EVALUATION OF ENDOSCOPIC SURGERY FOR MIDDLE EAR CHOLESTEATOMA

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ABSTRACT

Background: Endoscopy as a new tool in ear surgery is showing increasing benefit in cholesteatoma surgery. During ear surgery, the use of endoscopes facilitates the eradication of cholesteatoma in areas difficult to visualize with the operating microscope. Management of limited attic cholesteatoma with total transcanal endoscopic ear surgery is a new era in otology providing less invasive type of surgery. In extensive cholesteatoma surgery, the complementary use of endoscopes guarantees better disease control. **Aim of work:** To solve the problem of recurrent and residual cholesteatoma via application of endoscopes and video systems which provide better visualization through panoramic view and better control of hidden areas with aid of angled endoscopes. **Patients and methods:** This study was applied on 73 patients that have middle ear cholesteatoma. They are subdivided into 31 cases who have limited attic cholesteatoma operated upon using total transcanal endoscopic approach. And 42 cases with extensive cholesteatoma operated upon using endoscopic assisted canal wall up approach. Eradication of cholesteatoma was established, reconstruction of ossicles was performed when indicated and reconstruction of the outer attic wall and tympanic membrane were performed for all cases. All patients were exposed to full preoperative evaluation, and full postoperative assessment of attic retraction, recidivistic disease, and the hearing gain expressed by the change of the air bone gap postoperatively. **Results:** Cholesteatoma surgery performed successfully with total transcanal approach in 42.5% of cases. The incidence of cholesteatoma in the facial recess that was visualized by the endoscope was (26%) compared with (20.5%) by the microscope with no significant difference (p=0.134), whereas the incidence of cholesteatoma in the sinus tympani visualized by the endoscope was (37%) compared with (12.3%) by the microscope, with a high significant difference (p<0.001). Cholesteatoma in the anterior epitympanic space was detected by the endoscope in (15.1%) of ears compared with (0%) by the microscope with a statistically significant difference (p= 0.003).**Conclusion**: introducing the endoscope into the otologic surgical field is a step forward, as it provides a wide field of vision with minimal dissection, exploring hidden areas of the middle ear cavity with much lesser requirement for surgical dissection and the need to drill healthy bone; therefore, effective control over the disease can be achieved with establishment the concept of 'functional endoscopic ear surgery.'

Keywords: limited attic cholesteatoma, total transcanal endoscopic ear surgery, recidivism.

INTRODUCTION

The main goals for Cholesteatoma surgery are disease eradication leading to safe and dry ear, hearing preservation and/or restoration, maintenance of temporal bone anatomy, and prevention of recurrence. Complete resection of cholesteatoma is paramount among these prerequisites. [1, 2]

Surgical management of cholesteatoma is still a controversial issue. Classic concepts are based on microscopic surgical management, in the form of the basic classification of canal wall up (CWU) and canal wall down (CWD) approaches, depending on preservation or removal of the posterior bony meatal wall. The choice between these two techniques is based on multiple factors, although in most cases, the main factors influencing the definitive

attitude toward surgical management of cholesteatoma are experience, personal beliefs and confidence of each surgeon with each technique.[2]

The introduction of small, high quality and angled rigid endoscopes has improved visualization of the middle ear recesses not well seen with the operating microscope. [3]

Endoscopically assisted surgery and, more recently, total transcanal endoscopic ear surgery (TTEES) procedures have been advocated in the management of middle ear cholesteatoma. [4, 5]

PATIENTS AND METHODS

Selection of patients

Our study were performed in Otolaryngology, Head and Neck Surgery Departments of both Zagazig and Alexandria University Hospitals in the period from February 2015 to July 2017 on 73 patients (44 male patients and 29 female patients) their ages ranged from 9 to 56 years. They underwent either total transcanal endoscopic ear surgery (TTEES) in the form of transcanal atticotomy in cases of limited attic cholesteatoma, (31 case) or endoscopic assisted canal wall up (CWU) mastoidectomy, (42 case) with complete eradication of the disease and reconstruction of the outer attic wall with composite tragal chondroperichondrial graft.

They all underwent:

Pre-operative evaluation

All patients in the study had done basic preoperative assessment, which include the following:

- Thorough general examination and ENT examination.
- Audiological assessment.
- Tympanometry.
- Pure tone audiometry (PTA).
- High resolution computerized tomography (HRCT) of the temporal bone.
- An informed consent had been taken from all the patients in this study.

Surgical techniques

A) *As regard patients with limited attic cholesteatoma they were operated with TTEES in the following steps:*

1. anesthesia :

All patients were operated under general anaethesia with controlled hypotensive technique

2. Skin Preparation:

Skin disinfection was done with povidone iodine 10%.

3. Dressing:

4.Triming the hair of the external auditory canal to avoid fogging of the endoscope.

4. Injection:

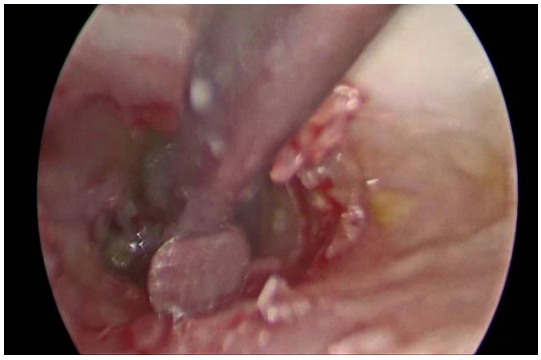
This is done by 1/200000 adrenalin lidocain solution injected in the external auditory canal under posterior meatal wall skin , at 6th Ooclock and 12th Ooclock.

Fig, (1): shows attic perforation and blanching of external canal skin after injection.

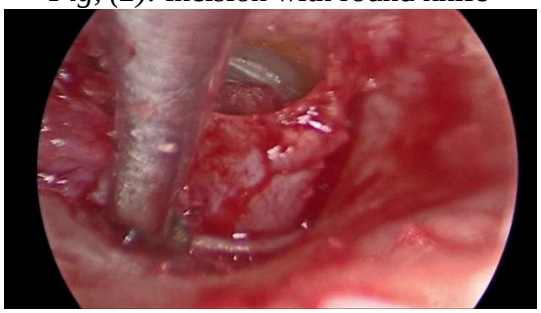
5. Incision and elevation of the flap:

Using the 0 degree endoscope Wide tympanomeatal flap was designed to extend from 6ooclock inferiorly to1ooclock superiorly in right ear and

11ooclock in the left ear and to be about 5 millimeters from the annulus. It was performed with the round knife and haemostasis during this step occurs with aid of cottonoids soacked with adrenalin solution and the round knife with suction tip. Elevation of the flap till reach the annulus and identify the chorda tympani and then transposed inferiorly to expose the superior and posterior portion of the medial part of the external auditory canal

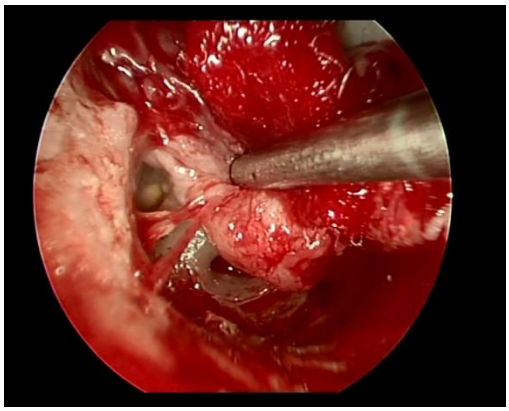


Fig, (2): incision with round knife



Fig, (3): elevation of the tympanomeatal flap with round knife with suction tip till reaching the annulus

6.Entery to the middle ear and continuous careful dissection of the tympanic membrane from the posterior malleolar ligament and then from the handle of malleus till the umbo then separating the flap from it with sharp scissor as the tympanic membrane is adherent to the malleus at that point. A clear view of the protympanum and eustachian tube region was possible after transposing the flap inferiorly.



Fig, (4): elevation of the annulus and entering the middle ear

*7.management of the disease in the attic***:**

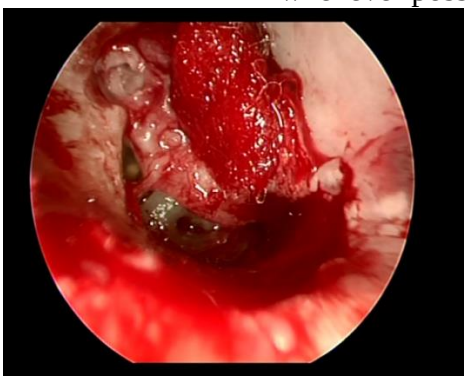
The scutum was totally removed with sharp curette or burr until the anterior bony wall of the epitympanic space was explorable representing the anterior limit of the dissection. Right angle curette is useful in completion of this step. Then, dissection of the cholesteatoma was performed from the anterior bony wall

of the anterior epitympanic space (AES) to the posterior epitympanic space (PES) toward the antrum and the periantral mastoid cells maintaining the integrity of the sac whenever possible.

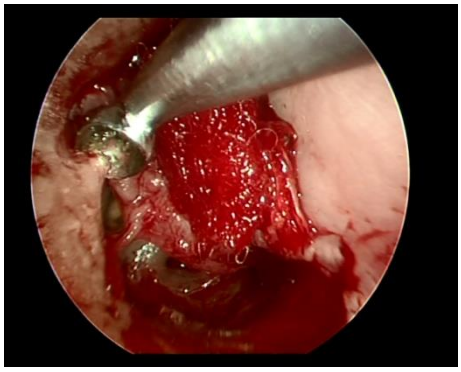
The attitude toward the ossicular chain was preserved as much as possible, but when cholesteatoma present medial to the ossicular chain, the malleus head and incus was removed exposing the medial attic.

Removal of the most superior and posterior bony wall of the medial portion of the external auditory canal is done to reach the antrum and the periantral mastoid cells.

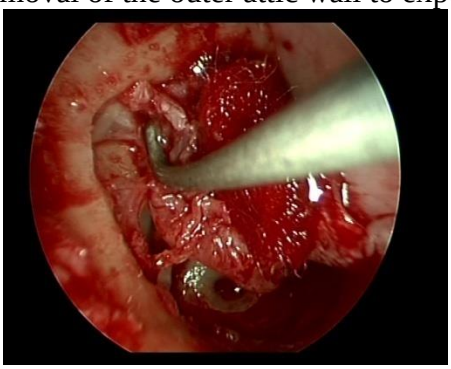
At the end of this procedure, a sort of small open cavity was created. This procedure allowed us to isolate the most posterior extension of the cholesteatoma sac removing en bloc the disease and maintaining the integrity of the sac whenever possible.



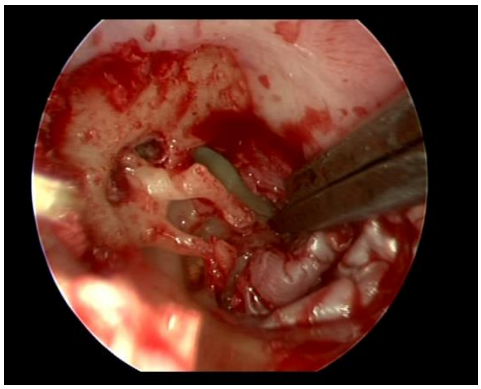
Fig, (5): Attic cholesteatoma is seen after elevation of the flap



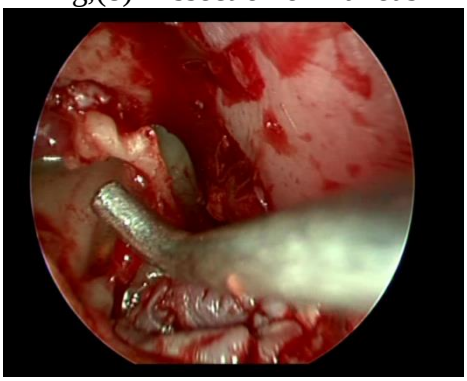
Fig, (6) Removal of the outer attic wall to expose the sac



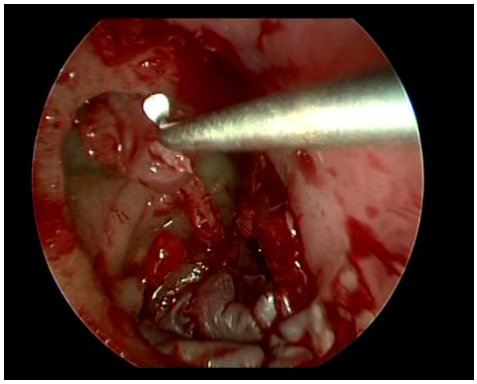
Fig, (7) Dissection of the sac from the incus by curved dissector



Fig,(8) Dissection of malleus



Fig, (9) Removal of incus *(Curved suction tip points to the tympanic segment of the facial nerve)*



Fig, (10): Dissection with curved dissector

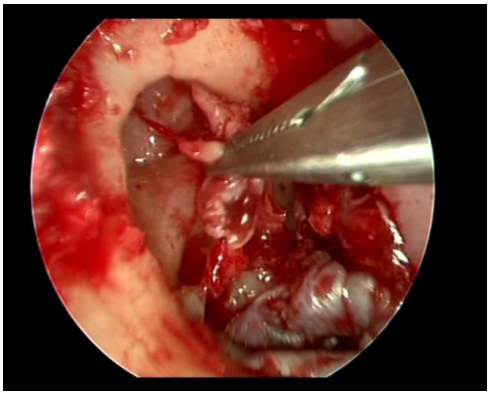


Fig (11) removal of malleus head and clearing anterior epitympanic space from cholesteatoma

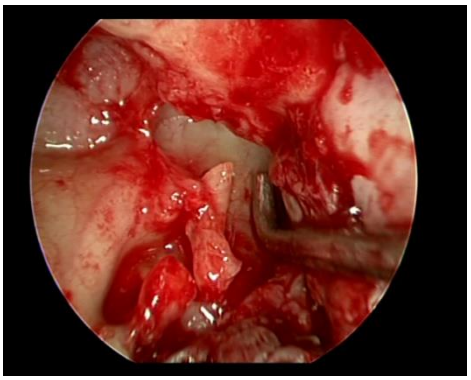
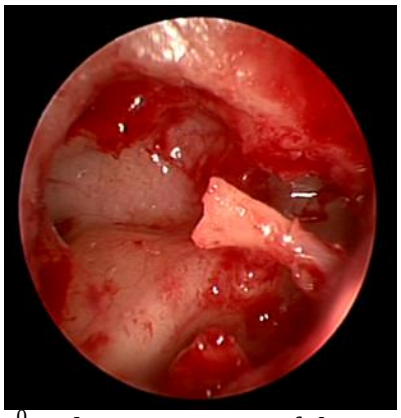


Fig (12) Clearing of the supratubal recess and Eustachian tube orifice
(Suction tip in the Eustachian tube orifice)

8. work with angeled endoscopes
After these surgical steps, a 45° or 30° endoscope was used to check the retrotympanic spaces removing the cholesteatoma sac in these spaces. curved instruments and suction tips are mandatory in dissection in these sites.



Fig, (13) 45^0 endoscope picture of the epitympanum

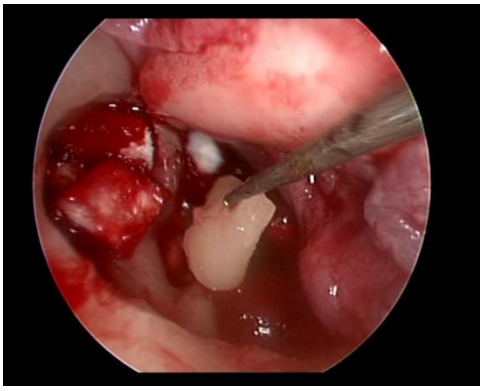
Fig (14) 45^0 endoscope picture shows clean Eustachian tube orifice

9.When located, mesotympanic and hypotympanic cholesteatoma fragments were removed .

10. Ensure patency of the area of isthmus and division of the tensor fold to provide adequate attic ventilation.

11. Ossicular chain reconstruction

When necessary, an ossicular chain reconstruction was performed by a remodeled autologous incus or by prosthesis.

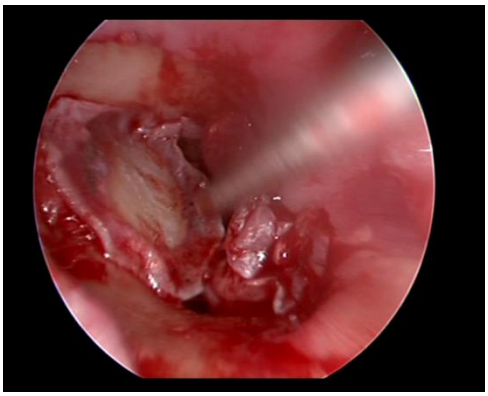


Fig, (15) Incus fitted well on the stapes head

Fig(16)Reconstruction with total ossicle replacement prosthesis(TORP)

12. Attic reconstruction

The attic defect was reconstructed with composite chondroperichondrial tragal graft with excess porichondrium.



Fig, (17) Reconstruction of the attic with chondroperichondrial graft with excess perichondrium

13.Tympanic membrane grafting

The defect was grafted with perichondrium with gelfoam pieces under it**.**

14.Repositioning of the flap

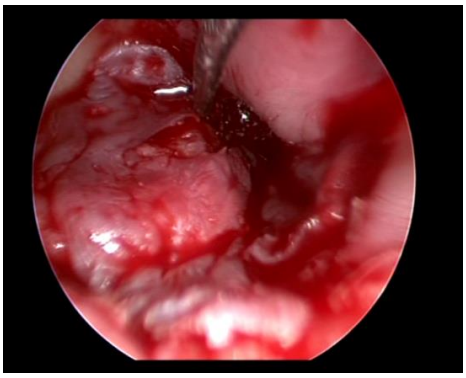


Fig (18) repositioning the flap

15.packing of the external canal

Filling the external auditory canal with moistened gelfoam then small pack impregnated with antibiotic ointment .

16.closure of the site of tragal incision

17. Dressing

B) *As regard patients with more extensive cholesteatoma with extension to the mastoid cavity, they were managed by endoscopic assisted CWU mastoidectomy where the endoscope was used complementary through the whole surgery specially management of the cholesteatoma in the middle ear and its hidden areas.*

Follow up:

This include:-

- Systemic antibiotics for 2 weeks

-Removal of the dressing and the stitches after 1 week, then application of topical ear drops for 2 weeks.

-Otoscopic and otoendoscopic examinations are done weekly for the first month, then monthly in the first 3 months, then every 3 months afterwards .

-Pure tone audiometry and HRCT temporal bone are done 1 year postoperative.

RESULTS

Statistical Analysis:

All data were collected, tabulated and statistically analyzed using SPSS 22.0 for windows (SPSS Inc., Chicago, IL, USA), MedCalc 13 for windows (MedCalc Software bvba, Ostend, Belgium) and Microsoft Office Excel 2010 for windows (Microsoft Cor., Redmond, WA, USA). Continuous variables were expressed as the mean ± SD & median (range), and the categorical variables were expressed as a number (percentage). Continuous variables were checked for normality by using Shapiro-Wilk test. McNemar's test was used for paired categorical data. Wilcoxon signed ranks test was used to compare between two dependent groups of non-normally distributed variables. Changes in distribution of categorical variables over time were compared using Kendall's test. All tests were two sided. p-value < 0.05 was considered statistically significant (S), p-value < 0.001 was considered highly statistically significant (HS), and p-value ≥ 0.05 was considered non-statistically significant (NS).

As shown in table (1) and fig. (19) 42.5% of patients were managed by TTEES and 57.5% of patients were managed by endoscopic assisted CWU approach.

Table (1): Surgical technique of the studied subjects (N=73).

	The studied patients (N=73)	
Surgical technique	No.	%
Technique		
TTEES	31	42.5%
Endoscopic assisted CWU	42	57.5%

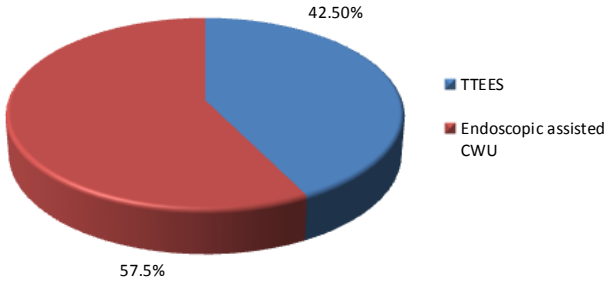


Figure (19): Pie diagram shows surgical technique of the studied subjects (N=73).

As shown in table (2) and fig(20), The overall visibility of hidden areas of the middle ear was assessed by the endoscope versus the microscope. The facial recess was visualized by the endoscope in (100%) of the ears compared with (90.4%) of the cases (66 out 73 patients), by the microscope. This difference was statistically significant (P =.0023). The incidence of endoscopic visibility of the sinus tympani was (100%) compared with (46.6%) (34 out 73 patients), by the microscope, with a highly significant difference (p <0.001). The anterior epitympanic space (AES) in this study was visible by the endoscope in (69.9%) of the cases (51 out 73 patients), whereas it was not visible by the operating microscope. This difference was statistically significant (p <0.001).

Table (2): Visibility of hidden area by Endoscope and Microscope among the studied subjects (N=73).

Endoscope	Microscope: Not visible (N=73)	Microscope: Visible (N=73)	Total	Test‡	p-value (Sig.)
Sinus tympani					
Not visible	0 (0%)	0 (0%)	0 (0%)	37.026	<0.001 (HS)
Visible	39 (53.4%)	34 (46.6%)	73 (100%)		
Total	39 (53.4%)	34 (46.6%)	73 (100%)		
Facial recess					
Not visible	0 (0%)	0 (0%)	0 (0%)	5.143	0.023 (S)
Visible	7 (9.6%)	66 (90.4%)	73 (100%)		
Total	7 (9.6%)	66 (90.4%)	73 (100%)		
Anterior epitympanum					
Not visible	22 (30.1%)	0 (0%)	22 (30.1%)	49.020	<0.001 (HS)
Visible	51 (69.9%)	0 (0%)	51 (69.9%)		
Total	73 (100%)	0 (0%)	73 (100%)		

‡ McNemar's test.
p-value< 0.05 is significant. Sig.: significance.

As shown in table (3) and Fig, (21) The incidence of cholesteatoma in the facial recess that was visualized by the endoscope was (26%) compared with (20.5%) by the microscope with non significant difference (p=0.134), whereas the incidence of cholesteatoma in the sinus tympani visualized by the endoscope was (37%) compared with (12.3%) by the microscope, with a high significant difference (p<0.001). Cholesteatoma in the anterior epitympanic space (AES) was detected by the endoscope in (15.1%) of ears compared with (0%) by the microscope with a statistically significant difference (p= 0.003).

Table (3): Visibility of cholesteatoma by Endoscope and Microscope among the studied subjects (N=73).

	Microscope				
Endoscope	Not visible (N=73)	Visible (N=73)	Total	Test‡	p-value (Sig.)
Sinus tympani					
Not visible	46 (63%)	0 (0%)	46 (63%)	16.05	<0.00
Visible	18 (24.7%)	9 (12.3%)	27 (37%)	6	1
Total	64 (87.7%)	9 (12.3%)	73 (100%)		(HS)
Facial recess					
Not visible	54 (74%)	0 (0%)	54 (74%)	2.250	0.134
Visible	4 (5.5%)	15 (20.5%)	19 (26%)		(NS)
Total	58 (79.5%)	15 (20.5%)	73 (100%)		
Anterior epitympanum					
Not visible	62 (84.9%)	0 (0%)	62 (84.9%)	9.091	0.003 (S)
Visible	11 (15.1%)	0 (0%)	11 (15.1%)		
Total	73 (100%)	0 (0%)	73 (100%)		

‡ McNemar's test.
p-value< 0.05 is significant. Sig.: significance.

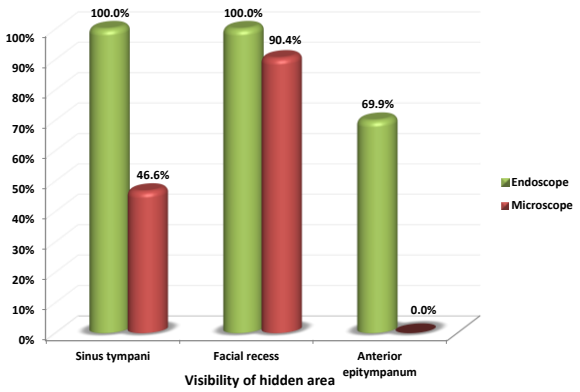


Figure (20): Bar chart shows visibility of hidden area by endoscope and microscope among the studied patients (N=73).

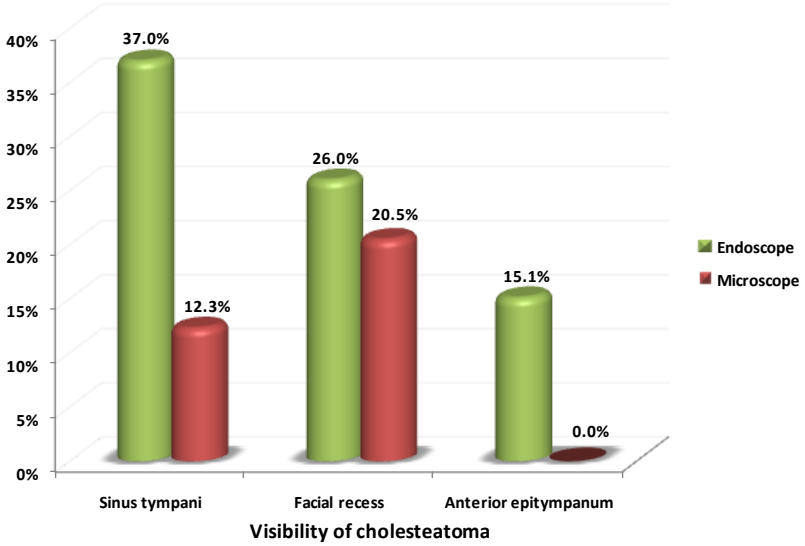


Figure (21): Bar chart shows visibility cholesteatoma by endoscope and microscope among the studied patients (N=73).

As shown in table (4) and Fig, (22) the incidence of recidivism was 12.3%, incidence of residual disease was 6.8% and recurrent disease was 5.5%.

Table (24): cholesteatoma recidivism after 12 months of surgery of the studied subjects (N=73).

cholesteatoma recidivism after 12 months of surgery	The studied patients (N=73)	
	No.	%
Recidivistic cholesteatoma	**9**	**12.3%**
Residual cholesteatoma	5	6.8%
Recurrent cholesteatoma	4	5.5%

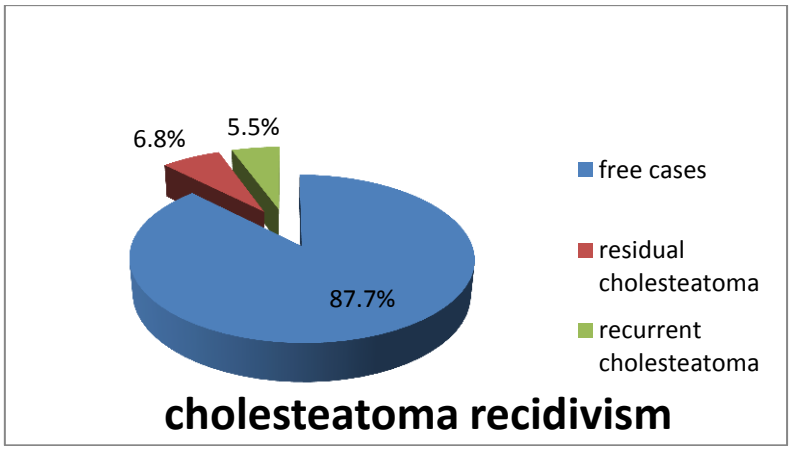


Figure (22): Pie diagram shows cholesteatoma recidivism. (N=73).

Pure tone audiogram has been done for all patients preoperatively and 12 months from the initial surgery. The mean pure tone average air–bone gap had decreased to 24.04 ± 13.37 dB after it was 34.56 ± 8.50 dB preoperatively.

As shown in table (5) and Fig. (23) , The ABG had been improved in 53 cases (72.6%), unchanged in 17 cases (23.3%) and worsened in 3 cases (4.1%).

Table (5): Air bone gap (ABG) changes in the studied subjects (N=73).

	The studied patients (N=73)	
Air bone gap (ABG) changes	No.	%
Improved	53	72.6%
Unchanged	17	23.3%
Worsened	3	4.1%

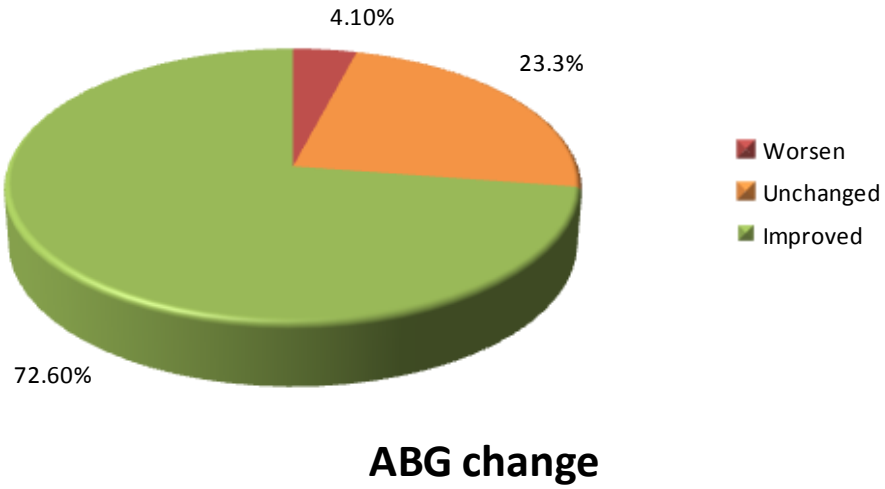


Figure (23): Pie diagram shows ABG change among the studied subjects (N=73).

DISCUSSION

Cholesteatoma is a cyst-like, expansile lesion of the temporal bone lined by a stratified squamous epithelium that contains desquamated keratin. It may be either congenital or acquired cholesteatoma. The most common cholesteatoma seen clinically is the primary acquired or the retraction pocket type .[6, 7]

Cholesteatoma surgery aims to eradicate the disease. Full exposure and visualization of the entire middle ear spaces involved by cholesteatoma is mandatory for definite eradication.[8, 9]

Starting in the 1990s, operative endoscopy was introduced in otologic surgery and significantly changed not only surgical concepts but also anatomic and physiologic concepts. Endoscopic middle ear surgery can offer some advantages compared to the traditional microscopic technique, guaranteeing excellent visualization of middle ear structures and direct visual control of hidden areas.[10, 11, 12]

Because the view during microscopic surgery is defined and limited by the narrowest segment of the ear canal, it was a must to create a parallel port through the mastoid to gain keyhole access to the attic, but the visualization with the microscope was still limited. The surgeon can visualize structures only directly ahead and is unable to see objects that are "around the corner." These limitations can be overcome with the complementary help of endoscopes which enable clear visualization of middle ear recesses not well seen with microscope. [3, 13, 14]

Cholesteatoma surgery should be tailored to the anatomic and physiologic concepts that eradicate attic cholesteatoma preserving as much as possible the physiology and the anatomy of the middle ear to get an optimal functional result. As regard management of limited attic cholesteatoma either with (CWU) or (CWD) approaches, the surgeon needs to remove healthy mastoid air cells and mucosa to reach the attic cholesteatoma from behind .[15]

From these concepts, the surgical approach to attic cholesteatoma should respect some conditions: disease eradication with direct access to the hidden areas, preservation of the mastoid cells and mucosa wherever possible, and restoration of the physiologic aeration pathways from the Eustachian tube to the attic, by removing the block of the isthmus and by creating additional aeration pathway through the tensor fold. From all these concepts, when the cholesteatoma is limited to the tympanic cavity, the transcanal endoscopic approach guarantees all these points establishing the concept of functional endoscopic ear surgery (FEES). [15, 16, 15]

This study was conducted on 73 patients that have middle ear cholesteatoma in Otolaryngology Head and Neck Surgery departments of both Zagazig University and Alexandria university Hospitals, in the period from February 2015 to July 2017.

As regard surgical procedure applied in our study (42.5%) of patient having limited attic cholesteatoma were managed by total transcanal endoscopic ear surgery (TTEES) in the form of transcanal atticotomy whereas (57.5%) of patient who have more extensive disease extending to the mastoid cavity were operated by endoscopic assisted canal wall up (CWU) mastoidectomy where the endoscope was used complementary through the whole procedure.

The second approach was Chosen either preoperatively when the cholesteatoma is seen reaching the mastoid cavity in the preoperative HRCT or when we start as TTEES and we found that cholesteatoma extending beyond the limits of lateral semicircular canal and could not be removed completely even with angled instruments and angled endoscopes.

This is In agree with Badr El-Dine et al 2013[17] who perform similar study with (33%) of cases managed by TTEES and (67%) managed with endoscopic assisted

CWU approach. On the other hand Marchioni et al 2009[18] reported (81%) of cases with TTEES and (19%) with assisted approach moreover Tarabishi et al 2013[16] reported in his case series management of all cholesteatoma cases with TTEES.

The difference between our study and Tarabishi et al 2013[16] and Marchioni et al 2009[18] is that they managed more extensive cases in which cholesteatoma extending beyond the limit of lateral semicircular canal and even reaching petrous apex and also cases with narrow external auditory canal. This was done by aggressive bone removal posteriorly and posterosuperiorly to control the disease in mastoid and marked enlargement of the external bony canal. For us we remove endoscopically only the outer attic wall and limited amount of bone posterosuperiorly with curette or with burr and we shift to postauricular approach if we found that there is need for more bone removal.

One important parameter that was assessed in this study was the overall visibility of hidden areas of the middle ear (whether they were involved by cholesteatoma or not) by the endoscope versus the microscope. The facial recess was visualized by the endoscope in 100% of the ears compared with 90.4% of the cases where it visualized well by the microscope. This difference was statistically significant (P =0.023).

The incidence of endoscopic visibility of the sinus tympani was (100%) compared with (46.6%) visibility by the microscope, with a highly significant difference (p <0.001). The anterior epitympanic space (AES) in this study was visible by the endoscope in (69.9%) of the cases, whereas it was not visible by the operating microscope because excessive drilling and removal of the scutum and cog is needed to visualize it. This difference was statistically significant (p <0.001). These results are similar to what was stated by Ayache et al 2008[5] and Badr El- Dine et al 2013[17]

In this study, the sinus tympani was the most common site that was involved by cholesteatoma in about (37%) of cases whereas the facial recess was considered to be the second most common site and represents (26%) these results are similar to those reported by Badr El-Dine et al 2013[17], Magnan et al 1994[19] and Pratt 1983[20].it is also similar to results of El-Fiky et al 2017[21] but they reported higher rates of intraoperative residuals in the form of (88.9%) for sinus tympani and (49.3%) for the facial recess.

In our study, (AES) is a less commonly affected hidden space of the middle ear cleft at about (15.1%) patients with residual disease and this is similar to Badr El-Dine et al 2013[17] but different from the results of Migirov et al 2011[22] who found a relatively higher rate of cholesteatoma involvement in the (AES) in their study.

The incidence of cholesteatoma detection in the facial recess that was visualized by the endoscope was (26%) compared with (20.5%) for the microscope with non significant difference (p=0.134), whereas, the incidence of cholesteatoma detection in the sinus tympani visualized by the endoscope was (37%) versus (12.3%) for the microscope, with a high significant difference (p<0.001).Cholesteatoma in the anterior epitympanic space (AES) was detected by the endoscope in (15.1%) of ears compared with (0%) by the microscope with a statistically significant difference (p= 0.003) as the operating microscope could not visualize cholesteatoma in the anterior epitympanic space unless the scutum and cog were drilled out. this is also similar to what was stated by Ayache et al 2008[5] and Badr El-Dine et al 2013.[17]

From the previous results it becomes clear that the endoscope has upper hand over the microscope in management of hidden areas in the middle ear.

Recidivism is the main problem after cholesteatoma surgery. It means detection of cholesteatoma matrix during planned second look or unplanned revision

operation after primary cholesteatoma surgery. Recidivistic cholesteatoma may be either residual or recurrent form.[15, 23]

Residual cholesteatoma means presence of cholesteatoma matrix in the tympanic cavity or mastoid cavity postoperatively due to inadequate primary resection of the epidermal matrix either due to its infiltrative nature or as a result of limited exposure of the hidden areas. It is not associated with pathological otoscopic findings like retractions or perforations. It grows and become visible and resectable after 6-12 months of the primary surgery. [1, 14, 15, 23]

It can be diagnosed clinically only if the matrix present very near to the tympanic membrane or erosive complications developed. HRCT one year postoperatively is used for assessment of residual cholesteatoma it has only (43%) sensitivity and (50%) specificity. DWI-MRI is much better modality but it has limited sensitivity for very small lesions. So, staged surgical exploration is the most accurate method for definitive diagnosis. [24, 25]

Recurrent cholesteatoma means new cholesteatoma formation after initial successful eradication. It presents as non-self cleaning re-retraction of the attic. It is associated with clear otoscopic findings like attic retraction or perforation. It results from inadequate reconstruction of the scutum and persistence of poor middle ear ventilation due to Eustachian tube dysfunction or selective attic dysventillation.[1, 14, 15, 23]

Several reports have presented the utility of endoscopic ear surgery as a method for lowering the rates of residual and recurrent disease after cholesteatoma removal. [26]

Tarabishi 2004[27] first reported (6.8%) recidivism rate after TTEES . Badr El-Dine et al 2013[17] published a study on 60 patients managed either by TTEES or endoscopic assisted approach and recorded no recidivism with 16 ± 6.6 months postoperative follow up.

Marchioni et al 2013[15] reported (2.7%) recurrence rate and (4.8%) residual rate with a mean follow-up of after 31 months in TTEES. Neudert et al 2014[23] reported (16%) recidivism rate after endoscopic and endoscopic assisted techniques.

Marchioni et al 2015[28] compared cholesteatoma recurrence rates in pediatric patients who underwent TTEES with pediatric patients who underwent canal wall up microscopic approaches without endoscopes, noting recurrence rates of (12.9%) and (17.2%) respectively. With a mean follow-up of 36 months, residual disease was present following (19.3%) of TTEES and (34.4%) of canal wall up cases. Similar outcomes were also recorded by Hunter et al 2016[29] with rates of (20%9) residual disease and (10%) recurrence rate among the endoscopic group.

Alicandri-Ciufelli et al 2016[14] studied 244 attic cholesteatoma cases with longer follow up period (64.3 months) SD 22.2. The recurrence rate was found to be (12%) while the residual rate was (20%).

A systematic review conducted by Kozin et al 2015[30] found residual cholesteatoma in second-look procedures when endoscopes were used for inspection only ranging from (4.2% to 50%) while when endoscopic ear surgery was used as an operative tool cholesteatoma was found in (7.5% to 33.3%) of cases.

As regard our results we report recidivism rate (12.3%) after 12 months postoperative follow up. Recurrence rate was (5.5%) presented as (4 cases) complain of recurrent offensive discharge and hearing impairment. on otoendoscopic examination there were attic retraction pocket with keratin debris and small perforation. These cases showed opacity in the attic and mastoid in HRCT.

On the other hand residual rate was (6.8%) presented as (5 cases) without suggestive otoendoscopic findings but they showed considerable opacity in HRCT. In spite we know the low sensitivity and specificity of HRCT in detection of residual disease but

we depend on it as a preliminary method because DWI MRI was not available regularly through the study period. These cases are planned for second look surgery to confirm disease recidivism.

Our results are comparable with results of Tarabishi et al 2004[27], Badr El-Dine et al 2013[17] and Marchioni et al 2013.[15] But we are not agreeing strongly with other studies like Neudert et al 2014.[23], Marchioni et al 2015[28], Alicandri-Ciufelli et al 2016[14], Hunter et al 2016[29].

The later studies reported higher rates of recidivism and this explained by different aspects. Firstly, the longer period of follow up in the later studies. Secondly, we depend in our study only on clinical findings and HRCT which is less sensitive and less specific in residual detection. On the other hand other studies depend mainly on the second look surgery or DWI-MRI for confirmation of disease recidivism.

As regard postoperative audiometric results, the mean pure tone average air–bone gap (ABG) had been decreased to be 24.04 ± 13.37 dB after it was 34.56 ± 8.50 dB preoperatively. The (ABG) had been improved in (72.6%) of cases, unchanged in (23.3%) of cases and worsened in (4.1%) of cases.

Our audiometric results are similar to O'Connell et al 2016[31] as they reported mean ABG was 20.0 db ± 15.4 and 60% achieved normal hearing ABG less than 20 db. But Yawn et al 2017[32] reported better results in the form of mean postoperative ABG 15.9 db and normal hearing in 74.3%.

Improved hearing is explained by disease control, ossicular sparing, successful ossiculoplasty and tympanic membrane grafting, while worsening and unimprovement could be explained by disease recidivism, residual perforation, and tympanic membrane retraction and postponing ossiculoplasty for another setting due to unfavorable condition of the middle ear mucosa.

In our study we found that limited attic cholesteatoma could be managed successfully with total transcanal endoscopic approach without need for mastoidectomy. Also endoscopy adds a great benefit in more extensive cholesteatoma as it made all cases can be managed with CWU approach instead of CWD approach.

Endoscopic ear surgery generally has some limitations: first, the endoscopic approach depends on the experience and skills of the surgeon. Second, operating with one handed prevents the ability to simultaneously dissect and suction the operative field but this point is partially resolved by development of new instruments with suction incorporated in it. Third, fogging and smearing of the tip of the endoscope and the need for frequent cleaning and application of defogging agents affect the operative time. Fourth, the safety of excessive heat dissipation from the endoscope tip is still unclear. Fifth, the mastoid is not accessible by the endoscope, and when the mastoid is involved with the cholesteatoma, a microscopic technique is required. Sixth, as regard length of operation time many admit that although increased familiarity with the equipment and manipulation within the ear, time is negligible between TTEES and microscopic techniques. Finally, the cost of equipment involved is a disadvantage.[2, 15, 24, 27, 33, 34, 35]

Our study has some limitations: first is the relatively small number of the studied patients (73 patients). Second, the short duration of follow up (12 months). Third that we depend only on HRCT with its low sensitivity and specificity in assessment of recidivism and not using the newer techniques in imaging as non echo planner DW MRI techniques, but this is because it was not available regularly during most of the study period. Second look surgery is recommended to confirm disease recidivism.

We recommend in future research to improve and bypass these limitations by including large number of patients and follow them for longer period. Non echo

planner DWI MRI should be used for detection of disease recidivism.

CONCLUSION

Endoscopic ear surgery appears to allow an important reduction of unnecessary mastoidectomies in cases of cholesteatoma limited to the middle ear cavity, favouring the increase of exclusive transcanal middle ear surgeries. Moreover, in cases of pathologies involving the mastoid, endoscopic assistance may promote the choice of canal wall up procedures limiting the rate of recurrences and residual disease typically associated with this approach.

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