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Original Research Article

COMPARE THE OUTCOMES OF UNDERLAY AND ONLAY MYRINGOPLASTY

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ABSTRACT

Background: Myringoplasty is a frequently performed surgical procedure in the repair of perforations of the TM due to chronic suppurative otitis media (CSOM). The objective is to compare the anatomical and functional results of underlay and onlay myringoplasty in patients with tympanic membrane perforation.

Materials and Methods: A comparative cross-sectional study was carried out in the Department of ENT and Head & Neck Surgery, Suleman Roshan Medical College Tando Adam, Sindh for One year duration after obtaining approval from the Institutional Review Board. The duration of study is from May, 2025 to April, 2026. Eighty patients were recruited by non-probability consecutive sampling and divided equally between the underlay (n=40) and onlay (n=40) myringoplasty groups. Postoperative graft uptake, pure tone audiometry hearing improvement and complications were assessed at 12 weeks after surgery.

Results: 92.5% of patients in the underlay group and 87.5% in the onlay group had successful graft uptake. The mean air-bone gap of the underlay group (12.1 ± 3.4 dB) was lower than that of the onlay group (13.8 ± 3.9 dB). The mean hearing gain for the underlay group was 16.7 dB (4.8 dB SD) and 15.4 dB (4.5 dB SD) for the onlay group. Postoperative complications were rare, and occurred only in the onlay group, as the graft was lateralized.

Conclusion: Both underlay and onlay myringoplasty are effective techniques for tympanic membrane reconstruction.

Keywords: Myringoplasty, Underlay Myringoplasty, Onlay Myringoplasty, Tympanic Membrane Perforation, Chronic Suppurative Otitis Media.

INTRODUCTION

Chronic suppurative otitis media (CSOM) is one of the most common chronic ear diseases worldwide and remains an important cause of preventable conductive hearing loss. Tympanic membrane perforation, which may occur as a result of chronic infection or trauma, can persist and lead to recurrent ear discharge, hearing loss and a significant decrease in patients' quality of life. The typical surgical treatment for a perforation of the TM is a myringoplasty, which is used to repair the perforation and restore hearing by enhancing sound transmission through the middle ear, and to prevent recurrent infection. Over the years, several techniques have been developed for tympanic membrane reconstruction, among which the underlay and onlay (overlay) techniques are the most commonly practiced. Both procedures have been shown to achieve good anatomical and functional results in cases of chronic tympanic membrane perforations.[1] Each technique has technical advantages and limitations which may affect the outcome of surgery depending on the size and location of the perforation.[2] For these reasons, the choice of the most suitable surgical approach is still a crucial factor for otologic surgeons.[3]

The underlay technique consists of the grafting of the tympanic membrane remnant and the handle of the malleus, which is technically easy and is especially well suited for central perforations. The onlay technique, however, involves elevating the epithelial layer and placing the graft laterally to the remaining tympanic membrane and thus offers greater visualization and support for the repair of large anterior or subtotal perforations. The underlay technique is simpler to perform and is also related to a shorter operative time, but the onlay technique is still useful in a selected patient suffering from difficult anterior perforations.[4] Comparative studies have shown that both methods have good rates of graft uptake and considerable postoperative hearing improvement when strict surgical technique and careful patient selection are used.[5] Randomized controlled trials have also demonstrated equivalent graft uptake and hearing results for underlay and over-underlay techniques, emphasizing the need for standard operating procedures and meticulous handling of the graft during surgery.[6]

Anatomical and functional results are used to evaluate the success of myringoplasty. Complete closure of the tympanic membrane perforation is used to determine anatomical success while functional success is measured through postoperative pure tone audiometry and a decrease in the air-bone gap. The maintenance of an intact tympanic membrane will prevent the recontamination of the middle ear, increase the vibration of the membrane during sound transmission and improve hearing performance. The clinical assessment of the patients who underwent underlay myringoplasty has shown that the hearing level improved significantly after surgery and the perforations were closed in the majority of cases.[7] In addition, endoscopic techniques have enhanced the visualization of the tympanic membrane reconstruction and have shown to be effective in achieving both excellent anatomical reconstruction and a satisfactory improvement in hearing, both underlay and overlay techniques.[8] In addition, there are several factors that have been reported as significant for graft failure after myringoplasty in systematic reviews, such as active infection, smoking, poor Eustachian tube function, large perforation size, and revision surgery.[9]

Although myringoplasty has a high success rate, failure of the graft is an important clinical problem that can adversely affect the long-term anatomical and functional results. A large number of institutional studies have shown that when the above principles of surgery are followed, excellent graft uptake and substantial postoperative hearing improvement has been consistently obtained.[10] Postoperative infection remains one of the most important causes of graft loss as it disrupts epithelization, slows wound healing, and can lead to chronic perforation of the TM. It has been demonstrated in clinical studies that early postoperative infections have a strong negative impact on graft survival, whatever surgical technique is used, emphasizing the need for strict aseptica precautions and careful postoperative monitoring.[11] Patient-related factors, including age, length of time ear has been dry, Eustachian tube function, middle ear condition, and surgeon experience, have also been shown to be important predictors of graft uptake and hearing restoration following myringoplasty.[12]

In recent years, a number of changes have been made in the standard procedures for tympanic membrane reconstruction to further enhance anatomic and functional results. Interlay tympanoplasty is one of these alternatives and has shown to have good graft take and satisfactory postoperative improvement in selected patients.[13] Postoperative management also has improved significantly, along with the techniques used in surgery. There are several prospective studies that have reported that topical antibiotic ointment after underlay myringoplasty aids in epithelial healing, decreases postoperative infection, and improves graft integration, which leads to increased procedure success.[14] However, more recent comparative studies have shown that the anatomical closure and hearing results after interlay and underlay tympanoplasty are equivalent, and that multiple reconstructive techniques can be used to achieve favorable results under specific clinical conditions and with careful surgical technique.[15]

The long term follows up studies have also shown the stability of the reconstructed ear drums. In the past, imaging studies of cartilage that has been evaluated after myringoplasty have shown that the integrity of the graft and the anatomical repair have remained stable during follow-up for several years, suggesting that with the right placement, the graft can offer long-term structural support and sustained hearing improvement.[16] In addition, there is increasing clinical data that indicates the size and location of the perforation is an important factor in graft uptake, hearing restoration and surgical success, making surgical planning an important factor to consider for each individual patient.[17] Several studies have compared underlay and onlay myringoplasty, but the superiority of the technique in various clinical situations is still controversial. Thus, the present study aimed to compare the results of underlay and onlay myringoplasty in terms of postoperative hearing gain and graft uptake to provide evidence for choosing the proper technique and optimizing the postoperative results for the surgeon.

Objective: To compare the anatomical and functional outcomes of underlay and onlay myringoplasty by evaluating graft uptake, hearing improvement, postoperative complications, and overall surgical success in patients with tympanic membrane perforation.

MATERIALS AND METHODS

Study Design: Comparative cross-sectional study.

Place of Study: Department of ENT and Head & Neck Surgery, Suleman Roshan Medical College Tando Adam, Sindh

Study Duration: One year (May, 2025 to April, 2026).

Sample Size: A total of 80 patients (40 in the underlay myringoplasty group and 40 in the onlay myringoplasty group).

Sampling Technique: Non-probability consecutive sampling.

Inclusion Criteria

Patients of both sexes aged 18-60 years with dry central tympanic perforation due to chronic suppurative otitis media (mucosal type) for at least 6 weeks were considered. Patients with a conductive hearing loss, normal middle ear mucosa, normal Eustachian tube function, and written informed consent and willingness to follow-up visits were recruited for the study.

Exclusion Criteria

Patients with cholesteatoma, active ear discharge, mixed or sensorineural hearing loss, revision myringoplasty, trauma perforated TM, uncontrolled systemic diseases (diabetes mellitus, immunocompromised, congenital ear anomaly, unwilling to participate or follow-up) were excluded.

Methods

After obtaining approval from the Institutional Review Board and written informed consent, eligible patients were enrolled using non-probability consecutive sampling. Preoperatively, detailed history, clinical examination, otoscopic examination and pure tone audiometry were performed to determine the size and location of the perforation of the eardrum and baseline hearing thresholds. Patients were divided into two groups with equal numbers based on the surgical technique used: Group A, underlay myringoplasty; Group B, onlay myringoplasty. The surgeries were carried out by experienced otolaryngologists under general anesthesia with temporalis fascia as the grafting material. Patients were followed up for 12 weeks after surgery for graft uptake, tympanic membrane healing, improvement of hearing, and postoperative complications such as graft failure, infection, residual perforation, and lateralization. Pure tone audiometry was used to evaluate postoperative hearing. IBM SPSS version 26.0 was used for data analysis. The continuous variables were represented as mean ± standard deviation and the categorical variables were represented as frequencies and percentages. A p-value < 0.05 was deemed to be statistically significant.

RESULTS

A total of 80 patients were selected for the study, 40 patients in the underlay myringoplasty group (Group A) and 40 patients in the onlay myringoplasty group (Group B). The average age of the subjects was 34.9 ± 10.8 years. There were 46 (57.5%) males and 34 (42.5%) females. There were no significant differences between the two groups in terms of demographic characteristics and the preoperative hearing status (p>0.05).

Table 1: Comparison of Graft Uptake and Postoperative Complications

Outcome	Underlay	Onlay	p-value
Successful graft uptake	37 (92.5%)	35 (87.5%)	0.46
Residual perforation	2 (5.0%)	3 (7.5%)	
Graft lateralization	0	2 (5.0%)	
Postoperative infection	1 (2.5%)	2 (5.0%)	
Overall surgical success	37 (92.5%)	34 (85.0%)	0.29

Anatomical results showed a very good success rate in both the study groups. The graft uptake rate was 92.5% in the underlay myringoplasty group and 87.5% in the onlay group. The difference in graft success was not significant (p=0.46) although the underlay technique had a slightly higher graft success rate. There were two patients with residual perforation in the underlay group and three patients in the onlay group. Only two patients in the onlay group had graft lateralization and postoperative infection was uncommon in both groups. The overall success rate of surgery was 92.5% for underlay and 85.0% for onlay. The results showed that both techniques were effective in repairing the TM, but the underlay technique had a slight superiority in terms of the anatomical result and postoperative complications.

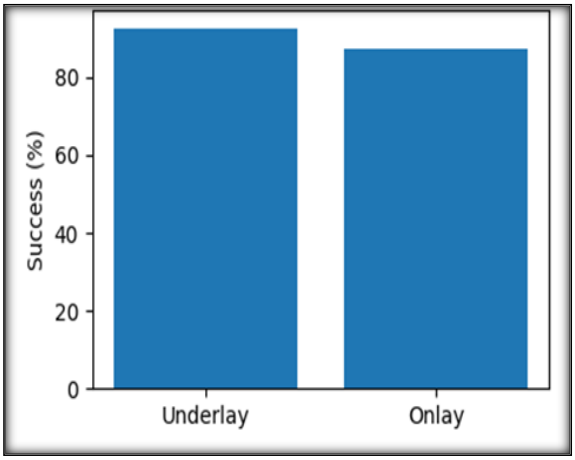

Figure 1: Comparison of successful graft uptake between the two surgical techniques

The bar chart shows that the underlay technique had a graft uptake percentage of 92.5% while the onlay technique had a graft uptake percentage of 87.5%. The difference was not large, but the underlay approach had a higher percentage of successful closure of the TM. This discovery is consistent with the positive anatomical outcomes seen in the study with the underlay technique. Both procedures, however, yielded graft success rates greater than 85%, suggesting that either procedure can yield good clinical results if used in the appropriate patient and with careful surgical technique. The graph clearly shows anatomical success and indicates that the slight advantage with the underlay approach is evident.

Table 2: Comparison of Hearing Improvement

Outcome	Underlay	Onlay	p-value
Pre-op ABG	28.8±5.3	29.2±5.1	0.73
Post-op ABG	12.1±3.4	13.8±3.9	0.04
Mean Hearing Gain	16.7±4.8	15.4±4.5	0.21
≥15 dB improvement	31 (77.5%)	28 (70.0%)	0.45

Both groups showed improvements in hearing following surgery in the audiological assessment. There was no difference in the mean air-bone gap between the two groups preoperatively. Patients who had underlay myringoplasty had a statistically significant better air-bone gap of 12.1 ± 3.4 dB than those who had onlay myringoplasty (13.8 ± 3.9 dB, p=0.04). The underlay group had a mean hearing gain of 16.7 ± 4.8 dB compared to 15.4 ± 4.5 dB for the onlay group, but this difference was not statistically significant. In addition, 77.5% of patients receiving the underlay technique and 70.0% of those who received the onlay technique had a minimum improvement of 15 dB. Both procedures were effective in improving hearing results and the underlay approach had a slight functional benefit.

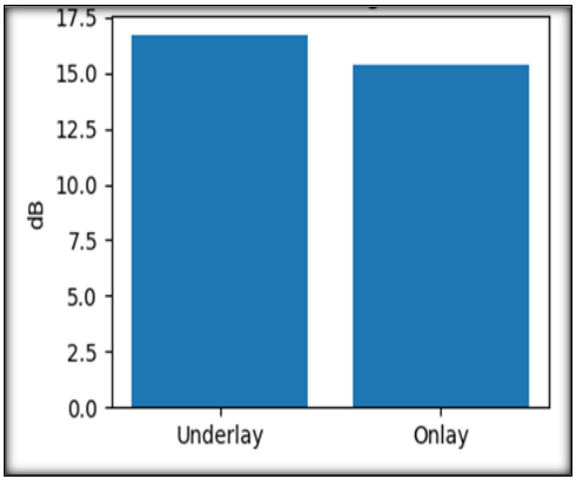

Figure 2: Comparison of mean postoperative hearing gain between the two treatment groups

The mean improvement in hearing for patients who received underlay myringoplasty was 16.7 dB, and for those who received onlay myringoplasty, it was 15.4 dB. Both methods led to clinically relevant improvement of hearing, which was statistically proven and indicates their effectiveness in reconstructing the TM and enhancing sound conduction. The difference between the two groups is only small, as shown in the graphical presentation, which means that both surgical methods give satisfactory functional results. The slightly greater hearing gain achieved using the underlay technique is correlated with a higher graft uptake rate and fewer complications, thus potentially providing a small clinical benefit in certain patients.

DISCUSSION

The present study showed that both underlay and onlay myringoplasty were equally effective in the repair of TM perforation and improvement of hearing. The underlay technique, however, had slightly better graft uptake rate (92.5%) than the onlay technique (87.5%) and fewer postoperative complications, and marginally better hearing improvement. The differences between the two techniques were not statistically significant for most variables, but the results indicated that the underlay technique may have a clinical advantage because of its technical simplicity and reduced complication rate. Both techniques have been reported to have high graft success and satisfactory hearing improvement, with the underlay technique having slightly better anatomical results due to the stability of the graft and ease of surgical implementation.[1]
The present study shows that postoperative hearing has been significantly improved in both groups, and the underlay group has had a smaller postoperative air-bone gap and more mean hearing gain than the onlay group. Regardless of technique, successful TM closure will restore sound conduction and enhance auditory function. Comparative studies with the previous procedures also revealed that both underlay and over-underlay myringoplasty had significant positive effect on postoperative hearing with little difference in the overall surgical success. The authors found that the position of the graft placement is not the most important factor for hearing improvement, and that successful graft integration is the most important factor, as in the present study.[2] The results of this study are in line with those of larger retrospective studies comparing various myringoplasty techniques, which have shown anatomical success. Both underlay and overlay techniques have been reported to have high graft uptake rates and rates above 85% have been

consistently reported. Previous studies also showed that patient selection, middle ear condition and surgeon experience are more important for surgical success than the surgical technique. This corresponds with the current results, which showed good anatomical and functional results for both procedures, with a slight advantage for the underlay technique.[3] Patients that have undergone underlay myringoplasty have fewer postoperative complications, which could be attributed to the simplicity of the procedure. The underlay technique allows for less graft displacement as the graft is placed medial to the remnant of the tympanic membrane, while onlay requires careful elevation of the epithelial surface and precise positioning of the graft, which is technically more challenging. Previous comparative studies also showed that the onlay technique is especially suitable for anterior perforations, but has a relatively high risk of lateralization of the graft and a longer operating time, which is similar to the present study.[4] Myringoplasty is primarily aimed at audiological improvement. In this study, over 2/3 of patients in both groups experienced a gain of 15 dB or more. The difference in hearing gain was not statistically significant between the two groups, but the underlay group showed a slight advantage, suggesting that both approaches are effective for restoring hearing following graft uptake. Previously, similar results have been reported, with both underlay and overlay myringoplasty showing significant postoperative improvement in hearing, indicating that the closure of the perforation rather than the type of surgery was more important to functional recovery.[5]

Randomized controlled trials comparing the various tympanoplasty techniques also support the present findings. Controlled studies have shown similar graft uptake and hearing levels between underlay and over-underlay types of surgery, with careful surgical technique and careful handling of graft material being important factors to ensure success. The findings confirm their previous findings that proper surgical knowledge and uniform operative techniques play a significant role in achieving good results in either technique.[6] This improvement in hearing that was seen in patients that received underlay myringoplasty in the present study is similar to previous reports that have assessed the postoperative audiological outcomes. Postoperative pure tone audiometry showed significant improvement in the patients who had been successfully treated in terms of conductive hearing loss. Previous studies also found that underlay myringoplasty was effective at improving hearing and that it was well tolerated and achieved a satisfactory perforation closure rate. The results of this study further validate the continued use of the underlay approach as a reliable method in routine clinical practice.[7] With the development of endoscopic ear surgery, the visualization during tympanic membrane reconstruction has been enhanced, especially in anterior perforations that are hard to access with conventional microscopy.

Comparative studies have shown that both underlay and overlay myringoplasty have excellent graft uptake and hearing improvement, indicating that better visualization does not significantly affect the overall success of either surgical approach. The results presented here suggest that technological progress can further improve the results of the traditional surgical techniques.[8] In the present study, cases of graft failure were rare, but for a small number of patients, the procedure failed due to the remaining perforation or infection after the surgery. Several factors were found to be predictors of graft failure in a recent systematic review and meta-analysis, including active middle ear infection, smoking, poor Eustachian tube function, large perforation size, and revision surgery. These observations underscore the importance of multiple patient factors in the successful myringoplasty, apart from the surgical technique, and are consistent with the good results seen in well selected patients in this study.[9,10] Excellent results have been consistently reported in large clinical reviews after myringoplasty with graft uptake rates typically higher than 85% and good postoperative hearing improvement. The results of this study are similar to those of the aforementioned studies, in which overall surgical success was high in both treatment groups. It has also been emphasized in these studies that, regardless of the surgical placement technique, sound surgical principles and proper patient selection are key to the predictable achievement of long-term results. Infection is still the most significant cause of graft failure. Infection in the present study was uncommon and was treated effectively without any significant complications in the majority of patients. Previous studies have shown that early postoperative infection has a negative impact on healing of the grafts and has been linked to the risk of a persistent perforation, which means that careful postoperative monitoring and meticulous aseptic technique is important for successful recovery.[11]

Surgical outcomes after myringoplasty are also affected by the characteristics of the patient. Previous studies have indicated that age, duration of ear dryness, middle ear mucosal condition, Eustachian tube function, perforation size and surgeon experience are important variables that influence graft uptake and hearing restoration. In the present study, these confounding factors were minimized by including only patients with dry central perforations and normal middle ear mucosa, which may have been a factor in the high success rate in both groups.[12] Other reconstructive methods have been developed to enhance the surgical outcome, especially in difficult perforations. Comparative analysis of endoscopic underlay vs interlay tympanoplasty showed comparable graft take and hearing improvement, suggesting that many methods can achieve good outcomes if they

are used appropriately. The underlay technique remains the method of choice due to its simplicity, repeatability, and consistently good results.[13] Postoperative care is also an important part of the success of the graft healing. In the present study, standardized follow-up and appropriate medical management were followed, which led to a low incidence of infection and to satisfactory anatomical results. In a previous prospective study, it was shown that adjunctive postoperative treatment with topical antibiotic ointment accelerates epithelialization and promotes better graft healing following underlay myringoplasty, thus contributing to the success of the surgery.[14] Recent studies comparing interlay and underlay tympanoplasty have reported similar rates of anatomical and functional success and the technical advantages of underlay.[15] Similarly, long-term imaging studies have shown stable integration of the graft and stable hearing improvement after cartilage underlay myringoplasty, which is evidence of successful reconstruction over long-term follow up.[16] The results of the present study suggest that underlay and onlay myringoplasty are safe and effective surgeries for the repair of chronic TM perforation. The underlay technique, however, showed slightly better uptake, fewer postoperative complications, and marginally better hearing improvement. These results concur with those demonstrating that the size and location of the perforation have a significant impact on surgical planning and outcomes, with careful patient selection key to optimal results. Thus, the underlay technique might be the best approach for most central perforations, and the onlay technique may be useful in selected cases in which the anterior defect is large or the perforation shape is difficult to manage.[17]

CONCLUSION

The results of the present study showed that both myringoplasty with underlay and with onlay are good surgical procedures for repairing chronic tympanic membrane perforation with high percentage of graft uptake and considerable postoperative improvement in hearing. The underlay technique yielded a slightly higher graft success rate, better hearing gain and fewer postoperative complications (graft lateralization and infection) compared to the other technique; satisfactory anatomical and functional results were achieved in both groups. It is technically simple, has a short learning curve, and performs consistently in the treatment of most central TMPs. The onlay technique is still a useful one, however, in selected patients with large anterior or subtotal perforations, it may be beneficial to provide better support for the graft. Optimizing outcomes will still depend on careful patient selection, a meticulous surgical technique and appropriate postoperative care. More multicenter studies with larger numbers of patients and longer follow-up are suggested to confirm the long-term superiority of either surgical technique.

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