

## Original Research Article

# Comparative study of anterior tucking and cartilage support tympanoplasty with respect to graft uptake and hearing outcome

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### ABSTRACT

**Background:** Tympanic membrane perforation in chronic otitis media exposes the middle ear mucosa to exogenous source of infection and also produces conductive hearing loss. To overcome this problem various surgical techniques of tympanoplasty using different graft materials have been tried with varying degrees of success rate. The purpose of this study was to compare anterior tucking and cartilage support tympanoplasty with respect to graft uptake and hearing outcome.

**Methods:** This prospective study comprised of 50 consecutive patients with chronic otitis media of tubo tympanic type during October 2015 to September 2017, which were divided into two groups. Group A (25 patients) underwent type 1 tympanoplasty with anterior tucking method, Group B (25 patients) underwent type 1 tympanoplasty with cartilage support. The primary result was measured in view of graft uptake & hearing capacity outcome at 6 months post operatively by performing pure tone audiometry.

**Results:** In anterior tucking tympanoplasty group out of 25 patients, the graft uptake was good in 22 patients and 23 patients showed good improvement in hearing, while in cartilage support tympanoplasty group all the 25 patients the graft uptake was good and all showed good hearing improvement postoperatively. In our study both the groups have significant hearing improvement and in cartilage support tympanoplasty results were better.

**Conclusions:** The aim of tympanoplasty is to treat middle ear and tympanic membrane defects. In this study we subjected the patients for anterior tucking and cartilage support tympanoplasty for two different groups respectively and both methods showed significant hearing improvement.

**Keywords:** Anterior tucking, Cartilage support, Tympanoplasty, Cortical mastoidectomy

### INTRODUCTION

Chronic otitis media (COM) is an inflammatory process of the middle ear cleft, which persists for more than 3 months. Possible causes for the tympanic membrane defect include infection, trauma, retraction pockets developing from chronic negative middle ear pressure, and therapeutic interventions such as ventilation tubes.<sup>1</sup> The term tympanoplasty was first used in 1953 by Wullstein to describe surgical technique for reconstruction of the middle ear hearing mechanism that

had been impaired or destroyed by chronic ear disease. The first of these procedures was the stapes mobilization of Kessel in 1878, soon followed by Berthold's plastic repair of a perforated tympanic membrane in the same year.<sup>2,3</sup> In 1950, Moritz first described the use of pedicle flaps to construct a closed middle ear cavity in cases of chronic suppuration, to provide sound shielding or protection for the round window.<sup>4</sup> Zöllner in 1951, and Wullstein in 1952, reported similar operations to provide sound protection for the round window and to reconstruct sound pressure transformation for the oval window.

Wullstein advocated free skin transplants rather than pedicle grafts used by Moritz, Zöllner soon after changed from pedicle to free grafts as well.<sup>5</sup> Shea and Tabb reported the use of vein as a grafting material independently.<sup>6</sup> Temporalis fascia was described by Heermann and was introduced in the United States by Storrs.<sup>7,8</sup> Glasscock and House reported the first large series of homograft tympanic membrane procedures in 1968.<sup>9</sup> In 1965, the American Academy of Ophthalmology and Otolaryngology subcommittee on conservation of hearing set forth a standard classification for surgery of chronic ear infection and defined tympanoplasty as a procedure to eradicate disease in the middle ear and to reconstruct the hearing mechanism, with or without tympanic membrane grafting.<sup>10</sup> In this classification, types of tympanoplasties are distinguished according to the method of ossicular reconstruction. The subcommittee's classification also enumerates a set of rules for describing the gross pathology present at the time of surgery for COM. These rules have to do with the type and location of a perforation of the tympanic membrane, status of the ossicular chain, presence of otorrhoea, and status of the mucosa and Eustachian tube (ET). Various techniques have been attempted in order to achieve better results with improved hearing. These include the overlay tympanoplasty, the underlay tympanoplasty over underlay tympanoplasty, gelfilm sandwich tympanoplasty, crown cork tympanoplasty, swinging door tympanoplasty, laser assisted spot welding technique, microclip techniques and others like the fascial pegging, annular wedge tympanoplasty, loop tympanoplasty, which are but modifications of the basic technique.<sup>11-21</sup> Office tympanoplasty techniques like the paper patching, ear lobule fat graft and the self-stabilizing tympanic membrane patchers.<sup>22</sup>

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. However due to its anatomic proximity, translucency and suppleness, temporalis fascia is the most preferred grafting materials among the otologists and successful closure is anticipated in approximately 90% of primary tympanoplasties. Failure rates are higher in repair of larger perforations with graft displacement, improper placement, autolysis, infection, hemorrhage.<sup>23</sup> In the last decade, however, there has been an increasing interest in using cartilage grafts as the primary alternative to its use. Initially it was used to manage retraction pockets for many years. Recently, use of cartilage for reconstruction of large portions of pars tensa of tympanic membrane incases of recurrent perforation, atelectasis and cholesteatoma.<sup>24</sup> The cartilage graft retains its rigid quality and resists absorption and retraction, even in continuous Eustachian tube dysfunction.<sup>25</sup> Two basic techniques are commonly employed for cartilage reconstruction of the tympanic membrane: perichondrium/cartilage island flap, which uses tragal cartilage, and the palisade technique, which uses cartilage from tragus or cymba. In this technique, tragal cartilage

of size 0.5mm, with thinned cartilage with advantage of unacceptable curling of the graft with perichondrium is left attached to one side. The flap is constructed by using round knife; cartilage is dissected from graft to produce an eccentrically located disc of 7-9 mm in diameter. Flap of perichondrium is produced posteriorly that eventually drapes over posterior canal wall, complete strip of cartilage of 2 mm wide is removed vertically from centre of the graft to accommodate entire malleus handle. Entire graft is placed in underlay fashion the palisade technique is used for reconstruction of the tympanic membrane, cartilage can be harvested either the tragus or the cymba. Conchal cartilage if it is postaural approach, tragal cartilage if it is transcanal or endaural. The thickness of graft used was 1 mm, the cartilage is cut into several pieces that are pieced together similar to jigsaw puzzle to reconstruct tympanic membrane. This technique is favoured in cases which requires ossicular reconstruction, allows direct visualization and contact of the notched prosthesis to manubrium handle, which improves hearing.<sup>26</sup>

### **Myringoplasty**

An operation limited to superficial repair of TM defects, without exploration of the middle ear cleft. These are generally performed in an office or ambulatory operating room setting.

### **Tympanoplasty**

An operation involving exploration of the middle ear cleft through a transcanal approach or through a post auricular incision. This is performed to eradicate disease from the middle ear, repair TM defects, and reconstruct the ossicular chain to restore hearing. This procedure is frequently performed in conjunction with a mastoidectomy.

Following principles can be deduced to restore hearing surgically

- An intact tympanic membrane, to provide hydraulic ratio between tympanic membrane and stapes foot plate.
- Ossicular chain, to conduct sound from tympanic membrane to the oval window.
- Two functioning windows, one on the scala vestibule and the other on the scala tympani.
- Acoustic separation of two windows - so that sound does not reach both windows simultaneously.
- Functioning Eustachian tube - to provide aeration to the middle ear,
- A functioning sensory neural apparatus, the cochlea and eighth nerve.<sup>27</sup>

### **Aims and objectives of the study**

- To compare the effectiveness of both types of tympanoplasties.

- To compare the graft uptake and hearing improvement in both types of tympanoplasties.
- To know the complications of two types of tympanoplasties.

## METHODS

This prospective randomized control study was conducted on 50 patients of COM having tubo-tympanic type of disease who attended ENT OPD from October 2015 to September 2017. Those cases willing to participate in the study were taken up for anterior tucking (AT) and cartilage support (CS) tympanoplasty with written informed consent. Follow up done at 1, 3 & 6 months for hearing outcome. The ethical clearance obtained from the institutional ethical committee.

### Inclusion criteria

Inclusion criteria were cases of tubotympanic type COM with subtotal perforation, where discharging ears were also included; patients with age group – 15 to 60 yrs.

### Exclusion criteria

Patients with or who had following conditions were excluded cholesteatoma with atticofacial disease; hearing impairment more than 50 dB which indicate ossicular chain discontinuity; already undergone tympanoplasty or any other otologic surgery; sensorineural hearing loss.

### Clinical evaluation

All patients were subjected to detailed medical history and clinical examination. Each patient underwent otoscopic examination, otoendoscopy, tuning fork tests, pure tone audiometry. And relevant preoperative investigations done for all patients.

### Surgical procedure

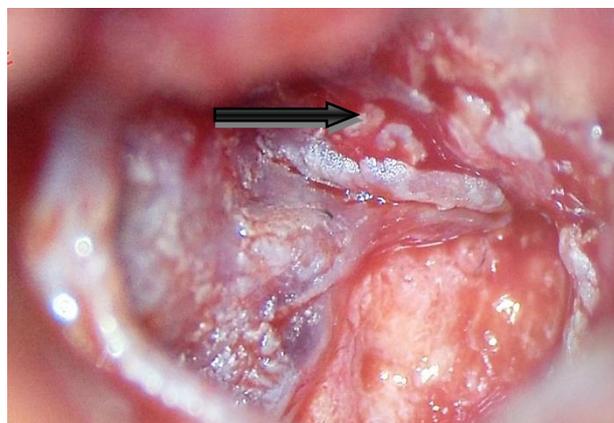
After induction of general anesthesia or under local anaesthesia using lignocaine 2% with 1:200000 adrenaline is injected into the postauricular region and the external auditory canal. The ear is prepared by scrubbing the auricle and postauricular area with povidone iodine and spirit.

Incisions are made in the external ear canal and posterior meatal vascular skin flap is elevated. A post auricular Wilde's incision is made in the post auricular skin crease, temporalis fascia harvested and kept aside to dry. The mastoid bone is exposed using periosteal elevator by raising periosteum posteriorly, the vascular strip is elevated and reflected out of ear canal anteriorly using a self-retaining retractor. Tympanomeatal flap elevated and reflected anteriorly. The middle ear was examined for the status of mucosa, ossicular chain continuity and mobility assessed. Both the groups shared the same operative steps till elevation of the tympanomeatal flap. Simple or

cortical mastoidectomy was done in cases having discharging ear, edematous and congested middle ear mucosa, aditus patency confirmed. In anterior tucking tympanoplasty a small window is made in the anterior remnant of tympanic membrane lateral to the annulus. The temporal fascia graft placed by underlay technique after placing the gelfoam in middle ear to support the graft. Anterior end of the graft brought through the window made in the remnant of tympanic membrane and secured in place Figure 1A and Figure 1B. Then tympanomeatal flap was repositioned, middle ear and external auditory canal were packed with gel foam. Wound was closed in layers and mastoid dressing done.



**Figure 1A: Anterior window in the tympanic membrane remnant.**



**Figure 1B: Anterior tucking of the graft.**

In cartilage support tympanoplasty method: Here the tragal or conchal cartilage was harvested in addition to the temporalis fascia, harvested Cartilage was cut into a bow or a crescentric shape this shape helps in proper alignment of the graft in relation to the antero-superior middle ear space. The temporalis fascia graft was placed over the antero-superiorly based tragal or conchal cartilage graft. This harvested cartilage graft placed medial to the annulus in the middle ear space not only supports the temporalis fascia, but prevents its medialisation Figure 2A. The cartilage will hold the fascia in place, preventing a possibility of residual

perforation due to graft mobilization. The middle ear and external auditory canal were packed with gel foam after placing the flap in position. Wound closed in layers and mastoid dressing was done.



**Figure 1C: Post operative anterior tucking tympanoplasty.**



**Figure 2A: Placing cartilage graft under temporalis fascia graft.**



**Figure 2B: Post-operative cartilage support tympanoplasty**

All patients were discharged either on the first or second post-operative day with the mastoid bandage in place and were given an oral antibiotic, analgesic and antihistaminic medication for one week. cotton pack removed after 2 weeks of surgery and advised antibiotic and steroid drops for 2 weeks. Patients were called for follow-up 1 month, 3 months and 6 months postoperatively. Assessment of graft uptake Figure 1C and Figure 2B and pure tone audiometry done 6 months after the surgery was considered for hearing outcome.

The following features were noted. 1. Graft uptake, 2. Presence of retraction in the neotympanum, 3. Any residual perforation of tympanic membrane, 4. Pure tone audiometry values pre & post-op comparison.

**Software**

The clinical data was analyzed by using Statistical tool IBM SPSS version 22. Descriptive statistics were used and data was expressed infrequencies and percentages. Inferential statistics like Student’s ‘t’ test, Chi square test and Fisher’s exact test were used for comparison. P<0.05 was considered to be statistically significant.

**RESULTS**

In group A patients undergoing anterior tucking tympanoplasty and group B cartilage support tympanoplasty using conchal or tragal cartilage, the age of patients in this study ranged from 15 to 60 years. Distribution of patients in two methods by age and sex represented in Table 1 and 2. Out of 50 patients 27 were below 30 yrs, 23 patients were above 30yrs, 28 were male and 22 female patients.

**Table 1: Distribution of patients in two methods by age groups.**

Age (years)	CST	%	ATM	%	Total	%
<30	11	44	16	64	27	54
>30	14	56	9	36	23	46

Chi square 2.013, df=1, p=0.156, not significant

Follow up at 6 months postoperative period comparison of two methods with graft uptake as in Table 3. Graft uptake was good in cartilage support tympanoplasty (100%) when compared to anterior tucking tympanoplasty (94%). Complications like residual perforation, sensorineural hearing loss, seen in anterior tucking group 4 patients (8%) as shown in Table 4.

In our study when we compare pre and post-operative audiometry with the anterior tucking method and cartilage support tympanoplasty, the p value was <0.2295 in both the groups which was statistically not significant. The hearing improvement was better in cartilage support tympanoplasty than anterior tucking method Table 5.

**Table 2: Distribution of male and females in our study.**

Gender	C.S.T method	%	A.T.M method	%	Total	%
Male	14	56.00	14	56.00	28	56.00
Female	11	44.00	11	44.00	22	44.00
Total	25	100.00	25	100.00	50	100.00

**Table 3: Comparison of two methods with graft uptake.**

Graft uptake	C.S.T method	%	A.T.M method	%	Total	%
Not taken	0	0.00	3	12.00	3	6.00
Taken	25	100.00	22	88.00	47	94.00
Total	25	100.00	25	100.00	50	100.00

Chi-square with Yates's correction = 1.4183 P = 0.2343, df=1

**Table 4: Comparison of two methods with complications.**

Complications	CST	%	ATM	%	Total	%
Yes	0	0	4	16	4	8
No	25	100	21	84	46	92

Fisher's exact test p value 0.1099, not significant

**Table 5: Comparison of two methods with pre-operative and post-operative PTA by t test.**

Variable	Group	Mean	SD	SE	t-value	p-value
Pre-operative	C.S.T method	42.32	8.21	1.64	0.1684	0.8669
	A.T.M method	41.88	10.46	2.09		
Post-operative	C.S.T method	24.90	6.03	1.21	-0.9797	0.3321
	A.T.M method	27.88	14.01	2.80		
Changes	C.S.T method	17.43	7.60	1.52	1.2171	0.2295
	A.T.M method	13.99	11.89	2.38		

## DISCUSSION

In our study, out of 25 patients underwent AT tympanoplasty, 20 underwent cortical mastoidectomy. Out of 25 patients underwent CS tympanoplasty, 23 underwent cortical mastoidectomy. There was no significant changes seen in the results with or without mastoidectomy in both types of tympanoplasty. This was compared with study by Mishiro et al in 2001 reviewed 251 cases found that there was no statistically significant difference between the two groups.<sup>28</sup>

In contrast to our study, Jackler and Schindler in 1984 studied 48 patients with chronic otitis media with tympanic perforations who underwent myringoplasty with mastoidectomy. In their study, it was found that simple mastoidectomy was found to be an effective means of re-pneumatizing the sclerotic mastoid and restoring the hearing.<sup>29</sup>

A study conducted by Burse et al on anterior tucking tympanoplasty and cartilage support tympanoplasty regarding graft uptake and hearing outcomes over 50 cases found that 21 were males and 29 are females. Age ratio shows approximately 54% patients were between

the age group 10 and 30 with mean age of 32.48 yrs in C.S.T and 31.32 yrs in A.T.M. It appeared that the onset of COM was more in younger age group and also that many of them opted for tympanoplasty.<sup>30</sup>

Study by Kumar et al on comparison of temporalis fascia and cartilage palisade technique of type 1 tympanoplasty on 50 patients found that the age of the patients ranged from 10 to 60 years with most of them (38%) were between 10 and 30 years age group.<sup>31</sup> Study conducted by Burse et al on regarding graft uptake and hearing outcomes over 50 cases found that Most common age group involved in study was between 25 to 34 years (36%).<sup>30</sup>

In our study of 50 patients who underwent tympanoplasty, 26 patients (52%) underwent surgery on left side and 24 (48%) patients on right side. Study conducted by Burse et al on regarding graft Uptake and hearing outcomes over 50 cases found that the right ear was affected in 24 patients whereas the left ear was affected in 26 patients.<sup>30</sup> Graft success rate was compared with the techniques of tympanoplasty used. Successful TM closure was observed in 22 ears (88%) with temporal fascia graft alone and 25 ears (100%) with cartilage support.

Temporalis fascia is ideal in the aspect of the primary hearing improvement; it is softer than normal TM, which suggests that it is far more likely to be retracted or re-perforated after tympanoplasty. Study by Kumar et al on comparison of temporalis fascia and cartilage palisade technique of type 1 tympanoplasty on 50 patients found that the successful TM closure was observed in 23 ears (92%) with temporal fascia graft and 21 ears with cartilage palisades (84%) respectively.<sup>31</sup>

The results of Zahnert and couple or other authors stated no significant difference between cartilage and fascia graft uptake.<sup>32</sup> In comparison, some authors had better graft uptakes in palisade cartilage tympanoplasty.

Neumann et al, reviewed 84 cases of the patient, who underwent cartilage palisade tympanoplasty and found an overall graft acceptance rate of 97.6%.<sup>33</sup> Uzun achieved 100% TM closure with palisade cartilage tympanoplasty, whereas and 84.2% success rate was observed in temporalis fascia grafting. Nevertheless with time, bigger sample sizes will provide more reliable results.<sup>34</sup> In our study, graft success rate of A.T.M. group and C.S.T. group was 88% and 100% respectively. None of the cases had residual perforation when cartilage support tympanoplasty was performed, but three had residual perforation with anterior tucking method. Chopra and Collins show better results of palisade cartilage tympanoplasty for blocked E.T Tubes.<sup>35,36</sup>

In study done by Kumar et al found that on cartilage palisade tympanoplasty was performed in 10 patients having E.T. dysfunction, and it was successful in all of them.<sup>31</sup> Study by Burse et al on regarding graft uptake and hearing outcomes over 50 case found that in all the 50 study subjects, we encountered 2 cases of failure wherein the patients developed re-perforation. 1 patient belonged to each the cartilage and the tucking groups.<sup>30</sup> Pre-operative pure tone audiometry amongst the groups suggested that in cartilage group 3 patients and in anterior tucking group 3 patients were having air bone gap between the 20–30 dB. 8 patients with 31–40 dB air bone gap belonged to the Cartilage group and 9 patients were from the tucking group. Whereas 14 patients with air bone gap of 41–60 dB belonged to the cartilage group and 13 patients were from the tucking group. The average pre-operative Air bone gap the anterior tucking cases was found to be 41.88dB with a standard deviation of  $\pm 10.46$ db whereas in the Cartilage support method it was found to be 42.32 dB with a standard deviation of  $\pm 8.21$ dB. The paired t-test applied revealed a value of  $p > 0.05$  ( $p = 0.8669$ ), stating that there was no significant difference between the pre operative audiometry values between the two groups. Post-operative audiometry was performed after 6 months post-operative duration. Majority of patients that is 16 in cartilage group and 18 patients from anterior tucking group had improvement between 10–30 dB.

Study conducted by Burse et al on regarding graft uptake and hearing outcomes over 50 cases found that the majority of patients that is 15 in cartilage group and 13 patients from anterior tucking group had improvement between 11–20 dB.<sup>30</sup> The average post operative Air bone gap in the anterior tucking cases was found to be 27.88 dB with a standard deviation of 14.01 dB. Caye–Thomassen et al. in their study of 26 cases, noted that the mean preoperative Pure tone average air bone gap to be 20.1 dB, the mean postoperative pure tone average of 11.5 dB and thus the mean hearing gain of 8.6 dB.<sup>37</sup> Brown et al, in their study of 193 cases of myringoplasty, the mean pre operative air conduction average was 35 dB while the mean postoperative air conduction average was 25 dB, thus average air conduction improvement was 10 dB.<sup>38</sup>

Burse et al on regarding graft uptake and hearing outcomes over 50 cases found that in group of Anterior tucking, the mean pre-operative air conduction average was 29.04 dB while the mean postoperative air conduction average was 10.12 dB, thus average air conduction improvement was 18.94 dB. Whereas in the Cartilage method it was found to be 24.90 dB with a standard deviation of  $\pm 6.03$  dB.<sup>30</sup> Burse et al on regarding graft Uptake and hearing outcomes over 50 cases found that group of Cartilage support, the mean pre-operative air conduction average was 26.2 dB while the mean postoperative air conduction average was 14.48 dB, thus average air conduction improvement was 11.72 dB.<sup>30</sup> The paired t' test applied revealed a value of  $p > 0.001$ , stating that there was no significant difference between the post-operative audiometry values between the two groups.

In 2004, Gierek performed 112 cases with cartilage and 30 cases with Temporalis fascia. They observed that there was no significant hearing difference between the two groups.<sup>39</sup>

Yung found no significant difference in graft take or hearing gain between cartilage (with or without perichondrium) and fascia graft in perforations larger than 50%.<sup>40</sup> In our study in cartilage support tympanoplasty 25 patients showed improvement (100%). In anterior tucking method out of 25, 23 patients showed improvement (92%) with p value 0.2343.

In our study, in anterior tucking method out of 25 patients, 21 patients (84%) post operatively no complications, two patients with residual perforation (8%). One patient with mixed hearing loss (4%), one patient with both residual perforation and mixed hearing loss (4%). while in cartilage support tympanoplasty all the 25 patients, there were no complications postoperatively.

## CONCLUSION

The procedure tympanoplasty done to eradicate disease from the middle ear, repair tympanic membrane effects.

Here in this study we studied 50 patients who underwent two types of tympanoplasty both anterior tucking and cartilage support tympanoplasty. Our study showed results on par with other studies and both the groups had significant hearing improvement.

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