The Efficacy of Endoscopic Tympanic Membrane Repair

Amal Pradeep Xinjiang Medical University

Professor Feng juan Xinjiang Medical University

Sadia Hassan Department of General Surgery, DHQ hospital Hunza

Farhan Ahmad Xinjiang Medical University

Syed Muhammad Ali Xinjiang Medical University

Associate Professor Nilipaer Alimu Xinjiang Medical University

Abstract

Purpose of this review article to improve the visualization of endoscopic tympanic membrane repair. Chronic otitis media (COM) and Chronic suppurative otitis media (CSOM) is a common disease facing by General practitioners and otolaryngologists in children and adults. This article reviews the aetiopathogenesis, presentation, complications, and management of COM and CSOM. The data and material were reviewed of this review article by using the literature, Previous published articles, search engines, PubMed, EMBASE and Cochrane databases. A combination of terms including Chronic otitis media COM and CSOM diagnosis, complications, and management. Chronic otitis media (COM) and Chronic suppurative otitis media (CSOM) is a common problem with various sub-categories according to the disease state. It most commonly presents with painless hearing loss, watery discharge and itching in ear etc. Treatment options vary according to the activity and type of disease encountered. Tympanoplasty is performed to close the tympanic membrane perforation and recover the hearing level of patients with non-suppurative chronic otitis media and Chronic suppurative otitis media. The efficacy of endoscopic tympanic membrane repair is generally evaluated based on the rate of successful perforation closure (graft take), improvement in hearing outcomes and patients' life.

Key words: *Tympanic membrane, Endoscopic tympanoplasty, Chronic otitis media.*

Introduction:

Tympanic membrane (TM) perforation is a common surgical indication in an otolaryngology practice. it can be managed by tympanoplasty.[1] A larger percentage of patients with chronic tympanic membrane perforations also prefer to have medication and surgery, The main benefits of the endoscopic approach are improved visualization and minimal invasiveness.[2] With success rates ranging from 83% to 100%, microscopic ear surgery (MES) has long been the primary method for fixing TM perforations worldwide.[3] Because of these unpredictable results, close observation and monitoring play a crucial role in the management of TM retraction. For this reason, numerous staging systems have been created and are frequently utilized.[4]

Comparable TM closure rates and hearing outcomes were shown in a prior systematic review and meta analysis comparing endoscopic and microscopic tympanoplasty; however, the results were constrained by a dearth of recruited studies and possible bias that might have compromised the study's integrity.[5] The external incision, soft tissue dissection, and bone removal can be successfully avoided when using an endoscope. Furthermore, there may be a decrease in the use of medical resources, which may be partially explained by a lower hospitalization rate.[6]

An increasing number of ear, nose, and throat (ENT) surgeons now favour endoscopic tympanoplasty when treating tympanic membrane perforations.[7-8] Endoscopic surgery exhibits several advantages over the classical approach when compared to the use of a microscope. These advantages include a shorter duration of the procedure, the ability to visualize the entire surgical field without requiring the patient to change position or angle, as is typically the case when using a microscope, the ability to operate with a minimal incision, a short recovery period following surgery, and minimal pain.[9-10] Otoendoscopy-assisted tympanic membrane restoration has been progressively implemented in clinical practice with the advancement of endoscopic technology and associated instruments. The tympanic membrane can be directly observed during an otoendoscopy, allowing the surgeon to operate in close proximity to the lesion. The image displayed is sharp and enlarged, according to the least invasive approach. But the mirror's surface is easily contaminated, and the little operation. [11]

This procedure often necessitates hair removal, a deep postauricular incision, and general anaesthesia while having a high graft take rate (>90%).[12] Total endoscopic ear surgery (TEES) has been more common in the recent past because it can solve the problems caused by the straight line of vision of the microscope.[13–14] This method achieves a high-resolution, magnified picture of the full TM by avoiding some canal segments, which improves vision, particularly in narrow, tortuous ear canals.[15]

Methods:

A comprehensive search of relevant systematic reviews and articles was performed using the PubMed and Google Scholar databases. The publication years ranged between 2000 and 2024. To expand The Efficacy of Endoscopic Tympanic Membrane Repair concept was introduced. The search strategies included the following terms: ‘Tympanic membrane Repair. Furthermore, citation tracking of the studies retrieved was used to identify additional relevant articles, which were obtained using Google Scholar. Illustrates the general idea of the study and the cited references, correspondingly.

Pathogen of disease:

Chronic otitis media (COM) is considered a multifactorial disease resulting from a complex series of interactions between environmental, bacterial, host and genetic risk factors.[16] The most common cause of OM is bacterial infection of the middle ear. AOM is predominantly caused by Streptococcus pneumoniae, Haemophilus influenzae and Moraxella catarrhalis.[17] However, Pseudomonas aeruginosa and Staphylococcus aureus are the most common aerobic microbial isolates in patients with CSOM, followed by Proteus vulgaris and Klebsiella pneumoniae . It is important to identify the genes that contribute to CSOM susceptibility, which will provide insights into the biological complexity of this disease and ultimately contribute to improve the methods of prevention and treatment .[18]

Classification of disease:

There are three main subtypes of Chronic otitis media. Acute otitis media (AOM), Otitis media with effusion (OME) and chronic suppurative otitis media (CSOM).

Acute otitis media (AOM) is predominantly a disease of children. The most important risk factors for AOM are young age and attendance at a day-care facility. Acute otitis media is predominantly a bacterial infection; viruses cause one-third of cases. Antibiotic treatment for AOM is controversial.[19]

Otitis media with effusion (OME) is characterized by a non purulent effusion of the middle ear that may be either mucoid or serous. Symptoms usually involve hearing loss or aural fullness but typically do not involve pain or fever. In children, hearing loss is generally mild and is often detected only with an audiogram. Otitis media with effusion (OME) is the most common cause of deafness in children in the developed world.[20]

Chronic suppurative otitis media (CSOM) is a common cause of hearing impairment and disability. Occasionally it can lead to fatal intracranial infections and acute mastoiditis, especially in developing countries. CSOM is a common cause of hearing impairment, disability, and poor scholastic performance. Occasionally it can lead to fatal intracranial infections and acute mastoiditis, especially in developing countries. Hearing impairment is the most common sequela of CSOM.[21]

Treatment:

1.1 Medication:

One kind of glycosaminoglycan is hyaluronic acid (HyA). By drawing water molecules to the area, changing its viscoelastic characteristics to promote tissue repair, and organizing scaffolds, HyA contributes to tissue healing.[22]

Tympanoplasty has long made use of gelatin, which is derived from the hydrolysis of collagen. Compared to other film types like silastic, gelatin film is superior because it prevents fibrosis and is safe for the middle ear's lining mucosa.[23]

Because of their appropriate mechanical properties and biocompatibility, materials based on silk fibroin also exhibit promise for tissue engineering applications. In addition to their ability to sustain human tympanic membrane keratinocyte growth in vitro, silk fibroin scaffolds have been demonstrated to possess mechanical and structural attributes like transparency, stability, and tensile strength, which have made them attractive options for application in otology.[24]

1.2 Endoscopic Surgery:

the surgical maneuver's that must be performed with one hand limit endoscopic surgery. In particular, severe bleeding is challenging to control, and even little amounts of blood can obstruct the endoscopic image, making it challenging to do the surgery. Last but not least, the endoscope is a very controversial topic in middle ear surgery due to its two dimensional perspective, loss of depth perception, potential for thermal harm from the tip, and lengthy learning curve.[25-26] It is well acknowledged that improved vision of the middle ear's anatomy is crucial when doing middle ear surgery. Correct prosthesis implantation and evaluation, especially for ossiculoplasty, are linked to improved postoperative audiological results. In this instance, TEES appears to have an advantage by offering panoramic, wide angle, magnified views.[27-28]

The inability to determine the depth of retraction using a static, two-dimensional endoscopic image in comparison to the dynamic, or especially microscopic, view that is accessible during clinical practice, is probably a contributing factor. [29] Total endoscopic ear surgery (TEES) has been more common in the recent past because it can solve the problems caused by the straight line of vision of the microscope.[30-31] Comparing endoscopic and microscopic tympanoplasty, recent research shows comparable success rates in terms of graft uptake and post-operative closure of the air-bone gap.[32] Systemic antibiotics and surgery are reserved for cases of Chronic otitis media patients.

1.3 Preparation for procedure:

Initially, any patient presenting with chronic Otitis media and hearing loss should undergo a complete history and examination, including a focused head and neck examination and examination of the ear using an otoscope/microscope. This will provide crucial details on the size of the TM hole, its location (which may be classified into a quadrant as previously indicated), the kind of otorrhea ('wet' or 'dry'), and whether or not there is current inflammation present. Before and after surgery, typography, pure tone audiometry (PTA) with speech discrimination, and tuning fork evaluation (Rinne and Weber tests at 512 Hz) should be carried out for a comparative assessment of the difference between air and bone conduction thresholds (airbone gap[33-34] Simple tympanic membrane perforations seldom require imaging, but when they do, computed tomography (CT) is the recommended imaging technique.[35]When considering the surgical care of cholesteatoma, CT scanning of the temporal bone is commonly used. Patients will give their approval for tympanoplasty prior to surgery. Pain, haemorrhage, infection, graft failure, recurrence, additional surgery, progressive hearing loss or deafness, disorientation, and damage to the facial nerve that results in facial palsy or to the chorda tympani nerve that results in taste abnormalities are among the risks. Usually

carried out under general anaesthesia, patients will have a chance to consult with an anaesthetist before the treatment.[36]

1.4 Comparable effect with respect to graft success rate and hearing outcome:

While a prior meta-analysis comparing graft success rates and hearing outcomes related to surgical approaches was presented in this way, the results were constrained by a dearth of recruited trials and consequent small-study effects that may have introduced bias. Given the recent growth in the body of knowledge regarding the consequences of EES, it is still necessary to reestablish the clinical effectiveness of the two surgical methods.[37]

The current study, which included a sizable number of patients, found that the graft success rates for endoscopic and microscopic techniques were similar. According to qualitative research, the EES's graft success rate varied from 83% to 100%, matching the MES's results. Since there were no discernible risk variations or publication biases between the two surgical instruments, the projected impact on the rate of transplant success might not be changed. Age, a variable that was previously linked to the success rate of grafts, could limit this outcome, though. In 17%–20% of patients undergoing the MES, the tympanic annulus could not be fully visible due to the limited surgical view obtained from microscopy while analysing complicated structures of the external auditory canal, such as a convoluted, stenotic ear canal and bony overhangs. Therefore, in order to see the entire pathophysiology of TM or the middle ear, surgeons will probably drill out bony overhangs. Prolonged surgery was found to be substantially linked with both canaloplasty and partial visibility of the perforation margin. [38]

Previous reports have indicated comparable success rates, ranging from 83.3-100% and 82.4-100%, respectively. Notably, this study's analysis showed that MES patients had higher hearing improvements than EES patients. Improvement in hearing may be hampered by certain one-hand technique drawbacks such as trouble controlling bleeding and heat damage caused by light.[39] The quality of this analysis, however, may have been compromised by potential publication bias with a significant degree of heterogeneity, indicating that the trim-and-fill procedure corroborated the small-study impact. Furthermore, because only three studies provided data, we were unable to evaluate sub-group analysis utilizing a moderator, such as perforation site or size and revision surgery that may effect hearing results.[40]

1.5 Instrumentation of EES:

Once the surgeon has familiarised themselves with the anatomy, indications and procedures by attending an appropriate course then it suggested that the method is commenced immediately in a step-wise manner to reinforce previous learning. Currently available equipment in most hospitals can be used before any specialised endoscopic ear equipment is required. Suggested available equipment to start with includes:

- 4 mm sinuscopes 0 and 30°
- HD Camera
- LED or Xenon Light source and shielded fiberoptic light lead – set at 50%
- Basic otology tray.

1.6 The benefit of this procedure (Endoscopic Tympanic Membrane Repair):

Endoscopic Tympanic Membrane Repair is a more accurate procedure than the microscopic procedure. It visualizations is more as compared to other procedures. A minimal invasive procedure with less pain, less blood loss, the patient can recover very fast as compared to other procedures. The time for procedures is very short as compared to other procedures for tympanic membrane repair. There is no major complications noted.

Foreign bodies and foreign body materials are among the others. Many synthetic materials have shown promise in mending the tympanic membrane and enhancing hearing with advances in tissue engineering and medicine. By combining the 3D printing technologies of bioengineering with tympanic membrane regeneration, surgical techniques can be made simpler, more stents can be obtained, and surgical success rates can be raised. The purpose of this article is to provide an overview of the most recent advancements in the repair of tympanic membranes using artificial synthetic materials, foreign bodies and materials, and autologous materials.[41]

The results of reports indicate that the results in terms of hearing improvement and graft take-up rates are comparable to those published in the rest of the world literature; however, there is a lack of a standard. The authors suggest creating uniform standards for tympanoplasty results reporting that apply to the entire Indian subcontinent. A consistent reporting standard will be promoted by this endeavor, serving as a solid foundation for upcoming middle ear reconstruction analysis and research.[42]

In the United Kingdom, The United Kingdom (UK) national standard for the closure rate for myringoplasty is 89.5%. The surgical technique can be easily adopted, used for all types of tympanic membrane perforations and gives good results of graft uptake, and results in hearing improvement with no significant complications. This work illustrates that temporalis fascia graft can be utilized to obtain outcomes similar to other types of grafts, contributes to the body of research supporting the use of cortical mastoidectomy in discharging ears, and demonstrates that the underlay approach produces favorable results. The national average for the closure rate of myringoplasty in the United Kingdom (UK) is 89.5% (90.6% and 84.2% for primary and revision operations, respectively). The average hearing gains for primary and revision myringoplasty are 9.14 dB and 7.86 dB, respectively. This study compared the myringoplasty outcomes for a single surgeon over 5 years. [43]

1.7 Mechanisms to future therapies:

Endoscopic ear surgery is commonplace and frequently takes the role of special microscopic ear surgery. Tympanic membrane perforations may now be treated using tympanoplasty as an alternative procedure.Also improve the patients time and quality of life.

1.8 Discussion:

Endoscopic ear surgery represents the ever-increasing, minimally invasive branch of otologic surgery. Updated meta-analysis was necessary to settle arguments between the two methodologies in light of new discoveries that culminated in the last few years. According to our findings, the endoscopic approach produced more desired aesthetic outcomes and a lower rate of canaloplasty (i.e., less invasive) than the microscopic method, while still competitively achieving graft uptake and hearing restoration.

These results confirm that the endoscope is a very useful tool for treating persistent suppurative otitis media. [44] There are numerous benefits of using endoscopes in otologic surgery. While the microscope remains the gold standard for ear surgery, endoscopic techniques are becoming more and more common, particularly for diagnostic and simple tympanoplasties. Previously used mainly for diagnostic purposes, endoscopes are now used in surgical procedures [45], and the procedures themselves are becoming less invasive.[46-47] The surgical view is the primary distinction between endoscopy and microscopy.

According to Tarabichi et al. [48], the narrowest part of the ear canal defines and limits the view during microscopic surgery. On the other hand, even with a 0° endoscope, trans canal endoscopy avoids the tight portion of the ear canal and offers a broad view. [49] Age, the size and location of the perforation, postoperative otorrhea, revision surgery,

and inadequate visualization of the perforation margin are some of the factors that affect the success rate of myringoplasty.[50-51] When compared to microscopy, endoscopy in ear surgery has a number of drawbacks. Initially, one hand must hold the endoscope while the other is free to operate; this is especially difficult when bleeding makes it difficult to see the operative field. Furthermore, compared to the binocular image obtained through microscopy, endoscopy offers a monocular view that impairs depth perception. Furthermore, additional training experience is still needed for endoscopic myringoplasty.[52-53] The shorter operating duration of endoscopic tympanoplasty is probably due to the soft-tissue dissection, increased frequency of canaloplasty, and skin closure when using an endaural or post-auricular approach.[54-55]

The length of the operation is also increased by the periodic readjustments of the microscope made during the process. While the primary benefit of ET's shorter operating times is that patients are less likely to experience general anaesthesia, ET also lowers health care costs by minimizing patient use of operating room resources and surgical instruments, like disposable burr drills for canaloplasty.[56] These results back up the widespread use of ET as an affordable way to lighten the load on the healthcare system in addition to improving patient outcomes. To find out whether using endoscopic techniques more frequently may negatively affect otologists' ability to do microscopic tympanoplasty, more research is necessary.[57-58] There are numerous benefits of using endoscopes in otologic surgery. While the microscope remains the gold standard for ear surgery, endoscopic techniques are becoming more and more common, particularly for diagnostic and simple tympanoplasties. Endoscopes, which were only used for diagnostics until recently.[59-60]

Conclusion:

We concluded that endoscopic tympanic membrane repair is a more accurate procedure than the microscopic procedure. Endoscopic procedure visualizations is more as compared to other procedures. Its a minimal invasive procedure with less pain, less blood loss, the patient can recover very fast as compared to other procedures. The time for procedures is very short as compared to other procedures for Tympanic Membrane Repair. The tympanoplasty with an endoscope is comparable to tympanoplasty with microscope in terms of graft uptake and hearing improvement. There is no major complications noted.

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