

A comparative study of underlay and overlay techniques of type I tympanoplasty

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Abstract

Background: Tympanoplasty is now an established surgery for tympanic membrane perforations being carried out routinely by otorhinolaryngologists. Type I Tympanoplasty refers to any operation involving reconstruction of the tympanic membrane defect. Autologous graft materials such as temporalis fascia, tragal perichondrium, cartilage, fat, and fascia lata have stood the test of time in repairing tympanic membrane perforations. Keeping all these factors in mind, my attempt is to compare results with other literatures so that the present “comparative study of underlay and overlay techniques of type I tympanoplasty” is better analysed and understood to evaluate the postoperative graft take-up and hearing improvement. It will help the suffering mankind, especially the cases of chronic suppurative otitis media, medical fraternity and society at a larger scale in proper surgical management, prevention of complications and in reducing recurrence. **Methods:** is a prospective study of 100 patients who had attended the OPD of ENT department of Darbhanga Medical College and Hospital and were being operated for tympanic membrane perforation during the period of October 2015 to April 2017. The patients were followed up for six months from the date of operation. The study was conducted in the department of ENT of Darbhanga Medical College and Hospital. **Results:** In this study the age range of patients were from 13 to 48 years, although most patients were within 20-30 years of age. In our study the number of females was more than the number of males and male: female ratio was 1:1.22. Left sided disease was predominant in our study and right: left ratio was 1:1.38. Mean duration of symptoms was 7.37 (+/- 4.25) years. Discharge with hearing loss was the predominant symptom. The size of perforation was mostly small (70%) and the status of middle ear was mostly normal or healthy (90%). **Conclusion:** According to our results, overlay and underlay techniques of tympanoplasty are equally effective in terms of graft success rate and hearing improvement, but in terms of complications underlay technique is superior to overlay technique.

Key Word: Tympanoplasty, CSOM, underlay, overlay

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INTRODUCTION

Chronic suppurative otitis media is the chronic inflammation of mucoperiosteal lining of the middle ear cleft characterized by ear discharge, a permanent perforation of the tympanic membrane and impairment in

hearing. It is one of the most common ear diseases encountered in developing countries due to poor socio-economic standards, poor nutrition, lack of health education and unhygienic habits. It is a major cause for deafness in India. A perforation in the tympanic membrane can result from either trauma, pressure effects or infective process, out of which the infective or suppurative process is the most common cause. A few of these perforations usually heal spontaneously. A non-healing permanent perforation results due to chronicity of infection and certain patho-physiological changes at the perforation margins. This leads to constant exposure of middle ear for reinfection and hearing impairment. Most agree that tympanic membrane perforations that show no signs of healing at 3 months are unlikely to close spontaneously and can at that point be considered a chronic perforation, making the surgical intervention an

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appropriate step. The main aim of surgery in Chronic Suppurative Otitis Media is to eliminate disease process and reconstruct middle ear to give the patient a dry, safe and functioning ear. The repair of the tympanic membrane dates back to more than a century. In 1878, Berthold successfully closed a perforation with a full thickness skin graft and introduced the term "MYRINGOPLASTIK." In 1960, Shea¹ described the closure of tympanic membrane perforation using vein graft. Such abundance of materials implies that there is no clear cut favourite and the choice of graft material depends on individual surgeon's preference. However, due to its anatomic proximity, low BMR, translucency and suppleness, temporalis fascia is the most preferred grafting material among the otologists and successful closure is anticipated in approximately 90% of primary tympanoplasties. There are many factors which influence this success rate, including age of the patient, site and size of the perforation, duration of the ear being dry prior to surgery, surgical approach (endaural, postaural, transcanal), surgical technique i.e. underlay vs overlay, using dry or wet temporalis fascia graft. Thus, consistent achievement of good hearing is still a challenge and one of the most difficult tasks of otologic surgery. Failure rates are higher in larger perforations with temporalis fascia as a graft material. Graft displacement, improper placement, autolysis, infection, hemorrhage, eustachian tube dysfunction are the known contributing factors for the failure of closure of perforation.

METHODS

It was prospective study of 100 patients who had attended the OPD of ENT department of Darbhanga Medical College and Hospital and were being operated for tympanic membrane perforation during the period of October 2015 to April 2017. The patients were followed up for six months from the date of operation. The study was conducted in the department of ENT of Darbhanga Medical College and Hospital.

Place: All the patients attending the ENT OPD of Darbhanga Medical College and Hospital with history of discharge per ear with hearing loss were subjected to detail clinical history taking and clinical examination. After taking thorough clinical history and clinical examination, the patients with age range of 12-60 years with clean cut dry central perforation of pars tensa without any complication and with good cochlear reserve were screened. These patients were recommended for tympanoplasty operation. These patients who underwent tympanoplasty operation in the ENT OT of Darbhanga Medical College and Hospital were followed up for this study.

Sample size: 100 patients

Sampling procedure: Patients were randomly taken from those patients fulfilling the inclusion criteria and exclusion criteria.

Inclusion criteria

1. Unilateral chronic otitis media of safe or tubotympanic type having dry central perforation.
2. Dry ears for at least 6 weeks before the surgery.
3. Age above 12 years and below 60 years
4. Conductive hearing loss.
5. Good cochlear reserve.
6. Intact and mobile ossicular chain.
7. Normal Eustachian tube function.

Exclusion criteria

1. Patients having active ear discharge.
2. Patients having any obvious ossicular dysfunction.
3. Patients with sensorineural hearing loss
4. Patients having unsafe or attic-antral disease.
5. Patients with septic focus in the form of rhinitis, sinusitis, tonsillitis etc.
6. Known Eustachian tube dysfunction.

Method of data collection

1. Cases selected for study were subjected to detail history taking including patients particulars, chief complaints, present and past medical and surgical history, personal history, family history etc.
2. Detailed clinical examination was then done by local examination, aural speculum examination, otoscopic examination, Siegel's pneumatic speculum examination and finally by examination under microscope.
3. Then auditory function test was done specially the tuning fork test including Rinne test, Weber test and ABC test
4. Patients were then subjected to various vestibular function tests, Eustachian tube function test and facial nerve function test.
5. Examinations of nose, throat and other systemic examinations were done to rule out any potential source of infection.
6. Cases were then investigated as follows:-
 - X-ray B/L mastoid lateral-oblique view or Schuller's view
 - Pure tone audiometry
 - Routine blood tests- CBC, BT, CT, RBS
 - HIV, HBsAg and HCV viral markers

Follow up: Patients were followed up for six months or more. Patients were called up for first follow up at the end of first week post operatively, second follow up at three weeks post operatively, third follow up at six weeks post operatively (status of the graft was noted on that

visit) and then at monthly interval for four months or more. A complete hearing test was performed six weeks post operatively.

RESULTS

One hundred successive patients fulfilling the inclusion criteria underwent tympanoplasty operation during the period of October 2015 to April 2017. Among these patients overlay technique was done in 50% (n=50) patients and underlay technique was done in 50% (n=50) patients. Various data and their analysis as obtained are given below.

(A) Demographic Profile of the Patients

In our study the youngest patient was of 13 years age and the oldest was of 48 years of age. The mean age was 27.50 (+/- 6.65). The mean ages of patients who underwent overlay and underlay techniques tympanoplasty were 28.50 and 26.56 respectively. The differences among the two groups were statistically insignificant. Most of the patients' ages were from 20-30.

Table 1: Age distribution in years

Technique	N	Minimum	Maximum	Mean	SD
Overlay	50	15	42	28.50	7.14
Underlay	50	13	48	26.56	6.04
Total	100	13	48	27.50	6.65

P = 0.722, ANOVA, one way analysis of variance (f = 0.328)

Sex: In our study 55 % (n=55) were females and 45 % (n=45) were males. Male : female ratio was 1:1.22. The sex ratio did not have statistical significance among the two groups.

Table 2: Comparison of two groups on the basis of sex distribution

Technique	Male	Female	Total
Overlay	23	27	50
Underlay	22	28	50
Total	45	55	100

p = 0.739 (>0.05) Pearson's Chi Square Test (0.606) DF = 2

(B) Clinical Presentation (Side)

In our study the left ear was involved in 58% (n=58) and the right ear was involved in 42% (n=42) patients. Right to left sided ratio was 1: 1.38. The difference in the side among the two groups failed to achieve any statistical significance.

Table 3: Side distribution among the two groups

Technique	Right	Left
Overlay	20	30
Underlay	22	28
Total	42	58

P = 0.982 (>0.05) Pearson's Chi Square Test (0.037) DF = 2

Duration of symptoms (in years): Mean duration of symptoms like discharge per ear, hearing loss etc. in our study was 7.37 years (+/- 4.25). Shortest duration was of

2 years and the longest duration was of 20 years. Mean duration among overlay and underlay techniques were 8.28 and 7.93 years respectively. Durations were insignificant among the groups.

Table 4: Distribution of duration of symptoms (in years)

Technique	Minimum	Maximum	Mean	SD
Overlay	3	18	8.28	3.98
Underlay	2	20	7.93	4.56
Total	2	20	7.37	4.25

p = 0.685, ANOVA one way analysis of variance, (F = 0.383)

Symptomatology: In our study commonest symptom were discharge per ear with hearing loss found in 58% cases (n=58). Other symptoms were discharge per ear alone, 25% (n=25), hearing loss alone, 12% (n=12) and others, 5% (n=5). There were negligible variation of symptomatology among the two groups.

Table 5: Distribution of symptoms

Symptoms	Overlay	Underlay	Total
Discharge + Hearing Loss	28	30	58
Discharge only	15	10	25
Hearing loss alone	5	7	12
Others	2	3	5

P = 0.972, 0.602, 0.643 and 0.714 respectively for different symptom types. Chi Square test, DF = 2 for each of them.

(C) Pre-Operative Finding

Pre-operative A-B gap by PTA: In our study the mean pre-operative air-bone gap measured by pure tone audiometry was within the range of 25-48 and the overall mean value was 29.15 (+/- 5.56). The mean values pre-operative A-B gap among the two groups did not vary significantly.

Table 6: Showing distribution of pre-operative A-B gap (dB)

Technique	Minimum	Maximum	Mean	SD
Overlay	25	45	28.78	6.25
Underlay	25	48	29.18	5.34
Total	25	48	29.15	5.56

P = 0.781, ANOVA, one way analysis of variance, (F = 0.249)

Pre-operative Rinne test and ABC test: In our study all the patients had negative pre-operative Rinne test and none of the patients had reduced ABC test.

Size of perforation: In our study the size of perforation was divided into two groups for simplicity, the first, large perforation having perforation size of more than 50% of TM area and the second, small perforation having perforation size less than 50% of TM area. Size of perforation was small in 70% (n=70) cases and was large in 30% (n=30) cases. Differences in the size of perforation among the two groups were not significant (>0.05) statistically.

Table 7: Size of perforation among the two groups

Technique	Small	Large
Overlay	30	20
Underlay	40	10
Total	70	30

$p = 0.987 (<0.05)$, Pearson's Chi Square test (0.026) $df=2$

Status of middle ear: In our study pre-operative status of middle ear was normal in 90% cases ($n=90$) and abnormal (like mildly oedematous or mildly polypoidal middle ear mucosa) in 10% cases ($n=10$). Variations in the status of middle ear mucosa among the two groups were negligible.

Table 8: Status of middle ear mucosa among the two groups

Technique	Normal	Abnormal
Overlay	46	4
Underlay	44	6
Total	90	10

$p = 0.888 (>0.05)$ Pearson's Chi square test (0.238) $DF=2$

(E) Post Operative Minor Complications: In tympanoplasty surgery there are different complications that may occur post operatively. In our study the overall wound infection occurred in 7% ($n=7$) cases, discharge at three weeks found in 13% ($n=13$) cases, granular myringitis occurred in 10% ($n=10$) cases, granulations in the EAC found in 5% ($n=5$) cases, graft lateralization, graft medialization and OME / atelectasis occurred in 7% ($n=7$), 6% ($n=6$) and 5% ($n=5$) cases respectively. Method wise break up of these minor complications are given below.

Table 9: Distribution of different post operative minor complications

Complication	Overlay	Underlay	Total
Wound infection	3	4	7
Discharge per ear	6	7	13
Granular myringitis	4	6	10
Granulations in the EAC	3	2	5
Graft lateralization	7	0	7
Graft medialization	0	6	6
OME / Atelectasis	1	4	5

P values were >0.05 on comparing two methods for a particular complication at a time by Chi Square technique.

(F) Post Operative Follow Up for Anatomical Success Graft Taking at 6 weeks: Graft taking was observed at 6 weeks. In our study overall 93% ($n=93$) patients had successful graft take up while only in 7% ($n=7$) patients the grafts were failed. Graft take up rate among the two groups were comparable.

Table 10: Graft take up rate among the two groups

Technique	Yes	No
Overlay	46	4
Underlay	47	3
Total	93	7

$P = >0.05 (1.000)$ by Fisher's exact test two tailed P value and by comparing two groups at a time.

Perforation at 6 months (Anatomical failure): Patients were studied finally at 6 months to assess a number of reperforations or the persistence of perforations which indicated the anatomical failure rate. In our study overall 12% ($n=12$) cases were failed with a presence of perforation even at 6 months. Number of perforations among the two groups are shown in the table below. Results were statistically insignificant.

Table 11: Reperforations or failures at 6 months

Technique	Yes	No
Overlay	7	43
Underlay	5	45
Total	12	88

$p = >0.05 (1.000)$ by Fisher's exact test two tailed p value, comparing two groups at a time.

(G) POST OPERATIVE HEARING ASSESSMENT

Post operative Rinne tes: The cases were assessed for hearing improvement by Rinne test with 512 Hz tuning fork 6 weeks or later after the operation. In our study overall 78% ($n=78$) patients had improved hearing as indicated by Rinne test. Positive Rinne test among the two groups are given in the table below.

Table 12: Post operative Rinne test

Technique	Positive	Negative
Overlay	38	12
Underlay	40	10
Total	78	22

$p = 0.95 (>0.05)$ Pearson's Chi Square test (0.102) $DF=2$

Post operative ABC test: For assessing the post operative sensory neural hearing status Absolute bone conduction tests were done among the patients 6 weeks or later after the operation. In our study overall 5% ($n=5$) patients had reduced ABC test indicating poorer bone conduction.

Table 13: Post operative ABC test

Technique	Reduced	Not Reduced
Overlay	2	48
Underlay	3	47
Total	5	95

Post operative reduction in mean A-B gap by PTA: The actual fraction of post operative patients who had hearing improvement was measured by pure tone audiometric test at 6 weeks or later after the operation. In our study overall 85% ($n=85$) patients had reduced mean A-B gap while 15% ($n=15$) had no improvement. Results were statistically insignificant.

Table 14: Post operative reduction in mean A-B gap by PTA

Technique	Reduced	Not Reduced
Overlay	42	8
Underlay	43	7
Total	85	15

$P = >0.05 (1.000)$ by Fisher's exact test two tailed p value, comparing two groups at a time.

Post operative mean A-B gap within 0-20db: Among the patients having reduction in A-B gap by PTA, some had post-operative A-B gap even within 0-20dB. In our study 70% (n=70) patients had post-operative A-B gap within the range of 0-20dB. Below is the distribution of this result among the two groups.

Table 15: Post operative mean A-B gap within 0-20dB

Technique	Yes	No
Overlay	33	17
Underlay	37	13
Total	70	30

P = 0.632 (>0.05), Pearson's Chi Square test (0.918) DF=2

(H) OVERALL SUCCESS RATE

At the end of 6 months overall success, that is patients with both anatomical closure of TM defect and hearing improvement were also counted. In our study overall success was found in 85% (n=85) patients. Overall success among the two groups are shown below. Overall success rate among the two techniques did not vary significantly.

Table 16: Overall success rate

Technique	Yes	No
Overlay	42	8
Underlay	43	7
Total	85	15

p = >0.05 (1.000) by Fisher's exact test two tailed p value, comparing two groups at a time.

(I) DURATION OF FOLLOW UP

In our study patients were followed up starting from first week post operatively upto six months or more. The lowest period of follow up was six months and the highest period of follow up was twelve months. The mean period of follow up was 8.5 months (+/- 1.85). Periods of follow up among the two groups are as follows.

Table 17: Period of follow up

Technique	Minimum	Maximum	Mean	SD
Overlay	6	11	8.83	1.66
Underlay	6	12	8.04	1.72
Total	6	12	8.5	1.83

P = 0.368, ANOVA one-way analysis of variance (F=0.328)

DISCUSSION

Paper patch technique for repair of tympanic membrane perforation was developed by **Blake** in 1877²⁻⁵. In the year 1878, first surgical closure of tympanic membrane defect by removing the epithelium and grafting with skin was done by **Berthold**. In 1958, **Heerman** began to use temporalis fascia⁶. Initially overlay technique was widely used. But this technique was not giving consistent results. In the year 1959, **Shea**, **Austin** and **Tabb** introduced the concept of placing the graft material medial to the drum remnant (underlay technique) using vein graft.

Age distribution: In our study the youngest patient was of 13 years age and the oldest was of 48 years of age. The

mean age was 27.50 (+/- 6.65). Most of the patients' ages were from 20-30 years. The differences among the two groups were statistically insignificant. In a study done by **Ashfaq Ahmed Shaikh et al** (2009), the age range was 18-40 years with mean age 31.2. 68% of the patients in his study were within 25-40 years. So our study correlated with this study as far as age is concerned. **Juvekar M R et al**⁷, in his study took age range of 15-60 years.

Sex distribution: In our study 55 % (n=55) were females and 45 % (n=45) were males. Male: female ratio was 1:1.22. The sex ratio did not have statistical significance among the two groups. In a study conducted by **Fadl A Fadl** (2003)⁸, the male: female ratio was 1:1.425. This result correlated with our study.

Symptomatology: In our study commonest symptom were discharge per ear with hearing loss found in 58% cases (n=58). Other symptoms were discharge per ear alone, 25% (n=25), hearing loss alone, 12% (n=12) and others, 5% (n=5). **Sheahan P et al** (2001)⁹, in their study showed 74% and 69% patients of active mucosal disease had hearing loss and discharge per ear respectively.

Pre operative A-B gap by PTA: In our study the minimum mean A-B gap was 25dB and the maximum mean A-B gap was 48dB and the overall mean value was 29.15 (+/- 5.56). **Shrestha S et al** (2006)¹⁰, in their study found pre-operative A-B gap of around 30dB in 76% patients.

Graft taking at 6 weeks: In our study anatomical success at 6 weeks were estimated by finding the graft taking at 6 weeks. In our study overall 93% (n=93) patients had successful graft take up. Although percentage wise the anatomical success at 6 weeks was slightly greater in underlay technique, 94% (n=47) as compared to overlay technique, 92% (n=46), statistically it failed to be significant (p=>0.05). In a study by **Chanvimalueque et al** (2001)¹¹, anatomical success rate by underlay and overlay technique was 89.5%. In our study overall 12% (n=12) cases were failed with a presence of perforation even at 6 months. Although the overlay technique had slightly greater failures (14%) percentage wise, there was no significant difference among the two groups statistically (p>0.05).

Failure rates of tympanoplasty

Study	Technique	Failure rate (%)
Adnan Salem Umar et al (2008)	Myringoplasty	7.05
Jack M Kartush et al (2001)	Over-underlay	12

So, our study correlated with the above studies.

Post operative Rinne test: In our study overall 78% (n=78) patients had improved hearing as indicated by Rinne test. Results were statistically insignificant among the two groups (p>0.05).

In a study by Ogisi F O *et al* (2004)¹², the overall hearing improvement by type I tympanoplasty was 77%.

Post operative ABC test: In our study overall 5% (n=5) patients had reduced ABC test, among them we have 2 patients of overlay technique and 3 patients of underlay technique, although, in all the patients the pre-operative ABC test was normal.

Post operative mean A-B gap within 0-20db: Among the patients having reduction in A-B gap by PTA, some had post-operative A-B gap even within 0-20dB. In our study 70% (n=70) patients had post-operative A-B gap within the range of 0-20dB. For overlay and underlay techniques, the results were 66% and 74% respectively. In a study by M Crovetto de La Torre *et al* (2000)¹³, the post operative A-B gap within 0-20 dB was found in 83% of overlay technique and 88.4% of overlay technique. So, the results are more or less similar to our results and both the two techniques gave comparable results.

Overall success rate: In our study 85% (n=85) patients had overall success results that is both anatomical closure of tympanic membrane as well as hearing improvement. The overall success rates among overlay and underlay techniques were 84% and 86% respectively. The two groups statistically failed to differ significantly ($p > 0.05$). There are various other studies to estimate the overall success rate of tympanoplasty operation by different techniques. The table below is showing some of them.

CONCLUSION

Predominance of tympanic membrane perforation in females was seen in our study. Predominance of left sided disease was also an observation of our study. Post operative minor complications may occur with both the types but graft medialization, OME and atelectasis are common with underlay technique, where as graft lateralization is common in overlay technique in our study. Although percentage wise overall success rate was better in underlay technique (86%) as compared to overlay technique (84%) in our study, but the difference was not significant statistically, that is the methods are comparable among them. Hearing improvement with underlay technique was better (86%) than overlay technique (84%) but statistically the hearing results of the two groups are comparable. Failure rate in our study was more with overlay technique (14%) and less in underlay technique (10%). But again these differences are not

significant statistically. Tympanoplasty is a safe and effective technique to improve the quality of life of patients, avoiding continuous infections and allowing them contact with water. According to our results, overlay and underlay techniques of tympanoplasty are equally effective in terms of graft success rate and hearing improvement, but in terms of complications underlay technique is superior to overlay technique. Underlay technique of tympanoplasty is also relatively simple, technically easier to perform and takes less time as compared to overlay technique of tympanoplasty. Therefore, underlay technique of tympanoplasty should be widely used, but the overlay technique should be preferred in cases of anterior quadrant perforations.

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