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Otorhinolaryngology

Comparison of Outcome of Tympanoplasty with or without Mastoidectomy

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Abstract **Original Research Article**

Chronic suppurative otitis media is a common condition seen in patients attending the otolaryngology clinic. The discharging ear presents to the otologist with the dilemma of operating on it or not. This is due to wide spread belief that the success rate while doing tympanoplasty on wet ear varies. Whether mastoidectomy is useful in tympanoplasty for perforated chronic otitis media (COM) remain controversial. Despite the high success rate and the nature of the procedure, the effect of many influencing factors remains unresolved. These include the age of the patient, site and size of perforation, length of time the ear has been dry prior to surgery, the presence of infection at the time of surgery and the status of the opposite ear. The purpose of this study is to ascertain whether the mastoidectomy should be combined as a standard operating procedure for closing central perforations in safe type of chronic suppurative otitis media or not so as to achieve acceptable functional status postoperatively and hence minimize graft failure. A total of 132 patients were included in the study and divided into two group (66 in each group A and B). The age group was between 15-60 years. Most of them were in the age group of 31-40 years. In this male: female ratio was 1.06. All the patients presented with ear discharge and decreased hearing. The conclusion drawn were: Hearing improvement following tympanoplasty alone and tympanoplasty with mastoidectomy were comparable. No statistical difference was found in either of the two groups. Combining Mastoidectomy with tympanoplasty will not give additional significant benefit in terms of hearing improvement or disease clearance. Mastoidectomy procedure will result in additional surgical time without added benefit. Mastoidectomy may be considered in following situation: 1) If ear continue to discharge after adequate medical treatment**.** 2) In presence of polyp/polypoidal middle ear mucosa or granulation tissue in the middle ear. 3) Infection also represents a very important cause of graft failure and can result from a hidden mastoid disease. A simple mastoidectomy is an effective means of repneumatising the mastoid air cell system as well as eradicating the mastoid source of infection.

Keywords: Tympanoplasty, Mastoidectomy, otolaryngology clinic.

INTRODUCTION

Chronic suppurative otitis media is a common condition seen in patients attending the otolaryngology clinic. The discharging ear presents to the otologist with the dilemma of operating on it or not. This is due to wide spread belief that the success rate while doing tympanoplasty on wet ear varies [1].

Despite the high success rate and the nature of the procedure, the effect of many influencing factors remains unresolved. These include the age of the patient, site and size of perforation, length of time the ear has been dry prior to surgery the presence of infection at the time of surgery and the status of the opposite ear [2]. Whether mastoidectomy is useful in tympanoplasty for perforated chronic otitis media (COM) remain controversial. There are 3 positions on this issue.

- The first is that mastoidectomy is useful for both infected and dry ears.
- The second is that mastoidectomy is useful for infected ears, but not for dry ears.
- This third is that mastoidectomy is not useful for either infected or dry ears [3].

The two opposing demands of tympanoplasty namely removal of all disease process and at the same time trying to maintains as much of normal tissue as possible to facilitate reconstruction of normal hearing mechanism. As long as there is infection present in and around the middle ear cleft and mastoid antrum, any

attempt at reconstruction may seem futile. In this context cortical mastoidectomy seems to be an integral part of every tympanoplasty [4]. The safe variety or mucosal chronic otitis media carries no serious risks. Disease affects mainly the mucosa of mesotympanum, hypotympanum and eustachian tube so considered as tubotympanic.

In contrast, the unsafe variety i.e. active chronic with cholesteatoma; threatens the hazard of spread of infection intracranially. This disease is associated with erosion of surrounding bone. It involves the attic perforation or posterosuperior retraction pocket with cholesteatoma / granulation and pus and so anatomically it is described as atticoantral.

In the safe type the perforation is central. No matter how large is the perforation; there is always a rim of drum or even just its annulus around perforation. Discharge from the safe variety arises from the inflamed and secreting mucosa of the middle ear and is intermittent, mucopurulent, non-foul smelling, moderate to profuse, non-blood stained discharge and is aggravated with episodes of upper respiratory tract infection. Diagnosis is made by examining the ear drum by otoscopy and ideally under an operating microscope.

In safe ears, the aim is to eliminate discharge and possibly to assist hearing deficit. Drying is achieved by treating infection or allergy in the upper respiratory tract. Swab culture will indicate appropriate antibiotics to be given systemically. After regular gentle toilet to remove infected discharge and debris from the meatus, topical antibiotics and steroid drops should be massaged into the middle ear by pressure on the tragus for about 5-7days. Systemic antihistamines may also be part of the regimen, to reduce allergic swelling of the mucosa around the orifice of the Eustachian tube. Once the ear is dry for more than 3 months, the state may be described as inactive chronic otitis media, and recurrent discharge may often be prevented by protecting the ear from water and by promptly treating upper respiratory tract infection, or by closing the defect in the ear drum surgically by performing myringoplasty. Hearing defects may, if necessary, be helped by using a hearing aid or by reconstructing the drum and the ossicular chain by tympanoplasty.

The use of mastoidectomy as a means to re-establish drainage of mastoid antrum in safe or non-cholesteatomatous chronic suppurative otitis media is still controversial. Mastoid factors which contribute to the graft failure include the extent of mastoid pneumatization and the presence of inflammatory disease in mastoid, whereas the main non mastoid causes include general disability, technical error, presence of allergy, condition of middle ear mucosa and most importantly the Eustachian tube function.

The purpose of this study is to ascertain whether the mastoidectomy should be combined as a standard operating procedure for closing central perforations in safe type of chronic suppurative otitis media or not so as to achieve acceptable functional status postoperatively and hence minimize graft failure.

OBJECTIVE OF THE STUDY

1. Evaluation of hearing improvement and graft take rate in patients undergoing tympanoplasty with or without mastoidectomy in safe type of CSOM.
2. To assess the effect of mastoidectomy in the safe type of CSOM.
3. To form a common consensus regarding the surgical management of CSOM.

REVIEW OF LITERATURE

In 16th century, surgery for mastoid infection was first proposed by Ambrose Pare on the young king Charles II of France, who was dying with a high fever and discharging ear. In 18th century, the first documented successful surgery for a mastoid infection was performed by Jean Petit of Paris.

Perforations of the ear drum were first patched by Yearsley in 1850 with use of a cotton wool pellet, a successful artificial drumhead mad of a disk on a silver wire was invented by Toynbee in 1860. Blake in 1887 used a paper patch for perforations of the tympanic membrane, and Joynt proposed the use of cautery and patches for defect of the drumhead in 1919 [5]. In1649, Riolanus first described mastoid surgery to relieve obstruction of the eustachian tube and tinnitus, and Petit in 1736 was the first to perform successfully a mastoid operation for mastoiditis [5]. Ortegren in 1967 presented a paper on the result of myringoplasty carried out since 1957 by various eminent otologists like Zollner, Wright, Heerman et al etc. based on the extensive study he concluded that connective tissue grafts i.e. fascia are superior to skin grafts in myringoplasty and the results of myringoplasty performed on patients above 40 years were not so good as those below this limit. He also noticed that reperforations occurred before 6 months in most cases at follow up and the role of mastoid cellularity in myringoplasties were not clear in these studies [6]. Of all these grafting materials, the most effective have been those from connective tissue. While each type of graft has its own advocates, the temporalis fascia graft is by far the most popular and has become the standard to which all other materials are compared today [7].

During the next 20 years, it became evident that creating an open cavity was necessary for these diseases, and in 1890 Zaufal described removing the superior and posterior canal wall, tympanic membrane, and the lateral ossicular chain, a procedure now known as the radical mastoidectomy. This procedure was

modified by Bondy, who recognized that disease limited to the pars flaccida could simply be exteriorized, leaving the uninvolved middle ear alone. His description of the "modified radical mastoidectomy" or "Bondy's procedure" in 1910 represented one of the first reports addressing hearing function. Interest in hearing preservation and restoration gained further attention after Lempert introduced the fenestration operation in 1938 and Zollner and Wullstein described tympanoplasty techniques in the early 1950s. During the next decade, Jansen, Sheehy, and others extended these principles of restoring function and maintaining normal anatomy with the introduction of the intact canal wall mastoidectomy with facial recess approach [8].

A high incidence of surgical success was found in ears with good ETF and small sized MACS. In ears with other combinations of ETF and different size MACS, distinct trends in surgical outcome could not be detected but the results are not as good as in the other two groups [9].

Holmquist and others studied 31 cases of chronic otitis media concluded that there is a need to have an air reservoir connected with the middle ear for the treatment of patients with poor tubal function. Therefore, obliteration of the mastoid cavity in middle-ear surgery should be avoided [10]. Wehrs and others observe that aeration of the mastoidectomy cavity is also important to prevent collapse of the posterior canal wall, retraction pockets and ensure an adequate air reserve [11]. Tympanoplasty may be performed with or without mastoid surgery as directed by their disease process or preferred by surgeon [12]. The most limited form of chronic inflammatory ear disease is the perforated tympanic membrane, which usually does not require mastoid operation. The most prevalent form of disease is chronic otitis media with otorrhoea but no cholesteatoma [13].

Hegde and colleagues did a prospective study which consisted of 100 patients with unilateral middle ear pathologies over a period of 24 months. They concluded that the decreased pneumatization in patients with middle ear disease is secondary to the chronic inflammation and not due to otitis media in infancy or congenital causes. Hypocellularity is an affect but not the cause of middle ear pathologies. This study proved that there is a definite relation between the area of the mastoid air cells and the duration of middle ear disease [14]. Yung studied hearing gain in relation to the perforation site. It was also shown that posterior perforations had a greater hearing loss than anterior perforations [15].

Adkins, White and Chalestun, studied 71 type 1 tympanoplasties utilizing autograft temporalis fascia and an underlay technique upon which a minimum follow up of 18 months was available, were analyzed for the effect of influencing factors. Those cases which had undergone a previous tympanoplasty were excluded. The overall success rate was 89%. Neither the age of the patient at the time of surgery, the length of time the ear had been dry, nor the finding of mucopus in the ear at the time of surgery had a significant bearing on the success. There was a definite relationship between the size of the perforation and the likelihood of success. Seven of the eight failures occurred in patients with near total or total perforations. No patients in the series had active disease in the opposite ear at the time of surgery. Despite the precaution, 1 out of 4 failures in the adult group and 3 out of 4 failures in children occurred in patients with bilateral perforations [16]. Rizer [7] did a prospective comparison study which included, 712 cases over 9 years, to find out whether the tympanic membrane was repaired by an underlay or an overlay technique.

Sharp Terzis and Robinson studied in 47 patients with either an anterior or subtotal perforation of tympanic membrane extending upto the anterior annulus margin. They concluded that use of the Kerr flap is recommended when repairing the anteriorly placed tympanic membrane perforation [17]. Emmett [18] studied 260 cases of type 1 tympanoplasty to determine whether age is a factor in healing. He concluded that age is not a factor in success or failure of healing following tympanoplasty surgery. Syeed Al Ghamdi found that that only the status of the middle ear and the presence of tympanosclerosis at the time of surgery were found to have a major effect on the final outcome of surgery [19]. Mathai studied the results of 200 cases of underlay myringoplasty using temporalis fascia and reported a success rate of 95%. Failure was high in revision surgeries and in patients with chronic nasal allergy. His study showed that transcanal underlay myringoplasty with temporalis fascia is an easy technique which gives high success rates and a minimal rate of complications [20]. How the size of the temporalis fascia alters with its state of hydration was reported by England, Strachen and Buckley. They concluded that graft shrinkage should be considered when positioning the graft [21]. Tympanoplasty with or without mastoidectomy is indicated for chronic ear disease process such as tympanic membrane perforation resulting from previous middle ear infections [22]. Balyan and others, observed no statistically significant difference in terms of graft success rates or functional hearing outcome between those who underwent type 1 tympanoplasty with mastoidectomy and those without mastoidectomy. They also concluded that the success rates were similar for both dry and discharging ears [23]. Ruhl and Pensak, analyzed 135 patients available for clinical and audiometric studies with a minimum of 18 months follow up. The conclusion was that for patients with non-cholesteatomatous chronic otitis media who have failed prior tympanoplastic reconstruction, an aerating cortical mastoidectomy may

be indicated and may improve the success rate at the time of surgery [24].

Type 1 tympanoplasty refers to more extensive grafting, usually requiring surgery on the canal and exploration of the middle ear [25]. Retrospective study of patients at a tertiary referral centre done by McGrew, where four hundred and eighty-four patients who underwent surgical repair of simple tympanic membrane perforation were identified and reviewed in a retrospective manner. Surgical outcome and clinical course were assessed to compare results of tympanic membrane perforation with and without canal wall up mastoidectomy. They noted that tympanic membrane repair was equally effective in both groups at 91. This suggests that even in the absence of active evidence of infection, mastoidectomy improved the underlying disease process. Combining mastoidectomy with tympanoplasty during repair of simple perforations in patients with no active evidence of infection remains an appropriate option and may be valuable in reducing the need for future surgery [26]. Eradication of the disease from the mastoid and the middle ear is essential and involves mastoidectomy with tympanoplasty [27].

Cases of non-cholesteatomatous chronic otitis media (COM) were reviewed by Mishiro and others to determine whether mastoidectomy is helpful when combined with tympanoplasty for these conditions. A retrospective analysis of 251 ears with non-cholesteatomatous COM operated by Mishiro in 11-year period. He concluded that mastoidectomy is not helpful in tympanoplasty for non-cholesteatomatous COM, even if the ear is discharging [28].

Krishnan and colleagues studied a sample consisting of 120 ears with chronic suppurative otitis media without cholesteatoma subjected to surgical treatment. Group 1 (patients who underwent and 8 were quiescent. In group 2 (patients who underwent tympanoplasty with cortical mastoidectomy) consists of 76 cases of which 40 were dry and 36 were quiescent. They observed that postoperative hearing gain was 75% in both groups.

They concluded that it is good practice to open the mastoid antrum and air cells if the middle ear mucosa is unhealthy. If the middle ear mucosa is healthy, tympanoplasty alone seems sufficient for a successful surgical outcome, irrespective of the fact whether the ear was dry or quiescent prior to surgery. Meticulous and complete removal of disease from the middle ear cleft, with a stable assembly with ossicular chain, will surely give a dry ear with good hearing. Mastoidectomy did not seem to play a significant beneficial role as regards the postoperative hearing gain [29].

Nayak, Balakrishnan, Hazarika and Mathew did a prospective study which compared the results of myringoplasty alone with that of combined cortical mastoidectomy and myringoplasty, to verify and establish the role of the surgically created mastoid air reservoir in the success of myringoplasty. Finally, they concluded that especially in a small and sclerosed mastoid (<9 sq. cm), it is desirable to do a cortical mastoidectomy even if the ear is dry, to create a mastoid air reservoir which probably can buffer the detrimental effects of a poorly functional Eustachian tube. Concomitant cortical mastoidectomy with myringoplasty has high success rates compared to myringoplasty alone with respect to graft take up and hearing gain [30].

48 patients with chronic otitis media with tympanic perforations who underwent type 1 tympanoplasty with cortical mastoidectomy were studied by Jackler and Schindler. Cortical mastoidectomy was found to be an effective means of repneumatising the sclerotic mastoid and eradicating the mastoid source of infection. The study concluded that cortical mastoidectomy is a safe and useful adjunct to type 1 tympanoplasty in selected cases of chronic otitis media with perforations [31]. Ashok *et al*., [32] did a prospective study which included 40 patients treated for CSOM with central perforation. Only type 1 tympanoplasty was done in 30 patients with dry central perforation and cortical mastoidectomy with type 1 tympanoplasty was performed in 10 patients with moist or discharging perforation. Type 1 tympanoplasty utilizing an underlay technique with temporalis fascia graft shows a high probability of success (85%). Type 1 tympanoplasty with cortical mastoidectomy results in excellent surgical success rate (100%) but gives less improvement of hearing. In type 1 tympanoplasty alone, surgical success rate drops to 80-75% but it offers more improvement of hearing.

ANATOMY OF THE TYMPANIC MEMBRANE STRUCTURE

The tympanic membrane consists of an outer epithelial layer, in continuity with the skin of the external auditory canal, a middle fibrous layer, and an inner mucosal layer, in continuity with the mucosa of the middle ear.

It is a thin, nearly oval disc, slightly broader above than below, forming an angle of 55 degrees with the floor of the meatus. Its longest diameter from postero-superior to anterior infection is 9 to 10mm. Perpendicular to this the shorter diameter is 8 to 9 mm. Most of the circumference is thickened to form a fibro cartilaginous ring, called the tympanic annulus.

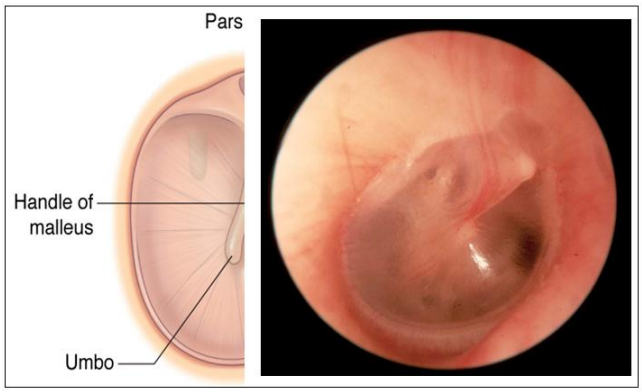


Fig-1: Anatomy of normal tympanic membrane

BLOOD SUPPLY

ANATOMY OF MIDDLE EAR CLEFT:

The middle ear cleft is a vertical air containing cleft in the temporal bone and consists of –

1. Tympanic cavity
2. Eustachian tube
3. Mastoid air cell system [33].

TYMPANIC CAVITY

It is situated between the tympanic membrane and the cochlea divided into 3 regions.

1. Epitympanum or attic – corresponds to an upward extension behind the roof of the EAM; accommodates the main body of the ossicles, measures 6mm.
2. Mesotympanum – corresponding to the tympanic membrane, measures 2 mm.
3. Hypotympanum – corresponding to below the level of the floor of external auditory meatus, measures 4 mm [9].

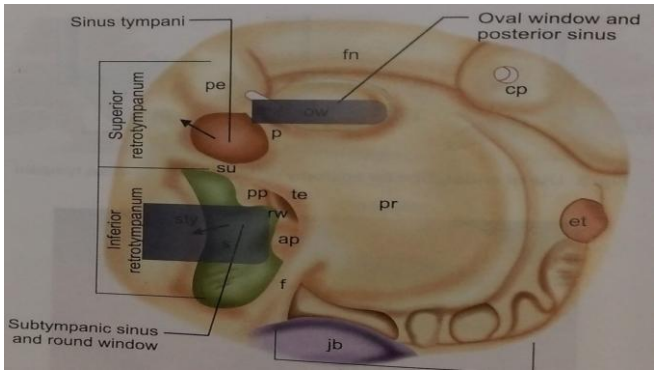


Fig-2: Various parts of retrotympanum: pe-pyramidal eminence, fn-facial nerve, jb-jugular bulb, p-ponticulum, pr-promontary, rw-round window, su-subiculum, ap-anterior pillar, cp-cochleariform process, et-Eustachian tube, f-funiculum, pp-posterior pillar

AUDITORY OSSICLES

It is constituted by 3 ossicles with their muscles, ligaments and tendons and the chorda tympanic nerve.

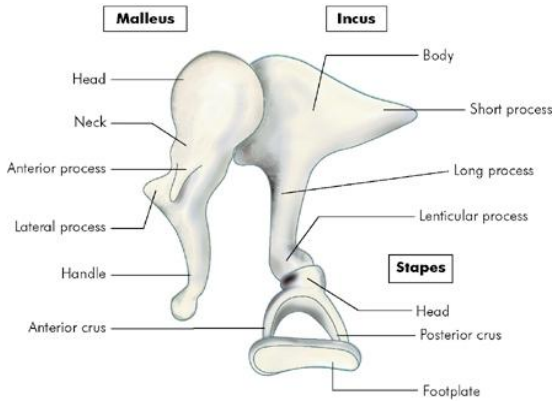


Fig-3: Ear ossicles

EUSTACHIAN TUBE

It was first described by Eustachian in 1564. It connects the tympanic cavity with nasopharynx. It's overall length in an adult is about 36mm. It is divided into 2 parts, Tympanic bony portion (1/3rd) and Pharyngeal cartilaginous portion (2/3rd). Its diameter is greatest at the pharyngeal end and least at the isthmus. Nerve supply of Eustachian tube is by the tympanic branch of glossopharyngeal nerve [34].

MECHANISM OF HEARING:

A sound signal in the environment, is collected by the pinna, passes through the EAC, and strikes the tympanic membrane. Vibration of TM is transmitted to the stapes footplate through the chain of ossicles coupled to the TM. Movements of stapes footplate causes pressure change in the labyrinthine fluids which moves the basilar membrane. This stimulates the hair cells of the organ of corti, which in turn act as transducers and convert the mechanical energy into electrical impulses which travel along the auditory nerve. Mechanism of hearing can be broadly classified into Mechanical conduction of sound (conductive apparatus). Transduction of mechanical energy to electrical impulses (sensory system of cochlea) and conduction of electrical impulses to the brain (neural pathway).

Conduction of Sound

When air conducted sound has to enter the inner ear fluids, nature has compensated for the loss of energy by interposing the middle ear which converts sounds of greater amplitude but lesser force, to that of lesser amplitude but greater force. This function is called the impedance matching mechanism or the transformer action [35]. This is accomplished by - as explained by Helmholtz in 1868.

a. Lever action of the ossicles: Handle of the malleus is 1.3 times longer than the long process of incus, providing a mechanical advantage of 1.3.
b. Hydraulic action of tympanic membrane: Area of the tympanic membrane is longer than that of the footplate, average rate between the two being 21:1. As the effective area of the tympanic membrane is only 2/3rd, the effective areal ratio is reduced to 14:1. The mechanical advantage provided by the tympanic membrane product of the areal ratio and lever action of the ossicles is 18:1 [15].
c. Curved membrane effect: Movements of the tympanic membrane are more at the periphery and less at the centre, where malleus handle is attached, and this too gives some leverage.

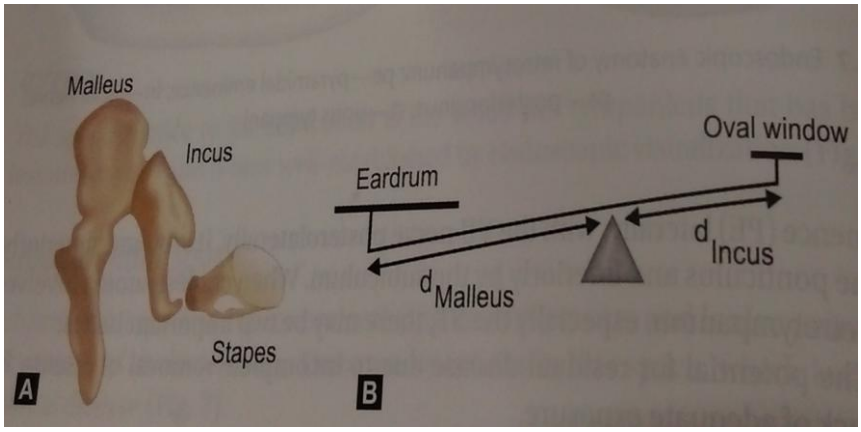


Fig-4: (A) Ossicular level mechanism (Hydraulic lever); (B) Cantenary lever mechanism

Phase Differentials between Oval and Round Window

Sound waves incident upon the tympanic membrane do not reach the oval and round windows simultaneously. The ossicular chain is a preferential part to the oval window. Thus, when the oval window is in the stage of compression, the round window is in the stage of rarefaction. This acoustic separation of the windows is achieved by the presence of an intact tympanic membrane and a cushion of air in the middle ear around the round window [37, 38].

DEFINITION OF CHRONIC OTITIS MEDIA

Defined as permanent abnormality of the parse tensa or parse flaccida most likely a result of earlier acute otitis media, negative middle ear pressure or otitis media with effusion. Chronic otitis media is not necessarily a result of "the gathering of pus". Previously it was defined as a long-standing infection of a part or whole of the middle ear cleft characterized by ear discharge and a perforation [39].

Classification of COM

Inactive Mucosal COM (Dry Perforation)

There is a permanent perforation of pars tensa, but the middle ear mucosa is not inflamed. A perforation may be completely surrounded by a remnant of pars tensa or a part of perforation may extend to the fibrous annulus. The lamina propria around the perforation is thickened due to proliferation of fibrous tissue.

The mucocutaneous junction is usually located at the margin of the perforation, but not necessarily. Squamous epithelium can migrate medially into the middle ear. At the time of tympanoplasty care should be taken to remove this epithelium completely, which can be recognized by its velvety appearance under the operating microscope.

Active Mucosal COM (Perforation with Otorrhoea)

There is chronic inflammation within the mucosa of the middle ear and mastoid, with varying degree of edema, sub mucosal fibrosis, hypervascularity and infiltration with lymphocytes plasma cells and histiocytes. Area of mucosa may ulcerate with proliferation of blood vessels, fibroblasts and inflammatory cells, leading to granulation tissue. There is production of mucopurulent discharge which drains via a perforated tympanic membrane. The mucosal changes may progress to form an 'aural polyp' that can protrude through defects in a tympanic membrane. Inflammatory changes occur in the entire middle ear cleft including mastoid antrum and various air cell tracts of the temporal bone. Active mucosal COM is often associated with resorption of parts or whole of the ossicular chain. The ossicles may show hyperaemia with proliferation of capillaries and prominent histiocytes. The long process of incus, stapes crura, body of incus and manubrium are involved in that order of frequency. The infection, inflammation pressure and keratin can lead to elaboration of a variety of molecular factors which lead to recruitment development and activation of osteoclasts. These activated osteoclasts then result in bone resorption.

Fig-5: Active chronic otitis media

Inactive Squamous Epithelial COM (Retraction, Atelectasis and Epidermization)

Negative static middle ear pressure can result in retraction of tympanic membrane. A retraction pocket consists of an invagination into middle ear space of a part of ear drum, and may be fixed when it is adherent to structures in the middle ear or free when it can move medially or laterally depending on the state of inflation of the middle ear. Epidermization is a more advanced type of retraction and refers to replacement of middle ear mucosa by keratinizing squamous epithelium without retention of keratin debris.

Fig-6: Dry central perforation of ear drum

Active Squamous Epithelial COM (Cholesteatoma)

The hallmark of cholesteatoma is retention of keratinous debris. Histologically the squamous epithelial lining or 'matrix' of a cholesteatoma is similar to that of skin. The matrix of a cholesteatoma is usually surrounded by a layer of inflamed, vascular, sub-epithelial connective tissue. A cholesteatoma can be filled with keratin and be quite dry, or be associated with active bacterial infection leading to profuse malodorous otorrhoea. Cholesteatoma is potentially dangerous because of their potential to incite resorption of bone, leading to infratemporal or intracranial complications.

Fig-7: Active sqamous chronic otitis media

Healed COM

Loss of lamina propria of tympanic membrane due to atrophy or failure to reform during healing of a perforation leads to a dimeric membrane that consists of epidermis and mucosa only. Such a thin membrane is prone for retraction if there is negative static middle ear pressure [40].

PHYSIOLOGICAL & PATHOLOGICAL FACTORS INFLUENCING THE DECISION MAKING TO DO OR NOT TO DO MASTOIDECTOMY

Bekesy's calculations of effective vibrating surface area compared with the stapes footplate area of 17 to 1 d lever effect of ossicular chain of 1.3 to 1 are generally accepted rather than the somewhat larger ratios calculated by Helmholtz. The 17 to 1 hydraulic ratio times the 1.3 to 1 lever ratio yields a total increase of pressure at the oval window of 22 times. This is termed the sound pressure transformer ratio of the normal human ear.

To accomplish the two physiologic principles of tympanoplasty, sound protection for the round window must first be provided by means of a tissue graft to repair the tympanic membrane defect, and the middle ear must be lined with mucosa and must contain air to the protected window. Then sound pressure transformation for the oval window must be provided by mobile Ossicular continuity between the large tympanic membrane and small oval window [41].

TYMPANOPLASTY DEFINITIONS AND TYPES:

Definition of Tympanoplasty

Tympanoplasty is "an operation performed to eradicate disease in the middle ear and to reconstruct the hearing mechanism, without mastoid surgery, with or without tympanic membrane grafting" [42].

In the transactions of the American Academic of Ophthalmology and Otolaryngology of February 1965, a report of the subcommittee of the committee on conservation of hearing set forth an standard classification for surgery of chronic ear infection, which has been adopted when reporting tympanoplasty results [4].

Myringoplasty

"An operation where in the procedure is limited to the repair of the tympanic membrane", or "An operation performed to repair or reconstruct the tympanic membrane, after incorrectly referred to as type 1 tympanoplasty" (because Myringoplasty does not remove the disease from the middle ear) [44].

WULLSTEIN CLASSIFICATION OF TYMPANOPLASTY

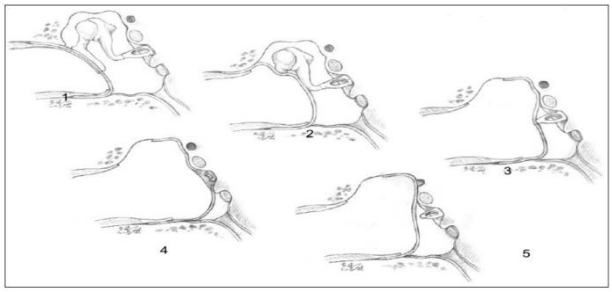


Fig-8: Wullstein classification of tympanoplasty --1 Type I with restoration of the normal middle ear. 2 Type II. Ossicular chain partially destroyed but preserved and continuity restored. Skin graft laid against the ossicles after removal of the bridge. 3 Type III. Myringostapediopexy producing a shallow middle ear and a columella effect. 4 Type IV. Round window protection with a small middle ear mobile footplate left exposed. 5 Type V. Closed middle ear with round window protection; fenestra in the horizontal semicircular canal covered by a skin.

Type 1 and Type 2 can be performed by using any graft material like temporalis fascia and tragal perichondrium. Type 3, Type 4 and Type 5 can be avoided by using allograft ossicles and auto grafts to reconstruct the transmission mechanism and maintain a tympanum of normal lateral depth [45].

Indications for tympanoplasty (Myringoplasty with ossiculoplasty) without mastoidectomy:

- Dry central perforation associated with ossicular necrosis.
- Post traumatic perforation with ossicular discontinuity.
- Congenital ossicular discontinuity.

Indications for Tympanoplasty with Mastoidectomy

1. Resistant chronic otitis media with persistent discharge not responding to medical line of treatment with intact ossicular chain or ossicular necrosis with different sizes of perforation or when the middle ear mucosa appears abnormal (hypertrophied or polypoidal).
2. Posterior marginal perforation with retraction of remnant tympanic membrane with ossicular necrosis/discontinuity.
3. Atelectatic / Adhesive otitis media with tympanosclerosis [46].

CONTRAINDICATIONS FOR TYMPNOPLASTY

Absolute Contraindications

1. Tympanoplastic reconstruction of the conductive hearing mechanism is clearly useless in a functionally "dead ear" or in an ear without useful residual cochlear function.
2. Tympanoplasty is contraindicated in malignant neoplasm of the outer or middle ear .
3. In invasive, life threatening pseudomonas infections of the outer or middle ear.
4. In diabetics.
5. In threatened or actual intracranial complications of middle ear disease, where the treatment of the complication takes precedence.

Relative Contraindications

1. Acute exacerbation of chronic otitis media, which must first be brought under control by appropriate antibiotic therapy.

2. An allergic type of chronic tubo-tympanic with profuse mucoid discharge associated with an allergic rhino sinusitis, in which allergic factors must be controlled by Rinkels methods of optimum dosage, dust and mold therapy according to skin titration, plus diminution of food intolerance as determined by cytotoxic and provocative testing [47].

PREOPERATIVE TESTS AND EVALUATION

A complete history and otolaryngologic examination should be performed on all patients. The otoscopic evaluation is best accomplished with the aid of an otoscope using speculum or operating microscope. An audiogram is essential and should consist of pure tone air and bone conduction curves with adequate narrow band masking as well as of speech discrimination scores. All hearing tests should be confirmed with tuning fork test. Mastoid X ray is also very important.

General anesthesia is preferred for all chronic ear surgical procedures and is particularly helpful for children exceeding apprehensive patient.

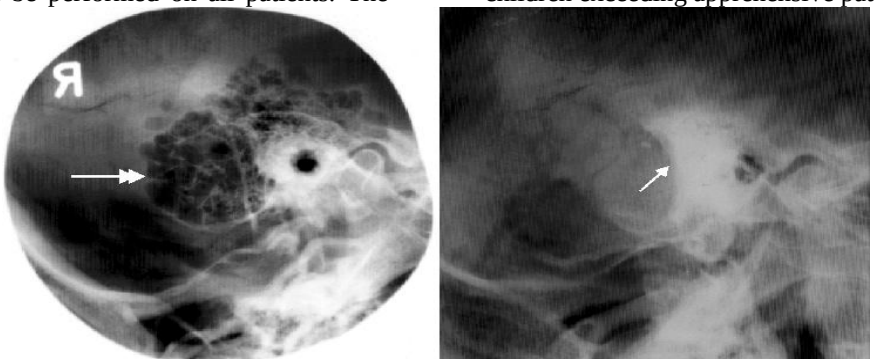


Fig-9: Schüller view: Well-developed normally pneumatized mastoid air cells can be observed in the picture on the left side (double arrow). In the picture on the right side, the mastoid cells (arrow) are obscured, and not air-containing, due to chronic otitis media

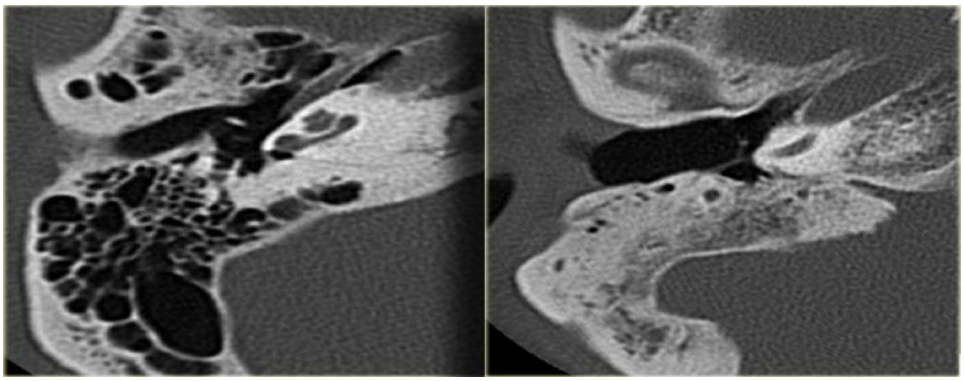


Fig-10: Axial NCCT temporal bone showing well-developed normally pneumatized mastoid air cells can be observed in the picture on the left side and on the right side, the mastoid cells are sclerosed

RADIOLOGY

To rule out the presence of the disease in the mastoids, forced lying dural or sinus plate, other malformations, and to establish the status of the mastoids, with regard to cellularity x-ray give the information about the ear that cannot be determined by careful otoscopic examination such as:

- Whether or not the mastoid process in pneumatic or sclerotic nature.
- Whether the sigmoid plate is anteriorly placed and the middle fossa dura unusually low.
- Whether the labyrinth has been fistulized by cholesteatoma
- Whether there is other pathology involved in the temporal bone.
- Such as acoustic tumor Computerized tomography scan may help to identify ossicular defects and cholesteatoma size and extension [48].

PURE TONE AUDIOMETRY

In pure tone audiometry we test hearing sensitivity of a subject only for pure tone sounds. Though Pure Tone audiometry doesn't determine exact pathology of disorder, it broadly classifies the deafness into 3 categories that is conductive, sensorineural or mixed. It does help to limit the number of possibilities in diagnostic work up. Pure tone audiometry is a part of ascertaining the hearing threshold level of a subject for pure tone sounds of various frequencies. The resultant plotted graph is called pure tone audiogram. Technique of bone conduction tests: the bone conduction vibrator attached to a spring metal band is placed over the mastoid bone. The region over the mastoid should be free of hair as possible. The bone conduction vibrator is

moved over the mastoid bone area till appoint is reached where maximum sound is heard. The vibrator is then placed over this point and test is done. The vibrator should not touch the pinna or the earphone since it might impede the vibrations of the bone conductor. The technique is same of air conduction testing (5up-10down method) [49].

In chronic otitis media usually conduction deafness is found. Degree of deafness may be anything between very mild to severe. No definite correlation is established between the size or location of the perforation and degree of the deafness. A-B gap of about 6odB sensorineural deafness though not very common is sometimes present, and causes mixed type of deafness. Sensorineural impairment usually affects the higher frequencies and is due to diffusion of toxins (liberated by ineffective organisms through round window membrane into scala tympani of the inner ear at region of basal turn of the cochlea. However, damage to the scala tympani may not be restricted to basal turn only and the whole of cochlea may be severely damaged in some cases, causing total or profound sensorineural deafness [50].

Types of Grafts

1) Auto Graft

Temporalis fascia
Tragal perichondrium
Tragal perichondrium and cartilage
Fat from lobule of the ear
Vein from dorsum of the hand
Fascia lata
Skin- split thickness or full thickness
External meatus skin
Dura
Periosteum

2) **Allograft (homograft**)

Dura matter

3) **Xenografts (heterograft**)

Bovine jugular vein
Calf caecal serosa [51].

APPROACHES

Three main approaches used in tympanoplasty are: Transcanal, Endaural and Post auricular. The approach used depends on the perforation size, the anatomy of the external auditory canal, and the surgeon's preference. Most importantly, the approach used should provide complete visualization of the perforation.

The Transcanal approach is usually used for small posterior perforations or for medium-size perforations when the ear canal anatomy is favorable and the entire perforation and an anterior tympanic membrane rim can be seen; it should be avoided in cases in which the anterior margin of the perforation is not well visualized, particularly in the hands of surgeons with less experience.

The Endaural approach can be used with all perforations and is more commonly used in Europe. It is most useful if a limited atticotomy is anticipated in conjunction with tympanoplasty. A self-retaining retractor can be used with this approach. The post auricular approach is the most commonly used approach for tympanoplasty in the United States. It can be used with all perforation sizes and offers a better angle of visualization of the anterior tympanic membrane, even without canalplasty. The use of self-retaining retractors allows for easier use of both hands for instrumentation and suctioning.

INCISIONS

Endomeatal/ Transcanal

It is used to raise a Tympanomeatal flap to expose the middle ear. Rosen's incision used most commonly for stapedectomy. It consists of 2 parts a) a small vertical incision at 12 O'clock near the annulus and b) a curvilinear incision starting at 6 O' clock position to meet the first incision in the posterosuperior regions of the canals, 5-7 mm away from the annulus.

Endaural Approach (Lempert's Incision)

- Lempert-1: Semicircular incision from 12 O'clock to 6 O'clock position in the posterior meatal wall at bony-cartilaginous junction.
- Lemperts-2: Starts from 1st incision at 12o'clock and passes upwards in a curvilinear fashion between the tragus and the crus of helix. It passes through incisura terminalis.

Post aural (Wildes Incision)

Starts at highest attachment of pinna, follows a curve of retro auricular groove, lying 1 cm behind it and ends at the mastoid tip [52].

BASIC SITUATIONS FOR TYMPANOPLASTY

There are five basic situations for middle ear reconstruction:

1. The ossicular chain is functioning normally but the tympanic membrane is defective. Closure of the perforation restores the sound pressure transformer to normal (Type 1 tympanoplasty).
2. The incus is partially or totally defective, but the malleus and stapes are normal. Here a connection is established between the head of the stapes and the malleus handle or tympanic membrane. The procedures are respectively named malleostapediopexy and myringostapediopexy
3. The stapes footplate is mobile but the crura are absent. Connections are made between stapes footplate and malleus, tympanic membrane or incus depending on the circumstances. These procedures are respectively called

malleoplatinopexy, myringoplatinopexy and incudoplatinopexy.

4. The stapes footplate is fixed, it is not possible to mobilize the footplate of the stapes, and stapedectomy or footplate fenestration is required at a second stage when the tympanic membrane and middle ear are healed. The mobile malleus handle or long process of the incus is used to connect prosthesis to the tissue graft, sealing the oval window after stapedectomy. These procedures are known as malleovestibulopexy and incudovestibulopexy respectively.
5. The whole ossicular system is absent. Either a monobloc tympanoossicular implant or an allograft tympanic membrane with the malleus handle and columella interposition as a one or two stage procedure can be used.
6. Sono inversion, where all ossicles absent except footplate of stapes, the round window is exposed and the oval window and Eustachian tube area are covered with fascia.

COMPLICATIONS OF TYMPANOPLASTY:

- Lateralization or blunting of the graft.
- Facial nerve palsy
- Postoperative infection and perichondritis
- Graft failure
- Injury to chorda tympani
- Stenosis of EAC
- Prosthesis development of extrusion
- Sensorineural hearing loss
- Injury to Dura or sigmoid sinus.[53]

CANAL WALL UP MASTOIDECTOMY WITH TYMPANOPLASTY SURGICAL PROCEDURE

- Canal incisions and elevation of posterior meatal skin flap.
- Post auricular incision.
- Harvesting temporalis fascia.
- Subcutaneous tissue incision and exposure of mastoid cortex and middle ear.
- Cortical mastoidectomy and removal of polypoidal mucosa and
- diseased cellular system and delineation if present at the antrum.
- Superior and inferior Tympanomeatal incisions.
- Elevation of anteriorly based Tympanomeatal flaps and securing
- Tympanomeatal flaps in the anterior sulcus.
- Skeletonising of malleus handle.
- Transcanal widening of posterior canal wall (Canalplasty).
- Transcanal exposure of posterior tympanum spaces.
- Trans canal atticotomy.
- Assessment of ossicular chain and removal of diseased ossicles.
- Total clearance of the disease from the attic antrum and middle ear.
- Preparation of the graft bed.
- Underlay fascia grafting.
- Ossiculoplasty.
- Lateral attic wall reconstruction.
- Repositioning of posterior meatal skin flap.
- Closure of the wound.

MATERIALS AND METHOD

Source of Data

Data for the study will be collected from the patients undergoing tympanoplasty with or without mastoid surgery in the Department of Otorhinolaryngology at Manipal Hospital, Bangalore, Karnataka.

Method of collection of Data

Sampling Procedure: A predesigned proforma will be used to record the relevant information (patient's data, clinical findings, and investigation reports) from the individual patient selected with inclusion and exclusion criteria.

Study design: A prospective study.

Study period: Dec 2013 to June 2015.

Statistical Methods: Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data is made,

Assumptions:

1. Dependent variables should be normally distributed,
2. Samples drawn from the population should be random, Cases of the samples should be independent

Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

Significant figures

\+ Suggestive significance (P value: $0.05<P<0.10$)

* Moderately significant (P value: $0.01<P \leq 0.05$)

** Strongly significant (P value: $P \leq 0.01$)

Statistical Software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc**.**

METHODOLOGY

The patients are allocated to the two study groups based on surgeon preferences, considering the inclusion and exclusion criteria. The patients who underwent tympanoplasty with mastoidectomy were included in Group A. All patients who underwent tympanoplasty alone were included in group B and the outcome of results of tympanoplasty with mastoidectomy will be compared with tympanoplasty without mastoidectomy in the safe type of CSOM. The purpose of this study is to ascertain whether the mastoidectomy should be combined as a standard operating procedure for closing central perforation in safe type of CSOM or not, as to achieve acceptable functional status post-operatively and hence minimize graft failure.

Inclusion Criteria

- Patient with safe type of CSOM.
- Age between 15 -60 years.
- Duration >3 months.
- Patient having central perforation.
- Patient with or without conductive hearing loss.
- Mucoid or minimal purulent discharge.

Exclusion Criteria

- Age less than 15 years and more than 60 years.
- Patients having multiple tympanic membrane perforations.
- Patients having marginal tympanic membrane perforations.
- Patients having foul smelling discharge.
- Medical contraindications to undergo surgery.
- CSOM with complications (Intracranial and Intratemporal)
- CSOM with attico-antral disease (unsafe ear).

A complete ENT examination and appropriate investigations were done in all cases.

- Otoscopy.
- Tuning fork tests – Rinnes, Weber, and ABC tests.
- Eustachian tube functions like Valsalva's maneuver, surgical speculum test.
- Routine blood examination
- Plain x-ray bilateral mastoid
- Pre-operative audiometry
- Postoperative and examination and PTA test at 1 ½ month and 3rd month

The type of graft material used was temporalis fascia.

Preoperative Preparation

- Shaving of hair of the post auricular region 3cm inside the hair line done.
- Vital parameters were recorded.
- Informed consent of the patients was taken.
- Preoperative dose of an antibiotic given.
- Preoperatively Tablet Calmpose 10mg given at bed time to relieve anxiety and Tablet Ranitidine 150mg.
- Anesthesia – General anaesthesia was preferred.
  - General anaesthesia after pre anaesthesia checkup was given.
  - Induction-Inj fentanyl 2 mg /kg
  - Propofol 1.2 to 2 mg/kg
  - NMB (neuromuscular blocker) Atrac-0.5 mg/kg and intubated Maintenance by O2 + air + inhalation agent Sevoflurane / Isoflurane)
- Position of the patient-Supine with face turned to opposite side, the ear to be operated is up.

Intraoperative

- Local infiltration of 2% Xylocaine with 1 in 2 lakh adrenaline taken and infiltrated to meatal wall and post auricular region.
- Post aural approach was used in all patients.
- Skin and sub cutaneous tissue cut. Harvesting of temporalis fascia graft done.
- Spine of Henle identified.
- Mac Ewen's triangle delineated.
- Cortical mastoidectomy was done.
- Aditus patency was achieved.
- Examination under microscope:
- Tympanic membrane visualized. Margins of perforation freshened.

6'O clock and 12'O clock incision was taken about 5mm away from the annulus. The posterior tympanomeatal flap was elevated and middle ear was inspected and the status of ossicles noted. Round window reflex was visualized and continuity of ossicular status was confirmed. Graft placed by underlay technique in all cases. Reposition of tympanomeatal flap was done. Gel foam soaked with antibiotic was placed in the middle ear and EAC. Medicated ear wick placed in canal. Periosteum, subcutaneous tissue and skin were sutured. Post aural wound was closed in layers. Mastoid dressing applied.

Post-Surgery

Reversal with Neostigmine 0.005 mg /kg Glycopyrollate 0.01 mg/kg and extubated.

Patient was put on antibiotics, analgesics and anti-inflammatory drugs. Mastoid dressing removed on 1st post op day. Ear wick removed after 1 week. Patients were followed up postoperatively at regular interval. The condition of the graft was appreciable

from the 2nd week onwards. All patients were examined by otoscope at 4weeks and 6weeks to determine the condition of the graft. Follow up was done at monthly intervals for 6 months. Pure tone audiometry was done 1 ½ month postoperatively and 3rd month postoperatively.

Fig-11: Instrument used for tympanoplasty

Fig-12: Microscope used for tympanoplasty

Fig-13: Exposing temporalis fascia

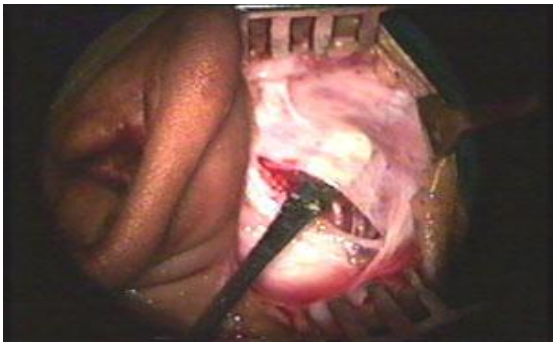


Fig-14: Harvesting temporalis fascia

Study design: A Comparative two group study.

Table-1: Age distribution of patients studied

Age in years	Group A [With Mastoidectomy]	Group B [Without Mastoidectomy]	Total
10-20	11(16.7%)	14(21.2%)	25(18.9%)
21-30	14(21.2%)	20(30.3%)	34(25.8%)
31-40	19(28.8%)	18(27.3%)	37(28%)
41-50	8(12.1%)	4(6.1%)	12(9.1%)
51-60	14(22.7 %)	10(15.2%)	24(18.2%)
Total	66(100%)	66(100%)	132(100%)
Mean ± SD	36.88±13.63	32.91±12.87	34.90±13.37

P=0.100, Not Significant, Student t test

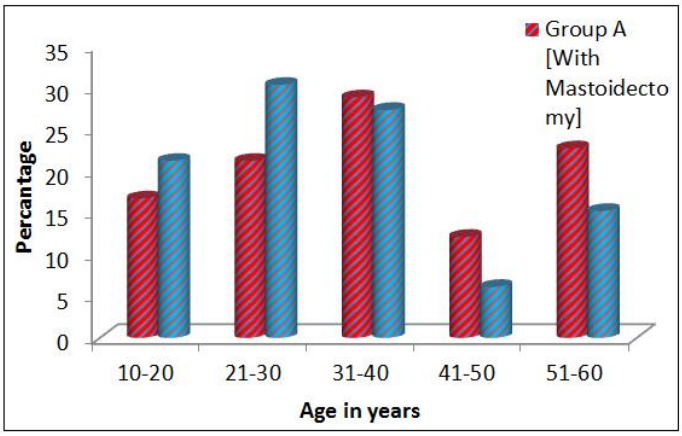
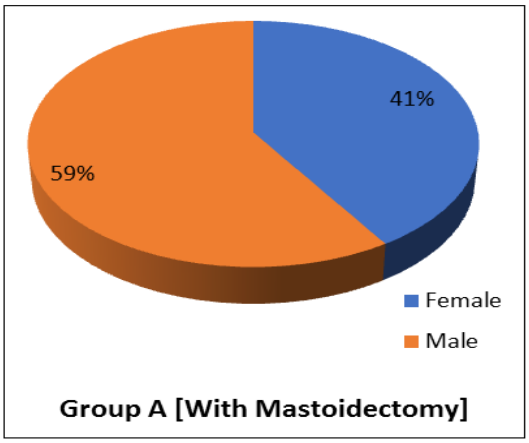


Table-2: Gender distribution of patients studied

Gender	Group A [With Mastoidectomy]	Group B [Without Mastoidectomy]	Total
Female	27(40.9%)	37(56.1%)	64(48.5%)
Male	39(59.1%)	29(43.9%)	68(51.5%)
Total	66(100%)	66(100%)	132(100%)

Samples are gender matched with P=0.099



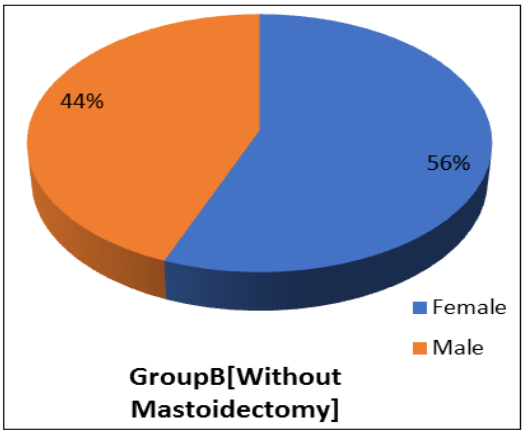


Table-3: Laterality

Laterality	Group A [With Mastoidectomy]	Group B [Without Mastoidectomy]	Total
Left	27(40.9%)	33(50.0%)	60(45.5%)
Right	25(37.9%)	18(27.3%)	43(32.6%)
Bilateral	14(21.2%)	15(22.7%)	29(21.9%)
Total	66(100%)	66(100%)	132(100%)

P=0.240, Not significant, Chi-Square test

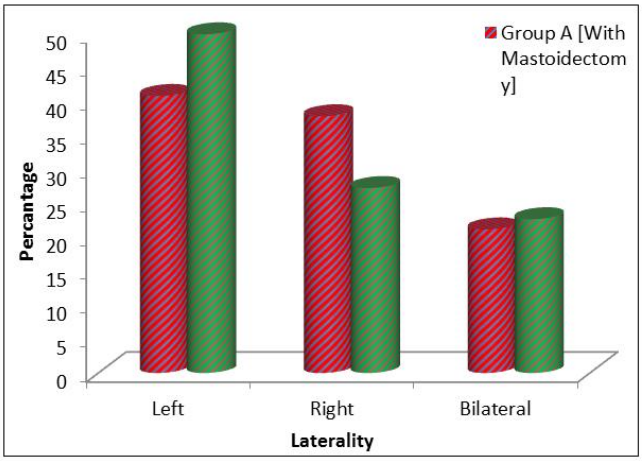
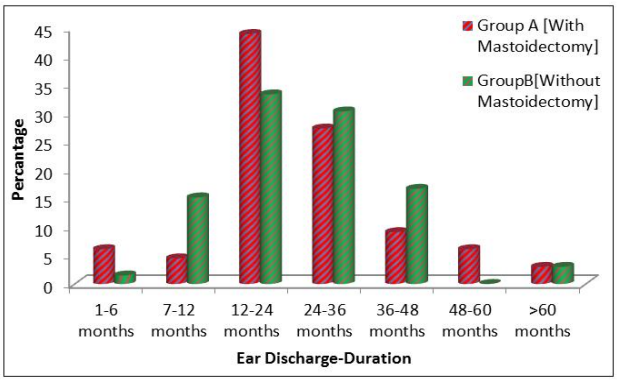
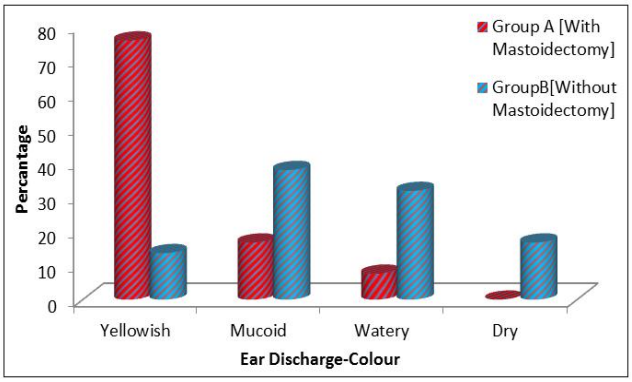


Table-4: Ear Discharge

Ear Discharge	Group A [With Mastoidectomy] (n=66)	Group B [Without Mastoidectomy] (n=66)	Total (n=132)	P value
Duration				
• 1-6 months	4(6.1%)	1(1.5%)	5(3.8%)	0.060+
• 7-12 months	3(4.5%)	10(15.2%)	13(9.8%)	
• 12-24 months	29(43.9%)	22(33.3%)	50(37.9%)	
• 24-36 months	18(27.3%)	20(30.3%)	38(28.8%)	
• 36-48 months	6(9.1%)	11(16.7%)	17(12.9%)	
• 48-60 months	4(6.1%)	0(0%)	4(3%)	
• >60 months	2(3%)	2(3%)	4(3%)	
Colour				
• Yellowish	50(75.8%)	9(13.6%)	59(44.7%)	<0.001**
• Mucoid	11(16.7%)	25(37.9%)	36(27.3%)	0.006**
• Watery	5(7.6%)	21(31.8%)	26(19.7%)	<0.001**
• Dry	0(0%)	11(16.7%)	11(8.3%)	0.001**
Active/Inactive				
• Active	66(100%)	55(83.3%)	121(91.7%)	<0.001**
• Inactive	0(0%)	11(16.7%)	11(8.3%)	

Chi-Square test/Fisher Exact test





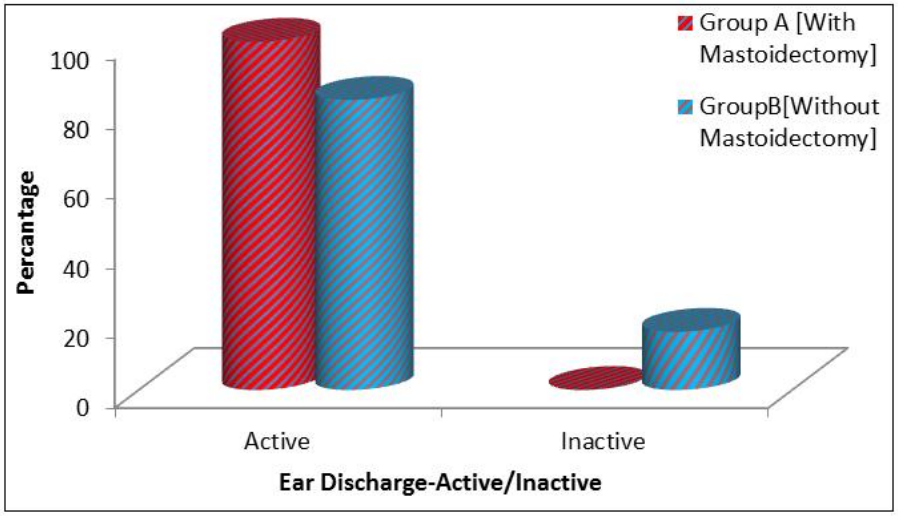
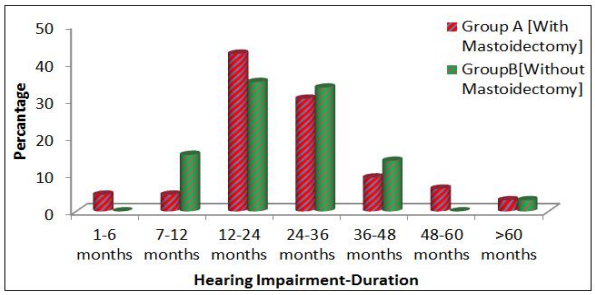
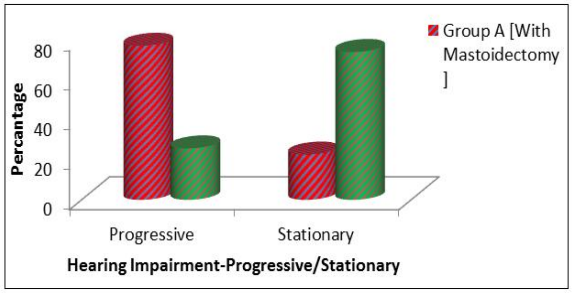


Table-5: Hearing Impairment

Hearing Impairment	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
Duration				
• 1-6 months	3(4.5%)	0(0%)	3(2.3%)	0.063+
• 7-12 months	3(4.5%)	10(15.2%)	13(9.8%)	
• 12-24 months	28(42.4%)	23(34.8%)	51(38.6%)	
• 24-36 months	20(30.3%)	22(33.3%)	42(31.8%)	
• 36-48 months	6(9.1%)	9(13.6%)	15(11.4%)	
• 48-60 months	4(6.1%)	0(0%)	4(3%)	
• >60 months	2(3%)	2(3%)	4(3%)	
Progressive/ Stationary				
• Progressive	51(77.3%)	17(25.8%)	68(51.5%)	<0.001**
• Stationary	15(22.7%)	49(74.2%)	64(48.5%)	
Degree				
• Minimal	10(15.2%)	20(30.3%)	30(22.7%)	0.136
• Mild	29(43.9%)	25(37.9%)	54(40.9%)	
• Moderate	26(39.4%)	21(31.8%)	47(35.6%)	
• Severe	1(1.5%)	0(0%)	1(0.8%)	





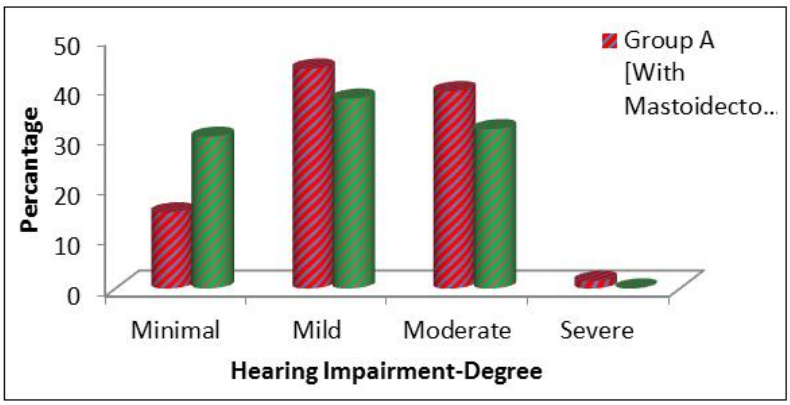
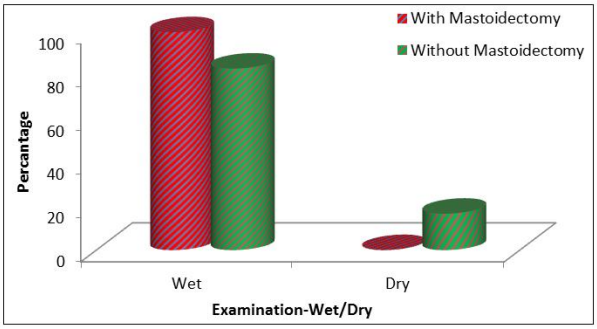
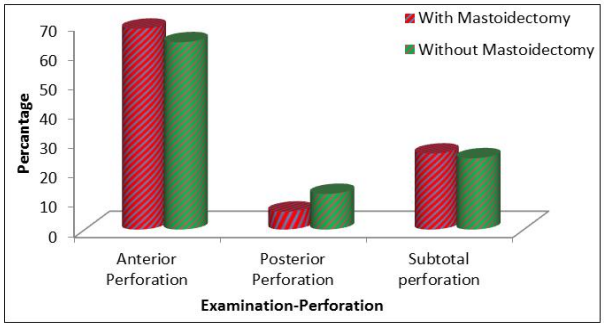


Table-6: Examination

Examination	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
Perforation				
• Anterior Perforation	45(68.2%)	42(63.6%)	87(65.9%)	0.480
• Posterior Perforation	4(6.1%)	8(12.1%)	12(9.1%)	
• Subtotal perforation	17(25.8%)	16(24.2%)	33(25%)	
Wet/Dry				
• Wet	66(100%)	55(83.3%)	121(91.7%)	0.001**
• Dry	0(0%)	11(16.7%)	11(7.3%)	
Ossicle Chain Status				
• Intact	60(90.9%)	62(93.9%)	122(92.4%)	0.878
• IS joint eroded	4(6.1%)	2(3%)	6(4.5%)	
• Handle of malleus eroded	2(3%)	2(3%)	4(3%)	





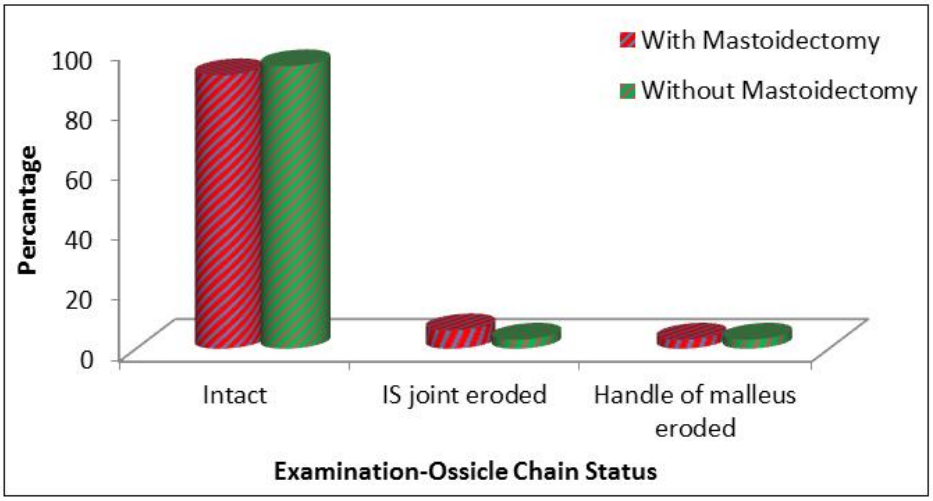
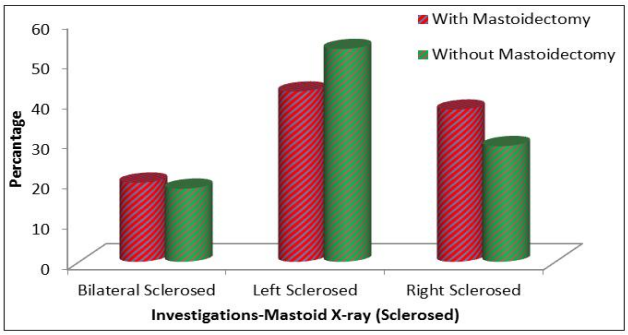
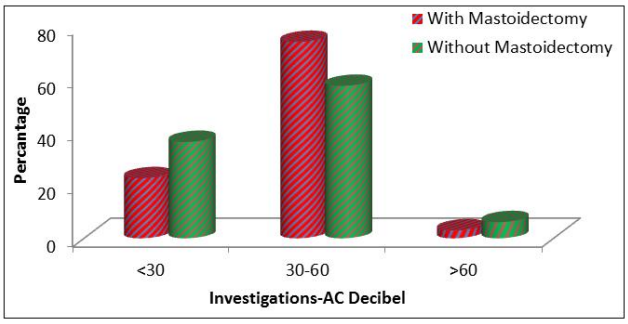


Table-7: Investigations

Investigations	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
Mastoid X-ray (Sclerosed)				
• Bilateral Sclerosed	13(19.7%)	12(18.2%)	25(18.9%)	0.441
• Left Sclerosed	28(42.4%)	35(53%)	63(47.7%)	
• Right Sclerosed	25(37.9%)	19(28.8%)	44(33.3%)	
AC Decibel				
• <30	15(22.7%)	24(36.4%)	39(29.5%)	0.116
• 30-60	49(74.2%)	38(57.6%)	87(65.9%)	
• >60	2(3%)	4(6.1%)	6(4.5%)	
AB gap Decibel				
• <30	38(57.6%)	42(63.6%)	80(60.6%)	0.593
• 30-60	27(40.9%)	24(36.4%)	51(38.6%)	
• >60	1(1.5%)	0(0%)	1(0.8%)	





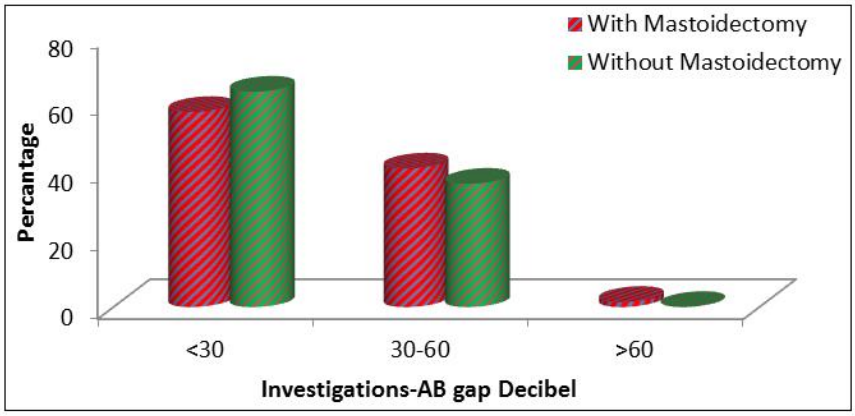
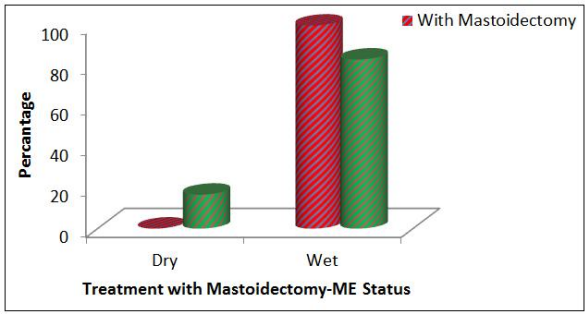


Table-8: Treatment

Treatment	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
ME Status				
• Dry	0(0%)	11(16.7%)	11(7.3%)	0.001**
• Wet	66(100%)	55(83.3%)	121(91.7%)	
Reconst +/-				
• Done	2(3%)	1(1.5%)	3(2.3%)	1.000
• Not done	64(97%)	65(98.5%)	129(97.7%)	
Graft				
• TF	66(100%)	66(100%)	132(100%)	1.000



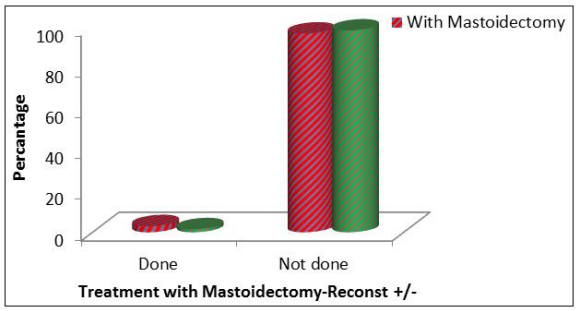
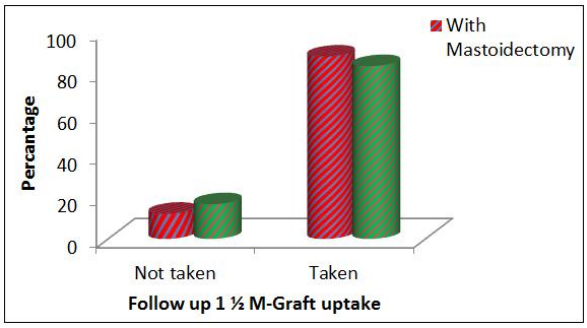


Table-9: Follow up 1 ½ M

Follow up 1 ½ M	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
Graft uptake				
• Not taken	8(12.1%)	11(16.7%)	19(14.4%)	0.457
• Taken	58(87.9%)	55(83.3%)	113(85.6%)	
Pure tone audiometery				
• Improved	54(81.8%)	52(78.8%)	106(80.3%)	0.662
• Not improved	12(18.2%)	14(21.2%)	26(19.7%)	



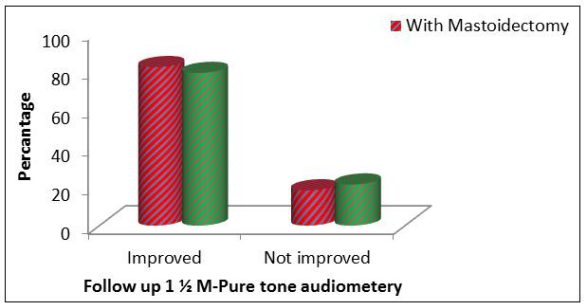
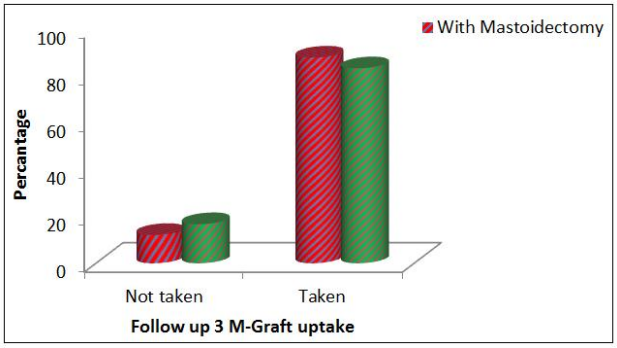


Table-10: Follow up 3 M

Follow up 3 M	With Mastoidectomy (n=66)	Without Mastoidectomy (n=66)	Total (n=132)	P value
Graft uptake				
• Not taken	8(12.1%)	11(16.7%)	19(14.4%)	0.457
• Taken	58(87.9%)	55(83.3%)	113(85.6%)	
Pure tone audiometery				
• Improved	57(86.4%)	54(81.8%)	111(84.1%)	0.475
• Not improved	9(13.6%)	12(18.2%)	21(15.9%)	



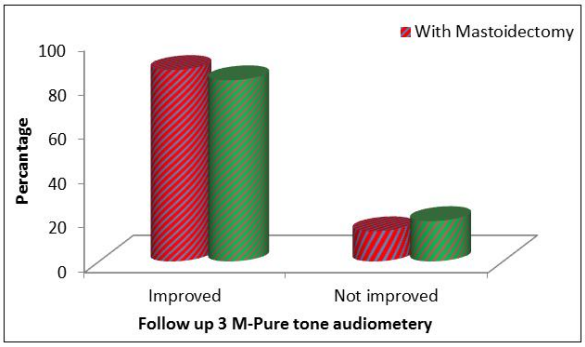
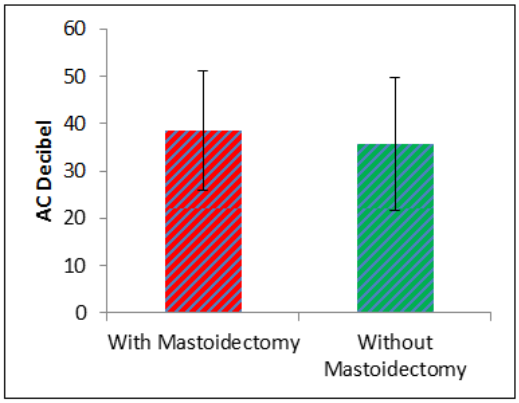
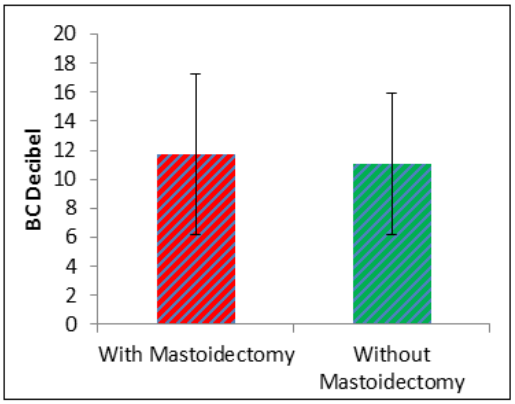


Table-11: Pure tone audiometery

Pure tone audiometery	With Mastoidectomy	Without Mastoidectomy	Total	P value
AC Decibel	38.68±12.66	35.73±14.15	37.20±13.45	0.208
BC Decibel	11.73±5.55	11.05±4.86	11.39±5.20	0.454
AB Gap	26.65±12.16	24.68±14.11	25.67±13.16	0.392





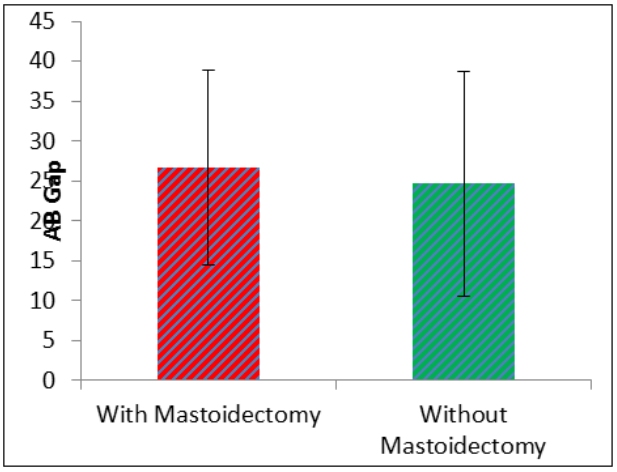
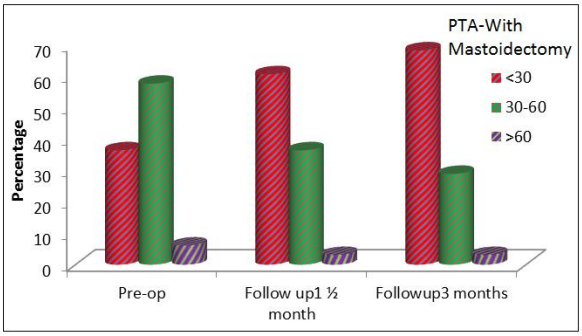
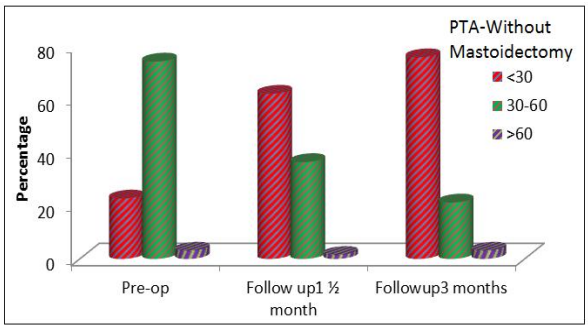


Table-12: PTA: An Evaluation at pre-op and Follow up 11/2 month and 3 months

Pure tone audiometery (PTA)	Pre-op		Follow up				% change
			1 ½ months		3 months		
	No	%	No	%	No	%	
With Mastoidectomy(n=66)							
• <30	15	22.7	41	62.1	50	75.8	+53.1
• 30-60	49	74.2	24	36.4	14	21.2	-53.1
• >60	2	3.1	1	1.5	2	3.1	0.0
Without Mastoidectomy(n=66)							
• <30	24	36.4	40	60.6	45	68.2	+31.8
• 30-60	38	57.6	24	36.4	19	28.9	-28.7
• >60	4	6.1	2	3.1	2	3.1	+3.1
P value	0.116		1.000		0.623		-





DISCUSSION

AGE GROUP WISE DISTRIBUTION

The age of patients in our study ranged from 15- 60 years as per inclusion criteria. The majority of patients were between 31-40 years i.e., 37 patients (28%). 34 (25.8 %) patients were found in the age group of 21-30 years. This correlates with the studies conducted by Saurabh Varshney *et al.*, The early presentation may be due to increased awareness to health issues and difficulty in hearing affecting the work efficiency, making patients and parents to seek early medical intervention [54]. In another study conducted by Akeem Olawale Lasisi the majority of patients were young aged 21-34 years who are economically productive and are by one way or the other affected socially or economically by the disease condition [55]. In another study by Vrabec *et al.*, found better success with advancing age. This was due to low incidence of upper airway infections and better Eustachian tube function in this age and the relative immaturity of immune function in younger children [56].

Younger the age, the incidence of the cold and upper respiratory infection is high probably which might be the reason for higher incidence of CSOM in this age group.

SEX DISTRIBUTION

Male: Female ratio in our study is 1:0.69 in group A, 1:1.28 in group B and 1:0.94 in all cases. In group A (with mastoidectomy) males were slightly more i.e. 39 patients (59.1%) and in group B (without mastoidectomy) females were slightly more i.e. 37 patients (56.1 %). There is no statistically significant difference between male and female patient. No definitive reason could be identified for the slightly higher incidence in the male patients in group A. This is against the study of Lasisi AO *et al.*, In which male to female ratio was 2: 3 in the literature. Probable poor socio-economic status, overcrowding in the residing places and close contact with children having upper respiratory tract disease, and higher incidence of CSOM discharge during pregnancy were reasons for higher female preponderance [55]. In another study conducted by M R Haque male to female ratio was 1:1.5 [57]. In a study conducted by Saurabh Varshney the most commonly affected age group was between 16-25 years as observed by various other studies due to increased awareness to health issues and difficulty in hearing affecting the work efficiency, leading patients and parents to seek early medical intervention [54].

PATHOLOGY IN THE MIDDLE EAR VS MASTOID ANTRUM (INTRAOPERATIVE)

In our study middle ear mucosa was normal was dry in 11 (7.3%) patient and wet in 121(91.7%) patients with edematous mucosa. In a study by Anitha Krishnan *et al.*, Middle ear mucosa was normal in 37% patients, polypoidal in 21% and granulations were found in 20%, and in 80 % patients with granulations tissue in the middle ear antrum, patients having polypoidal middle ear mucosa had granulations in antrum in 75% of cases hence reflecting the fact that middle ear pathology reflects the antral pathology [58].

In a study by Jonas Rickers Middle ear mucosa was normal in 11% patients, Polypoidal in 4%, Oedematous in 36% and granulation tissue was found in 57% of patients [59]. Hence preoperatively patients can be assessed whether cortical mastoidectomy is beneficial by looking at the status of the middle ear mucosal status.

Incidence of perforation in relation to side of the ear affected

In our study, left sided ear was found to be affected in 60 cases (45.5 %), this significant side predominance could not be explained, since majority of them were right-handed persons and ear picking as a cause could not be attributed to the side predominance.

This was in correlation with the study conducted by MR Haque [57]. In a study done by S.K. Nagle the perforation was more commonly found on the right side which was in contrast to our study [60].

Radiological Findings

In our study bilateral sclerosed mastoids in 25(18.9%), left side 63(47.7 %) and right side 44(33.3%), which well correlate with other study findings. Since the cases were chronic in nature probable involvement of the bone early in the disease and body defense trying to ward off the infection / confine the disease to middle ear cleft by forming reactive sclerosing around the bone could explain the sclerotic nature of the bones in the patients.

In a study by Ruhl Charles M *et al*., only 17% of patients had pneumatized bone in the Xray [61]. A well aerated mastoid is thought to act as an air reservoir for the middle ear, thus minimizing the development of negative pressures during periods of eustachian tube dysfunction [62]. The fact that these patients have developed the disease it is understood that this protective mechanism has already been lost by forming reactive sclerosis.

In another study conducted by Ruhl *et al*., 38 patients had soft tissue or fluid identified in the mastoid, epitympanum or middle ear space leading to development of sclerosis of mastoid bone [61]. This also correlates with findings of Jonas Rickers the cellular mastoid was described as well pneumatized in 47%. Of these patients 74% had mastoid inflammation and 28% had fluid in the mastoid cells [59].

Graft material Used

In our study, temporalis fascia (132 cases) was used in tympanoplasty. Informed consent was taken before the surgery. In a study conducted by S. K. Nagle Temporalis fascia remains the most commonly used graft material in tympanoplasty [58]. In a study conducted by Karkanevatos the type of graft used had no apparent effect on surgical outcome when using temporalis fascia, subcutaneous tissue or perichondrium [62].

Improvement

End point of the study was considered by two points Post-operative hearing improvement and graft take up at the end of three months.

Hearing Improvement

In our study, after three months in group A, 57 patients (86.4%) hearing had improved, while in group B, 54 patients (81.8%). In a study by Krishnan A *et al*., post-operative hearing gain was 75% in both groups [58]. In a study conducted by Albu *et al*., found many anatomic and technical factors responsible for postoperative hearing results. The mucosal status of the middle ear was the most important predictive factor. The presence of the manubrium mallei was the second most important predictive factor as it allows for the proper adaptation of the Myringoplasty graft and optimizes the stability of the reconstructed ossicular chain [63].

Contradictory to the above Halik and Smyth found that secretion type, site of perforation, and graft material had no adverse effect on hearing. They report their success rates as being comparable to other quoted literature. They had approximately an 80% success rate of closure of the air-bone gap to within 10 dB at five years but could not comment on results beyond this period as many of their patients were discharged from follow -up. They recommended aiming for a final air-conduction threshold less than 30 dB or within 15 dB of the other ear for the patient to benefit from binaural hearing and sound localization [64].

Blakley *et al*., studied the relationship between pre- and post-operative hearing in 124 patients undergoing tympanoplasty. They found that poor hearing before surgery was associated with poor healing after surgery, regardless of anatomy. They concluded that, in ears with persistent infection, the hearing outcome after mastoidotympanoplasty surgery depended more on pre-operative hearing levels than on the type of tympanoplasty performed. This was in cordinance with K V Bhat who observed that ears with a wider preoperative air–bone gap fared more poorly after surgery, compared with those with a narrower air–bone gap [65]. In a study conducted by Asok K Saha Type 1 tympanoplasty with simple cortical mastoidectomy showed excellent surgical success rate (100%) but lesser degree of improvement of hearing. In type 1 tympanoplasty alone the surgical success rate dropped to 80-75% but there was more closure of AB gap (6.70dB) indicating greater degree of improvement of hearing [66].

GRAFT TAKE UP

In our study patients undergoing tympanoplasty alone using temporalis fascia graft in 66,

55(83.3%) had taken up. Among patients undergoing tympanoplasty with mastoidectomy 66 patients had temporalis fascia used and 58(87.9%) had taken up the graft.

In a study conducted by Sudhangshu Shekar Biswas temporalis fascia graft take up was 85% (51 out of 60) and graft failure was15% (9 out of 60) [34]. This rate of graft uptake was more or less similar to Kotecha (82%) and Ugo fish (86%), whereas Eero vartiainen showed that rate of graft intake 91.2% which is significantly higher than this study.

In a study conducted by Halik JJ Homograft dura and autologous temporalis fascia had no significant difference in take rates. They did report a trend for better results when using fascia and operating on dry ears [64]. In a study conducted by Mishiro *et al*., compared their own surgical experience with and without mastoidectomy in CSOM and found no significant difference in graft success rates, regardless of otorrhoea or whether computed tomography showed an antral block [3]. Similarly, Balyan *et al*., 48 studied patients with CSOM, treated by means of tympanoplasty with and without mastoidectomy, and patients with current dry perforation with a history of CSOM treated with tympanoplasty alone. They found no significant difference in graft failure rates or hearing results compared with the literature, or any difference in outcome measures whether or not drainage was present. They also concur that the addition of mastoidectomy adds increased effort and risk to the surgery [67].

GRAFT FAILURES

In our study group A, 8 patients (12.1%) graft was not taken, while in group B, 11 patients (16.7 %) graft was not taken.

In 1993, Vartianiner, in his report on study of failures in myringoplasty using temporalis fascia, put the necrosis in the middle of the graft without infection and anterior blunting as the commonest of the cause of early failures. Infection was the most common cause of late failures. They claim that the preoperative factors such as dry or wet ear, site of perforation, or grafting technique (overlay or underlay) do not affect the take up rate [1]. In a study conducted by Vijayendra H the graft failure rate is more in totally dry perforation than in wet perforation mainly because of avascularity of remnant of tympanic membrane in totally dry central perforation [68]. In a study conducted by Hirsch B E states that one must attempt to determine whether failure of the graft was due to technical error, infectious complications, or poor tubal function. Failures due to the first two reasons are often amenable to revision surgery. Patients with poor tubal function and recurrent otorrhoea may require a revision mastoidotympanoplasty [69].

RESULTS IN RELATION TO THE SIZE OF PERFORATION

In this study there is no relation between size of perforation and graft take up rate and hearing gain.

The larger the perforation, greater the decibel loss in sound perception. The location of perforation on the tympanic membrane and the duration of ear discharge have significant effect on the magnitude of hearing loss [70]. In a study conducted by K V Bhat states that higher surgical failure in cases of larger perforation [65]. This was similar to a study done by Warren Y Adkins who stated that larger perforations had more failure rates [71]. Contradictory to this in a study conducted by Raj A the size of the perforation had no effect on the results of myringoplasty [72]. Similarly in a study conducted by Benjamin D Webb, smaller perforations are sometimes thought to have higher success rates of closure than larger perforations. There was a significantly higher percentage of cases of perforation smaller than 40% in the dry perforation group than in the CSOM group (66.0% vs 48.7%; P=.046). However, the success rates for perforations smaller than 40% and 40% or larger at 1 year were not significantly different in general (93.0% vs 85.1%, respectively; P=.11) [73].

In a study conducted by Eero Vartianen, re perforations were found significantly more in ears with large perforations (>50% of the total drum area) in contrast to ears with small perforations (<50%). This was probably due to poor vascular supply to the graft, when a large area of the graft lies unsupported in space so that the surface area from which the blood supply is derived is relatively small. Grafting a large area is also technically more difficult than grafting a smaller one [74]. In a study conducted by R Aggarwal higher success rate with smaller perforations (measuring less than 50% of the tympanic membrane pars tensa) [62]. In a study done by Toros S Z *et al*., Tympanic membrane perforation closure was successful in 76.1% of the 46 patients undergoing myringoplasty and in 78.3% (n = 36) of the 46 patients undergoing myringoplasty with mastoidectomy. The difference between the closure rates of the two groups was not statistically significant ($p > 0.05$). The difference between the two groups for hearing gain was also not statistically significant ($p > 0.05$) [75].

SUCCESS RATE IN PATIENTS UNDERGOING TYMPANOPLASTY WITH OR WITHOUT MASTOIDECTOMY

TYMPANOPLASTY WITH MASTOIDECTOMY GROUP

Balyan *et al*., have reported equivalent results of graft take up and hearing result with or without mastoidectomy in their series of 323 tympanoplasties [67]. Mishiro *et al*., also supported the use of tympanoplasty without mastoidectomy in chronic non-cholesteatomatous otitis media with an equivalent rate

of grafting success and hearing results regardless of the state of the ear at repair (draining vs. nondraining) or the addition of a mastoidectomy [3]. Although mastoidectomy may be done on simple tympanic membrane perforation, there is no clear advantage for its routine practice in CSOM in the absence of any sign of active infection or disease [76]. In a study conducted by Holmquist and Bergstrom suggested that mastoidectomy improves the chance of successful tympanoplasty for patients with noncholesteatomatous chronic otitis media. They maintained that creation of an aerated mastoid enhances success in patients with poor tubal function or a small mastoid air cell system [77]. In their retrospective study Balyan *et al*., maintain that mastoidectomy is usually not necessary for treatment of patients with non cholesteatomatous chronic otitis media [67].

In a study conducted by Ruhl who believed that by restoring the connection between the middle ear and mastoid, and by opening up the mastoid, a physiological pressure buffer can be re-created. In accordance with Boyle's Law, the additional volume created by the surgically opened mastoid would restore the pressure-buffering effect of the mastoid air cell system [61]. A study by McGrew et al examined the effect of mastoidectomy with canal wall up on 484 dry, post infectious, unoperated, noncholesteatomatous TM perforations v/s tympanoplasty alone. Their results showed identical perforation closure success rates of 91% in each group. Hearing results were also statistically insignificant. With a mean follow-up time of 32 months in each group, there were more subsequent procedures related to the original indication for surgery in the group that underwent tympanoplasty alone, but this was not statistically significant [78]. This is supported by Ryner Jose C *et al*., stating that although mastoidectomy may be done on simple TM perforations there is no clear advantage for its routine practice in CSOM in absence of active infection or disease [76].

STUDIES SUPPORTING MASTOIDECTOMY IN CHRONIC OTITIS MEDIA

In a study conducted by Holmquist & Bergstrom of a sample size of 31 patients which were followed up for a period of 6 months had a success rate of 83% in MTP and 50% in TP remarking only small mastoids were selected [77]. In a study conducted by Jackler & Schindler of a sample size of 48 patients which were followed up for a period of 8 years had a success rate of 84.6% in MTP revealing MTP a safe & useful adjunct to TP in selected cases [79]. In a study conducted by Lau & Tos of a sample size of 229 patients which were followed up for a period of 11 years had a success rate of MTP reperforations 12% and reoperations 16% recommending single stage, canal wall up MTP in non cholesteatomatous granulating otitis [80]. In a study conducted by Vartiainen & Kansanen of a sample size of 221 patients which were followed up for a period of 6.3 years had an infection control rate of 92% in MTP revealing that MTP compared for pseudomonas & non pseudomonas infected CSOM 84% underwent single stage MTP [81].

In a study conducted by Ruhl *et al*., of a sample size of 135 patients which were followed up for a period of 8 years had a success rate of 90.4% in MTP revealing MTP indicated for previous, failed TP [61]. In a study conducted by Krishnan et al of a sample size of 120 patients which were followed up for a period of 3 years had a success rate of 80% in MTP and 50% in TP revealing open the mastoid antrum only if middle ear mucosa is unhealthy [58]. In a study conducted by Nayak D R *et al*., of a sample size of 40 patients which were followed up for a period of 20.4 months had a success rate of 100% in MTP and 60% in TP revealing that mastoidectomy is required even if ear is dry [82].

STUDIES NOT SUPPORTING MASTOIDECTOMY IN CHRONIC OTITIS MEDIA

In a study conducted by Pratt *et al*., of a sample size of 50 patients which were followed up for 2yrs had a success rate of 84% revealing that mastoidectomy does not prevent failures when done with tympanoplasty [83]. In a study conducted by Balyan *et al*., of a sample size of 81 patients which were followed up for a mean 34 months MTP had a success rate of 85.7% TP had a success rate of 90.5% revealing mastoidectomy as a avoidable procedure in this disease adding only extra effort and risk [67]. In a study conducted by Mishiro *et al*., of a sample size of 251 patients which were followed up for a 31.7 months had a success rate of 90.5% in MTP and in TP 93.3% revealing that Mastoidectomy is not helpful in tympanoplasty even if ear is discharging as it only increases risk of post-operative complications [84].

In a study conducted by McGrew *et al*., of a sample size of 484 patients which were followed up for a period of 33 months had a success rate of 91.6% in MTP and 90.6% in TP revealing that mastoidectomy is not necessary for successful repair of simple TM perforations but may improve underlying disease process [78]. In a study conducted by Mutoh *et al*., of a sample size of 49 patients which were followed up for a period of 16.8 months had a success rate of 90% in MTP and 62.5% in TP revealing that MTP was found to be superior to TP only in MRSA infected ears [85]. In a study conducted by R Aggarwal, tympanoplasty done alone or in combination with mastoidectomy did not produce successful closure of tympanic membrane [62].

CONCLUSION

From Dec 2013 to June 2015, this prospective study was conducted on 132 patients. The patients are allocated to the two study groups based on surgeon preferences, considering the inclusion and exclusion criteria. The outcome of results of tympanoplasty with

mastoidectomy were compared with tympanoplasty without mastoidectomy in the safe type of CSOM. The conclusion drawn were:

- Hearing improvement following tympanoplasty alone and tympanoplasty with mastoidectomy were comparable. No statistical difference was found in either of the two groups. Combining Mastoidectomy with tympanoplasty will not give additional significant benefit in terms of hearing improvement or disease clearance.
- Mastoidectomy procedure will result in additional surgical time without added benefit.
- Mastoidectomy may be considered in following situation
  - If ear continue to discharge after adequate medical treatment
  - In presence of polyp/polypoidal middle ear mucosa or granulation tissue in the middle ear.
  - Infection also represents a very important cause of graft failure and can result from a hidden mastoid disease. A simple mastoidectomy is an effective means of repneumatising the mastoid air cell system as well as eradicating the mastoid source of infection.

SUMMARY

- A total of 132 patients were included in the study and divided into two group (66 in each group A and B).
- The age group was between 15-60 years. Most of them were in the age group of 31-40 years. In this male: female ratio was 1.06
- All the patients presented with ear discharge and decreased hearing. Of these 87 (65.9%) patients presented with anterior perforation, 12(9.1%) patients had posterior perforation and 33(25%) patients had subtotal perforation.
- Majority of patients were affected on left (60 patients 45.5%). On taking x-ray mastoids 63(47.7 %) patients had sclerosed left mastoid.
- Degree of hearing loss in group A, 66 patients were minimal hearing loss in 10 (15.2%), mild hearing loss in 29 (43.9%), moderate hearing loss 26 (39.4%) and severe hearing loss in 1(1.5 %) patient. Degree of hearing loss in group B, 66 patients-minimal hearing loss in 20 (30.3%), Mild hearing loss in 25 (37.9%), and moderate hearing loss 21 (31.8%). Post aural approach was used in the above two groups.
- Temporalis fascia was used in all cases. Graft take up success rate was statistically insignificant in both the groups.
- Postoperatively hearing improvement was found in 111(84.1%) patients, tympanoplasty with mastoidectomy 57 (86.4%) patient and tympanoplasty without mastoidectomy 54 (81.8 %) patients.
- Post-operative follow-up after three months showed significant improvement in PTA value in both the study group, where maximum number of patients in group A 75.8%, PTA was within range of <30 dB, while in group B 68.2% of patients were having PTA value within similar range.
- Considering the preoperative AC average and postoperative AC average, 3 months after the surgery. In our study hearing improvement was slightly more in group of tympanoplasty with mastoidectomy, but in comparison of both the study group it is statistically insignificant.
- Graft take rate in group A was 87.9 % and failure in 12.1 %, in group B however the graft take rate was not statistically significant.

LIMITATIONS OF THE STUDY

- A sample size of 132 was taken from a population attending our hospital, is less and selection is too difficult to prevent confounding factors.
- The study period was 3 months postoperatively for each subject; however, a longer duration could have shown more significant response.
- Either randomization or inclusion of controls in the study would have given more insight into the data obtained.
- Allocation of surgery in terms of tympanoplasty alone or tympanoplasty with mastoidectomy was sequential and was not grouped or randomized.
- Techniques followed for tympanoplasty differed from surgeon to surgeon.
- Size of perforation varied in two groups and groups were not comparable.

MASTER CHART – WITH MASTOIDECTOMY

SI	Age	Sex	R/L, B/L	Presenting Complaints – Ear Discharge – Duration	Presenting Complaints – Ear Discharge – Colour	Presenting Complaints – Ear Discharge – Active/ Inactive	Presenting Complaints – Hearing Impairment – Duration	Presenting Complaints – Hearing Impairment – Progressive/Stationary	Presenting Complaints – Hearing Impairment – Degree	Examination – T M – Perforation AP/PP/ST	Examination – M E – Wet/Dry	Examination – Ossicle Chain Status	Investigations – Mastoid X-ray (Sclerosed)	Investigations – PTA – AC dB	Investigations – PTA – BC dB	Investigations – PTA – AB gap dB	Treatment with mastoidectomy – ME Status	Treatment with mastoidectomy – Reconst +/-	Treatment with mastoidectomy – Graft	Follow-up – 1 ½ M – Graft uptake	Follow-up – 1 ½ M – PTA /AC	Follow-up – 3M – Graft uptake	Follow-up – 3M – PTA/AC
1	35y	M	B/L	4yrs	Yellowish	Active	4yrs	Progressive	Mild	AP	Wet	Intact	Left Sclerosed	38	15	23	Wet	Not done	TF	Taken	Improved 25	Taken	Improved 20
2	45y	M	L	1yr	Yellowish	Active	2yrs	Stationary	Mild	AP	Wet	Intact	Left Sclerosed	32	10	22	Wet	Not done	TF	Taken	Improved 20	Taken	Improved 15
3	57y	F	B/L	2yrs	Yellowish	Active	2yrs	Progressive	Mild	AP	Wet	Intact	Right Sclerosed	40	10	30	Wet	Not done	TF	Taken	Improved 25	Taken	Improved 20
4	20y	F	B/L	3yrs	Watery	Active	3yrs	Stationary	Mild	AP	Wet	Intact	B/L Sclerosed	40	10	30	Wet	Not done	TF	Taken	Improved 35	Taken	Improved 20
5	30Y	M	R	6mths	Watery	Active	6mths	Stationary	Minimal	AP	Wet	Intact	Right Sclerosed	30	5	25	Wet	Not done	TF	Taken	Improved 20	Taken	Improved 15
6	27y	F	L	2ys	yellowish	Active	2ys	progressive	Moderate	AP	Wet	Intact	Left Sclerosed	50	15	35	Wet	Not done	TF	Taken	Improved 50	Taken	Improved 25
7	25y	M	R	6mths	Yellowish	Active	1 yr	Stationary	Moderate	AP	Wet	Intact	Left	40	5	35	Wet	Not done	TF	Taken	Improved 25	Taken	Improved 20
8	50y	F	L	1yr	Yellowish	Active	1yr	Progressive	Mild	ST	Wet	Handle of malleus eroded	Left Sclerosed	30	5	25	Wet	Not done	TF	Taken	Improved 25	Taken	Improved 20

Improved 20	Improved 30	Not Improved 55	Improved 15	Improved 45	Improved 45	Improved 45	Improved 30	Improved 20	Improved 20	Improved 15	Not Improved 30
Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Not Taken
Improved 25	Improved 35	Not Improved 50	Improved 25	Improved 50	Improved 50	Improved 50	Improved 35	Improved 25	Improved 25	Improved 15	Not Improved 30
Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Not Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
25	35	20	40	28	40	36	20	23	13	18	18
5	5	30	5	28	15	25	20	8	17	5	10
30	40	50	45	56	55	61	40	31	30	23	28
Right Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	BL Sclerosed	B/L Sclerosed	BL Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	IS joint eroded	Intact	Intact	Intact	Intact	Handle of malleus eroded
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	AP	AP	AP	ST	ST	AP	AP	ST	ST	AP	PP
Mild	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Mild	Minimal	Mild
Progressive	Progressive	Progressive	Stationary	Progressive	Stationary	Progressive	Progressive	Progressive	Progressive	Progressive	Progressive
4yrs	1yr	2yrs	8mths	3yrs	2yrs	4yrs	8mths	5yrs	6yrs	7yrs	6yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Yellowish	Mucoid	Yellowish	Mucoid	Watery	Watery	Yellowish	Yellowish	Mucoid	Yellowish	Mucoid	Yellowish
4yrs	1yr	3yrs	6mths	3yrs	2yrs	4yrs	8mths	5yrs	6yrs	8yrs	6yrs
R	L	L	R	L	B/L	L	B/L	L	R	L	L
F	M	M	F	M	M	M	F	F	M	M	F
39y	27y	35y	30y	20y	60y	59y	54y	55y	49y	18y	60y
9	10	11	12	13	14	15	16	17	18	19	20

Improved 45	Improved 20	Improved 20	Improved 15	Improved 15	Not Improved 65	Improved 16	Improved 20	Improved 15	Improved 20	Improved 16
Taken	Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken
Improved 50	Improved 40	Improved 25	Improved 20	Improved 20	Not Improved 60	Improved 20	Not Improved 30	Improved 20	Improved 25	Improved 20
Taken	Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
45	45	30	23	10	45	13	15	20	15	20
15	13	5	5	13	15	10	15	10	15	5
60	58	35	28	23	60	23	30	30	30	25
BL Sclerosed	B/L Sclerosed	BL Sclerosed	Left	Right Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	BL Sclerosed	Left Sclerosed
IS joint Eroded	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
ST	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP
Moderate	Moderate	Mild	Mild	Minimal	Moderate	Minimal	Mild	Minimal	Mild	Mild
Progressive	Stationary	Progressive	Progressive	Stationary	Progressive	Progressive	Stationary	Stationary	progressive	Progressive
8yrs	1yr	1yr	1yr	2yrs	6 yrs	4Yrs	6mths	2yrs	4yrs	3 yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	yellowish	Yellowish	Yellowish	Mucoid	Yellowish	Yellowish
8yrs	1yr	1yr	2yrs	2yrs	6 yrs	4 yrs	1yr	2yrs	4yrs	3 yrs
B/L	L	B/L	L	R	B/L	L	L	R	BL	L
M	F	M	M	F	M	M	F	M	M	M
32y	60y	19y	37y	30y	20y	33y	35y	34y	50y	36y
21	22	23	24	25	26	27	28	29	30	31

Improved 35	Not Improved 50	Improved 30	Improved 15	Improved 20	Not Improved 50	Improved 15	Improved 30	Improved 35	Improved 15	Improved 20	Improved 50
Taken	Not Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken
	Not Improved 45	Improved 35	Improved 20	Improved 25	Not Improved 50	Improved 25	Improved 35	Not Improved 45	Improved 20	Not Improved 35	Not Improved 55
Taken	Not Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
40	30	35	12	19	39	21	32	32	20	25	42
13	15	5	13	16	11	10	11	13	8	10	11
53	45	40	25	35	50	31	43	45	28	35	53
Left Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	BL Sclerosed	BL Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
ST	AP	AP	PP	ST	AP	AP	ST	ST	AP	AP	ST
Moderate	Moderate	Minimal	Mild	Mild	Moderate	Mild	Moderate	Moderate	Mild	Mild	Moderate
Progressive	progressive	Progressive	Progressive	Progressive	Progressive	Stationary	Progressive	Progressive	Stationary	Progressive	Progressive
1y	4yrs	2yrs	4yrs	8yrs	8yrs	10yrs	4yrs	2yrs	1Y	6yrs	4yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Watery	Yellowish	Yellowish	Yellowish	Mucoid	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish
1y	4yrs	2yrs	4yrs	8yrs	8yrs	10yrs	4yrs	2yrs	1y	6yrs	4yrs
L	R	L	L	L	R	L	L	R	R	B/L	B/L
M	M	M	M	M	F	M	M	M	M	F	M
43y	32y	32y	19y	44y	53y	27y	20y	28y	16y	47y	37y
32	33	34	35	36	37	38	39	40	41	42	43

Improved 20	Improved 15	Not Improved 60	15	Improved 20	Not Improved 75	Improved 30	Improved 25	Improved 15	Improved 45	Not Improved 25	Not Improved 60
Taken	Taken	Not Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Not Taken
Improved 25	Improved 20	Not Improved 55	Improved 20	Improved 25	Not Improved 75	Improved 35	Improved 25	18	Improved 50	Improved 25	Not Improved 60
Taken	Taken	Not Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Not Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
25	16	45	10	13	63	35	21	11	23	19	45
8	15	5	15	20	10	13	15	10	10	16	13
33	31	50	25	33	73	48	36	21	53	35	58
Right Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	Left Sclerosed	Right Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	AP	AP	ST	AP	ST	AP	AP	AP	AP	ST	AP
Mild	Mild	Moderate	Mild	Mild	Severe	Moderate	Mild	Minimal	Moderate	Mild	Moderate
Progressive	Progressive	Progressive	Progressive	Progressive	Progressive	Stationary	Progressive	Progressive	Progressive	Progressive	Progressive
1yr	2yrs	1yr	2yrs	10yrs	1.5y	2yrs	1y	3yrs	5yrs	2yrs	4yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Yellowish	Yellowish	Mucoid	Yellowish	Yellowish	Yellowish	Yellowish	Mucoid	Yellowish	Yellowish	Mucoid	Yellowish
2yrs	2yrs	6mths	2yrs	10yrs	1.5y	2yrs	1y	4yrs	5yrs	2yrs	4yrs
R	L	BL	R	R	L	R	R	R	R	B/L	R
M	F	M	M	F	F	M	M	F	F	M	F
18y	17y	38y	25y	60y	54y	29y	27y	60 y	27y	36y	40 y
44	45	46	47	48	49	50	51	52	53	54	55

Improved 15	Improved 20	Improved 15	Improved 43	Improved 15	Improved 15	Improved 14	Improved 13	Improved 15	Improved 25	Improved 15
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
Improved 25	Improved 20	Improved 30	Improved 58	Improved 30	Improved 20	Improved 15	Improved 15	Improved 30	Improved 30	Improved 20
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
19	15	40	50	40	5	13	15	33	35	12
16	15	5	10	10	21	8	8	10	10	13
35	30	45	60	50	26	21	23	43	45	25
Left Sclerosed	Right Sclerosed	Left Sclerosed	BL Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	BL Sclerosed	BL Sclerosed
Intact	Intact	Intact	IS joint eroded	IS joint eroded	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	W et	Wet	Wet	Wet	Wet	Wet	Wet
AP	AP	PP	ST	ST	PP	AP	AP	ST	AP	AP
Mild	Mild	Moderate	Moderate severe	Moderate severe	Mild	Minimal	Mild	Moderate	Moderate	Mild
Progressive	Progressive	Stationary	Progressive	Progressive	Progressive	Progressive	Progressive	Progressive	Progressive	Stationary
2yrs	2yrs	4yrs	4yrs	2yrs	6mths	4yrs	3yrs	4yrs	7mths	3yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Mucoid	Mucoid	Yellowish	Yellowish	Yellowish	Yellowish
2yrs	2yrs	2yrs	4yrs	2yrs	7mths	4yrs	2yrs	4yrs	8mths	2yrs
L	R	L	B/L	L	R	R	R	R	R	L
M	F	F	F	M	F	M	F	F	M	F
35 y	38y	34 y	60y	43y	59y	29y	55y	31y	17 y	23y
56	57	58	59	60	61	62	63	64	65	66

MASTER CHART – WITHOUT MASTOIDECTOMY

SI	Age	Sex	R/L, B/L	Presenting Complaints						Examination			Investigations				Treatment without mastoidectomy			Follow-up			
				Ear Discharge			Hearing Impairment			TM	ME			PRE.OP PTA						1 ½ Month		3M	
				Duration	Colour	Active/ Inactive	Duration	Progressive/ Stationary	Degree	Perforation AP/PP/ST	Wet/ Dry	Ossicle chain status	Mastoid X-ray Sclerosed	AC dB	BC dB	AB gap dB	ME Status	Reconst +/-	Graft	Graft uptake	PTA/AC	Graft uptake	PTA/AC
1	27y	M	L	3y	Mucoid	Active	3yrs	Progressive	Moderate	AP	Wet	Intact	Left Sclerosed	50	5	45	Wet	Not done	TF	Not Taken	Not Improved 55	Not Taken	Not Improved 60
2	30y	F	R	2yrs	yellowish	Active	2yrs	Stationary	Mild	ST	Wet	Intact	Right Sclerosed	40	10	30	Wet	Not done	TF	Taken	Improved 30	Taken	Improved 25
3	51y	M	L	2yrs	Watery	Active	2yrs	Stationary	Mild	ST	Wet	Handle of malleus eroded	Left Sclerosed	40	15	25	Dry	done	TF	Not taken	Not Improved 45	Not Taken	Not Improved 50
4	60y	M	L	1Y	Dry	Inactive	1Y	Stationary	Moderate	AP	Dry	Intact	Left Sclerosed	50	35	15	Dry	Not done	TF	Taken	Improved 35	Taken	Not Improved 35
5	35y	F	B/L	8mths	Dry	Inactive	8mths	Stationary	Mild	PP	Dry	Intact	Right Sclerosed	30	15	15	Dry	Not done	TF	Taken	Improved 25	Taken	Improved 20
6	35y	M	R	10mths	Dry	Inactive	10mths	Stationary	Minimal	AP	Dry	Intact	Left Sclerosed	25	10	15	Dry	Not done	TF	Taken	Improved 20	Taken	Improved 15
7	60y	F	L	3yrs	Watery	Active	3yrs	Stationary	Mild	AP	Wet	Intact	Left Sclerosed	40	10	30	Wet	Not done	TF	Taken	Improved 30	Taken	Improved 25
8	35y	F	B/L	1Y	Mucoid	Active	1Y	Stationary	Mild	ST	Wet	Intact	BL Sclerosed	40	8	32	Wet	Not done	TF	Taken	Improved 20	Taken	Improved 15
9	30y	M	B/L	10yrs	Yellowish	Active	10Yrs	Progressive	Moderate severe	AP	Wet	Intact	BL Sclerosed	60	5	55	Wet	Not done	TF	Taken	Improved 50	Taken	Improved 45

Improved 15	Not Improved 50	Not Improved 65	improved 20	Not Improved 55	Improved 15	Improved 15	Improved 25	Not Improved 45	Improved 15	Improved 15	Not Improved 40
Taken	Not Taken	Not Taken	Taken	Not Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Not Taken
Improved 20	Not Improved 50	Not Improved 65	Improved 25	Not Improved 50	Improved 20	Improved 20	Improved 30	Not Improved 45	Improved 20	Improved 20	Not Improved 35
Taken	Not taken	Not taken	Taken	Not Taken	Taken	Taken	Taken	Not Taken	Taken	Taken	Not Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Dry	Wet
25	37	58	20	32	20	15	25	40	25	8	26
5	11	3	15	13	10	15	10	5	5	15	5
30	48	61	35	45	30	30	35	45	30	23	31
Right Sclerosed	B/L Sclerosed	BL Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed
Intact	Intact	IS joint eroded	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Dry	Wet
AP	AP	AP	ST	AP	ST	ST	PP	ST	AP	PP	AP
Mild	Moderate	Moderately severe	Minimal	Mild	Mild	Minimal	Mild	Moderate	Minimal	Minimal	Mild
Stationary	Stationary	Stationary	Stationary	Stationary	Progressive	Stationary	Stationary	Stationary	Stationary	Stationary	Progressive
4Yrs	6Yrs	1Y	9Mths	3yrs	2yrs	3yrs	8mths	1Y	4yrs	7mths	8mths
Active	Active	Active	Active	Active	Active	Active	Inactive	Inactive	Active	Inactive	Active
Mucoid	Watery	Yellowish	Watery	Watery	Watery	Mucoid	Dry	Dry	Mucoid	Dry	Watery
4yrs	6yrs	5Yrs	2Yrs	3yrs	2yrs	3yrs	8mths	1y	4yrs	7mths	8mths
R	B/L	B/L	L	R	R	R	L	L	L	L	L
F	M	M	M	F	F	M	F	F	M	M	F
24y	40y	20y	39y	15y	28y	26y	28y	15y	15	57y	34y
10	11	12	13	14	15	16	17	18	19	20	21

Improved 15	Improved 55	Improved 35	Improved 25	Improved 30	Improved 15	Improved 30	Improved 15	Improved 35	Improved 50	Improved 15	Improved 15
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
Improved 20	Improved 60	Improved 40	Improved 30	Improved 40	Improved 20	Not Improved 36	Improved 20	Improved 40	Improved 55	Improved 20	Improved 20
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Dry	Wet	Dry	Dry	Dry	Wet	Wet	Wet	Wet	Wet	Wet	Wet
15	53	32	28	37	9	20	20	35	48	20	15
10	15	16	10	13	16	11	10	15	13	10	10
25	68	48	38	50	25	31	30	50	61	30	25
Right Sclerosed	L Sclerosed	R Sclerosed	BL Sclerosed	Right Sclerosed	Right Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	BL Sclerosed	Left Sclerosed	Left Sclerosed
Intact	IS joint eroded	Intact	Intact	Intact	Intact	intact	Intact	Intact	Intact	Intact	Intact
Dry	Wet	Dry	Dry	Dry	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	ST	ST	AP	ST	PP	AP	AP	ST	ST	ST	AP
Minimal	Moderate severe	Moderate severe	Mild	Moderate	Minimal	Mild	Minimal	Moderate	Moderate severe	Mild	Mild
Stationary	Progressive	Progressive	Stationary	Stationary	Stationary	Stationary	Stationary	Progressive	Progressive	Progressive	Stationary
4yrs	6yrs	5yrs	8mths	3yrs	5yrs	3yrs	8mths	3yrs	2yrs	1Y	3yrs
Inactive	Active	Inactive	Inactive	Inactive	Active	Active	Active	Active	Active	Active	Active
Dry	Watery	Dry	Dry	Dry	Watery	Watery	Yellowish	Mucoid	Mucoid	Mucoid	Watery
6mths	6yrs	5yrs	8mths	8Mths	5yrs	3yrs	8mths	3yrs	2yrs	1Y	3yrs
R	L	B/L	B/L	B/L	R	L	R	L	B/L	L	L
M	M	M	F	F	F	M	M	F	M	M	M
32y	34y	30y	26y	31y	60y	18y	15y	52y	28y	15y	51y
22	23	24	25	26	27	28	29	30	31	32	33

Not Improved 60	Improved 45	Not Improved 60	Improved 15	Improved 15	Improved25	Improved 15	Improved 15	Improved 15	Improved 15	Not Improved 70	Improved 30
Not Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Not Taken	Taken
Not Improved 60	Improved 50	Not Improved 60	Improved 20	Improved 20	Improved 30	Improved 25	Improved 24	Improved 20	Improved 20	Not Improved 70	Improved 40
Not Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Not Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
39	38	43	20	20	26	23	13	23	17	58	22
16	15	13	8	10	10	13	13	13	13	10	23
55	53	56	28	30	36	36	26	36	30	68	45
Left Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	BL Sclerosed	BL Sclerosed	BL Sclerosed	Left Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	PP	AP	AP	PP	PP	AP	AP	ST	AP	AP	AP
Moderate	Moderate severe	Moderate severe	Mild	Mild	Mild	Mild	Mild	Mild	Minimal	Moderately severe	Moderate
Progressive	Progressive	Progressive	Stationary	Stationary	Progressive	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
6yrs	6yrs	2yrs	5yrs	1y	2y	5yrs	1y	2yrs	2yrs	1y	3yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Yellowish	Mucoid	Watery	Mucoid	Mucoid	Yellowish	Mucoid	Mucoid	Watery	Mucoid	Mucoid	Mucoid
6yrs	6yrs	2yrs	5yrs	1y	2y	5yrs	1y	2yrs	2yrs	1y	3yrs
L	L	R	L	R	L	L	R	B/L	B/L	B/L	L
F	F	F	F	M	F	F	F	F	F	F	F
55y	58y	28y	27y	15y	24y	27y	29y	33y	45y	27y	26y
34	35	36	37	38	39	40	41	42	43	44	45

Improved 15	Improved 20	Improved 15	Not Improved 55	Improved 15	Improved 15	Improved 40	Improved 30	Improved 15	Improved 20	Improved 15	Improved 20
Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
Improved 20	Improve 25	Improved 20	Not Improved 50	Improved 20	Improved 20	Not Improved 50	Improved 35	Improved 20	Improved 25	Improved 20	Improved 25
Taken	Taken	Taken	Not Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
8	27	6	36	25	17	40	35	25	19	20	30
13	8	15	10	5	8	10	10	10	11	5	10
21	35	21	46	30	25	50	45	35	30	25	40
Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	BL Sclerosed	BL Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	Intact	Handle of malleus eroded	Intact	Intact	Intact	Intact
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	AP	AP	AP	AP	PP	ST	ST	AP	AP	AP	AP
Minimal	Mild	Minimal	Moderate	Minimal	Minimal	Moderate	Moderate	Minimal	Mild	Minimal	Minimal
Stationary	Progressive	Stationary	Stationary	Stationary	Stationary	Stationary	Progressive	Stationary	Stationary	Stationary	Stationary
1y	3yrs	1y	6yrs	4yrs	8mths	3yrs	10yrs	3yrs	3yrs	3yrs	4yrs
Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Watery	Mucoid	Mucoid	Watery	Mucoid	Mucoid	Mucoid	Watery	Watery	Mucoid	Mucoid	Watery
1y	3yrs	1y	6yrs	4yrs	8mths	3yrs	10yrs	3yrs	3yrs	3yrs	4yrs
L	L	L	L	L	L	B/L	B/L	B/L	L	L	L
M	F	M	M	F	M	F	F	M	F	F	M
19y	39y	44y	58y	43y	38y	19y	19	20y	35y	36y	25y
46	47	48	49	50	51	52	53	54	55	56	57

Improved 40	Improved 15	Improved 40	Improved 40	Improved 30	Improved 15	Improved 20	Improved 15	Improved 25	Improved 15	Improved 20	Improved 15	Improved 25	Improved 20	Improved 25	Improved 15	Improved 25	Improved 20	Improved 25	Improved 20	Improved 20	Improved 15
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
Improved 50	Improved 20	Improved 45	Not Improved 40	Improved 15	Improved 25	Improved 25	Improved 20	Improved 25	Improved 15	Improved 25	Improved 20	Improved 25	Improved 20	Improved 25	Improved 15	Improved 25	Improved 20	Improved 25	Improved 20	Improved 20	Improved 15
Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken	Taken
TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF	TF
Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
45	13	37	30	8	18	23	8	25	10	25	15	15	15	25	10	35	30	31	30	25	10
10	8	13	8	12	12	8	10	10	15	15	15	15	15	15	10	10	15	8	15	10	10
55	21	50	38	30	30	31	35	35	30	30	30	30	30	30	30	35	30	31	30	25	25
Right Sclerosed	Left Sclerosed	BL Sclerosed	Left Sclerosed	Right Sclerosed	Right Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed	Right Sclerosed	Left Sclerosed	Left Sclerosed	Left Sclerosed
Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact	Intact
Wet	Wet	Dry	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP
Moderate severe	Minimal	Moderate	Mild	Minimal	Minimal	Mild	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Mild	Minimal	Mild	Mild
Progressive	Stationary	Stationary	Progressive	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
2yrs	3yrs	8mths	3yrs	3yrs	3yrs	1Y	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	2yrs	1Y	2yrs	2yrs	2yrs
Active	Active	Inactive	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Mucoid	Watery	Dry	Mucoid	Watery	Watery	Watery	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Yellowish	Watery	Yellowish	Yellowish	Yellowish
2yrs	3yrs	8 mths	3yrs	3yrs	3yrs	1Y	2yrs	2yrs	5yrs	5yrs	5yrs	5yrs	5yrs	5yrs	5yrs	2yrs	5yrs	1Y	5yrs	5yrs	2yrs
R	L	R	L	R	R	R	R	R	L	L	L	L	L	L	L	R	L	R	L	R	R
M	M	F	F	F	F	F	F	F	M	M	M	M	M	M	M	F	M	F	M	F	F
17y	15Y	29y	33y	40y	40y	48y	37y	37y	28y	28y	28y	28y	28y	28y	28y	37y	28y	48y	28y	40y	40y
58	59	60	61	62	62	63	64	64	65	65	65	65	65	65	65	64	65	63	65	66	66

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