ORIGINAL ARTICLE

"Hearing results of ossicular chain reconstruction with cartilage in type III tympanoplasty in tubotympanic disease"

Dr. Sujan R.Patel*, Dr. Rupa P. Parikh**

*3rd year resident, **Professor & Head of Department, ENT Department,

SMIMER Medical College & Hospital, Umarwada, Surat.

KEY WORDS : Tympanoplasty, minor columella, cartilages

ABSTRACT

This article is to evaluate the functional and hearing outcomes using different cartilages for ossicular chain reconstruction in cases of tubotympanic disease where type III tympanoplasty (minor columella) with canal wall up mastoidectomy is done.

The retrospective study is performed at tertiary referral institute which included 30 patients with tympanic membrane perforations requiring tympanic membrane and ossicular chain (type III) reconstruction. Patients with disease extending beyond the aditus requiring canal wall down mastoidectomy were excluded. Ossicular chain reconstruction was performed using different cartilages like tragal cartilage, conchal cartilage or homologus septal spur cartilage.

Patients were assessed by comparing pre operative air bone gap(ABG) with post operative air bone gap(ABG) and thus hearing improvement was assessed at the end of 12 weeks.

Abbreviations:

CSOM: Chronic suppurative otitis media - OCR: Ossicular chain reconstruction

ETF: Eustachain tube function ABG: Air bone gap

INTRODUCTION

Chronic suppurative otitis media is worldly prevalent disease with otorrhoea, hearing loss, otalgia. Chronic suppurative otitis media (CSOM) is of two types, tubotympanic (mucosal) and atticoantral(squamous). CSOM tubotympanic type is the main indication for Tympanoplasty. It is a disease of the middle ear with a wide range of pathology affecting ossicular chain, mastoid air cell system, facial nerve and eustachain tube.

Tympanoplasty is defined as "an operation performed to eradicate disease in the middle ear and to reconstruct the hearing mechanism, without mastoid surgery, with or without tympanic membrane grafting." Tympanoplasty techniques for chronic otitis media were first developed in Germany and the temporalis fascia was first used by Heermann[1]. The goals of a successful tympanoplasty procedure are creation of an intact and mobile tympanic membrane, mucosalized and aerated middle ear, and a mobile ossicular conductive apparatus. An intact ossicular chain is one of the most desirable attributes of a tympanoplasty procedure and represents the most favorable hearing outcome[2].

Since the fundamental principles of Tympanoplasty[3] were introduced by Wullstein and Zollner, surgery of the ear has been directed towards the restoration of functional ear by ossicular chain reconstruction. Zollner and Wullstein provided a classification of Tympanoplasty that focused on the type of ossicular chain reconstruction (OCR) needed.

The five types of Tympanoplasty they described refer to the most lateral intact structure on which the conductive mechanism will be constructed.

Type I : perforation in tympanic membrane to be repaired with graft. All three ossicles to be present and mobile. Thus, OCR is not needed.

Type II : defective or absent handle of malleus but intact incus and stapes. Graft kept to an intact incus and stapes.

Type II a: necrosis of handle of malleus,, graft kept over remnant malleus and long process of incus

Type II b: malleus and stapes assembley(incus transposition), joining handle of malleus with head of stapes

Type II c: reconstruction between head of stapes and tympanic membrane

Correspondence Address : **Dr.Sujan R.Patel**
303/ Riddhi, Happy home Near china gate- 2, new city light road,
Surat-395007 E mail: sujan128@gmail.com

Type III: malleus and incus are absent. Intact mobile stapes superstructure is present and the tympanic membrane or graft remains directly on the stapes superstructure.(Columella effect)

Type IV: describes an absent or eroded superstructure of stapes with mobile stapes footplate,exteriorized with reconstruction of tympanic membrane as a round window baffle.

(Baffle effect)

Type V: stapes footplate is fixed but round window is functioning. Another window is created on horizontal semicircular canal and covered with a graft. (Fenestration operation)

Modified Wullstein classification has been introduced[4]

Type I: repair of tympanic membrane without altering ossicular chain

Type II: repair of ossicular chain with restoration of lever mechanism

Type III: has 3 other subtypes

Minor columella – reconstructive material kept between stapes head and graft

Major columella – reconstructive material kept between stapes footplate and graft

Stapes columella – graft directly on stapes head

Type IV: mobile stapes footplate directly exposed to incoming sound from ear canal, graft placed to shield the round window

Type Va: fenestarion of horizontal semicircular canal

Type Vb: fixed stapes footplate removed, oval window sealed by tissue graft

Certain conditions, however, mandate a type III ossicular reconstruction due to ossicular erosion (resorptive osteitis, cholesteatoma induced, granulations around ossicular chain) or ossicular disarticulation and removal for epitympanic disease clearance[5]. This can be associated with poorer hearing outcomes due to the primary pathology itself or the less than optimal prosthesis designs, materials and implant extrusions[6,7].

The use of cartilage in the middle ear has been suggested for use on a limited basis to manage retraction pockets for many years[8]. It has been shown that cartilage is well tolerated by the middle ear, and long-term survival is the norm. Jansen[9] found autologus tragal cartilage and autologus or preserved allogenic nasal septal cartilage suitable for tympanic membrane to stapes head interpos6;%

This prospective and observational study is focused on tubotympanic type of CSOM in which modified type III Tympanoplasty with minor columella and reconstruction of the tympanic membrane done and analyses the audiometric pattern of hearing loss in CSOM patients undergoing Tympanoplasty pre- operatively, and assess the outcome of the surgery in terms of improvement in hearing after 3 months later postoperatively. For the reconstruction of the functioning ossicluar chian we used different types of cartilages. We commonly used tragal cartilage, conchal cartilage or homologus nasal septal spur cartilage. Homologus septal spur cartlige had been harvested from nasal surgery and preserved in 70% ethyl alcohol from patients with all serological test for transferble diseases were negative.

AIMS AND OBJECTIVES:

To evaluate the functional and hearing outcomes using different cartilages for ossicular chain reconstruction in tubotympanic disease type III tympanoplasty (minor columella) with canal wall up mastoidectomy

MATERIAL AND METHODS:

This is a prospective study to assess the result of surgical treatment of tubotympanic type CSOM with type III tympanoplasty with minor columella with canal wall up mastoidectomy. The study is also done to assess the result of hearing improvement after ossicular chain reconstruction with cartilage over stapes head. Adult, pediatric and revision cases were included and patients with epithelium/cholesteatoma requiring canal wall down mastoidectomy were excluded from the study.The procedure to be performed was explained to the patients and their relatives and written informed consent was ta

All the patients with discharging ear were treated conservatively first using antibiotics, antihistaminics and topical ear drops. Nasal endoscopy had been done to rule out any nasal or nasopharyngeal pathology.

Pre operative assessment of status of ear before surgery, ETF, type of hearing loss were done and recorded.

Detailed history, clinical and otomicroscopic examinations were carried out after taking informed written consent of patients. X ray of both mastoids in Schuller's view in all patients were done.

Pre operative pure tone audiometry was carried out in 1 week or less before surgery on OPD basis. The hearing was tested at frequencies 500Hz, 1000 Hz, 2000Hz,4000Hz. The air conduction threshold and bone conduction threshold averages were calculated. The air bone gap (ABG) was calculated taking differences between air conduction and bone conduction threshold.

Once a dry ear was achieved the patient underwent tympanoplasy with canal wall up mastoidectomy. All the

surgeries were done in general anaesthesia. After clearing the disease

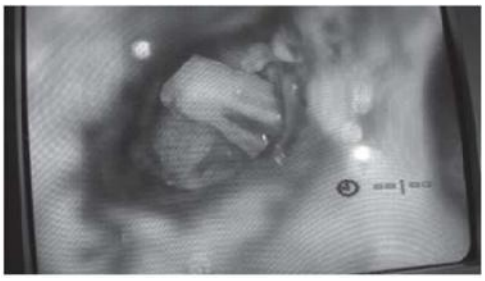
from the middle ear and mastoid, the status of ossicular chain was assessed. Type of tympanoplasty procedure was planned according to the status of the middle ear and ossicular chain.

In all cases we found that there was no continuity between incus and stapes or just a fibrous band between eroded incus and stapes with absent of round window reflex. In all cases tympanoplasty with canal wall up mastoidectomy with ossicular chain reconstruction was performed in one stage by post aural incision. Temporalis fascia was used as a graft material for tympanic membrane reconstruction.

We had used tragal cartilage, conchal cartilage or homologus nasal septal spur cartilage for ossicular chain reconstruction. We kept one of this cartilage kept over stapes head and round window reflex was check for ossicular chain continuity. Temporalis fascia graft was kept over this assembly supported with antibiotic soaked gelfoam.

The allograft septal spur cartilage is a firm cartilage and does not undergo softening post-operatively over long term. It is shaped using a 15 number blade such that the length is enough to just protrude through the neotympanic membrane. The superior contact surface of the cartilage should be sloping, have enough contact area (at least 5 sq.mm) and the margins should be smooth so that there are no sharp edges against the tympanic membrane. The inferior portion of cartilage is drilled using 0.6mm diamond burr to form a socket for stapes head stapedius tendon and a slit is designed using 11 number blade for stapedius tendon[10].

Homologus nasal cartilage with facet for stapedius tendon over stapes head



From conchal cartilage, strip is cut and at one end of strip, small socket is made to accommodate stapes head. Other end of cartilage strip is kept in groove made near tympanic sulcus lateral to annulus. TFG kept over this assembly.

Sometime for tragal cartilage, palisades technique is used. After putting the single piece of tragal cartilage as describe above for chonchal cartilage, other similar pieces were kept above and below it to support it.

Patients were followed up post operatively on 7th day for stitch removal and after 3 weeks, 2 months and 3 months for assessment of graft uptake. Post operative pure tone audiometric thresholds for air conduction and for bone conduction were recorded on 12th week. Post operative ABG was calculated. Hearing improvement was calculated by pre operative and post operative ABG evaluation.

OBSERVATION

In present study, 30 patients were included. There were total 23 females and 7 males. In which 9 patients had bilateral perforation while 21 had unilateral perforation, in which 12 patients were operated on right side and 18 patients were operated on left side. All 30 patients had complain of ear discharge from affected ear, 22 patients had complain of decrease hearing, 19 patients had complain of earache and 2 patients had complain of ringing in ear. No patient had complain of giddiness and facial deviation.

Table I. Distribution of patients according to age group(in years)

Age group(yrs)	No of patients
0-10	0
11-20	10(33.33%)
21-30	12(40%)
31-40	6(20%)
41-50	2(6.67%)
>50	0

Table II. Pre operative hearing threshold.

Pre operative ABG (db)	No of patients
25-30	2
30-35	2
36-40	3
41-45	9
46-50	7
>50	7

In 30 patients average mean preoperative AC threshold was 54.375(±11.31) dB and mean post-operative AC threshold was 40.66(±13.09) dB. Mean pre-operative BC was 9.875(±7.03) dB and mean post-operative BC was 9.95(±7.32) dB. The mean pre-operative Air Bone Gap was 44.91(±8.49) dB and postoperative air bone gap was

30.70(±9.90) dB. The mean air bone gap closure was 14.20(±9.58). This hearing gain was statistically highly significant (p<0.001).

Table III : Post operative ABG gain.

Post operative ABG gain (db)(Hearing gain)	No of patients
0-10	12
11-15	7
16-20	5
21-25	1
26-30	3
31-35	1
>35	1

Out of 30 patients, we used tragal cartilage in 11 patients, conchal cartilage in 4 patients, while homologus nasal septal spur cartilages in 15 patients. In tragal cartilage use we had mean ABG improvement of 14.09±0.74 db while in conchal cartilage mean ABG improvement is 17.18±14.00db while in septal cartilage mean ABG improvement is 13.5±8.85db. All this hearing improvement is statistically highly significant.

Table IV. Overall hearing improvement

Hearing improvement	No of patients
0-25 (normal range)	11
26-40 (mild deafness)	19

Out of 30 patients, pre operatively 1 patient had mild hearing loss while 1 patient had severe hearing loss and rest 28 patients had moderate hearing loss. After tympanoplasty type III with ossicular chain reconstruction with cartilage, 11 patients had hearing within normal limit while 19 patients had mild hearing loss.

DISB

The primary goal of surgery of COM is the achievement of a safe, dry ear and hearing improvement. Ossicular chain reconstruction has always been a challenge in disease involving incus and stapes. The ideal prosthesis for ossiculoplasty should be bio-compatible with surrounding tissue, stable, cost effective, capable of optimal sound transmission, easy to harvest and easy to handle during surgery.

Comparative study on outcome of ossiculoplasty using different materials in different ossicular status of middle ear had already been done by various authors previously.

Goode and Nishihara14 reported that the "ideal" ossiculoplasty should have the following characteristics: prosthesis mass < 40mg; proper tension of the prosthesis; angle between tympanic membrane and stapes< 45°, prosthesis with head angulated at about 30° to increase the surface area connected to the tympanic membrane.

Many materials have been proposed to restore sound transmission in case of lysis or absence of incus with intact stapes. Current techniques tend to use biocompatible materials: mastoid cortical bone, incus transposition, hydroxyapatite partial ossicular replacement prosthesis(PORP) , titanium PORP and also autologus or homologus cartilage graft. The biocompatibility of ossicular prosthesis now appears to have been improved but their cost still remains a problem. So we decided to use autologus or homologus cartilages.

Similar study has been done by Solamaz11 and group for perichondium attached cartilage island graft in tympanoplasty with tragal cartilage. In their study, pre operative mean ABG was 56.58 ± 10.27 dB HL and post operative mean ABG was 44.84 ± 12.45 dB HL in type III tympanoplasty with tragal cartilage while in our study we had pre operative mean ABG 44.91(±8.49) dB and postoperative air bone gap was 30.70(±9.90) dB, which was significant.

Guneri12 reported a mean gain of 20 dB (64%) in a retrospective clinical study presenting their experience with cartilage grafts in ear surgery while we had 55% patient with mean gain of 15db or more; postoperative hearing levels were improved in all type III tympanoplasties with ossicular reconstruction with canal wall up mastoidectomies.

Similar study is also done by Masahiro Okada13 in which post operative mean ABG in 56 patients was 17.1± 6.9 dB HL by putting auricular cartilage in type III tympanoplasty.

Similar study is also done by Querat and group15 with mean pre operative ABG 23.6±11.7db HL operated with tragal or conchal cartilage over stapes head. Mean post operative ABG is 18.8±14.1db HL.

We analazed the hearing results after 3 months of surgery. It was generally accepted that short term results would be better than long term results in ossiculoplasties and absorption and / or extrusion of ossiculoplasty materials were among the reason cited.

CONCLUSION

Tympanoplasty is a beneficial procedure for hearing improvement and the eradication of the disease but ossicular reconstruction still presents challenges. In our study we had a remarkabable improvement of hearing

after various cartilages used in type III tympanoplasty with canal wall up mastoidectomy. Ossiculoplasty with different cartilages over stapes head has good outcome in hearing. Postoperative PTA-ABG results demonstrated a significant improvement in our study for cartilage use in ossicular chain reconstruction.

Obvious limitations of the present study include its relatively small sample size. More research with a larger sample size and longer follow-up would certainly shed more light on the subject.

REFENECES

1. Storrs LA. Myringoplasty with the use of fascia grafts. Arch Otolaryngol 1961; 74: 65.
2. Aslan Felek S, Islam A, Celik H, Demirci M, Samim E, Kose KS (2009) The functional and anatomic results of canal wall down tympanoplasty in extensive cholesteatoma. Acta Otolaryngol129:1388–1394
3. Wullstein H. Theory and practice of tympanoplasty. Laryngoscope 1956;66:1076-1093
4. Merchant SN, Rosowski JJ, Shelton C. Reconstruction of middle ear. Ballenger's otorhinolaryngology 17. 17th ed. Hamilton, Ont.: B C Decker; 2009: 240-45.
5. Duckert LG, Makielski KH, Helms J (2002) Management of anterior epitympanic cholesteatoma: expectations after epitympanic approach and canal wall reconstruction. Otol Neurotol 23:8–13
6. Bahmad F Jr, Merchant SN (2007) Histopathology of ossicular implants in chronic otitis media. Ann Otol Rhinol Laryngol 116:181–191
7. Huttenbrink KB, Zahnert T, Wustenberg EG, Hofmann G (2004) Titanium clip prosthesis. Otol Neurotol 25:436–442
8. Sheehy JL. Surgery of chronic otitis media. English otolaryngology. Philadelphia: Harper and Row;1985: 1-86.
9. Jansen, C.(1963). Cartilage tympanoplasty. Laryngoscope, 73: 1288-1302.
10. Mahadevaiah A, Parikh B. Surgical techniques in chronic otitis media and otosclerosis. Chapter 9, ossiculoplasty. Shaping of cartilage graft: 98
11. Solamaz F. The audiological and take results of perichondrium attached cartilage island graft in tympanoplasty:PACIT. ACTA otorhinolaryngologica ita lica 2016;36:275-281
12. Guneri EA, Ikiz AO, Erdag TK, et al. Cartilage tympanoplasty: Indications, techniques and results. J Otol-Head Neck Surg 2009;38:362-8.
13. M. Okada.(2014). Auris Nasus Larynx 41:153–159
14. Goode R, Nishihara S. Experimental model of ossiculoplasty. Otolaryngol Clin N Am. 1994;27;663-75
15. Querat C, Martin C. Canal wall up mastoidectomy with intact stapes. Comparison of hearing results between cartilage and PORP in stapes and impact of malleus removal and total reinforcement of the tympanic membrane by cartilage. European Annals of Otorhinolaryngology, Head and Neck disease, 131(2014):2011-216