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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(3): 1651-1658. **OPEN ACCESS**

Interlay versus Onlay Technique Tympanoplasty in Tympanic Membrane Perforation

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Perforation of the tympanic membrane is most commonly the result of chronic ear disease. However, it can also result from various forms of trauma, which includes iatrogenic and direct physical injuries, burns, scalds and pressure effects. Most of these tears heal naturally, whereas the remaining old perforations that cause recurrent ear discharge requiretympanoplasty. The aim of this study was to improve hearing and evaluate graft uptake by comparing between Interlay and Onlay technique Tympanoplasty. A total of 36 Patients, their age ranged from 12 to 60 years presented with dry large central tympanic membrane perforations. Patients divided into two equal groups, Group (A) had tympanoplasty via interlay technique and Group (B) had it by onlay technique using temporalis fascia graft. All patients were subjected to the following: I. Preoperative evaluation including history taking, endoscopic assessment and radiological CT studies), II. Surgical management (tympanoplasty with interlay or onlay techniques after elevation of tympanomeatal flap),III. Post-operative, endoscopic and audiological follow up were recorded.In our study, there was statistically significant difference among both studied surgical groups regarding pre-operative AB gab assessment. In terms of graft up take and complete closure of the tympanic membrane perforation, the success rate has been recorded in 17 patients (94.4%) in interlay group and 16 patients (88.9) in Onlay group with no significant difference between both groups. The interlay technique of doing type I tympanoplasty has high success both in terms of graft uptake as well as ABG closure.Therefore, it should be preferred over the other conventional approach especially in patients with large central perforations.

Keywords: Tympanoplasty, Interlay Technique, Tympanic Perforation and Onlay Technique.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is a perforated tympanic membrane with persistent drainage from the middle ear (ie, lasting >6-12 wk) (Matsuda et al., 2009). Chronic otitis media is important being a curable cause of deafness. It is the end result of acute otitis media and is characterized by a persistent discharge from the middle ear through a tympanic membrane perforation (Michels et al., 2019). Over the years, various techniques have been attempted to improve tympanoplasty results. These include onlaytympanoplasty, underlay tympanoplasty and interlay tympanoplasty (Kartush, 2000). Tympanoplasty is the operative procedure performed to repair the perforation in ear drum by repairing the tympanic membrane (Karatas and Dogan, 2017). It is a beneficial procedure to protect the middle ear and inner ear from future damage. Improvement in hearing sensitivity is also observed (Hussain et al., 2004). Successful tympanoplasty was defined as the one that should include (1) integrity of the graft,(2)post-operative gain of minimum of 10 dB in the auditory threshold, or

conservation of hearing, and (3) complete healing with the space of the aeratedmiddle ear manifested by the graft located in the correct anatomical position, with neither atelectasis nor otitis media with effusion(OME)(Collins et al., 2003;Yung et al., 2007). Interlay technique is also considered to be better as getting an interlay plane between the fibrous layer and mucosa is easier and faster. Moreover, it has no fear of residual epithelium. The Interlay tympanoplasty approach has shown promising results with success rates higher than 90% (Hay and Blanshard, 2014). Therefore, the aim of this study to improve hearing and evaluate graft uptake by comparing between interlay and onlay technique Tympanoplasty.

MATERIALS AND METHODS

A prospective study was performed on 36 patients with medium sized to large tympanic membrane perforation and all were subjected to repair of their tympanic membrane perforation. Patients were divided into two equal groups, Group (A) had tympanoplasty via interlay technique and Group (B) had it by onlay technique using temporalis fascia graft.

Inclusion criteria:

All patients proved to have CSOM of tubo-tympanic type (Safe CSOM) with medium sized and large central perforation. Patient must be fit for surgery and their age between 12-60 years old.

Exclusion criteria:

Patients proved to have cholesteatoma or unsafe type of CSOM and patients who are not fit for surgery.

I: Preoperative evaluation

A careful history is obtained from all patients. Otolaryngologic examination including otoscopic examination with the aid of endoscope or microscope for evaluation of size and type of perforation and condition of the middle ear mucosa. With Ethics Committee approval, all patients were informed and consented for the surgery.

Hearing assessment: was evaluated by Tuning fork tests, Pure tone audiometry (PTA) Speech discrimination score (SDS) and Eustachian tube function (ETF) was assessed by tympanometry. Appropriate masking was performed throughout four frequencies (250Hz, 500Hz, 1000Hz, and 2000Hz), pure-tone average air and bone conduction thresholds were used to calculate air-bone gap (ABG).

II - Operative Technique:

General hypotensive anesthesia (GA), Post auricular approach was applied in all cases. Karl-Zeiss operating microscope was used in all surgeries using proper magnification.

Graft harvesting: Temporalis fascia used as a graft material and obtained from the outer surface of temporalis muscle at operation time, through the post auricular approach. After fascia is exposed over temporalis, an incision is made at the lower margin of temporalis and extends through the periosteum of the mastoid bone.

Technique of interlay tympanoplasty:

The edge of the perforation is circumcised to prepare abed for the graft. Tympanomeatal flap is elevated from the posterior canal wall from 12 o'clock to 6 o'clock extending anteroinferiorly till reaching the annulus and elevated it out of the sulcus and the tympanic membrane (TM) is gently dissected off the malleus handle.. Drilling of bony hump and insert curved hock anterior in the plane between annulus and mucosal layer. Temporalis fascia graft was placed between the fibro-squamous layer and mucosal layer of drum TM then reposition of tympanomeatalfalp. Gel foam are arranged for covering the whole surface grafts and angles specially to prevent fibrosis and blunting. Internal pack of small piece of non-adhesive gauze is applied above gel foam pieces. External pack of a 3cm non adhesive gauze is applied to the external canal to keep the skin flap in place. Dry piece of gauze is put in the concha. Suturing of the post auricular incision in two layers, periosteal and skin layers.

Technique of onlaytympanoplasty:

Primary steps of the operation are the same as interlay technique, the difference lies in the graft's placement maneuver. Transmeatal incisions and elevations of the vascular strip: Incisions are made along the tympanomastoid and tympano-squamous suture lines, demarcating the vascular strip with (sickle) knife. The periosteum and canal skin are removed from the bone and kept moist in solution. Enlargement of the ear canal by removal of the anterior and inferior canal bulge: through the use of a drill and continuous suction-irrigation, the ear canal is enlarged by removal of the anterior and inferior canal bulges. Removal of this bone enlarges the field of surgery. Placement of the rehydrated fascia on the outer surface of the remnant under the manubrium then canal skin replaced. Internal and external pack were applied

similary as other technique and replacement of the vascular strip transmeatally.

III.Post operativefollowup:

One week post-operative the external packing and auricular incision sutures was removed after evaluation of wound healing, antibiotic ear drops applied for one week then inner pack of ear canal were removed two weeks post operative. Assessment for successful graft after one month post-operative.PTA three months post-operative.

Statistical analysis:

Data were analyzed using IBM SPSS 23.0 for windows (SPSS Inc., Chicago, IL, USA) and NCSS 11for windows (NCSS LCC., Kaysville, UT, USA). Quantitative data were expressed as mean± standard deviation (SD), Quantitative data were tested for normality using KolomogrovSmirnove test, assuming normality at P>0.05. Qualitative data were expressed as frequency and percentage.

RESULTS

This study included thirty-six patients with ages ranging from 12 to 46 years with mean of 28.8 years, and 55.6% of them were males. 44.4% of the studied group presented with CSOM of right ear and 47.2% of left ear, while only 8.4% presented with bilateral affection (Table 1).There was no statistical significant difference among both surgical groups regarding demographic data and history of disease.

Table 1:Demographic data and past history of the studied group.

Variables	Cases N=36	
Age \years Mean ±SD Range	28.8 ± 10.3 12 - 46	
Variables	(N=36)	Percent %
Sex Male Female	20 16	55.6 44.4
Affected side by disease RT ear LT ear Bilateral	 16 17 3	 44.4 47.2 8.4

Regarding totype of surgery and site of disease affection among both studied surgical groups. It showed that 50% of the studied patients subjected for Onlay, and Interlay done with 50% of the studied group. The data showed 61.1% of the studied group presented with air bone gab ranged from 20-25, while 22.2% ranged from 26-30 and 16.7% had air bone gab ranged from 31-35 (Fig.1).

In table (2) showed that 61.1% of Onlay patients suffered of anterior perforation and 38.9% of them had posterior perforation versus (44.4% and 55.6% respectively) of Interlay patients with no statistically significant difference among both surgical groups.

The obtained results in table (3) revealed that 52.8% of studied patients presented with anterior perforation and sixteen patients (47.2%) with posterior perforation, also the graft uptake failed or rejected among only 3 cases (8.3%) of the studied group, 2 of them had Onlay technique myringoplasty and 1 case had interlay technique.

Regarding pre-operative air bone gab assessment in table (3) showed that a statistical significant difference among both studied surgical groups regarding pre-operative AB gab assessment ranged from 20 to 25, as 77.8% of patients subjected to Onlay surgery had AB gab at this range versus 44.4% of the Interlay group, while there was no statistical significant difference regarding the other ranges.

Regardingpost-operative assessment of graft uptake among both studied surgical groups I figure (2) showed that the majority graft uptake in both onlay and interlay technique are succeeded in percentage of 91.7% versus failed graft uptake (8.3%).

The presented data in table (4) illustrated that 16% of studied patients who had onlay technique tympanoplasty presented in the endoscopic follow up sessions with graft blunting in the anterior sulcus compared to interlay technique patients who had a significantly lower percentage of only 5.5%

The attainable results showed that 11.1% of studied Onlay patients presented with failed graft uptake versus 5.6% of Interlay patient, but the difference not reach statistical significant level (Table 5). The results in table (6) demonstrated that the ranges of hearing gain among both surgical groups, 22.2% and 27.8% of Interlay group gain hearing at ranges of 16-20 dB and 21-25 dB versus (11.1 and 11.1% of Onlay group respectively),38.9% of Onlay group gained hearing at range of 11-15 dB versus 11.1% of Interlay group, and this was statistically not significant among both groups.

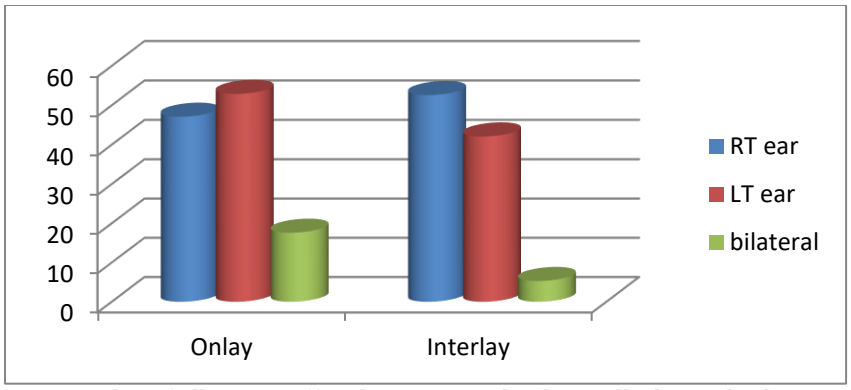

Figure 1: Site of disease affection among both studied surgical groups.

Table 2: Difference in site of perforation of both studied surgical groups.

Variables	Onlay cases N=18		Interlay cases N =18		X^2	P-value
	N=	%	N	%		
Anterior perforation	11	61.1	8	44.4		
Posterior perforation	7	38.9	10	55.6	1.003	0.317(NS)

Table 3: Difference in pre-operative air bone gab assessment of both studied groups.

Variables	Onlay cases N=18		Interlay cases N =18		X^2	P-value
	N=	%	N	%		
AB gab 20-25	14	77.8	8	44.4	4.21	0.04 (S)
AB gab 26-30	2	11.1	6	33.3	2.57	0.109 (NS)
AB gab 31-35	2	11.1	4	22.2	0.8	0.371 (NS)

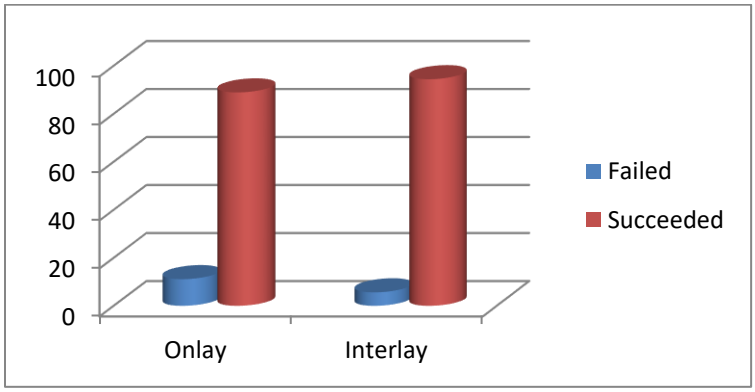

Figure 2: Post-operative assessment of graft uptake among both studied surgical groups.

Table 4: Post-operative assessment of graft blunting in the anterior sulcus.

Graft blunting in the anterior sulcus	Number of cases	Percentage
Interlay cases (18)	1 case	5.5%
Onlay cases (18)	3 cases	16 %

Table 5: Difference in graft uptake of both studied surgical groups.

Variables	Onlay cases N=18		Interlay cases N =18		X^2	P-value
	N=	%	N	%		
Failed	2	11.1	1	5.6	0.365	0.543
Succeeded	16	88.9	17	94.4		(NS)

Table 6: Difference in range of hearing gain among both studied surgical groups.

Variables	Onlay cases N=18		Interlay cases N =18		X^2	P-value
	N=	%	N	%		
Hear gain 6-10	5	27.8	3	16.7	0.643	0.423 (NS)
Hear gain 11-15	7	38.9	2	11.1	3.7	0.05(NS)
Hear gain 16-20	2	11.1	4	22.2	0.8	0.371 (NS)
Hear gain 21-25	2	11.1	5	27.8	1.61	0.203 (NS)
Hear gain 26-30	1	5.6	4	22.2	2.1	0.184 (NS)
Hear gain 31-35	1	5.6	0	0.0	1.03	0.310 (NS)

DISCUSSION

Our study was undertaken with the objective of improving hearing and evaluating graft uptake by compare between in interlay and onlay technique Tympanoplasty using temporalis fascia for large tympanic perforation. The Temporal fascia graft have high success rate and hearing restoration in primary tympanoplasty, temporalis fascia remains the gold standered and most popular grafting materials for its unique qualities like low metabolic rate, hence less oxygen requirement, more ischemic tolerability, resistant to infection, easily obtained in ample amount in same incision site. Incidence of healing problems (blunting,
lateral healing) was minimum with temporal fascia (Bhoopendra et al., 2015).

In the present study operations were performed in all 36 patients of chronic suppurative otitis media with inactive mucosal disease with large tympanic membrane perforation. 20 patients were males (55.6 %) and 16 were females (44.4%) with the mean age 28.8 ± 10.3 years ranged from 12 to 46 years. Age of patients ranged from 12 to 43 years in Onlay group and from 15 to 46 years in Interlay group. Mean age of patients in groups Onlay and Interlay group was 25.6±10.02 and 31.9±9.9years respectively, 55.6% of patients were male and 44.4% were female in both groups. This results are in agreement with Kawatra et al. (2014) who found that age of patients ranged from 15 to 47 years. Majority of patients in both the groups were aged between 21 and 40 years. Meanage of patients in Onlay and Interlay group was 29.43±7.00 and 29.70±8.80 years respectively. In Onlay and Interlay group, a total of 16 (53.3%) patients each were males and remaining 14 (46.7%) were females.

In the present study, we found the preoperative ABG in Interlay and Onlay technique was between 20 and 25 dB in 44.4% and 77.8% of patients respectively, 26–30 dB in 33.3% and 11.1% of patients respectively and 31–35 dB in 22.2% and 11.1% of patients respectively.This results are concured with Kawatra et al. (2014) who demonstrated that air bone gap ranged from 15 to 35 db in different groups. Half or more than half the cases in the two groups had air-bone gap in the range of 20 to 25 db. There were 30% cases in Onlay group and 50% in Interlay group had air bone gap of 30 or more. Similary, Patil et al. (2014) who found that 34 patients (34%) had preoperative ABG within the range of 31–40 dB, 32 cases (32%) had it above 40 dB, 26 cases (26%) and 8 cases (8%) had ABG in the range of 21–30 dB and 11–20 dB, respectively. Regarding onlay technique the

mean post op ABG was17.5 dB: for 16 patients, the ABG was 10 dB (29.6 %), for 18 was from 11 to 20 dB (33.3 %), for 11 from 21 to 30 dB (20.3 %) and for 9 was more than 30 dB (16.6 %). Overall total of 62.9 % from onlay group had post op ABG to be <20 dB.

In our study, in Onlay technique graft rejected in 2 patients (11.1%). While it was rejected in 1 patient (5.6%). Besides, we found 38.9% of Onlay group gained hearing at range of 11-15 dB.Besides, Jainet al. (2017) who found that only 17 (3.4%) patients had graft failure in their study. There was no improvement in hearing in 20 (4%) patients while deterioration in hearing was seen in 3 (0.6%) patients. Also, Sharma et al.(2019),found in interlay technique graft rejected in 2 patients. However, Guo et al.(1999) and Kartush (2002) who illustrated that the successful graft takes up rate was 85.7–100%inOnlay, underlay or combined technique.

In the present study, the final success rate was 94.4% in Interlay technique and 88.9% in Onlay technique. This results are in agree with Komune et al. (1992), who reported that the success rate to be 94.2% in Interlay technique. Similary, Sheehy and Anderson (1980) who demonestrated that the rate of success in 472 onlaytympanoplasty surgeries was 97%. In a series of 554 onlay grafts, Rizer (1997) who conducted that, a success rate of 95.6%. The same author's success rate in 158 underlay grafts was 88.8%. Moreover, Kawatra et al. (2014) who concluded that the success rate was 83.3% and 93.3% in onlay and interlay group respectively. Least graft failure rate was found in group interlay Tympanoplasty. They found no complication noticed in Interlay procedure. The success rate was lower in a study done by Hay and Blanshard (2014), who reported that,a 91% success rate with interlay tympanoplasty. While it was higher in a study done by Sharma et al. (2019) who found no complication was noticed. The final success rate was 96% in Interlay technique.

In the present study, Onlay placement of graft gives excellent ABG closure and healing, but need a support from the remnant of fibrous layer of pars tensa; hence it is moreconvenient when some portion of fibrous layer is still attached on either side of themalleus. Thus, in present study as far as resolution of air bone gap is concerned, Interlay technique showed a better hear gain 16-20, 21-25 and 26-30 as compared to the Onlay group with no significant difference. The findings in present study showed a better graft take in Interlay method which coupled with a better postoperative air bone gap provided a better overall outcome. This results are in agreement with Sharma et al. (2019),found that Interlay technique showed a statistically significant better outcome. They showed a better graft take in Interlay method which coupled with a better postoperative air bone gap provided a better overall outcome.

None of the cases in the present study had blunting, lateralization, epithelial cyst formation, and medialization. This finding was consistent with the study done by Patil et al., (2014). It could be seen that all the studies, including the present study the success rates for Interlay technique have been quite promising, generally above 90%. The better graft take in Interlay method is that it provides support to graft from both sides. The difference in the surgical success results between the studies may be attributed to the number of the patients included in each study, the mean follow up period, the types of graft used, and the cumulative experience of the ear surgeons.

However, given the number of studies and result of Interlay tympanoplasty, we find that it is not as much popular. The reason for its lower popularity is that it requires additional skill and it is time consuming. To overcome the surgical difficulties, adequate exposure of ear drum isa must before proceeding with surgery, it isnot necessary to see all areas of drum in one view, different areas of drum should be seen by simple manipulation of patient position, 5-10% of patients may have a prominent bulgein the anterior canal wall obscuring theanterior rim of ear drum and anterior portionof the annulus (Mowlavi and Pham, 2010).

In the study by Kawatra et al.(2014),ABG changed from 27.50 dB preoperatively to 13.67 dB postoperatively after 16 weeks. In our study the ranges of hearing gain, 22.2% and 27.8% of Interlay group gain hearing at ranges of 16-20 dB and 21-25 dB.Similary, Jain et al.(2017), had graft uptake rate to be 96.6% in interlay technique and 95.4% of the patients, reported an improvement in terms of hearing. Kawatra et al.(2014),concluded interlay technique has a significantly better graft uptake and hearing improvement. Also, Komune et al.(1992), reported a 94.2% graft uptake rate. Guo et al. (1999), had a better graft uptake rate and hearing improvement in interlay technique. Patil et al.(2014), had a graft uptake rate of 96% and a significant haring gain in interlay technique and found that Interlay technique is consideredbetter than both Onlay as well as the underlay techniques. However, Potsangbam (2017),found that the result of ABG closure and graft success

was not significantly different in the two groups.

It has been suggested that onlay graft placement is a superior technique as it is more useful in repairing large and anterior perforation (Kartush et al.,2002),and it provides a broader support for the graft, avoids compromise of the middle ear space, allows for better blood supply to the graft, is suitable for all sizes of perforation and gives better graft take results (Sheehy and Glasscock,1967 ; El-Seifi and Fouad, 1992). In addition, removal of the anterior bony overhang with canalplasty and detailed inspection of the middle ear are routine aspects of the onlay procedure. This ensures adequate exposure and eradication of all disease at the time of surgery (Sheehy and Anderson, 1980). An incision in the fascia (V shape) allows the graft to be placed medial to the malleus, preventing lateralization (Te et al., 1998). Because the entire tympanic membrane can be replaced and exposure of the entire mesotympanum achieved, the onlay technique is often used in more severe cases with more advanced pathology and in revision cases (Rizer, 1997).

In Onlay technique there are chances of anterior canal wall blunting, lateralization of the graft, formation of epithelial pearls, excessive membrane thickness, and longer duration of healing and increased risk of iatrogenic cholesteatoma (Rizer, 1997). On the other hand, Interlay technique is also considered to be better than Onlay as getting an Interlay plane (between the fibrous layer and mucosa) is easier and faster than getting an Onlay plane (between the epithelium and fibrous layer) and having no fear of residual epithelium. Interlay technique has many advantages. In it the graft is kept in between the mucosal and the fibrous layers which eventually grow on the inner and the outer surface of the graft leading to closure of the perforation. Thus, this mucosal and fibrous layer plane is the most physiological plane for keeping the graft. It obviously prevents medialization as well as lateralization of the graft since graft is supported on both the sides by the outer fibrous and the inner mucosal layer. It also prevents any reduction of the middle ear space as well as the operating time and the healing times are short. There are very less chances of residual epithelium andanterior blunting. The interlay technique has more than 90% graft take up rate (Hay and Blanshard, 2014).

CONCLUSION

The present study showed that the interlay technique of doing Type I tympanoplasty has high success both in terms of graft uptake as well as ABG closure. Therefore, it should be preferred over the other conventional approach especially in patients with large central perforations.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

All author contributed in all parts of the paper.

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