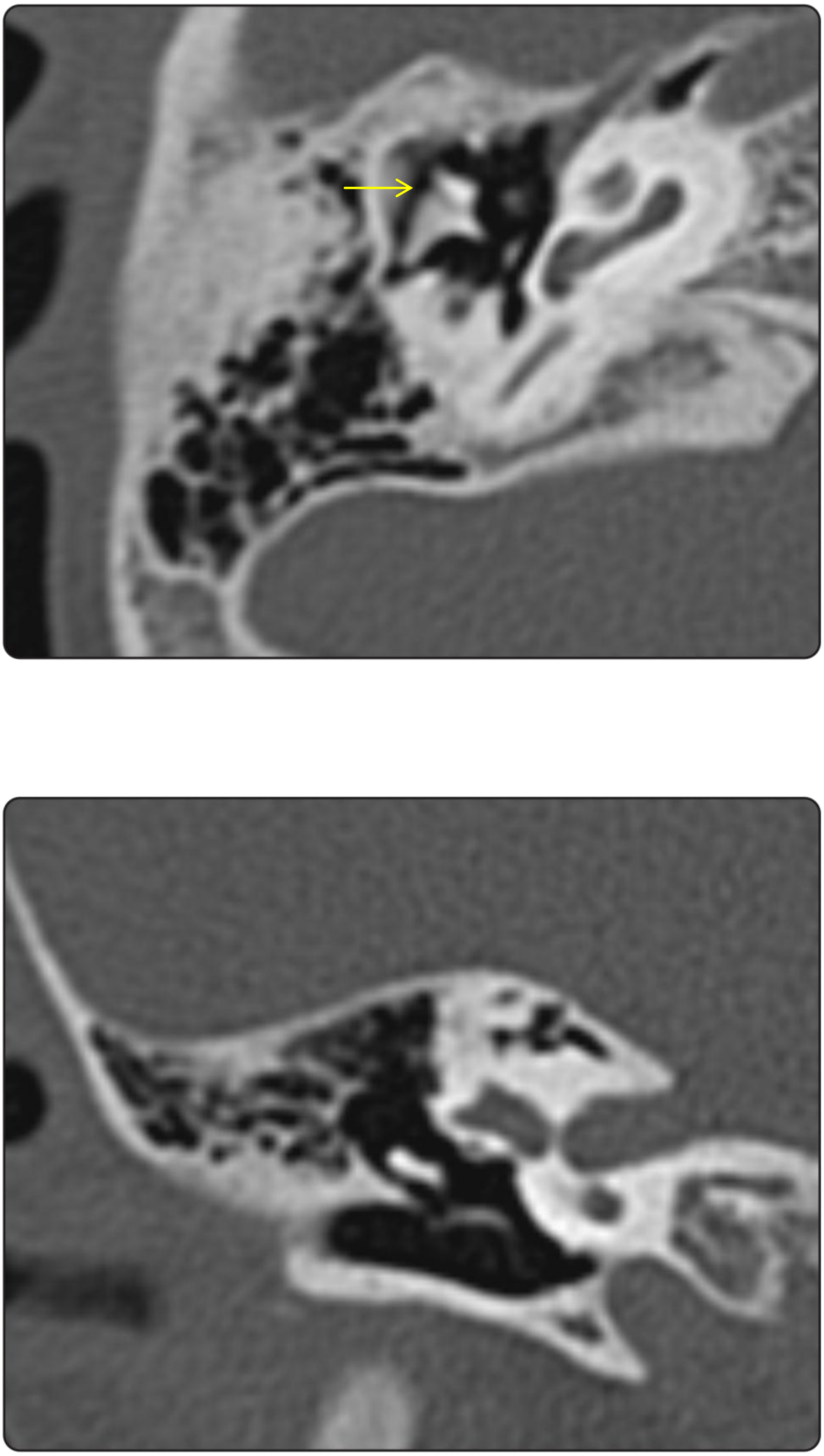


Figure 2 : Normal Epitympanum: Axial and coronal images,

showing ice-cream cone sign (arrow),

formed by head of malleus and body of incus

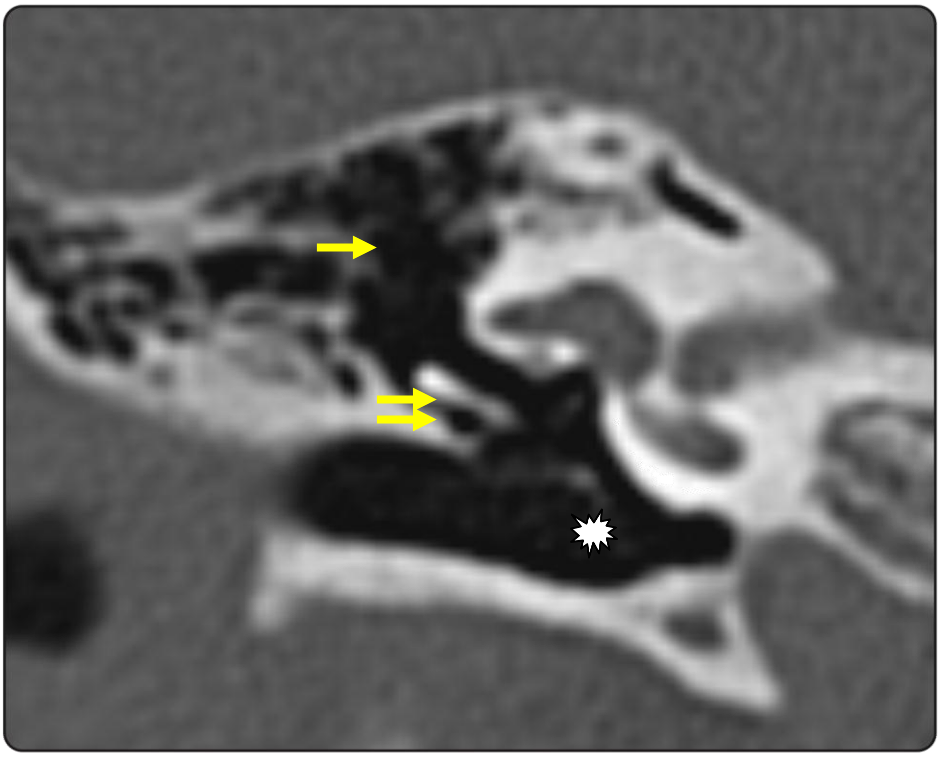


Figure 3: Coronal HRCT image showing normal epitympanum(arrow), mesotympanum (double arrows) and hypotympanum(asterix).

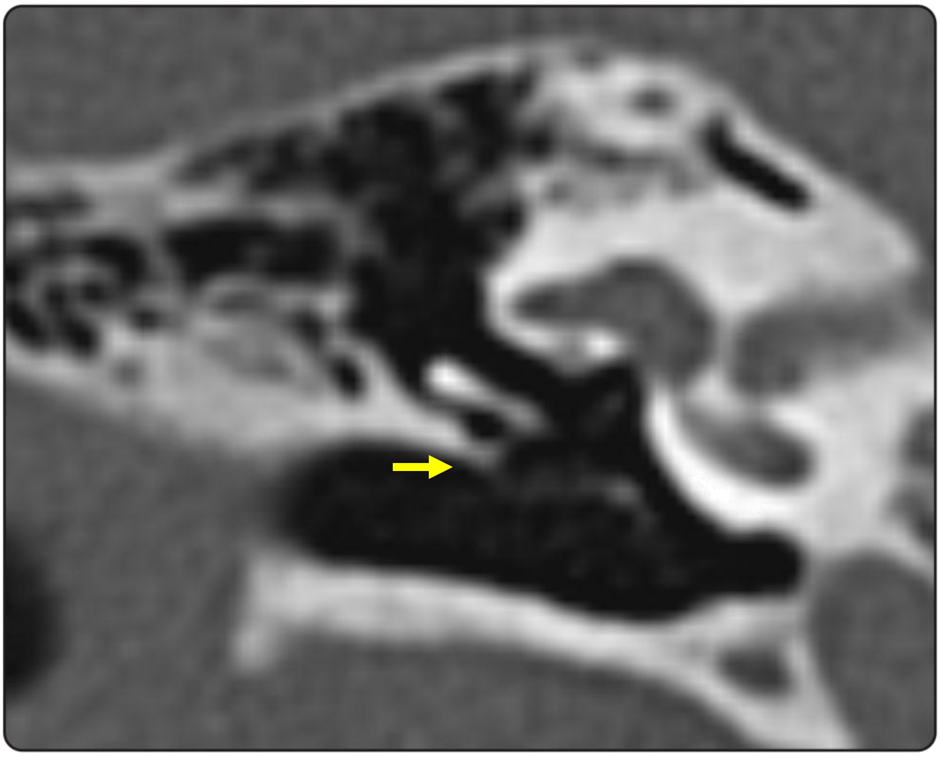


Figure 4: Coronal image showing normal scutum (arrow) and prussak's space medial to scutum.

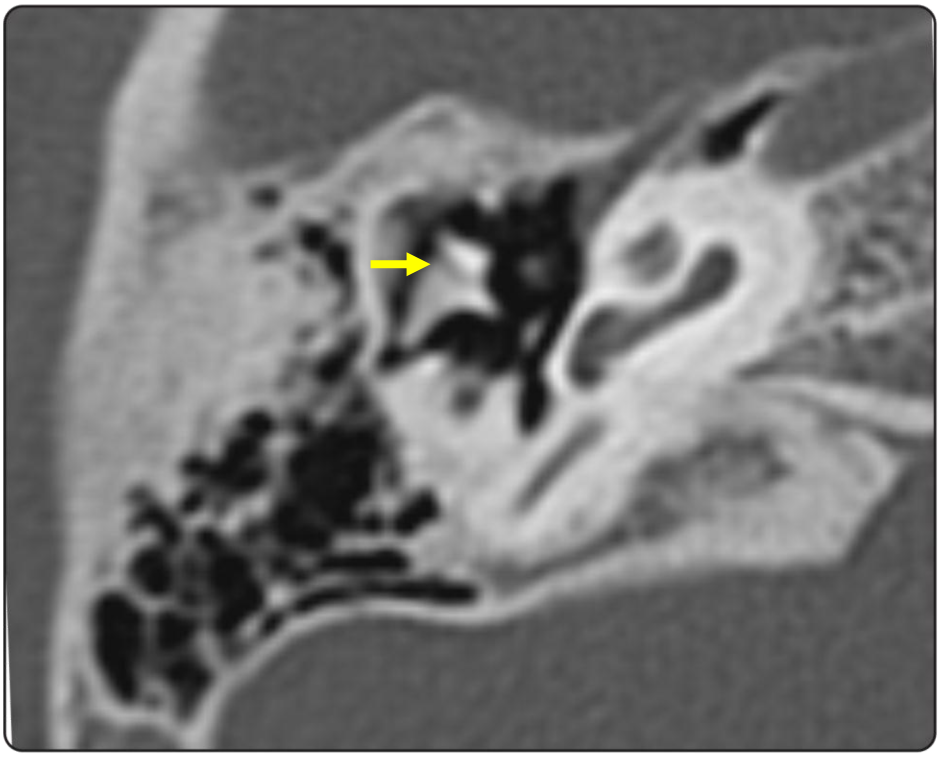


Figure 5: Axial image showing normal incudo-malleolar joint (arrow).

Figure 6: Axial image showing normal stapes (arrow) and oval window (asterix)

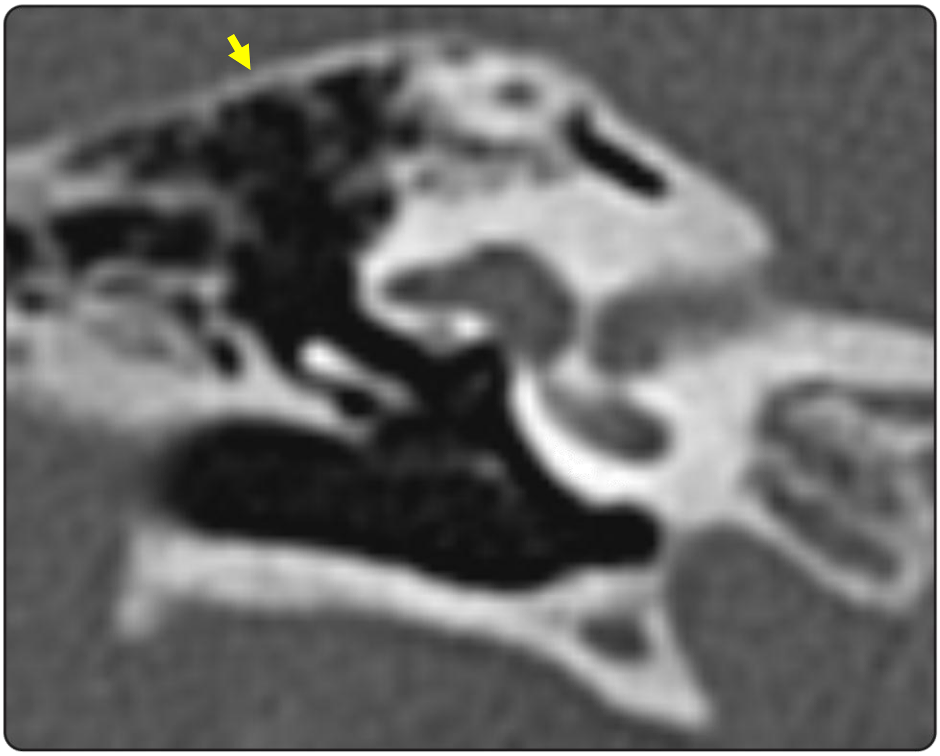


Figure 7: Coronal image showing normal tegmen tympani (arrow)

Figure 8: Axial images showing normal cochlear promontory and basal turn of cochlea (arrow) in medial wall of the tympanic cavity

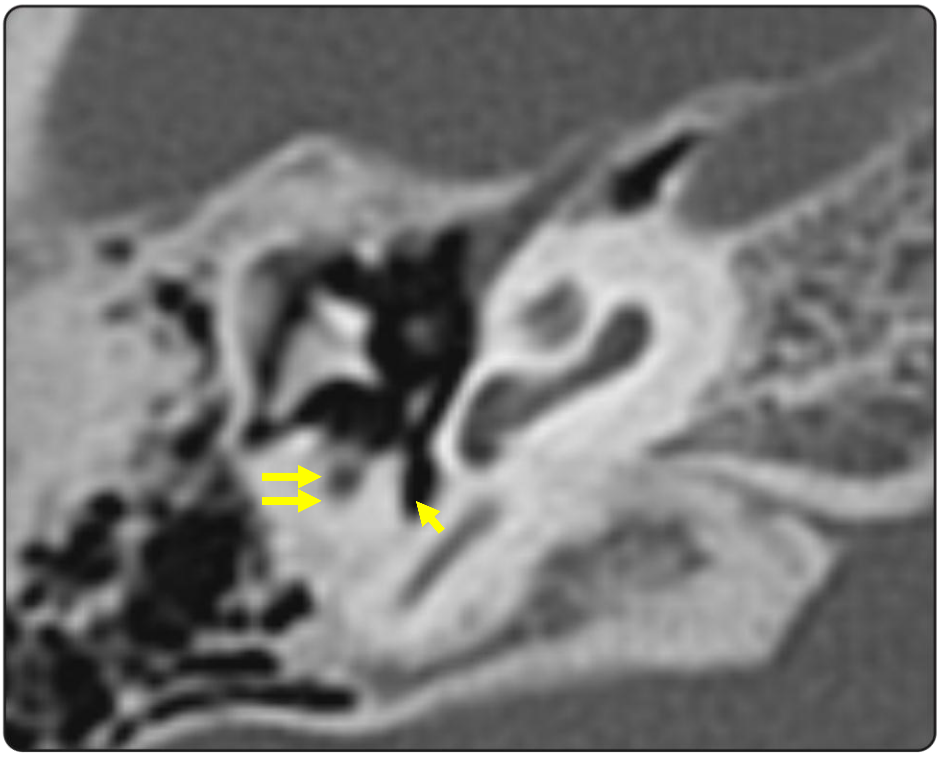


Figure 9 : Axial images of normal posterior wall of tympanic cavity showing sinus tympani (arrow) medially, pyramidal eminence and facial recess (double arrow) laterally.

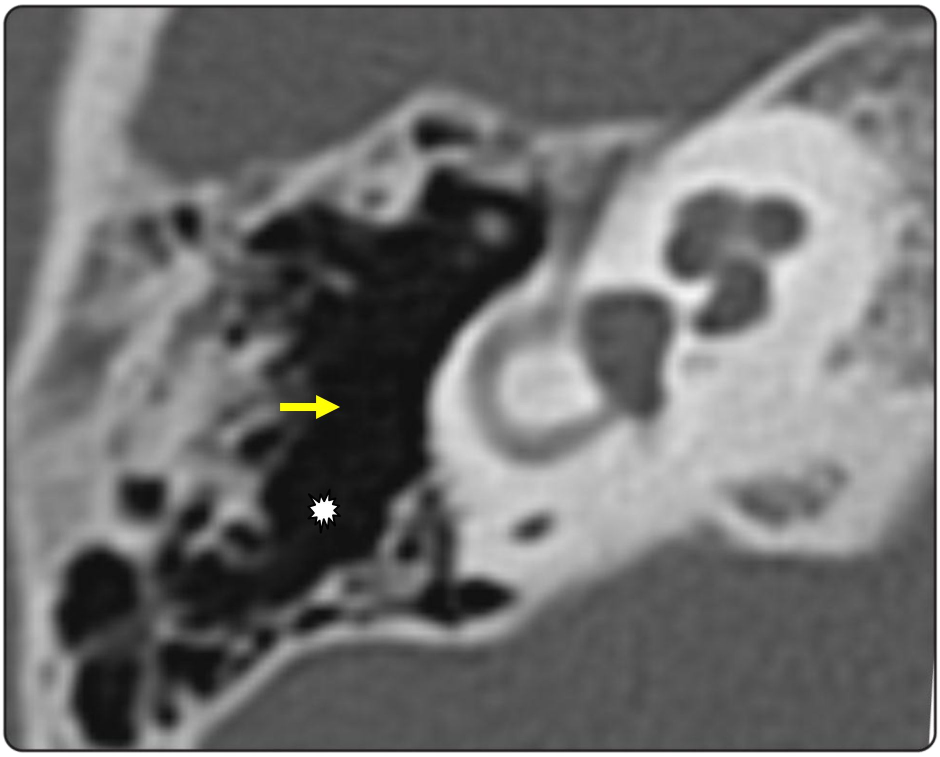


Figure 10 : Axial image showing normal aditus (arrow) and mastoid antrum (asterix)

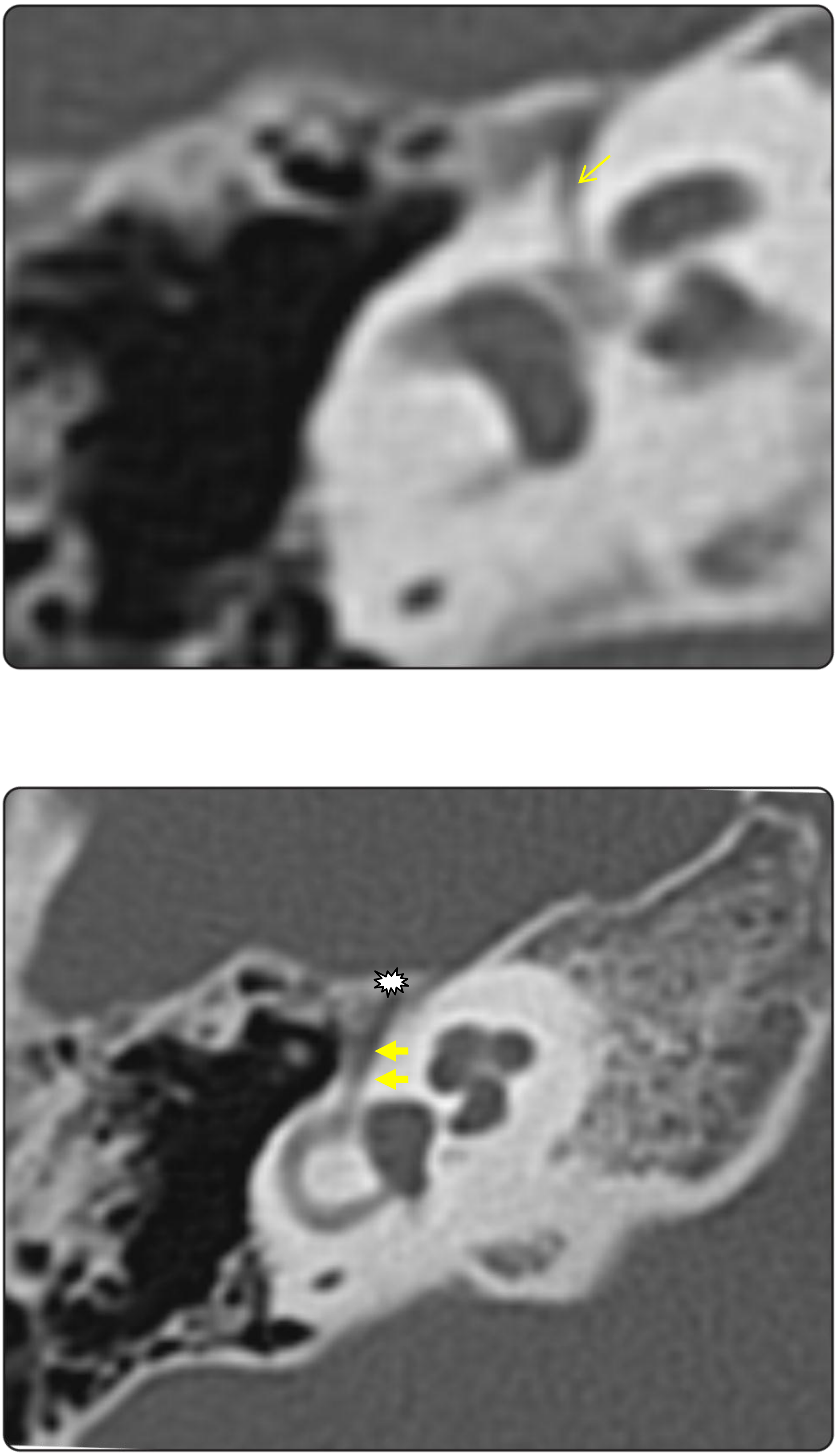


Figure 11 : Axial image showing normal labyrinthine (arrow) and tympanic segments(double arrow) of facial nerve canal with genu (thick arrow).

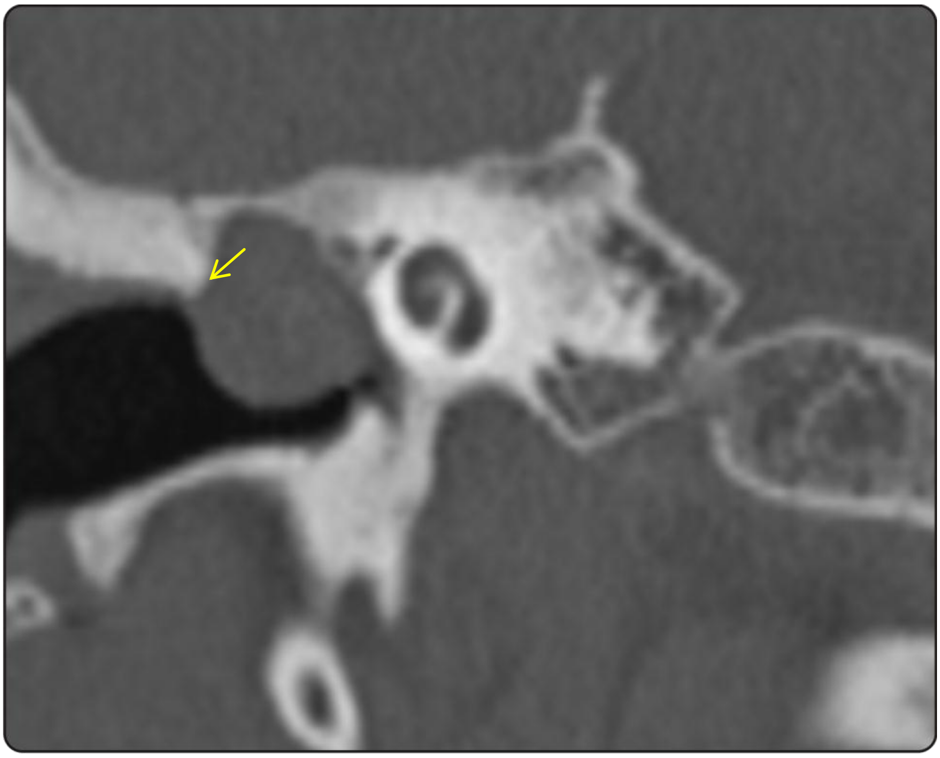


Figure 12 : Coronal image showing scutum erosion (arrow) and nondependent soft tissue.

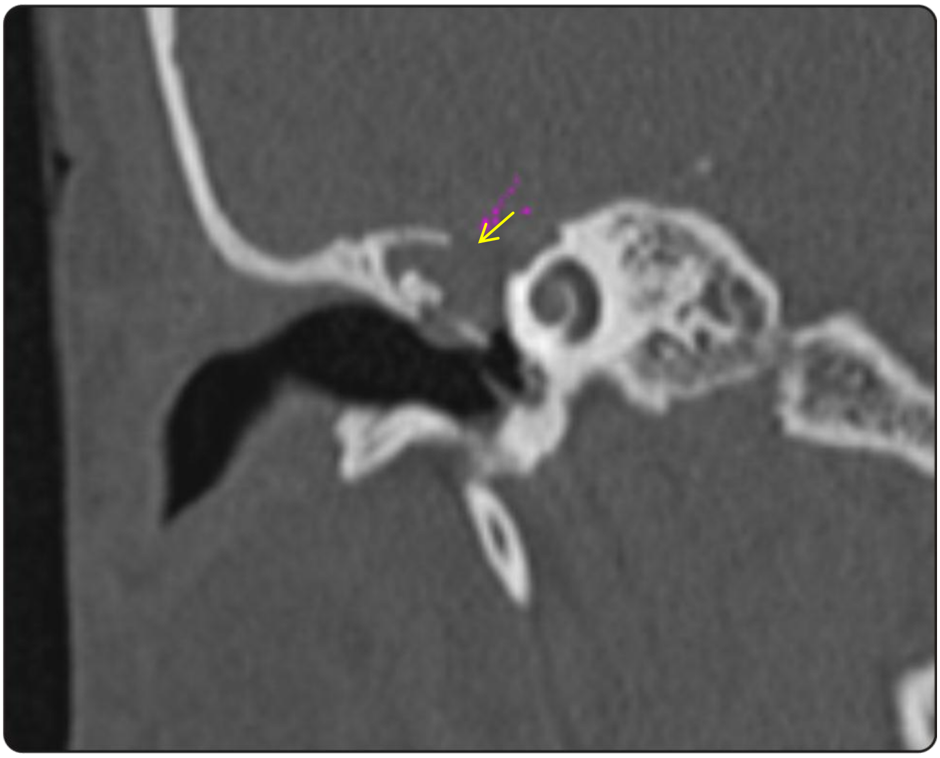


Figure 13 : Coronal image showing tegmen erosion (arrow) .

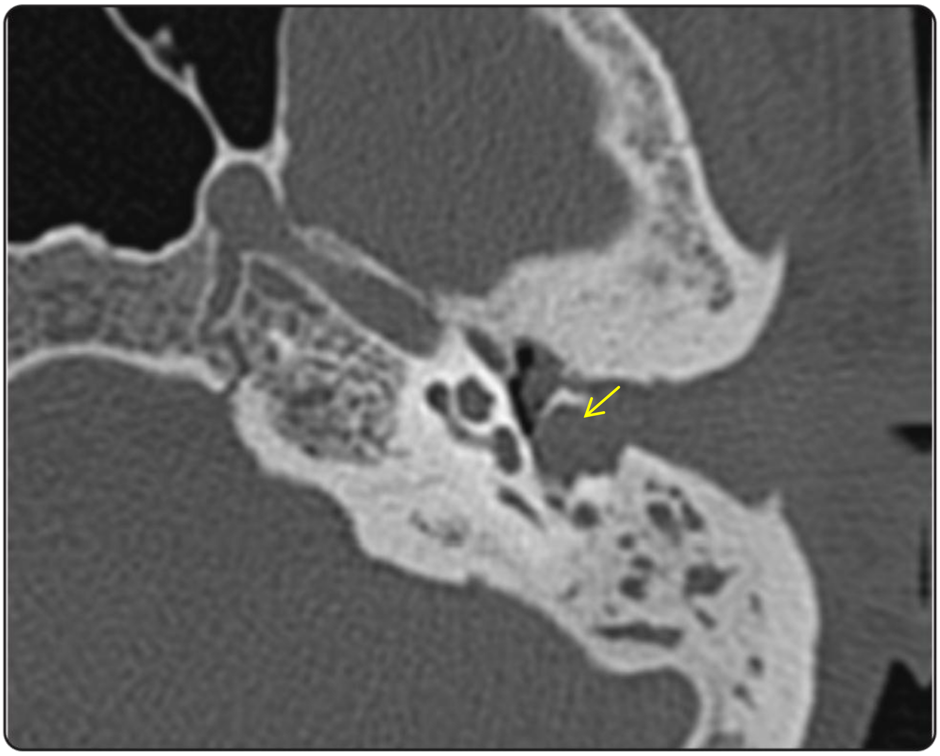


Figure 14 : Axial image showing erosion of body of incus and stapes with displacement(arrow).

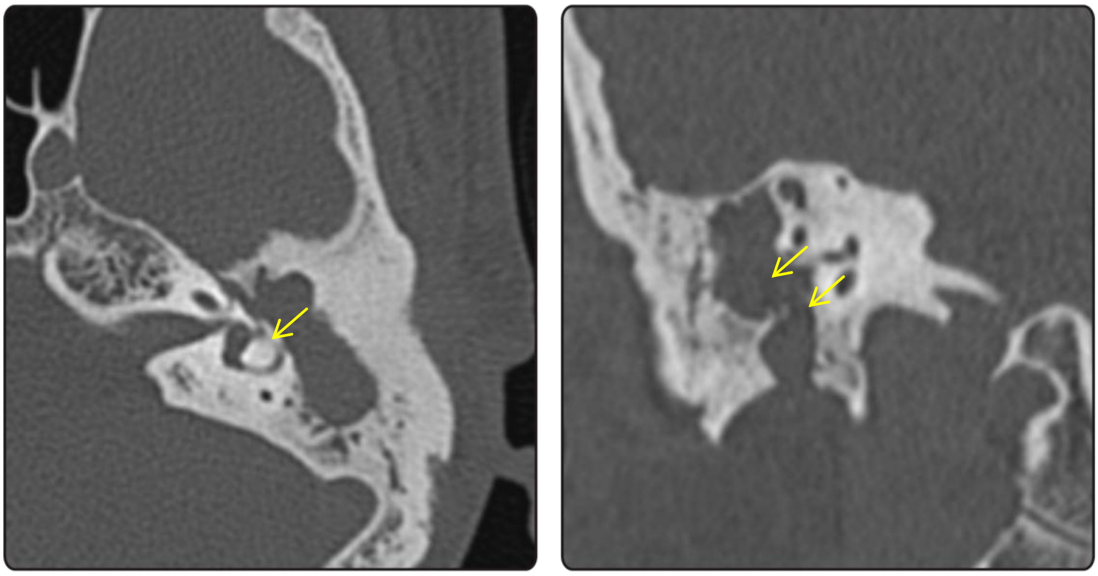


Figure 15 : Axial and coronal images depicting erosion of tympanic (arrow) and mastoid parts(double arrow) of facial nerve canal.

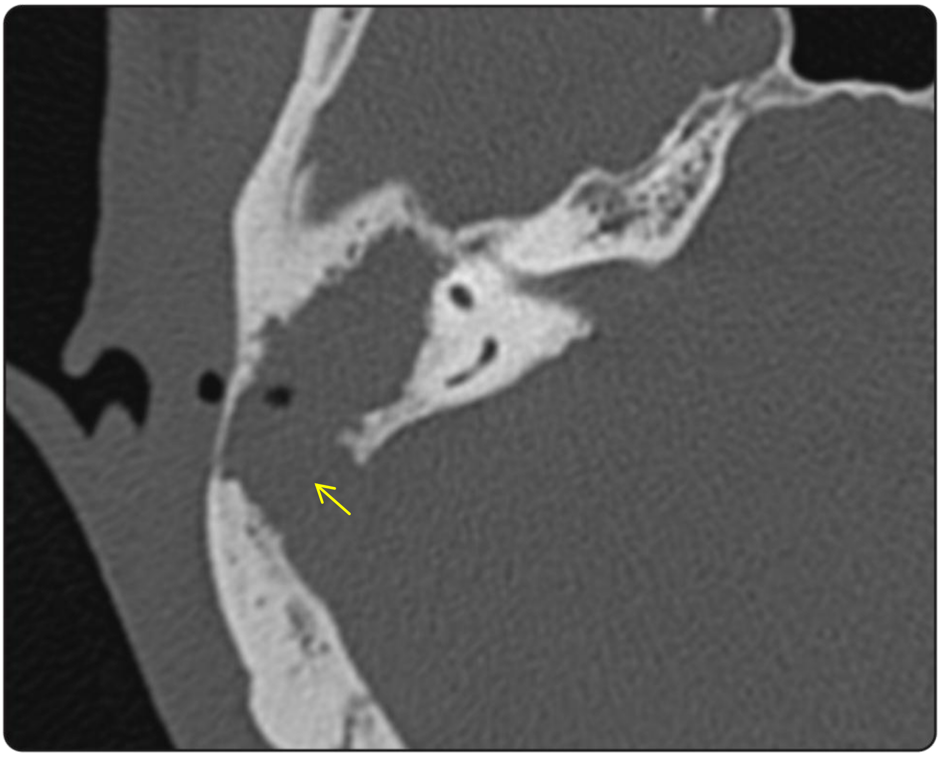


Figure 16 : Axial image showing cholesteatoma causing widening of aditus (arrow)

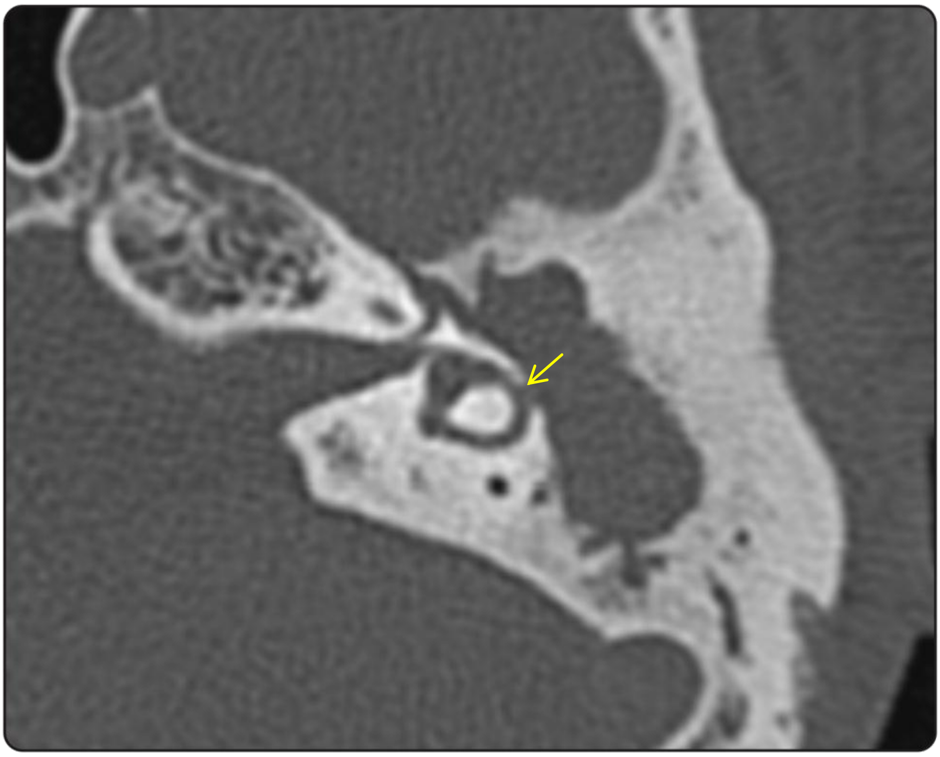


Figure 17 : Axial image showing cholesteatoma causing lateral semi circular canal fistula (arrow)

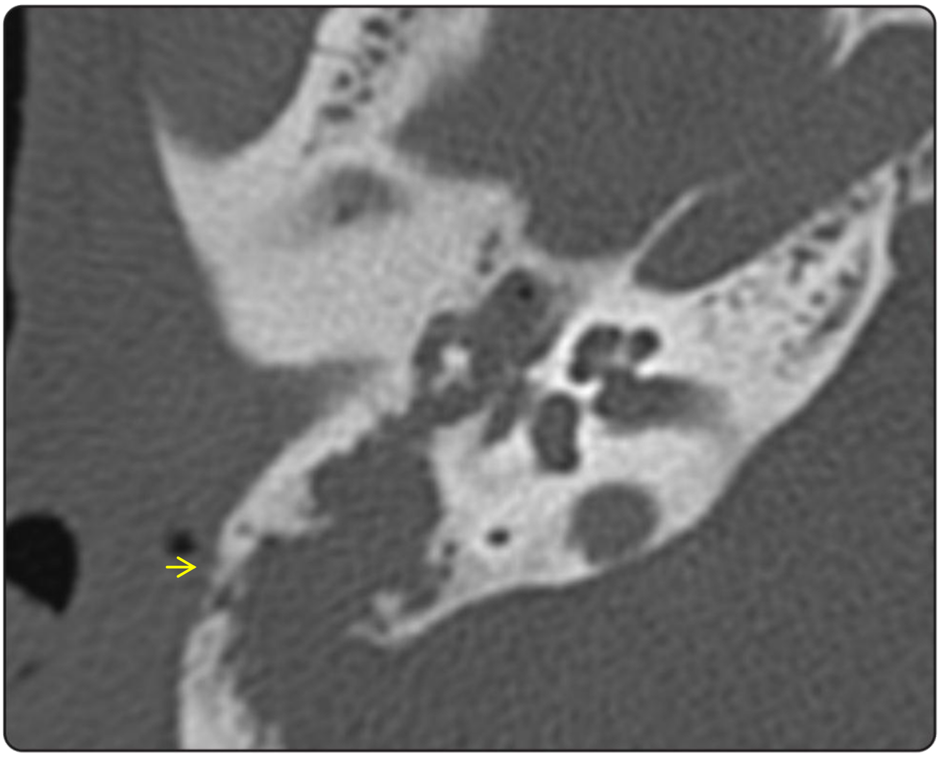


Figure 18: Axial image showing cholesteatoma eroding the mastoid cortex (arrow)

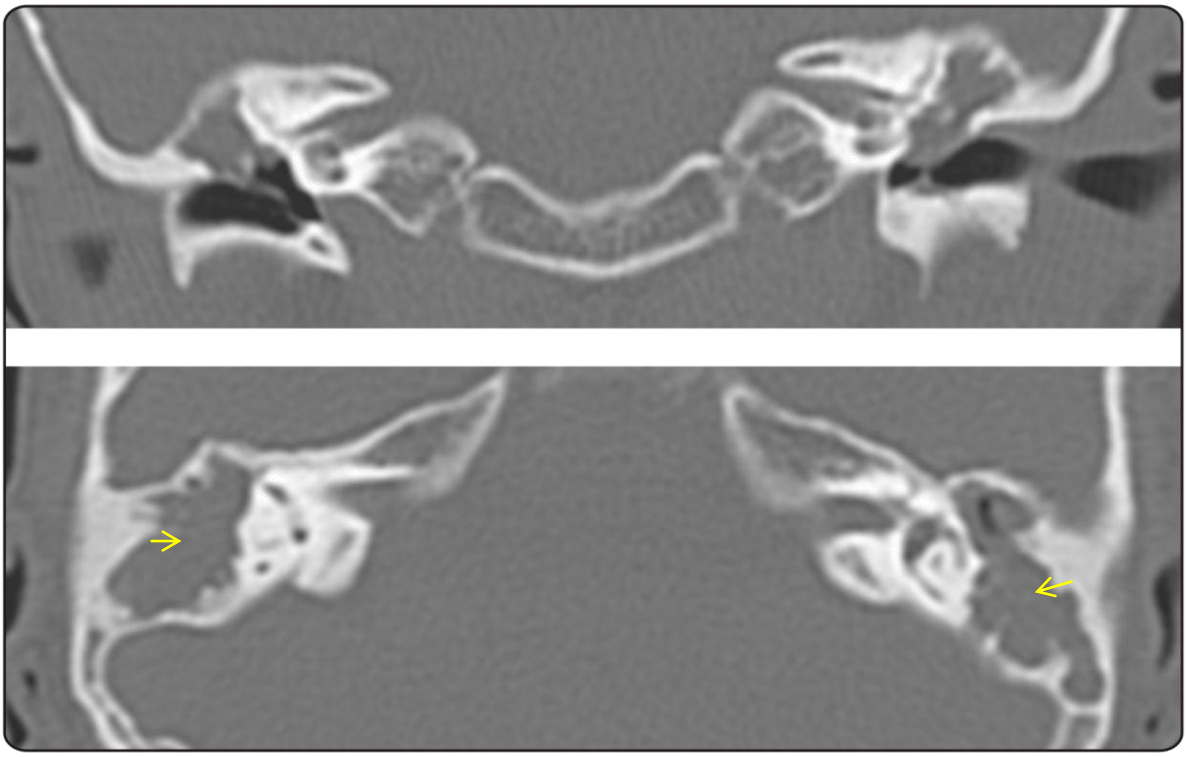


Figure 19 : Axial and coronal images showing bilateral cholesteatoma

DISCUSSION

The high resolution computed tomography (HRCT) scan is the standard imaging technique for the temporal bone. Scanning is usually done in axial plane with coronal reformations.

In our study, out of 30 cases, the maximum percentage of patients was in the age group of 21 to 30 years (33.3%), followed by 11 to 20 years (30%). The peak age group is variable from 20-50 years in literature.[2,16,20]

In our study, there was a male preponderance (53.3%) when compared to females (35%) which is in agreement with other case studies.[21,22]

The common clinical features were ear discharge, otalgia and hearing loss which is in agreement with other studies. Left ear was most commonly involved (63.3%) than the right (36.6%) in our study which is variable in literature.[2,16]

In our study, a moderate radio-surgical correlation was noted for differentiating cholesteatoma and granulation tissue in the middle ear cavity using soft tissue mass and bony erosions as the radiologic criteria. At surgery, cholesteatoma was present in 26 out of 30 patients (86.6%) whereas it was reported in 27 of the 30 CT scans (90%) thereby giving a sensitivity of 86.6%, specificity of 92.3%, positive predictive value of 88.8% and negative predictive value of 33.3% for HRCT in detecting cholesteatoma preoperatively. Similar findings were also noted in the study conducted by

Leighton et al [81] reported that CT scan of temporal bone had an excellent predictive value for diagnosing cholesteatoma and in another study by **Gaurano and Joharjy** **[16]** reported that the correlation of pre-operative CT with surgical and histopathological findings was 97%. **N W C Chee & T Y Tan** [21] also showed that cholesteatoma can be accurately diagnosed by the HRCT scan in the vast majority of cases. They considered tissue mass, typical location (epitympanum and mastoid antrum) and bone erosion as the radiographic criteria for diagnosis of cholesteatoma and showed that using at least 2 of the 3 features, cholesteatoma could be diagnosed in 94.4% of cases. High specificity in detecting cholesteatoma may be due to the accuracy of HRCT in detecting soft tissue mass with bone erosion. However inability of HRCT to differentiate fluid and soft tissue mass based on the attenuation values and also due to the presence of ossicular erosion in some of the cases of chronic mucosal disease has to be considered.

In contrast, **Firas Q et al** [82] who found a sensitivity of 80% and specificity of 48% for HRCT in differentiating cholesteatoma from chronic mucosal disease. **Jackler et al** [83] found cholesteatoma to be present in 30% of cases where soft tissue mass along with bone erosion was present.

Among various parts of temporal bone assessed for bony erosions, scutum was the most common structure to be involved followed by malleus, incus, facial canal, stapes, tegmen and semicircular canals. Mastoid cortex and sigmoid sinus plate were the least commonly involved sites. **Gaurano and Joharjy** [16] showed scutum and facial canal as the commonest site of erosion in CSOM followed by incus and tegmen. Ossicular chain erosion was the most common bony erosion in study conducted by **Sandeep Berry-et al** [25] with incus being the most commonly involved ossicles. They also showed that sigmoid sinus plate was the least common site to be involved.

In our study, for the assessment of status of various middle and inner ear structures, radiosurgical correlation was excellent for erosions of malleus and semicircular canals, moderate to good for erosions of incus, scutum, sigmoid plate, tegmen tympani, labyrinthine and tympanic segments of facial canal and poor for stapes and dehiscenc of mastoid segment of facial canal.

Pre-surgical knowledge of the status of the ossicular chain would allow the surgeon to better advise the patient on the degree of hearing attainable after surgery. For example, the hearing outcomes in patients with an intact stapes tend to be better than those where the stapes suprastructure is absent.[84]

Table 25 : Radiosurgical correlation for status of various middle and inner ear structures - comparision with Chee et al [21] and Gerami et al [85] studies

	Current study	Chee et al	Gerami et al
Malleus erosion	Excellent	Excellent	Good
Incus erosion	Good	Good	Good
Stapes erosion	Poor	Excellent	Good
Facial canal dehiscence	Poor	Poor	Poor
Labyrinthine fistula	Good	Excellent	Poor
Tegmen erosion	Good	Good	Poor

Labyrinthine fistula can be accurately detected most of the time when both axial and coronal images are taken to look for erosion of the semicircular canals. The most common canal affected is the lateral semicircular canal and reliance on coronal sections alone may lead to a 50% false positive rate of dehiscence due to the artifact of partial volume averaging.[83] In our study all cases of lateral SCC erosion were accurately diagnosed. Even with the combined coronal and axial images, minute fistula may still be missed. The surgeon is well advised to treat every case as a potential fistula until proven otherwise. The discrepancy between our study and **Gerami et al** study for labyrinthine fistula may be because of the difference in the slice thickness employed. Cuts of 2mm slice were employed in Gerami et al study whereas our study was done using 0.65mm slice thickness.

Tegmen erosion is well seen on coronal imaging, but again misinterpretations may result from volume averaging effects.[83] Such is the case in three patient where the scan suggested the tegmen to be intact but surgically proven to be breached. The reverse is also possible whereby an intact area may appear dehiscent radiologically [20] seen in three of our cases. Discrepancy with Gerami et al study may be because of the reason described above.

The problem with partial volume averaging artifact is again evident with facial canal dehiscence as the canal can be so thin even in a non-pathological ear as to appear dehiscent on a CT scan. This explains for the poor radiological correlation with the surgical findings. In addition, visualisation of tympanic portion of the facial canal may be difficult when there is an adjacent pathologic soft tissue mass in the mesotympanum.[83]

Knowledge of facial nerve anatomy, careful dissection technique in the vicinity of the nerve and the use of intra-operative facial nerve monitoring all help towards reducing the likelihood of an iatrogenic facial nerve injury.

Our study shows high sensitivity for HRCT in detecting erosions of epitympanum (100%), aditus (100%) , mastoid antrum (96%), lateral SCC (100%), malleus (83.3%) whereas sensitivity is low in depicting erosions of incus(66.6%), stapes (50%). Similar results were also noted in Gerami et al study with high sensitivity for ossicular erosions and low sensitivity for tegmen, semicircular canal and facial canal erosions.

HRCT showed 100% specificity for erosions of epitympanum, mastoid antrum, hypotympanum, extension beyond middle ear cleft whereas it is relatively less specific for erosions of facial recess and sinus tympani.

Besides giving information on the status of the middle ear structures, the HRCT scan can also delineate the extent and location of disease. Mastoid antrum was involved in most of the cases of attico-antral disease included in the study. Tympanic cavity was involved in 95% of cases and aditus in 90% of cases. Knowledge of the disease extent and information on the degree of mastoid pneumatisation aid in planning the surgical approach, e.g. whether to keep the canal wall up or down. However one should note that the scan may overestimate the extent of disease as it often cannot distinguish definitively between cholesteatoma and granulation tissue.[20] An enhanced MRI scan may be used to discern the two better if clinically indicated.[86]

SUMMARY AND CONCLUSION

The advent of HRCT scans of the temporal bone has significantly enhanced the pre-operative evaluation of cholesteatoma. Maximum number of cases was in the age group of 21 – 30 years with male predominance.

A good radio-surgical correlation was observed for differentiating cholesteatoma from granulation tissue and chronic mucosal thickening as the underlying pathology in cases with attico-antral disease. At surgery, cholesteatoma was present in 26 out of 30 patients (86.6%) whereas it was reported in 27 of the 30 CT scans (90%) thereby giving a sensitivity of 86.6%, specificity of 92.3%, positive predictive value 88.8% and negative predictive value of 33.3% for HRCT in detecting cholesteatoma pre-operatively.

Our study shows high sensitivity for HRCT in detecting involvement of epitympanum (100%), aditus (100%) , mastoid antrum (96%), lateral SCC (100%), malleus (83.3%) whereas specificity is low in depicting erosions of incus(66.6%), stapes (50%).

Among various parts of temporal bone assessed for bony erosions, malleus (83.3%) was the most common structure to be involved followed by scutum (70%), incus (56.6%), facial canal (50%), stapes (33.3%), tegmen (20%) and semicircular canals (16.6%).

Malleus (83.3%) and scutum erosions (70%) were the most commonly encountered findings in cholesteatoma with sinus plate erosion (13.3%) being the least common.

HRCT of temporal bone plays a promising role in pre-operative assessment of cholesteatoma as it depicts the extent of the disease and integrity of most of the middle ear structures. The scan alerts the surgeon to potential surgical dangers and complications of disease. However certain drawbacks of CT such as partial volume averaging do lead to false interpretation of the disease process. Partial volume artifacts can best be avoided by using a thin acquisition section width. Despite limitations, the HRCT scan is a valuable and useful investigative tool prior to cholesteatoma surgery.

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MASTER CHART

SL.NO	NAME	AGE	SEX	HR.CHOL	OT.CHOL	HR.EPI	OT.EPI	HR.ADIT	OT.ADITU	HR.ANTR	OT.ANTR	HR.FACR	OT.FACR	HR.SINTY	OT.SINTY	HR.HYPO	OT.HYPO	HR.EUST	OT.EUST	HR.BEYO	OT.BEYO	HR.MALL	OT.MALL	HR.INCU	OT.INCU	HR.STAP	OT.STAP	HR.LABY	OT.LABY	HR.TYMP	OT.TYMP	HR.MAST	OT.MAST	HR.L SCC	OT.L SCC	HR.P SCC	OT.P SCC	HR.S SCC	OT.S SCC	HR.DUR	OT.DUR	HR.SIN	OT.SIN
1	NAZEER	30	M	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	P	P	P	P	P	P	A	A	P	P	A	A	P	P	A	A	A	A	A	P	P	P
2	MANJUNATH	13	M	A	P	P	P	P	P	P	P	A	A	P	A	A	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A
3	SANTOSH	18	M	P	P	P	P	P	P	P	P	P	P	A	P	A	A	A	A	A	A	P	P	P	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	KEMPAMMA	45	F	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	P	P	P	P	P	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A
5	SRIKANTH	15	M	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	P	P	P	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	A	A
6	VIJAYA	45	F	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	P	P	P	A	P	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	P	A	A
7	SUSAN	36	F	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
8	SAVITHRAMMA	35	F	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	P	P	P	P	A	P	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A
9	SANTOSH KUMAR	18	M	A	A	P	P	P	P	P	P	P	P	A	P	A	A	A	A	A	A	P	A	P	P	A	P	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A
10	SHAHEENA	27	F	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11	SYED	26	M	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
12	NAGEEN TAJ	42	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P	A	A	A	A	A	P	P	A	A
13	RATHNAMMA	42	F	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	P	P	P	P	P	P	P	P	A	A	P	P	A	A	A	A	A	A	A	A	A	A	P	P
14	Sufia H	12	F	A	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
15	Haritha	14	F	P	A	P	P	P	P	P	P	P	A	P	A	A	A	A	A	A	A	A	P	A	P	P	P	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A
16	Yellamma	25	F	P	P	P	P	P	P	P	P	A	P	P	P	A	P	A	A	A	A	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	P	P	A	A
17	Dhanush	11	M	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	P	A	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
18	Srinivas	50	M	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	P	P	P	P	P	P	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A
19	Ramakka	28	F	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
20	Swetha	21	F	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
21	Shabeer	25	M	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	P	P	P	P	P	P	P	P	A	A	P	P	A	P	P	P	P	P	A	A	P	P	P	P
22	Muneer Ahmed	61	M	P	A	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
23	Suresh	20	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	A	A	P	P	P	P	A	A	A	A	A	A	A	P	A	A
24	Venkatesh	22	M	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	A	A	P	P	P	P	P	P	A	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A
25	Nagarjuna	40	M	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	P	P	P	A
26	Lohith Kumar	11	M	P	P	P	P	P	P	P	P	P	A	P	A	A	A	A	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
27	Sujatha	27	F	P	P	A	P	A	P	A	P	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	P	P	A	A	A	A	P	P	A	A
28	Appayya	22	M	P	P	P	P	P	A	P	P	P	P	P	A	A	A	A	A	A	A	P	P	P	P	A	A	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A
29	Udandappa	40	M	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
30	Varalakshmamma	45	F	P	P	P	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

PROFROMA

ROLE OF HIGH RESOLUTION CT OF THE TEMPORAL BONE IN ATTICO-ANTRAL DISEASE

1. Name of patient : Hospital No:
2. Age : Date of admission:
3. Sex : Date of Surgery :
4. Father's name : Date of Discharge :
5. Occupation :
6. Residential Address :
7. **SYMPTOMS**

   A. Ear discharge : Duration

   B. Ear ache : Duration

   C. Hearing loss : Duration

   D. Symptoms related to complications of CSOM if any, specify:

8. **PAST HISTORY:** Similar complaints in past – Yes/No.
9. **SIGNS**

   A. Ear discharge

      a. Scanty / Profuse
      b. Purulent / Mucopurulent
      c. Blood stained – Yes / No.
      d. Foul Smelling – Yes / No.

   B. Otoscopic Findings –

a. Primary acquired cholesteatoma – Attic / Postero – superior.

b. Secondary acquired cholesteatoma

c. Congenital cholesteatoma

C. Signs of complications of CSOM if any, specify:

10. HRCT FINDINGS:

A. Presence or absence of cholesteatoma - Present / Absent

B. Extent of Cholesteatoma

a. Epitympanum

b. Aditus

c. Mastoid antrum

d. Mastoid process

e. Mesotympanum – Facial recess / Sinus tympani

f. Hypotympanum

g. Eustachian tube

h. Beyond middle ear cleft

C. Status of ossicular chain

a. Malleus

b. Incus

c. Stapes

D. Integrity of facial canal

a. Labyrinthine

b. Tympanic

c. Mastoid

E. Detection of erosions or dehiscence in bony labyrinth

a. Lateral semicircular canal

b. Posterior semicircular canal

c. Superior semicircular canal

d. Promontory

F. Detection of erosions or dehiscence in the dural or sinus plates

a. Dural plate

b. Sinus plate

11. OPERATIVE FINDINGS:

A. Presence or absence of cholesteatoma - Present / Absent.

B. Extent of Cholesteatoma

a. Epitympanum

b. Aditus

c. Mastoid antrum

d. Mastoid Process

e. Mesotympanum – Facial recess / Sinus tympani

f. Hypotympanum

g. Eustachian tube

h. Beyond middle ear cleft.

C. Status of ossicular chain

a. Malleus

b. Incus

c. Stapes

D. Integrity of facial canal

a. Labyrinthine

b. Tympanic

c. Mastoid

E. Detection of erosions or dehiscence in bony labyrinth

a. Lateral semicircular canal

b. Posterior semicircular canal

c. Superior semicircular canal

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F. Detection of erosions or dehiscence in the dural or sinus plates

a. Dural plate

b. Sinus plate