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Effect of interlay tympanoplasty on anterior tympanomeatal angle and pure tone audiometry at one month, six month and one year follow up

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ABSTRACT

Background: The aim of the study was to determine the effect of interlay tympanoplasty on anterior tympanomeatal angle and on puretone average at 1 month, 6 month and 1 year follow up.
Methods: This study was done at department of Otorhinolaryngology, RMRI, Bareilly, India, a tertiary-care Teaching hospital. A total number of 187 patients (86 females, 101 males) were included in this study from April 2014 to March 2018. Age range of selected patients was 15 years to 62 years, 133 patients were having subtotal perforation and remaining having perforation in the anterior half extending upto the annulus.
Results: The anterior tympanomeatal angle blunting and pure tone audiometry (PTA) at the due follow up time was assessed and results were analyzed in terms of angle of blunting and hearing loss detected by PTA. Anterior tympanomeatal angle (ATA) blunting was categorized in three groups as follows $<90^o$, $90\text{-}120^o$ and $>120^o$. Only 3 patients were having $>120^o$ ATA after one year and mean hearing loss (air bone gap) was significantly less after 1 year follow up. There were only 3 patients with remnant perforation, after 1 year of surgery out of 187 cases, with 98.4% success rate.
Conclusions: Interlay tympanoplasty was significantly effective in repairing anterior and subtotal tympanic membrane perforations with avoidance of blunting at the anterior tympanomeatal angle and achieved good functional results.

Keywords: Interlay tympanoplasty, Anterior tympanomeatal angle, Anterior perforations, Puretone average

INTRODUCTION

Surgery of the middle ear, tympanic membrane and ossicles also known as tympanoplasty has evolved a lot in last few decades and in last few years there is tremendous progress. Earlier mostly temporalis fascia was used as graft while now cartilage and perichondrium use is quite common as graft material.[1-3] This refinement in technique and graft material transformed into better results both in providing intact tympanic membrane and hearing. But some techniques also have associated side effects with them, like in interlay tympanoplasty an important side effect is blunting of anterior tympanomeatal angle {normal anterior tympanomeatal angle (ATA) being less than 90^0}, and in overlay tympanoplasty the quite bothersome side effect of cholesteatoma.[4] This technique of tympanoplasty is very successful for large perforations or anterior perforations, but the side-effect of ATA blunting made this technique quite infamous. ATA blunting decreases the sound transfer function of the tympanic membrane and middle ear and correlates to nearly 10 to 20 dB hearing loss thus prevention of blunting at the ATA during tympanoplasty must be emphasized.[5]

In our study 187 cases of interlay tympanoplasty are being presented after three different follow up periods to see the level of anterior blunting present in such cases, effect of that blunting on hearing, and changes in blunting level with time.

The objective of the study was to determine the effect of interlay tympanoplasty on anterior tympanomeatal angle and on puretone average at 1 month, 6 month and 1 year follow up.

METHODS

This longitudinal case study was carried out on patients undergone interlay tympanoplasty at RMRI, Bareilly, a tertiary care teaching hospital. 187 patients were selected from April 2014 to March 2018. Age range was 15 years to 62 years, to exclude the unintended bias of graft failure due to age.[6] 101 were male and 86 were female. 133 patients were having subtotal perforation and remaining having perforation extending to the anterior annulus. The main outcome was to assess was any change in anterior tympanomeatal angle (TMA) pre op and post op and also change in the ATA in remaining follow up period. Effect of anterior TMA blunting on hearing was also assessed. At 1 month of operation puretone audiometry was done with endoscopy of the canal and TMA was assessed. Same assessments were done at 6 months and 1 year follow up also.

The size of the study was considered enough after two years of observation of the patients meeting the inclusion criteria. All the patients provided an informed consent to the surgical procedure and our institutional review board approved this study. 0^{O} 4 mm Hopkins rod endoscope was used for the approximate assessment of ATA. The study was approved by the ethics board of the RMRI Hospital

Selection criteria

Inclusion criteria

Age more than 15 years and less than 62 years, perforation reaching upto the anterior annulus whether it's subtotal or only anterior and patients who attended follow up clinic at due time were selected.

Exclusion criteria

The exclusion criteria consisted of patients with clinical or intraoperative evidence of cholesteatoma, any patient with ossicular discontinuity, or any patient in which any ossiculoplasty was done and patients having gross middle ear mucosal hypertrophy or granulations. Also patients having pre op sensorineural or mixed hearing loss were excluded. The primary post-surgical exclusion criteria were missed any 1 month, 6 months or 1 year follow up, iatrogenic cholesteatoma or any other complication of middle ear surgery like granulations or SNHL.

Pure tone audiometry and speech audiometry was done in all the patients 1 month post op, 6 month post-operative and 1 year post-operative and any. No patient was selected for bilateral surgery either in same sitting or in different time period. Pure tone average was taken at 0.5 KHz, 1 KHz and 2 KHz. The variables considered were patient age, size and site of perforation, middle ear conditions (i.e., ear drainage and middle ear mucosal features), and size of the external bony auditory canal. All the procedures were performed by the same surgeon to exclude operator bias and the surgical technique in all the patients was autologous graft of temporal fascia, by post aural route.

Procedure was done in local anaesthesia in all cases except in 7 patients, where due to patient's request general anaesthesia was used. In all patient's infiltration was done with 2% lignocaine with adrenaline. Then postaural incision was given and flaps were elevated. Tympanomeatal flap was elevated in posterior half in similar way but in this technique incision was extended in the anterior half also. 4-5 mm lateral to the annulus the incision was given in the anterior half of the canal skin and flap elevation was continued. Depending on the anterosuperior level of perforation's upper limit the incision's upper limit was determined, that is 1-2 mm superior to the perforation's superior limit. Fibrocartilaginous annulus was dislodged carefully from the bony annulus all around taking care not to injure the inner mucosal layer. Preservation of the inner mucosal layer was the main precaution for preventing the blunting of TMA. Exteriorization of handle of malleus was done as commonly practiced. Temporalis fascia graft was harvested as usual and it was used wet for easy handling. Anterior, inferior and posterior temporalis fascial graft's tucking was done as is done only posteriorly in underlay method. Entire fibrous annulus elevation away from the sulcus tympanicus and placement of the graft between it and the anterior bony canal provide adequate support for prevention of falling away of the graft and are not associated with increased risk of anterior blunting and severe lateralization of the graft, if the anterior sharp tympanomeatal angle is adequately restored.[7]

Anterosuperior part checked for any residual perforation. Dry gel foam pieces were pushed in the anterior TMA after keeping the fibrocartilaginous annulus aligned in bony annulus. Canal was filled completely with dry gel foam and ciprofloxacin ear drop was instilled on top, so much so that all the gel foam was soaked. Than after stitching mastoid dressing was applied, which was removed 1 week after.

After operation patient was discharged on first postop day with canal filled with gel foam, Ciprofloxacin ear drops instilled over the gel foam and mastoid dressing was done. Gel foam was not used medial to the graft in any patient. Patients were called after 6 days and mastoid dressing was removed and stitches were taken out. There was not a single case of wound infection and all the

stitches were healthy. After stitch removal all the patients were called upon weekly for assessment of health of the graft and postaural wound, till one month of procedure.

All the cases with anterior canal blunting were revised after one year of primary surgery by transcanal route.

Statistical analysis was done by chi square test and P value was assessed for proving significance.

RESULTS

A total of 187 patients undergoing the interlay tympanoplasty were selected for the study (101 males and 86 females) (Table 1). The mean age was 39.4 years (range, 15 to 62 years) (Table 2).

Table 1: Patient inclusion data (gender).

	Male	Female	Total
No.	101	86	187
%	54	46	

Table 2: Patient inclusion data (age).

Min. age in years	Max. age in years	Mean age (±SD) in years
15	62	39.4 (±15.54)

Table 3: Location of perforation.

	No. of patients	%
Patient with subtotal perforation	133	71.1
Patient with anterior perforation	54	28.9

Table 4: Pre op and Post op (at one year) ABG.

	Preop ABG (in dB)	Postop ABG (in dB)
Minimum ABG	14	5
Maximum ABG	38	22
Average ABG	24	11

ABG: Air bone gap[8]

All the patients selected for the study were having perforations reaching upto the anterior margin, in 54 patients perforation was in anterior half and in remaining 133 patients patients there was subtotal perforation (Table 3). Complete perforation closure was achieved in 184 (98.4%) out of 187 patients. The graft success rate was as high as 98.4% and anterior tympanomeatal angle was maintained at $<90^{O}$ in 174 (94.5%) patients at one year. Patients with postoperative complications as lateralization, and epithelial cyst were not included in study. Pre- and postoperative ABG were 24.1±13.0 and 11±7.5 dB with significant improvement after the surgery ($p<0.001$) (Table 4 and 5). Before the surgery, 150 patients (80.2%) had an ABG of >20 dB. After the surgery, 177 patients (94.6%) showed an ABG of ≤20 dB. The change in ABG distribution after the surgery was statistically significant ($p<0.001$). The Chi-square statistic is 211.6888. The p-value is <0.00001. The result is significant at $p<0.01$.

At 1 month follow up, 8 patients were having blunting of ATA, with 2 having blunting of more than 120°, then after 6mth follow up the blunting was found in 12 patients out of which 3 were having ATA more than 120°, lastly after 1 year follow up only one more addition was there in patients with ATA blunting and that was only with 90° to 120° group (Table 6).

Table 5: Pre op and post op (at one year) ABG.

	Preop ABG		Postop ABG	
	No. of patients	**%**	**No. of patients**	**%**
0-20 ABG	37	19.8	177	94.6
21-40 ABG	126	67.4	10	5.3
>41 ABG	24	12.8	0	0

ABG: Air bone gap.

Table 6: Tympanomeatal angle incidence at follow up.

	After 1 month postop		After 6 month postop		After 1 year postop	
	No. of patients	**%**	**No. of patients**	**%**	**No. of patients**	**%**
Patients with $<90^{o}$ TMA	179	95.7	175	93.6	174	93
Patients with 90^{o}-120^{o} TMA	6	3.2	9	4.8	10	5.3
Patients with $>120^{o}$ TMA	2	1.0	3	1.6	3	1.6

At one month follow up none of the patient was having remnant perforation, it developed in 1 patient at six months and 3 patients at one year (Table 7).

6 out of 8 patients with blunted ATA were having ABG of >20 dB at one month, 7 out of 12 patients at 6 months (Table 8). At one year 9 patients out of 187 operated patients were having ABG more than 20 db and only 13 patients were having blunted TMA, which proves that all cases of blunting were not responsible for deafness but as the blunting increases deafness increases (Table 9).

Table 7: Patient data related to perforation remnant/residual perforation or recurrence.

	After 1 month postop	After 6 month postop	After 1 year postop
Patients with closed perforation	187	186	184
Patients with remnant perforation	0	1	3

Table 8: Audiometry data in relation to anterior tympanomeatal angle.

	After 1 month postop		After 6 month postop		After 1 year postop	
	No. of patients	**%**	**No. of patients**	**%**	**No. of patients**	**%**
Patients with 0-20 db air bone gap	181	96.8	179	95.7	177	94.6
Patients with <90^0 ATA	181		178	95.2	177	94.6
Patients with 90^0-120^0 ATA	0		1	0.5	1	0.5
Patients with <120^0 ATA	0		0		0	
Patients with ABG* >20 db and 90^o-120^o ATA	2	1	2	1	3	1.6
Patients with ABG >20 db and >120^o ATA	4	2.1	5	2.7	6	3.2

Table 9: Audiometry data in relation to remnant perforation.

	After 1 month postop		After 6 month postop		After 1 year postop	
	No. of patients	**%**	**No. of patients**	**%**	**No. of patients**	**%**
Patients with <20 db ABG* with remnant perforation	0		0		0	
Patients with >20 db ABG* with remnant perforation	0		1	0.5	1	0.5
Without remnant perforation	4	2.1	7	3.7	9	4.8

*****ABG: Air bone gap; ATA: Anterior tympanomeatal angle.

DISCUSSION

Surgery of tympanic membrane perforation has been developed a lot in last century, from skin graft to vein graft and from temporalis fascia to cartilage and perichondrium.[9] Though the material to use on a perforation was important but the type and location of perforation and condition of the middle ear was also very important and an important factor to consider for type of tympanoplasty.

If a perforation is in anterior half of the tympanic membrane the results are not that good than if a perforation is in posterior half of the tympanic membrane. Also when more than 50% of tympanic membrane is perforated like in subtotal perforation results are not good.[10] Main problem to deal with for an anterior perforation is to support the graft material anteriorly, because posteriorly graft is sandwiched between canal bone and tympanomeatal flap, but anteriorly no tucking is possible by usual underlay flap elevation technique, so to provide the anterior stability to the graft various techniques were developed, like anterior buttonhole technique in which a small anterior wall incision is given and flap elevated and a tongue shaped extension of temporalis fascia is pulled through the pocket, but this technique can be utilized only in cases where perforation is small and anterior and not in large anterior perforations. Another similar technique termed window shade technique by Bluher et al was advocated with good results.[11] Then there is a technique known as Felix tympanoplasty is advocated for large perforations, where the anterior annulus is lifted at two places and tucked with temporalis fascia underneath.[12]

For large perforations some have advised pushing the graft to some distance in eustachian tube orifice and some have advised pushing gel foam underneath. But no conclusive technique has been developed giving consistently good results in anterior or large perforations. Interlay tympanoplasty was developed keeping in mind problems with anterior and large perforations reaching anterior annulus. It gave good results as far as perforation closure is considered but led to anterior TMA blunting in some patients which resulted in deafness. Though if interlay tympanoplasty is done by our technique was uncommon.

Komune et al also reported another advantage of interlay tympanoplasty, that is the unusually rapid epithelization compared to other techniques. They also reported very good graft take up rates upto 94.2% and our study showed 98.4 closure rate.[13] In Patil et al the mean post-operative ABG at the end of 3rd month was 9.7±6.71 dB

(p=0.0000) which was statistically highly significant and similar to 11 dB in this study.[14]

CONCLUSION

The technique mentioned here of interlay tympanoplasty was significantly effective in repairing anterior and subtotal tympanic membrane perforations with avoidance of blunting at the anterior tympanomeatal angle and achieved good functional results.

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REFERENCES

1. Nevoux J, Roger G, Chauvin P, Denoyelle F, Garabedian EN. Cartilage shield tympanoplasty in children, review of 268 consecutive cases. Arch Oto Laryngol Head Neck Surg. 2011;137(1):24-9.
2. Chen XW, Yang H, Gao RZ, Yu R, Gao ZQ. Perichondrium/cartilage composite graft for repairing large tympanic membrane perforations and hearing improvement. Chinese Med J. 2010;123(3):301-4.
3. Cavaliere M, Mottola G, Giampiero M, Iemma M. Tragal cartilage in tympanoplasty: Anatomic and functional results in 306 cases. Acta otorhino - laryngologica Italica. 2009;29:27-32.
4. Adams ME, El-Kashlan HK. Tympanoplasty and ossiculoplasty. Cummins OtorhinoLaryngology and Head and Neck Surgery. 6th edition. Philadelphia: Elsevier Saunders; 2015: 2181-2183.
5. Mullin DP, Ge X, Jackson RL, Liu J, Pfannenstiel TJ, Balough BJ. Effects of tympanomeatal blunting on sound transfer function. Otolaryngol- Head Neck Surg. 2011;144(6):940-4.
6. Lin YC, Wang WH, Weng HH, Lin YC. Predictors of surgical and hearing longterm results for inlay cartilage tympanoplasty. Arch Otolaryngol Head Neck Surg. 2011;137:215-9.
7. Mokhtarinejad F, Okhovat SAR, Barzegar F. Surgical and hearing results of the circumferential subannular grafting technique in tympanoplasty: a randomized clinical study. Am J Otolaryngol Head Neck Med Surg. 2012;33:75-9.
8. Martin, Michael, Summers, Ian R. Dictionary of Hearing, First Edition. London: Whurr Publishers; 1999: 6.
9. Salviz M, Bayram O, Bayram AA, Balikci HH, Chatzi T, Paltura C, et al. Prognostic factors in type I tympanoplasty. Auris Nasus Larynx. 2015;42(1):20-3.
10. Dispenza F, Battaglia AM, Salvago P, Martines F. Determinants of Failure in the Reconstruction of the Tympanic Membrane: A Case-Control Study. Iran J Otorhinolaryngol. 2018;30:(6):341-6.
11. Bluher AE, Mannino EA, Strasnick B. Longitudinal analysis of ‘‘window shade’’ tympanoplasty outcomes for anterior marginal tympanic membrane perforations. Otol Neurotol. 2018;40:e173-7.
12. Castelli ML, Vitiello R, Ponzo S, Evangelista A. Ten years’ experience with Felix tympanoplasty: analysis of anatomical and functional results. J Laryngol Otol. 2015;129:1064-8.
13. Komune S, Wakizono S, Hisashi K, Uemura T. Interlay method for myringoplasty. Auris Nasus Larynx. 1992;19(1):17-22.
14. Patil BC, Misale PR, Mane RS, Mohite AA. Outcome of interlay grafting in type 1 tympanoplasty for large central perforation. Indian J Otolaryngol Head Neck Surg. 2014;66(4):418-24.

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