

## Original Research Article

# Analysis of hearing improvement following fat graft myringoplasty

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### ABSTRACT

**Background:** Fat graft myringoplasty (FGM) is a procedure with a short learning curve, cost effective, with minimal morbidity in properly selected patients. It is useful to relieve the patient of annoyance caused by a small perforation in terms of ear discharge and hearing loss. The aim was to assess postoperative hearing improvement and investigate influence of factors like age, gender and location of perforation on audiological outcomes.

**Methods:** This study was a prospective study done on 25 patients at a tertiary care hospital who underwent FGM. All patients had small dry central perforation. Air and Bone conduction (AC/BC) thresholds and air-bone gap (ABG) were evaluated both preoperatively and postoperatively.

**Results:** Mean hearing improvement was 14.4762 dB in <40 yrs age group whereas it was 11.2500 dB in >40 yrs age group. Mean hearing improvement in females was 13.75 dB whereas it was 14.154 dB in males. Mean hearing improvement was 15 dB in posterior, 14.7 dB in inferior and 14.46 dB in anteriorly located perforation.

**Conclusions:** FGM is effective in improving postoperative hearing thresholds hence it can be used in small dry central perforations of tympanic membrane in patients irrespective of patient variables such as age, gender, and location of perforation. As no significant statistical difference was observed in terms of gender, location or aetiology of perforation, we consider it a procedure to be recommended across all spectrums of patients.

**Keywords:** Tympanic membrane perforation, Fat graft myringoplasty, Hearing improvement

### INTRODUCTION

Chronic persistent perforations of tympanic membrane (TM) need to be subjected to surgical repair as they predispose to recurrent infection of middle ear cleft with resultant ear discharge. When perforation and purulence has persisted for some length of time, hearing loss manifests due to the inflammatory response in the middle ear mucosa affecting the ossicular chain and/ or the labyrinth.

Myringoplasty is closure or reconstruction of perforation of pars tensa of tympanic membrane to eliminate the susceptibility to middle ear infections and improve hearing. The idea is to denude the edges of the perforation, and put in a tissue graft. This tissue graft

replaces the missing fibrous element of tympanic membrane and allows normal epidermis and mucosa to regenerate over the graft.

Berthold is credited with first surgical closure using auto graft (a full thickness free skin graft). He introduced the word 'Myringoplasty'.<sup>1</sup> The technique of tympanoplasty was popularized by Wulstein and Zoellner in 1950s.<sup>2</sup>

Various graft materials used for myringoplasty are: temporalis muscle fascia, tragal cartilage alone or along with perichondrium, fascia lata, conchal cartilage, vein, periosteum and fat. The temporalis muscle fascia has remained the frequent choice for most surgeons who perform myringoplasties, since its introduction by Storrs.<sup>3</sup>

The property of the fat tissue for myringoplasty, first introduced by Ringenberg in 1962 deserves mention.<sup>4</sup> Fat grafts secrete angiogenic growth factors that promote neo-vascularization and tissue repair, thus increasing the scanty blood supply around the tympanic membrane perforation.<sup>5</sup> This procedure is fat graft myringoplasty (FGM).

The purpose of present study was to assess the effectiveness of ear lobule fat graft myringoplasty in improvement of hearing and to correlate it with patient related factors namely– age, gender and location of perforation.

## METHODS

The study was carried out in the Department of Ear, Nose and Throat, Surat Municipal Institute of Medical Education and Research, Surat over the period June 2014 to November 2015. The study was a prospective cohort study among patients who were advised surgery for small dry central perforation. The sample size was of 25 patients. The study was carried out after obtaining approval of Institutional Ethical Committee.

All the patients were evaluated as for other routine ear surgery by detailed history, physical examination, otoscopic examination, tuning fork test, pure tone audiometry, tympanometry for Eustachian tube patency and diagnostic nasal endoscopy to rule out nasal and nasopharyngeal pathology.

### Inclusion criteria

Small central perforation, dry for at least 6 weeks, with mild conductive hearing loss. TM perforation was considered small if its surface area was less than a quarter of the TM surface area.<sup>6</sup>

### Exclusion criteria

Middle ear mucosa and residual TM not healthy, moderate to severe conductive hearing loss.

### Procedure

After infiltration of local anaesthetic a small incision was given on margin of ear lobule. A sufficient amount of fat without skin was taken, and plugged in an hourglass/dumbbell fashion after freshening the margin and the under surface of perforation. Due care was taken to ensure that no epithelium was entrapped inside the perforation. A few pieces of gel foam were placed around perforation. Oral antibiotics and anti-inflammatory were given till suture removal. Ear drops were instilled in canal after 3 weeks. A significant bulging on the tympanic membrane was observed till the end of the third month postoperatively. After three months, bulging of the fat graft progressively disappeared as it was converted into a smooth sclerotic area on the tympanic membrane by the fifth month.

## Statistical analysis

We checked the normality of data using Kolmogorov-Smirnov test for pre-operative and post-operative hearing loss. To know the significant improvement in hearing threshold before and after operation paired t-test was applied. Whereas to compare the effectiveness of treatment in male and female, in age group <40 yrs and >40 yrs age, and location of perforation, independent t-test and ANOVA were applied respectively. All Statistical analysis was done at 95% level of significance. SAS university version was used to analyse the data.

## RESULTS

Pure tone audiometry was done to find air conduction, bone conduction threshold and the air bone gap at 500, 1000, 2000 and 4000 Hz. It was done preoperatively and postoperatively at 1 and 3 months. The difference between air conduction threshold and bone conduction threshold yielded the air bone gap (ABG). The difference between preoperative and postoperative air bone gap yielded the hearing improvement.

In our series of 25 patients, the youngest patient was 15 years and oldest was 60 years (Table 1). Among them 12 patients were male and 13 patients were female. The perforation was located in anterior quadrant in 13 patients, 3 patients had perforation in inferior quadrant and 9 patients had perforation in posterior quadrant. 20 patients had diagnosis of chronic otitis media (infective aetiology) as evidenced by history and clinical examination and 3 patients had history of surgery of tympanoplasty with persistent perforation. The remaining 2 had history of trauma.

**Table 1: Age distribution.**

Age (years)	No. of patients	Percentage (%)
0-20	4	16
21-30	12	48
31-40	5	20
41-50	3	12
51-60	1	4
<b>Total</b>	<b>25</b>	<b>100</b>

After fat graft myringoplasty, in 96% patients graft was in place and in 4% patients graft was rejected. Hearing improvement was satisfactory and significant. The postoperative mean Air Bone gap at 4 weeks was 20.6±1.65 dB and at 12 weeks it was 20.4±1.38dB, showing an improvement over the mean preoperative air bone gap of 34.52±5.11 dB (Table 2).

The Table 3A shows that mean of improvement in <40 yrs age group was 14.4762 dB and the mean of improvement in >40 yrs age group was 11.2500 dB. The difference between pre and post-operative ABG was found to be statistically significant in both age groups. But the inter group difference was not statistically significant (Table 3B).

**Table 2: Audiometric observation of the patients in the study.**

Sr. No	Variable	Mean	S.D	Mean Diff.	95% confidence interval	
					Lower	Upper
1	Pre-op ABG	34.52	5.11	37±9	32.39	36.60
2	Post op @4_wk	20.6	1.65	26±8	19.91	21.28
3	Post op @12_wk	20.4	1.38	24±7	19.83	20.96

P value less than 0.05, statistically significant.

**Table 3A: Hearing improvement in different age categories.**

Age (in years)	Preop ABG	Postop ABG	Mean improvement	P value
<40	34.952±5.278	20.621±1.631	14.4762	P<0.001*
>40	32.5±2.887	21.25±2.50	11.2500	0.002895812*

**Table 3B: Comparison of hearing improvement in both the two age groups.**

Age (in years)	Mean improvement	P value
<40	14.4762±5.2343	0.3019
>40	11.2500±2.5	

**Table 4A: Hearing improvement in different genders.**

Gender	Preop ABG	Postop ABG	Improvement	P value
Male	35±3.693	21.25±2.261	13.75	0.0000000068*
Female	34.154±6.094	20.077±0.277	14.154	0.000000246*

**Table 4B: Comparison of hearing improvement in both the genders.**

Gender	Improvement	P value
Male	13.75±3.769	0.845407621
Female	14.154±6.0943	

**Table 5A: Hearing improvement with respect to location of perforation of tympanic membrane.**

Location	Preop ABG	Postop ABG	Improvement	P value
Anterior	33.769±5.847	20.76923±1.878	14.46154	P<0.0001*
Inferior	35.0±5	20.3±0.6	14.7	0.0371*
Posterior	35.556±3.909	20.556±1.667	15	P<0.0001*

**Table 5B: Comparison of hearing improvement at various location of perforation.**

Location	Improvement	P value
Anterior	14.46154±5.043	0.9635
Inferior	14.7±5.0	
Posterior	15±3.536	

Mean improvement of 13.75 dB occurred in males and 14.15 dB in females. P value was found to be 0.84, so this difference in hearing improvement between genders was not significant (Table 4B).

The hearing improvement was best for posteriorly located perforation as seen from Table 5A at 15 dB. The hearing improvement was 14.7 dB and 14.4 dB respectively for inferior and posterior perforation. The improvement is statistically significant for each location, but when

compared among location themselves it was statistically not significant (Table 5B).

## DISCUSSION

The healing of perforation of tympanic membrane involves a continuous centrifugal migration of the outer squamous epithelial layer. The supportive matrix under the regenerating epithelial layer facilitates the influx of reparative cells and nutrients into the area of healing.<sup>7</sup>

The purpose of surgery is to provide this supportive matrix in the form of graft, which can be different tissue. Although fat can be harvested from the abdomen, buttock and ear lobule, harvesting the ear lobule fat is much simpler than from the other sites. It can be harvested from the same sterile area of surgical field prepared for the fat graft myringoplasty (FGM). Microscopic study of ear fat shows that adipocytes are compact and contain more fibrous supporting tissue than either the buttocks or abdominal fat.<sup>8</sup> The fat of ear lobule being denser has better support for both epithelial and mucosal growth. It presents a big revascularization activity. These unique properties of the ear lobule fat make it suitable to be used in FGM.<sup>7</sup>

Fat graft myringoplasty has many advantages; it is usually performed by transcanal / transtympanic approach which is simpler and easier to perform under local anaesthesia. As the tympanomeatal flap is not elevated there is no risk of injury to the tympanic annulus, chorda tympani nerve, ossicles or middle ear mucosa. In addition, the donor site for FGM is easily accessible through a small skin incision with minimal morbidity. The procedure can be performed in a very short period of time.

### **Hearing improvement**

In the group that underwent fat plug myringoplasty the mean preoperative hearing threshold was  $34.52 \pm 5.11$  dB and postoperative mean hearing threshold at 4 weeks  $20.6 \pm 1.65$  dB and at 12 weeks  $20.4 \pm 1.38$  dB. On analysis p value is  $<0.05$ , so the result is statistically significant.

### **Age distribution**

The youngest patient in the present study being 15 years old and the eldest being 60 years old.

We analysed age as a categorical variable and divided all the patients into two categories with one group consisting of patients aged less than 40 yrs and another group of patients more than 40 yrs. of age. In our study, improvement in hearing was significant in both the groups. On comparing between both the groups the hearing gain was more in patients aged less than forty years, but this difference was not found to be statistically significant. This result could be due to chronicity of the disease and adverse effect of advancing age.

Likewise in a study by Sharma et al, age-group wise postoperative improvement in AB gap was not statistically significant ( $p=0.939$ ).<sup>9</sup> In a study by Saliba no difference was observed between children 10 years or younger and children older than 10 years.<sup>6</sup>

In paediatric group, patient age is the most debated subject with no consensus on the optimum age.<sup>10-12</sup> Early closure of the tympanic membrane in children allows rapid restoration of middle ear function and helps to prevent hearing deterioration.<sup>13</sup> Lin and Messner have carried out large retrospective review as well as meta-

analysis. According to them success in paediatric tympanoplasty is dependent more on proper selection of patients and not on age.<sup>11</sup> In Kwong's experience, FGM with umbilical fat can be successfully performed for small perforations sized less than 25% of total TM surface area regardless of age, as long as patients selected are free of active middle ear pathology or Eustachian tube dysfunction.<sup>14</sup>

### **Gender of patients**

In males patients, mean improvement of 13.75 dB was recorded. In female patients mean improvement was 14.154 dB. This did not reveal any statistical significance in difference between genders. Our result of gender variance in this study is in concurrence with the study by Sharma et al, carried out on 20 patients treated with fat plug myringoplasty. They concluded that the difference between the audiometric improvement in both sexes was not significant ( $p=0.809$ ).<sup>9</sup>

### **Site of perforation**

The current study indicated that postoperative hearing improvement varied with site of perforation. It is evident that hearing improvement was maximum in posteriorly situated perforation at 15 dB, followed by inferiorly placed perforation and least in anteriorly placed location, although they did not present any statistically significant difference. So we can conclude that hearing improvement occurred regardless of the location of perforation.

Gun et al analysed the difference in hearing results between anterior perforations and perforation at other locations in their series of FGM.<sup>15</sup> In each of the anterior and other-located perforations, the mean postoperative ABG improved after the FGM procedure. The mean postoperative air conduction threshold was lower than the preoperative values. After analysing the difference between anterior perforations and other locations they concluded there were no significant differences between hearing results.

Majority of studies on tympanoplasty demonstrate that the most difficult to treat cases are in anterior quadrant with less than expected outcomes in terms of hearing improvement. Applebaum and Deutsch showed that the anterior part of the tympanic membrane is less vascularized than the rest. This may be the factor for higher failure rate when the perforation takes place at this level.<sup>16</sup> Others feel that there is a higher rate of recurrence when the location is posterior, and several authors do not find the location of the perforation as having a determining influence on the final results.<sup>17,18</sup>

According to Ayache et al and Kim et al, the perforation site is not a crucial factor for the success of the FGM procedure.<sup>19,20</sup> Fat plugging requires no support at the level of the anterior annulus so FGM is effective for closing anterior TM perforations.<sup>5,11</sup>

Here a special mention can be made that irrespective of cause of persistent perforation (CSOM, traumatic, post-surgery), FGM can give satisfactory results as post-operative hearing improvement occurred in all patients.

A few words are in order for post-surgery defects of which there were three patients, which were successfully addressed to the great satisfaction of both patients and surgeons. Defect in neo-membrane due to displaced graft or residual perforation can be distressing both for the patient and surgeon alike. The defects can be taken care of at minimal costs in terms of money, time and cost to health infrastructure by using FGM.

No worsening of hearing was recorded in any case post operatively. This may be the finding because of small sample size and absence of long term follow up.

Auditory outcomes following fat graft myringoplasty are gratifying across several studies conducted globally due to minimal disturbance of the annulus and minimal manipulation of middle ear contents. There are bound to be variations in the results of an intervention, which is inherent to the characteristics of the patient, the ability of the surgeon and technical details.

## CONCLUSION

Fat graft myringoplasty improved hearing in majority of cases. Satisfactory hearing improvement was achieved irrespective of patient related variables namely age, gender, site of perforation and aetiology. These variables do not seem to have any significant detrimental bearing on postoperative hearing improvement. Hence the patients with small central perforation irrespective of age, gender, site or aetiology of perforation can be safely advised to undergo this procedure with a fair chance of optimal hearing recovery.

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