A DISSERTATION ON THE COMPREHENSIVE ANALYSIS OF POSTERIOR CANAL WALL RECONSTRUCTION TECHNIQUES ON PATIENTS UNDERGOING CANAL WALL DOWN MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA

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DECLARATION

I HEREBY DECLARE THAT THIS DISSERTATION ENTITILED **"A DISSERTATION ON THE COMPREHENSIVE ANALYSIS OF THE POSTERIOR CANAL WALL RECONSTRUCTION TECHNIQUES ON PATIENTS UNDEGOING CANAL WALL DOWN MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA"** HAS BEEN PREPARED BY ME UNDER THE GUIDANCE AND SUPERVISION OF **DR.KR. KANNAPPAN MS, DLO, M.Ch, PROFESSOR AND HEAD OF DEPARTMENT OF OTORHINOLARYNGOLOGY,** 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.

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CERTIFICATE

This is to certify that the thesis titled **“A DISSERTATION ON THE COMPREHENSIVE ANALYSIS OF THE POSTERIOR CANAL WALL RECONSTRUCTION TECHNIQUES ON PATIENTS UNDERGOING CANAL WALL DOWN MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA”** submitted by **DR. PRIYA JAYAN.M** under my supervision & guidance in partial fulfillment for the award of the degree of **Master of Surgery in Otorhinolaryngology** by the Tamil Nadu Dr. M.G.R. Medical University, Chennai, is a bonafide record of the work done by her during the academic period 2006-2009.

She has evinced keen interest in collecting the cases from the ward and analysing them. I have great pleasure in forwarding it.

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"The function of a teacher is not to tell only the meaning of words, but to knock the doors of mind".

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Place:

Date:

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INTRODUCTION

The chronic discharging ear is still one of the common problems that the Otorhinolaryngologist in India and other developing countries are encountering. Although, thanks to the advent of newer antibiotics, the incidence of acute suppurative otitis media and its complications have reduced, chronic suppurative otitis media and their complications are still prevalent.

The continuation of the infection and the bone eroding properties of granulation tissue and cholesteatoma seen in CSOM are known to be the major pathological process causing these complications. As there is no simple means to eradicate this chronic pathology, appropriate and timely intervention by an otologist goes a long way in the prevention of these human maladies.

In cases of chronic suppurative otitis media with atticoantral / postero superior marginal pathology, treatment modality is only surgery. Surgical options available are the canal wall down mastoidectomy and intact canal wall mastoidectomy.

Goals of surgical management of chronic otitis media include the eradication of disease, restoration of hearing, and, to the extent possible, maintenance or restoration of a normal anatomic configuration. Prior to the mid-1950s, the first 2 of these goals were usually accomplished by removal of the posterior external auditory canal wall, resulting in a radical or modified radical mastoidectomy cavity. The past 50 years have witnessed a trend away from mandatory canal wall removal. Many otologic surgeons now prefer intact canal wall mastoidectomy with tympanoplasty except when canal wall removal is required because of extensive disease, inadequate access for cholesteatoma excision, operation on an "only hearing ear," or uncertainty of adequate follow-up. The popularity of intact canal wall mastoidectomy stems from the benefits of maintaining a canal wall, which include freedom from the need for frequent mastoid bowl cleanings, freedom from water intolerance and calorically induced vertigo, and less difficulty in fitting and use of hearing aids.

Immediate or delayed mastoid bowl obliteration with soft tissue, bone pâté, synthetic bone cement, hydroxyapatite crystals, or other materials has been used in attempts to reduce mastoid cavity size and reclaim some of the advantages of normal ear canal anatomy. However, mastoid obliteration risks trapping residual cholesteatoma, impedes postoperative surveillance, and can be defeated by infection or resorption or shrinkage of the graft materials. Radical mastoidectomy with complete obliteration of the mastoid, middle ear, and ear canal, with closure of the meatus, can be effective for treatment of recurrent otorrhea due to mastoid bowl infections and offers freedom from debridement but causes maximal conductive hearing loss.

In contrast to mastoid obliteration procedures, reconstruction of the posterior external auditory canal wall creates an aerated mastoid cavity that is contiguous with the middle ear space. Whether performed immediately after canal wall resection or delayed, this procedure re-creates an anatomic configuration similar to that which results from intact canal wall mastoidectomy. Multiple materials have been used for this purpose, including autologous and homologous cartilage and bone, hydroxyapatite in granular cement and preformed solid forms, porous polytetrafluoroethylene-carbon filament composite, and titanium mesh.

In canal wall down mastoidectomy, complete disease clearance can be given. But this could be achieved only at the cost of post operative cavity problem and considerable hearing loss.

Though these complications are not present in intact canal wall mastoidectomy, disease clearance could not be achieved completely in intact canal wall technique.

Hence canal wall down mastoidectomy with posterior canal wall reconstruction is a better option. This technique has the advantage that complete disease clearance could be given as we do the canal wall down technique. As we also reconstruct the posterior canal wall, the complications such as post operative cavity problems, hearing impairment could be averted.

Though the complications of CSOM can be averted , still they are on the rise due to poverty, ignorance of the patient and the non availability of facilities on time. Therefore there is a need to make public aware of the serious nature of this illness, the importance of early diagnosis and managing so as not only to reduce the morbidity and mortality but also to give them safe, dry and functioning ear.

The present study has been carried out to highlight the comprehensive analysis of post operative result of posterior canal wall reconstruction technique after canal wall down mastoidectomy in patients with atticoantral / postero superior marginal type of chronic suppurative otitis media.

AIMS OF THE STUDY

1. To perform posterior canal wall reconstruction on patients undergoing canal wall down mastoidectomy for atticoantral / postero superior marginal pathology of CSOM , using various graft materials like mastoid cortical bone, conchal cartilage.
2. To follow up the patients post operatively by clinical examination, otoendoscopy and pure tone audiogram.
3. To study the post-operative results like recurrence of ear discharge, improvement in hearing and requirement of post operative follow up.

REVIEW OF LITERATURE

The history of Chronic Otorrhoea and its complications are as old as the human race itself. Some of the Mummies found in the pyramid show evidence of middle ear infection. The earliest written history of ear discharge and its treatment are found in 'PAPYRUS EBEARS' written more than 1500 years BC. It describes treatment with olive oil sprinkled with spells.

Atharvana veda of 700 BC contains the earliest Indian medical information including ear disease.

Sushrutha the Indian physician of 500 B C has written in detail about CSOM describing it a ' Pooti Karna' and is the first person o describe its complications. He says that if ' Pooti Karna' is not treated properly, the patient may develop hallucinations and vomiting . He not only used herbal tonics and ear drops but also devised many surgical instruments to drain an abscess when it is pointing and to pack the cavity daily with herbal medicines.

Hippocrates , the Father of Medicine (460BC) ,was probably the first to inspect the tympanic membrane as dry thin spun web and to recognize it as a part of organ of hearing. He mentioned that the patient with acute ear pain and high continuous fever may become delirious and die.

Medicines used till 1500 AD were honey, breast milk, one's own urine, bull's urine , rain water, etc..

Gabriel Fallopious (1523-62) discovered the facial nerve canal and also described the aural polyp and its treatment.

Joseph Dureuney (1648-1730) remembered as the Father of Otology gave an account of scientific explanation with the tympanic cavity.

Glovauni-Morgagni (1682-1771) was the first to clearly recognise that the ear infection came first and the brain abscess was secondary.

Herman an Schwartz in 1870 first published a report of having opened the mastoid antrum. So well did Schwartz succeed, that by 19 th century it attained a general acceptance and came to be known as Simple or Cortical Mastoidectomy.

Emanuel Gaufal in 1890 described the technique of Radical Mastoidectomy in detail and in 1891 Stacks advocated plastic meatal skin flap for drainage. Then the Radical mastoid operation came to be known as Gaufal or Stack operation.

Johannes Kessel in 1885 had done the first endaural Radical Mastoidectomy.

Lane .W.A in 1890 established the surgical treatment for sinus thrombosis.

Though the concept was very old , the first mastoid operation trying to preserve the ossicular chain and hearing was described by Bondi in 1910.

Alexander Fleming in 1928 discovered the antibiotic Penicillin which revolutionized the treatment of CSOM.

Gerhard Domagic discovered Sulphonamides in 1932 and since then many more useful broad spectrum antibiotics have been introduced.

The reconstructive surgery to create a soundconductive system and tympanoplasty operations started with Zollner in 1951 and Wallstein in 1952.

Heerman in 1958 used temporalis fascia graft for tympanic membrane perforations.

The invention of computerized axial tomography by Godfrey Hounsfield in 1972 is described as the greatest step in the field of radiology, after the invention of X- ray by Roentgen in 1895.

The development of Argon Laser microscope is considered as the greatest advancement in the field of middle ear surgery, invented by Rodney.C. Perkins in 1978.

In 1987 studies of Rubin R. showed that environmental factors in addition to genetic factors exert a strong influence on the development and ultimate size of mastoid air cells.

In recent years many have studied the problems complications of CSOM and further contributed to its better understanding .Browning .G.G says that all active cases of CSOM with and without Cholesteatoma, and whether or not they had previous surgery, should be considered as liable to lead to major complications.

Even today the debate is still on, regarding an open or closed technique to be adopted for eradicating cholesteatoma .the opinion seems unanimous in a case of complication of CSOM, that the eradication of the pathology from the middle ear is more important than its auditory function.

SURGICAL ANATOMY OF MIDDLE EAR CLEFT

The middle ear cleft consists of the tympanic cavity, the Eustachian tube, the mastoid air cell system and extension of the air cell system into anterior and posterior petrous apex.

THE TYMPANIC CAVITY

It is an irregular laterally compressed air filled space in the temporal bone, lined by mucous membrane. It is hour glass shaped with a volume of about 2 cm^3. For descriptive purpose it may be thought of as a box with four walls, roof and floor.

The lateral wall of tympanic cavity

The tympanic membrane forms the central portion of the lateral wall, while above and below there is bone, forming the outer lateral walls of epitympanum and hypotympanum. Superiorly the scutum separates the epitympanic recess from the roof of the external auditory canal. Inferiorly a part of tympanic bone separates the tympanic cavity from the medial part of temporomandibular joint. The pearly white tympanic membrane is 0.1 mm thick and forms an angle of 55º with the floor of meatus, is oval in shape, slightly broader above than below. Its longest diameter from posterosuperior to anteroinferior is 9.1 mm, perpendicular to this is the shorter diameter, 8.9mm. The circumference of pars tensa is thickened to form a fibro-cartilagenous ring-the tympanic annulus, that sits in the tympanic sulcus. From the superior limit of sulcus, the annulus becomes a fibrous band which runs centrally as anterioir and posterior malleolar fold to the lateral process of malleus. The lax area above this fold, that does not have annulus is pars flaccida. Below these malleolar folds is the pars tensa.

In pars tensa, the lateral most collagen fibres of the lamina propria, which are in direct contact with the basement membrane of the epithelial layer, are arranged in regular radial orientation. These fibres are believed to direct the migration of epithelium from the surface of tympanic membrane to the outside. The upper limit of tympanic sulcus is marked by anterior and posterior canaliculus for chorda tympanic nerve which traverse the middle layer of tympanic membrane at the level between malleus and incus. The anterior canaliculus is at the medial end of the petrotympanic fissure which lodges the anterior ligament of malleus and admits the anterior tympanic artery. The posterior canaliculus is situated at the junction of lateral and posterior wall at the level of upper end of handle of malleus. The opening leads to a bony canal that descends through the posterior wall. It descends obliquely and joins the nerve. A branch of stylomastoid artery accompanies the nerve.

Arterial supply is through the deep auricular branch of maxillary artery, anterior tympanic branch of maxillary artery, twigs from the stylomastoid branch of posterior auricular artery and from the middle meningeal artery.

The venous drainage occurs through the external jugular vein, tranverse sinus, dural veins and venous plexus around the Eustachian tube.

Nerve supply is from the auriculotemporal nerve supplying anterior portion and auricular branch of vagus. The posterior portion from tympanic branch of glassopharyngeal nerve.

Roof of the tympanic cavity

It is a thin plate of compact bone, the tegmen tympani, that separates the middle cranial fossa from the tympanic cavity. It is formed by petrous and squamous bone and the petrosquamous suture. This suture is unossified in the young and does not close until adult life. Veins from the tympanic cavity running to the superior petrosal sinus pass through this line and this may allow infection to spread into middle cranial fossa.

Floor of tympanic cavity

It is much narrower than the roof and consists of a convex plate of bone separating the cavity from the superior bulb of internal jugular vein. Occasionally the bone is deficient and the uncovered vein may come upto the level of tympanic membrane covered only by mucous membrane and fibrous tissue and lie in a dangerously exposed position from the point of view of middle ear disease and surgery. The floor sometimes may be thick and contain some accessory air cells. Anteromedial to the vein, the tympanic branch of glassopharyngeal nerve pierces the floor.

Medial wall of tympanic cavity

The medial wall is the lateral wall of the inner ear. The basal turn of the cochlea forms a rounded elevation called promontory, occupying much of the central portion of the medial wall. The promontory surface is grooved by filaments of tympanic plexus. Behind and below the promontory is the oval window leading to vestibule, but in life is closed by the base of stapes and its surrounding annular ligament. The round window lies below and behind the oval window, separated by an extension of promontory called subiculum. Occassionally a spicule of bone leaves the promontory above the subiculum and runs to the pyramid on the posterior wall of tympanic cavity. This spicule is called ponticulus. The round window is covered by secondary tympanic membrane of 0.7mm thickness. The facial nerve runs above the promontory and turns inferiorly behind the oval window to descend in the posterior wall. Above the facial nerve, in the epitympanum, is the dome of lateral semicircular canal. The triangular area posterior to the round window is the sinus tympani which can have cellular communication with the mastoid process and is thus of significance in the pathology and surgery of the tympanic cavity, as it can lodge cholesteatoma hidden during surgery.

Anterior wall of tympanic cavity

It is a narrow wall, as the medial and lateral walls of the tympanic cavity converge. In the superior portion, there are two canals, one for tensor tympani above and the Eustachian tube below. The septum between them extends backwards and forms the processus cochleariformis on which the tendon of tensor tympani glides. The inferior part of the anterior wall consists of thin bony lamina forming posterior wall of carotid canal and is perforated by superior and inferior caroticotympanic nerves and the tympanic branch of internal carotid artery.

Posterior wall of tympanic cavity

It is wider above than below and has in its upper part an opening - the aditus-into the mastoid antrum. This is a large irregular hole that leads backwards from the posterior epitympanum. Below this is the fossa incudis, housing the short process of incus and the ligament connecting the two. Below the fossa incudis and medial to chorda tympani opening is the **pyramid** housing the stapedius muscle. The bony portion of the posterior wall below the pyramid is the pyramidal recess which may be perforated by air cells communicating with the mastoid process. The facial nerve as it descends here is in danger from air cells infection and from surgical attempts at air cells extirpation. Between the promontory and the tympanic annulus is the **facial** recess. Deep to both promontory and the facial nerve is the posterior, extension of the mesotympanum, the **sinus tympani'.** The importance of facial recess is in posterior tympanotomy operation where an access to middle ear from mastoid is made between facial nerve and chorda tympani nerve.

CONTENTS OF TYMPANIC CAVITY

The tympanic cavity contains a chain of the small movable bones - the malleus, incus and stapes, two muscles, the chordatympani and tympanic plexus of nerves.

The malleus has a head, neck, two processes and a handle. The head lies in the epitympanum has a superior ligament which runs to the tegmen tympani. Its posteromedial surface shows a facet for the incudomalleolar joint. The anterior process receives a ligament from the petrotypmpanic fissure, and the lateral process receives anterior and posterior malleolar folds from tympanic annulus. The handle is embedded between the mucosal and fibrous layers of tympanic membrane and its rounded end forms the umbo. Tensor tympani tendon is inserted on the deep surface of handle near its upper end.

The incus has a body and two processes. The body lies in the epitympanum and has a cartilage covered facet for the incudo-malleolar joint. The short process projects backwards to fossa incudis, from which it receives a ligament. The ligament of incus is little more than a fold of mucosa. The tip of long process – the lenticular process is directed medially and forms a ball and socket joint with the head of stapes.

The stapes consists of head, neck, two crura and a foot plate. The stapedius tendon is inserted into the neck. The two crura arise from the neck, and join the foot plate which covers the oval window and is attached to its margins by the annular ligament of base of stapes.

The muscles of the tympanic cavity help in stabilizing the ossicles, augmenting the sound signals and in protection of the inner ear. The tensor tympani and stapedius are stimulated into activity by sound and acting in combination, they exert a dampening effect on amplitude of vibratory wave protecting the cohlea from excess stimulation. The tensor tympani by pulling the tympanic membrane medially may contribute to the functional role of the tensor palate in cleaning the middle ear when the auditory tube is opened.

COMPARTMENTS OF MIDDLE EAR

The middle ear is divided into three compartments: The mesotympanum, epitympanum and hypotympanum.

The mesotympanum

It is that portion of the middle ear that lies between horizontal plates drawn at the top and bottom edges of pars tensa. It contains stapes, long processes of malleus and incus, oval and round windows. The esustachian tube exits from its anterior aspect. While most of the mesotympanum is readily accessible to surgeon, two crescent shaped recesses are extended posteriorly that are often impossible to visualize directly. These spaces, the facial recess and sinus tympani are the most common locations for cholesteatoma persistence after chronic ear discharge surgery.

The epitympanum (attic)

It is that portion of the tympanic cavity that lies above the malleolar folds. Superiorly it is bounded by tegmen tympani, medially by the prominence of lateral semicircular canal and the horizontal part of facial nerve, laterally by the scutum and posteriorly by fossa incudis. It contains the head of malleus, body of incus and their associated ligaments and mucosal folds. The epitympanum lies within a fan shaped dehiscence on the tympanic bone – Notch of Rivinus. It is bounded posteriorly by tympanomastoid line and anteriorly by tympanosquamous line. The tympanic membrane here is deficient of the dense fibre that forms the middle layer of pars tensa. Because the pars flaccida lacks this structural support, it is more prone to retraction in the face of negative middle ear pressure. This helps to explain the propensity for cholesteatoma to form in the epitympanum.

The hypotympanum

It is that portion of middle ear that lies below the floor of bony ear canal. It is an irregular bony groove that is seldom involved by cholesteatoma. Occasionally the bone covering the jugular bulb may be dehiscent in the hypotympanum.

MUCOUS MEMBRANE OF MIDDLE EAR CLEFT

The lining of the middle ear spaces is an extension and modification of the respiratory mucous membrane that lines the nasal cavity, nasopharynx and Eustachian tube. In all these regions the mucous membrane consists of a layer of ciliated columnar cells with a subepithelial layer of connective tissue. A film of mucous clothes the membrane and is replenished by strategically located goblet cells and mucous glands. The mucous film is kept in constant motion by the continuous action of cilia, the direction of movement of the cilia being from the tympanic cavity into the nasopharynx.

A thin delicate mucous membrane lines the whole of middle ear cavity and is reflected onto the ossicles and tendons. It is continuous with the mucous membrane of the mastoid antrum and Eustachian tube. It consists of non-ciliated cuboidal epithelium, two or three cell deep, without a basement membrane, but becomes ciliated columnar type especially near the opening of Eustachian tube and hypotympanum, and changes to flat pavement epithelium in the attic and air cells.

As one progresses from the cartilaginous to the bony portion of Eustachian tube and from the tympanum to the antrum and air cells, the sub epithelial connective tissue becomes thinner until the pavement epithelium and the periosteum together form a thin delicate membrane. The property to produce mucous is largely lost in the pavement epithelium.

These differences in the thickness of the mucous play an important role in the genesis of ‘benign’ tubotympanic otitis media and ‘dangerous’ atticoantral type of disease.

MUCOSAL SPACES OF THE MIDDLE EAR

The mucous membrane is thrown into a series of folds by the intartympanic structures dividing the middle ear into mucosal spaces of surgical importance. The ossicular chain, ligaments, tendons of tensor tympanic and stapedius muscles and the chorda tympani nerve are called the ‘viscera’ of the middle ear and the mucosal folds are the mesenteries.

The attic is almost completely separated from the mesotympanum by the ossicles and their folds except for two small but constant openings called isthmus tympani anticus and isthmus tympani posticus.

The transversely placed superior malleolar fold divides the attic into a small anterior malleolar space which lies above the tensor tympani fold that may prevent cholesteatoma from the attic reaching the anterior mesotympanum and a larger posterior compartment. The posterior compartment is further subdivided by the superior incubal fold into a superior incudal space (lateral to the fold) and a medial incubal space. The entrance into the Prussak's space is usually located between the lateral malleolar fold and lateral incudal fold. This latter fold may arrest the passage of cholesteatoma, through a posterior superior marginal perforation, into the attic.

The interior incudal space

It is limited superiorly by the lateral incudal fold, medially by the medial incudal fold, laterally by the posterior malleolar fold and anteriorly by the interosseous fold, which lies between the long process of incus and upper two thirds of the handle of malleus.

The anterior pouch of Von Troeltsch

Lies between the anterior malleolar fold and that portion of the tympanic membrane anterior to the handle of malleus.

The posterior pouch of Von Troeltsch

Lies between the posterior malleolar fold and that portion of the tympanic membrane posterior to the handle of malleus.

Prussack's space

It is small space lying between the neck of malleus medially and the pars flaccida laterally. It is bounded below by the short process of malleus and above by the fibres of lateral malleolar fold, which fan from the neck of malleus to be inserted along the entire rim of the notch of Rivinus. A cholesteatoma may extend from Prussack's space, under lateral incudal fold, into the posterior mesotympanum.

The mucosal folds may limit the infection to one or several of the compartments in the middle ear and if the disease is thus limited it may be possible to control it in the affected compartment while preserving the integrity and function of the adjacent structures.

From the Prussack's space cholesteatoma may spread in three directions.

Posterior route

This is the commonest route. The extension would be into the superior incudal space lateral to the body of incus which lies in the posterolateral portion of the attic. From here it penetrates the aditus and gains access to the mastoid.

Inferior route

This occurs frequently into the inferior incudal space or posterior pouch of Von Troeltsch into the posterior mesotympanum. Cholesteatoma may then spreads to the region of stapes, round window, sinus tympani and facial recess.

Anterior route

It is less common. Penetration anterior to the malleus head leads to involvement of the anterior epitympanum and supratubal recess. Downward growth into the anterior mesotympanum may occur via the anterior pouch of Von Troeltsch.

Connection between middle ear and mastoid

A seris of mucosal folds and suspensory ligaments, known as the tympanic diaphragm, nearly separates the mesotympanum from the epitympanum and mastoid. The major components of this partition are the malleus head and incus body, lateral and medial incudal folds, anterior and lateral malleolar folds, and the tensor tympani fold. Only two narrow passages anterior and posterior tympani isthmus breach this diaphragm. The anterior tympanic isthmus is larger, lies medial to the body of the incus and passes between the stapes and the tensor tympani tendon. The posterior isthmus is small and lies between the medial incudal fold and posterior tympanic wall. The epitympanum is connected to the mastoid antrum by a small triangular bony passage known as aditus ad antrum.

The clinical importance of this tympanic diaphragm is that it resists the spread of epitympanic cholesteatoma to the mesotympanum and vice versa. Also, the patency of the aditus and antrum and tympanic isthmus is important for aeration of the mastoid.

MASTOID ANTRUM, ADITUS AD ANTRUM AND AIR CELLS

Mastoid antrum

The mastoid antrum and its air cells lie within the petrous portion of the temporal bone. The air filled spaces communicate with the middle ear by way of the attic and some small spaces between the suspensory ligaments of ossicles.

The roof of the mastoid antrum and mastoid air cell space forms the floor of the middle cranial fossa, whereas the medial wall relates to the posterior cranial fossa. Just deep to the aural plate of the posterior cranial fossa is the saccus endolymphaticus, which derives from the endolymphatic duct, which in turn has passed through the vestibular aqueduct of the temporal bone. There are several straight blood vessels running along the temporal bone. There are several straight blood vessels running along the length of the sac on its mastoid surface. Posterior to the endolymphatic system is the sigmoid sinus, which curves downwards only to turn sharply upwards to pass medial to the facial nerve and then become the dome of the jugular bulb in the middle ear space. The posterior belly of the digastric muscle forms a groove in the base of the mastoid bone. The corresponding ridge inside the mastoid lies lateral not only to the sigmoid sins, but also to the facial nerve and is a useful landmark for finding the nerve itself. The periosteum of the digastric groove on the undersurface of the mastoid bone continues anteriorly and part of it becomes the endosteum of the stylomastoid foramen and subsequently of the facial nerve canal.

The outerwall of the mastoid lies just below the skin and is easily palpable behind the pinna. Suprameatal triangle (Mac Ewan’s triangle) is a direct lateral relation to the mastoid antrum and is formed by a posterior prolongation of the line of the zygomatic arch and a tangent to this that passes through the posterior border of external auditory meatus. The mastoid antrum lies 15mm deep to this triangle.

Aditus ad antrum

It is a narrow communicating passage from the upper attic space of the epitympanum into the mastoid antrum. The horizontal semicircular canal lies between its medial wall and the floor and the short process of incus lies on its floor. The facial nerve lies on a plane below and deep to the opening of the aditus from the attic.

Mastoid process

It lies behind the tympanic portion of the temporal bone and on the deeper aspect behind the styloid process. At birth it is flat and the facial nerve which emerges from the stylomastoid foramen is superficial. The development starts with development of sternocleidomastoid muscle around two years of age, continuing till the end of puberty.

During development the mastoid process excepting the antrum is filled with bone marrow which later, in about 80% of cases, becomes pneumatised resulting in a cellular mastoid. In some cases the bone marrow persists, then it is known as diploeic. In a third type the air cells are totally absent, known as acellular or ivory of sclerosed mastoid. The latter two types have relation to cholesteatoma.

The air cells also form in both the petrous and squamous parts of the mastoid and when well developed they may be classified according to the anatomical location into the following groups.

1. Zygomatic – Extending into the root of zygomatic process
2. Tegmen- Spread under tegmen tympani
3. Angle – Sinodural angle
4. Marginal – Behind the sigmoid sinus
5. Perisinus – Over the sigmoid sinus plate
6. Periantral – Close proximity to the antrum
7. Retrofacial – in gallories around the facial nerve or tunneling medial to it to communicate with the middle ear.
8. Perilabyrinthine: Sometimes extending to the petrous apex, perilabyrinthine cells may occur about the arch of the superior semicircular canal (supralabyrinthine); beneath the labyrinthe (infralabyrinthine) or behind it (retrolabyrinthine cells).

9. Tip-Occasionally extending beyond the mastoid tip into the styloid process.

10. Peritubal-Joining the cells in the hypotympanum.

Radiological evidence of pnuematisation is usually not present till the age of three years. The two mastoids are similar except in disease.

FACIAL NERVE

The facial nerve is the nerve of the second branchial arch, which explains its complex and intimate relationship with the middle ear cleft and the ossicular chain. Facial nerve is a mixed nerve containing motor, sensory and parasympathetic fibres.

The facial nerve enters the temporal bone through the porus acousticus and internal auditory canal together with the cochlear nerve, the nervus intermedius and the internal auditory artery and veins, all these structures being ensheathed in a prolongation of the subarachnoid space with its meninges.

At the fundus or lateral extremity of the internal auditory canal the nerve continues with the nervus intermedius, into the bony fallopian canal, which runs laterally above the vestibule (the labyrinthine portion of the facial nerve which is the narrowest part of facial canal, 0.7 mm in diameter at the site of entry) separated from the middle cranial fossa by a thin layer of bone. Upon reaching the medial wall of the epitympanic recess, it bends sharply backwards above the promontory and arches downwards in the medial wall of the aditus to the tympanic antrum. The point at which it bends sharply backwards is the first genu, at which point it manifests a reddish ganglioform swelling, the geniculate ganglion. In some cases the bony roof of the canal is absent so that ganglion is directly related to the dura matter.

From the geniculate ganglion the nerve runs posteriorly and slightly inferiorly in the medial wall of tympanum. Here the bony fallopian canal forms a cylindrical ridge- tympanic course of nerve, lying slightly inferior to the horizontal semicircular canal and superior to the oval window and promontory. The anterior limit of this section of nerve is marked by the processus cochleariformis with its emerging tensor tympani tendon, a valuable landmark.

In the bony floor of the aditus, the nerve makes a gradual bend, the second genu, turning inferiorly 1 or 2 mm behind the pyramid to the commencement of the vertical or mastoid segment. The descending portion of the facial nerve runs directly inferior to the stylomastoid foramen and is surrounded by the mastoid air cells.

APPLIED PHYSIOLOGY

Sound conduction

Sound can be transmitted to the inner ear in one of three ways:

1. By way of the ossicular chain, from the vibrating tympanic membrane to the oval window. This is the most important route.

2. Directly across the middle ear, when waves fall on the round window membrane. This may occur when there is a large perforation of the drumhead.

3. By bone conduction, sound energy is taken up and transmitted to the inner ear through the bones of the skull.

Effective functioning of tympanic membrane and ossicular chain is necessary to conduct sound energy selectively to oval window. They also help to overcome the impedance mismatch between the air and cochlear fluid. The most important factor for efficient impedance transfer mechanism is the difference in the area of tympanic membrane to that of oval window. The effective ratio of these areas is about 14.1. The ossicles themselves constitute a lever mechanism (acting through the rotational axis of malleus and incus) which has a mechanical advantage of 1.3:1. The product of these areal and lever ratios (14 and 1:3) is about 18:1, which represents the transformer ratio of the whole mechanism. By this effect the amplitude of vibration at the stapes is reduced as compared with that of the membrane, while the force exerted by the stapes upon the labyrinthine fluids is increased in same proportion.

The directly measured values of tympanic membrane impedance suggests that some 68% of the incident energy would be absorbed by the cochlea, as against 1% expected in the absence of middle ear transformer. Tensor tympani and stapedius muscle helps in regulation of sound pressure applied at oval window, thus protecting the cochlea from excessively loud sound.

A perforation in the tympanic membrane, describes the resistance offered to the traveling sound wave. Even a small perforation in the posterior part of tympanic membrane can hamper the perception of sound, by reducing the 'baffle' effect of round window, when acoustic separation of this window is lost. Impairment of conductive function of middle ear can occur due to underlying middle ear pathology such as mucosal edema, fluids, granulation, cholestatoma, osteitis and ossicular necrosis.

A cholesteatoma mass or granulations can bridge the necrosed ossicles and increase the sound conduction too. Sensory – neural hearing loss can occur in CSOM probably because of diffusion of toxins from inflammation into scala tympani via round window membrane or serous labyrinthitis. Recent studies indicate that the pathology is confined to the basal turn of cochlea.

Pressure equalization

The middle ear in health should contain air at atmospheric pressure, which is achieved by a normally functioning Eustachian tube. The Eustachian tube allows the passage of air inside of air inside the middle ear by contracting the levator palate muscle, thus dilating the pharyngeal opening and the tensor palate muscle opening the cartilaginous tube during swallowing. The

Eustachian tube also allows the secretions of the middle ear to pass onto nasopharynx and also prevents pharyngeal secretions from entering the middle ear by the action of cilia. Interference of this basic function of the tube in equalization of air pressure may arise from intrinsic or extrinsic causes which affects both the normal physiology of sound conduction and resistance to infection. The Eustachian tube function is deficient in 1/3 of chronically infected ears with cholesteatoma.

When the middle ear is cut off from the atmosphere by blockage of tube, absorption of air initially leads to retraction of tympanic membrane, and further absorption of air promotes exudation from the blood and lymphatic vessels of the mucoperiosteum. This secretion is a ready culture medium for bacteria if the tube obstruction is of long standing, fibrotic changes in the tympanic membrane and the ossicular joint may cause fixation of the membrane. Though the middle ear mucosa is not less effective in controlling middle ear infection than the respiratory epithelium, a malfunctioning Eustachian tube makes it impossible to function normally. Even when the infection is cured, the hypertrophied glands in the middle ear can cause continued otorrhoea, making the ear wet and prone to recurrent infection. A long standing negative middle ear pressure can cause thinning of the tympanic membrane making it more prone for perforation.

Vestibular system

The vestibular sense organ contains three semi-circular canals, the utricle and saccule. Hair cells in the ampulla of canals sense the rotational acceleration of the head in three mutually perpendicular planes. The macular receptors in utricle and saccule sense linear acceleration and static head position in gravitational field. This sensory information is analysed by the brain for balancing the body.

When there is bony dehiscence and the perilymph is only separated by mucosa, spontaneous vertigo occurs. When the labyrinth is invaded by bacteria, a total and permanent loss of vestibular and auditory function of that ear will result, with distressing episodes of vertigo lasting several days, unless treatment is initiated very early in the course of invasion of bacteria. When complete labyrinthine loss in one ear occurs, compensation occurs due to relearning by the other vestibular apparatus and within a few weeks the patient no longer experience vertigo.

IMMUNOLOGY

The role of immune system in middle ear disease has received a considerable amount of attention in the recent years. In essence, the reaction of middle ear to disease process is highly involved with immune response including the immunoglobulins, complement system and the cellular reaction which includes migration factors.

Normally Langerhan's cells are present only in the suprabasal portion of the epithelium, however in the cholesteatoma matrix the Langerhan's cells are situated at various levels within the epithelium. It is believed that Langerhan's cells are able to bind antigens and present them to lymphocytes either in the epithelium or regional lymphnodes. It appears that the Langerhan's cells are able to initiate an immunological response in the presence of antigen, the end product being an inflammatory reaction to its subsequent bone destruction.

As in any part of the body, in the middle ear too, specific antibodies are produced against the chronically infecting organisms. The persistence of organisms in middle ear, even in the presence of specific antibodies is noteworthy.

ROLE OF CHOLESTEATOMA IN DEVELOPMENT OF COMPLICATIONS

Majority of the complications of CSOM are due to bone erosion. Clinical evidence has shown that presence of cholesteatoma enhances the process of bone erosion.

Cholesteatoma may be defined as the presence within the middle ear cleft of a squamous epithelial pocket or sac filled with keratin debris. Three types are recognized.

1. Congenital cholesteatoma

This is an epithelial cyst occurring within one of the bones of the skull (usually the temporal bone) without contact with the external ear. It may occur deep in the temporal bone or in the squama.

2. Primary acquired choelsteatoma

This type of cholesteatoma develops in continuity with the perforation of the pars flaccida of the tympanic membrane. It first fills the Prussack's space and then may enlarge to occupy the attic, mastoid antrum and portions of the middle ear.

3. Secondary acquired cholesteatoma

Usually follows active middle ear infection where the keratinizing epithelium has migrated through a perforation into the middle ear.

Many theories have been proposed, but none as yet has been shown to be entirely causative in this disease. Among the postulates are:

1. Habermann (1889) demonstrated that migration of stratified squamous epithelium from the skin of the meatus through a perforation into the middle ear led to the subsequent development of a secondary acquired keratoma.

2. Bezold (1908) stated that attic retraction type of keratoma was due to Eustachian tube occlusion causing retraction of Sharpnel's membrane into Prussak's space and later into the attic.

3. Wittmack (1933) has shown that persistence of hyperplastic embryonic mucoperiosteum in the attic might cause adhesions to form retraction pockets as the retraction pocket deepens, desquamated keratin cannot be cleared from the recess and cholestatoma results.

4. Ruedi (1963) reported two predisposing factors for the development of acquired keratoma.

The special growth potential of the basal cells in the stratum germinatum in the circumscribed zone of the meatal skin adjoining the upper margin of the tympanic membrane.

Submucous connective tissue layer in the middle ear spaces associated with incomplete pneumatisation of the performed spaces.

5. Wendt (1873) theorized that the simple squamous or cuboidal epithelium of the middle ear cleft could undergo a metaplastic transformation into keratinizing epithelium.

Sade (1971) supported that theory, pointing out that epithelial cells are pluripotent and can be stimulated by inflammation to become keratinizing.

Although the exact mechanism of bone erosion by cholesteatoma is debatable, many theories are postulated.

Chole (1984) has shown evidence that bone resorption is primarily due to action of multinucleated osteaclasts on bone. Although many mononuclear cells (histocytes and fibroblasts) were present in the vicinity of active bone resorption, only multinucleated osteoclasts were seen to disrupt the lamina limitans of bone and cause resorption lacunae.

In order for bone resorption to occur, enzymatic removal of the organic and inorganic components must occur. It is likely that these enzymes are elaborated or activated by the resorbing cells (osteoclasts) in their immediate micro – environment. These enzymes include acid phosphatase, collagenase and acid proteases.

Guasa et al. (1978) demonstrated that the pH of keratin debris within cholesteatoma was acidic which might lead to demineralization of the hydroxyapatite of bone.

Moriyama et al (1984) have shown that keratin itself may induce an inflammatory reaction which leads to locular bone resorption.

The physical effects (pressure) of cholesteatoma may lead to transient electrical potentials and the recruitment of monocytes into the subepithelial spaces. These monocytes may activate the cellular events of bone resorption. Activated monocytes can produce prostaglandin E_2 which is a stimulator of bone remodeling. Other osteoclastic activating factors, such as interleukin 1α and 1β and TNF α and β may be produced, which then lead to localized osteoclastic activity.

ROLE OF GRANULATION TISSUE

Granulation tissue is the natural result of epithelial ulceration and is directly proportional to the persistence of infection. Granulation tissue, believed by some to be atleast more prevalent if not more significant than cholesteatoma, in the natural bulk impairs drainage and its enzymatic production erodes bone. Formation of granulation tissue is a host defence mechanism in response to inflammation. Granulation also forms in response to the presence of cholesterol crystals formed from blood clot and also from oily drops and cholaramphenicol applied as medication. It is a proliferation of fibrous and vascular tissue. These capillaries are surrounded by pericyctes, some of which transform into histocytes. Histocytes predominate in the zone close to bone and this zone is shown to have marked acid phosphatase activity associated with bone resorption. With maturation, granulation tissue becomes more dense with increased collagen and reticular formation. It is self perpetuating in that it reduces the effectiveness of medical therapy and ventilation of middle ear.

RECONSTRUCTION OF THE POSTERIOR EAR CANAL WALL

Reconstruction of the ear canal wall is performed after canal wall-up or canal wall-down mastoidectomy, only part of the bony canal wall is missing, either because of spontaneous resorption. Typically found in attic cholesteatoma, or after partial removal of the ear canal wall in order to eradicate the disease. Sometimes both of these possibilities are present a the same time. In such cases, partial reconstruction of the ear canal wall also called scutumplasty, is performed.

After canal wall-down mastoidectomy, the entire posterior ear canal wall is missing, and it can be either totally or partially reconstructed. In total reconstruction of the ear canal wall, the mastoid cavity can be either ventilated or obliterated. Obliteration can be partial eg: the mastoid tip alone, resulting in a cavity that is only partially ventilated.

In partial reconstruction of the ear canal wall after canal wall-down mastoidectomy, the bridge is usually reconstructed in order to achieve a high tympanic cavity, and in some cases also to ventilate the attic. In cases with a preserved bony bridge. The lateral attic wall is reconstructed using a piece of cartilage or bone to secure ventilation of the attic, and this form of reconstruction of the attic is also used in cases with an absent bridge.

Total Reconstruction with Ventilation of the Cavity

Reconstruction of the ear canal wall with ventilation of the mastoid cavity can be a dubious procedure, especially if ventilation of the cavity is insufficient at any stage following surgery. In such situations the ear canal wall, which has been reconstructed using soft tissue, may retract and adhere to the cavity walls, resulting in an "open" cavity, which is a reasonable outcome. However, in cases where reconstruction of the ear canal wall has been performed using hard tissues, such as autogenous bone or hydroxyapatite, retraction pockets may similarly occur, located between the medical edge of the reconstructed ear canal wall and the drum, resulting in an unstable situation.

RECONSTRUCTION WITH FASCIA

Retroauricular Approach, with Palva Flap

Reconstruction with a Palva flap is possible only via the retroauricular approach. Reconstruction with temporalis muscle fascia is the basic method with the fascia used to cover other grafts in combined graft reconstructions. The principle is to create a tight connection between the drum medially, the bony wall superiorly, the facial ridge inferiorly, and the meatal soft tissues laterally. In addition, canal skin flaps must be place on the meatal aspect o the fascia, and although theoretically this is easy to achieve, practically it is far more complicated, mainly because any pressure on the fascia must be avoided in order to maintain the opening between the tympanic cavity and keep the attic open to ventilate the cavity. For the same reason, any support for the fascia from the attic or from the cavity eg: by filling the cavity with Gelfoam balls, is not desirable, since this may obstruct the attic. However, sometimes this can not be avoided.

After ossiculoplasty and preparation of the ear canal skin flaps used to cover the fascia a few Gelfoam balls are placed in the attic temporarily to maintain the space for ventilation, as well as to support the fascia. A 2 x 3 cm semi-dry and malleable sheet of fascia is placed onto the cavity walls and into the tympanic cavity. Semi-dry fascia is the easiest to handle during placement under the drum remnant; dry fascia has to become softer and malleable in order to be manipulated. The fascia is carefully adapted to the undersurface of the drum. The epithelial flaps are replaced, fixing the fascia, and the flaps are then fixed with Gelfoam balls. The Gelfoam is initially placed over the region of the bridge, to secure a connection between the fasica and the interposed incus and also to avoid lateralization of the fascia in this region. The ear canal is gradually packed with Gelfoam and small pieces of gauze moistened with cortisone and Terramycin ointment. While the fascia is still being carefully adapted to the remaining bony structure of the ear canal. After the ear canal is packed, the fascia is gently pulled laterally and adapted to the canal wall, bringing it as far laterally as possible, so that the posterior ear canal skin flap can cover it from the meatal side. Communication between the tympanic cavity and the mastoid cavity is thus secured, allowing removal of the Gelfoam balls from the attic region.

The self-retaining retractor that held the auricle anteriorly during the retroadricular approach, is now removed. The previously prepared Palva flap is gradually pushed into the cavity, strengthening the posterior canal wall as the auricle is replaced in its original position. Some further packing of the ear canal is required but this should not be too firm in order to avoid displacement of the fascia posteriorly. The auricle is placed in its proper position and the postauricular wound is sutured.

The ear canal pack is not touched until three weeks after he operation when is it removed. The patient is asked to perform the Valsalva maneuver from the fourteenth postoperative day, as long as the Valsalva is positive preoperatively, if no he or she should start after one week. The final situation after a successful operation resembles.

One to six years after reconstruction of the ear canal wall using a Palva flap in 12 prognostically favourable ears with old radical cavities. 19% were dry and 66% had a ventilated cavity.

Smith et al. (1986) performed canal wall reconstruction using a large piece of fascia and a Palva flap, totally obliterating the cavity behind the flap with Gelfoam with relatively good results of 30 patients operated upon, the reconstructed ear canal wall was intact in 53% of cases two years postoperatively, and was within the position normally occupied by the bony posterior canal wall. In the remainder, a variable degree of retraction of the membranous posterior canal wall was noted. This indicates that a significant of Gelfoam can be placed in the cavity.

This reconstruction of the ear canal is an important element of several obliteration techniques.

RECONSTRUCTION WITH AUTOGENOUS CARTILAGE

In total reconstruction of the ear canal wall, autogenous tragal cartilage and allogenous septal cartilage have been used. In contrast to scutumplasty, large pieces of cartilage are needed to reconstruct the entire ear canal wall.

Tragal Cartilage

Even though tragal and conchal cartilage are the most commonly used graft materials in scutum plasty only small series have been published using tragal cartilage.

Endaural approach. Eviater (1978) reconstructed the ear canal wall in ten cases using tragal cartilage and perichondrium after conservative radical surgery. In the endaural approach, the canal skin is elevated and widely preserved. A compound cartilage – perichondrium graft with the perichondrium partially elevated from one side is placed in the original position of the ear canal wall in contact with the head of the malleus. The perichondrium is then placed as an underlay graft under the drum remnant closing the perforation. The skin flaps are replaced and the ear canal is thus partially reconstructed. Laterally, there is still a defect that needs to be covered. In Eviatar’s method, it is evident that the tragal cartilage cannot reach from the superior to the inferior cavity wall, and additional tissue, eg: a large piece of fascia, is required to cover the defect between the tragal cartilage and the facial ridge.

Retroauricular approach : Tragal cartilage is used as a compound graft in reconstruction of the ear canal wall when performing obliteration of old radical cavities. (Tos 1977. Siim and Tos 1987), but in some cases the author has reconstructed the ear canal with tragal cartilage in order to ventilate the cavity in the following way : A tragal cartilage of maximum size is harvested and the perichondrium is elevated from the concave meatal side so that perichondrium is still connected to both edges of the tragal cartilage. This perichondrium fixes the tragal cartilage to the meatal side of the remaining ear canal wall and cavity wall. Perichondrial flaps are similary elevated from the outer aspect of the tragus and are used to fix the cartilage inferiorly onto the mastoid side of the facial ridge and to the cavity wall. After the tragal cartilage has been placed between the facial ridge and the anterosuperior wall of the cavity, and after perichondrial flaps have been placed and adapted onto the meatal sides of the ear canal, the perichondrium fixes the tragal cartilage to the mastoid side of the facial ridge. Fascia covers the drum perforation and the entire ear canal wall. The epithelial flaps are replaced and the upper edge of the tragal cartilage is further secured by placing a small Palva flap into the cavity.

In the present author's opinion, this method of reconstructing the ear canal wall using autogenous cartilage, Palva flap, and fascia is an important element of several obliteration techniques and can be applied to cover all allogenous material even autogenous bone.

RECONSTRUCTION WITH ALLOGENOUS CARTILAGE

Reconstruction of the ear canal wall is also performed using allogenous septal cartilage.

Septal Cartilage

Smyth and Dowe (1971) introduced allogenous septal cartilage as a method of reconstructing the ear canal wall in order to ventilate the cavity. An appropriately sized piece of allogenous septal cartilage preserved in 70% alcohol for two to six weeks is cut and shaped to fit exactly into the defect of the bony ear canal wall. This can be done most easily and without wasting valuable cartilage by first making a template from a piece of sterile metal foil such as that used in suture material packing. Once the cartilage is shaped it then needs to be worked so that it adapts to form a curve matching the contour of the normal ear canal wall. This can be achieved by thinning and cross-hatching. The cartilage is then inserted into slots already cut into the superior cavity wall along the zygomtic root and inferiorly along the facial ridge. The slots are made with a 2mm diamond burr. The superior slot starts at the junction of the attic wall with the anterior meatal wall, and passes laterally. The inferior slot starts just lateral to the facial nerve, and continues along the facial ridge. After ossiculoplasty and closure of the drum perforation with an underly tascia graft the previously trimmed septal cartilage is placed into the slots in such a way that it remains concave towards the meatus in the same way as the normal ear canal. Sufficient communication between the tympanic cavity and the mastoid cavity – the artificial aditus – must be secured. Smyth lined the space with a thin silastic sheet in order to maintain its patency.

The fascia covers the perforation as well as the meatal surface of the septum. The lateral third of the cartilage can be covered with a small Palva flap.

Of 10 cases operated on the cartilage was displaced posteriorly into the cavity in two cases when a lateral periosteum – subjects flap had not been used. A fistula developed through the septum in the case and this was closed secondarily. In the remainder of the cases the shape of the new year canal appeared to have been maintaining to a large degree at follows up 2-2 ½ years after surgery.

Pappas et al (1981) used septal cartilage in the reconstruction of the ear canal and in scutumplasty. They advocate incision of the cartilage with several parallel-placed V-notched incisions through two-thirds of its thickness on the convex side, in order to increase its flexibility so that the cartilage will adapt to the curvature of the defect, as illustrated.

Strauss (1974) used exactly the same technique as Smyth and Dowe, with superior and inferior grooves and a large septal cartilage graft, stored in Cialit (otimerate sodium). He performed small incisions on the mastoid aspect of the cartilage in order to achieve convexity. Using a palva flap on the mastoid aspect of the cartilage and a large piece of fascia on the meatal aspect, the septal cartilage was extruded in only 5% out of 40 operated ears. In two patients fistulas were found at the junction between the septal cartilage and the skin, and this could be avoided by using a Palva flap behind the septal cartilage.

Information is needed on the late results of ear canal reconstructions using allogenous septal cartilage.

MASTOID CORTICAL BONE

Mastoid cortical bone has been used by Portmann (1966). Ekval (1973), Pou (1977), Magtan et al. (1991) and others. The problem in ear canal wall reconstruction with mastoid cortical bone is the need to harvest sufficiently large pieces of the cortical bone to be shaped as an ear canal and placed into two grooves in the cavity walls. This can be impossible in cases with previous mastoidectomy and previous radical operations. The other problem is the shaping of the bone which is technically difficult and time-consuming. During shaping, the edges of the cortical bone can fracture, and the new ear canal can become too small.

Using a retroauricular approach. Ekvall (1973) elevates a large musculoperiosteal flap, based both superiorly and inferiorly, and consisting of part of the temporalis muscle, fibrous tissue, and periosteum from the mastoid process. This double – based flap is elevated and held in place anteriorly with a self retaining retractor. Then a large piece of bone is harvested using a thin, straight broad chisel. After elevation of large inferiorly and large superiorly pedicles ear canal skin flaps a canal wall-down mastoidecotmy is performed. After ossiculoplasty, grooves are drilled along the superior border of the cavity and along the facial ridge. The cortical bone is shaped and placed as the new ear canal wall into the grooves. The musculoperiosteal flap is placed over the lateral part of the new bony ear canal, and forms the lateral part of the ear canal itself. Finally, the perforation and the new ear canal wall are covered with fascia or perichondrium, and the epithelial flaps are replaced. Ventilation through the isthmus is maintained by a large piece of Silastic, extending from the tympanic cavity through the isthmus to the mastoid cavity. Ekvall (1980) has abandoned this method, and prefers firm obliteration of the cavity. His reason for changing the method was the frequency of retraction around the medial edge of the newly formed ear canal wall and the lack of ventilation of the mastoid cavity, despite extensive use of Silastic sheeting, Magnan et al.

(1991) prefer an ear canal made of mastoid cortical bone rather than cartilage in the reconstruction of old radical cavities. This ensures good viability for the covering skin, but late results are again lacking.

Iliac Crest Bone

The use of autogenous iliac crest bone was introduced by Schiller in 1961, mainly to obliterate the mastoid cavity, but the iliac crest has also been used in ear canal reconstruction in order to ventilate the cavity. The bone harvested from the iliac crest is large enough to be shaped to the proper size of the bony ear canal even in cases with a very low facial ridge.

Bone Pate

Autogenous bone paste, allogenous lyophilized dura, and allogenous tympanic membrane with a malleus-incus block are used in a sophisticated method described by Perkins (1976) of reconstructing the ear canal with bone pate placed in a retainer made of allogenous dura. The technique is a follows : Endaurally, an anteroinferiorly based ear canal skin flap is created by incising the canal skin close to the annulus going over the facial ridge and then back through the inferior part of the cavity laterally towards the 6-O'clock position. Similarly an anterosuperiorly based skin flap is created by continuing the incision along the annulus laterally towards the mastoid tegmen and then further laterally toward the 12 O'clock position. Before a retroauricular incision is performed a 3 x 4 cm piece of fascia is obtained from the lateral surface of the temporalis muscle through a separate incision superior to the pinna. After a retroauricular incision, a large amount of bone pate is collected using a special facility described by Perkins. The bone pate is passed through a piece of fine rayon, supported by a stainless steel mesh strainer. Excess fluid is gently squeezed from the pate by twisting the rayon. After the cavity has been entered the superior and inferior ear canal skin flaps are elevated the tympanic cavity is cleaned the annulus is removed and the tympanic cavity is prepared for the allograft drum ossicle block which is placed in the tympanic cavity. The allogenous drum is attached with its fibrous cuff placed on the denuded bone around the tympanic cavity area. The dried temporalis fascia is then shaped to fit the curve of the anticipated posterior ear canal wall, and placed so that it lies adjacent to but not overlying, the pars tensa of the allograft tympanic membrane. This fascia lies anterior to the long posterior cuff of the allograft.

When the allograft drum – ossicle bloc is being placed, attention should be given to attaching the lenticular process to the patient's stapes or – if the stapes is absent – to the footplate area liniking the allogenous long process of the incus to footplate with a columella.

Behind the fascia, a large piece of allogenous dura is preshaped to the curve of the posterior canal wall and placed so that it serves as a retainer for the bone paste. Several adjustments have to be made until the piece fits anteriorly at the mastoid tegmen and inferiorly at the facial ridge. Using a small elevator the bone pate is introduced into the dural mold. Perkins mixed the pate with a small amount of the patient's own blood. But today allogenous fibrin glue is used instead of blood. After the dural mold has been filled with bone paste the superior and inferior skin flaps are replaced. The postauricular incision is sutured and the ear canal is packed with Gelfoam soaked with chloramphenicol and then gauze.

Twenty five cases were evaluated with respect to the reconstruction of the ear canal wall. The wall was completely intact in 80% of cases while minor defects were present in 12% and major defects in 8%. The reconstructed ear canal wall was hard and had all the characteristics of normal bone. Long term follow-up of the earliest patients indicates that one the wall is mature and firm. There is no evidence of resorption over five years. However, systematic late results are needed. Re-perforation of the allograft drum was reported in 18% and in 12 cases a second – stage procedure was performed. This re-perforation rate is unacceptably high. This very sophisticated but interesting ear canal reconstruction method can be 'modernized' using fascia lata instend of allogenous drum. Also laterally an anteriorly – based Palva flap provides better support for the ear canal.

Bone pate is used for reconstruction of the scutum and is currently widely used in various obliteration methods.

ALLOGENOUS EAR CANAL WALL TRANSPLANTATION

In the mid 1970s, transplantation of an entire allogenous posterior ear canal wall; together with the drum and attached malleus was performed (Below 1975, Smith 1975) in cases with a previous radical operation that had resulted in an extremely large matoid cavity and high facial ridge. The allogenous ear canal wall is harvested with the attached tympanic membrane and malleus, and a generous periosteal cuff. The advantage of this type of graft is that the relationship of the scutum to the tympanic membrane is anatomically correct, and the shape of the allogenous posterior canal wall is perfect. After a postauricular incision, a large temporalis fascia graft is harvested, and an anteriorly pedicled Palva flap is prepared. After removal of the mastoid cavity lining the ear canal, skin flaps are elevated over the facial ridge and over the mastoid tegmen, creating large superior and inferior ear canal skin flaps, similar to the flaps created by Perkins. The mastoid cavity is revised, all residual disease is removed, and the drum remnant together with the residual fibrous annulus is removed. The canal skin adjacent to the drum is elevated and preserved to eventually cover the allogenous drum. The allograft annulus is positioned in the bony sulcus, the periosteal cuff is approximated to the ear canal, and the anterior tympanomeatal angle is created by placing the periosteal cuff carefully on the bony ear canal wall. The precisely trimmed allograft ear canal wall is placed in position, touching the smoothed wall of the cavity superiorly and the facial ridge inferiorly. The periosteal cuff covers the junction between the facial ridge and the allograft ear canal wall. A large piece of fascia is placed over the allogenous ear canal wall. The ear canal skin flaps are replaced, and the canal is packed with Gelfoam and gauze.

In some cases, the cavity was obliterated behind the reconstructed ear canal wall by placing a larger Palva flap that lined the cavity walls Smith (1975) used these techniques in 16 consecutive patients. 12 of whom developed an air containing middle ear space. The long-term stability of the reconstructed allogenous ear canal wall has not been described. Plester (1970) and Portmann (1979) have also used allogenous ear canal wall and allogenous drum. But both soon abandoned the method.

RECONSTRUCTIONS WITH BIOCOMPATIBLE MATERIALS

All allogenous materials have to be covered on the meatal side by an autogenous graft, such as fascia perichondrium periosteal flap, canal skin or Palva flap. The same is the case in reconstructions using biocompatible materials.

Proplast

Shea and Homsy (1974) were the first to introduce this porous plastic into middle ear surgery, particularly in ossiculoplasty. The important property of Proplast is its porus structure, which allows living tissue to infiltrate it leading to effective integration and biocompatibility. However porous plastic prostheses tended to extrude even when covered with cartilage. In reconstruction of the posterior ear canal, a large piece of proplast is shaped to the contour of the natural ear canal and placed in the same way was in reconstruction with an allogenous ear canal. However, because of granulation formation on the meatal side and lack of epithelialization. This method has not been used by other surgeons.

Biocompatible Glass Ceramic Material

Cervital has been used in some centres for ossicular reconstruction. Reck (1985) used Ceravital (produced by Xomeed, Jacksonville, Florida) to reconstruct the ear canal and reventilate the cavity, Few other surgeons have used this material (Zollner and Busing 1986).

Bioglass and Ceravital protheses have the disadvantages of being nonporous materials and are less easy to drill into specific shapes. The material has been more or less abandoned.

Glass Ionomer Cement

Complete or partial reconstruction of the ear canal wall with ventilation of the cavity using glass ionomer cement (Ionos, Seefeld, Germany) was carried out by Geyer and Helms (1992) on 57 ears after canal wall down mastoidectomy. Using a retroauricular approach, a Palva flap is first elevated: this is to cover the cement on its meatal side. The cement is activated after a ear canal skin flaps, ossiculoplasty with a glass ionomer cement prosthesis, and myringoplasty with perichondrium. The cement is premolded to serve as an ear canal wall and then placed between the roof and the floor of the auditory canal. The cement hardens, and can be neatly fixed in place, making direct contact with the adjoining bone. Two silicone tubes are temporarily placed in the central attic region to serve as spacers ensuring communication between the newly created cavity and the tympanic cavity.

It has however, been questioned whether covering this allogenous material with perichondrium alone is sufficient. Ear canal granulation may result and late results are therefore needed.

Hydroxyapatite

The ear canal wall can be reconstructed with porous hydroxyapatite ceramic. This material has a macroporosity of 30% and a microporosity of less than 5%. The size of the microspores is approximately 3μm. Three sizes of hydroxyapatite ear canal wall are available, varying in length from 17mm to 21mm. The skin flap is retracted outward providing a good view of the cavity. Ear canal skin flaps are created superiorly and inferiorly. The superfluous cavity skin is removed, the mastoid cavity is cleaned.

And the tympanic cavity is prepared for reconstruction. Two grooves are made, one superiorly in the zygomatic root, and the other inferiorly along the facial ridge. Using a diamond burr, the hydroxyapatite ear canal wall is drilled to the exact length required. Along the facial ridge, the ear canal has to be shaped individually. Grote uses special instruments to measure the length and depth of the ear canal. The hydroxyapatite ear canal wall is placed in the grooves, providing a large tympanic isthmus. The ossiculoplasty is performed, and the drum is reconstructed with a large vein or fascia as an underlay graft, also covering the meatal surface of the hydroxyapatite. The musculoperiostal flap is placed on the meatal side of the hydroxyapatite . The laterally based epithelial flap is replaced, as are the inferior and superior ear canal skin flaps, and the cavity is packed.

In 30 patients with preoperative dry cavities reconstructed using this technique, no extrusions were found 3 ½ years after surgery. The meatal aspect of the hydroxyapatie was lined by epithelium, and the mastoid cavity was aerated in most cases. The reason for the good ventilation in that the new ear canal wall is placed laterally and posterirly, allowing the tymphanic membrane to be placed more laterally, which gives a widely opened tympanic isthmus and prevents obliteration of the tympanic cavity. It is important to cover the hydroxyapatite with a periosteum – subcutis flap and to have healthy cavity epithelium.

The porous type of hydroxyapatite is recommended for canal wall reconstruction where tissue penetration is desirable. In hydroxyapatite prosthesis, the ingrowth and remodeling capacities have been experimentally documented. The dense type of hydroxyapatite is most suitable for ossicular reconstruction (Hormann and Donath 1987, Lenis 1990), where tissue penetration should be minimized.

Precise reconstruction using the hydroxyapatite ear canal wall implant requires considerable reshaping of the prostheses, resulting in delay and occasionally breakage, and Black therefore (1991) recommends using a thin aluminium foil template to obtain a precise fit. After preparation of the cavity a deep groove is made in the root of the zygoma to allow the implant to engage deep into the bone for stability and to avoid retractions. The aluminium foil is cut to size, then molded to cover the convex surface of the required wall. The curved foil is trimmed with scissors until the shape that precisely fits the canal wall defect from the anterior attic to the facial ridge is obtained. The curved template is placed over the implant, and the latter is drilled to the appropriate shape. The implant is then placed in situ, and any final adjustments are made. The small defects are sealed with bone pate. The implant can also be stabilized with hydroxyapatite fragments or bone chips. The meatus is lined with fascia or periosteal flaps and is covered with the previously preserved cavity lining skin flaps.

Recognising that the hydroxyapatite ear canal wall has to be covered on both sides – the meatal side and the mastoid side – with well vascularized autogenous tissue and that previous techniques based on free grafts or on local flaps are of suspect vascular adequacy, Black and Kelly (1994) recently published a method of revascularization of the underlying grafts. They suggested a temporal pericranial flap, which introduces a vascular supply directly to the site of the canal wall defect.

The nerve vascular supply is provided by a superiorly based pericranial flap consisting mainly of periosteum deep to the temporal muscle, and including the middle temporal artery, which is a branch of the internal maxillary artery. The size of the flap can be adjusted according to the extent of the canal wall, but normally extends about 4cm above the linea temporalis to allow for some retraction. The flap can be combined with a Palva flap, if desired.

After a posteriorly based retroauricular incision through the subcutaneous tissue and along the lower border of the temporalis muscle, a Palva flap is elevated and held in place with a selfretaining retractor. The periosteum is then carefully elevated from the mastoid plane posteriorly. After elevation of the temporalis muscle, the periosteal incision is continued superiorly, demarcating a flap which includes the middle temporal artery. The flap is elevated and pushed with a periosteal elevator in an inferior direction periosteal elevator in an inferior direction resulting in a large periosteal flap with some attached fibres of muscular tissue and the temporal vessels. The hydroxyapatite flap is placed in the grooves as described previously, and after tympanoplasty and ossiculoplasty the drum perforation is closed with an underlay fascia graft extending over the medial half of the hydroxypatite ear canal graft. The periosteal flap is pulled anteriorly to cover the entire meatal surface of the graft and finall the Palva flap is placed on the mastoid side.

The technique of harvesting this flap is similar to the technique the author has already used, the only difference being that the periosteum flap is used as a free graft in contrast to the Black technique, where it is pedicled anterosuperiorly. The Black technique is an improvement on other reconstruction methods, because additional autogenous tissue is introduced. In the Black technique, the fascia can be harvested from the outer layer of the temporalis muscle and the periosteum, as well as the Palva flap, can be raised from the mastoid process and under the temporalis muscle region. Finally, the temporalis muscle flap can also be used if obliteration is needed. It is true that the small vessels of the middle temporal artery supplying the periosteal flap can be damaged while it is being elevated, but more important is the side of the hydroxyapatitie with the Palva flap on the mastoid side. This is in contrast to the Grote technique, which has no covering at all on the mastoid side, and very little covering on the meatal side.

Black uses a small perichondrium – cartilage graft instead of bone pate, as described previously in order to close the small fissure between the drum and the ear canal. After replacing the ear canal skin flaps, the ear canal is packed with fine Silastic strips.

In Black's series of 62 cases after an average follow up of 18 months (five months to four years) dehiscence rate of hydroxyapatite wall implants was 10%. Subsequent to the use of the periosteal flap, no dehiscence occurred, but three implants were removed due to immediate or delayed infection.

The characteristics feature of all of the methods of ear canal wall reconstruction with ventilation is that the results are based on small series and short observation periods. Usually, the methods using allogenous materials and knee cartilage, ear canal wall, lyophilized dura) and biocompatible materials have been used by their inventors alone and these methods are still waiting to be confirmed by other surgeons. However, the techniques of reconstruction using autogenous tissues described can be used in connection with obliteration. A proper ear canal wall reconstruction is always an important part of any obliteration.

MATERIALS AND METHOD

50 patients who attended ENT Department, Govt Rajaji Hospital, Madurai from June 2006 to September 2008 were included in this study.

The diagnosis of chronic suppurative otitis media – atticoantral pathology with or without cholesteatoma or granulations was made on clinical grounds.

SELECTION CRITERIA:

- Chronic suppurative otitis media
- Atticoantral pathology – retraction or perforation
- Posterosuperior marginal pathology – retraction / perforation
- Cholesteatoma or granulations.
- Secondary acquired colesteatoma.

EXCLUSION CRITERIA:

- Age less than 5 years.
- Age above 40 years.
- Pregnant and lactating women
- CSOM- Tubotympanic type.
- CSOM with intracranial complications.

All patients were explained about the disease and the benefits and side effects of the procedure. Informed written consent was obtained before the initiation of the study.

All patients were evaluated as follows:

1. History.
2. General examination
3. Systemic examination
4. Otorhinolaryngological examination
5. Investigations

    -Complete hemogram

    -Urine analysis

    -Blood sugar, urea, serum creatinine

    -Aural swab culture & sensitivity

    -X-ray both mastoids

    -Pure tone audiogram

    -CT- temporal bones.

6. Assessment of the patient under general anaesthesia.

SURGICAL PROTOCOL AND METHODOLOGY

Canal wall down mastoidectomy was planned.

Materials used for the reconstruction of posterior canal wall:

- **Mastoid cortical bone.**
- **Conchal cartilage.**

The above mentioned grafts were selected as needed to the individual case. During mastoidectomy anterior and posterior butress was removed. complete disease clearance was done. A groove was made in the posterior buttress using 0.6 mm burr. The harvested graft material was tailored for the reconstruction of posterior canal wall. Temporalis fascia graft and periosteal graft was used to layer on the reconstructed posterior canal wall. Ossicular reconstruction was done if needed according to the case. The procedure was completed with a tympanoplasty.

Post operatively the patients were treated with appropriate antibiotics, analgesic antiinflammatory drugs and decongestants. Patients were discharged one week postoperatively.

FOLLOW UP:

- Mastoid cavity pack removal on post op day 2.
- Post auricular wound suture removal on post op day 7.
- External auditory canal pack removal on post op day 21.

- Oral antibiotics for 21 days.
- Antihistaminics for one month.
- Antibiotic drops for 2 months.
- Monthly once follow up for a period of 6 months.

POST OP RESULT ASSESSMENT:

1. Symptoms:

*discharge from operated ear.

*hearing improvement.

2. Clinical findings.

3. Otoendoscopic finding.

4. **Pure tone audiogram** at the end of third month post operatively.

The data so collected was analysed and the same discussed here.

ANALYSIS OF RESULTS

1) PATIENT PROFILE

Age	Number of Patient
05– 20 Years	35
20 – 30 Years	7
30 – 40 Years	8

Out of 50 patients majority of them were from 5-20 yrs.

Sex of the Patient	Number of patients
Male	35
Female	15

Out of 50 patients, 35 were male and 15 were female.

2) PRE-OPERATIVE HEARING LOSS

Hearing loss	Number of patients	Percentage
Moderate to Severe conductive hearing loss	30	60
Moderate CHL	20	40

Out of 50 patients 30 had Moderate to Severe conductive hearing loss and 20 had Moderate conductive hearing loss preoperatively.

3) GRAFT MATERIAL

Graft material	No of patients	Percentage
Mastoid cortical bone	35	70
Conchal cartilage	15	30

In 70% of patients Mastoid cortical bone graft was used and for the rest conchal cartilage was used for reconstruction of posterior canal wall.

4) PER-OPERATIVE FINDING

Disease pathology	No of pts	Percentage
Cholesteatoma alone	33	66
Cholesteatoma +granulation	17	34

33 patients had Cholesteatoma alone whereas Cholesteatoma and granulation was present in the rest 17 patients.

5) POST OPERATIVE COMPLICATIONS

Complications	No of patients	Percentage
Nil Complications	40	80
Recurrence of ear discharge	5	10
No significant improvement in hearing or deterioration	5	10

6) POSTOPERATIVE HEARING

Post operative hearing	No of patients	Percentage
Improvement	45	90
No significant improvement in hearing	3	6
Deterioration in hearing	2	4

7) REQUIREMENT OF REGULAR POST OPERATIVE FOLLOW UP

Post op follow up	No of patients	percentage
Nil follow up required	40	80
Regular follow up required	10	20

DISCUSSION

A similar study was conducted at Baltimore medical center and published in Archives of Otorhinolaryngology – Head and Neck Surgery 2006:132; 617 – 623. It was a retrospective review of a case series over a 21 year period, the study population being 20 patients aged 12 – 60 years. Reconstruction of the canal wall was with bioactive glass ceramic.

In that study prosthetic walls had remained intact in 16 patients. Prosthesis removal was required in 3 patients because of infection and displacement. In one patient a 5 db sensorineural hearing loss was recorded.

The most recent audiogram available, obtained 7.7 ± 5.8 years (range, 0.3-17.8 years) after reconstruction, revealed a mean air PTA of 43.9 ± 20.5 dB HL, bone PTA of 16.8 ± 13.8 dB HL, and air-bone gap of 27.1 ± 11 dB HL. Compared with the prereconstruction audiograms (mean air PTA of 52.3 ± 20.6 dB HL, bone PTA of 15.5 ± 13.6 dBHL, and air-bone gap of 36.8 ± 14.6 dB HL), this represents a significant improvement (reduction) in air PTA ($P = .03$) and air-bone PTA gap ($P = .004$), with no significant change in bone PTA ($P = .20$).

In our study posterior canal wall reconstruction was done using mastoid cortical bone graft and conchal cartilage.

About 90% of patients had improvement in hearing. Preoperative hearing was an air bone gap of 35 +/- 10 db and postoperative air bone gap reduced to 25 +/ - 7 db. In this study air bone gap has improved by 7-10 db. 6% had no significant improvement in hearing and 4% had deterioration in hearing.

90% had no problem of recurrence of ear discharge, whereas 10% had recurrence of ear discharge. No regular follow up was required in 80% of patients. Hence there is a significant improvement in hearing post operatively. As well as recurrence of ear discharge was present only in minimal number of patients.

CONCLUSION

This study – **“A DISSERTATION ON THE COMPREHENSIVE ANALYSIS OF POSTERIOR CANAL WALL RECONSTRUCTION TECHNIQUES ON PATIENTS UNDERGOING CANAL WALL DOWN MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA”** was carried out in the Dept. of ENT Govt Rajaji Hospital Madurai during the study period of June 2006 to Dec 2008.

This study consists of detailed history, preoperative investigations, surgery, postoperative follow up and evaluation and statistical analysis of data.

- Total number of 50 cases of CSOM with Atticoantral / postero superior marginal pathology were surgically treated and evaluated.
- Goals of surgical management of CSOM is eradication of disease, restoration of hearing and to an extent possible maintenance or restoration of a normal anatomical configuration.
- Reconstruction of posterior external auditory canal after canal wall down mastoidectomy creates an aerated mastoid cavity that is contiguous with the middle ear space.
- It recreates an anatomical configuration similar to that which results from intact canal wall mastoidectomies.

- Hence there is significant improvement in hearing post operatively.
- In addition there is nil cavity problems. Regular follow up for cavity cleaning is not required.
- As the disease is removed after canal wall down procedure, complete disease clearance could be achieved.
- Hence ear is free from discharge or residual disease.
- Recurrence of disease is also rare.

Hence canal wall down mastoidectomy with posterior canal wall reconstruction is a better option. This technique has the advantage that complete disease clearance could be given as we do the canal wall down technique. As we also reconstruct the posterior canal wall, the complications such as post operative cavity problems, hearing impairment could be averted.

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DISSERTATION - PROFORMA

COMPREHENSIVE ANALYSIS OF POSTERIOR CANAL WALL RECONSTRUCTION TECHNIQUES ON PATIENTS UNDERGOING CANAL WALL DOWN MASTOIDECTOMY FOR CHRONIC SUPPURATIVE OTITIS MEDIA.

PATIENT DETAILS : **[PATIENT NO:]**

NAME :
AGE / SEX :
ADDRESS :

CONTACT NO. :
OCCUPATION :
D OA/ IP NO. :

HISTORY :

PRESENTING COMPLAINTS:-

1) Ear discharge :- Side
Onset
Duration
Amount

Type of discharge
Aggravating / relieving factors
Response to treatment

2) Hard of hearing :- Side
Acute / insidious
Nature – mild / Mod / Mod-Sev / Profound
Progressive / continuous /intermittent
Whether handicapping for him - Y / N
Family History - + / -
H/o trauma to ear
H/o exposure to loud noise

3) Ear ache :- Side
Onset
Progressive / stationary
Continuous / intermittent
Nature of pain
Aggravating / relieving factors

4) Vertigo:- Onset
Duration
Associated nausea / Vomiting

5) Tinnitus
6) Fever
7) Head ache
8) Facial weakness

- **Relevant Past History:-**

GENERAL EXAMINATION

GC --

CVS --

RS --

EXAMINATION OF EAR:-

	Right	**Left**
1. Preauricular area		
2. Pinna		
3. Postauricular		
4. Ext. auditory canal		
5. Tympanic Membrane		
Colour		
Lustre		
Retraction		
Perforation		
- Size		
- Quadrant		
Cholesteatoma		
Others		
6. Mastoid tenderness		
7. Tragal tenderness		
8. Fistula test		

9. Facial.N testing
10. Tuning fork test

    Rinne

    Weber

    ABC

11. Romberg's sign

<u>EXAMINTATION OF NOSE, ORAL CAVITY & OROPHARYNX:-</u>

DIAGNOSIS:

Chronic Suppurative Otitis Media:-

_________________ Ear

_________________ Type

_________________ Stage

_________________ hearing loss

_________________ Complications

PRE – OP EVALUTION:-

1) Pure Tone audiogram :- R →

L →

Air bone gap

2) Plain X Ray Both Mastoids:-

3) CT – Temporal Bone :-

SURGERY:-

Canal Wall down Mastoidectomy with posterior Ear Canal wall reconstruction – Side

Date :-

Anas:-

D/B :-

A/B :-

Reconstruction Material:-

Peroperative Finding:-

POST OPERATIVE FOLLOW UP

Date:

1) Post auricular wound suture removal :-

2) EAC pack removal :-