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Outcomes of circumferential tympanomeatal flap tympanoplasty in large central perforation

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ABSTRACT

Background: Tympanoplasty is the commonest procedure performed in patients with chronic otitis media. Circumferential elevation of tympanomeatal flap and underlay graft placement is thought to be a good surgical technique as it ensures elevation of canal skin over the Eustachian tube area to form a good assemble between the temporalis graft and the flap to increase the success rate. In our study we intend to study the surgical and hearing outcome in patients undergoing tympanoplasty with circumferential tympanomeatal flap in large central perforations.
Methods: A prospective study with 25 patients in a tertiary care hospital for a period of 2 years, who underwent circumferential tympanomeatal flap tympanoplasty. Patients were followed up on one month and two months. Graft outcomes and hearing outcomes were studied.
Results: Graft uptake was 92%. Blunting was noticed in 4% and medialisation in 4% of patients in circumferential group. Average air-bone gap closure achieved was 17.468 dB.
Conclusions: Circumferential flap elevation in tympanoplasty is an effective surgical technique in patients with anterior and large central perforations with satisfactory outcomes.

Keywords: Tympanic membrane perforations, Tympanoplasty, Circumferential tympanomeatal flap, Air bone gap

INTRODUCTION

Tympanoplasty is defined as a surgical procedure to eradicate infection and restore the function of the middle ear. It is the commonest procedure performed in patients with chronic otitis media. Different graft materials have been tried for reconstruction of the defect in the tympanic membrane and temporalis fascia is the most common auto graft used.[1, 2] Underlay and overlay techniques refer to the placement of the graft material either medial or lateral to the annulus.

Although underlay grafting technique is preferred over overlay technique, it is challenging for subtotal or anterior perforations as the graft falls away from the anterior remnant of tympanic membrane causing medialisation of graft causing failure.[3] Overlay technique has a higher success rate in anterior and subtotal tympanic membrane perforations, but serious complications including lateralization, blunting and cholesteatoma formation may occur.[4]

Elevation of tympanomeatal flap with placement of temporalis fascia graft is crucial for successful uptake of graft. In the past various tympanomeatal flaps have been designed for reconstruction of the subtotal and anterior perforations to overcome the poor success rate. It is very important to provide support to the graft material by additional canal incisions for large central perforations, in order to avoid any residual perforations and medialisation.[5]

Classically described vascular strip technique has some limitations with respect to anterior and large or subtotal perforations. Circumferential elevation of tympanomeatal flap and underlay graft placement is thought to be a good surgical technique as it ensures elevation of canal skin over the Eustachian tube area to form a good assemble between the temporalis graft and the flap to increase the success rate, but elevation of tympanic annulus over anterior superior quadrant can lead to blunting of the tympanomeatal angle resulting in conductive hearing loss.[3]

In this study we have studied the graft uptake, hearing results, post-operative lateralization and medialisation of graft, retraction pockets in patients who underwent circumferential tympanomeatal flap tympanoplasty.

METHODS

Source of data:

All consenting patients, aged between 10-56 years, diagnosed with CSOM-TTD, who had satisfied the inclusion criteria mentioned below during the study period of 2 years from July 2015 to July 2017 done at SSIMS RC, a tertiary care centre in Davangere were included in the study to collect data.

Inclusion criteria

Inclusion criteria were CSOM-TTD- inactive with large central perforation; tympanoplasty carried out in conjunction with cortical mastoidectomy.

Exclusion criteria

Exclusion criteria were medical co morbidities (diabetes, immuno-compromised state); marginal perforation.

Surgical technique

Patient was supine with operating ear up position, under anesthesia, either local or general, parts painted and draped, local anesthetic infiltration with 2% xylocaine and 1:2,00,000 adrenaline given post aurally and to all four quadrants of external auditory canal. Through post aural approach temporalis fascia was harvested, periosteal incision given and periosteum elevated, posterior meatotomy done just below spine of Henle. After retracting the pinna anteriorly, meatotomy cuts extended till 11 'O' clock in clockwise direction and till 2 'O' clock position in anticlockwise direction (Figure 1a). Margins of perforations were freshened. Circumferential tympanomeatal flap along with fibrous annulus was elevated all around from the bony annulus, (Figure 2) keeping it pedicled at 11-12 'O' clock position above handle of malleus (Figure 1b, 1c and 3). The flap just anterior to malleus was cut and released. Middle ear was inspected and ossicular mobility checked, graft placed by underlay technique and stabilized with gel foam (Figure 4). Tympanomeatal flap positioned back after ensuring that flap and graft were closely approximated with each other. Post aural incision closed in layers and mastoid dressing done.

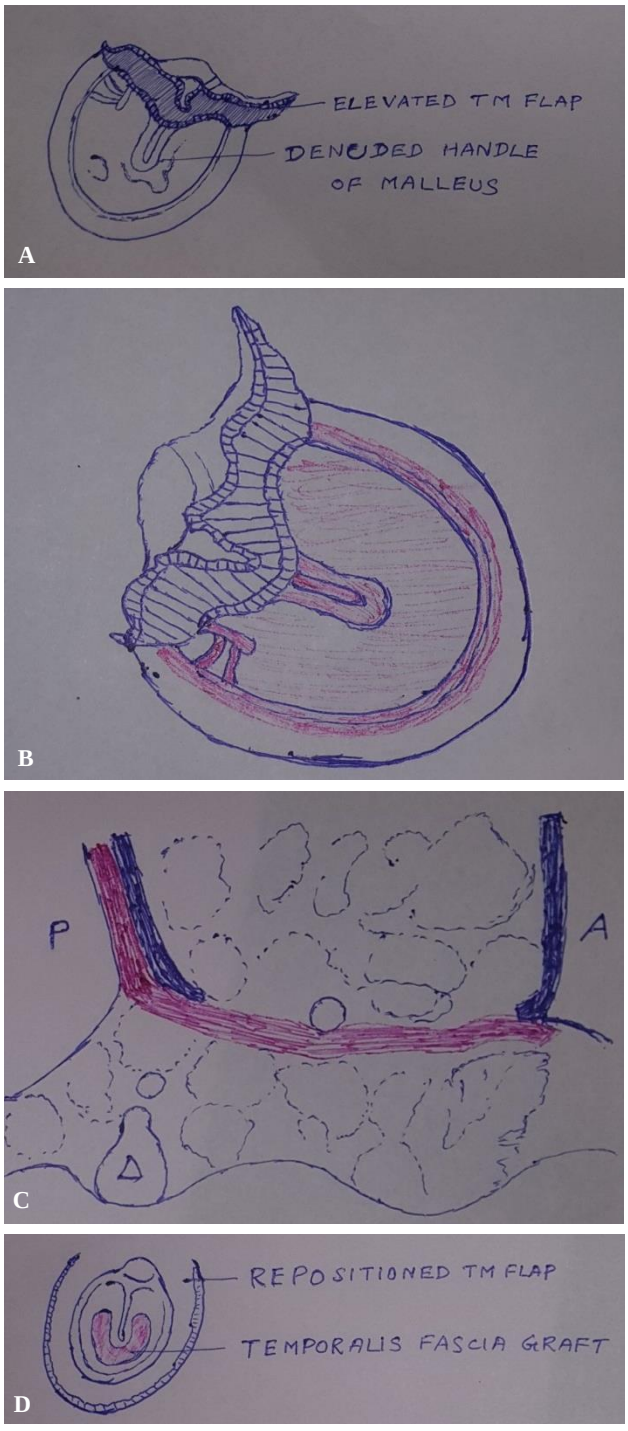

Figure 1: Schematic representation of the surgical procedure. (A) Extent of elevation of tympanomeatal flap, keeping pedicle over the malleus; (B) Temporalis fascia Graft (depicted in pink) placement below the handle of malleus; (C) Coronal view showing graft placement below the annulus; (D) Trans canal view showing graft placement under tympanic membrane remnant.

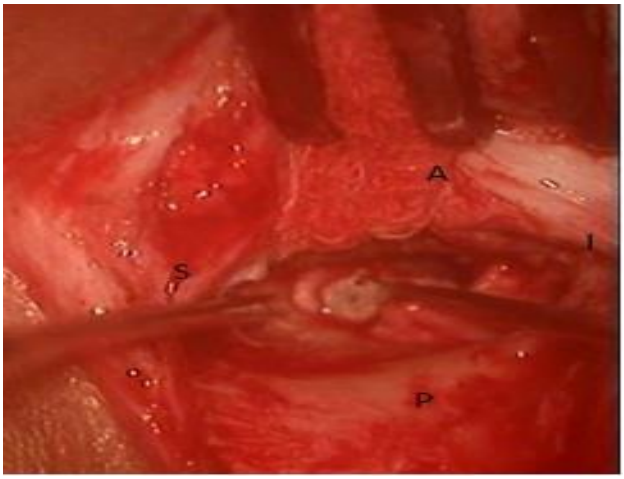

Figure 2: Microscopic view showing circumferential elevation of tympanomeatal flap.
P: Posterior, A: Anterior, S: Superior, I: Inferior.

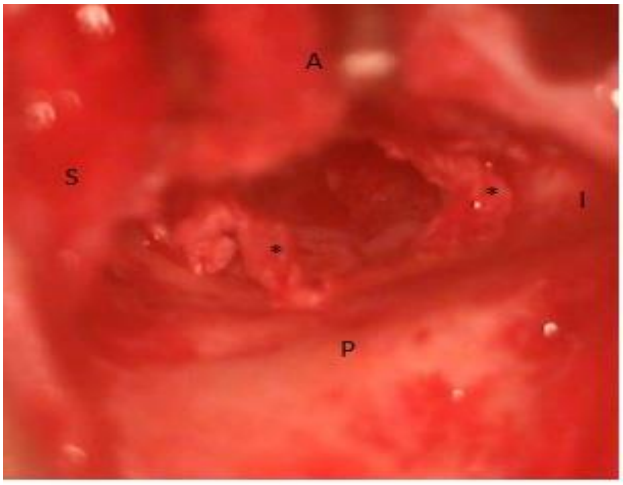

Figure 3: Photograph showing completely elevated tympanomeatal flap.

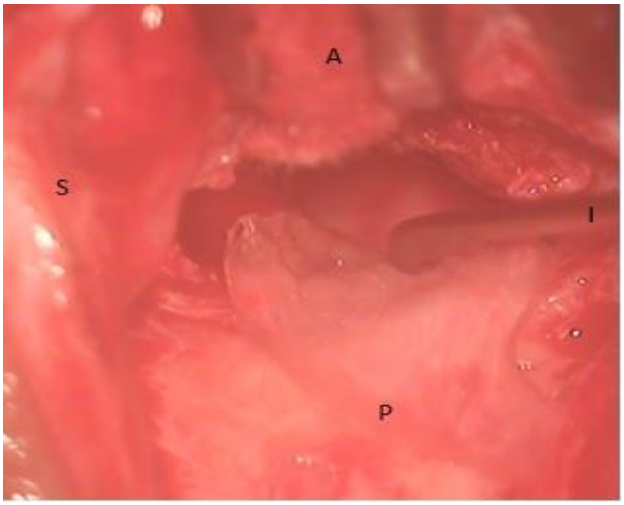

Figure 4: Photograph showing placement of graft by underlay technique.

Outcomes were studied in respect to

- Complete graft uptake.
- Retraction pockets
- Reduction in AB gap
- Subjective hearing improvement
- Lateralization or medialisation of graft
- Dry ear at the end of 2 months

Procedure was considered successful with respect to graft uptake when no residual perforation noted, at the end of follow-up. Blunting of graft, graft retraction or lateralization or medialisation if any, was also noted. Hearing results were analyzed by noting the pre-operative and post-operative AB gap in speech frequency range (500 Hz, 1 kHz, and 2 kHz) and air-bone gap closure after surgery was calculated.

Statistical analysis

The data collected was entered in Microsoft excel and analyzed using SPSS version 16, Descriptive analysis was done by calculating frequencies, proportions and mean, total Air-Bone Gap closure was calculated at the end of the 2 months and compared using paired T test.

RESULTS

Demographic details of the subjects involved in the study are briefed in Table 1. Subjects aged between 31-40 comprised majority of the study group constituting 48% of the study population. Male to Female ratio was 36:64 and Left sided involvement was seen in 52% of the subjects (Table 1).

Table 1: Table showing demographic details of the study group.

Age group	Frequency (n=25)	Percentage (%)
10-20	6	24.0
21-30	6	24.0
31-40	12	48.0
41-50	1	4.0
51-60	0	0.0
Gender		
Male	9	36.0
Female	16	64.0
Side of disease		
Right ear	12	48.0
Left ear	13	52.0

Graft uptake was noted in 23 subjects (92%) (Figure 6) with anterior blunting and medialisation of graft (Figure 8) noted in 1 patient each (4%). Residual perforation was seen in 2 subjects (8%) (Table 2) (Figure 7).

Figure 5: Photograph showing graft below the remnant tympanic membrane.

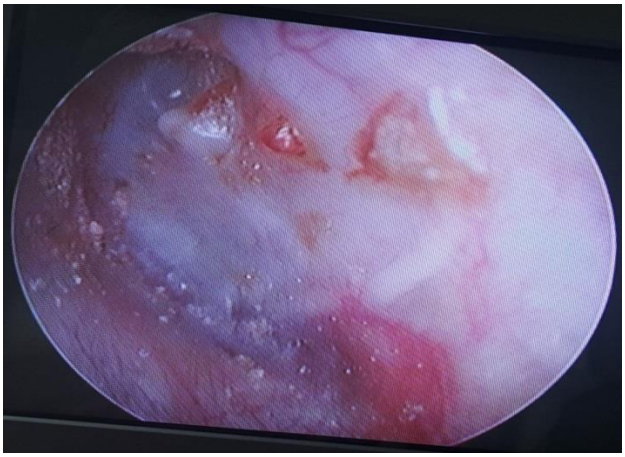

Figure 6: Four week post operative photograph showing intact graft.

Figure 7: Post operative photograph showing residual perforation in anterosuperior perforation.

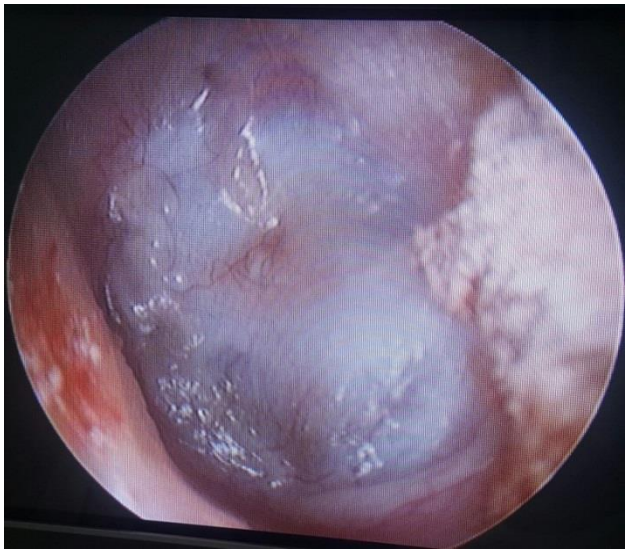

Figure 8: Post operative photograph showing medialisation of the graft.

Table 2: showing various graft outcomes

Graft outcome		
Anterior blunting	1	4.0
Intact graft	21	84.0
Medialisation of graft	1	4.0
Residual perforation	2	8.0
Total	25	100

Table 3: showing comparison between pre-operative and post-operative air bone gap in circumferential flap.

Air bone gap	Pre- op	Post-op
0-10	0 (0.0)	17 (68.0)
11-20 dB	6 (24.0)	3 (12.0)
21-30 dB	6 (24.0)	3 (12.0)
31-40 dB	11 (44.0)	1 (4.0)
41-50 dB	2 (8.0)	1 (4.0)

There was significant number of subjects (17-68%) shown air gap closure to less than 10 dB in post operative period (Table 3).

There was statistically significant association between pre-operative and post-operative air bone gap (p=0.001) and there was significant difference in air bone gap in postoperative follow-up at second month (Table 4).

Table 4: Showing association between pre-operative and post-operative air bone gap in circumferential flap.

Variable	N	Mean	Std. Deviation	T value	p value
Pre operative air bone gap	25	29.572 dB	10.2689	8.5	0.001*
Post operative air bone gap	25	12.104 dB	10.4749		

DISCUSSION

A number of surgical modifications to address the issue of poor graft uptake in anterior and large central perforations have been reported. Recent notable studies are over-underlay tympanoplasty, modified window shade tympanoplasty, mediolateral graft tympanoplasty, the anterior flap technique and loop overlay tympanoplasty.[6-10] Using a modified anterior tagging technique, Hosamani et al recently reported a success rate of 96 per cent for underlay tympanoplasty.[11] Creation of a pocket between the anterior canal skin and its underlying bony canal wall for graft placement was described by Faramarzi et al in 2012.[12] A three-flap technique and an inferior flap technique have also been used for closing anterior and subtotal perforations, with impressive results.[13,14]

Mokhtarinajad et al, Mishra et al, Guneri et al, Singh et al and Potsic et al did circumferential sub annular grafting with lateral placement of graft.[5,16-19] Pradhan et al elevated circumferential tympanomeatal flap and compared outcomes between underlay and overlay technique.[3] We preferred circumferential elevation of tympanomeatal flap with underlay technique of graft placement.

Poor success rates have been reported for anterior and subtotal perforations. The causes are reported to be poor vascularization of the anterior half of the tympanic membrane, inadequate access to the anterior annulus for graft placement, and shrinkage of the temporalis fascia graft.[20]

We preferred post auricular approach in all patients. As per Schraff et al, post aural approach will increase the exposure especially anteriorly[7]. Robinson J et al stated that post-auricular approach gives a 20 per cent larger viewing area compared with conventional endomeatal and endaural routes.[21] Vikram Kulkarni et al *a*dvocates endoscopic transcanal circumferential single flap elevation.[22]

We preferred underlay placement of graft. Underlay technique has many advantages, that there is no risk of blunting, lateralization of graft and epithelial cyst formation, as elaborated by Doyle (1972).[23] These findings are in contrast to the results of Rizer, who achieved drum healing in 95.6% in overlay, as compared to 88.8% in underlay tympanoplasty.[24] Stage and Bak-Pederson advocated use of graft placement lateral to malleus, but noted occasional blunting.[25] Rogha et al reported that both medial and lateral placement of graft is effective and there is no statistically significant difference between two techniques in term of hearing outcomes.[26] The advantages of medial (underlay) graft include ease of learning the technique, avoidance of the risk of lateralization and blunting of the anterior sulcus, and high success rate, especially for the posterior perforation.[27]

The disadvantages of medial graft are inadequate visualization of the anterior middle ear, possible anterior graft fall-away, reduction of middle ear space with consequent increased risk of adhesions, and less suitability for reconstruction of anterior perforation.[27]

Hearing outcome

Postoperative mean AB closure attained was 17.468 dB. Ninety two percent of patients showed post-operative AB gap less than 30 dB at the end of 2 months, which is comparable with other studies.

In our study one patient reported left sided worsening of hearing post operatively at 2nd month follow up. He had bilateral large central perforation and circumferential flap tympanoplasty done on both sides. Intraoperatively lateral process of malleus and long process of incus was found to be eroded on left side. Stapes found fixed on right side and it was mobilized. Tragal cartilage graft is placed over stapes superstructure on left side. Right side also tragal cartilage was used as graft. This patient reported decreased hearing after surgery on left side and worsening of AB gap by 10 dB was noted. It was due to the ossicular erosion noted intraoperatively. In both ears he had residual perforation. Same patient on right side reported AB gap reduction of 26.7 dB. Patient was not giving any history of upper respiratory infections or ear discharge. All other patients in our study showed subjective improvement in hearing. In Moras et al study 7% of patients reported no improvement in hearing postoperatively.[28] Faramirzi et al noticed failure of AB closure in 10 cases. All had disrupted ossicular chain.[12]

Graft uptake

Graft uptake was 92% at the end of 2 months, which is comparable with other studies. In our study both ears of same patient who underwent circumferential flap tympanoplasty had residual perforation. There was an anterosuperior perforation on right side and large central perforation on left side at the end of 2 months follow up but both ears were completely dry. Both sides temporalis fascia and tragal cartilage were used as graft material. Residual perforation could be attributed to patient factors; selection of graft material, thickness and size of cartilage graft used and could be poor eustachian tube function. We were not using any eustachian tube function tests prior to surgery. According to Takahashi et al, examination of patency of eustachian tube before surgery is indicated, as obstructed eustachian tube has poor outcome of tympanoplasty and they recommend ears with mechanically obstructed eustachian tubes as contraindication for tympanoplasty.[29] Moras et al stated that there were 8 patients with graft failure and 4 of them were smokers, who started smoking immediately after discharge from hospital. Our patient was non-smoker.[28]

Complications

Anterior blunting

One patient had anterior blunting; in this patient tragal cartilage with temporalis fascia was used as graft material. As the circumferential flap was elevated all around from bony annulus, flap repositioning was important to prevent blunting. In this case blunting occurred could be because of faulty repositioning of circumferential flap or the anterior tympanomeatal angle area might be obscured with gel foam or cartilage graft. This can be also due to improper size of cartilage graft used persistence of curved shape memory of the cartilage which prevents visualization at anterior annulus and also could be due to change in middle ear pressure leading to displacement of graft laterally. Patient was asymptomatic and showed improvement in hearing (AB gap reduction of 6.7 dB). The ear was dry at 2 months follow up. Mishra et al reported 1% of anterior blunting where graft was placed lateral to handle of malleus.[16] Moras et al reported 3% of anterior blunting.[28] Mokhtarinejad et al, Pradhan et al did same flap technique as ours and didn't encounter any blunting or lateralization of graft.[15,3] Jung et al did mediolateral graft tympanoplasty and noticed one patient with anterior blunting.[8]

Medialisation

One patient had medialisation of graft. She was asymptomatic on follow up and showed improvement in hearing (AB gap reduction of 26.7 dB) at second month. The ear was completely dry at the end of 2 months. It can be due to the complication of underlay placement of graft and poor Eustachian tube functions. Kartush et al mentioned that the chances of medialisation are minimal by placing graft lateral to handle of malleus.[6] It will provide good medial support and there is increased overlap between graft and drum remnant.

Lateralisation

There was no lateralization observed in our circumferential technique because the graft placement was by underlay technique and supported by annulus all around the circumference and it was held firmly by tympanomeatal flap. Mishra et al reported graft lateralization of 1% where graft was placed by underlay technique after elevating circumferential tympanomeatal flap.[16] Mokhtarinejad et al stated that in case of chronic otitis media with normal ossicular mobility, the most important factor which decides the hearing outcome may be proper relationship of graft and ossicles, which means absence of blunting and lateralization.[15] Circumferential sub annular tympanoplasty has several distinct features that make it suitable for anterior and subtotal perforations. As the graft is placed directly onto the bony annulus anteriorly under microscopic vision and not tucked blindly under the tympanic membrane remnant, there is adequate support to the graft anteriorly, which prevents it falling away, facilitates epithelial migration and thus leading to better graft uptake. To compensate for physiological shrinkage of a temporalis fascia graft, a minimum of 3 mm overlap all around the circumference of the annulus at graft placement under microscopic vision is recommended to compensate for physiological shrinkage of the temporalis fascia graft. This technique also provides an adequate graft bed all around the circumference of the annulus, with the handle of malleus in the middle for ideal anchorage.[18]

In our study temporalis fascia was used as a graft material in all patients and 6 patients in circumferential group, with large central perforation, tragal cartilage was also used with temporalis fascia for support. All our patient's ossicular integrity and mobility was normal except one, where lateral process of malleus and incus erosion was noticed on left side and stapes fixation was noticed on to the right side.

No patient in our study experienced surgical complications like intra operative significant bleeding, facial nerve palsy, wound hematoma, perichondritis, epithelial pearl formation and granulation tissue formation at the tympanomeatal flap.

Limitations of our study

Study cohort was small. Data reflects experience of a single institution, and surgeries were done in a tertiary care centre by three different faculties.

CONCLUSION

Circumferential flap elevation in type I tympanoplasty is an effective surgical technique in patients with anterior and large central perforations with satisfactory outcomes.

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