Study of the Role of Otoendoscope in Detecting Residual Disease in Cholesteatoma Surgery

Original Article

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ABSTRACT

Introduction: Residual cholesteatoma occurs due to incomplete removal after primary surgery by microscope and is frequently caused by inaccessible locations such as the sinus tympani. The use of the surgical endoscope brought advances in the surgical management of cholesteatoma.

Aim: This work aims to assess microscope-assisted otoendoscopy in cholesteatoma surgical management.

Patients and Methods: Forty patients underwent ear surgery for a cholesteatoma using different canal wall up or canal wall down mastoidectomy techniques. Surgery was initially performed using a surgical microscope. After complete disease excision microscopically, the middle ear and mastoid cavities were examined by otovideoendoscopy, especially sinus tympani, facial recess, anterior epitympanic recess, Eustachian tube, and hypotympanum. Residual cholesteatoma was identified, and its location was reported.

Results: Residual cholesteatoma was found by endoscope in 10 sites; 6, 3, and 1 in sinus tympani, anterior epitympanic recess, and facial recess, respectively. These ten sites were divided into 4 in modified radical mastoidectomy and 6 in conservative approaches.

Conclusion: Endoscopic-assisted ear surgery had much-increased benefits in cholesteatoma surgery. Endoscope had become a crucial complement to the operating microscope through visualizing the middle ear cleft hidden areas and discovering any residual disease in such areas as the sinus tympani..

Key Words: Cholesteatoma Surgery, mastoidectomy, otoendoscope.

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INTRODUCTION

Cholesteatoma is a severe otolaryngologic disorder that continues to be a significant concern and a challenge for otolaryngologists worldwide. Surgical management is the main treatment. One of the common complications is a residual disease in hidden areas. The gold standard for mastoid, middle ear, and lateral skull base reconstruction is microscopic surgery with excellent pathology management and hearing function results. The anterior epitympanum and retrotympanum are anatomical structures that are difficult to visualize using otomicroscopy.[1]

Endoscopic ear surgery is gaining popularity worldwide as a complement and refinement of classic microscopic ear surgery. Endoscopic ear surgery (EES) has several advantages, including a broad field of vision, increased resolution with high magnification, and visual access to the middle ear's hidden passages.[2]

Otoendoscopes with direct and lateral angles provide a vast field of vision, notably in the supratubal recess and sinus tympani with few surgical techniques. As an auxiliary to the microscope, 0, 30°, 45°, and 70° endoscopes are used to remove cholesteatoma from blind places such as the epitympanum, retrotympanum, hypotympanum, and Eustachian tube opening,[3] with less removing of healthy bone and more preserving of temporal bone architecture.[4,5]

The current study aims to highlight the impact of using microscope-assisted endoscopy in cholesteatoma management, evaluate middle ear endoscopy in effective disease control through visualizing middle ear cleft hidden areas.

PATIENTS AND METHODS:

2.1. Subjects

The study was a prospective cross-sectional study that included 40 patients with unilateral acquired cholesteatoma (primary or secondary) randomly selected from the outpatient clinic and operated upon consecutively at the

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Department of Otorhinolaryngology, Cairo University Hospital, during two years period from June 2018 to June 2020.

The forty patients underwent ear surgery by the same surgeon. Surgery was initially performed using a surgical microscope. After complete disease excision microscopically, middle ear and mastoid cavities were examined by otovideoendoscopy, especially sinus tympani, anterior epitympanic recess, facial recess, eustachian tube, and hypotympanum. Residual cholesteatoma was identified, and its location was reported.

All patients who had previous surgery, complicated chronic suppurative otitis media, otitis externa, or otomycosis were excluded from the study.

2.2. Methods

Each participant in the study had to provide signed written informed consent before the study could begin. All patients were subjected to complete history taking, clinical and otological examination using a hand-held otoscope or microscopic examination.

Assessment of pure tone audiometry (PTA) was done Madsen Itera II audiometer (Otometrics, Denmark), for air conduction (AC) and bone conduction (BC) thresholds were calculated at the following frequencies (500, 1000, 2000, and 3000) Hz.

Multislice CT scan petrous temporal bone was performed for assessment of the following: mastoid pneumatization, the position of the tegmen and the sigmoid sinus, dehiscence of the tegmen, facial nerve, or horizontal semicircular canal.

2.3. Operative procedures

General anesthesia & preferred hypotensive anesthesia were done. Examination of the ear under the microscope to confirm the diagnosis of cholesteatoma. Twenty-one patients with Modified radical mastoidectomy (MRM) for extensive cholesteatoma. Nineteen patients underwent conservative approaches for limited attic and posterior mesotympanium cholesteatomas; Five patients with atticotomy, six patients with retrograde atticoantrostomy, four patients with mastoidectomy with antegrade atticotomy, and four patients with cortical mastoidectomy.

A postauricular incision was made, and temporalis fascia was harvested if planned to use it. A periosteal flap was done. The mastoid cortex was exposed. Tympanomeatal flap was elevated, the middle ear was approached through anterior tympanotomy, and the extent of pathology was rechecked. Cortical mastoidectomy was done if it was planed. Antegrade atticotomy was done in 4 cases. The cholesteatoma sac was identified and dissected using operative microscopy (Figure 1). Completion of modified radical mastoidectomy was done in 21 cases. Once cholesteatoma resection under operative microscopy was completed, the endoscope was used to verify the eradication degree of the cholesteatoma. We used 3mm diameter, 11cm length endoscopes. The 0° endoscope provides a good image to perform many surgical steps of any endoscopic operation (Figure 3, 4, 6, 8). Endoscopes with different angles (30, 45 degrees) have been introduced, either transcanal or transmastoid (Figure 2, 5, 9). All previously mentioned middle ear recesses are visualized, and any hidden pathology can be detected and removed endoscopically (Figure 2, 3, 5).

2.4. Statistical Measures

Data analysis was conducted using SPSS version 26 (IBM Corp., Armonk, NY, USA). Data were summarized using mean and standard deviation for quantitative variables and numbers and percentages for categorical variables. Chi-square or exact test was used for comparing categorical data.[6] *P-values* less than 0.05 were considered statistically significant.

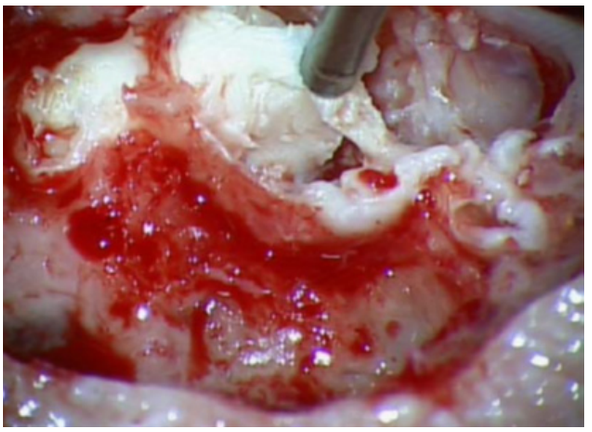

Fig. 1: Microscopic view of a right ear cholesteatoma excision. Squamous debris within the antrum cavity was being debulked with a suction.

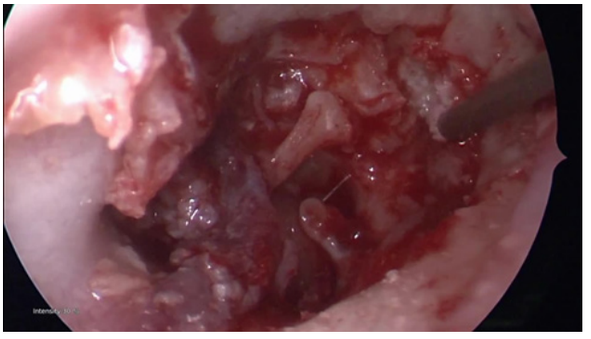

Fig. 2: (left ear) 30º endoscopic view of middle ear cavity showing residual anterior epitympanic cholesteatoma (arrows) after atticotomy and amputation of head of malleus and removal of remnant of incus, S stapes, M malleus.

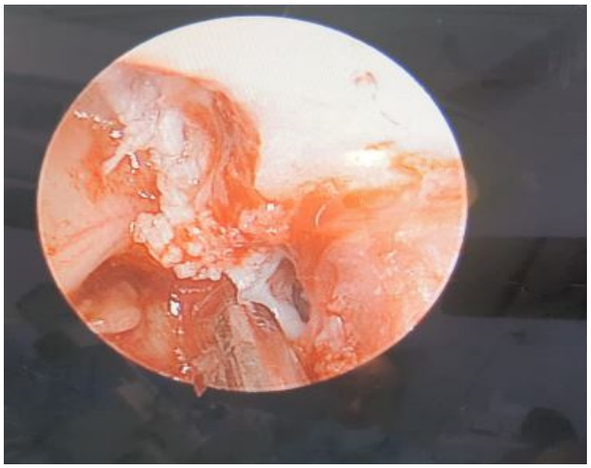

Fig. 3: Endoscopic view of right ear showing residual disease in anterior epitympanic recess (arrows), ET Eustachian tube.

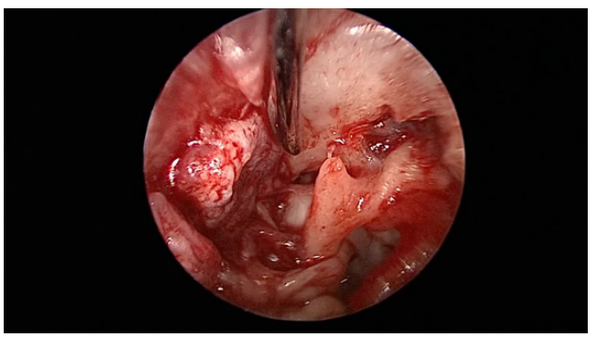

Fig. 4: Endoscopic view of left ear showing no residual disease in anterior epitympanic recess(AER) and Eustechian tube, M malleus.

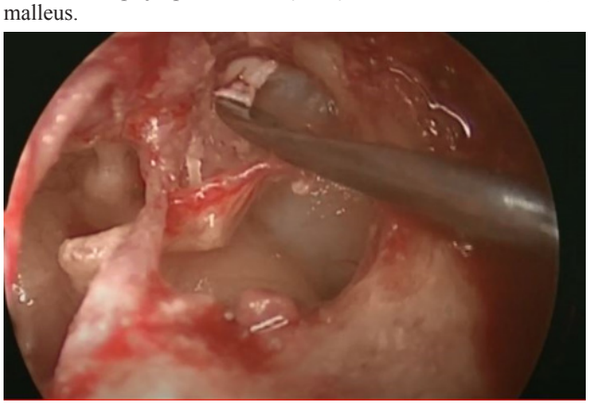

Fig. 5: 30º endoscopic view of left ear showing residual disease in anterior epitympanic recess (arrows).

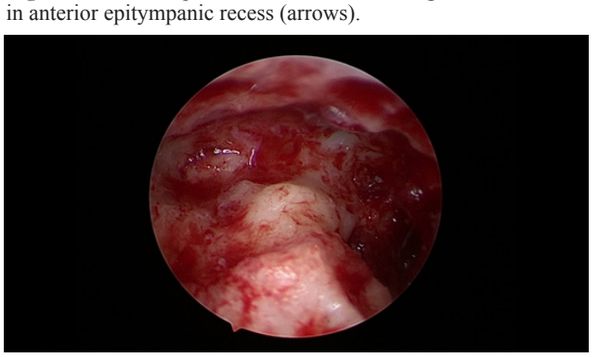

Fig. 6: Right ear view of anterior epitympanic recess(AER) and sinus tympani (ST) in patient with modified radical mastoidectomy which is clear of cholesteatoma, M mastoid, FR facial ridge.

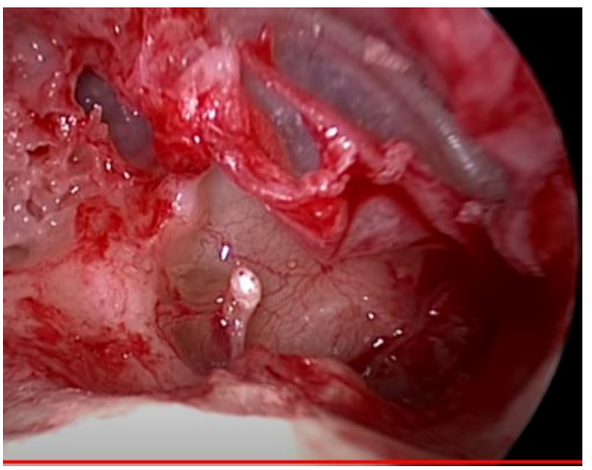

Fig. 8: Endoscopic view of right ear (0° endoscope) showing no residual cholesteatoma in anterior epitympanic area and hypotympanum, M malleus.

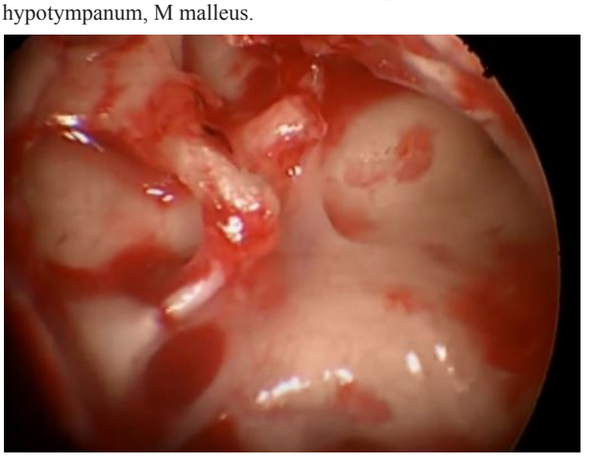

Fig. 9: Endoscopic view of right ear by 30 angled endoscope showing no residual cholesteatoma in Eustechian tube orifice (ET), P pyramid, malleus separated from tensor tympani tendon

RESULTS:

The study included 40 patients with acquired cholesteatoma. The average age of the 40 patients was 37 years [range 12-65 years]. There were 22 female patients and 18 male patients (Table 1). The percentage of each type of surgical intervention is shown in (Figure 13).

3.1. The sinus tympani

By microscope, we found cholesteatoma in ST in 16 patients (Table 2); 13 in patients with MRM (Table 3), and 3 patients with conservative approaches (Table 3). After complete microscopic work, the endoscope found a residual disease in sinus tympani of 6 out of 40 (15%) (Table 4). These 6 cases were divided into 3 cases in the modified radical mastoidectomy approach. In one of them, the sinus tympani was previously cleaned by the microscope, but the endoscope discovered a residual disease. Two cases were not sighted by microscope (Table 5). Three cases in conservative approaches were not detected by microscope (Table 5); one case in retrograde

atticoantrostomy, one case in mastoidectomy, and one case in mastoidectomy with antegrade atticotomy. Total cholesteatoma was found by microscope and endoscope in ST in 21 patients (Figures 6, 10, 11).

3.2. The anterior epitympanic recess

By microscope, we found cholesteatoma in AER of 14 patients (Table 2); 5 in patients with MRM approach (Table 3), and 9 in patients with conservative approaches (Table 3). After complete microscopic work, the endoscope found a residual disease in AER of 3 out of 40 cases (Table 4). These 3 cases were divided into one case in modified radical mastoidectomy approach where the microscope previously cleaned AER, but the endoscope discovered that there was still residual disease (Table 5). Two cases in the conservative approach were not found by microscope (Table 5); one case in atticotomy and one case in mastoidectomy with antegrade atticotomy. We discovered cholesteatoma in the anterior epitympanic recess of 16 individuals using a microscope and an endoscope (Figures 2, 3, 5).

3.3. The facial recess

By microscope, we found cholesteatoma in the FR of 22 patients (Table 2); Sixteen patients with modified radical mastoidectomy approach (Table 3), and six patients with conservative approaches (Table 3). After complete microscopic work, the endoscope detected a residual disease in the facial recess of one case (case of cortical mastoidectomy) that had been missed by the microscope (Table 5) (Figure 11).

3.4. The eustachian tube

By microscope, we found cholesteatoma in the eustachian tube orifice of 6 patients (Table 2); three in patients with the MRM approach (Table 3) and three in patients with conservative approaches (Table 3). After complete microscopic work, no residual cholesteatoma was detected in the eustachian tube orifice by the endoscope (Figures 4, 7, 9).

3.5. The hypotympanum

By microscope, we found cholesteatoma in the hypotympanum in 8 patients (Table 2); three in patients with the MRM approach (Table 3), and five patients with conservative approaches (Table 3). After complete microscopic work, no residual cholesteatoma could be detected in the hypotympanum by the endoscope (Figures 7, 8).

Total residual cholesteatoma was found by endoscope in 10 sites; 6 in ST, 3 in AER, and 1 in FR. These ten sites were divided into four in modified radical mastoidectomy and six in the conservative approach. Those ten sites were found in eight patients as one of them had residual disease in ST and AER, and another patient showed residual disease in ST and FR. The eight patients (20%) with the residual disease were three patients with modified radical mastoidectomy and five patients with conservative approaches (Figure 12) (Table 5).

Table 1: Demographic data of the study population:

	Mean	Standard Deviation	Minimum	Maximum
Age	37.05	15.54	12.00	65.00
			Count	%
Sex		Male	18	45.0%
Female		22	55.0%	

Table 2: Intraoperative microscopic assessment of cholesteatoma of each examined area.

Microscope		Count	%
Patients	Positive	30	75.0%
	Negative	10	25.0%
Sinus tympani	Positive	16	40.0%
	Negative	24	60.0%
Epitympanic recess	Positive	14	35.0%
	Negative	26	65.0%
Facial recess	Positive	22	55.0%
	Negative	18	45.0%
Eustachian tube	Positive	6	15.0%
	Negative	34	85.0%
Hypotympanum	Positive	8	20.0%
	Negative	32	80.0%

Table 3: Intraoperative microscopic assessment of cholesteatoma of each examined area in each procedure separately.

Microscope		Approach			
		MRM		Conservative	
	Count	%	Count	%	
Patients	positive	16	76.2%	14	73.7%
	negative	5	23.8%	5	26.3%
Sinus tympani	positive	13	61.9%	3	15.8%
	negative	8	38.1%	16	84.2%
Epitympanic recess	positive	5	23.8%	9	47.4%
	negative	16	76.2%	10	52.6%
Facial recess	positive	16	76.2%	6	31.6%
	negative	5	23.8%	13	68.4%
Eustachian tube	positive	3	14.3%	3	15.8%
	negative	18	85.7%	16	84.2%
Hypotympanum	positive	5	23.8%	3	15.8%
	negative	16	76.2%	16	84.2%

Table 4: Count and percentage of Residuals seen by endoscope after complete microscopic work.

Endoscope		Count	%
Patients	Positive	8	20.0%
	Negative	32	80.0%
Sinus tympani	Positive	6	15.0%
	Negative	34	85.0%
Epitympanic recess	Positive	3	7.5%
	Negative	37	92.5%
Facial recess	Positive	1	2.5%
	Negative	39	97.5%
Eustachian tube	Negative	40	100.0%
Hypotympanum	Negative	40	100.0%

Table 5: Count and percentage of Residuals seen by endoscope after complete microscopic work in each procedure separately.

Endoscope		Approach			
		MRM		Conservative	
	Count	%	Count	%	
Patients	positive	3	14.3%	5	26.3%
	Negative	18	85.7%	14	73.7%
Sinus tympani	positive	3	14.3%	3	15.8%
	negative	18	85.7%	16	84.2%
Epitympanic recess	positive	1	4.8%	2	10.5%
	negative	20	95.2%	17	89.5%
Facial recess	positive	0	0.0%	1	5.3%
	negative	21	100.0%	18	94.7%
Eustachian tube	negative	21	100.0%	19	100.0%
Hypotympanum	negative	21	100.0%	19	100.0%

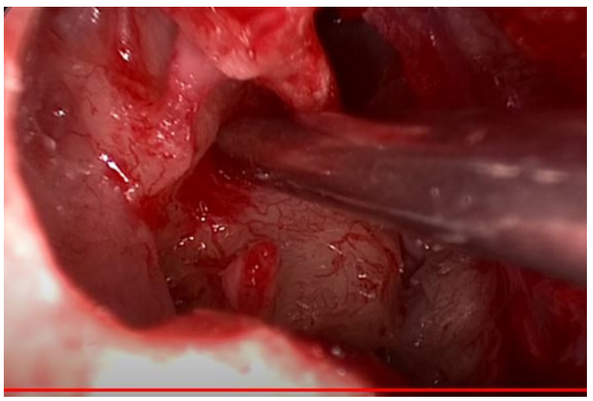

Fig. 7: Endoscopic view of right ear showing no residual cholesteatoma in anterior epitympanic area (AER) and Eustechian tube (ET) and hypotympanum, head of stapes (S).

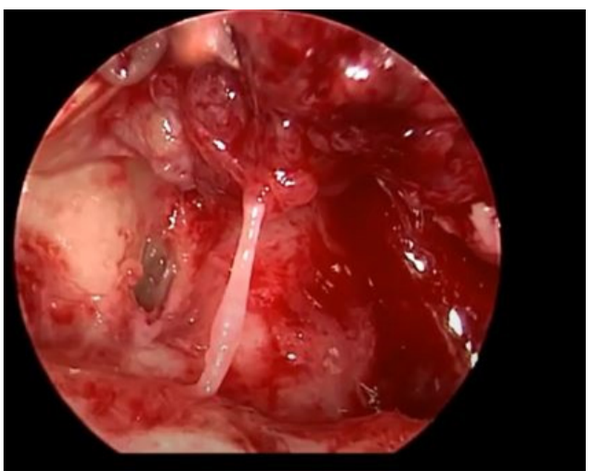

Fig. 10: Endoscopic view of right ear showing clear sinus tympani (ST) and foot plate of stapes(F) (preserved chorda tympani= arrows).

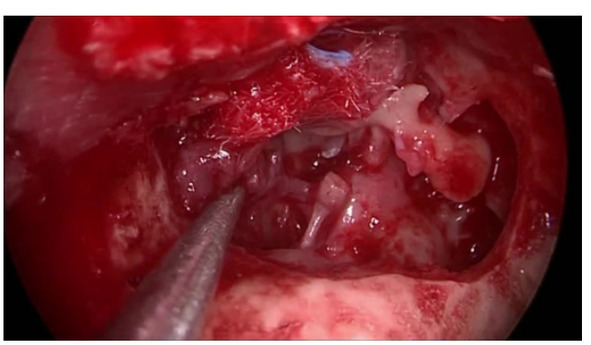

Fig. 11: Endoscopic checkup after atticotomy and removal of incus showing middle ear cavity with no cholesteatoma in sinus tympani, Facal recess, stapes (s) and malleus (m) (left ear).

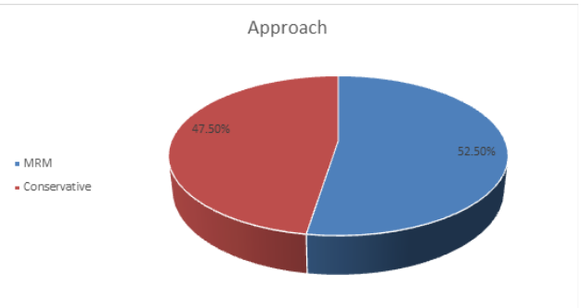

Fig. 12: Pie chart showing distribution of approach between modified radical mastoidectomy and conservative approaches.

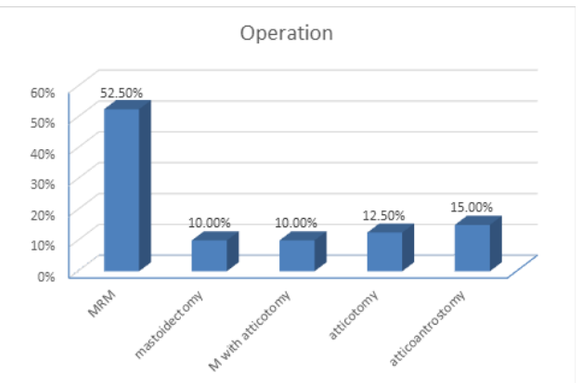

Fig. 13: Chart showing the percentage of each type of surgical intervention.

DISCUSSION

Cholesteatoma surgery continues to be a challenging endeavor. Residual cholesteatoma is a significant cause of surgical failure in cholesteatoma treatment.

While the current surgical microscope provides an unparalleled view during otologic surgery but seeing recesses in the middle ear can be challenging at times owing to the microscope straight-line vision and lighting.[7]

Recurrence rates vary widely by location, and the highest recurrence occurs in the sinus tympani, facial recess, and anterior epitympanum. Endoscopes give excellent views of these difficult-to-reach locations.[5] Endoscopes, in conjunction with high-definition camera systems capable of looking around corners and projecting panoramic magnified pictures of the middle ear (on a screen), have resulted in a total change of middle ear surgery.[8,9]

Total cholesteatoma was found in ST in 21 (52.5%) patients out of 40 patients. Microscope discovered the presence of disease in 16 patients (40%). Residual cholesteatoma was sighted by endoscope in 6 patients (15%) as one patient still had residual disease after complete microscopic work. Endoscope discovered a residual disease in sinus tympani in 6 sites out of 10 sites (60%) of all residuals, which supports that ST is the commonest site of residual disease (*P-value 0.026*) (statically significant).

Nyrop and Bonding[10] reported that the most common area of recurrent disease was ST due to its poor visualization. They also reported that sinus tympani is the most frequent site of residual disease.

Total cholesteatoma was found in AER in 16 (40%) patients out of 40 patients. Microscope discovered the presence of disease in 14 patients (35%). Residual cholesteatoma was sighted by endoscope in 3 patients (7.5%) as one patient still had residual disease after complete microscopic work (*P-value 0.241*) (not statistically significant). Endoscope discovered the residual disease in AER in 3 sites out of 10 sites (30%) of all residuals.

Total cholesteatoma was found in 23 patients in FR by both endoscope and microscope as 55 % of all patients. One patient was discovered endoscopically to have a residual disease (2.5%) which is statistically insignificant (*P-value 1*).

The endoscope found residual cholesteatoma in ten sites, divided into four in MRM and six in the conservative approach. Those ten sites were found in eight patients of the forty patients (20%) (*P-value 0.005*) (three patients with MRM 14.3% and five patients with conservative approach 26.3%). It is reasonable to suppose that all residual cholesteatoma would develop and necessitate another surgery if not eliminated. Conservative approaches were more liable for residual disease.

Conservative therapy of cholesteatoma improves middle ear structure preservation and postoperative care and maintenance. However, it is frequently associated with increased recurrence rates, necessitating rigorous follow-up.[11,12] Overall rates of recurrent cholesteatoma with the microscope by any approach in the literature vary between 20% and 40%. It was about 30% recurrence after CWU and about 10% after CWD.[12]

For instance, in a study of cholesteatoma treated with adjunctive endoscopy, residual rates of 9.4% and 8.7% for closed and open cavities, respectively, were recorded. This study demonstrates that endoscopes have reduced recurrence rates in closed procedures to levels comparable to open techniques.[13]

No residual disease could be detected by endoscope in both Eustachian tube orifice and hypotympanic recess. Microscope discovered cholesteatoma in six patients in Eustachian tube orifice and eight patients in hypotympanic recess. According to Bennett *et al*.[14], no recurrences were observed in the hypotympanum, eustachian tube, or mastoid. As a result, dissection in these locations may be accomplished sufficiently with microscopes alone, and the use of an endoscope offers no further benefit for monitoring residual illness in these anatomic areas.

Mastoid surgery is still mostly performed with a microscope, with endoscopes commonly employed as an adjuvant. Exclusive use of endoscopes in cholesteatoma surgery is not widely accepted. Numerous causes exist; lack of the ease of two-handed operation, loss of depth perception, which results in disorientation, and training workshops that focus only on the microscope. Cholesteatoma dissection from the dehiscent facial nerve, ossicles, and stapes footplate frequently requires two-handed surgery. With only one hand, ossicular reconstruction is extremely difficult to execute. While in drilling, the surgical field is constantly occluded by bone dust, blood, and irrigating fluid.[15]

Endoscopic surgery involves a learning curve, and results highly depend on the surgeon's ability and experience. Endoscopic surgeons observe the monitor through the endoscope, leading to visual and motor axes separation and impaired depth perception. Direct trauma from the endoscope tip to the dehiscent seventh nerve, ossicles, or low-lying tegmen is possible.[16] Additionally, there is a risk of thermal injury associated with the heating of the tip of the endoscope. It is highly recommended that light intensity should be kept < 50%.[17]

CONCLUSION

Endoscopic guided cholesteatoma surgery has become a crucial complement to the operating microscope by visualizing hidden middle ear cleft areas and discovering any residual disease in such areas as the sinus tympani. The endoscope helps us have a wide field of vision with much less surgical exposure and the need to drill healthy bone, which is required by conventional techniques. Incorporating the endoscope into surgical methods in otology contributes much to the concept of more conservative surgery with the establishment of functional endoscopic ear surgery.

ABBREVIATIONS

AC: Air conduction

AER: Anterior Epitympanic Recess

BC: Bone Conduction

CWA: Canal Wall Up

CWD: Canal Wall Down

EES: Endoscopic ear surgery

FR: Fascial Recess

MRM: Modified radical mastoidectomy

PTA: Pure Tone Audiometry

ST: Sinus Tympani

CONFLICT OF INTEREST

There are no conflicts of interest.

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