Evaluation of Results of Cartilage Augmentation in Type III Tympanoplasty

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ABSTRACT

Introduction

In conventional Type III tympanoplasty, post operative air-bone gap (ABG) is around 10-60dB. This study aimed to assess the hearing results in patients undergoing canal wall down mastoidectomy with cartilage augmented type III tympanoplasty.

Materials and Methods

Patients of 6-50 years of age with the diagnosis of Chronic Otitis Media (Squamous) with conductive or mixed hearing loss, requiring canal wall down mastoidectomy and with intact and mobile stapes suprastructure at surgery who underwent cartilage augmentation were included in the study. Pure tone audiometry (PTA) was performed and evaluated. Post- operative hearing was assessed in terms of average air bone gap (ABG) and size of ABG closure.

Results

The results concluded that mean of pre and post operative air bone gap were 37.5db and 29.7db respectively with net gain of 7.8db.These differences were significant. Also ABG closure was within 30 db in 28 cases (70%).

Discussion

The results of this study were compared with other reported series. The mechanical and acoustical aspects of canal wall down surgeries as also the probability of variation in results due to differences in surgical procedures and post-operative fibrosis have been mentioned.

Conclusion

There was significant improvement in postoperative hearing after stapes head augmentation in type III tympanoplasty.

Keywords

Tympanoplasty; Mastoid; Cartilage; Audiometry, Pure-Tone; Hearing

Chronic otitis media (COM) is a common condition, affecting 0.5–30% of any community.[1] A conservative estimate of the number of people in the world suffering from COM is over 20 milion.[2] The objective of tympanomastoid surgery for chronic otitis media, in decreasing order of priority are elimination of disease to produce safe and dry ear; alteration of anatomy to prevent recurrent disease, optimization of cleaning and reconstruction of the middle ear to achieve serviceable post-operative hearing.

The goal of tympanoplasty is to restore sound pressure transformation at the oval window by coupling an intact tympanic membrane with a mobile stapes footplate via an intact or reconstructed ossicular chain and to provide sound protection for the round window membrane by a closed, air containing, mucosa lined middle ear.[3] The modern era of tympanoplasty was ushered in by Wullstein and Zollner. In classical type III tympanoplasty or myringostapediopexy, disease is removed from tympanomastoid compartment and advancement of the tympanic membrane (TM) or placement of tissue graft is done on top of the stapes head. After this procedure, air-bone gap (ABG) range is around 10-60dB. Merchant et al. in laboratory model demonstrated that improved hearing results could be achieved in myringostapediopexy by interposing a thin cartilage disc between the graft and stapes head.[4]

For augmented type III tympanoplasty, either cartilage or sculptured cortical bone can be kept between the intact stapes and the fascial graft. Cartilage disc was hypothesized to improve the "effective" vibrating area of the graft that was coupled to the stapes head.[5]

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Cartilage also offers the advantage of higher mechanical stability compared with membranous transplants, thus preventing retraction of tympanic membrane in the long run but others argue that it may alter the acoustic transfer characteristics of the graft due to its increasing mass and stiffness of the reconstructed tympanic membrane. The aim of this study was to compare pre and post operative hearing results after cartilage augmentation type III tympanoplasty.

Materials and Methods

A prospective, analytical and longitudinal study was performed after institutional ethical committee approval from October 2012 to April 2014. Patients between the ages of 6 to 50, with an intact and mobile stapes superstructure who underwent canal wall down mastoidectomy, were selected for this study. Pure tone audiometry was performed within seven days prior to the operation. Air and bone conduction thresholds were calculated by taking the averages of 500, 1000, 2000 and 4000 Hz frequencies.

The Air Bone Gap (ABG) was calculated by taking differences between air conduction and bone conduction threshold. air conduction and bone conduction threshold were recorded post-operatively at 6weeks, 6 months and at the end of one year. Postoperative ABG closure was calculated by taking the difference between preoperative and postoperative ABG of the average frequencies of 500, 1000, 2000 and 4000 Hz. For cartilage augmentation, thin disc of conchal cartilage of partial thickness of 4-6 mm in diameter was interposed between the stapes head and temporalis fascia graft. Cartilage disc did not touch the external auditory canal or facial nerve canal. The follow up was performed after a week then after six weeks postoperatively. Results were analyzed in terms of average postoperative ABG and ABG closure. The data analysis was performed with the help of SPSS 11.5 software package. P value was calculated using the independent samples test and P value of 0.05 was taken as significant.

Results

A total of 40 patients were enrolled in this study. Distribution of the patients according to age and gender are shown in Table I. All 40 (100%) patients had adequate follow up.

The preoperative ABG at frequencies at 500Hz, 1000Hz,2000Hz, and 4000Hz were found to be 47.5dB, 38.5dB, 29.7dB and 34.5dB respectively as compared to postoperative ABG of 36.3dB, 30.6dB, 22.4dB and 22.4dB respectively. The difference in four frequency average post-operative ABG was also found to be statistically significant with p value of <0.001. The four frequency average preoperative ABG which was 37.5 dB was reduced to 29.9 dB postoperatively with net gain of 7.8 dB with p value <0.001 which is statistically highly significant. (Table II).

Table I: Age and Gender distribution of patients.

AGE (YEARS)	NUMBER OF PATIENTS	MALE	FEMALE	AVERAGE AGE (%)
< 10	3	2	1	7.5
11-20	7	4	3	17.5
21-30	18	12	6	45
31-40	8	4	4	20
41-50	4	3	1	10

The ABG closure with cartilage augmented type III tympanoplasty at different frequencies (500Hz, 1000Hz, 2000Hz, and 4000Hz) was analyzed and their average was plotted and found to be statistically significant.

The ABG closure was again divided into different categories like 0-5dB, 0-10dB, 0-20dB, 0-30dB and 0-40dB. It was noted that 3(7.5%) cases fell within 0-5dB , 11(27.5%) cases fell within 0-10 dB,.12(30%) cases fell in 0-20dB bin , 13(32.5%) cases fell in 0 -30dB category and only 1case (2.5%) fell in .>30dB bin. (Table III).

Table II: Pre and post operative AB Gap (n=40)

PARAMETERS	FREQUENCY	MEAN	SD	P VALUE
Preop ABG	500HZ	47.5	13.75	<0.0001
Post op ABG		36.3	10.1	
Preop ABG	1000HZ	38.5	15.5	0.0001
Post op ABG		30.6	10.25	
Preop ABG	2000HZ	29.7	15.15	0.0139
Post op ABG		22,4	9.8	
Preop ABG	4000HZ	34.5	10.42	<0.0001
Post op ABG		22.4	7.8	
Preop ABG	AVERAGE	37.5	11.9	0.0011
Post op ABG	AVERAGE	29.9	7.7	

Table III: ABG Closures in different categories (n=40)

0-5 DB	6-10 DB	11-20 DB	21-30 DB	>30 DB
3	11	12	13	1
7.5(%)	27.50%	30%	32.50%	2.50%

Discussion

The objectives of this study were to evaluate and analyze post-operative hearing results in terms of average ABG and the ABG closure in patients undergoing CWD mastoidectomy with cartilage augmented type III tympanoplasty. In each case, post-operative airbone gaps were calculated using post-operative air conduction and post-operative bone-conduction thresholds at frequencies 500, 1000, 2000 and 4000 Hz. None of the patient in the whole group had an acute worsening of bone conduction post operatively. During the length of follow up, there were no cases of cartilage extrusion.

Different methods have been used by different authors to report post-operative hearing results in middle ear surgery. Among these ABG closure, post operative ABG presented in 10 dB bins and air conduction threshold gain are commonly reported indicators of tympanoplasty outcome. We had applied average PTA-ABG and the ABG closure for audiological assessment. For calculation of the size of the post-operative PTA-ABG closure ABGs were divided into different bins of 0-5 dB,6-10 dB,11-20 dB, 21-30 dB, and >30 dB.

In our study, while comparing the average post operative air bone gaps at various frequencies the differences were found to be statistically significant ($P<0.001$). The difference in four frequency average post-operative air bone gap between these two groups

was also found to be statistically significant.

Our findings are to some extent in agreement with those of Merchant et al who observed a 5 dB improvement at 250Hz, 500Hz and 2000Hz with interposition of thin disc of cartilage between the graft and the stapes head in both of their temporal bone model as well as in their clinical study.[5] In their clinical study, cartilage augmentation was done after canal wall reconstruction and cavity obliteration. Variation in functional hearing results between the two studies may also have occurred due to this difference in the technique used.

While analyzing the frequency wise post-operative average Merchant et al in their review article state that a canal wall-down mastoidectomy poses several considerations from an acoustical and mechanical perspective when compared to a canal wall-up procedure. Firstly, the canal wall-down procedure i.e., radical or modified radical tympanomastoidectomy results in significant reduction in the size of residual middle ear air space. Secondly, a canal wall down procedure results in the creation of a large air space lateral to the tympanic membrane (TM), i.e., the air space within the mastoid bowl including the external auditory canal.

This mastoid bowl and ear canal air space generates resonances that can influence middle ear sound transmission favorably or unfavorably.[6] Thirdly, after a canal-wall down procedure, the TM graft comes to lie in a more medial position compared to normal.

The mechanics of a TM graft coupled to the stapes / TORP are likely to be different from normal and also need to be characterized.[7] The mechanics of such a TM graft and its coupling to the stapes/ TORP are likely to be different from normal and also need to be characterized.[7] In our study, 28 (70%) cases fell within 30 dB ABG closure. Similar studies with some modifications in the technique have been published in the literature report varying proportions of PTA-ABG closure. Cheang et al in his myringolenticulopexy group (n= 20) achieved an ABG of less than 30 dB in 92 % and ABG of less than 20 dB in 64% of cases.[8]

Moustafa and Khalifa in their myringo-cartilago-stapediopexy group (n= 95) achieved an ABG of less than 20 dB in 84%.[9] Kyrodimos et al in their cartilage shield type III tympanoplasty (n=52) using a 0.8 mm thick cartilage piece with no capitulum for stapes head report that post-operative PTA-ABG of 25dB or less was achieved in 41 (79%) of patients and of 20 dB or less in 54% of patients.[10] However their study included both canal wall up and canal wall down procedures.

Malafronte et al. in cases of both canal down and up procedures used modified folded double cartilage block with shallow acetabulum for stapes capitulum to augment their type III tympanoplasty procedure.[11] Another factor leading to failure of tympanoplasty is wide variability in the surgical techniques employed, criteria used to evaluate hearing results and a number of other anatomical, physiological and pathological events that occur post-operatively in the middle ear.

It must be remembered that fibrosis could be due to the underlying middle-ear or upper airway pathology that caused the disease and may not be caused by surgery.

Conclusion

The results concluded that mean pre and post operative air bone gap were 37.5dB and 29.7dB respectively with net gain of 7.8dB. These differences were statistically significant. Also ABG closure was within 30 dB in 28 cases (70%). Thus hearing results after cartilage augmentation in type III tympanoplasty showed improvement in mean post-operative PTA-ABG and also in ABG closure suggesting thin cartilage disc increased the effective vibrating area of tympanic membrane graft.

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