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Comparison of the Efficacy of Endoscopic Tympanoplasty Over Microscopic Tympanoplasty: An Institutional Review

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Abstract

Introduction: Otological surgery has progressed rapidly over the past century. With the recent introduction of the 3-chip camera system and high definition video systems, endoscopes now provide ultra high resolution images of the middle ear that were never seen previously. We conducted this study to compare the efficacy of endoscopic tympanoplasty over microscopic tympanoplasty in terms of graft uptake, hearing improvement, pain score and post-auricular hypoesthesia.

Methods: The present study is a prospective observational study, conducted over a period of 2 years in a tertiary care centre.

Results: Endoscopic tympanoplasty can be a better alternative over microscopic tympanoplasty due to its various advantages.

Conclusion: Endoscopic ear surgery provides a better magnification, wide field view, and the ability to look around corners without major complications. Further, Trans canal endoscopic ear surgery (TESS) approaches transform external auditory canal into a minimally invasive surgical portal to access middle ear disease.

Keywords: Endoscopic, Tympanoplasty, Tess, Microscopic ear surgery

Introduction

The term tympanoplasty was introduced in 1953 by Wullstein to describe surgical techniques for reconstruction of the middle ear hearing mechanism that had been impaired or destroyed by chronic ear disease [1]. Zollner reported on surgical techniques for improving the sound conduction mechanism of the middle ear following surgery for chronic ear disease [2]. Another major contribution by Wullstein and Zollner was the introduction of operating microscope in performing otologic surgery. The introduction of endoscopy into the middle ear has opened up new opportunities for minimally invasive temporal bone surgery. The use of the surgical microscope brought revolutionary advances into the field of otologic surgery. Similarly, endoscopic imaging provides dramatic vistas to the otologists. The operating microscope provides magnified images in a straight line extending from the objective lens. Many deep recesses within the temporal bone cannot be directly seen without the surgeon taking measures to expand the operative exposure endoscopes have an immediate advantage with an inherently wide field of view that extends from the tip of the instrument's lens. Additional angulations of view are accomplished by placing prisms into the tip [3]. The "working space" in endoscopic surgery is cone shaped, and above the apex of the cone "the ear canal" needs only to be wide enough to admit the endoscope and surgical instruments. In contrast, microscopic surgery requires an upside-down conical "working space" that requires much more bone

removal superficially to obtain access and to prevent the surgeon from "digging his/her self into a hole. In endoscopic surgery, the surgeon gets a bird's-eye view of the field beyond the shaft of the instrument. When using the microscope, it is important to bring the structures almost to a right angle to the axis of the microscope. In contrast, the endoscope can visualise structures that lie in the same plane as the endoscope. Changing the magnification with the endoscope is simply achieved by moving it closer to the structure. There is no need for refocusing when changing position [4].

Endoscopes, therefore, offer the surgeon the capability of wide fields of view with minimal exposure, looking behind the obstructions or overhangs and peering into recesses with much less requirement for surgical exposure than in microscopic surgery. Surgical morbidity and operating time can be substantially reduced [3]. The first published description of imaging of the middle ear by endoscopy was by Mer and colleagues in 1967 [5].

Endoscopy of the middle ear itself may be done through a myringotomy. Nomura introduced the concept of middle ear exploration by passing a rigid endoscope through a myringotomy in an otherwise intact tympanic membrane [6].

Aims and Objectives

1. To evaluate the perioperative considerations of endoscopic ear surgery and compare its efficacy over the microscope in terms of operative time, need for post auricular incision and need for mastoidectomy.
2. To evaluate the surgical outcomes of endoscopic ear surgery in terms of graft uptake, hearing improvement, complications and need for reoperation.
3. To evaluate postoperative patient outcomes after endoscopic ear surgery in terms of pain score, surgical site morbidity (wound dehiscence, hematoma and infection) and post auricular numbness and hypoesthesia.
4. To evaluate the cases in which preoperative findings are different when viewed with the endoscope and surgery has to be completed with microscopic assistance (in cases where cholesteatoma is seen and mastoidectomy is required).

Materials and Methods

The present study is a prospective observational study, was conducted in ENT department of ESIC Medical College and Hospital, Faridabad. A total of 100 patients were included in the study. Using MEEI Classification, surgical approach was divided into four classes. Class 0, which included use of microscope only, Class 1, which included use of endoscope for inspection only, Class 2, which included use of both endoscope and microscope for the surgery and Class 3 ,which included use of endoscope only for the surgery.

Various perioperative parameters like operative time need for post auricular incision and need of mastoidectomy were noted. Intra operative findings like character of ear canal, whether drilling was required for any anterior canal bulge, size and shape of perforation, type of graft used and type of tympanoplasty, amount of bleeding during surgery was noted, visualisation of incudostapedial joint and eustanchian tube with zero degree and 30 degree endoscope and microscope were noted. Ossiculoplasty and mastoidectomy, atticotomy, stapedectomy, excision of retraction pocket if done were also noted and compared with each class. Postoperative pain scoring was done for each patient according to Wong –Baker Faces Pain Rating Scale for 2 days, and whether patient required any medication for pain were noted and compared.

Patients were followed up for a mean of 3 months. Following points such as wound gaping infection and hematoma, post auricular hypoesthesia were noted and compared with each class after first week of follow up.

Surgical outcome was noted and compared after 3 months of follow up in view of graft uptake A-B closure, whether there was need for reoperation and any complication if present were noted like worsening of bone conduction, blunting anterior angle, tympanic membrane cholesteatoma, pearl or iatrogenic cholesteatoma.

Patients aged 10-50 years, both sexes; with conductive hearing loss and small to large sized perforation of tympanic membrane were selected for the study. Those patients with pure sensor neural hearing loss, active discharge at the time of admission, attico-antral disease and any medical reasons like uncontrolled hypertension or deranged blood coagulation profile were excluded from

the study. Patients were randomly selected for endoscopic and microscopic tympanoplasty.

Tuning fork test 256, 512, 1024 Hz tuning fork and PTA was done to determine the type and degree of hearing loss. A-B gap at frequencies 500, 1, 2 KHz was noted and taking the average of three, the hearing loss was calculated. Of total100 patients, 50 patients underwent microscopic (class 0) tympanoplasty, 49 patients underwent endoscopic (class 4) tympanoplasty, and in 1 patient both endoscope and microscope (class2) was used for the surgical procedure. All microscopic tympanoplasty were done by post-auricular WilliamWilde'sincision.

Technique

For endoscopic surgery 16cm, 4mm, 0 degree, 30 degree Hopkins rod lens endoscope with 3 chip CCD camera system was used. All surgeries were done under local anesthesia. Proper trimming of ear canal hair was confirmed preoperatively. For homeostasis-1:30,000 lignocaine: epinephrine, with 27 gauge needle was used for in filtrating external auditory canal at 3-o clock, 6 –o clock, 9 –o clock and 12 o-clock at the bony-cartilaginous junction. The patient was pre medicated with intramuscular injections of 1 ampule for twin and 1 ampule Phenergan. Temporal is fascia or the conchal cartilage were used as the graft material. All tympanoplasty were done by the underlay technique. All endoscopic assisted tympanoplasty were done through

Permeatal route. In endoscopic tympanoplasty temporal is fascia was harvested through 1.5cm supra auricular incision just above the helix. Character of EAC was noted in every procedure. Size and shape of perforation was noted. A margin of the perforation was fresh enduing horizontal pick. Posterior tympanomeatal flap was elevated. The middle ear was inspected and following findings were noted and compared for each case: status of ossicular chain, visualization of eustanchian tube opening, oval and round window position. Middle ear was packed with dry gel foam and graft was placed by underlay technique in each case and anteriorly tucked. Flap was then repositioned. Antibiotic soaked gel foam was used to pack the EAC. Mastiodantiseptic dressing was done. Among the 100 patients, Ossiculoplasty was done in 2 cases. Incas was refashioned and used in one case and in the other a small piece of conchal cartilage was used .Only in 1patient cortical mastoidectomy was done along with tympanoplasty, which required the use of both endoscope and microscope for the procedure(class 3).

All the patients were kept for 2 days irrespective of endoscopic or microscopic tympanoplasty; pain scoring was done for these 2 days of hospital stay and discharged after2 days with oral medications. All the patients were kept under weekly follow up for the first month and then followed twice for next 2 months. The suture was removed on the 7th postoperative day. During follow up all patients were examined for wound gaping, infection, hematoma, and post auricular hypoesthesia. Final assessment of surgical outcome regarding graft uptake was done at 3 months and hearing was assessed by postoperative PTA, where post op A-B gap was calculated by taking average at 500, 1000 and 2000 Hz.

Observation and Result

In our study a total of 100 patients were included, 50 in each microscopic and endoscopic ear surgery, 25 were males, 25 females. All age groups from 10 years to 50 years were selected. There were50 patients who were operated with microscope only, 49 patients operated using endoscope only and 1 patient who operated using both endoscope and microscope ,it was shifted to microscope for doing cortical mastoidectomy as it was a case of revision surgery. With endoscopeal sizes of perforation from small to subtotal perforation was done successfully, 70% were medium size perforation, 18% large, 5%small and 2% subtotal. While with microscope

70 %were small, 28%large and2%medium size perforations (Tables 1-5). The temporal is fascia graft was placed via underlay technique in both endoscopic and microscopic surgery. In one case of endoscopic surgery cartilage shield tympanoplasty was done as it was a case of revision ear surgery, conchal cartilage was used. With endoscope the perforation location encountered was central (84%), anterior inferior quadrant (7%), and subtotal (1%), all were repaired successfully. Moderate amount of bleeding was seen in 38% cases of endoscopic surgery, however it was controlled using adrenaline soaked cotton patties. Minimal bleeding seen in 98% cases of microscopic surgery. Incudostapedial joint was seen in 49 cases of endoscopic surgery and 45 cases of microscopic surgery. Eustachian tube was seen in 45 cases and 9 cases in endoscopic and microscopic surgery respectively. In microscopic

Sex	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Male	16 (64)	09 (36)	0.048
Female	09 (36)	16 (64)	

Table 1. Sex distribution among two groups (n=100)

Age	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
10-20	03 (12)	04 (16)	0.464
20-30	14 (56)	09 (36)	
30-40	04 (16)	04 (16)	
40-50	04 (16)	08 (32)	

Table 2. Age distribution among two groups (n=100)

MEEI Classification	Frequency	Percentage (%)
Class 0 (Microscope only)	50	50
Class 1 (Endoscope for Inspection only)	0	0
Class 2 (Endoscope + Microscope)	1	1
Class 3 (Surgery with Endoscope only)	49	49

Table 3. MEEI Classification, Frequency and Percentage (%) among two groups (n=100)

Size of perforation	Endoscopic (%) n=50	Microscopic (%) n=50
Small	5(10)	35(70)
Medium	35(70)	1(2)
Large	9(18)	14(28)
Subtotal	1(2)	0(0)

Table 4. Size of perforation among two groups (n=100)

Type of Surgery	Endoscopic (%) n=50	Microscopic (%) n=50
Underlay	48 (96)	50(100)
Cartilage	1(2)	0(0)
Cortical	1(2)	0(0)

Table 5. Type of Surgery among two groups (n=100)

surgery none of the cases required Ossiculoplasty, while in endoscopic surgery 2 patients required Ossiculoplasty, in one case incurs was removed and was refashioned and was used, while in the other a small piece of conchal cartilage was used. External ear canal encountered during endoscopic surgery was narrow (68%), wide (28%), and tortuous in 4%, while using microscope it was wide (84%), narrow (16%) and none were tortuous. Anterior canal wall drilling was not required in any of the surgeries done using endoscope and in 1 case of microscopic surgery anterior canal wall drilling was done as anterior margin of the perforation was not seen .The graft uptake after 3 months of regular follow up, surgeries done with endoscope had 47 successful graft uptake and 3 cases had graft failure. The post operative AB gap closure after 3 months was less than 10db in 49 cases and 47 cases of endoscopic and microscopic surgery respectively. The pain score was done on day 1 and day2 of the post operative period using Wong Baker Pain Rating Scale (Tables 6-10).

43 patients of the endoscopic group didn't require any analgesic while 47 patients of the microscopic group required pain medication. On day 1of post operative period there were 9 patients with pain score 0, 36 patients with pain score 1 and 5 patients with pain score 2 with endoscopic surgery. On day 2 of post operative period there were 37 patients with pain score 0, 11 patients with pain score 1 and 2 patients with pain score 2 with endoscopic surgery. With microscopic surgery on day 1 of post operative period there were 2 patients with pain score 0, 11 patients with pain score 1and 37 patients with pain score 2. On day 2 there were3 patients with pain

Perforation Location	Endoscopic (%) n=50	Microscopic (%) n=50
ASQ	0(0)	2(4)
AIQ	7(14)	28(56)
PSQ	0(0)	1(2)
PIQ	0(0)	1(2)
Central	42(84)	18(36)
Subtotal	1(2)	0(0)

Table 6. Perforation location among two groups (n=100)

Bleeding during surgery	Endoscopic (%) n=50	Microscopic (%) n=50
Minimal	11(22)	49(98)
Moderate	38(76)	1(2)
Excessive	1(2)	0(0)

Table 7. Bleeding during surgery among two groups (n=100)

I.S. Joint Visualized	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Yes	49	45	0.204
No	1	5	

Table 8. I.S. Joint Visualized among two groups (n=100)

I.S. Joint Visualized	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Yes	45	9	0.0001
No	5	41	

Table 9. Eustachian Tube visualized among two groups (n=100)

Ossiculoplasty done	Endoscopic (%) n=50	Microscopic (%) n=50
Yes	2(4)	0(0)
No	48(96)	50(100)

Table 10. Ossiculoplasty among two groups (n=100)

score 0, 40 patients with pain, score 1 and 7 patients with pain score 2with microscopic surgery. Various complications like recurrent cholesteatoma, blunting of anterior angle, and surgical site morbidity like wound gaping, infection and hematoma formation was not encountered in any of the cases either microscopic or endoscopic ear surgery. However post auricular hypoesthesia was complained by every patient who underwent microscopic surgery. The maximum operative time with endoscopic was 50 min and minimum was 40 min. With microscopic

Type of Ear Canal	Endoscopic (%) n=50	Microscopic (%) n=50
Wide	14(28)	42(84)
Narrow	34(68)	8(16)
Tortuous	2(4)	0(0)

Table 11. Type of Ear Canal among two groups (n=100)

Anterior Canal Bulge Drilling Required	Endoscopic (%) n=50	Microscopic (%) n=50
Yes	0(0)	1(2)
No	50 (100)	49(98)

Table 12. Anterior Canal Bulge Drilling Required among two groups (n=100)

Graft Take up	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Yes	47	47	1.000
No	3	3	

Table 13. Graft Take up among two groups (n=100)

Post OP AB Gap	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Yes	49	47	0.617
No	1	3	

Table 14. Post OP AB Gap (less than 10Db) among two groups (n=100)

Analgesic Required	Endoscopic (%) n=50	Microscopic (%) n=50	p-value
Yes	7	47	0.0001
No	43	3	

Table 15. Analgesic required among two groups (n=100)

ear surgery the maximum operative was 60min and minimum was 45 min (Tables 11-15).

Discussion

The basic aim of our study was to compare the efficacy of endoscopic ear surgery over the microscope in terms of factors like operative time, surgical outcome, pain score, and surgical site morbidity. Endoscopes can be used for all sizes of perforation, small to large and subtotal. In our study 7(14%) of the perforation was located in the anterior inferior quadrant during endoscopic surgery and the graft was placed successfully. In case of severe bleeding during endoscopic surgery it becomes

difficult to operate and moreover blood soils the tip of endoscope and requires regular cleaning and hence prolongs the operative time. In our study minimal amount of bleeding was encountered during endoscopic surgery and was controlled using adrenaline soaked cotton patties.

In case of narrow and tortuous ear canal, canal plasty is done to see the structures in microscopic ear surgery. It requires manipulation of head of the patient in narrow canal and to refocus every time the position is changed. However with endoscope to adjust the magnification it just requires to move the endoscope closer to the structure. Moreover with angled endoscopes it is possible to visualise structures like round window niche, sinus tympani, anterior epitympanum, eustanchian tube area, facial recess, which are difficult to visualise with microscope. Other authors like Raj A, Mehar R et al. [7], Tarabichi M [8] and Usami S, Iijima M et al. [9] reported similar observation in their studies.

The graft uptake was seen in 47 cases and graft rejection was seen in 3 cases of both endoscopic and microscopic surgery. A-B gap closure of less than 10 was achieved in 49 cases of endoscopic and 47 cases of microscopic ear surgery. Surgical site morbidity like wound gaping, infection, hematoma formation was not encountered in any of the patients. However post auricular hypoesthesia was seen in all the patients who underwent microscopic ear surgery. 43 patients in endoscopic group required no pain medication, while 47 patients in microscopic surgery required analgesic. In microscopic ear surgery the graft was harvested via the William Wilde's incision requiring more tissue dissection and more of post operative pain, delayed wound healing. Similar results seen in terms of graft acceptance and hearing improvement in both endoscopic and microscopic surgery and hence endoscopic tympanoplasty can be an alternative over microscopic tympanoplasty with minimum post operative pain, no post auricular hypoesthesia.

Conclusion

Endoscopes have certain advantages over the microscopes, including wider angle of view, better visualisation of structures that are parallel to the axis of the microscope, visualisation of deep recesses and hidden structures (i.e. around corners) and the ability to visualise beyond the shaft of the surgical instrument. On the other hand, the disadvantages of endoscopes include loss of depth perception and binocular vision, the inevitable one-handed surgical technique which necessitates the need for a strictly bloodless field (hence meticulous attention to haemostasis is essential) and recurrent fogging and smearing of the tip of the endoscope [10].

Overall, we found the endoscope to be a useful adjunct for performing tympanoplasty. As the learning curve improves, the operating surgeon can operate rather flawlessly given the better and wider field of view. The results with both endoscopic and microscopic surgery are comparable and the microscope can be additionally used in cases of extensive disease which may require drilling. The patient satisfaction score is also higher with the endoscopic technique with reduced pain and incomprehensible scar. Now, with the advent of piezoelectric drills with inbuilt suction there is a lesser risk of damaging the endoscope tip and surgeons have progressed to performing complete mastoidectomy procedures with the endoscope alone. We hope that this technique will change the way tympanoplasties are performed in the future.

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