OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA

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CHENNAI

TAMIL NADU

CERTIFICATE

This is to certify that this dissertation entitled **"OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA"** presented herewith by **Dr.P.S.K.Thangaraj** to the faculty of otorhinolaryngology in the Tamilnadu Dr.MGR Medical University, Chennai, in partial fulfilment of the requirements for the award degree of the Master of Surgery Branch IV (Oto-trhino-laryngology) March 2010 session is a bonafide work carried out by him under my direct supervision and guidance during the period of 2008 – 2010.

Dr.KR.Kannappan, M.S., MCh., D.L.O
Professor & Head of the Dept.,
Dept. of Oto-Rhino-Laryngology,
Madurai medical college,
Madurai – 625020.

DECLARATION

I hereby declare that this dissertation entitled **"OSSICULAR PATHOLOGY IN CHRONIC SUPPURATIVE OTITIS MEDIA"** has been prepared by me under the guidance and supervision of **DR.KR. KANNAPPAN MS, DLO, M.CH,** Prof. HOD Department of ENT Diseases, Govt Rajaji Hospital, Madurai.

This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University in partial fulfillment of the university regulations for the award of "The Master of Surgery" in Otorhinolaryngology.

This work has not formed the basis of the award of any Degree/ Diploma to me previously by any other university.

PLACE: Madurai

DATE :

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Lastly, I am conscious of my indebtness to all my patients for their kind co-operation during the course of study.

CONTENTS

INTRODUCTION

In developing countries, chronic suppurative otitis media accounted for 60 to 80% of middle ear disease. Chronic suppurative otitis media is a disease affecting especially people with poor health, hygiene, and nutrition throughout the world. If improperly treated in childhood, chronic suppurative otitis media in children will often continue into adulthood. Up to one-third of the population in developing countries has their quality of life affected by CSOM and its precursors. In children in developing countries chronic suppurative otitis media is the most common cause of hearing impairment.

Chronic suppurative otitis media of unsafe type, by its most common complication can produce hearing disability. The hearing defect usually occurs due to ossicular interruption, and not frequently by fixation.The challenge of hearing improvement depends on proper ossicular reconstruction and its long term stability. In the past very many type of biomaterials were used for ossicular reconstruction. The end result of biomaterials regarding stability of hearing is inferior to that of auto or homograft Ossiles. So there is immense demand for auto and homograft ossicle to have ossicular bank. In this prospective study the frequency of ossicular defects and histopathology were analysed.

AIMS AND OBJECTIVES

A comprehensive study of pathology of ossicular defects in chronic otitis media

To aid the study of long term hearing stability in patients under going ossicular reconstruction using auto or homo graft ossicles taken from chronic suppurative otitis media

DEVELOPMENT OF THE MIDDLE EAR

MIDDLE EAR

The middle ear cavity is endodermal. It originates at about four weeks from the first pharyngeal pouch, which grows laterally, and expands rapidly to pre-form two fundamental structures: the distal part forms the tubotympanic recess, which will become the primitive tympanic cavity; and the proximal part constricts to form the fibrocartilaginous Eustachian tube.

The primitive tympanic cavity gradually expands like a growing bud to include the ossicles and their associated muscles and blood vessels. The accompanying dissolution of the mesenchyme facilitates this progression. Starting in the inferior half of the future tympanic cavity, this extension is hindered, higher up by a projection of the otic capsule: the superior periotic process, which will constitute the superior wall of the tympanic cavity, and lower down by the bony wall of the floor of the tympanic cavity, originating from separate bone or from a lamellar projection of the petrous pyramid.

Possible progression occurs in the sagittal plane leading to, late in fetal life only, epitympanic recesses, antrum, and mastoid gas cells. Expansion of the tympanic cavity is virtually complete by about thirty-three weeks. The epitympanum follows approximately four weeks later.

Malleus and Incus

The anlage of the ossicles has been the subject of much discussion. The consensus

now holds that the ossicles have multiple origins. It is believed that the manubrium of the malleus and the long process of the incus erive from the hyoid visceral bar, while the head of the malleus and body of the incus differentiate from the mandibular visceral bar.

The anterior process of the malleus, however, emerges from intramembranous ossification distinct from the visceral bars. In this context, it is useful to draw a distinction between the mandibular and hyoid visceral bars as opposed to

Meckel's and Reichert's cartilages . Lying within the branchial arches is a condensation of mesenchymal tissue. With maturation it differentiates nto cartilage and eventually becomes bone in some, although not all, regions. Visceral bar is the term used to describe the entire masses of condensed mesenchymal tissue, whereas the terms Meckel's and Reichert's cartilages refer only to the cartilage formed from the ventromedial portions of these mandibular and hyoid visceral bars, respectively.

At approximately four weeks of gestation , areas of condensation of the mesenchyme appear at the dorsolateral ends of the mandibular and hyoid bars. An interbranchial bridge is formed which connects the upper end of the mandibular visceral bar to the central region of the hyoid visceral bar; it is this bridge that gives rise to the blastemae of the malleus and incus.

Stapes

The stapes, like the malleus and incus, has a dual origin first described by Gradenigo in 1887. Stapes development involves a complex morphogenesis starting as a blastema at 4½ weeks. A stapedial "ring," which arises from mesenchyme of the hyoid visceral bar, gives rise to the capitulum, crura, and tympanic (lateral) surface of the footplate. The lamina stapedialis, which gives rise to the annular ligament and the labyrinthine (medial) surface of the footplate, develops from the otic capsule and retains some of its cartilaginous structure throughout life. A blastemal mass is all that is recognizable of the future stapes at the fourth week of gestation. This blastema is composed of the condensed mesenchymal cells of the dorsolateral end of the hyoid visceral bar, adjacent to the facial nerve, and the nascent stapedial artery. By the sixteenth week, the ossicles attain adult size, and ossification begins at discrete ossification centers.

ANATOMY OF THE MIDDLE EAR

The middle ear, or tympanic cavity, is an irregularly shaped chamber, which measure approximately 15 mm. each, while the transverse diameter the lateral wall (membranous wall) of the middle ear is formed for the most part by the tympanic membrane.

The posterior wall is somewhat triangular, with the narrowest portion situated inferiorly, Salient features of the posterior wall include The pyramidal eminence, fossa of the incus, eiter chordae tympani posterior The medial wall separates the middle ear cavity from the inner ear. Its major features are the promontory, fossula fenestrae cochleae, tympanic sinus, fossula fenestrae vestibuli

The Malleus The most lateral of the ossicles is the malleus. It has a head, neck, lateral process, anterior process, and manubrium. The anterior process is a thin projection of bone which extends from the neck of the malleus into the petrotympanic (Glaserian) fissure, accompanied by the chorda tympani nerve It is held to the walls of the petrotympanic fissure by the anterior malleal ligament which, with the posterior incudal ligament, serves to establish the axis of rotation of the ossicles. The malleus is held in place by five ligaments, one articulation, the tensor tympani tendon, and the tympanic membrane. Three of the five ligaments are well outside the axis of rotation and have a suspensory function; they are:

(1) the anterior suspensory ligament which lies superior to the anterior malleal ligament and attaches the head of the malleus to the anterior wall of the epitympanum ,

(2) the lateral suspensory ligament which attaches the neck of the malleus to the bony margins of the tympanic notch (the notch of Rivinus), and

(3) the superior suspensoryligament which bridges the gap between the head of the malleus and the tegmen of the epitympanum. The tendon of the tensor tympani muscle extends laterally from the cochleariform process to attach to the neck and manubrium of the malleus

The Incus

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)

The long process reaches inferiorly, paralleling the manubrium, to end in the lenticular process; the convex surface of this process articulates with the concave surface

of the head of the stapes in the diarthrodial incudostapedial articulation

The horizontal, cross-sectional configuration of the long process of the incus is circular. Three ligaments anchor the incus in place. The posterior incudal ligament secures the short process in the posterior incudal recess. Anteriorly, the medial and lateral incudomalleal ligaments secure the body of the incus to the head of the malleus

The long process of the incus is highly susceptible to osteitic resorption caused by chronic otitis media. It is common for the long process to show slight pneumatization in the form of a pit. Highly pneumatized incudes are rare.

The Stapes

The stapes is the smallest and the most medial link of the ossicular chain; it consists of a head, footplate (the basis stapedis), and two crura or legs. The anterior crus is straighter and more delicate than the posterior. There is an irregular area near the superior aspect of the posterior crus to which the stapedius tendon variably attaches the footplate, in association with the annular ligament, seals the oval window. The shape, thickness, and curvature of the footplate are inconstant the head articulates with the lenticular process of the incus at its fovea, and it may have a muscular process for the attachment of the stapedius tendon.

The relative thickness and curvature of the crura vary among individuals, as does the locale for attachment of the stapedius tendon.

VASCULAR SUPPLY TO THE MIDDLE EAR

Nager and Nager, in an exhaustive study of serially sectioned human temporal bones, elucidated the arterial supply of the middle ear and mastoid The blood supply of the middle ear stems from:

(1) the external carotid artery by way of the ascending pharyngeal artery, the occipital artery (directly and via its posterior auricular branch), and the internal maxillaryartery and its branches (the middle meningeal artery and accessory meningeal artery),

(2) The internal carotid artery, and (3) the basilar artery via the subarcuate branch of the labyrinthine (internal auditory) artery

Branch	Parent artery	Region supplied
Anterior tympanic	Maxillary artery	TM, Malleus,Incus, anterior part of tympanic cavity
Stylomastoid	Posterior Auricular	Posterior part of tympanic cavity, stapedius muscle
Mastoid	Stylomastoid	Mastoid air cells
Petrosal	Middle meningeal	Roof of mastoid,roof of Epitympanum
Superior tympanic	Middle meningeal	Malleus, Incus, Tensor tympani
Inferior tympanic	Ascending pharyngeal	Mesotympanum
Tympanic branches	Internal carotid	Mesotympanum andhypotympanum

PHYSIOLOGY OF THE MIDDLE EAR

Acoustic signals are transmitted from the air of the external environment to the fluid filled inner ear.

The middle ear acts as a transformer to increase sound pressure at the footplate relative to that at the tympanic membrane at the expense of a decrease in stapes volume velocity relative to the tympanic membrane volume velocity.

The transformer of the middle ear although working as a complex whole may be divided in to three stages

1. That provided by the drum
2. That provided by the ossicular lever
3. That provided by the area difference between the drum and stapes foot plate.

Cantenary lever

The curved membrane of the drum head act as a cantenary lever which stretched , exerts greater force upon its point of attachment. Because the fibrous annulus is immobile, soun energy applied to the tympanic membrane is amplifiedat its central attachment, the malleus.

Ossicular lever:

This is the lever action caused by differing lengths of the manubrium and long process of incus around the axis of rotation of the ossicles. This axis of rotation is an imaginary line joining the anterior malleal ligament to the incudal ligament that anchors the short process of the incus. pressure gain, which is the result of the area ratio and the ossicular lever, can be quantified and measured using the ratio of sound pressure in the vestibule to the sound pressure in the ear canal hydraulic lever Sound pressure collected over the large area of the tympanic membrane and transmitted to the smaller footplate area results in an increases in force proportional to the ratio of the area.

Cantenary Lever	Force acting on TM/Force acting on malleus	2.0
Ossicular lever	Force acting on maleus/ Force acting onstapes	1.15
Area ratio	Area of TM / Area of Footplate	21.0
Total Leveradvantage	Force acting on footplate/Force acting on TM	48.3

The theoretical (ideal) middle ear gain is 28 dB, whereas the actual (measured) middle ear gain is only about 20 dB actual middle ear sound pressure gain is frequency dependent, with a maximum gain of only about 20 dB near 1,000 Hz, with lower gains at other frequencies

Bone Conduction

The inertial component of the bone conduction is due to the lag of the conduction apparatus in following

The vibration of the skull, thus creating a relative movement of the stapes on oval window. This movement of stapes on oval window is important between 500 and 2000hz. Fixation or interruption of the ossicular chain reduces this energy transfer and causes falsely depressed scores on bone conduction test

The middle ear acts as a low pass filter, allowing frequencies below the network resistance of 1000hz to pass while attenuating higher frequencies at a 16dboctave slope.

PATHOLOGY OF CHRONIC OTITIS MEDIA

Inactive mucosal COM the perforation of tympanic membrane mucosa of the middle ear and mastoid is not inflamed. Squamous epithelim can migrate medially in to the middle ear.

Active mucosal COM

There is chronic inflammation of the mucosa of the middle ear with varying degree of edema and submucosal fibrosis, hypervascularity and infiltration with lymphocytes, plasma cells and histiocytes.

Mucosa may ulcerate proliferation of blood vessels, fibroblasts and inflammatory cells leadinin to formation of granulation tissue. Active mucosal Chronic otitis media is often associated with resorption of parts or all of the ossicular chain. The ossicle thus affected shows hyperemia with proliferation of capillaries and prominent histiocytes Inactive suamous epithelial COM

Negative static middle ear pressure result in retraction of the tympanic membrane. Epidermidization is a more advanced type of retraction and refers to replacement of middle ear mucosa by keratinizing squamous epithelium with out retention of keratin debris. Epidermization is often remains quiescent and does not progress to cholesteatoma or suppuration.

Active squamous epithelial COM Epidermization of the middle ear cleft with retention of the keratin debris is characteristic. Histologically the matrix of the cholesteatoma is similar to that of the skin. The matrix is surrounded by layer of inflamed, vascular, subepithelial connective tissue. Inflammatory changes similar to active mucosal COM present throughout the mucosal and submucosal regions of the middle ear cleft. Resorption of bone leads to intra temporal and intracranial complications

PATHOLOGY OF CHRONIC SUPPURATIVE OTITIS MEDIA

Cholesteatoma is cystic lesion formed from keratinizing stratified squamous epithelium, the matrix of which is composed of epithelium that rests on a stroma of varying thickness, the perimatrix. The resulting hyperkeratosis and shedding of keratin debris usually results in a cystic mass with a surrounding inflammatory reaction. It may present extradurally or intradurally.

In 1683 Duverney published the first description of what might correspond to cholesteatoma. Muller in 1829 used the term cholesteatoma as he became aware of the presence of cholesterin and fat in what he believed to be a tumor. Virchow classified cholesteatoma among squamous cell carcinomas and atheromas. Von Troeltsch was the first to consider the epidermal origin of cholesteatoma. Gruber and Wendt and Rokitansky considered that middle ear mucosa rather than bone underwent malphigian

metaplasia in response to chronic inflammation. Bezold and Habermann proved that cholesteatoma could originate from the skin of the external auditory canal.

The precise pathogenesis of the cholesteatoma has been debated for more than two centuries. Four predominant theories has been debated 1) Invagination, 2) basal cell hyperplasia, 3) metaplasia 4) Epithelial invasion. The invagination theory is currently regarded as one of the primary mechanism of the formation of primary acquired cholesteatoma. Anatomic or pathologic conditions that predispose to Eustachian tube dysfunction result in barometric perturbation of the middle ear space. Impaired ventilation secondary to a dysfunctional Eustachian tube leads to negative middle ear pressure. The negative pressure is the culprit for structural weakening of the tympanic membrane and development of the retraction pockets. THE experimental model illustrating the implication of eutachian tube dysfunction in the formation of the retraction pockets and later choleteatoma was described by Kim and Chole. The geometrical changes attributed to progressive retraction lead to narrowing of the anatomic passages and impairment of the epithelial migration and cleaning of the debris. As the pocket deepens and insinuates between mucosal folds and crevices, it becomes nonself cleaning and leads to accumulation of keratin debris. Bacterial proliferation and super infection of the accumulated debris form a biofilm that leads to chronic infection and epithelial proliferation. Bacterial biofilms are anatomically defined as communities of bacteria enclosed in a self-produced glycocalyx matrix. They are structured by adhesion of plank-tonic or free-living bacteria to a surface, then proliferate in bacterial

microcolonies along with the production of the glycocalyx matrix. This active progression of biofilm formation results in a mature biofilm that persists on surfaces. Physiologically, bacterial biofilms are markedly resistant to host defense mechanisms and antibiotics; they can be up to a thousand times more resistant to antimicrobial treatments than planktonic bacteria of the same species The most common bacterial isolate of chronic otitis media is *P. aeruginosa*.12,16 Other isolates include aerobic organisms, such as enteric gram-negative bacilli, *S. aureus, streptococci, K. pneumoniae*, and *H. influenzae*. Anaerobic isolates, associated with a malodorous otorrhea, include Peptostreptococcus and Bacteroides species.

The exact mechanism and triggers that lead to development of an active cholesteatoma in some patients with and attic retraction pocket while others continue to have a quiescent and self-cleaning pocket remain unclear. It has been shown recently that the combination of tympanic membrane retraction and basal cell proliferation is the hallmark for cholesteatoma formation and development.

Sudhoff and Tos performed immunohistochemical analysis of surgical specimens obtained from 14 patients with middle ear cholesteatoma. In their clinical study, they compared the expression of MIB-1, a marker of cellular proliferation, between the cholestatoma content and the normal external auditory canal skin. In addition, the investigators analyzed the integrity of the basement membrane by using avidin biotin complex peroxidase to stain collagen type IV. At the level of the basement membrane,

interruption in the continuity was seen at the cholesteatoma – lamina propria interface, whereas the integrity was preserved in the adjacent normal auditory canal skin. They also showed an increased expression of MIB-1 in the keratinocytic population of the basal cell layer. This increased expressivity was consistent with proliferating keratinocytes localized primarily in small epithelial cones or pseudopods growing into the subeithelial stroma through interruptions of the basement membrane. In the initial retraction pocket stage, the epithelial migratory pattern is maintained until the pockets deepen and the drainage pathways become small leading to keratin debris accumulation. As the debris becomes infected, the bacterial proliferation and resultant inflammation leads to an influx of inflammatory cells and production of cytokines. This progression along with local release of collagenases created breaks in the basement membrane allowing the formation of epithelial cones that grow toward the stroma. The combination of subepithelial invasion and keratinocytic proliferation in the form of microcholesteatoma is the hallmark of the precholesteatomatous stage of cholesteatoma.

As the microcones expand and fuse together, an attic cholesteatoma is formed.

Using immunohistochemistry, Kim and Coworkers, analyzed the pattern of cellular proliferation and epithelial migration in the Mongolian gerbil animal model. They showed an increase in the expression of cytokeratin (CK0 13/16, markers of epidermal cell proliferation, in the expanding part of the cholesteatoma and o a lesser degree an increase in the expression of CK 5/6 and CK 1/10, markers of epithelial migration. They concluded that cellular migration (or invasion) and proliferation play a

role in the expansion of cholesteatoma.

Secondary acquired cholesteatoma has been described to occur as the result of the migration of tympanic membrane epidermis into the middle ear at the site of a marginal perforation or as the result of the implantation of viable keratinocytes into the middle ear cleft. The implantation occurs during a blast injury to the tympanic membrane leaving keratinocytes behind a healed perforation, at the site of a temporal bone fracture, or as the result of an iatrogenic introduction of these cells. The latter have been described to occur in various otologic surgeries such as stapedectomy, tympanoplsty, pressure equalization tube placement, and middle ear exploration.

Incidence of 1.1% of middle ear cholesteatoma attributed to the insertion of the pressure equalization tube. The presence of cholesteatoma around the tube site was a prerequisite to incriminate the procedure as a cause of cholesteatoma.

Production of new keratin was observed up to 9 months postimplantation. Various histopathologic changes ranging from granulation tissue to cholesteatoma formation were described. Neonatal aspiration of viable keratinocytes may not fully account for the development of congenital cholesteatoma, it provides a valuable experimental platform that the implantation of viable keratinocytes can lead to formation of middle ear or mastoid cholesteatoma. This is observed frequently in revision middle ear surgery and described as “Cholesteatomatous pearl” formation that is the result of a trapped viable keratinocytic formation that leads to a small localized cholesteaoma.

Pathogenesis of cholesteatoma is paralleled by the ongoing research to help

elucidate the mechanism of expansion, bone destruction and invasion seen in middle ear cholesteatoma. Two predominant mechanisms are believed to account for the osteolysis seen in middle ear cholesteatoma: pressure-induced bone resorption and enzymatic dissolution of bone by cytokine-mediated inflammation. Pressure necrosis initially described by Steinbrugge in 1879 and Walsh in 1951, and direct bone resorption as described by Chole and coworkers in 1985 have been proposed as possible mechanisms of bone destruction. Chole and colleagues implanted silicone sheets in the middle ear of gerbils without cholesteatoma and noted bone resorption at the pressure site. They estimated that pressures of 50 to 120 mm Hg resulted in osteoclastic-induced bone resorption. The interaction of osteoclasts and osteo blasts to extrinsic biomechanical factors is a well-documented biological response.

PATHOLOGY OF OSSICULAR EROSION

Two predominant mechanisms are believed to account for the osteolysis seen in middle ear cholesteatoma: pressure-induced bone resorption and enzymatic dissolution of bone by cytokine-mediated inflammation. Pressure necrosis initially described by Steinbru¨gge in 1879 and Walsh in 1951, and direct bone resorption as described by Chole and coworkers in 1985 have been proposed as possible mechanisms of bone destruction. It is uncertain to what degree the pressure-induced activation of osteoclasts play a role in the osteolysis seen in cholesteatoma. Enzymatic-induced and cytokine-induced bone destruction has been studied in the last two decades.

Matrix metalloproteinases (MMP), a family of zinc metalloenzymes that degrades unmineralized extracellular matrix, have been shown to be present in the cholesteatoma. MMP-2 (72 kD collagenase) and MMP-9 (92 kD collagenase) were expressed in suprabasal epithelial layers of Cholesteatoma. Other investigators found the increased expression of MMP-9 but not MMP-2 in cholesteatoma cells. Schmidt and coworkers analyzed the in vivo significance of MMP-9 activity in relation to the production of cytokines interleukin (IL)-1a, IL-1b, TNF-a, transforming growth factor (TGF)-b, and epidermal growth factor (EGF) in tissue homogenates of cholesteatoma and nine external ear skin specimens. IL-1a production was found to be significantly elevated; however, no correlation was found between MMP-9 activity and cytokine production.

IL-1 and IL-8, important intercellular mediators of osteoclastic activities have been shown to increase in cultured cholesteatoma cells compared with normal external auditory canal skin.

The role of another important cytokine, TNF-a, has also been found. Yan and coauthors found that by in vitro stimulating monocytes, they were able to produce multinucleated cells with osteoclastlike activity that produced acid phosphatase-induced bone demineralization. The amount of osteolysis was increased by adding osteoblasts to the TNF-a– treated osteoclasts containing medium, suggesting a cell to cell interaction mediated by TNF-a. In addition, the latter enhanced the production ofcollagenases by macrophages and osteoblasts. However, by performing enzyme- linked immunosorbent assay on tissue samples from 23 patients with cholesteatoma and 16 patients with chronic otitis without cholesteatoma, the detection of IL-1a, TNF-a, and EGF was significantly higher in the cholesteatoma samples. Histopathologic evidence was obtained from the temporal bone of two patients with ruptured cholesteatoma sac resulting in local inflammation and osteolysis . These changes were associated with a small abscess formation at the site of the rupture. They noted a marked inflammatory cellular infiltrate surrounding the rupture site with evidence of epithelial proliferation at the lining of the perforation site.

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Jung and coworkers showed the possible role of nitric oxide as an important mediator of osteoclast function. Using in vivo analysis of a murine model of cholesteatoma-induced bone resorption and in vitro analysis of osteoclast culture, the investigators studied the gene expression of nitric oxide synthase (NOS) and the effect of aminoguanidine (an inhibitor of cytokine mediated nitrite production). They showed a selective upregulation of the inducible NOS or NOS II compared with NOS I and III and a dose-dependent stimulation of osteoclastic activity (not proliferation) using low concentration of nitric oxide donors (sodium nitroprusside and S-nitro-N-acetyl-D, L-penicillamine). In vitro, only interferon (IFN)-g (not IL-1b or TNF-a) was able to generate nitrite. This nitrite production was blocked in vitro by the addition of aminoguanidine (but not in vivo) and was synergistically enhanced in the presence of IFN-g, IL-1b, and TNF-a.

These findings indicate a role for nitric oxide in the osteoclastic-mediated bone resorption in cholesteatoma and suggest the implication of additional cytokines in the in vivo osteoclastogenesis and bone resorption. In contrast to the increased osteoclastic activity without increase in the number of osteoclasts seen by Jung and colleagues, in a separate study, Hamzei and coauthors found an increase in thenumber of the osteoclast

precursor cells in the perimatrix of 21 cholesteatoma surgically obtained. These studies highlight the importance of osteolysis and its regulatory mechanisms in the bone destruction seen in middle ear cholesteatoma that results in significant morbidity.

Austin's classification of ossicular chain defects

1. Malleus handle present, stapes superstructure present.
2. Malleus handle absent, stapes superstructure present.
3. Malleus handle present. Stapes super structure absent.
4. Malleus handle absent, stapes superstructure absent.

Rare defects

1. Isolated loss of the malleus handle
2. Isolated loss of the stapes
3. Malleus handle present and stapes fixed
4. Malleus handle absent and stapes fixed

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REVIEW OF LITERATURE

Goto, S

Nature of study : Status of the stapes in chronic middle ear suppuration

Result: The stapes was not commonly affected in this disease and when the pathological changes where severe enough to eliminate srapes other ossicle were affected.

Source: Archives of Otolaryngology

Grippaudo, M.

Nature of study:Histopathological studies of ossicles in chronic otitis media

Result : The incus and malleus were involved with similar frequency but the extent and distribution of disease was greater in the incus

Sade, J and Berco, C

Nature of study

Result : where bone destruction was present in cholesteatomatous cases, granulation tissue connective tissue, or both were found between the bone defect and epithelium.Prominent cell found in the sub epithelial connecxtive tissue was fibroblast, and the areas where osteolysis was underway immature fibroblasts were abundant.

Nager, G.T. and Nager, M

Nature of study : Blood supply of ossicles

Result : The precarious blood supply of the incus, chronic inflammation of the bone spaces, through which blood vessels pass may further lessen the vascularity of the

long process and cause subsequent destruction and dissolution

Mariyama, H et al

Nature of study: Bone resorption factors in chronic otitis media.

Result : Collagenase released by osteoclasts and mononuclear cells were responsible for bone resorption

W.Y. Chao and C.C. Wu (1994) where erosion of all ossicles was seen in 34 (35.42%) cases, absence of all ossicles except for the stapes footplate in 13 (13.54%) cases and 13(13.54%) had intact ossicles

I.H. Udaipurwala et al.(1994) showed ossicular damage in 76 (52.05%), no ossicular pathology in 69(47.58%) cases and involvement of all three ossicles in 30 (40%) cases . The reason for this deviation may be that in their study both atticoantral and tubotympanic diseases were included

D.K. Banskota et al. (1997) reported intact ossicles in 72 (30.51%), and absence of all ossicles in 60 (25.85%) cases. In this series, the most common ossicle affected by disease was incus. It was seen in 96 (88.89%) patients followed by malleus which was seen in 52 (48.15%) patients. Similar incidence of ossicular defects have been mentioned by others. D.K. Banskota found that lenticular process of incus was the most commonly affected part 164 (69.49%) followed by head of malleus 142 (60.17%), the long process of incus 136 (57.63%) and suprastructure of the stapes 105 (44.49%). In this study, lenticular process of incus was the most common part of ossicles eroded by the disease which was seen in 86 (80.57%) patients followed by long process of incus

which was seen in 77 (71.31%) patients and body of incus which was seen in 51 (47.23%) patients. Suprastructure of stapes was affected in 46 (42.60%) and head of malleus in 44 (40.74%) cases

M. Tos (1979) reported that in granulation otitis without cholesteatoma and in sequelae to otitis there was less ossicular pathology and 57% of these ears had intact ossicles .

According to Schuknecht (1976) also the long process of incus, crural arch of the stapes, body of the incus, and manubrium are involved in that order of frequency

A. Palva et al. (1977) revealed ossicular chain intact in 23 (35%) cases out of 65 cholesteatomatous ears in children. In a study done by V. Jahnke and W. Falk (1976) also ossicles were found to be destructed in 77% cases out of 117 cholesteatomatous cases.

J. Karja (1976) revealed that ossicular chain was damaged in 75% cases with cholesteatoma without discharge and 79-97% in discharging ears with cholesteatoma . This study showed M+S+ defect of ossicular chain needing MSA in 45 (41.67%) patients followed by M+S-defect needing MFA in 27 (25%) patients. M-S+ defect was seen in 6 (5.55%) cases and M-S- defect was seen in 18 (16.17%) cases. In both cholesteatomatous and granulation tissue cases of M+S+defect was common with 33 (30.56%) and 12 (11.11%) cases respectively. M+S- defect needing MFA was seen in 24 (22.22%) of ears with cholesteatoma and 3 (2.77%) of ears with granulation tissue.

In D. F. Austin (1989) series, has mentioned that the most commonly encountered

ossicular defects in order of their incidence, were: long process of incus (36.4%), arch of the stapes (18.0%), entire incus (17.0%), entire malleus (8.6%), head of the malleus (6.0%), handle of the malleus (4.3%) M+S+ defect was found in 59.2% of cases followed by M+S- defect in 23.2% of cases. M-S+ defect accounted for 7.8% of ossicular defect and M-S- defect accounted for 8.2% of ossicular defect.

Thomsen et al. (1974) have mentioned that the long process of incus and the stapes suprastructure are the parts of the chain most frequently affected

MATERIALS AND METHODS

Fifty cases of unsafe chronic suppurative otitis media who underwent a modified radical mastoidectomy or radical mastoidectomyfor their disease process were taken up for the study. All the ossicles were studied grossly under 4X magnification while performing surgery. The ossicle in the cases where their chain was completely intact were not removed during surgery, and hence were not studied histologically. Only thirty five ossicles (24 incus, 11 Malleus) were studied hitologically. They were removed partially or completely as a part of the surgical procedure on such cases. The stapes was never removed or studied histologically. Whenever possible biopsy was also taken from attic, aditus, antrum and sinus tympani. The removed ossicle and biopsy materials were preserved in separate formalin containers. The ossicles were decalcified before sectioned. The following details were analysed.

GROSS OSSICULAR FINDINGS

a. Incus – Intact/Pitted / Body eroded / Short process eroded / long process eroded / Incus completely missing
b. Malleus - Intact / Pitted / Handle eroded / Head eroded / Malleus completely missing
c. Stapes – Intact / Head eroded / Crura eroded / Not seen

NATURE OF BONE CHANGES

HISTOLOGICALLY

a. Normal bone

b. Changes in bone spaces :

i) Congestion of blood vessels

ii) Infiltration of inflammatory cells

iii) Epithelium in bine spaces

iv) Granulation tissue

v) Necrosis

vi) Vascular thrombosis

vii) Fibrous tissue

c. Bone formation : Lamellar and intra membrane

d. Bone destruction : i) Absorption

ii) Sequestrum formation

e. Sclerotic bone features

CHANGES IN MUCOSA COVERING THE OSSICLES

a. Epithelial : i) Stratified squamous

ii) Keratinised stratified squamous

iii) Columnar

iv) Cuboidal

OBSERVATION

Cholesteatoma and granualation tissue are the specific pathologies in atticoantral disease. Though cholesteatoma is invariably associated with granulation tissue, there may be only granulation tissue in active mucosal disease.

GROSS PATHOLOGY

Erosion of bone was most commonly seen in the long process of incus (54%). It was followed by erosion of handle of malleus, body and short process of incus, in order of frequency. Whenever the stapes superstructure was eroded, the incus and malleus were markedly disrupted ossicular surface looked pitted under x4 magnification in five incus and two malleus. Cholesteatoma was not always associated with ossicular disruption, and even in the absence of choleteatoma, the ossicular disruption was present.

Seventy percent cases with mainly cholesteatoma, ninety percent with only granulations or chronic inflammation and ninety six percent with both cholesteatoma and granulations or chronic inflammation in the middle ear cleft shoed the evidence of bone destruction on gross examination in one or all the ossicles.

HISTOPATHOLOGY

Two out of the thirty five ossicles studied histopathologically looked intact on

gross examination under x4 magnification. They were however studied histopathologically while they were removed completely or partially as a part of the surgical procedure, because the ossicular chain in these cases was not intact one of the two ossicles showed bone changes on histological study. All the ossicles which looked pitted on gross examination showed bone changes. Only one ossicle was absolutely normal histologically.

Bone absorption was the most common histopathological change and was found in 84% ossicles. It was followed by infiltration by inflammatory cells in bone spaces.

Keratinized stratified squamous epithelium was seen in the mucosal covering of four (12%) ossicles. Proliferation of fibroblast was present just adjacent to the surface in seven (19%) ossicles. In 12% ossicles there was evidence of sequestrum. New bone formation was observed in 20% ossicles.

Table I

GROSS OSSICULAR FINDINGS IN 50 UNSAFE CSOM CASES

Ossicle	Gross finding under x4 magnification	No. of ossicles	Percentage
Incus	Intact	5	16
	Pitted	5	16
	Body eroded	5	12
	Long process eroded	23	54
	Short process eroded	14	32
	Incus completely eroded	7	18
Malleus	Intact	8	20
	Pitted	2	4
	Handled eroded	20	44
	Head eroded	14	24
	Malleus completely eroded	2	4
stapes	Intact	8	16
	Head eroded	4	8
	Crura eroded	4	8
	Not seen	30	60

* These findings are not mutually exclusive

Table II

INCIDENCE AND NATURE OF BONE CHANGES IN 35 OSSICLES STUDIED HISOPAHOLOGICALLY *

Findings		Number	Percentage
Normal bone		2	5.76

Change in bone spaces	Congestion of blood vessels	18	38.4
	Infiltration by inflammatory cells	25	71.0
	Epithelium in bone spaces	0	3.80
	Granuliation tissue	28	57.6
	Necrosis	1	1.92
	Vascular thrombosis	1	1.92
	Fibrous tissue	1	5.76
Bone formation	Lamellar & intra membrane	12	25.0
Bone destruction	Absorption	32	84
	Sequestrum formation	4	11.5
Sclerotic bone fractures		9	25

* These findings are not mutually exclusive

Table III

INCIDENCE AND NATURE OF THE CHANGES IN MUCOSA COVERING THE 35 OSSICLES*

	Mucosal changes	**Number**	**Percentage**
Epithelial	Stratified squamous	11	25.0
	Kerantinized stratified squamous	4	11.52
	Columnar	3	7.68
	Cuboidal	-	-
	Ciliated	-	-
	Epithelium not seen	24	5.7

Subepithelial	Congestion	8	19.2
	Granulation tissue, chronic or acute inflammatory cells	15	38.4
	Cystic dilated gland	1	5.76
	Cholesterin granuloma	-	-
	Tubercular granuloma	-	-
	Fibroblast proliferation	7	21.12

* These findings are not mutually exclusive

DISCUSSION

The blood supply of the long process was described by Nager and Nager. Chronic inflammation of the bone spaces, through which the blood vessels pass may further loses the vascularity of the long process and causes subsequent destruction and dissolution. This leads to the erosion of long process of incus, the most commonly involved structure in the present group of patients. In this study bone changes ere observed in 92.4% of the thirty five ossicles studied histopathologically, with the bone absorption in 84% cases and infiltration of bone spaces with inflammatory cells in 71% ossicles. The bone changes seen in chronic suppurative otitits media are more or less the manifestation of chronic osteomyelitis. In present study, the connective tissue with predominantly fibroblasts was seen between the mucosal epithelium and destroyed bone in 21% ossicles inflammatory or granulation tissue was present just adjacent to fifteen ossicles with underlying bone absorption. Therefore, probably it is not due cholesteatoma, but to the presence of granulation, inflammatory or connective tissue with fibroblasts adjacent to the ossicles that the bone absorption occurs.

CONCLUSION

The long process of the incus is the most commonly eroded part of an ossicle in unsafe chronic suppurative otitis media, followed by handle and head of malleus. Bone absorption is the most frequent pathological change and is usually observed where the granulation, inflammatory or connective tissue with fibroblast is adjacent to the ossicle.

The high incidence of bone changes seen in the ossicles in unsafe chronic suppurative otitis media suggests that their retention during mastoid surgery may not be as beneficial in producing the long term results.

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PROFORMA
EXAMINATION OF EAR

Name :

Age :

Sex :

Occupation :

Address :

Ear :

Complaints:

1. Ear discharge
2. Hard of hearing
3. Giddiness
4. Tinnitus
5. Ear ache

H/o present illness:

1. **Ear Discharge :**

   Side, Duration, Colour, Amount, Foul Smelling

2. **Hard of hearing :**

   Side, Duration

Sudden or slow and progressive, fluctuating

3. **Giddiness:**

   Duration

   Type – true or syncopial attack

   Certain posture

   Proceed by URI

   Nystagmus

   Ototoxic drugs.

4. **Tinnitus :** Side

   Unilateral or bilateral

   Duration

   Onset sudden or gradual

   Progression – Severe or static or decreasing

   Character : Continuous, intermittent, pulsatile, clicking

   Aggravating factors

   Relieving factors

5. **Ear Pain:** Duration

   Side

   Mild or Severe

More on movement of ear or during mastigation

Increases during ear discharge or not

Referred pain

Other Associated Symptoms

1. Head ache
2. Visual Impairment
3. Aphasia
4. Auditory and vestibular function
5. Facial N Palsy

Personal History

1. Tobacco, paan, Betelnut, alcohol usage
2. Mixed diet or veg
3. H/o exposure to STD

Family History

H/o consanguineous marriage

H/o HOH

Past History

1. History of previous Surgery
2. H/o taking ototoxic drugs as in TB treatment

3. Diabet c or HT.

Local Examination:

1. Pinna
2. Ext. Aud. Meatus
3. Pre auricular
4. Post auricular
5. Tympanic Membrance
6. Fistula test
7. Mastoid tenderness

Tunning fork tests

1. Rinne’s
2. Weber’s
3. ABC

Caloric Test

Facial Nerve (Palsy if positive)

Taste Test

Shirmer’s Test

Look for phonophobia

Rhombergism

1. Nasal Obstruction
2. Nasal Discharge
3. Epistaxis
4. Sneezing

Nose : External Contour

Any deformity

Swelling

Columellar retraction

Nasolabial fold obliteration

Mouth:

(i) Apperance of Palate :

any bluge or

Movements of soft palate

(ii) Post nasal drip & tonsils

(iii) Posterior pharyngeal wall

(iv) Dental hygiene

Throat : IDL Scopy

Systemic Examination:

CVS	CNS :	Higher function
RS		Cranial nerves
CNS		Sensory
Abdomen		Motor
		Reflexes
		Gait
		Cerebellar System
		Speech

Investigations:

1. Blood : Hb%, TC, DC, ESR
2. Urin : Albumin, Sugar, Deposits
3. TB – MX Sputum AFB
4. PUS – C & S
5. Audiogram – PTA
6. Radiography – Xray, mastoids

   CT – Scan

   MRI