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Main Articles

Comparative study of the underlay and overlay techniques of myringoplasty in large and subtotal perforations of the tympanic membrane

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Abstract

Myringoplasty is an established procedure. However, the quest is on to improve the results further by studying the different influencing factors, that could possibly affect the outcome. In the present randomized prospective study of one year's duration, 60 patients having dry, large and subtotal perforations of the tympanic membrane were subjected to myringoplasty, 30 by the overlay technique and 30 by the underlay technique keeping all other influencing factors constant. The graft take-up rate was found to be the same (93.3 per cent) in both techniques but the underlay technique was judged to be better because of its technical ease, better assessment of ossicular chain integrity and mobility, less time consumption (55 minutes *vs* 90 minutes), earlier healing of graft (four to six weeks *vs* six to eight weeks), hearing gain in more patients (92.8 per cent *vs* 57.1 per cent) and fewer minor complications (6.6 per cent *vs* 33.3 per cent).

Key words: Myringoplasty; Surgical Procedures, Operative; Treatment Outcome

Introduction

Chronic suppurative otitis media is a common disease in this part of India. It presents in all age groups with symptoms of recurrent ear discharge and diminished hearing for many years. Subtotal and large perforations of the tympanic membrane are found in a large number of such cases, necessitating myringoplasty, an established procedure. However, the quest is on for improving the results further by studying the different factors that could influence the outcome of myringoplasty. These are: age of patient, aetiology of perforation, stage of disease, size and site of perforation, presence of tympanosclerosis, condition of the mucosa of the middle ear, eustachian tube function, graft material, technique of operation; overlay or underlay, experience of operating surgeon and status of opposite ear.

In most of the published studies,[1–7] these factors have been analysed retrospectively. In this prospective randomized study, our aim was to find out which of the two techniques, overlay or underlay, was better for correcting large and subtotal perforations of the tympanic membrane keeping all other factors constant. To the best of our knowledge this is the only such prospective study.

Material and methods

This was a prospective randomized study over a period of one year. Sixty cases of chronic suppurative otitis media having subtotal or large perforations in *pars tensa* in the quiescent stage were selected randomly.

Cases in the age group of 16–40 years who were free from nasal allergy, diabetes, hypertension, chronic obstructive pulmonary disease, anaemia and cleft palate having dry, large or subtotal perforations in the pars tensa were included. Ears were dry for at least four weeks before surgery. Cases having polypoidal middle-ear mucosa were excluded. All patients had a normally functioning eustachian tube, as tested by the inflation-deflation test with the help of Siemen's SD-30 impedance audiometer. Pure tone audiometry including the patch test, complete haematological investigations and radiological evaluation of the paranasal sinuses and mastoid were carried out in all the cases. Patients having a haemoglobin level less than 10 gm per cent, high blood sugar and a radiological abnormality in the paranasal sinuses, sclerosis or a mastoid cavity were excluded from the present study. However, patients having the mixed type of hearing loss were included.

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TABLE I
PREOPERATIVE HEARING LOSS

Air conduction (in dB)	No. of cases	Underlay	Onlay
30–40	4	1	3
40–50	5	1	4
50–60	32	19	13
60–70*	7*	5	2
70–80*	7*	2	5
80–90*	4*	2	2
90–100*	1*		1
Total	60	30	30

*Mixed hearing loss

TABLE II
HEALING TIME IN SUCCESSFUL CASES OF OVERLAY AND UNDERLAY TECHNIQUES OF MYRINGOPLASTY

Healing time (In weeks)	Underlay (No. of cases) n = 28	Overlay (No. of cases) n = 28
4	15	2
5	3	5
6	7	13
7	0	3
8	0	2
10	0	0
12	1	2
14	0	0
16	2	1

Thirty cases were operated by the underlay technique and 30 by the overlay technique by the first author. The type of technique to be adopted was known neither to the patient nor to the surgeon before operation. Thirty slips labelled inlay and 30 labelled onlay were kept in a small box after mixing and one slip was picked up by the theatre staff at random and that decided the technique to be adopted in that patient. This continued until the 60th patient when the last slip was picked up. The graft used was autologous temporalis fascia. The approach used was endomeatal in 32 cases and postaural in 28 cases, where the anterior rim of the remnant membrane was not visible.

Underlay technique

The margin of the perforation was freshened and the mucosal surface was made raw for about 2 mm all around the margin. A curvilinear incision was made over the posterior canal wall 8 mm away from the tympanic annulus. At 6 o'clock and 12 o'clock positions this incision was extended medially 1 mm short of the tympanic annulus. A tympanomeatal flap was elevated in the standard fashion. The chorda tympani nerve was spared. The condition of the middle-ear ossicles and labyrinthine windows was checked and the graft was placed medial to the annulus tympanicus. It was assured that there was minimum overlap of 2 mm all around the margin of perforation. Gelfoam was not used in the middle ear. The tympanomeatal flap was repositioned and the position of the graft was checked and supported by gelfoam and a bismuth iodoform paraffin paste (BIPP) pack.

Overlay technique

The margin of the residual membrane was freshened and an incision made in the external auditory canal from the posterior malleolar fold to the anterior malleolar fold via the floor, 8 mm away from the annulus. The meatal skin flap was elevated in a bucket handle fashion. On approaching the annulus, only the squamous epithelium was separated so that the graft could rest on the lateral surface of fibrous layer. In the cases where the handle of malleus was intact, a 'V' shaped notch was made in the upper portion of the graft and the graft was placed medial to it. In subtotal perforations ossicular continuity was checked. The temporalis fascia graft was placed between the fibrous layer and elevated squamous epithelium. The elevated meatal skin flap and squamous epithelium was then repositioned. A small piece of gel foam was placed in the anterior recess to prevent lateralization and anterior blunting. The external auditory canal was packed with gelfoam and BIPP soaked ribbon gauge.

In the post-operative period, the BIPP pack was removed after one week. The gelfoam was removed after two weeks. The graft was inspected and the healing of the skin of the external auditory canal was observed. When the flap was found to be oedematous or had granulation tissue over the incision line, a steroid-antibiotic pack was placed in the EAC. All cases were regularly followed up after two weeks, four weeks, six weeks, six months and one year by the first author who had operated all the cases. Pure tone audiometry was done after six weeks and six months. An average gain in hearing of 10 dB or more at 0.5 KHz, 1 KHz and 2 KHz was considered as having improvement in hearing.

Results and analysis

In this study, 31 cases had subtotal perforation while 29 had a large central perforation of the pars tensa. Fourteen cases in the inlay group and 14 in the onlay group had a large perforation while 16 cases in each had subtotal perforations. Table I shows the preoperative audiometric threshold in each group of patients. Forty-one patients had a conductive hearing loss and 19 had a mixed hearing loss (Table I). The average time taken for the overlay technique was 80 minutes. Difficulty was felt while elevating the skin from the anterior meatal recess and squamous epithelium from the fibrous layer. It was difficult to visualize the incudo-stapedial joint and round window reflux, but graft placement and stabilization was easier. The underlay technique was found to be technically easier and less time consuming (55 minutes). It was easier to visualize the incudo-stapedial joint, assess the integrity of the ossicular chain and functioning of labyrinthine windows. Apposition between the antero-inferior residual tympanic membrane and underlay graft was found to be unstable in eight patients necessitating antero-inferior tunnelling deep to the annulus for stabilizing the graft. Table II shows the healing time

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TABLE III
POST-OPERATIVE GAIN IN HEARING (AFTER SIX WEEKS AND SIX MONTHS) IN OVERLAY AND UNDERLAY TECHNIQUES OF MYRINGOPLASTY

Gain in hearing (in dB)	Underlay (No. of cases) n = 28		Overlay (No. of cases) n = 28	
	6 weeks	6 months	6 weeks	6 months
Up to 10	12	12	4	4
11–15	5	6	4	5
16–20	3	2	3	3
21–25	4	4	4	4
26–30	2	2	1	1
Nil	2	2	12	11

for both techniques. It took four to six weeks for the underlay and six to eight weeks for the overlay for complete healing. Table III shows the post-operative gain in hearing. Patients receiving the overlay technique had less gain in hearing (57.1 per cent) as compared to those receiving the underlay technique (92.8 per cent). The difference in these values was highly significant ($Z>1.96$ and $p<0.005$). There was no statistically significant change in the threshold of hearing between the first audiometry at six weeks and subsequent audiometry performed at six months (Table III). The graft take-up rate in both techniques was the same (93.3 per cent). There were two failures each in both the techniques. There were more complications encountered in the overlay group (Table IV). All the residual pinhole perforations healed with repeated chemical cautery. Three out of four failures were females and one was male. Three had a subtotal perforation and one had a large central perforation. In three patients the endomeatal approach was used and in one the postaural approach was used. Two each were from the onlay and the underlay groups. One of the failed cases had pre-operative mixed hearing loss (bone conduction 30 dB and air conduction 80 dB, in speech frequencies). In this patient there was an initial gain of 15 dB in air conduction but the patient developed granular myringitis and the graft failed after five months of surgery. The hearing level reached to the pre-operative level after six months. The other three failed cases had a conductive hearing loss with an air bone gap of 55 to 60 dBs. Failure was evident after four weeks and audiometry at six weeks showed no significant change in speech frequencies. We did not do audiometry at six months in these three failed cases.

TABLE IV
COMPLICATIONS AFTER OVERLAY AND UNDERLAY TECHNIQUES OF MYRINGOPLASTY

Complications	No. of cases (%) Underlay	Overlay
Graft failure	2 (6.6)	2 (6.6)
Graft lateralization and anterior blunting	–	2 (6.6)
Granular myringitis	–	2 (6.6)
Pin-hole perforation	2 (6.6)	1 (3.3)
Healing problems	–	5 (16.6)

Discussion

This one year prospective study tried to compare the overlay and underlay techniques of placement of graft in large and subtotal dry perforations of the tympanic membrane, keeping all other influencing factors constant. Packer *et al.* (1982)[1] compared the two techniques but used both dura and temporalis fascia as graft material. There was no minimum qualifying period of duration of dryness and eustachian tube function was assessed by the Valsalva manoeuvre. All sizes of perforation were included in their study. Booth[2] studied all the factors retrospectively from the results of 284 cases. Both overlay

TABLE V
COMPARISON OF VARIOUS STUDIES DONE FOR OVERLAY AND UNDERLAY TECHNIQUES OF MYRINGOPLASTY

S. no.	Name of author n = no. of cases	Type of study R = retrospective P = prospective	Techniques of grafting Overlay O	Underlay U	Graft take up rate %	Gain in hearing Air-Bone gap <10 dB	Chief complications observed
1	Booth[2] n = 284	R	✓	✓	–	–	Lateralization, granular myringitis
2	Seifi[8] n = 520	R	✓		99.4%	84.6%	–
3	Sheehy and Anderson[3] n = 472	R	✓		97%	80%	Lateralization, anterior blunting
4	Gibbs[4] n = 365	R		✓	89.5%	–	Lateralization, anterior blunting
5	Packer *et al.*[1] n = 1065	R	✓	✓	O = 91% U = 93%	O = 36% U = 54%	Anterior blunting, neo cholesteatoma
6	Yung[6] n =240	R		✓	92.5%	–	Graft failure
7	Rodriguez *et al.*[7] n = 460	R	✓	✓	O > 1	64%	–
8	Ferraro *et al.*[9] n = not available	R	✓		96%	–	Lateralization, anterior blunting
9	Present study n = 60	P	✓	✓	O = 93.3% U = 93.3%	O = 57.1%* U = 92.8%*	Lateralization, anterior blunting, granular myringitis

*10 dB gain in hearing in 500 Hz, 1000 Hz, 2000 Hz was taken as improvement in hearing.

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and inlay techniques were performed but temporalis fascia and periosteum were used as graft material. Sheehy and Anderson[3] had taken even younger patients (<10 years) and all sizes of perforation. Gibb and Chang[4] over a period of 20 years, performed several techniques including mastoidectomy and additional reconstructive procedures. Abdul[5] used autologous as well as homologous temporalis fascia as graft material. Yung[6] had cases with subtotal as well as small perforations. Cortical mastoidectomy was also performed in a few cases. Rodriguez[7] had patients with the same site, size and cause but younger patients were also included. In contrast, this study included young adults in the 16–40 years of age group who had large or subtotal perforations that had been dry for the preceding four weeks. They had normally functioning eustachian tubes as tested by the physiological inflation-deflation test and only temporalis fascia was used as graft material. Thus, our study was unique in the sense that the only variable factor was the technique of placement of graft-overlay or underlay.

The underlay technique that we used was similar to that of Gibb[4] and Packer *et al.*[1] Yung[6] elevated the whole annulus along with the skin tube out on the bony canal which was based anteriorly. The bony canal was then enlarged. The tensor tympani tendon was divided to correct medialization of the malleus and a Silastic® sheet was placed in the middle ear to prevent adhesion in all cases. A radial incision was made in the graft to make it lie deep to the handle of the malleus, with the aim of preventing the lateralization of the graft. This technique was essentially a modification of the underlay technique. Although it was more elaborate and difficult, there was no difference in the success rate, which was less than the present study. Gibb and Chang[4] found that a severely retracted malleus would cause a problem for the underlay technique. Hearing results were affected because of the reduced middle-ear space. In the overlay technique the graft is kept lateral to the fibrous annulus. There are several methods of performing the overlay technique. We have done overlay by making an incision in the EAC, 8 mm away from the annulus, from the anterior to the posterior malleolar fold and raised the meatal skin and residual squamous epithelium in the form of a bucket handle. The graft was sandwiched between this flap and the residual fibrous layer of the tympanic membrane. We found this technique to be more difficult and time consuming (average 80 minutes). Sheehy and Anderson[3] and Packer *et al.*[1] elevated a cuff of epithelium off the drum remnant all around the perforation after freshening the margin. This method had more risk of leaving some squamous epithelium medial to the graft and the subsequent chance of graft cholesteatoma. They had a 4.4 per cent incidence of graft cholesteatoma in their series, while there was none in the present study. Seifi[8] utilized the endural incision and the whole canal skin was elevated forming an inferiorly based flap. The dried up fascia was introduced in a cup fashion and the anterior and inferior corners were tucked in to fit in the meatal sulcus. This reportedly gave a larger area of contact with the recipient bed and consequently a better blood supply. Ferraro *et al.*[9] used the annular wedge technique to prevent anterior blunting and lateralization.

- **This is a prospective study of underlay and onlay myringoplasty in patients with large or subtotal perforations of the tympanic membrane**
- **Graft take rates were identical but the authors argue that underlay is easier and more effective in restoring hearing as well as having fewer complications**
- **The authors contrast their findings with previously reported studies, three of which also compared underlay with onlay techniques**

We had an overall success rate of 93.3 per cent (56 out of 60 cases) and it was the same with the overlay and underlay techniques. These results are comparable to other studies (Table V). There were more healing problems and complications after the overlay technique (Table IV). Five cases of the overlay technique had healing problems such as granular myringitis, oedematous flap, synechia, blunting and granulation tissue over the incision line. The healing time of the graft was also more (six to eight weeks) than in underlay (four to six weeks) technique. In the presence study more patients undergoing the underlay technique (92.8 per cent) had a gain in hearing after surgery as compared to 57.1 per cent receiving the overlay technique. Packer *et al.*[1] also found a better hearing result after the underlay technique (54 per cent *vs* 36 per cent overlay). However, a good hearing result after the overlay technique was reported by Sheehy and Anderson[3] (80 per cent) and Seifi[8] (84.6 per cent). Ferraro *et al.*[9] suggested that supplementing the overlay technique with annular wedge tympanoplasty provided good functional recovery. It is difficult to ascribe a specific cause for the residual conductive deafness after a successful graft using the underlay technique (without any ossicular chain discontinuity). One of the reasons could be that the neo-tympanic membrane is not as mobile as the normal one thereby increasing the impedance of the middle ear. Poor hearing results after the overlay technique could be due to subclinical lateralization of the graft, missed ossicular chain discontinuity, fixation of incudomalleolar joint in attic due to surgical manipulation, or fixation of the foot-plate due to associated tympanosclerosis or otosclerosis. Thus, our own observations and available literature suggested that the underlay technique was better than the overlay technique because of its technical ease, shorter post-operative healing time, fewer problems and complications and better functional recovery in terms of hearing gain.

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