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Bone versus cartilage ossiculoplasty: a case series

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ABSTRACT

Background: Ossiculoplasty can be done by using both autologous bone and cartilage. Few literature shows cartilage is better and few shows bone is better. This study has been done to compare the both type of ossiculoplasty and find out the better one by comparing the hearing results.
Methods: Present study is a retrospective study with 6 years data collected from the inpatient's records. It was conducted in the department of ENT, in a tertiary care hospital of South India. Total number patients studied were 200. Patients with chronic ear disease having ossicular chain defects were evaluated for study. Two types of ossiculoplasty were performed (malleus-stapes assembly and membrane to stapes head interposition) using both cartilage and bone (each 100 patients). Postoperatively hearing result was evaluated at 1month, 6 months and 1 year and statistical analysis was done using z' test.
Results: Hearing improvement was better with bone ossiculoplasty then cartilage type. Average hearing gain was 33.34dB in bone where as in cartilage it is 29.34 dB. Average improvement in air bone gap is 21dB in bone type, whereas 19dB in cartilage type. But when we applied z' test, it showed z' value as 1.4506 indicating insignificant (z' value should be >1.96).
Conclusions: Study shows that, clinically bone ossiculoplasty is superior to cartilage in terms of hearing improvement. But it is statistically not significant.

Keywords: Ossiculoplasty, Autologous, Cartilage, Malleus-stapes assembly

INTRODUCTION

Ossiculoplasty is a microsurgical operative procedure. This operation performed to repair or reconstruct the ossicular chain[1] for hearing improvement. Ossicular chain is usually damaged in case of the infection like chronic suppurative otitis media (CSOM) and trauma. There is more chance of ossicular damage in case of CSOM with cholesteatoma.

Ossicular chain damage is found in all type of chronic suppurative otitis media, but tends to be more extensive in cholesteatoma cases. The decision as to whether or not to attempt reconstruction of the ossicular chain must be based on the chances of success.[2]

Commonest ossicle to be involved in CSOM is the incus (long process) followed by superstructure of the stapes. It is common in attico-antral disease. Destruction may be limited to the long process of incus or may also involve stapes superstructure, handle of malleus or the entire ossicular chain. Therefore, hearing loss in attico-antral type is always greater than the disease of tubotympanic type.[3]

Involvement of ossicular chain is rare in tubo-tympanic or safe type of CSOM. Ossicular chain damage is more common in subtotal perforations in comparison central perforations.

Formerly in cholesteatoma disease, bone destruction was believed to be due to pressure necrosis. But currently bone destruction has been attributed to different enzymes. Some of the enzymes are liberated by osteoclasts and mononuclear inflammatory cells and some are associated with cholesteatoma i.e. collagenage, acid phosphatase and proteolytic enzymes.

One of the proposed mechanisms for bone erosion in chronic middle ear inflammation is due to neovascularization and hyperemic decalcification of the ossicles.

Depending up on the type of ossicular damage, different types of ossiculoplasties are planned. Austin has classified the ossicular chain defect depending up on the presence or absence of malleus handle and superstructure of stapes (Incus absent in all the cases).

When both malleus handle and stapes superstructure are present, ideal procedure is malleus/stapes assembly (MSA). When stapes superstructure is absent sparing the handle of malleus, the procedure of choice is malleus/footplate assembly (MFA). When malleus handle is absent sparing the stapes superstructure, ossiculoplasty is tympanic membrane/to stapes head interposition (MmSI) or myringostapediopexy. Also we can use the prosthesis calledpartial ossicular replacement prosthesis (PORP). When both stapes superstructure and malleus handle are absent, procedure recommended is tympanic membrane to footplate interposition (MmFI) or myringostapediopexy using allograft stapes positioned on footplate. Also we can use the prosthesis called total ossicular replacement prosthesis (TORP).

Autologous bone (ossicles, cortical bone) and cartilage (conchal, tragal) are commonly used for the reconstruction of the ossicular chain. Some cases some biomaterials are used like bioglass, ceravital and hydroxylapatite. Titanium and Teflon prosthesis are more commonly used now a days with good result.

Autologous graft materials are always the best material for ossicular reconstruction, because there is no issue of graft rejection and extrusion. But there are certain situation where the processing the autologous material is difficult, like when stapes superstructure is absent. In these cases we have to depend upon the prosthetic materials.

Objective

- To compare the hearing result of ossicular chain reconstruction using autologous bone and cartilage graft.

METHODS

Approval from Institutional ethical committee was taken for the study as per reference no– APPROVAL/IEC/ASRAM.002/2017.

Study design

This is a retrospective study with 6 years data collected from the in patient's records (January 2011 to December 2016)

Study setting

Present study was conducted in the department of ENT, in a tertiary care hospital of South India.

Subjects

Total number patients studied was 200 (Ossiculoplasty was done).

Patients coming to ENT outpatient department (OPD) with history of ear discharge and hearing loss were examined thoroughly. Proper history and thorough clinical examination was done for each and every patient. All the patients were evaluated under microscope, otoendoscope and pure tone audiometry (PTA). X-ray mastoid was done in each cases to find out the type of mastoid air cells. Intra operative findings of the middle ear were correlated with preoperative findings. Patients with ossicular damage were considered for study.

As par Austin – Kartush classification, patient with type – A and type – C ossicular erosions were taken for study. Type – A means malleus handle and stapes superstructure were intact and type – C means, stapes superstructure intact with loss of handle of malleus. In both the types there is erosion of incus. Procedure planned for type – A is malleus-stapes assembly (MSA) and procedure for type – C is membrane to stapes head interposition (MmSI).

We used remnant incus, remnant malleus, cortical bone, conchal cartilage and tragal cartilage for the ossicular chain reconstructions. In MSA, one cup was made at one end for head of the stapes and a notch was made at other end for engaging the handle of malleus. And for MmSI, one cup was made in the prosthesis and placed over the head of the stapes, over which tympanic membrane was placed.

Total 200 patients were selected and divided in to two groups (100 in each group). In one group we did ossiculoplasty using bone like autologous incus, malleus or cortical bone and named as BOP (bone ossiculoplasty). In another group we did ossiculoplasty using autologous cartilage either from concha of the pinna or from tragus and named as COP (cartilage ossiculoplasty). Patents were selected for study by inclusion and exclusion criteria. After selected procedure, all the patients were evaluated by same pure tone audiometry at 1 month, 6 month and 1 year. Pre and postoperative hearing loss and air-bone gap were analyzed.

Inclusion criteria were patients with ossicular chain defect (A and C Austin-Kartush type); patient treated

with ossiculoplasty; patient's record with clear data is available in medical record department; patients came for regular follow up.

Exclusion criteria were proper patient's record was not available; not coming for regular follow up; patient with extensive disease where preoperative PTA is misleading; other than type A and type C of Austin –Katush classification; patient having sensory neural hearing loss; patient having remnant perforation and re-perforation after surgery.

Tool used for statistical analysis was z' test. It was applied to analyze the hearing improvement in the form of air bone gap (ABG) in both bone and cartilage type of ossiculoplasty.

RESULTS

Total 200 patients were divided in to two groups, BOP (bone ossiculoplasty) and COP (cartilage ossiculoplasty). In BOP group, out of 100 patients, 68 were male and 32 were female. In COP group 64 were male and 36 were female. Table 1 shows the age distribution of the patients in both the groups. It shows maximum number of patients were in the age group of 11-20 years in both BOP and COP group.

Table 2, shows the pre-operative hearing status in both BOP and COP groups. It shows in BOP group maximum numbers of patients were having moderate hearing loss (40–55 dB). In COP group also maximum numbers of patients were having moderate hearing loss preoperatively.

Table 1: Age distribution of the patients.

Age in years	BOP (No of pts)	BOP (%)	COP (No of pts)	COP (%)
11–20	54	54	36	36
21–30	24	24	34	34
31–40	16	16	18	18
41–50	4	4	10	10
>50	2	2	2	2

BOP=bone ossiculoplasty, COP=cartilage ossiculoplasty, pts=patients.

Table 2: Preoperative hearing loss (H/L).

Ossiculoplasty groups	No of pt with H/L 0-25 dB	No of pt with H/L 25–40 dB	No of pt with H/L 40 dB–55 dB	No of pts with H/L 55 dB-70 dB
BOP	0	0	62	38
COP	0	0	71	29

Pt=patient, H/L=hearing loss, dB=decibel.

Table 3: Different types of ossiculoplasties (n=200).

Groups	MSA	Percentage (%)	MmSI	Percentage (%)	Total
BOP	54	54	46	46	100
COP	16	16	84	84	100
Total	70	--	130	--	200

BOP – bone ossiculoplasty, COP – cartilage ossiculoplasty, MSA – malleus-stapes assembly, MmSI – membrane to stapes head interposition.

Table 4: Postoperative hearing assessment.

Type of ossiculoplasty	Postop duration	Hearing loss		
		0-25 dB	25-40 dB	40- 55 dB
BOP (No of patients)	1 month	70	30	0
	6 month	84	16	0
	12 month	90	10	0
COP (No of patients)	1 month	64	32	4
	6 month	70	22	8
	12 month	74	17	9

BOP – bone ossiculoplasty, COP – cartilage ossiculoplasty, dB – decibel.

Table 5: Comparison between pre and 12th month postoperative hearing loss.

Hearing loss (dB)	BOP preoperative (No of pts)	BOP postoperative (No of pts)	COP preoperative (No of pts)	COP postoperative (No of pts)
0-25	0	90	0	74
25-40	0	10	0	17
40-55	62	0	71	9
55-70	38	0	29	0

BOP – bone ossiculoplasty, COP – cartilage ossiculoplasty, dB – decibel, pts – patients.

Table 6: Improvement in air-bone gap (ABG) after 1 year.

Improvement in ABG (dB)	BOP (No of patients)	COP (No of Patients)
35	23	17
30	20	20
25	22	15
20	30	35
15	04	5
10	01	8

ABG – air bone gap, dB – decibel, BOP – bone ossiculoplasty, COP – cartilage ossiculoplasty), (z' value >1.4506 is insignificant.

Table 7: Average hearing improvement.

BOP group	COP group
1. Average preoperative hearing loss (H/L)- 54.36 dB	1. Average preoperative hearing loss (H/L)– 56.38 dB
2. Average postoperative H/L– 21.02 dB	2. Average postoperative H/L– 27.04 dB
3. Average hearing gain– 33.34dB	3. Average hearing gain– 29.34dB
4. Average preoperative Air-bone gape (ABG) – 37dB	4. Average preoperative Air-bone gap (ABG)– 37dB
5. Average post op ABG– 16 dB	5. Average postoperative ABG– 18 dB
6. Average improvement of ABG– 21dB	6. Average improvement of ABG– 19 dB

BOP – bone ossiculoplasty, COP – cartilage ossiculoplasty, ABG – air bone gap, dB – decibel.

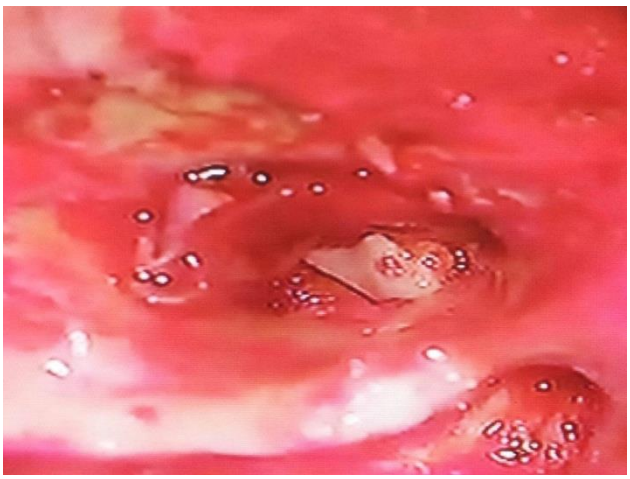

Figure 1: Malleus-stapes assembly (MSA).

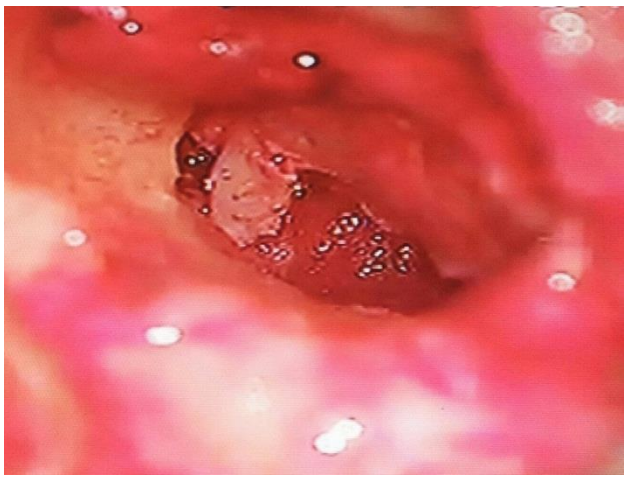

Figure 2: Membrane to stapes head interposition (MmSI).

We have performed only two types of ossiculoplasty MSA (malleus – stapes assembly) (Figure 1) and MmSI (membrane to stapes head interposition) (Figure 2) using cartilage and bone separately. Table 3 shows the different types of ossiculoplasty in BOP and COP group. It shows in cartilage group we did more MmSI and more number of MSA we did using bone.

In BOP category, out of 100 patients we used different types of bone, like processed incus in 53 cases, processed malleus in 32 cases and cortical bone in 15 cases. In COP category we used conchal cartilage in 56 cases and tragal cartilage in 44 cases.

Post operatively we have assessed all the patients with pure tone audiometry at 1 month, 6 months and 12 months. Table 4 shows the result of hearing in different months post operatively. It shows maximum number of patients were having normal hearing i.e. 0-25 dB and the result is better with bone ossiculoplasty. Few patients in cartilage ossiculoplasty showed hearing deterioration progressively i.e. in 40–55 dB category, 1st month 4 patients, 6th month 8 patients and 12th month 9 patients. In these 9 patients, we have opened the middle ear again to find out the causes of hearing deterioration. It was found that in 5 cases cartilage was displaced and in 4 cases size of the cartilage decreased and detached from the ossicle. No such thing happened in bone ossiculoplasty.

Table 5, shows the comparison between pre and 12th month postoperative hearing loss after ossiculoplasty. It shows, post operatively in bone ossiculoplasty more number of patients were improved to normal hearing (0-25 dB) than cartilage. In cartilage ossiculoplasty few patients were in the category of moderate hearing loss (40-55 dB).

When stapes superstructure is intact, aim is to achieve the air bone gap <20 dB and when superstructure is absent ABG <30 dB is acceptable. This criterion is used to interpret the success of ossiculoplasty.

Table 6, shows the improvement in air-bone gap (ABG) in both bone and cartilage type of ossiculoplasty. It shows, 20 dB ABG improvement occurred in maximum number of patients in both the categories. And the next category is improvement of ABG by 35 dB in both the categories. We have applied z' test to it and the value came as 1.4506 which is insignificant (z' value >1.96 is significant)

Table 7 shows the average hearing improvement and average improvement in air bone gap in both BOP and COP groups. So clinically, it shows that there is hearing improvement and improvement in air bone gap more in bone ossiculoplasty in comparison to cartilage type.

DISCUSSION

Ossiculoplasty is the procedure to repair or reconstruct the ossicular chain. The most common type of ossicular chain erosion encountered is necrosis of long process of incus because of its anatomical position and course of its blood supply.

Various surgical techniques and materials have been used for ossicular chain reconstruction since 1950 but still there is no standardized technique and ideal material has been accepted worldwide. Three general classes of prosthesis are used today- autograft, homograft and allograft. Commonly used autografts are ossicles (incus and malleus), cortical bone and cartilages (conchal and tragal). Homografts are usually preserved healthy cadaver ossicles or ossicles from other person. And the allografts are the presculptured prosthesis made up of metals or synthetic materials like hydroxylapatite, plastipore, glass-ceramic, stainless steel, teflon, titanium etc.

Autografts are the best graft materials, because it has got advantages of very low extrusion rate, no risk of transmitting the disease and biocompatibility. But displacement, complete absorption, small remnant size and possibility of harboring microscopic disease have been blamed as potential disadvantages of their use. Ossicular chain reconstruction is most commonly performed for an absent or diseased incus.

Reestablishing continuity by placing strut prosthesis between the stapes Capitulum and malleus handle minimizes the possibility of extrusion and displacement.[4] Main disadvantage of homograft is the transmission of the prions disease. Disadvantages of allograft prosthesis are ossicular necrosis, extrusion, displacement and unsatisfactory hearing restoration. Extrusion of the prosthesis has been reported as high as 39%. However it can be significantly reduced by placing cartilage or bone between the tympanic membrane and prosthesis.[5]

Assessment of air bone gap (ABG) is more informative in ossiculoplasty, because sometimes the patients were having sensory neural hearing loss. When stapes superstructure is intact, aim is to achieve the air bone gap <20 dB and when superstructure is absent ABG <30 dB is acceptable. This criterion is used to interpret the success of ossiculoplasty. In our study we got <20 dB postoperative hearing result in 78% cases in bone ossiculoplasty and 65% cases in cartilage ossiculoplasty. Using above criteria Dornhoffer in 1998, stated that, the incus interposition appear to be more successful than the use of the prosthesis. When stapes superstructure and canal were present, the success rate is 80%.[6]

Jha et al in 2007 to 2009 perform a study of ossiculoplasty outcome after 2 and 5 months of operation in relation to air bone gap and suggested the success rate among cartilage was 57%, incus was 59% and plastic PORP and TORP was 40%.[7]

In another study by Amith, Naragund et al, success rate of ossiculoplasty after 3 months post operatively using autologous incus was 58% and titanium prosthesis was 33%.[8]

Gardner et al published a retrospective study comparing the success rate of PORP and TORP using titanium and non-titanium prostheses. It shows that, successful rehabilitation of conductive hearing loss was obtained in 70% of partial ossicular chain reconstructions and 44% of total ossicular chain reconstructions when titanium prostheses were used. Comparison of data revealed successful rehabilitation in 48% and 21% of non-titanium-based partial and total reconstructions, respectively.[9]

In a study by Quaranta et al for cartilage ossiculoplasty in cholesteatoma surgery, it was found that preoperative average ABG was 39.2 dB and average postoperative ABG was 25.4 dB. In our study, in cartilage ossiculoplasty, the pre and postoperative ABG are 37 dB and 18 dB respectively.[10]

CONCLUSION

In the present study, we got that ossiculoplasty using bone is superior to the cartilage clinically. But it is not significant statistically.

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