"A COMPARATIVE STUDY OF MYRINGOPLASTY UNDERLAY TECHNIQUE WITH AND WITHOUT ANTERIOR ANCHORING OF GRAFT"

By

DR. KUNAL SHAHI M.B.B.S, D.L.O

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Under the guidance of

DR. N.H.KULKARNI D.L.O, M.S

PROFESSOR AND HOD

DEPARTMENT OF OTORHINOLARYNGOLOGY

BLDEU'S SHRI. B.M.PATILMEDICALCOLLEGE, HOSPITAL AND RESEARCH CENTRE, BIJAPUR -KARNATAKA

2012

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Date:

Place: Bijapur

DR. KUNAL SHAHI

Post Graduate student

Department of Otorhinolaryngology

B.L.D.E.U's Shri B. M. Patil Medical College, Hospital & ResearchCentre, Bijapur

B.L.D.E. UNIVERSITY

BIJAPUR – 586103, KARNATAKA

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation titled **"A COMPARATIVE STUDY OF MYRINGOPLASTY UNDERLAY TECHNIQUE WITH AND WITHOUT ANTERIOR ANCHORING OF GRAFT"** is a bonafide research work done by **DR. KUNAL SHAHI** in partial fulfillment of the requirement for the degree of M.S in Otorhinolaryngology.

DR.N.H.KULKARNI$_{\text{D.L.O,M.S.}}$
Professor and HOD,
Department of Otorhinolaryngology
B.L.D.E.U'S Shri B. M. Patil
Medical College, Hospital &
Research Centre,
Bijapur-586103

Date:

Place: Bijapur

B.L.D.E. UNIVERSITY

BIJAPUR – 586103, KARNATAKA

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT AND PRINCIPAL

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Seal & Signature of the

Head of Department of Otorhinolaryngology

DR. N. H. KULKARNI

D.L.O., M.S. (Otorhinolaryngology)

BLDEU'S Shri B.M Patil

Medical College, Hospital

& Research Centre, Bijapur

Date:

Place: Bijapur

Seal & Signature of the

Principal

DR. R.C. BIDRI

M.D. (Medicine)

BLDEU'S Shri B.M Patil

Medical College, Hospital

& Research Centre, Bijapur

Date:

Place: Bijapur

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Place**:** Bijapur

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Place: Bijapur Dr. Kunal Shahi

Date:

CONTENTS

S.No.	CHAPTER		PAGE No.
1.	INTRODUCTION		1-3
2.	OBJECTIVES		4-5
3.	REVIEW OF LITERATURE		6-61
4.	MATERIALS AND METHODS		62-65
5.	RESULTS AND OBSERVATIONS		66-79
6.	DISCUSSION		80-86
7.	SUMMARY		87-89
8.	CONCLUSION		90-91
9.	BIBLIOGRAPHY		92-97
10.	ANNEXURES		
	a. Annexure I	- Informed Consent	98-103
	b. Annexure II	- Case Performa	104-111
	c. Annexure III	- Colour Plates	112-119
	d. Annexure IV	- Key to Master Chart & Master Chart	120-123

INTRODUCTION

Tympanoplasty refers to any operation involving reconstruction of tympanic membrane and/or ossicular chain. Myringoplasty is a tympanoplasty without ossicular reconstruction. Over the years many methods have been used for closing perforations. The most widely used and accepted method is underlay graft of temporalis fascia or sometimes perichondrium.

The success rate in achieving an intact tympanic membrane in expert hands is often quoted at around (95%) however when results of large no of operations in hands of many surgeons are reported the success rate is much lower .The closure rate is reported to be higher in small perforation than large perforations. Numerous authors have reported the failure rate in anterior perforation is higher. However this failure rate can be greatly reduced by anchoring the anterior margin of graft beneath the annulus.[2]

In a study done in United Kingdom Surgical closure of the anteriorly located tympanic membrane perforation was studied. The lack of anterior support for the graft frequently leads to graft failure in an underlay method whereas anterior blunting is a complication of onlay techniques in this situation. The experience with the Kerr flap, an underlay graft fashioned to include a tab of fascia which is placed laterally under the annulus and the anterior meatal skin, was presented. This method gave a 97.5 percent closure rate with no cases of

anterior marginal blunting and a mean auditory threshold gain of 8.5 dB (95 percent confidence limits 5 to 11.9 dB, P less than 0.01) was achieved at the frequencies tested. The use of the Kerr flap was recommended when repairing the anteriorly placed tympanic membrane perforation.[6]

Anterior and subtotal tympanic perforations are difficult perforations to repair. We used the anterosuperior anchoring technique to repair 105 of those perforations.Our study showed that the anterosuperior anchoring technique produced excellent results in the repair of challenging anterior and subtotal perforations in both adults and children.[14]

Ideally, all myringoplasty efforts should result in an intact tympanic membrane. Tympanic membrane grafting in a clean, dry ear with normal eustachian tube function should be successful routinely. Residual perforations do occur and frustrate the surgeon and the patient. Graft failure is a complication that is often associated with postoperative infection. Faulty underlay grafting technique will often result in graft failure. There is marked diversity in the reported success rates for achieving an intact tympanic membrane following Myringoplasty.

We sought herein to demonstrate that the graft uptake and functional results following underlay myringoplasty with anterior anchoring technique is significantly better than underlay myringoplasty without anterior anchoring technique.

OBJECTIVE:

To assess the anatomical and functional results following underlay myringoplasty with and without anterior anchoring technique.

REVIEW OF LITERATURE

HISTORICAL REVIEW

1000 BC -The early Egyptian healers had a large number of perspectives available for treatment of the ear like the use of the herbs and other extracts. It is of note that ear was often attributed to brain disease and efforts directed accordingly.[1]

400 BC - One of the earliest physicians, Hippocrates, recognized that a painful, discharging ear with fever was a life threatening condition and described classic Symptoms of otitis media. "Acute pain of the ear with continued, strong fever is to be dreaded, for there is danger that the man may become delirious and die" Tools and techniques did not permit intervention or further work on chronic ear infection. Around the time Rafto described the tympanic membrane as a web like structure and as a part of the organ of hearing.

16thCENTURY -Surgery for mastoid infection was first proposed 4 centuries ago by Ambrose Pare on the young king Charles II of France who was dying with high fever and a discharging ear. The king's bride, Mary, Queen of Scotland, agreed, but the king's mother, Catherine de Medici, forbade the operation. The king died. This incident helped neither Pare's reputation nor the fledgling specialty of otology. So another 100 years passed before the next recorded attempt at otologic intervention.

17th CENTURY -In 1640, Banzer published an account of a case of tympanic membrane repair. A pig's bladder was stretched across an ivory tube and placed in the ear. This marks a trend in the repair of the drum, that of placing artificial membranes in the ear temporarily.

18thCENTURY - The first documented successful surgery for a mastoid infection was performed by Jean Petit of Paris. Shortly thereafter, in 1776, a Prussian surgeon named Jasser successfully performed a mastoid operation on a soldier with a draining ear. However, this new operation was discredited when Baron Berger, personal physician to the King of Denmark, persuaded a colleague to perform this procedure on Berger himself with a mistaken assumption that it would relieve his deafness and tinnitus. This operation led to sepsis and Berger's death, thus consigning the mastoid operation to obscurity for another century.

19th century - In 1853, Sir Oscar Wilde published a procedure for sepsis and suppuration of the ear. He described the post-auricular incision and removal of the mastoid cortex for purulent infections. This was the beginning of the modern era of otologic surgery. Nearly every operation that followed until today built upon this basic technique and expanded the indications and technique.

In 1873, Herman Schwartze published both indications and the procedure for removing the mastoid cortex and underlying air cells with mallet and chisel for acute mastoid infections. The art of using mallet and chisel persisted for another 75 years. In the pre-antibiotic era, simple Mastoidectomy

became the mainstay in the treatment of acute mastoiditis and saved many lives.

Also, in 1873, von Troltsch and von Bergmann expanded the simple mastoidectomy of Schwartze to include the attic and antrum. This increased the success of mastoid surgery. Nearly all the surgical techniques in use today had been described, but advances remained slow for the next 50 years. No significant changes in the therapy of otologic disease occurred until the advent of the operating microscope and antibiotics in the 1950s.

Parallel to these developments were efforts to improve hearing. In 1853, Toynbee placed a rubber disc attached to silver wire over a perforation with hearing improvement. Yearly in 1863 improved hearing by placing a cotton ball over a perforation.

In 1877, Blake introduced the idea of placing a paper patch over the perforation, a practice that has stood the test of time. Roosa and Okneuff promoted healing of the drum by application of chemical cautery.

20th century - Surgeons were able to control disease with the techniques developed earlier. In the 1930s, antibiotics helped to achieve dry ears by treating infection. Then, with the operating microscope, they became adept at examining the ear and developed instruments for manipulating the ear drum and ossicles.[1]

House, Sheehy and Glasscock developed techniques for creating a satisfactory onlay graft. Shea while performing stapedectomy, during a

surgical misadventure discovered that vein graft could be satisfactorily placed under the drum to repair a tear. Storrs switched to fascia and Patterson et al determined the reasons for the success of fascia as a grafting material, the popularity and techniques of tympanoplasty can be attributed to the success of many other surgeons who have refined other's techniques.

SURGICAL AND TECHNOLOGICAL DEVELOPMENTS

Artificial Ear Drum

This refers to a technique of placing a diaphragm of material in the ear on the end of a rod prosthesis. Such devices have been available since the 1800s.

Marcus Benzer was the first in 1840. Then, Toynbee, Yearsley and Blacke used rubber disk, cotton ball and paper patch over the perforation respectively. The paper patch was later used as an indication for tympanoplasty and till date helps in assessing the hearing gain to be expected after surgery. Pohlman devised an artificial ear drum made of rubber-like plastic known as korogel that was placed into the ear canal by the patient.

These nonsurgical attempts to close the drum and improve hearing were used primarily for dry perforations. These prostheses proved the hearing could be restored and provided an impetus for further investigation into operative repair of tympanic membrane.[1]

Management of the Infected Ear

In 1906, the first conservative surgical procedures were described by Heath and Bryant. These were modifications of radical mastoidectomy, preserving the tympanic membrane and ossicles. These were not widely accepted due to complications.

In 1910, Bondy described the classic modified radical mastoidectomy but this did not become popular until the 1940s when it was reintroduced by Day and Baron.

Antibiotics and Instrumentation

In the 1930s, medical therapy of the ear was becoming popular with the availability of sulfonamide antibiotics. Instrumentation facilitated further development. Dental drills were used for mastoid exenteration while cautery helped control haemorrhage.

Operating Microscope

Holmgren a pioneer in fenestration Surgery for otoslerosis, was the first otologist to use the binocular operating microscope. Lempert used the optic loupe.[1]

Office Cautery of perforations

Roosa and Okneuff applied silver nitrate and trichloroacetic acid to the edges of the perforation to promote healing. The treatment required weekly re

applications of TCA and a cotton patch to the perforation. Success rates of 75% were achieved after 14 weeks of treatment.[1]

CONCEPT OF TYMPANOPLASTY

In 1863, a landmark discovery of the workings of the middle ear was made by Hermann von Helmholtz. His description of the middle ear transformer mechanism was essentially ignored. It was not understood until 90 years later. This work formed the foundation for all reconstructive middle ear surgery.

The concept of tympanoplasty is credited to Berthold who in 1878 was thought to have performed the first true tympanoplasty. He de-epithelialised the tympanic membrane by applying a court plaster to the membrane for 3 days, then removing it with the epithelium. A skin graft was then applied. In 1914, tympanoplasty was reintroduced by Schulhof and Valdez. In 1952, the procedure was publicized and popularized by Wullstein using split thickness skin grafts.

Zollner began his work in 1952. The work of these two surgeons integrated all previous work and formed the basis for modern otologic practice. They recognized the principles introduced by Helmholtz stating "A new tympanic membrane and an adequate tympanic cavity with intact ossicles are necessary for the transformation of sound pressure upon the oval window as well as sound protection of the round window."[1]

Concurrently, stapes surgery was being changed radically. Kessel and Miot are credited with the first series of stapes mobilization and Blake and Jack with the first stapedectomies. Rosen reintroduced stapes mobilization in 1952 and in 1956, Shea performed the first modern stapedectomy with replacement by a prosthesis. The stability of the Zeiss operating microscope spurred further advances in middle ear surgery.

GRAFTING MATERIALS

The full thickness and split thickness skin grafts of Wullstein and Zollner laid over the drum remnant were prone for infection, graft failure and iatrogenic Cholesteatomas. They become boggy, edematous and desquamative as a result of the presence of sweat and sebaceous glands. The graft 'takeup' rate even in ideal cases was only 71%.

Canal Skin Grafts

In 1956 Soohy rotated a canal skin pedicle flap onto the drum remnant for closure of marginal perforations. House and Sheehy advanced the technique by using the canal skin as free grafts laid over the drum remnant. The take up rate was initially excellent in tympanoplasty cases (97%) but the problems of desquamation persisted, after long term follow-up only 77% cases were successful. The major problem was that the canal skin did not hold up well in the presence of infection.[1]

Vein Grafts

The technique of placing vein graft medial to the damaged tympanic membrane was accidentally discovered by Shea while doing a stapedectomy where the drum healed completely within 3 days. But they tended to atrophy after a few months and occasionally reperforated. They did not form durable repairs of the drum.

Temporalis Fascia

Ortegren first described the use of temporalis fascia as a graft in 1959. Heerman in 1960 used them successfully. The superior qualities of fascia, its ready availability, its ideal handling qualities, low basal metabolism rate, marked resistance against infection, its availability in required amount and its being a ready source of fibrous tissue all made it the standard for drum grafting, which it remains till today.

Perichondrium grafts

Goodhill used it in 1960, with results similar to that of fascia but it was not as easily harvested as fascia and was available in very limited quantities. It has therefore not been widely used.

Homograft tympanic membranes

Merquet first described use of Homograft tympanic membrane. Success reported was similar to that of fascia. The current difficulty with homografts is similar to other areas of human tissue transplantations. There is a shortage of adequate material and transmission of HIV and Creutzfeld-Jacob disease are

potential hazards. Hence the use remains infrequent although the results are excellent.

Others

Other materials used for grafting the tympanic membrane are[5]

- Autologous periosteum introduced by Claros Domenech (1959)
- Vein graft (Shea, 1960)
- Dura mater introduced by Preobrazkensky (I961).
- Unterberger suggested the use of fascia lata and Zollner used this tissue in 1956.
- Claus Jensen used heterograft tympanic membrane of bovine origin.
- Amniotic membrane (Schrimpt, 1954)
- Autologous mucous membrane (Hall, 1956)
- Cornea (Holewinski, 1958)
- Adipose tissue (Ringenberg, 1962)
- Connective tissue (Portmannetal, 1964)

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.

TECHNIQUES OF GRAFTING

After the evolution of grafting materials, there came the question of the technique employed for placing the graft material. Based on the early work of Wullstein and Zollner, most otologic surgeons in the 1950s used the overlay technique. Shea and Tubb in 1959 employed vein as an undersurface graft. Austin and Shea in 1961 elaborated the technique and reported additional cases.[3]

The two procedures have paralleled in development and the overlay method was the choice until the 1970s. Then there were certain problems associated with overlay grafting, namely[3]

- Lateralisation of the graft
- Blunting of the anterior sulcus
- Epithelial pearls and
- Delayed healing

So there was a change in trend and a general shift occurred towards the underlay technique of grafting. The underlay technique avoided the complications of overlay method and was quick and easy to perform.

The other methods subsequently developed were sandwich technique, Crown-Cork Tympanoplasty, swinging door technique, fascial pegging, spot welding (laser), microclip techniques and over-under tympanoplasty by Kharthush based on the earlier two basic techniques.[4]

The undersurface technique, though commonly used, had its own disadvantages like, there was increased failure in large perforations due to the limited bed size for the graft and middle ear space is reduced (insignificant). The failures were due to medialisation of the graft resulting in reperforation.[5]

Gibb *et al*[6] (1982; Myringoplasty: A review of 365 operations) have noticed that post-operative defects occasionally result from the graft falling inwards, probably because the graft is inadequately supported or fixed in position. An alternative method other than keeping gel foam is by tucking the edge of the graft through small incisions in the tympanic membrane remnant. In large perforations the area of contact between the graft and the host tympanic membrane may be reduced to a small rim at the periphery and, if this contact is lost at any point, a defect will develop in the reconstructed membrane. They quoted a graft take up rate of 87.5% for underlay technique and 88.2% using temporalis fascia. The percentage take up rate for large and small perforations were 87% and 92.4% respectively.

J. F. Sharp *et al*[7] (mypingoplasty for the anterior perforation: Experience with kerr flap 1992) stated that central and posteriorly placed perforations are easily repaired but closure of anterior perforations are more problematic. Anterior quilting of the grafts through an anterior tunnel, the Kerr technique (Primrose and Kerr, 1986) was proposed to eliminate graft failure rate. This technique was an extension of the quilting technique described by Gerlach Kley (1982) where adequate stability of central perforations can be achieved by pulling excess graft through holes made circumferentially around the original

perforation. Successful closure of the perforation was achieved in 95.7% of patients who were followed up for 2 to 5 years.

Sade *et al*[8] (Myringoplasty: Short term and long term results in a training program; 1981) showed a linear relationship between the size of the perforation and success of operation, smaller perforations having better success rates than larger ones. Anteriorly placed Perforations had a lower success rate. The large perforations had graft takeup rate of 73% Compared to 87% for smaller perforations. Anteriorly placed perforations had a success rate of 78% when compared with other sites which showed a 90% success rate.

Lorezo Pignataro *et al*[9] (Myringoplasty in children: Anatomical and functional results; 2001) showed that a higher rate of surgical failure was observed in the case of anterior perforations.

B. K. Roychoudhari[10] (3-flap tympanoplasty - A simple and sure success tympanoplasty; 2004) has proposed that very large or subtotal perforations with a very small remnant of tympanic membrane and anterior bony over hang are at many times more prove to failure after tympanoplasty. The success rate for graft uptake was 94.44%.

Ludman and Wright[11] (1998) opined that while performing tympanoplasties for subtotal perforations, after elevating the tympanomeatal flap, the dissection of the annulus should proceed far more anteriorly. They also suggested the creation of a limited tunnel, 1 to 2 mm wide, between the annulus and anterior bony canal wall to pull a small tag of graft material through the tunnel and locate the unstable segment in cases where there is no

anterior rim. It was suggested that when this was done, it was not necessary to place gel foam in the middle ear for support.

R. J. England *et al*[12] (Temporalis fascia grafts shrink; 1997) stated that graft failure following myringoplasty is a common complication and it is the anterior perforations that are least straight forward to close (Gesdorff et al, 1995). The reason being that there is insufficient support for the anterior aspect of the graft as the anterior mesotympanum is relatively spacious and this part of the graft falls away from the perforation edge.

Goycoolea[13] (1989) described a technique used for large anterior perforations where the annulus was de epithelialised anteriorly. A small incision 3-4 mm in length, was made and an anterior flap raised. The annulus was gently elevated anteriorly for the same extent as the incision made in the canal skin, the fascia being gently pulled beneath the annulus onto the anterior canal and covered with the small anterior flap.

Hung T. *et al*[14] (Anterosuperior anchoring myringoplasty technique for anterior and subtotal perforations; 2004) proposed that anterior and subtotal perforations are difficult to repair. They used anteriosuperior anchorage using temporalis fascia and underlay technique. The success rates were 100% for children and 93.8% for adults with a statistically significant improvement in air conduction thresholds.

Ricardo D'Eredita *et al*[15] (Kerr flap vs. standard underlay myringoplasty in children: A comparative study; 2004) performed Kerr flap myringoplasty in 59 children with 93.2% success rate. 52 children underwent standard

myringoplasty procedure with a success rate of 84.6%. They suggested that the Kerr flap myringoplasty, an underlay graft with an anterior tab under the anterior tympanic annulus could provide better stability of the graft.

W. J. Primrose and A. G. Kerr[16] (The anterior marginal perforation; 1986) stated that the anterior tympanomeatal angle remains the main problem in anterior marginal perforations. Onlay technique produced blunting and underlay grafts tended to fall off from the anterior annulus, while elevation of a significant section of the anterior annulus to get underlay also carried the risk of anterior blunting. They used underlay technique with the anterior hitch method creating a small tunnel under the annulus anteriorly and the graft was pulled through this.

Apart from the modifications of underlay technique, various canal incisions also evolved. Glasscock and Shambaugh[17] (1990) proposed a posteriosuperiorly based vascular strip incision at tympanosquamous and tympanomastoid suture lines. This was to achieve better blood supply to the graft, which is mainly derived from the superior part of the external auditory canal.

Cvjetkovic et al[10] (2003) studied the density of capillaries, arterioles, venulo-lymphatic spaces and a total volume density of all vascular elements of the auditory canal skin in 3 groups of patients. The first 2 groups had vascular strip and tympanomeatal flap respectively and the third group consisted of non-operated patients. They found no significant difference in the vascularisation of the canal wall skin between any of these 3 groups.

A posteriorly based tympanomeatal flap is also suggested by MirkoTos with radial incisions at 6 and 12 0 clock positions was used. When the tympanomeatal flap was thick and difficult to handle, Palva's swinging door flap was created where a radial incision is made at 9 o clock position of the tympanomeatal flap[18].

Ugo Fisch[19] suggested the elevation of tympanomeatal flap in a spiral fashion from the lateral part of the bony external auditory canal to the annulus, giving a wide exposure and good support to the graft.

Tympanomeatal flaps were also created transmeatally for closure of small perforations. The most commonly employed incisions are the vascular strip and the posterior tympanomeatal flap.

SURGICAL ANATOMY

The anatomy of the ear will be dealt with in relationship to:

1) External auditory canal
2) Tympanic membrane
3) Middle ear cleft
4) Eustachian tube

EXTERNAL AUDITORY CANAL

The external auditory canal is a short tube, 24mm in length in adults, open at one end and having the tympanic membrane at the other. Its outer one-third is cartilaginous (8mm) and inner two-thirds bony (16mm). The bony portion is formed by the tympanic and squamous part of the temporal bone, the narrowest part of the canal is the isthmus, 5mm lateral to the tympanic membrane. The floor of the canal dips deeply downwards and forwards to form the anterior recess. Another common finding in the meatus is the anterior canal wall bulge which has to be carefully tackled for successful myringoplasty. External auditory canal is 6 mm longer antero-inferiorly than postero-superiorly[20].

Important relations of the external auditory canal are:

Anteriorly - Gleniod fossa of temperomandibular joint

Parotid gland

Superiorly - Superficial temporal vessels

Auriculotemporal nerve

Middle cranial fossa

Posteriorly - Mastoid air cells

Vertical portion of facial nerve (deep)

NORMAL TYMPANIC MEMBRANE

The tympanic membrane separates the delicate structures of the middle and inner ear from the external environment. It is irregularly round and slightly conical in shape, the apex of the cone is located at the umbo, marking the tip of the manubrium. In the adult it is angulated approximately at 140° with respect to superior wall, 47° with the anterior wall and 127° with the posterior wall of the external auditory canal[20]. The vertical diameter along the manubrium is 8.5-10 mm, while the horizontal is 8-9 mm[21].

The anterior and posterior tympanic striae extend from the lateral process of malleus to the anterior and posterior tympanic spines respectively. The striae divide the tympanic membrane into the larger pars tensa below and the smaller, triangular pars flaccid (Shrapnell's membrane) above. The manubrium is firmly attached to the tympanic membrane at the umbo and the lateral process and is clearly visible (striamallearis).

The thickened periphery of the pars tensa, the tympanic annulus (limbus), anchors the tympanic membrane in a groove known as the tympanic sulcus. The tympanic sulcus and annulus are absent superiorly in the area of notch of Rivinus. The surgeon, when exposing the middle ear via a tympanomeatal flap approach, must elevate the tympanic annulus from the sulcus if perforation of the tympanic membrane is to be avoided[21]. It is the only membrane in the body that remains intact and closes an orifice[1].

Histology

The tympanic membrane consists of 3 layers, an outer ectodermal layer composed of keratinising squamous epithelium, an intermediate mesodermal fibrous layer and an inner endodermal mucosal layer.

The membrane is approximately 130µ thick, the outer squamous layer measuring about 30µ, the lamina propria l00µ and the mucosal layer about 1µ or less[1]. It weighs about 14 mg with a surface area of 85 mm (of which only 55 mm^2 is effective). Elasticity is close to that of rubber measuring 4.9 x 10^{-8} dynes/cm^2.

The outer epidermal layer is composed of

- Stratum corneum
- Stratum granulosum
- Stratum spinosum and
- Stratum basale.

The basal cells undergo cell division and migrate upward to replace lost and dying cells which are sloughed off as desquamated, cornified cell debris. Studies have shown the presence of epidermal growth factor (EOF) and fibroblast growth factor (FGF) which are thought to promote healing of membrane perforations.

The epidermal layer also has migrating properties which are responsible for the self-cleansing ability of the ear. The epidermis of the human tympanic membrane migrates centrifugally from the umbo outward in a predominantly

posterosuperior direction at about 131μ/day, with the umbo showing the greatest migration rate. There is also a centripetal movement of epithelium, thought to be central to healing of the tympanic membrane.

The epidermal layer also contains Langerhan's cells involved in immune response as antigen presenting cells (APCs), T-cells and mast cells. This suggests that the tympanic membrane is capable of an immune response and may play a significant role in middle ear defence.

The intermediate layer is also called lamina propria. The lamina propria of Shrapnell's membrane consists of a loose connective tissue network of collagen and elastic fibers with an external and internal network of blood vessels and nerves. The presence of elastic fibres account for the flaccidity of the Shrapnell's membrane. It lacks the fibrous layer of tensa. It also has abundant mast cells, the presence of which with their histamine content may play a role in the pathogenesis of middle ear effusion. Pars flaccida is thicker than tensa although lax.

In the pars tensa, the lamina propria has a sub epidermal loose connective tissue layer containing an internal network of blood vessels and nerves and a fibrous layer made up of outer radial, inner circular and parabolic and transverse fibers in addition to the circular fibers. This unique fibrous arrangement is thought to play a role in the vibratory function of the tympanic membrane.

The outer and inner fibres are composed predominantly of collagen types II and III. In addition procollagen I and III are seen in sub epidermal and

sub mucosal layers. Procollagen type III is present throughout the fibrous layer. Antibodies to these are found in injured ear drums, which may suggest some form of autoimmunity to collagen was responsible for tympanosclerosis like lesions.

The loss of fibrous layer as a result of inflammation or atelectasis leads to a flaccid membrane. Drums that have healed spontaneously failed to show the presence of fibrous layer. Elastic fibres are rare in pars tensa.

Embryology

During the ninth week of intrauterine life the tympanic membrane is derived from the fusion of ectodermal meatal plugs from the first branchial cleft and endodermally derived first branchial pouch, known as tubotympanic recess. The mesenchyme between the meatal plate and epithelial cells of tympanic cavity form the middle fibrous layer. All these three structures constitute the tympanic membrane[1].

Blood Supply

It consists of external and internal plexus. The external plexus is formed from the tympanic branch of deep auricular artery, a branch of mandibular branch of internal maxillary artery. The deep auricular branch sends large manubrial (arteriamanubrii) branches along Shrapnell's membrane and the manubrium and numerous radial branches into the tympanic membrane along its circumference. Angiography has shown that the maleal artery is the major blood supply of the posterior half of the drum, which is better perfused than the

anterior half. The anterior half is apparently supplied by small radial branches from around the annulus. The internal plexus is derived from the stylomastoid branch of the postauricular artery. The venous supply closely follows the arterial distribution.

On the medial aspect of tympanic membrane the internal plexus arises in the anterior aspect, goes up to the pars flaccida and then descends along the manubrium to supply thetympanic membrane. Thus the vascular strip incision is put based on this context[1].

Innervation

The lateral surface is innervated by the auriculotemporal branch of the trigeminal nerve in the anterior half and the auricular branch of vagus nerve (Arnold's nerve) in the posterior half while the tympanic branch of the glossopharyngeal (Jacobson's nerve) supplies the medial portion of the drum.

THE MIDDLE EAR CLEFT

This includes
- tympanic cavity
- opening of eustachian tube
- mastoid air cell system.

The tympanic cavity is an irregular air filled cavity with four walls, a roof and a floor. It is divided into the following parts[21]:

- The hypotympanum - below the drum head

- The protympanum - anterior to the drum head
- The epitympanum - medial to the outer attic wall and above tympanic membrane
- The mesotympanum - medial to the tympanic membrane

The roof is formed by the tegmen tympani which is part of the petrous part of the temporal bone. The floor is bony and separates from the jugular bulb. The lateral wall is partly bony and partly membranous; the lateral epitympanic wall is wedge shaped and its lower bony wall is called scutum or shield of Leidy[21].

The 2 openings seen in the lateral wall are[22]:

1) Posterior canaliculus - for chorda tympani nerve and branch of stylomastoid artery
2) Petrotympanic fissure (Glaserian fissure) -this receives anterior malleolar ligament and transmits the anterior tympanic branch of maxillary artery to the middle ear.

The anterior wall has four openings[22]:

1) Canal for tensor tympani
2) Canal for eustachian tube
3) Huguier canal for chorda tympani
4) Glasserian fissure - canal through which tympanic branch of internal caroticotympanic nerve and artery pass.

The medial wall separates middle ear from internal ear. The important structures are:

a) promontory with tympanic plexus
b) oval window
c) round window
d) facial nerve canal
e) processes cochleariformis
f) dome of lateral semicircular canal

The posterior wall has aditus, fossa incudis, pyramid, facial recess and sinus tympani.

The tympanic cavity measures 15mm vertically and anteroposteriorly. Mediolaterally it measures 6mm in epitympannum reduces to 2mm at umbo and 4mm in the hypotympanum[21].

Contents of tympanic cavity are:

- Ossicles —>Malleus, incus and stapes
- Muscles —>Tensor tympani and stapedius
- Nerves —>Chorda tympani and tympanic plexus mucosa and its folds and spaces

Ossicles

There are 3 in number namely:

Malleus

It is about 7.5mm in length. It has a head, neck and anterior and lateral (short) process and a handle. The head in the attic and articulates with the body of the incus. It weighs about 23 mg. It is ovoid on cross section.

The lateral process contains a cartilaginous cap attached to the pars tensa. The pars propria splits to envelop it (the umbo) and is firmly attached. Usually the manubrium lies midway between the anterior and posterior borders of tympanum, but may occupy a more anterior position. This anteriorly located malleus causes difficulty in repairs of anteriorperforation of tympanic membrane.The tendon of tensor tympani is attached to the neck and manubrium of malleus. Normally, the medial pull of tensor tympani tendon is opposed by the elasticity of pars propria. With a large perforation of tympanic membrane, the unopposed pull causes medial displacement of inferior end of manubrium,almost reaching the promontory. In myringoplasty procedure, it may be prudent to section the tensor tendon prior to manipulating the manubrium[21].

Incus

The largest of the auditory ossicles measuring about 6 mm x 6 mm and weighing 27 mg.It consists of a body, long process, short process and a lenticular process. The body of incus rests in the epitympanum articulating with

the head of the malleus. The long process parallels manubrium and ends in lenticular process to articulate with the head of stapes. The long process of incus is highly susceptible to osteitic resorption caused by chronic otitis media[21].

Stapes

It is the smallest and most medial link of the ossicular chain. It weighs around 2.3 mg and measures 3.26 mm x 2.99 mm x 1.41 mm. It consists of head, footplate(basis stapedis) and two crura. The anterior crus is more delicate and straight than the posterior. The footplate with annular ligament seals the oval window[21].

Blood supply

The malleus and incus are supplied by the ramus nutriciaincudomallei, a branch of middle meningeal artery. Malleus also receives a branch from anterior tympanicartery.

The incus is also supplied by the incudal artery. The stapes is mainly supplied by two vessels, the first supplies the footplate and crura, derived from anterior tympanic artery anteriorly and plexus around the facial nerve posteriorly. The other group supplies the apex of crura, neck ,head and incudo-stapedial joint with lower end of incus which arises from the plexus around facial nerve along the stapedius tendon[21] .

Eustachian Tube

It is named after Bartolomeus Eustachio (1520-74). It connects the tympanic cavity with the nasopharynx, measuring 36 mm in adults, lateral third being bony and the rest fibro-cartilaginous. The two portions meet at an angle called isthmus, which is the narrowest part of the tube. The cartilage forming the medial part contributes to the medial, superior and upper part of lateral wall of the tube; the rest of the tube being completed by fibrous tissue. The Eustachian tube is wider, shorter and more horizontal in infants, thus permitting infection to travel easily from nasopharynx.[22]

Histology of middle ear

Respiratory epithelia line the mucosa of the middle ear cavity. Ciliated mucosa and goblet cells line the antero-inferior part, whereas the postero-superior area is covered with a richly vascularised cuboidal or flat epithelium. This latter epithelium is responsible for gas exchange. Variations in blood flow and permeability of blood vessels allow wide adaptations to normal fluctuations in gas pressure.

The mucous membrane lines the tympanic cavity like the peritoneum covering the viscera. These mucosal folds separate the middle ear into various compartments.

ANATOMY OF TEMPORALTS FASCIA

There are six layers superficial to skull. The pericranium is adherent to calvarium, covered by a loose layer of connective tissue. Superficial to this, in the temporal region lies the temporalis muscle covered by deep temporal fascia, which in turn is covered by superficial temporal fascia. The outer two layers are subcutaneous fat and the scalp[23] **(Fig a).**

The superficial fascia has many synonyms like the temporoparietal layer, epicranial aponeurosis and the galeal extension. It is thin, highly vascular, loosely attached to the overlying sub dermal layer above zygomatic arch. It is separated from deep temporalis fascia by an avascular plane. The deep temporal fascia has clear boundaries and closely covers the temporalis muscle and its aponeurosis. The blood supply is from middle temporal artery, arising from superficial temporal artery.

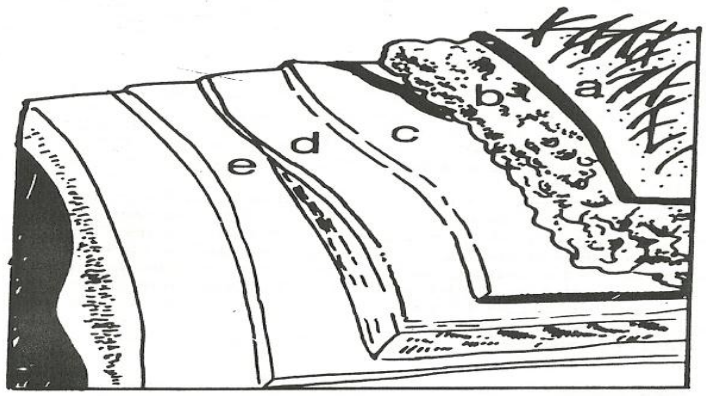

Fig a: Different layers of scalp a: Skin; b: subcutaneous fat; c: superficial temporalfascia; d: deep temporal fascia; e: periosteum

The total area of fascia available on one side of head is 260 sq.cm including both the layers[23].

Histologically and morphologically there is no significant difference between the two layers. But, most commonly deep temporal fascia is used in tympanoplasties as a graft material.

PHYSIOLOGY OF CONDUCTION OF SOUND

The ear perceives frequency as pitch and intensity as loudness. Range of pitch audible to man is 20 - 20000 Hz. The smallest change in frequency that the ear can detect is known as the difference linear for frequency.

The appreciation of sound in all its qualities is a function of the auditory areas of the temporal lobe of the brain. Sensitivity of the ear is greatest in the frequency range of 2000-3000 Hz. At its most sensitive, the ear has a threshold of 15-30 dB[17].

PHYSIOLOGY OF EXTERNAL EAR

The pinna functions as a sound collector, intercepting sound energy and deflecting it into the auditory canal. In man the pinna has no useful range of movement. The acoustic function of the external ear is to permit airborne sound waves to reach the tympanic membrane.

The external auditory meatus is like a tube which resonates at a particular frequency. In the human ear, the maximum resonance is approximately 15 dB at around 3 KHz. This resonance partly overcomes the less efficient sound conducting mechanism of the middle .ear for higher frequency[22].

TYMPANIC MEMBRANE

The movements of the tympanic membrane are studied by

- Attachment of small mirrors
- Sprinkling of fine silver particles and

- Use of an electrical probe (Bekesy)

Bekesy found that the area of maximum vibration was near the lower end of the membrane. But according to Khanna and Tondorff there were two maxima of vibrations on either side of the manubrium. They suggested that the movement of malleus is less than the mass movement of the tympanic membrane.

PHYSIOLOGY OF MIDDLE EAR

In the ear, the impedance of cochlea is much higher than air. If sound waves were to hit the oval window directly, only 1% of the incident energy will be taken up, the rest being reflected back. However the middle ear transformer apparatus by its action as impedance transformer improves this considerably. Functions of the middle ear

- Sound pressure transformation
  - Ossicular leverage
  - Hydraulic action
- Acoustic separation

Ossicular Leverage

The vibrations of the ossicles can be measured by means of (a) mirrors attached to ossicles (b) stroboscopic light observation and (c) cinematography.

The malleus and incus vibrate as a combined unit rocking on a linear axis, running along the anterior ligament of malleus to the attachment of short process of incus in fossa incudis. With sounds of moderate intensity the

anterior end of the footplate of the stapes oscillates with a greater amplitude than the posterior end. With high sound levels the mode of action changes to side to side rocking movements along the axis running through the footplate (longitudinally). The malleolar arm is longer than the incudal arm in the ratio of 1.3:1 to 1.15:1.

Hydraulic Action

The effective vibrating area of the tympanic membrane is two-thirds of the anatomical area. The effective areal ratio between the tympanic membrane and oval window is 14:1. So the overall effective advantage for the sound pressure transmitter mechanism is 14 x1.3=18.3.

In the normal ear the presence of the tympanic membrane, intact ossicular chain and the air containing-middle ear prevents the sound pressure waves from reaching the round window and opposing the outward movement of the round window membrane. This protection of the round window is lost where there is a large perforation of the tympanic membrane and this is one of the factors producing deafness.

The tympanic membrane is at its most efficient when the air pressures in the external auditory canal and the middle ear are equal. This is achieved by the Eustachian tube. The stapedius and tensor tympani muscles have a protective function, loud sounds causing a stiffening of the ossicular chain by reflex contraction of these muscles and protecting the inner ear from damage.

Inner Ear

The vibrations transmitted by the stapes produce displacement of the basilar membrane and shearing movements between the hair cells and the tectorial membrane of the organ of Corti, which initiates nerve impulses in the fibres of the auditory nerve. The basal turn of the cochlea responds to high frequency sounds while the apex responds maximally to low frequency sound. The nerve fibres supplying each area of the cochlea are stimulated by different frequencies.

These fibres then transmit impulses to the auditory nuclei in the brain stem. From there, the fibres pass through the superior olivary nucleus, lateral lemnicus, inferior colliculus and medial geniculate body to the auditory cortex where the impulses are perceived as sound.

EFFECT OF TYMPANIC MEMBRANE PERFORATION

For small perforations, there is no effect. In larger perforations, along with a loss of hydraulic action there is direct access of round window to sound[17]. Hearing loss in tympanic membrane perforation with intact ossicular chain :

% of Perforation	Hearing Loss
0-25	12dB
28-50	22 dB
50-95	28 dB

PATHOLOGIC TYMPANIC MEMBRANE

The tympanic membrane actively participates in the inflammatory process. Effusions, perforations, retraction pockets and tympanosclerosis are some of the common signs of middle ear pathology[1].

OTITIS MEDIA

Purulent type

In purulent otitis media the tympanic membrane is infiltrated with neutrophils, fibroblasts and occasional mononuclear cells. Edema, hyperemia and hemorrhage are more pronounced along the posterior half of the drum, since this area has a rich vascular supply and-a greater number of mast cells. Middle ear empyema produces pressure and causes the drum to bulge outward. The central portion of the drum, with the least blood supply, becomes ischemic and perforates, releasing purulent material and alleviating pressure symptoms.

Recurrent infections can result in destruction of elastic fibres and delay the maturation of new fibres. Infection may also affect the fibrous layer and result in thinning, atrophy or retraction of pars tensa. Again, these changes are more marked along the posterosuperior quadrant of the drum.

Serous type

Serous otitis media causes similar changes but of a milder degree[1].

TYMPANIC MEMBRANE PERFORATIONS

Infectious causes

Tympanic membrane perforations commonly occur as a result .of infections. The incidence is about 1-3%. The size and location of the perforation depend on the infectious agent, the severity and the chronicity. Generally, with the middle ear empyema that is produced in otitis media, the perforations are small and the vast majority heals spontaneously. However, perforations may become persistent with recurrent infections that impair the regenerative process. Large kidney shaped perforations may occur with β-hemolytic streptococci. There is fulminant necrosis and sloughing of the drum caused by necrotizing toxins and the proteolytic enzymes. Viruses, tuberculosis and an aggressive external otitis may also involve the drum.

Traumatic causes

Common causes include blunt and penetrating physical insults, barotraumas, acoustic and blast injury and, less commonly, thermal and chemical burns iatrogenic perforations may also result from myringotomy and ventilation tube insertion. The incidence is about 0.86%.

Regenerative Studies

The tympanic membrane has a powerful ability to heal itself. This ability has long been recognized as reflected in a statement by St. John Roosa in 1873 that “the tympanic membrane has a regenerative power second to that of no other membrane in the body”. Kristensen noted that the rate of

spontaneous healing of traumatic perforations is approximately 78.7%. Foreign body trauma and ventilation tube removal had better healing results (80-100% than thermal injury (38%)[1].

Spontaneous healing decreases after 30 years of age. This was thought to be due to reduced blood supply, reduced cellularity, less compliant collagen and more rigid elastin in the fibrous layer. The size and site of the perforation also have an effect on healing, with large and central kidney shaped perforations having the least chance to heal spontaneously. Likewise, perforations of the posterosuperior quardrant, due to the loss of this well-vascularised region, epithelial regeneration is interfered with. Malnutrition and immunosuppression impair healing. The presence of highly cellular/pneumatized mastoid air cell system favours spontaneous healing.

Tympanic Membrane Retraction Pockets

Tympanoplasty may be accomplished to address retraction pockets as well as perforations. This distinct clinical entity is an imagination of the tympanic membrane into the middle ear space. Retraction pockets develop as a result of an interaction of several factors including middle ear pressure, areas of weakness in the tympanic membrane, dysfunction of middle ear epithelium, embryologic and physiologic factors.

The pars flaccida and the posterior portion of the pars tensa are two areas of weakness and are prone to retraction pockets. The posterior pars tensa has a structured fibrous layer, the fibres of the circular layer are noted to be

more delicate and may even be absent in its postero-superior portion. Thus, the posterior pars tensa is always thinner, shorter, weaker and less able to withstand inflammation. The maturation of elastin is delayed in these areas further more, both the region are highly vascular, thus have higher degrees of inflammation.

HEALING OF THE TYMPANIC MEMBRANE

Concepts of Healing

Central to the understanding of tympanic membrane healing is the concept of epithelial migration. Two types, of epithelial migration have been described.

One is the centrifugal movement of epithelium away from the umbo at a rate of approximately 0.07 mm/day. This serves to remove keratin, cerumen and foreign bodies from the drum and the external auditory canal[1].

The second migratory pattern is a centripetal movement that is essential to tympanic membrane healing. In contrast to wound healing in other tissues, mitotic activity is not only confined to the wound edges but can be seen throughout the pars tensa, with highest activity seen around the annulus and 2 mm away from the wound edges and, to a lesser degree, around the manubrium. This distant migration is further suggested by the lack of proliferative basal cells in the wound edges, which normally would be very active in other tissues,

Immediately after the perforation, there is retraction of the edges of pars tensa followed by hemostatic and inflammatory changes. Epithelial hypertrophy and advancement of the wound edges begin as early as 48 hours after the trauma. The squamous epithelial layer migrates, attempting to bridge the perforation, and then followed by fibrous proliferation.

The hypertrophic wound edges close the gap followed by the other layers of the advancing epithelium. This supports the "scaffolding" theory long accepted as the mechanism by which patch material or other graft materials such as fascia, vein or perichondrium works. The material acts as a substitute for the stratum corneum, under which the lower epidermal layers can proceed to close the defect.

Further proof of the primary role of the epithelium in closing defects is seen with the use of graft replacement membranes. In these cases, despite an adequate mucosal and epithelial layer, the lamina propria consists only of a few disorganized fibrils without fibroblasts instead of the well-structured connective tissue and fibrous network. Thus the healing of lamina propria always lags behind that of the epithelium and mucosa. Sometimes, healing of the lamina propria may even fail leading to a dimeric membrane, with only a few disorganized fibrils in the lamina propria[1].

SURGERIES FOR RECONSTRUCTION OF TYMPANIC MEMBRANE

Myringoplasty

It is an operation performed to repair or reconstruct the tympanic membrane only.

Tympanoplasty

It is an operation performed to eradicate the disease in the middle ear and to reconstruct the hearing mechanism, without mastoid surgery, with or without tympanic membrane grafting[22].

Zollner and Wullstein Classification (1953)

Type I

This is done for perforated tympanic membrane with normal ossicular chain. The procedure includes inspection of the middle ear cleft with closure of the perforation.

Type II

Sound transmission through a functioning but deformed ossicular chain. Eg:- erosion of the malleus. It is called malleoincudopexy according to Wullstein.

Type II is modified to include any reformed mechanism joining the tympanic membrane with stapes or the footplate which retains a lever

advantage. Thus, there is a Type IIa which is the original type II reconstruction. Type II b is malleus-stapes assembly or malleus-footplate assembly. Type II c is. a new reconstruction independent of the malleus.

Type III

Perforated tympanic membrane with damaged ossicular chain, but stapes intact and mobile. Tympanic membrane graft is kept in contact with the stapes head. It also gives sound protection to the round window (Collumella Tympanoplasty, Sheehy, 1987).

Type IV

Head, neck and crura of the stapes are missing. Only a mobile footplate remains. Sound protection of round window is given by placing a graft such that the mobile footplate of the stapes is left exposed or the graft placed against the footplate, thus making an air containing cavity in continuity with the round window and Eustachian tube (Oval window or Cavum minor tympanoplasty, Sheeny. 1987).

Type V

Here the footplate is fixed. A fenestra is made to the horizontal semicircular canal. The graft seals off the middle ear to give sound protection to the round window.

Paparella and Saunders (1973) modified this Type V into a and b. Type Va is the classic fenestration of horizontal semicircular canal. Type Vb is stapedectomy done in cases of stapes fixation. Nowadays, most of the reconstructions come under the Type II classification.

Indications for Tympanoplasty — Type I

1) To improve the hearing after eradication of disease process from the middle ear
2) For providing support for hearing aid
3) In combination with canal wall up mastoidectomies
4) To waterproof the ear and prevent recurrence of infection
5) To protect the round window.

Contraindications

These are mainly relative.

1) Septic foci in the nose/throat or paranasal sinuses/nasopharynx, where the septic foci should be managed first.
2) Acute exacerbation of chronic otitis media should be controlled appropriately
3) Otitis externa
4) Bleeding disorders
5) Eustachian tube malfunction
6) Children less than 3 years of age, due to risk of recurrent of otitis media
7) Atticoantral type of chronic suppurative otitis media

8) Surgery for the only hearing ear, though controversial.

Prerequisites / Preoperative Evaluation

1) A complete history and otolaryngologic examination should be performed on all patients.
2) Otomicroscopy to be done to rule out cholesteatoma and to inspect and assess the status of the middle ear mucosa and site of perforation. Preferably, the perforationshould be dry.
3) Eustachian tube function is assessed by having the patients perform Valsalva or Politzer inflation.
4) Pure tone audiogram to assess the type of deafness, the cochlear reserve and the intensity of deafness.
5) X-ray of the mastoids to know the type of mastoid air cell system, whether the dura is low-lying or the sigmoid sinus anteriorly placed. It is mainly helpful to perform mastoidectomy.

ANAESTHESIA

Tympanoplasty type I with or without mastoidectomy can be done under local or generalanaesthesia,

Advantages of General Anesthesia

- Better airway control

- Patient remains still throughout the procedure making it technically easier
- Infiltration agents such as lignocaine with adrenaline can still be used
- Helpful for children and apprehensive patients

Advantages of Local Anesthesia

- Allows hearing and facial nerve function to be tested
- Results in slightly less bleeding
- Post-operative nausea and vomiting is less
- Early ambulation and reduced cost

In all cases, local anesthesia should be accompanied by adequate sedation. Sedation should be sufficient to allay apprehension and put the patient at ease, but it should not depress the respiration or blood pressure to a marked degree.

Local Anesthetic Techniques

Various local anesthetic techniques are employed in tympanoplasly with masloidcctomy surgery. These are[18]:

- Plester technique
- Jonkee's technique
- Wullstein technique

The Jonkee's technique is used for endaural incision. Wullstein and Plester techniques are used for post-aural incision. The most widely used is the Plester technique.

Plester technique

1% lignocaine with 5µg/ml of adrenaline is used. 0.5 cc is injected postaurally in the midline, 0.5 cc superior and 0.5 cc inferior to it. Then another 0.5 cc is given through the postaural prick to the posterior canal of the external auditory canal. Then 0.3 cc is injected into each of the four quadrants of the external auditory canal, at 12, 3, 6 and 9 0 clock positions.

SURGICAL TECHNIQUE

Position of the Patient

The patient is placed supine on the operating table with the head slightly rotated so that the ear to be operated upon faces upwards. The head is positioned so that a line drawn through the tragus and the antihelix and lobule is parallel to the floor.

Approaches

Various types of incisions can be used for performing the surgery.[18,20]

- Transcanal (Rosen's incision)
- Endaural (Lempert's incision)
- Postaural (Wilde's incision)

Transcanal

- Suitable for small perforations.
- Difficult in narrow canals.

- Gives a very limited access.

Endaural

It is suited for posterior and central perforations.

Anterior access is very limited.

Postauricular (Wilde's)

It is suited for all types of perforations.

- Gives a wide exposure of the middle ear.
- Suitable for patients with narrow canal and anterior canal wall bulge.
- It can be easily widened if dealing with extensive mastoid air cell system.
- Most of the surgeries nowadays are done through this approach.
- Temporalis fascia for grafting the tympanic membrane can be harvested through the same incision.

Advantages of Temporalis Fascia

- Graft can be obtained from the same Incision.
- It has a low basal metabolism rate.
- The texture of temporalis fascia containing collagen in matrix is similar to that of the tympanic membrane.
- It is an autologous graft, hence low rejection rate and no risk of disease transmission.
- Temporalis fascia is the most widely used graft material today.

Technique of Postaural Incision [1,17,18]

The incision can either be in the retro auricular fold or upto 1-2 cm posterior to it. It follows the curve of the fold beginning at the upper attachment of the pinna and continuing 0.5 cm behind the postaural fold downward to the tip of the mastoid process. The incision usually cuts across the posterior auricular artery or its larger branches, hence digital pressure by the finger tips helps to control any excessive bleeding. The blade of the scalpel is held perpendicular to the surface so as not to bevel the incision, while skin, subcutaneous tissue and perisosteum are incised - the bleeders are caught with a hemostats and electrocautery done. The periosteal incision is put either in a 'T' shape or 'V (Morimitsu) shape and the periosteum elevated exposing the mastoid process and the spine of Henle[18].

Incision of the Canal Skin

1) Posterior Vascular Strip (Sheehy)

It is started transcanal with an ear speculum. Two radial incisions are put along the tympanosquamous and tympanomastoid suture lines. Then a medial circumferential incision 1 mm lateral to the annulus connecting the two radial incisions is made. This part is retracted outwards from within. Next, a lateral circumferential incision is put from 12-7 O clock position, connecting the suture lines. The skin is elevated entirely along with the drum remnant,

epithelium of the malleus and Shrapnel's membrane. This is taken out and kept in physiological solution to place back in later stages[18].

Then the postaural approach is used to enter the external auditory canal.

Advantages

It gives excellent exposure of the middle ear.

Disadvantages

Replacement of the flap is difficult and healing is problematic.

2) Tympanomeatal Flap Incision (Plester)

This incision is medially based. A lateral circumferential incision put from 12-6 0 clock position. Two radial incisions are put at 12 and 6 O clock positions, connecting the lateral circumferential incision. The tympanomeatal flap is elevated upto the annulus. The middle ear is entered from the notch of Rivinus superiorly and the annulus is lifted from its bony groove. Sometimes the flap becomes thick hampering the visibility of the anterior edge of the perforation. To avoid this, Palva's swinging door technique is used, where an incision is put at 9 0 clock position along with the annulus[18].

Advantages

Healing is rapid and replacement of flap is easy.

Disadvantages

Exposure of the anterior half of the mesotympanum and tympanic membrane is not adequate. Prominent anterior canal wall accentuates the problem. This incision is most commonly used nowadays in performing tympanoplasty.

3) Rosen's Incision

This can be done for exploratory tympanotomy, stapedectomy and in closure of small tympanic membrane perforations situated posteriorly.

UNDERLAY TECHNIQUE OF MYRINGOPLASTY

PROCEDURE

The ear canal and post auricular area are infiltrated with 2% lignocaine or with 0.5%bupivacaine with 1:100000 adrenaline.

Step 1: Post auricular Incision

The incision can either be in the retro auricular fold or upto 1-2 cm posterior to it. It follows the curve of the fold beginning at the upper attachment of the pinna and continuing 1 cm behind the postaural fold downward to the tip of the mastoid process (fig b).

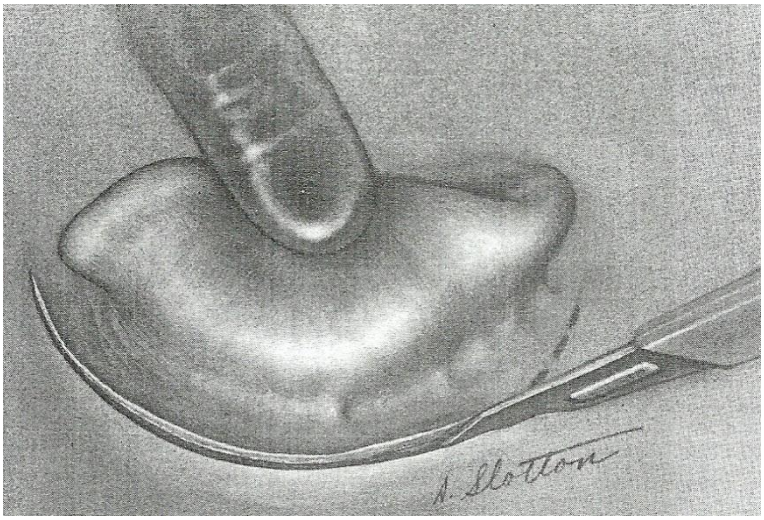

Fig b: Post aural incision

Step 2: Fascia Harvest

A retractor is put in the superior part of the incision, scalp is lifted off the temporalis muscle. The shiny layers of the temporalis fascia can be appreciated. An incision is made in the fascia of the temporalis muscle and, either using hydro dissection or not, the fascia is lifted off the muscle and harvested. Muscle tags are removed and the fascia is allowed to dry. Drying the fascia allows for better handling, (fig c)

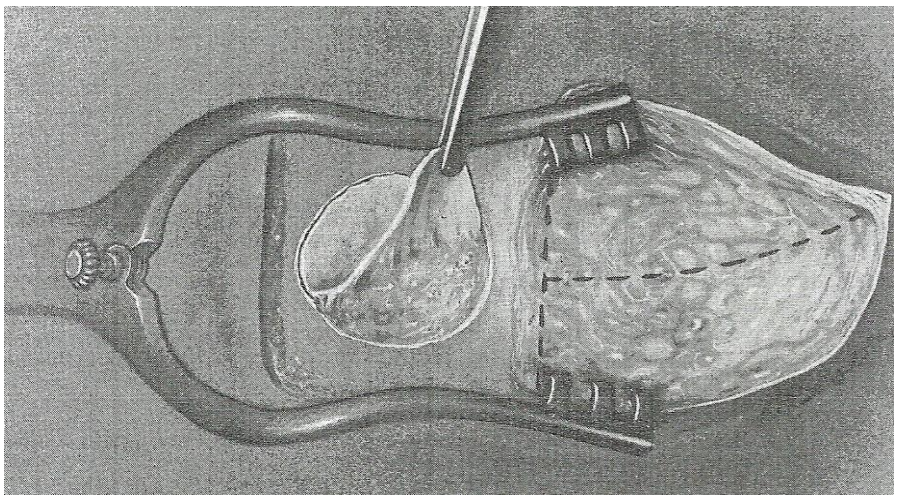

Fig c: Temporalis fascia being harvested and T-shaped periosteal incision

Step 3: Incision of the Periosteum

The periosteum on the mastoid bone is incised in a ‘T’ shaped fashion (fig c). A lateral circumferential incision is put after identifying the spine of Henle and the bony posterior canal wall. The incision through the canal skin should be oblique as it is easier to perform, flap edges are thinner and covering of bony defects is easier[17]. The incision extends from 12 to 6 o’clock position. A canal wall retractor is put and the pinna pushed anteriorly by the retractor.

Step 4: Freshen the Perforation

Freshening the edges of the perforation removes scar and thickened tympanic membrane with associated tympanosclerosis. Frequently, skin has turned over the edge of the perforation and is removed at this time. The underside of the flap must be inspected to be certain that all the skin has been removed from the there.

Step 5: Canal Skin Incisions and Flap Elevation

A tympanomeatal flap created by making a radial incision at 6 O clock position in the ear canal and another radial incision beginning just lateral and slightly posterior to the short process of the malleus, lateral to the notch of Rivinus. Elevation of the flap should be performed carefully and delicately. The blood supply for healing of the neotympanum, the graft will partially come from the flap. The dissection should be less traumatic for quicker healing. The annulus must be identified and fully elevated from its groove.

Step 6: Inspection of the Middle Ear

Once the flap has been lifted, all of the structures of the middle ear must be inspected. If inspection is performed in an orderly manner, nothing will be missed. The ossicles can be seen and palpated for damage and movement.

Step 7: Fascia Graft Placement

A small vertical slit is made in the graft superiorly for exteriorizing the handle of malleus. The graft is spread out on the promontory or the undersurface of the flap. The fascia should underlap the flap on all sides of the perforation by atleast 5 mm. (fig d)

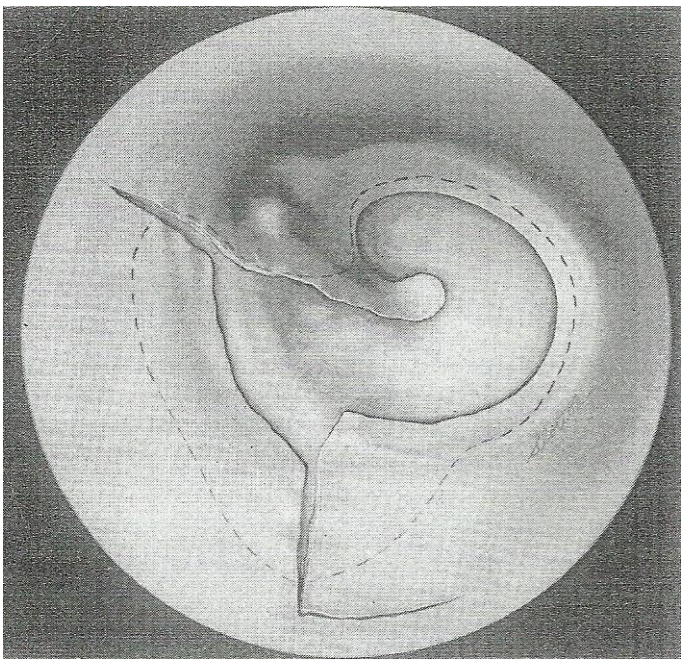

Fig d: Graft placement in standard underlay technique

Step 8: Packing

The middle ear is packed with gel foam. Special attention is paid to the area anterior to the malleus, where enough packing should be placed to push the graft against the perforation.

Step 9: Return the Fascia and the Drum

Both fascia and the tympanomeatal flap are returned to position. Care is taken to put the tympanomeatal flap in approximation to the incision. Fascia should be covered by the tympanomeatal flap completely.

Step 10: Packing the Ear Canal

Gel foam is packed gently on top of the perforation, which is soaked in antibiotic drops and the ear canal filled.

Step 11: Close the Postauricular Wound

With the ear back in the anatomic position, the postaural wound is closed in layers, taking care that post auricular muscles are approximated in layers.

Step 12: Apply Dressing

A snugly fitting, bulky mastoid bandage is applied on the ear, to put pressure and prevent bleeding from the postaural wound.

In the standard underlay technique of drum repair, the graft is placed under the annulus and held against the medial drum remnant by a bed of gelfoam.

DEVELOPMENT OF THE CONCEPT OF ANTERIOR TAGGING

Anterior tagging is a modification in one of the steps in tympanoplasty to fix the underlay graft under the drum remnant[18]. There are various nomenclatures given to this procedure, namely, Kerr flap[7,15,16], Bailey flap, anterior tunneling, anterior hitch method, anterior tucking, etc.

The underlay grafts usually tend to fall away from the anterior annulus into the deepest portion of the middle ear at the eustachian tube orifice. This may occur despite apparently adequate packing with gelfoam[16]. Elevation of large portion of fibrous annulus to fix the graft causes significant anterior blunting[16] of graft anteriorly.

Gerlach[18] (1975) described a quilting technique to prevent this; buttons of graft are pulled through tiny holes in the remnant tympanic membrane or lateral to annulus on external auditory canal and fixed with a drop of histoacryl glue. Based on this Gerlach's technique, A.G. Kerr *et al*[16] (1986) developed anterior tagging (anterior hitch method).

Subsequently Goycoolea M. V.[13] (1989) created small anterior flap to support the graft. J. F. Sharpe *et al* [7](1992), Ludman H. *et al* [11](1998) and

Riccardo D'Eredita[15] (2004) used this technique for underlay grafts with better results.

PROCEDURE

When there is total or anterior perforation without any remnant tympanic membrane or if the remnant tympanic membrane is less than 4mm then a window of about 3-4 mm length is made in the anterior meatal skin at about 4mm lateral to the annulus at 3 o clock position (fig e). The anterior fibrous annulus along with the meatal skin is elevated upto the window incision.

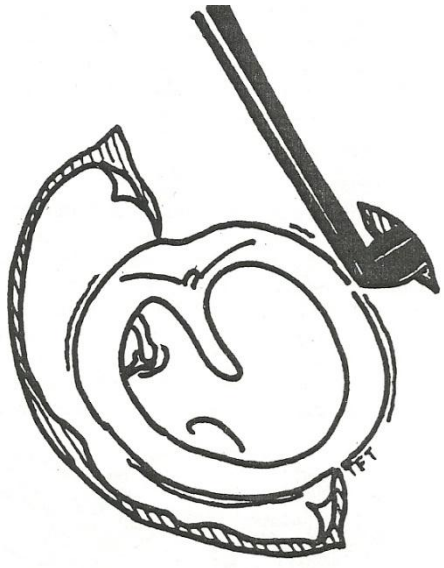

Fig e: Anterior window being created

The temporalis fascia is then pulled through the window. This step is essential to secure the fascia graft over the anterior bony meatal wall and into the sulcus (fig f). To prevent anterior blunting, a thin, dry gelfoam piece is

placed over the anterior part of the annulus which is pushed back into its original position[16]. Then the steps 8 to 12 are continued as mentioned earlier.

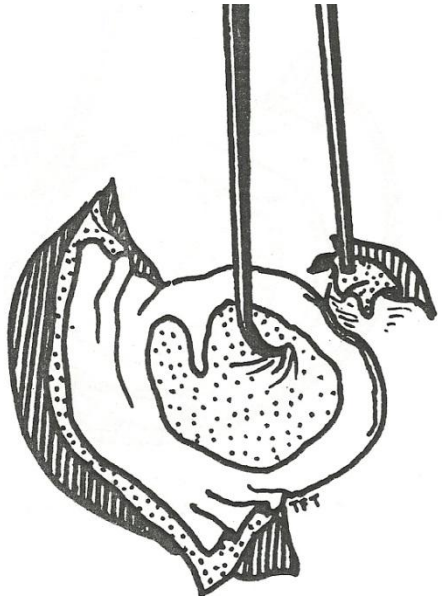

Fig f: Anterior tagging of the graft

COMPLICATIONS

The complications after tympanoplasty are rare.

Sensorineural loss

This may be due to excessive movement of the ossicular chain and the footplate resulting in high frequency sensorineural loss.

Facial nerve injury

This may occur when the canal is dehiscent in. the middle ear and constant pressure or stretching of the nerve may lead to facial nerve paralysis.

Hemorrhage

This is mainly primary hemorrhage which is dealt with the use of hemostats or local vasoconstrictors.

Infection

It is seen in about 4% of cases[1]. It is treated by local and systemic use of antibiotics postoperatively.

Anterior blunting

This is seen mainly in case of onlay technique of grafting and if a large part of anterior fibrous annulus is elevated from the sulcus[24].

Graft failure / Residual perforation

It can be either total rejection of the graft or a residual perforation smaller than the original tympanic membrane perforation.

Granular myringitis

This is a complication seen mainly in cases of overlay grafting (6.6%)[1,24].

Lateralization of graft

It is a condition in which visible surface of the tympanic membrane is located lateral to bony annulus and loses contact with the sound conducting mechanism of the middle ear.It may affect all or part of the tympanic membrane and is more common with onlay technique (1-5%). Anterior tagging prevents lateralization[25].

MATERIALS AND METHODS

1. SOURCE OF DATA:

All patients undergoing myringoplasty in the department of ENT, B.L.D.E.U'S Shri B. M. Patil Medical College Hospital & Research Centre from October 2010 to June 2011 were taken in the study.

2. METHOD OF COLLECTION OF DATA:

- Details of cases will be recorded including history and clinical examination with emphasis on detailed otoscopic examination and examination under microscope preoperatively and postoperatively.
- All patients undergoing middle ear reconstructive surgeries are subjected to pure tone audiometry pre operatively, one month and three month post operatively.
- Alternate patients will be assigned to Group A and Group B. Group A will consist of patients to undergo underlay myringoplasty with anterior anchoring of graft and Group B will consist of patients to undergo underlay myringoplasty without anterior anchoring of graft.
- Healing of tympanic membrane will be recorded postoperatively a month later and then three months post surgery.

3. INCLUSION CRITERIA:

All patients undergoing myringoplasty in BLDE University Shri B. M. Patil Medical College Hospital and Research Centre from October 2010 to June 2011.

4. EXCLUSION CRITERIA:

- Patients with unhealthy middle ear mucosa i.e. Polypoidal, edematous, tympanosclerosis.
- Patients with cholesteatoma, ossicular discontinuity.
- Patients with anemia, diabetes mellitus, retroviral disease.
- Patients with renal disease, jaundice.
- Patients with history of smoking, allergic rhinitis, chronic rhino sinusitis, chronic adenotonsillitis.
- Patients with history of intake of drugs like immunosuppressant.

5. SAMPLING

Time period of study: October 2010 to September 2011.

Incidence of tubotympanic disease in chronic suppurative otitis media is 72%.[40]

Formula used to calculate the sample size is

$$n = [(1.96)^2 \times p \times (1-p)] / L^2$$

Allowable error is considered as 20%.

Using above formula, minimum sample size is: 37, in each group.

Following statistical tests will be used to compare the results:

- Mean +/- SD.
- Paired t test.
- Z test ~ difference between two mean.
- Z test ~ difference between two proportions.
- P value of <0.05 will be taken as significant.
- Diagrammatic presentations.

6. INVESTIGATIONS

Investigations or interventions required in this study are routine standardized procedures. These investigations are required before taking any patient for surgery and for postoperative follow-up:

- Complete blood count.
- Urine Albumin, sugar and microscopy.
- Random blood sugar, serum creatinine, blood urea.
- X-ray bilateral mastoid.
- Pure tone audiometry.
- Examination under microscope.

DISCUSSION AND ANALYSIS

The present study was conducted from October 2010 to September 2011, during which 90 cases were studied. They were divided into two groups, comprising of 45 patients in group A and 45 patients in group B. Group A patients underwent Myringoplasty with anterior anchoring of the graft and group B patients underwent Myringoplasty without anterior anchoring of the graft.

Distribution of perforation

In our study, we observed that out of the 90 ears, 32 ears (35.55%) had subtotal perforation, 30 ears (33.33%) had a perforation which was centrally placed, 10 ears (11.11%) had posteriorly placed perforations and in 18 ears (20%) it was anteriorly placed.

In a study conducted by Eeero Vartainen *et al*[26] (1992) observed subtotal perforations in 36%, posterior perforations in 32%, inferior perforation in 19% and anterior perforation in 13%.

Similarly, Faith R Balyan *et al*[27] (1997) observed subtotal perforations in 26%, posterior perforations in 21.1%, central perforation in 36.3% and anterior perforation in 16.6%. The results in our study were comparable with the above study.

Graft success

A successful graft uptake is, an intact ear drum which moves on seigulisation. Of the 45 patients in Group A, 43 patients (95.55%) had successful graft uptake as seen in the follow up period, whereas 2 patients (4.45%) had a residual perforation.

In Group B consisting of 45 patients, 39 patients (86.67%) showed a successful graft uptake while 6 patients (13.33%) had residual perforations.

The results of standard underlay method and underlay with anterior anchoring method as obtained by various authors are compared and shown below.

SI. No.	**Name of the Author**	**No. of cases (n)**	**Method of Grafting**		**Graft uptake %**
			Anterior anchoring	**Standard Underlay Method**	
1.	J. F. Sharp *et al*[7](1992)	45	+	-	95.7
2.	Mangal Singh *et al*[24](2003)	30	-	+	93.3
3.	F. M. Rizer[1](1997)	427	-	+	87.6
4.	Gibb *et al*[6](1982)	365	-	+	89.5
5.	Packer *et al*[4] (1982)	106	-	+	82
6.	Chopra *et al*[29] (2001)	20	-	+	85
7.	Riccardo D'eredita *et al*[15](2004)	111	+ (93.2%) n=59	+ (84.6%) n=52	
8.	Our study	90	(95.55%) n=45	(86.67%) n=45	

Our results were comparable with the above study. The results of Group A (95.55%) were better than Group B (86.67%). Though the difference between the results of the two groups was statistically not significant (p=2.66).

GRAFT SUCCESS IN RELATION TO AGE OF PATIENTS

In our study group of 90 patients undergoing surgery myringoplasty with and without anterior tucking of graft, 15 patients were in age group 0-20yrs, 40 patients belonged to age group 21-30 yrs, 27 patients in age group 31-40 yrs and 8 patients were in age group 41- 60 yrs.

Success rate of graft uptake including group A and group B was 93.33% for 0-20 yrs age group, 90% for age group 21-30 yrs, 88.88% for age group 31 -40 yrs and 100% for age group 41-60 yrs. Overall success rate of 90%.

A study done by Adkins WY [42](1984), 30 type 1 tympanoplasty performed in age group 0-16 yrs and 41 surgeries with age group 16-67with success rate of 87% and 90%, with an overall success rate of 89%.

Our study results are comparable to the above study results, and shows that age does not have any significance on the graft uptake. P value >0.99 for both groups .

GRAFT SUCCESS IN RELATION TO PERFORATION SIZE

In group A out of 45 patients, all 13 small size perforations had successful graft uptake. Medium (19) and large (13) size perforations had 1 failure each with a successful graft uptake of 94.73% and 92.30% respectively.

Where as in group B out of 45 patients, 2 out of 15 small size perforations had graft failure, success rate of 86.66%. 11 medium size perforations had no graft failure

whereas out of 19 large size perforations 4 had graft failure with a successful graft uptake of 100% and 78.94% respectively.

It was observed that overall success rate for small and medium size perforations was 94.82% whereas success rate for large size perforations was 84.37%.

In a study conducted by Sade J *et al*[8] (1981) there was a linear relationship between the size of perforation and success of operation, smaller perforations have better success rate than larger ones. Our study also had similar observation, with comparable results. Though no statistical significance can be attributed .P value >0.05 for comparison between anterior, central and subtotal perforation in Group A and Group B.

GRAFT SUCCESS IN RELATION TO PERFORATION SITE

Group A

In group A of 45 patients, 9 anterior perforations, 4 posterior placed perforations had a successful graft uptake of 100%. There was 1 failure each out of 19 central perforations and 13 subtotal perforations. From our study, we can say that anterior and posterior perforation had 100% success rate, whereas central and subtotal perforations had 94.73 and 92.30% success rate respectively.

In the study conducted by J F Sharp *et al*[7] (1992) there was 94.7% success for anteriorly placed perforations and 96.4% success for subtotal perforations by anterior anchoring method. Our results are comparable to the above mentioned study.

Group B

In group B out of 45 patients, 6 posterior and 11 centrally placed perforations had successful graft uptake of 100%.

Of the 9 anteriorly placed perforations 2 had residual perforations, with 77.77% success rate. Of the 19 subtotal perforations, 4 had residual perforation with 78.94% success rate.

In a study conducted by Chopra *et al*[29] (2001) reported a success rate of 66.66% for anterior perforations (n=3), 100% for posterior perforations (n=3), 81.81% for centrally placed perforations (n=11) and 100% for subtotal perforations (n=3).

In our study, there was no difference between the two groups for posteriorly placed perforation, with a success rate of 100%. But, for anterior and subtotal perforations in group A had better results of 100% and 92.30% respectively, whereas group B had 77.77% and 78.94% success respectively.

But Chopra *et al*[29] study showed no failure for subtotal perforation using the standard underlay method. This could be due to less number of patients (n=3) in their study compared to our study (n=19).

HEARING GAIN IN RESPONSE TO THE TWO PROCEDURES

The patients having residual perforations were excluded for the assessment of hearing in both the groups post-operatively.

Group A

For the 43 successful cases, mean pre-operative air-bone gap was 34.38 dB, Post-operative mean air-bone gap was 14.30 dB. There was a mean hearing gain of 20.08 dB.

Group B

For the 39 successful cases, mean pre-operative air-bone gap was 34.96 dB, Post-operative mean air-bone gap was 14.96 dB. There was a mean hearing gain of 20 dB.

Though, the group A showed better hearing gain with mean air-bone gap closure of 20.08 dB than group B with mean air-bone gap closure of 20 dB, the difference in hearing gain between the two groups was not statistically significant ($p>0.05$).

SUMMARY

Tympanic membrane perforation closure can present a problem in anterior and subtotal perforations, due to the lack of support for the graft anteriorly, if an underlay method is used. Onlay techniques cause significant blunting. It was suggested that tympanoplasty with anterior anchoring, an underlay graft with an anterior anchoring under the anterior tympanic membrane annulus, could provide better stability of the graft. We undertook a prospective study of Myringoplasty (underlay technique) in 90 cases with and without anterior anchoring to compare the graft success rate and hearing outcome.

In our study:

- Subtotal perforations were commonest followed by centrally placed perforations, anterior and posterior perforations.
- The hearing loss was more with posterior perforations than anterior perforations while maximum loss was seen with subtotal perforations.
- Patients in group A underwent Myringoplasty with anterior anchoring and in group B Myringoplasty without anterior anchoring.
- Graft success rate was 95.55% in group A and 86.66% in group B,
- Group A had 100% and 92.30% success rates for anterior and subtotal perforations, compared to group B which had 77.77% and 78.94% success rates for anterior and subtotal perforations respectively.

- Anterior anchoring method had better results with respect to graft uptake, especially for anterior and subtotal perforations, although no stastical significance could be found in our study.
- Larger perforations have higher graft failure rate than small size perforation.
- Age as a factor has no stastical significance on graft uptake rate.

CONCLUSION

- In the present study, it appears that the graft uptake was better in patients undergoing Myringoplasty with anterior anchoring of the graft, especially in cases of anteriorly placed and subtotal perforations, but statistically the results were not significant ($p>0.05$).
- In cases of posteriorly placed and centrally placed perforations, the graft uptake was similar in both groups.
- The hearing outcomes were similar in both the groups, with no statistical significance ($p>0.05$)
- As the graft uptake is better in patients undergoing Myringoplasty with anterior anchoring of the graft in cases of anteriorly placed and subtotal perforations, we recommend that this procedure to be performed in the cases, where the anterior rim of the remnant tympanic membrane is inadequate, in spite of no stastical significance in our study.
- In our study, even though the results of Myringoplasty with anterior anchoring were better than the the Myringoplasty without anterior anchoring, no stastical significance could be found, hence a further larger study with longer follow-up period is proposed to assess the long term results.

BIBLIOGRAPHY

1) Rizer FM. Overlay Vs underlay tympanoplasty. Part I: historical review of literature. *Laryngoscope* 1997; 107 :l-25.

2) Gleeson M (eds) *Scott-Brown' Otorhinolaryngology,Head and Neck Surgery*. Vol 3 Edward Arnold 7th ed, 2008: 3421-3423pp.

3) Glasscock ME. Tympanic membrane grafting with fascia: overlay Vs undersurface technique. *Laryngoscope.*1973; 83: 754-770.

4) Packer P, Mackendrick A, Solar M. What's best in myringoplasty:underlay or overlay, dura or fascia? *Journal of Laryngology and Otology*. 1982; 96: 25-41.

5) Khartush JM, Michaelides EM, Becvarovski Z, Larouere MJ. Over-under tympanoplasty. *Laryngoscope.* 2002; 112: 802-807.

6) Gibb AG, Chang SK. Myringoplasty (A Review of 365 operations). *Journal of Laryngology and Otology*.1982; 96:915-930

7) Sharp J F, Terzis TF, Robinson J. Myringoplasty for the anterior perforation: experience with the *Kerr Flap. Journal of Laryngology and Otology.*1992;106: 14-16.

8) Sade J, Berco E, Brown M, Weinberg J, Avraham S. Myringoplasty : short and long term results in a training program. *Journal of Laryngology and Otology*.1981; 95:653-665.

9) Pignataro L, Berta LGD, Capaccio P, Zaghis A. Myringoplasty in children: Anatomical and functional results. *Journal of Laryngology and Otology*. 2001;115:369-373.

10) Roychoudhuri BK. 3-Flap tympanoplasty- A simple and sure success technique. *Indian Journal of Otolaryngology and Head and Neck Surgery*.2004; 56: 196-200.

11) Ludman H., Wright T. (eds). Diseases of the ear. Oxford University Press, Inc., 1995: 430-432.

12) England RJ, Strachan DR, Buckley JG. Temporalis fascia grafts shrink. *Journal of Laryngology and Otology*;1997; 111:707-708.

13) Goycoolea M V. Atlas of otologic surgery. Minnesota ;W.B.Saunders co. 1989: 230-233.

14) Hung T, Knight JR, Sankar V. Anterosuperior anchoring Myringoplasty technique for anterior and subtotal perforations. *Clinical Otolaryngology* 2004; 29:210-214.

15) Riccardo D, Lens MB. Kerr Flap Vs Standard underlay Myringoplasty in children a comparative study. *Otolaryngology and Head and Neck surgery* 2004; 131: 85.

16) Primrose WJ, Kerr AG. The anterior marginal perforation. *Clinical Otolaryngology*. 1986; 11: 175-176.

17) Gulya AJ, Glasscock M E and Shambaugh G E, Johnson GD. Surgery of the ear, Philadelphia. W.B.Saunders Co. 4th Ed. 1990: 302-343.

18) MirkoTos. Manual of middle ear surgery, Vol I: Approaches, Myringoplasty, Ossiculoplasty and Tympanoplasty. New York: Thieme medical publishers. Inc; 1993: l-236.

19) U Fisch. Tympanoplasty, Masioidectomy and Stapes Surgery. New York: Thieme medical publishers. Inc;1994: l-41pp.

20) Farrior JB, Tampa F L. Incisions in tympanoplasty: Anatomic considerations and indications. *Laryngoscope*. 1983; 93: 75-86.

21) Gulya AJ, Schuknecht HF. Anatomy of temporal bone with surgical implications. Philadelphia, Lea and Febiger, 1986: 35-110pp.

22) Gleeson M (eds). Scott-Brown's Oto laryngology, Vol I: Basic Sciences, Oxford, Butterworth-Heinemann. 6th Ed., 1997.

23) Wormald PJ, Alun-Jones T. Anantomy of temporalis fascia. *Journal of Larygology and Otology*. 1991;100 : 522-524.

24) Singh M, Rai A, Bandyopadhyay S, Gupta SC. Comparative study of the underlay and overlay techniques of Myringoplasty in large and subtotal perforations of the tympanic membrane. *Journal of Laryngology and Otology*. 2003; 117: 444-448.

25) Sperling NM, Kay D. Diagnosis and Management of lateralized tympanic membrane. *Laryngoscope*. 2000; 110: 1987-1993.

26) Vartiainen E, Kansanen M (1992). Tympanomastoidectomy for chronic otitis media without cholesteatoma. *Otolaryngology and Head and Neck Surgery*. 1992;106:230-234.

27) Balyan FR, Celikkanat S, Aslan A, Taibah A, Russo A, Sanna M. Mastoidectomy in noncholesteatomatous chronic suppurative otitis media: Is it necessary? *Otolaryngology and Head and Neck Surgery*.1997; 117: 592-595.

28) Yung MW. Myringoplasty: Hearing gain in relation to perforation site. *Journal of Laryngology and Otology*.1983; 97: 11-17.

29) Chopra H, Munjal M, Mathur N. Comparision between overlay and underlay techniques of Myringoplasty. *Indian Journal of Otology*.2001; 7: 83-85.

30) Palva T. Surgical treatment of chronic middle ear disease: l Myringoplasty and tympanoplasty. *Acta Otolaryngol (Stockh)* 1987;104:279-284.

31) Sheehy JL, Anderson RG. Myringoplasty: A Review of 472 cases. *Ann Otol* 1980; 89: 331-334.

32) Schwaber M K. Post auricular undersurface tympanic membrane grafting: Some modifications of the "swinging door" technique. *Otolaryngology and Head and Neck Surgery*.1986; 95: 182-187.

33) Glasscock M E, Jackson CG, Nissen AJ, Schwaber MK. Post auricular undersurface tympanic membrane grafting: A follow-up report. *Laryngoscope*.1982; 92: 718-727.

34) K Park., Park's Textbook of Preventive and Social Medicine, Jabalpur, Banarasidas Bhanoti: 17th Ed, 2003.

35) House WF, Sheehy JL. Myringoplasty. *Archives of Otolaryngology*.1961; 73: 53/407- 61/415.

36) Storrs LA. Myringoplasty with use of fascia grafts. *Archives of Otolaryngology*.1961; 74: 45-49.

37) Booth J B. Myringoplasty Factors affecting results. Final report. *Journal of Laryngology and Otology*.1973: 1039-1055.

38) Raghavan U, Malki DSI, Mahmoud NA. Myringoplasty: Update on onlay pedicle skin flap and temporalis fascia sandwich graft. *Journal of Laryngology and Otology*. 2000; 114: 174-177.

39) Mathai J. Myringoplasty with temporalis fascia: Analysis of 200 cases. *Indian Journal of Otolaryngology and Head and Neck Surgery*.1999; 51: 9-13.

40) Mitchell RB, Kenyon GS, Gardiner Q. Day-stay Myringoplasty. *Journal of Laryngology and Otology*.1996;110: 421-424.

41) Poorey VK, Iyer A. Study of bacterial flora in csom and its clinical significance. *Indian Journal of Otolaryngology and Head and Neck Surgery*.2002; 54: 91-95.

42) Adkins WY, White B, Charleston. Type I tympanoplasty: influencing factors. *Laryngoscope*.1984;94:916-918.

BLDEU'S SHRIB.M.PATILMEDICALCOLLEGE AND RESEARCH CENTER, BIJAPUR- 586103

TITLE OF THE PROJECT:	**A COMPARATIVE STUDY OF MYRINGOPLASTY UNDERLAY TECHNIQUE WITH AND WITHOUT ANTERIOR ANCHORING OF GRAFT**
PG GUIDE:	**DR. N. H. KULKARNI** **H.O.D. & PROF. OF E.N.T.** **B.L.D.E.U.'s Shri B. M.PatilCollege, Hospital & Research Centre,** **Bijapur, Karnataka.**
PG STUDENT:	**DR.KUNAL SHAHI** **P.G. Student,** **Dept. of E.N.T.**

PURPOSE OF RESEARCH:

I have been informed that this is a study, to demonstrate the anatomical and functional results following underlay myringoplasty with and without anterior anchoring technique.

PROCEDURE:

I am aware that in addition to routine care received, I will be asked series of questions by the investigator. I have been asked to undergo the necessary investigations and treatment, which will help the investigator in this study.

RISK AND DISCOMFORTS:

I understand there is no risk involved and I will experience some pain and discomfort during my procedures performed. This is mainly the result of my condition and the procedure of this study is not expected to exaggerate these feelings that are associated with the usual course of treatment.

BENEFITS:

I understand that my participation in this study will help the investigator to understand the anatomical and functional results following underlay myringoplasty with anterior anchoring technique.

CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of Hospital records and will be subject to the confidentiality and privacy regulation. Information of a sensitive personal nature will not be a part of the medical records, but investigator's research file and identified only by a code number. The code-key connecting name to numbers will be kept in a separate location.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs and audio or videotapes will be used only with my special written permission. I understand that I may see the photographs and videotapes and hear the audiotapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at anytime. Dr. Kunal Shahi is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation.

If during the study, or later, if I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. A copy of this consent form will be given to me to keep for careful reading.

REFUSAL FOR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital. I also understand that Dr. Kunal Shahi may terminate my participation in the study after he has

explained the reasons for doing so and has helped arrange for my continued care by my own physician or physical therapist, if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me, but no further compensation would be provided. I understand that by my agreement to participate in this study I am not waiving any of my legal rights.

STUDY SUBJECT CONSENT STATEMENT:

I confirm that Dr. Kunal Shahi has explained to me the purpose of research, the study procedures that I will undergo, and the possible risks and discomforts as well as benefits that I may experience in my own language. I have read and I understand this consent form. Therefore, I agree to give consent to participate as a subject in this research project.

_____ _____

Participant / Guardian Date

_____ _____

Witness to signature Date

I have explained to _____the purpose of the research, the procedures required and the possible risks and benefits to the best of my ability in patient's own language.

_____ _____

Dr. Kunal Shahi Dr. N. H. Kulkarni

(Investigator) (Guide)

PROFORMA

CASE RECORD

1) **Name**: CASE NO:

2) **Age**: IP NO:

3) **Sex**: DOA:

4) **Religion**: DOS:

5) **Occupation**: DOD:

6**) Residence**:

7) **Chief complaints**

8) **History of presenting illness**

9) **Past History**:

1. Diabetes mellitus
2. Hypertension
3. History of any drug intake
4. History of jaundice or renal disease.

10) **General Physical Examination**

Pallor	present/absent
Icterus	present/absent
Clubbing	present/absent
Generalized Lymphadenopathy	present/absent
Build	Poor/Moderate /Well
Nourishment	Poor /Moderate/Well

11**) Vital signs**

PR:	Temp:
BP:	Weight:
RR:	

12**) Systemic Examination**:

i. Respiratory System
ii. Cardiovascular System
iii. Central Nervous System
iv. Per abdomen

13**) Local examination**

Ear:

Right Left

1. Pinna
2. Pre-auricular area
3. Post-auricular area
4. Infra-auricular area
5. External auditory canal
6. Tympanic membrane

   Pars tensa

   Pars flaccida
7. Mastoid tenderness
8. Fistula sign
9. Tragal tenderness
10. Facial nerve functioning
11. Nystagmus
12. Tuning Fork test

    a. Rinnes test

b. Webers test

c. ABC test

Nose:

1. Extenal Appearance
2. Cold Spatula test
3. Anterior rhinoscopy
4. Posterior rhinoscopy
5. Paranasal sinus tenderness

Throat:

1. Oral cavity
2. Oropharynx
3. IDL Examination

14) **Investigation**:

Blood: Hb %

TC

DC

ESR

BT

CT

HbsAg

HIV

BLOOD UREA

SERUM CREATININE

RBS

Urine: Albumin

Sugar

Micro:

X-ray: Bilateral Mastoids

15) **Pure tone audiometry:**

- Preoperatively

16) **Final Diagnosis**:

17) **Treatment**:

Medical:

Aural toilet

Antibiotics-systemic & local

Decongestants

Surgical:

Anaesthesia: GA/LA with sedation

Incision: Post aural/ Endaural/Permeatal

Mastoid Exploration: done/not done

Operative findings

Ossicular chain: intact/ disrupted

Graft: Temporalis fascia/ vein/perichondrium

Graft placed: inlay/ interlay/ onlay

18**) Post operative follow up**

	1 month	3 months
Graft Take up:		
Pure tone audiometry:		

19) **Inference**:

20) **Comments**:

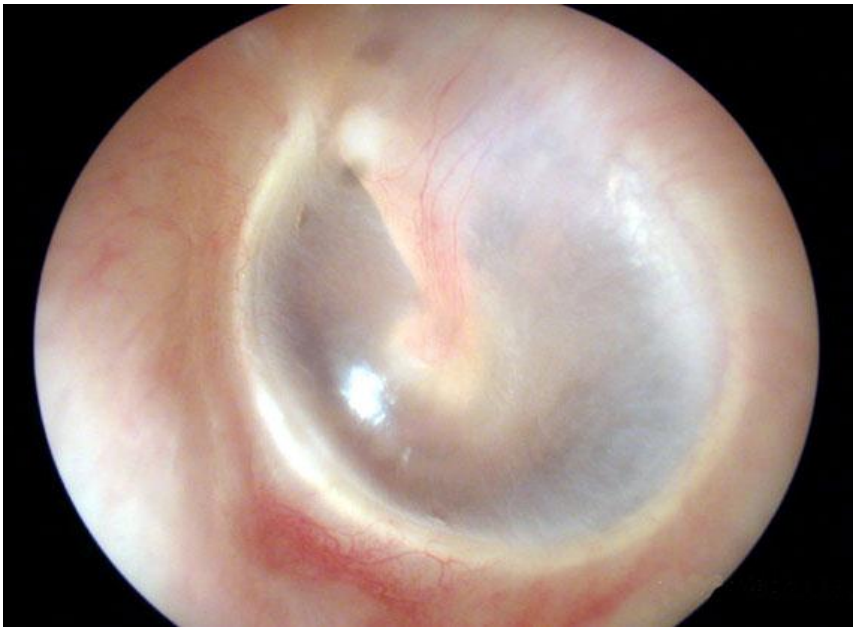

Fig – I Endoscopic photograph of normal tympanic membrane

Fig – II Endoscopic photograph of centrally placed perforation

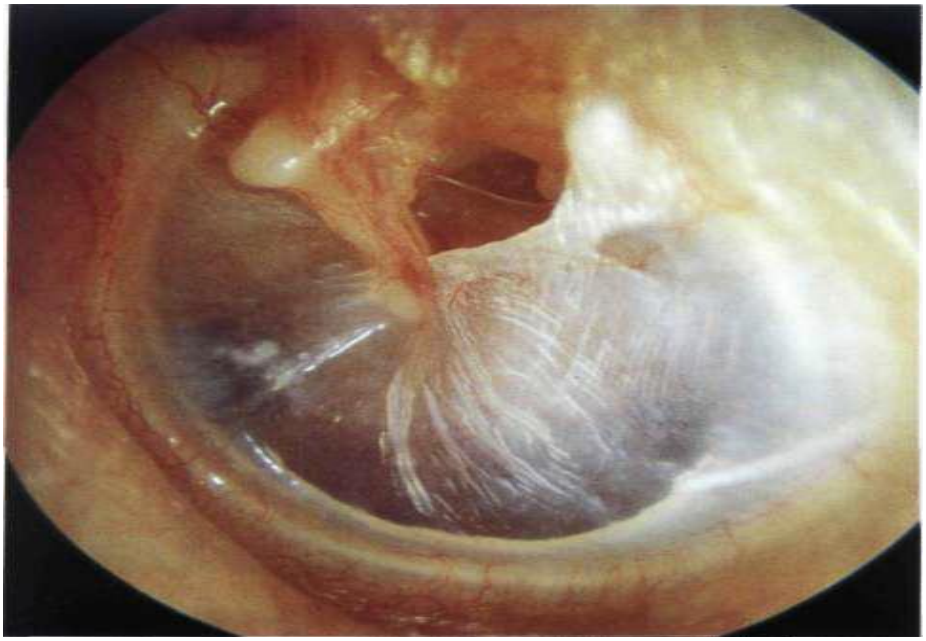

Fig – III Endoscopic photograph of posterior perforation

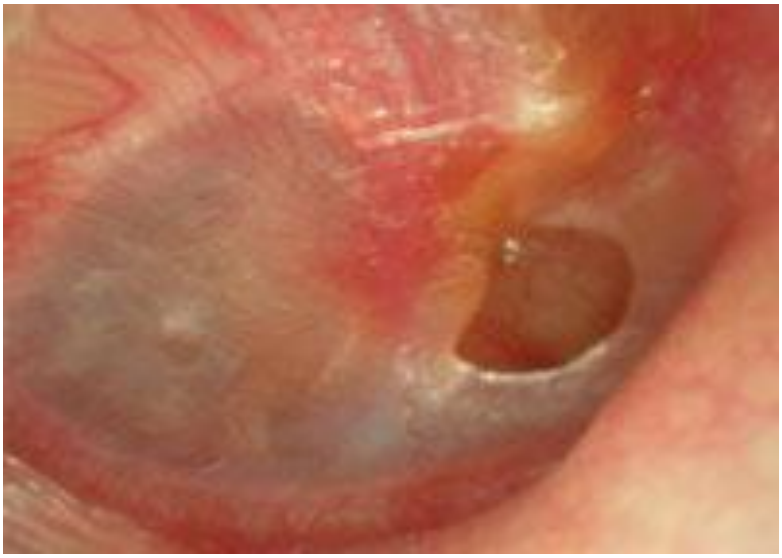

Fig – IV Endoscopic photograph of anterior perforation

Fig – V Endoscopic photograph of Subtotal perforation

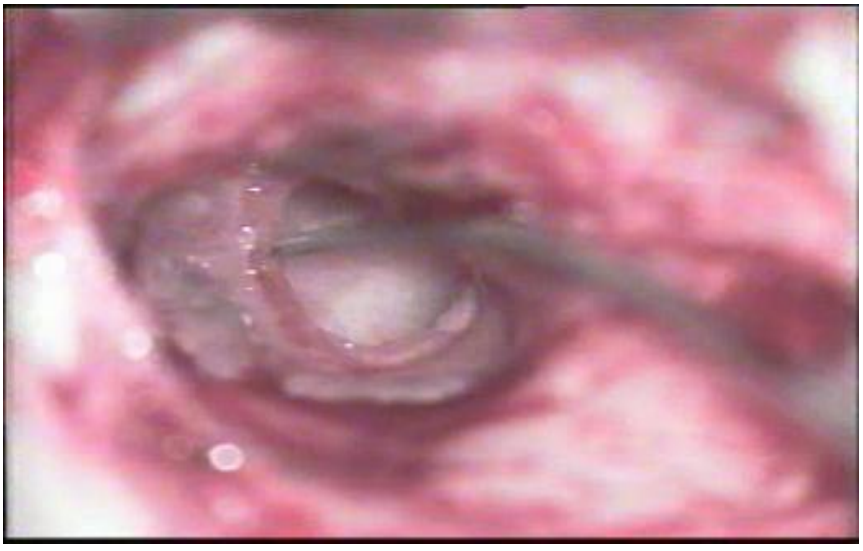

Fig – VI Microscopic photograph of centrally placed perforation

Fig – VII Post-aural Incision

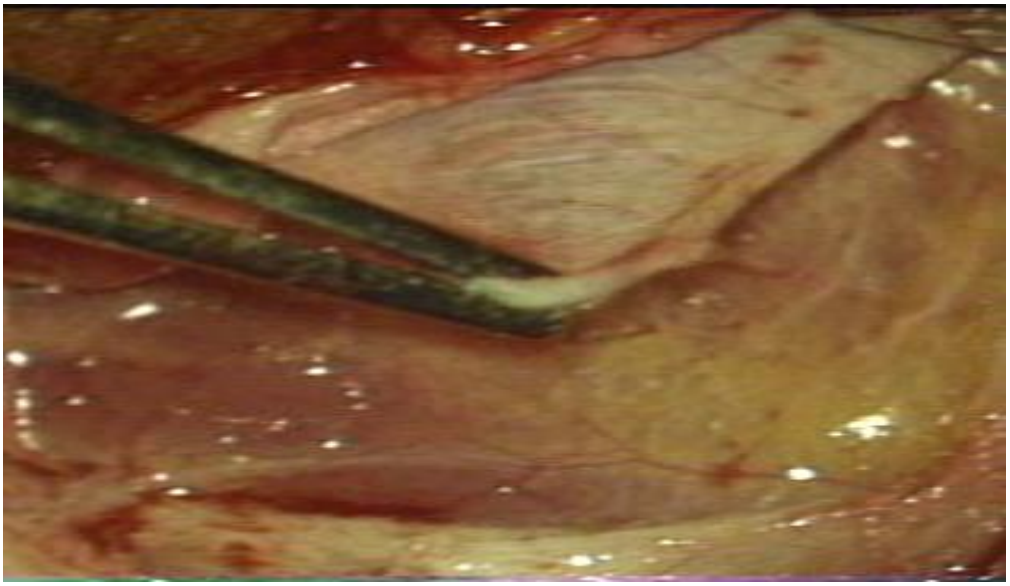

Fig – VIII Harvesting of Temporalis Fascia

Fig – IX Microscopic photograph of Posterior meatotomy.

Fig – X Microscopic photograph of tympano-meatal flap incision.

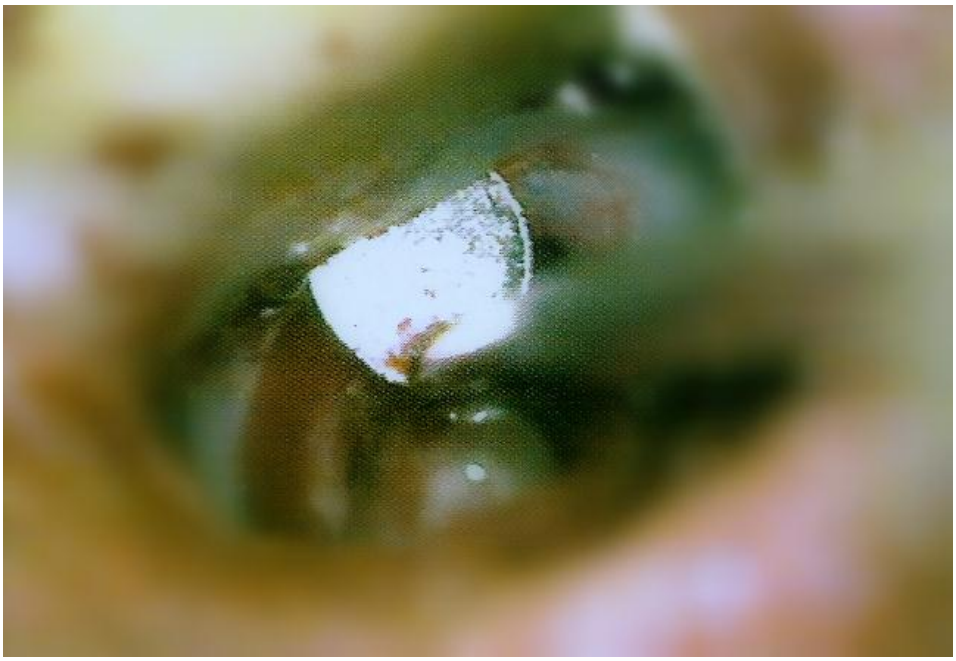

Fig – XI Microscopic photograph of anterior tunnel incision for anterior anchoring of the graft.

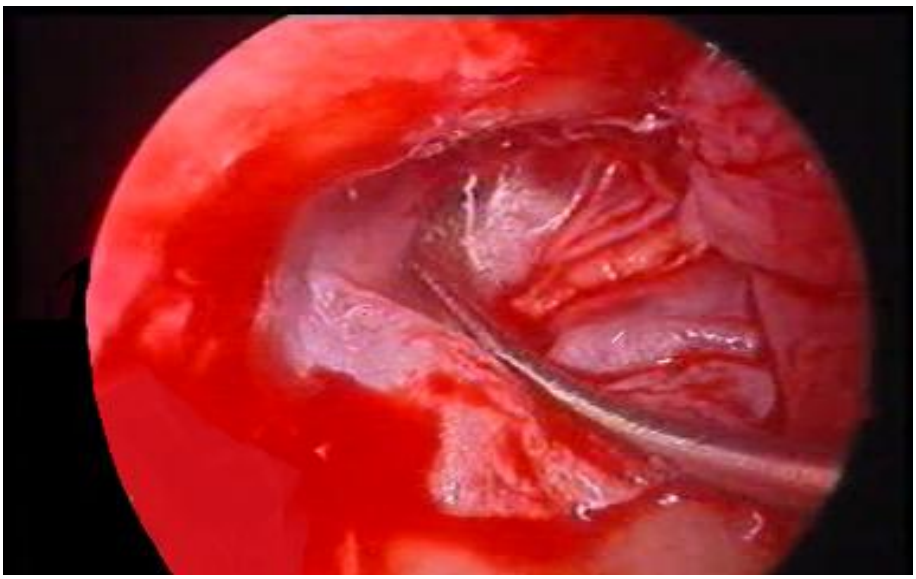

Fig – XII Microscopic photograph of graft placement with exteriorization of handle of malleus

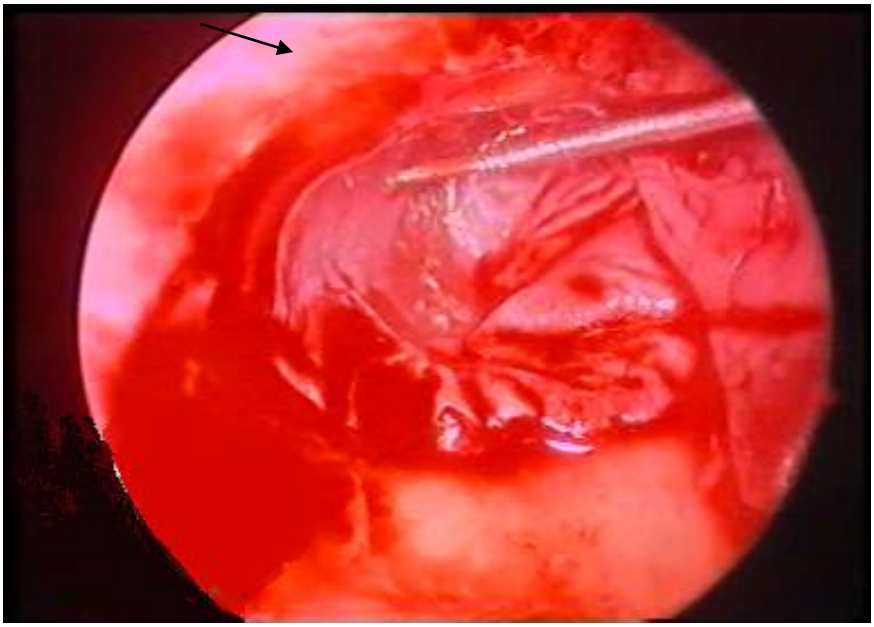

Fig – XIII Microscopic photograph of Anterior anchoring of the graft.

Sl no	Name	Age	Sex	Date	Ip no	Diagnosis	Treatment
1	Veerupaksha	55	M	11/23/2010	20347	Rt CSOM (tt)	Rt type 1 tympanoplasty
2	Ramesh	40	M	12/3/2010	27083	Rt CSOM (tt)	Rt type 1 tympanoplasty
3	Prabhavati	25	F	12/7/2010	27338	Rt CSOM (tt)	Rt type 1 tympanoplasty
4	Shantawwa	35	F	12/10/2010	27592	Lt CSOM (tt)	Left type 1 tympanoplasty
5	Dhullappa	30	M	12/14/2010	27854	Lt CSOM (tt)	Left type 1 tympanoplasty
6	Prakash	26	M	12/14/2010	27849	Rt CSOM (tt)	Rt type 1 typanoplsty
7	Devendra	60	M	12/17/2010	28091	Rt CSOM (tt)	Rt type 1 tympanoplasty
8	Kavita	27	F	12/21/2010	28304	Rt CSOM (tt)	Rt type 1 tympanoplasty
9	Suresh	21	M	12/27/2010	28692	Rt CSOM (tt)	Rt type 1 tympanoplasty
10	Gajanan	20	M	12/31/2010	28994	Rt CSOM (tt)	Rt type1 tympanoplasty
11	Kiran	35	F	1/1/2011	24	Rt CSOM (tt)	Rt type 1 tympanoplasty
12	Bhimangouda	30	M	1/18/2011	1157	B/L CSOM(tt)	Rt type 1 tympanoplasty
13	Shivappa	38	M	1/21/2011	1408	B/L CSOM(tt)	Right type 1 tympanoplasty
14	Sunil	30	M	1/22/2011	1480	Rt CSOM (tt)	Right type 1 tympanoplasty
15	Guramma	50	F	1/23/2011	1547	Rt CSOM (tt)	Right type 1 tympanoplasty
16	Prakash	52	M	1/25/2011	1654	Rt CSOM (tt)	Right type 1 tympanoplasty
17	Govind	28	M	1/28/2011	1879	Rt CSOM (tt)	Right type 1 tympanoplasty
18	Mahadev	44	M	1/29/2011	1960	Lt CSOM(tt)	Left type 1 tympanoplasty
19	Mahadevi	28	F	2/1/2011	2116	B/L CSOM(tt)	Left type 1 tympanoplasty
20	Parvati	36	F	2/4/2011	2380	Rt CSOM (tt)	Right type 1 tympanoplasty
21	Ramkrisnna	18	M	2/5/2011	2446	Lt CSOM(tt)	Left type 1 tympanoplasty
22	Suresh	26	M	2/5/2011	2469	Rt CSOM (tt)	Right type 1 tympanoplasty
23	Shridhar	15	M	2/10/2011	2848	B/L CSOM(tt)	Left type 1 tympanoplasty
24	Umesh	20	M	2/11/2011	2942	Rt CSOM (tt)	Right type 1 tympanoplasty
25	Sangamma	32	F	2/11/2011	2921	Rt CSOM (tt)	Right type 1 tympanoplasty
26	Sangamesh	53	M	2/16/2011	3363	Lt CSOM(tt)	Left type 1 tympanoplasty
27	Mallappa	21	M	2/16/2011	3364	Rt CSOM (tt)	Right type 1 tympanoplasty
28	Allapeer	25	M	2/17/2011	3492	Lt CSOM(tt)	Left type 1 tympanoplasty
29	Chandrappa	25	M	2/21/2011	3683	Lt CSOM(tt)	Left type 1 tympanoplasty
30	Sangappa	46	M	3/4/2011	4523	Rt CSOM (tt)	Rt type 1 tympanoplasty
31	Shivappa	25	M	3/5/2011	4600	Rt CSOM (tt)	Rt type 1 tympanoplasty
32	Shirish	26	M	3/11/2011	5006	Lt CSOM(tt)	Left type 1 tympanoplasty
33	Anita Biradar	22	F	3/12/2011	5069	Lt CSOM(tt)	Left type 1 tympanoplasty
34	Sunil	18	M	3/16/2011	5451	Rt CSOM (tt)	Right type 1 tympanoplasty
35	Faiz	23	M	3/15/2011	5332	Lt CSOM(tt)	Left type 1 tympanoplasty
36	Sushila	32	F	3/16/2011	5444	Rt CSOM (tt)	Right type 1 tympanoplasty
37	Raviraj	36	M	3/17/2011	5487	Lt CSOM(tt)	Left type 1 tympanoplasty
38	Javed Patel	32	M	3/18/2011	5567	Lt CSOM(tt)	Left type 1 tympanoplasty
39	Sheela	24	F	3/22/2011	5829	Lt CSOM(tt)	Left type 1 tympanoplasty
40	Shoba	19	F	3/22/2011	5851	B/L CSOM(tt)	Rt type 1 tympanoplasty
41	Kalawati Ugran	21	F	3/25/2011	6124	B/L CSOM(tt)	Rt type 1 tympanoplasty
42	Vanishree	22	F	3/26/2011	6161	Lt CSOM(tt)	Left type 1 tympanoplasty
43	Iranna	28	M	3/26/2011	6159	Rt CSOM (tt)	Rt type 1 tympanoplasty
44	Sahebgouda	32	M	3/28/2011	6312	Lt CSOM(tt)	Left type 1 tympanoplasty
45	Gangappa	30	M	3/29/2011	6357	Lt CSOM(tt)	Left type 1 tympanoplasty
46	Ramu	29	M	4/1/2011	6581	Lt CSOM(tt)	Left type 1 tympanoplasty
47	Kasruribai	45	F	4/4/2011	6734	Lt CSOM(tt)	Left type 1 tympanoplasty
48	Taranath	30	M	4/5/2011	6783	Rt CSOM (tt)	Right type 1 tympanoplasty
49	Koushik	22	M	4/8/2011	7047	Lt CSOM(tt)	Left type 1 tympanoplasty
50	Ramesh	28	M	4/8/2011	7045	Rt CSOM (tt)	Right type 1 tympanoplasty
51	Manoj	35	M	4/9/2011	7116	Rt CSOM (tt)	Right type 1 tympanoplasty
52	Ramesh	25	M	4/12/2011	7354	Rt CSOM (tt)	Right type 1 tympanoplasty

53	Basappa	30	M	4/15/2011	7555	Rt CSOM (tt)	Right type 1 tympanoplasty
54	Hunumappa	32	M	4/19/2011	7785	Rt CSOM (tt)	Right type 1 tympanoplasty
55	Ishwarappa	40	M	4/19/2011	7787	Lt CSOM(tt)	Left type 1 tympanoplasty
56	Shrisail	40	M	4/20/2011	8027	Lt CSOM(tt)	Left type 1 tympanoplasty
57	Iranna	32	M	4/22/2011	8029	Rt CSOM (tt)	Rt type 1 tympanoplasty
58	Basamma	32	F	4/23/2011	8078	Lt CSOM(tt)	Left type 1 tympanoplasty
59	Ningawwa	34	F	4/23/2011	8086	Lt CSOM(tt)	Left type 1 tympanoplasty
60	Bhimappa	38	M	4/26/2011	8269	Lt CSOM(tt)	Left type 1 tympanoplasty
61	Sharanappa	40	M	4/26/2011	8271	Rt CSOM (tt)	Right type 1 tympanoplasty
62	Shivappa	18	M	4/27/2011	8355	B/L CSOM(tt)	Left type 1 tympanoplasty
63	Pavitra	15	F	4/29/2011	8591	Rt CSOM (tt)	Right type 1 tympanoplasty
64	Jagadish	22	M	4/30/2011	8849	Rt CSOM (tt)	Right type 1 tympanoplasty
65	Laxman	30	M	5/3/2011	8849	Rt CSOM (tt)	Right type 1 tympanoplasty
66	Sharanappa	38	M	5/3/2011	8851	Rt CSOM (tt)	Right type 1 tympanoplasty
67	Gangadhar	32	M	5/6/2011	9089	B/L CSOM(tt)	Right type 1 tympanoplasty
68	Laxmi	25	F	5/6/2011	9093	Rt CSOM (tt)	Right type 1 tympanoplasty
69	Mallappa	28	M	5/7/2011	9141	Rt CSOM (tt)	Right type 1 tympanoplasty
70	Abhishek	30	M	5/13/2011	9591	Lt CSOM(tt)	Left type 1 tympanoplasty
71	Sunil	24	M	5/13/2011	9596	Rt CSOM (tt)	Right type 1 tympanoplasty
72	Veeresh	25	M	5/17/2011	9863	B/L CSOM(tt)	Left type 1 tympanoplasty
73	Raju	17	M	5/20/2011	10100	Lt CSOM(tt)	Left type 1 tympanoplasty
74	Mayappa	12	M	5/30/2011	10876	Lt CSOM(tt)	Left type 1 tympanoplasty
75	Supriya	35	F	5/31/2011	10908	B/L CSOM(tt)	Left type 1 tympanoplasty
76	Prakash	35	M	6/4/2011	11249	Lt CSOM(tt)	Left type 1 tympanoplasty
77	Abhay	27	M	6/4/2011	11247	B/L CSOM(tt)	Left type 1 tympanoplasty
78	Varun	28	M	6/7/2011	11426	Lt CSOM(tt)	Left type 1 tympanoplasty
79	Basappa	38	M	6/7/2011	11430	Rt CSOM (tt)	Right type 1 tympanoplasty
80	Gururaj	14	M	6/8/2011	11533	Rt CSOM (tt)	Right type 1 tympanoplasty
81	Keerthish	25	M	6/10/2011	11671	Lt CSOM(tt)	Left type 1 tympanoplasty
82	Bhagyashree	11	F	6/11/2011	11743	Rt CSOM (tt)	Right type 1 tympanoplasty
83	Sayawwa	14	F	6/11/2011	11740	Rt CSOM (tt)	Right type 1 tympanoplasty
84	Anusabai	40	F	6/13/2011	11909	Lt CSOM(tt)	Left type 1 tympanoplasty
85	Kamanna	27	M	6/14/2011	11965	Rt CSOM (tt)	Right type 1 tympanoplasty
86	Rohit	28	M	6/18/2011	12289	Rt CSOM (tt)	Right type 1 tympanoplasty
87	Rahul	18	M	6/18/2011	12285	Lt CSOM(tt)	Left type 1 tympanoplasty
88	Madevi	35	F	6/25/2011	12861	Rt CSOM (tt)	Right type 1 tympanoplasty
89	Ragavendra	35	M	6/28/2011	13078	Rt CSOM (tt)	Right type 1 tympanoplasty
90	Siddanna	18	M	6/28/2011	13121	B/L CSOM(tt)	Right type 1 tympanoplasty

CM	CD	GP	TP	DP1	preoperative levels				RP
					Air conduction threshold			A-B gap	
					0.5 Khz	1 khz	2 Khz	(mean)	
No	11/24/2010	A	CP	11/23/2010	35	35	40	36.6	Absent
No	12/4/2010	B	AP	12/3/2010	30	35	25	25	Absent
No	12/8/2010	A	AP	12/7/2010	25	30	25	18.3	Absent
No	12/11/2010	B	STP	12/10/2010	30	40	40	33.3	Absent
No	12/15/2010	A	AP	12/14/2010	20	25	30	21.6	Absent
No	12/15/2010	B	AP	12/14/2010	20	25	25	20	Present
No	12/18/2010	A	CP	12/17/2010	40	40	40	31.6	Absent
No	12/22/2010	B	PP	12/21/2010	25	30	25	21.6	Absent
No	12/28/2010	A	STP	12/27/2010	45	40	45	36.6	Absent
No	1/1/2011	B	PP	12/31/2010	30	25	30	21.6	Absent
No	1/3/2011	A	CP	1/1/2011	35	40	30	25	Present
No	1/19/2011	B	PP	1/18/2011	25	30	30	26.6	Absent
No	1/22/2011	A	AP	1/22/2011	30	30	25	25	Absent
No	1/24/2011	B	AP	1/22/2011	25	25	35	21.6	Absent
No	1/25/2011	A	CP	1/23/2011	35	30	30	30	Absent
No	1/26/2011	B	CP	1/25/2011	30	35	30	25	Absent
No	1/29/2011	A	AP	1/28/2011	25	30	25	30	Absent
No	1/31/2011	B	STP	1/29/2011	40	35	35	36.6	Absent
No	2/2/2011	A	STP	2/1/2011	45	50	45	38.3	Absent
No	2/5/2011	B	CP	2/4/2011	35	30	40	38.3	Absent
No	2/7/2011	A	CP	2/5/2011	40	35	45	31.6	Absent
No	2/7/2011	B	CP	2/5/2011	35	25	30	25	Absent
No	2/11/2011	A	CP	2/10/2011	35	30	30	26.6	Absent
No	2/12/2011	B	CP	2/11/2011	35	30	30	26.6	Absent
No	2/12/2011	A	STP	2/11/2011	30	40	35	38.3	Absent
No	2/22/2011	B	AP	2/16/2011	30	30	30	30	Absent
No	2/21/2011	A	AP	2/18/2011	30	30	35	26.6	Absent
Yes	2/18/2011	B	AP	2/18/2011	25	30	30	28.3	Present
No	2/22/2011	A	STP	2/21/2011	40	35	40	38.33	Absent
No	3/7/2011	B	STP	3/4/2011	40	45	45	41.6	Absent
No	3/7/2011	A	CP	3/5/2011	25	45	40	33.3	Absent
Yes	3/12/2011	B	STP	3/11/2011	30	45	50	36.6	Absent
No	3/14/2011	A	AP	3/12/2011	25	20	20	18.3	Absent
No	3/17/2011	B	PP	3/14/2011	35	35	40	28.3	Absent
No	3/16/2011	A	CP	3/15/2011	35	40	25	33.3	Present
No	3/17/2011	B	CP	3/16/2011	35	40	30	28.3	Absent
No	3/19/2011	A	CP	3/18/2011	40	35	35	35	Absent
No	3/19/2011	B	PP	3/18/2011	40	35	35	35	Absent
No	3/23/2011	A	CP	3/22/2011	35	50	45	33.3	Absent
No	3/23/2011	B	STP	3/23/2011	50	55	40	45	Absent
No	3/26/2011	A	CP	3/25/2011	40	45	45	40	Absent
No	3/28/2011	B	CP	3/26/2011	30	35	40	35	Absent
No	3/28/2011	A	CP	3/26/2011	40	45	30	33.3	Absent
No	3/29/2011	B	STP	3/28/2011	40	45	45	41.6	Absent
No	3/30/2011	A	STP	3/29/2011	50	45	45	36.6	Present
No	4/2/2011	B	CP	4/1/2011	35	35	45	35	Absent
No	4/5/2011	A	AP	4/4/2011	40	40	30	28.3	Absent
No	4/6/2011	B	STP	4/5/2011	45	45	40	45	Absent
No	4/9/2011	A	STP	4/8/2011	45	50	50	53.3	Absent
No	4/9/2011	B	STP	4/8/2011	35	40	50	41.6	Absent
Yes	4/11/2011	A	CP	4/9/2011	45	50	35	40	Absent
No	4/13/2011	B	STP	4/13/2011	40	45	45	41.6	Absent

No	4/16/2011	A	PP	4/15/2011	35	35	30	35	Absent
No	4/20/2011	B	PP	4/19/2011	35	35	25	31.6	Absent
No	4/20/2011	A	CP	4/19/2011	40	40	45	38.3	Absent
No	4/23/2011	B	AP	4/22/2011	30	30	35	26.6	Absent
No	4/23/2011	A	STP	4/22/2011	40	40	40	41.6	Absent
No	4/25/2011	B	STP	4/23/2011	50	50	40	41.6	Present
No	4/25/2011	A	STP	4/23/2011	50	40	40	41.6	Absent
No	4/27/2011	B	STP	4/26/2011	55	50	40	46.6	Absent
No	4/28/2011	A	CP	4/26/2011	35	35	40	38.3	Absent
No	4/29/2011	B	AP	4/27/2011	25	40	30	28.3	Absent
No	4/30/2011	A	STP	4/29/2011	40	50	45	48.3	Absent
No	5/2/2011	B	STP	4/30/2011	45	45	40	36.6	Absent
No	5/4/2011	A	CP	5/3/2011	30	40	40	40	Absent
No	5/4/2011	B	STP	5/3/2011	50	45	55	53.3	Absent
No	5/7/2011	A	STP	5/6/2011	35	40	40	38.3	Absent
No	5/7/2011	B	STP	5/6/2011	40	40	35	31.6	Present
No	5/9/2011	A	CP	5/7/2011	35	40	40	33.3	Absent
No	5/14/2011	B	AP	5/13/2011	30	35	35	28.3	Absent
No	5/14/2011	A	PP	5/13/2011	40	40	30	33.3	Absent
No	5/18/2011	B	STP	5/17/2011	45	50	50	48.3	Absent
No	5/21/2011	A	PP	5/20/2011	30	40	45	30	Absent
No	5/31/2011	B	AP	5/30/2011	20	30	35	28.3	Absent
No	6/1/2011	A	AP	5/31/2011	30	30	35	31.6	Absent
No	6/6/2011	B	CP	6/4/2011	30	35	35	38.3	Absent
No	6/6/2011	A	STP	6/4/2011	30	45	40	43.3	Absent
No	6/8/2011	B	STP	6/8/2011	40	45	45	46.6	Absent
No	6/8/2011	A	AP	6/7/2011	25	30	30	31.6	Absent
Yes	6/9/2011	B	STP	6/8/2011	50	45	40	50	Absent
No	6/11/2011	A	STP	6/10/2011	45	45	45	41.6	Absent
No	6/13/2011	B	STP	6/8/2011	30	40	45	36.6	Present
No	6/13/2011	A	STP	6/11/2011	40	40	45	41.6	Absent
No	6/14/2011	B	CP	6/13/2011	40	45	45	43.3	Absent
Yes	6/15/2011	A	CP	6/14/2011	30	30	35	21.6	Absent
No	6/18/2011	B	CP	6/18/2011	30	40	45	35	Absent
No	6/20/2011	A	PP	6/18/2011	30	40	40	38.3	Absent
No	6/27/2011	B	STP	6/25/2011	40	40	50	38.3	Present
No	6/29/2011	A	CP	6/28/2011	40	35	40	33.3	Absent
No	6/29/2011	B	CP	6/26/2011	35	35	40	36.6	Absent

DP2	postoperative levels 3 week				DP3	postoperative levels 7 week			
	Air conduction threshold			A-B gap		Air conduction threshold			A-B gap
	0.5 Khz	1Khz	2 Khz	(mean)		0.5 Khz	1 Khz	2 Khz	(mean)
12/24/2010	20	20	20	20	2/22/2011	20	20	15	16.6
1/4/2011	20	20	20	15	3/5/2011	20	20	20	15
1/7/2011	15	15	20	8.3	3/8/2011	15	15	15	6.6
1/10/2011	25	20	20	18.3	3/11/2011	20	20	20	16.6
1/15/2011	20	20	20	16.6	3/14/2011	15	15	15	11.6
1/15/2011					3/15/2011				
1/17/2011	25	25	20	15	3/16/2011	20	15	15	8.3
1/20/2011	15	10	10	6.6	3/22/2011	15	10	10	6.6
1/28/2011	25	25	30	20	3/28/2011	20	20	20	13.3
1/31/2011	20	15	20	11.6	3/30/2011	15	15	20	10
1/31/2011					4/1/2011				
2/19/2011	20	20	25	20	4/18/2011	15	10	15	11.6
2/22/2011	20	25	20	18.3	4/23/2011	15	15	10	10
2/22/2011	20	20	20	13.3	4/22/2011	15	20	15	10
2/22/2011	20	20	15	16.6	4/23/2011	15	10	10	10
2/25/2011	20	15	20	11.6	4/23/2011	15	15	20	10
3/1/2011	15	20	10	18.3	5/2/2011	15	15	10	16.6
3/1/2011	25	20	15	20	5/2/2011	20	20	15	18.3
3/2/2011	25	25	30	18.3	5/2/2011	20	25	20	13.3
3/5/2011	25	20	20	21.6	5/5/2011	20	15	20	18.3
3/7/2011	20	25	25	15	5/6/2011	20	15	15	8.3
3/7/2011	25	20	15	15	5/7/2011	20	15	15	11.6
3/10/2011	25	20	15	15	5/10/2011	20	20	15	13.3
3/10/2011	20	20	15	13.3	5/11/2011	20	20	15	13.3
3/10/2011	25	25	20	26.6	5/12/2011	20	15	20	21.6
3/16/2011	20	15	20	18.3	5/17/2011	20	15	15	16.6
3/17/2011	15	20	20	13.3	5/17/2011	15	20	15	11.6
3/17/2011					5/19/2011				
3/22/2011	25	25	20	23.3	5/20/2011	20	15	20	18.3
4/4/2011	25	20	25	21.6	6/4/2011	20	15	10	13.3
.04-04-201	20	25	20	18.3	6/4/2011	15	20	20	15
4/11/2011	15	20	20	15	6/13/2011	15	20	15	13.3
4/12/2011	15	10	10	6.6	6/13/2011	15	10	10	6.6
4/13/2011	25	20	20	13.3	6/13/2011	20	15	15	8.3
4/14/2011					6/13/2011				
4/18/2011	30	25	25	20	6/18/2011	15	20	15	10
4/17/2011	25	20	15	18.3	6/20/2011	20	20	15	16.6
4/17/2011	20	25	20	20	6/20/2011	15	20	15	15
4/23/2011	25	30	30	18.3	6/23/2011	20	15	25	10
4/22/2011	30	30	25	25	6/23/2011	20	15	15	13.3
4/25/2011	25	20	25	20	6/24/2011	20	20	20	16.6
4/26/2011	20	25	20	21.6	6/27/2011	20	15	20	18.3
4/26/2011	25	25	15	16.6	6/27/2011	15	20	15	11.6
4/28/2011	20	25	25	21.6	6/28/2011	15	20	20	16.6
4/28/2011					6/28/2011				
5/2/2011	25	20	25	20	7/2/2011	20	20	15	15
5/3/2011	20	15	15	8.3	7/5/2011	20	15	15	8.3
5/4/2011	30	25	20	26.6	7/5/2011	20	20	20	21.6
5/6/2011	20	25	30	30	7/6/2011	20	25	25	28.3
5/6/2011	15	20	20	18.3	7/7/2011	15	20	15	16.6
5/7/2011	20	20	20	16.6	7/9/2011	20	15	15	13.3
5/12/2011	15	20	25	18.3	7/12/2011	15	20	25	18.3

5/16/2011	20	20	20	21.6	7/14/2011	20	15	20	20
5/18/2011	20	20	20	20	7/18/2011	15	20	15	16.6
5/18/2011	20	15	20	13.3	7/19/2011	20	15	10	10
5/21/2011	15	10	20	10	7/22/2011	15	10	20	10
5/21/2011	25	30	25	28.3	7/22/2011	25	20	25	25
5/23/2011					7/25/2011				
5/23/2011	25	25	20	21.6	7/25/2011	25	20	20	20
5/25/2011	25	20	20	20	7/25/2011	25	20	20	20
5/24/2011	15	20	15	18.3	7/26/2011	15	20	15	18.3
5/28/2011	15	20	10	11.6	7/27/2011	15	15	10	10
5/28/2011	25	20	25	26.6	7/29/2011	20	15	20	21.6
5/30/2011	20	15	20	11.6	7/30/2011	15	15	20	10
6/4/2011	20	20	20	25	8/3/2011	20	15	15	21.6
6/5/2011	25	20	20	25	8/4/2011	25	20	20	25
6/6/2011	20	25	15	20	8/6/2011	20	20	15	18.3
6/7/2011					8/8/2011				
6/7/2011	25	20	20	16.6	8/6/2011	15	20	15	11.6
6/13/2011	15	20	15	11.6	8/15/2011	15	20	10	10
6/14/2011	20	15	10	11.6	8/15/2011	20	15	10	11.6
5/18/2011	20	20	15	18.3	8/18/2011	20	20	15	18.3
6/20/2011	15	20	15	8.3	8/20/2011	15	20	15	8.3
6/30/2011	15	20	15	16.6	8/29/2011	15	20	15	16.6
6/30/2011	15	20	15	16.6	8/31/2011	15	20	10	15
7/5/2011	20	15	10	20	9/3/2011	15	15	10	18.3
7/5/2011	20	15	20	13.3	9/3/2011	15	15	20	11.6
7/7/2011	25	15	20	20	9/6/2011	25	15	20	20
7/8/2011	15	15	10	16.6	9/8/2011	10	10	10	13.3
7/9/2011	20	20	15	23.3	9/9/2011	20	20	15	23.3
7/11/2011	20	25	20	18.3	9/12/2011	20	15	20	15
7/12/2011					9/12/2011				
7/14/2011	20	15	25	20	9/14/2011	20	15	25	20
7/13/2011	20	25	15	20	9/14/2011	15	25	15	18.3
7/15/2011	20	15	15	6.6	9/15/2011	20	15	15	6.6
7/18/2011	20	15	20	15	9/19/2011	20	15	20	15
7/20/2011	20	15	20	20	9/19/2011	15	15	20	18.3
7/26/2011					9/26/2011				
7/28/2011	15	20	20	13.3	9/28/2011	15	10	10	6.6
7/29/2011	15	20	20	18.3	9/28/2011	15	20	10	15

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