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A comparative study of middle ear evaluation by otomicroscopy and otoendoscopy in cases of chronic suppurative otitis media

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ABSTRACT

Purpose: Chronic suppurative otitis media (CSOM) is one of the common causes for hearing impairment and disability. Despite continuous technical improvements, the basic optical principles and their limitations have remained the same over the past three decades. This study was aimed at visualizing and evaluating the middle ear structures with the aid of an otomicroscope and 0, 30 and 70 degree-angled endoscopes in cases of chronic suppurative otitis media.

Methods: In this prospective study, 100 patients (63 males and 37 females) above the age of 10 years with CSOM were subjected to both otomicroscopy and otoendoscopy. The visualizations of middle ear structures were compared and statistically analyzed.

Results: Middle ear structures were better evaluated with 30 and 70 degree endoscopes ($p < 0.05$) than with a microscope. No statistically significant ($p > 0.05$) advantage of endoscopes over microscopes was detected in examining middle ear mucosa. However, the microscope was better than a 70 degree endoscope in visualization of the mouth of the retraction pocket.

Conclusion: Endoscopy provided a significantly better visualization for all the parameters studied versus a microscope. It is desirable to study the role of the endoscope in more cases of unsafe CSOM and also intraoperatively.

Key words: *Otoendoscopy, otomicroscopy, suppurative otitis media, middle ear, middle ear disease*

Introduction

Chronic suppurative otitis media (CSOM) is one of the common causes of hearing impairment and disability. The tympanic membrane is the window to the middle ear, but merely observing it with the naked eye is not sufficient for accurately diagnosing the pathology. The otologist has a large range of technological support at their disposal, such as the otologic microscope and otoendoscope, to visualize and document the pathologies of the middle ear, these being essential for surgical intervention [1]. Visual inspection supported by anamnestic information is the primary element in correctly formulating a diagnosis in otology [1]. Among the 65-330 million people affected worldwide, 60% receive significant hearing loss [2]. High-resolution fibers passed through the nasal cavity have been used to inspect the lumen of the Eustachian tube, sometimes being passed all the way into the middle ear cavity [3-5]. In the safe types of CSOM – tubotympanic - the infection was found to be limited to the mucosa and the

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anteroinferior part of the middle ear cleft without any risk of bone erosion, commonly associated with frequent upper respiratory tract infections. The discharge increases with the frequency of upper respiratory infections, and is attenuated by antibiotic treatment [6]. Unsafe disease - atticoantral - features erosion of the bony wall of the attic and cholesteatoma is commonly found. Surgical management is recommended [7].

Despite continuous technical improvements, the basic optical principles and their limitations have remained the same over the past three decades [8]. However, there have been limitations of the microscope during visualization of the posterosuperior area of tympanic cavity and blind niches. Middle ear endoscopy is a useful adjunctive or alternative method for microscopic surgical exploration of middle ear pathology [9]. A rigid endoscope can be employed to visualize and evaluate the extent of middle ear disease, assess ossicular integrity and explore the hidden niches of the middle ear, i.e., sinus tympani, facial recess, attic, hypotympanum, protympanum, Eustachian tube, etc. Incorporation of otoendoscopy in middle ear surgery provides the surgeon with better control over the pathology and therefore achieves enhanced eradication of disease [8]. However, the disadvantages of otoendoscopy include loss of binocular vision and depth perception, which are appreciated well in otomicroscopy. Furthermore, there is a distortion factor while using an otoendoscope. It is desirable to study role of otoendoscopy versus otomicroscopy in CSOM in the outpatient setup so that more cases can be correctly diagnosed. The aim of this study was to visualize and evaluate the middle ear structures with the aid of an otomicroscope and 0, 30 and 70 degree-angled endoscopes in cases of CSOM and compare the visualization of middle ear structures.

Subjects and Methods

This prospective study included 100 patients with CSOM who had presented to the Ear, Nose and Throat (ENT) Outpatient Department from September 2011 – October 2013. All CSOM patients were above the age of 10 years and agreed to both otomicroscopy and otoendoscopy were included in the study. All preoperative cases of tympanoplasties and mastoidectomies were also included. Informed consent was obtained from all patients before their inclusion. The study proto-

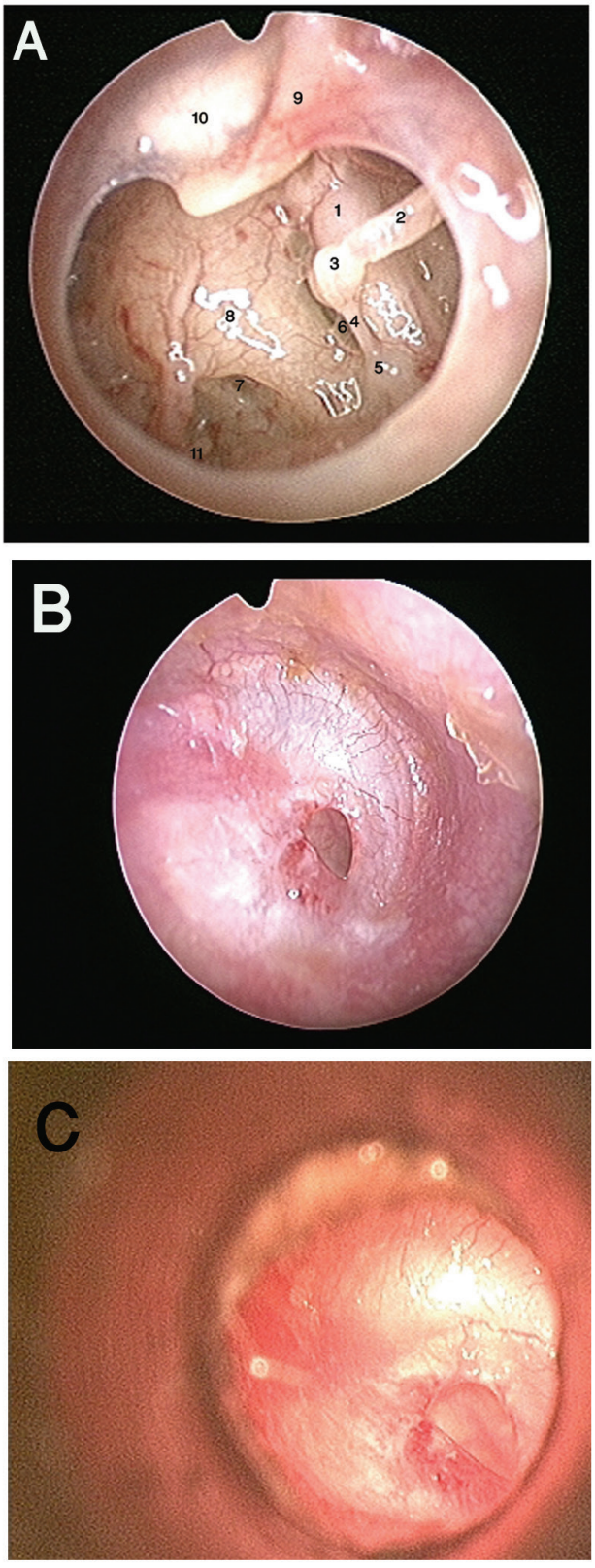

Figure 1. Visualization of middle ear structures by: A) Otoendoscopy - shows clarity of structures in a large central perforation, left ear (markings - 1. Tympanic segment of facial nerve; 2. Long process of incus; 3.Incudo stapedial joint; 4. Stapedius tendon; 5. Pyramid; 6. Stapes footplate; 7. Round window niche; 8. Promontory with tympanic plexus; 9. Handle of malleus; 10. Tympanosclerotic patch on anterosuperior aspect of remnant pars tensa; and 11. Hypotympanic cells. B & C) Otoendoscopy and otomicroscopy of a small-sized central perforation, right ear.

col was approved by the institutional ethics committee.

Exclusion criteria: Cases below 10 years of age, uncooperative patients, patients with otitis externa, wax granuloma, furunculosis, canal stenosis and all external auditory canal pathologies, such as external auditory canal polyps, were excluded from the study.

A detailed history and ENT examination of all patients was conducted followed by otoscopic evaluation of the ear. Patients were educated about both procedures and written informed consent was acquired prior to undertaking them. Both the procedures were performed in the same sitting. The patient was placed in the supine position with the ear to be examined uppermost. After suction clearance of the ear, a proper otomicroscopic evaluation was carried out (Figures 1 A, 1B and 1C). A Zeiss Opmi Pico Microscope (Jena, Germany) was used in the study. Comeg (Tuttlingen, Germany) 4mm diameter, 175mm long rigid 0, 30 and 70 degree nasal endoscopes attached to an external light source were used to visualize and evaluate the middle ear.

The middle ear structures assessed were the middle ear mucosa, medial wall of the middle ear (round and oval window area), auditory ossicles (malleus, incus, stapes), Eustachian tube, retraction pockets and blind niches (sinus tympani, facial recess, attic, hypotympanum). The percentage of cases of visualization using both techniques were calculated and subjected to statistical analysis.

Statistical Analysis

The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS; version 16.0, IBM, New York, USA). The Chi-square test was applied to determine statistical significance to compare middle ear evaluation with microscopy and 0, 30 and 70 degree endoscopy. A p-value of less than 0.05 was considered significant.

Results

In this prospective study, 100 patients (63 males and 37 females) with CSOM were studied, among which 20 were of the unsafe type and the rest (80) were of the safe type (Table 1).

Cases of the safe type of CSOM

The study included 80 patients with chronic CSOM. As narrow external auditory canal (EAC) was not present, no advantages were found with respect to visualizing EAC using either a microscope or various endoscopes. Similarly, no significance in visualization of middle ear mucosa pathology was observed with either technique (Figure 2). Full visualization of round window niche using endoscopes of 30o (p <0.01) and 70o (p <0.01) were better than with the microscope (Table 2). 33 cases (41.2%) were fully and 23 cases (28.8%) were partially visualized by 30o endoscopes, where as using the70o endoscopes, these were 29 (36.3%) and 26 (32.4%) cases, respectively.

Table 1. Sex distribution in all the 100 CSOM cases evaluated.

Group	Sex		Total
	Female	Male	
Unsafe	3	17	20
Safe	34	46	80
Total	37	63	100

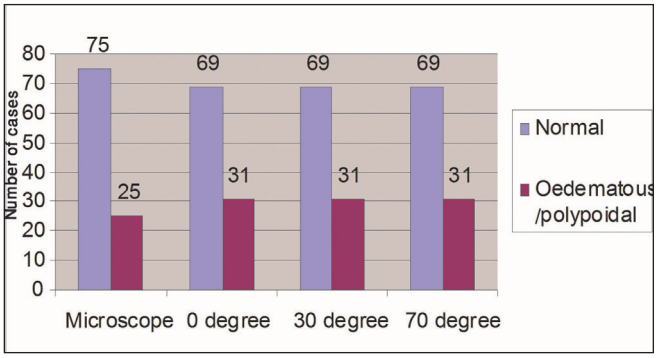

Figure 2. Visualization of middle ear mucosa. (n = 100); P > 0.05 - non-significant with respect to the microscope group.

The visualization of the oval window area using the microscope and various endoscopes is depicted in Table 2. Fully visualized oval window area was highly significant with both the 30o and 70o endoscopes. However, visualization of the facial recess was non-significant with either microscopic and various endoscopic techniques (Table 3). Visualization of the fundus of the retraction pocket with the microscope compared to the 0 degree and 70 degree endoscope showed statistical significance ($p < 0.01$). With 30 degree endoscopy, there was high statistical significance versus microscopy ($p < 0.001$) (Figure 3).

Visualization of sinus tympani exhibited significance for both the 30o (p <0.01)and 70o endoscopes ($p < 0.001$) (Table 3). Visualizations of pyramid and stapedius tendons were significant for the 30o and 70o endoscopes when compared to that using the microscope at zero percent (Table 4). We found significance

Table 2. Visualization of medial wall of middle ear (round and oval window area) using microscope and various endoscopes.

Medial wall of middle ear	Microscope		Endoscope 0°		Endoscope 30°		Endoscope 70°	
	No.	%	No.	%	No.	%	No.	%
Round window niche								
Not visualized	63	53.8	58	47.4	44	30.0	45	31.3
Fully visualized	3	3.8	9	11.3	33	41.2	29	36.3
Partially visualized	34	42.4	33	41.3	23	28.8	26	32.4
				NS		p <0.01		p<0.01
Oval window area								
Not visualized	76	70.0	72	65.0	51	38.8	45	31.2
Fully visualized	2	2.5	10	12.5	21	26.4	23	28.8
Partially visualized	22	27.5	18	22.5	28	35.0	32	40.0
				NS		p<0.001		p<0.001

n=100

Table 3. Visualization of blind niches (sinus tympani, facial recess, attic, hypotympanum) using microscope and various endoscopes.

Blind niches	Microscope		Endoscope 0°		Endoscope 30°		Endoscope 70°	
	No.	%	No.	%	No.	%	No.	%
Facial recess								
Not Visualised	100	100	100	100	99	98.8	95	93.8
Visualised	-	-	-	-	1	1.2	5	6.2
				NS		p>0.05		p<0.05
Sinus tympani								
Not Visualized	100	100	100	100	94	92.5	84	80.0
Visualized	-	-	-	-	6	7.5	16	20.0
				NS		p<0.01		p<0.001
Hypotympanum								
Not Visualized	97	96.2	92	90.0	55	43.8	47	33.8
Visualized	3	3.8	8	10.0	45	56.2	53	66.2
				NS		p<0.001		p<0.001

n=100

in the visualization of the handle of malleus, long process of incus, incudo stapedial joint, stapes supra structure, Eustachian tube opening and the hypotympanum with the 30o and 70o endoscopes versus the microscope (Table 4 and Figure 4). The lateral attic wall destruction with both techniques was found to be non-significant.

Cases of Unsafe Types of CSOM

With the unsafe type of CSOM (n = 20), there were cases of retraction pockets (17) as well as cases of lateral attic wall destruction (eight), out of which five cases had more than one pathology. In the present work, the mouth of the retraction pocket was visualized with the microscope and the 0 an d 30-degree endoscopes in the same number of patients (17). With the 70 degree endoscope, only 12 could be visualized, as in 5 cases, it was difficult to maneuver the scope, primarily because of patient non-compliance and secondary pain. This was a disadvantage that evolved throughout the study. The visualization of both the mouth of retraction pockets in unsafe CSOM and lateral attic wall destruction in safe CSOM were found non-significant when using either endoscopes or microscope.

Discussion

In the work presented here, the EAC was visualized in all 100 cases with both the microscope and endoscopes, but there was no additional advantage as there

Table 4. Visualization of stapes, handle of malleus, incudo stapedial joint and long process of incus using microscope and various endoscopes.

	Microscope		Endoscope 0°		Endoscope 30°		Endoscope 70°	
	No.	%	No.	%	No.	%	No.	%
Stapes supra structure								
Not Visualized	85	81.2	81	76.2	54	42.5	49	36.3
Visualized	15	18.8	19	23.8	46	57.5	51	63.7
				NS		p<0.001		p<0.001
Stapedius tendon								
Not Visualized	100	100	100	100	89	86.2	90	87.5
Visualized	-	-	-	-	11	13.8	10	12.5
				NS		p<0.001		p<0.001
Handle of malleus								
Not Visualised	79	73.8	72	65.0	63	53.8	59	48.8
Visualised	21	26.2	28	35.0	37	46.2	41	51.2
				NS		p<0.01		p<0.01
Incudo stapedial joint								
Not Visualised	82	77.5	76	70.0	54	42.5	50	37.5
Visualised	18	22.5	24	30.0	46	57.5	50	62.5
				NS		p<0.001		p<0.001
Long process of incus								
Not Visualized	92	90.0	88	85.0	76	70.0	72	65.0
Visualized	8	10.0	12	15.0	24	30.0	28	35.0
				NS		p<0.01		p<0.001

n=100

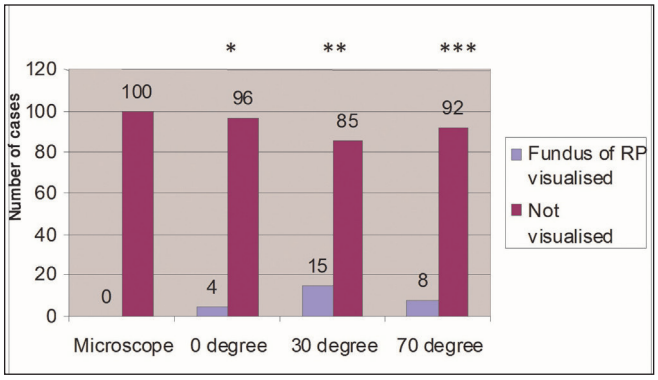

Figure 3. Visualization of fundus of retraction pockets in safe CSOM using microscope and various endoscopes. (n = 100);* p < 0.05, ** p <0.01 and *** p<0.001 - significantly different from the microscope group.

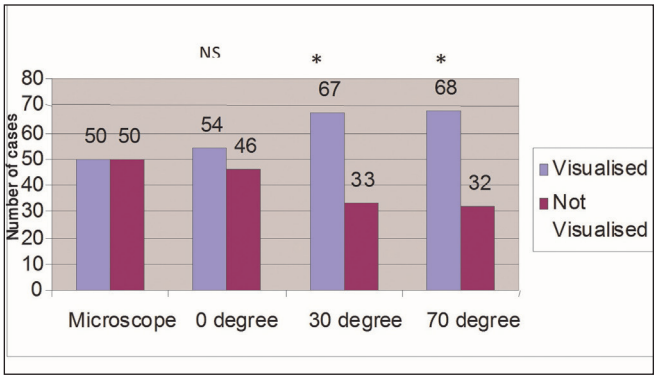

Figure 4. Visualisation of Eustachian tube opening using microscope and various endoscopes. (n=100); * p < 0.01 significantly and NS (p >0.05) - non-significantly different from the microscope group.

were no narrow EACs.

Evaluation of middle ear mucosa in this study (n = 80) showed no statistically significant advantage of endoscopes over the microscope, though appreciation was better with endoscopes as follows. With all three endoscopes, oedematous changes were appreciated in 28 cases compared to 23 cases with the microscope. In three cases, all three endoscopes showed polypoidal changes compared to 2 cases with the microscope. Visualization of round window niche with the zero degree endoscope versus the microscope showed no statistical significance. With the 30 and 70 degree endoscopes, there was a definite advantage over the microscope and this was statistically significant. Our results were supported by the Klug et al. and Livi et al. studies that found the round window niche was better visualized with the wider angle of the 30-degree endoscope [1,10].

Ghaffar et al. demonstrated that the medial wall of

the middle ear was best viewed with the 30 degree endoscope [8]. The oval window area in this study, comparing the zero degree endoscope with the microscope, exhibited no statistical significance. However, both the 30 and 70 degree endoscopes when compared with the microscope demonstrated high statistical significance.

Livi et al. and Tarabichi had previously observed that the facial recess is best viewed with a 70 degree endoscope. In this study, the facial recess was not visualized with either microscopy or 0 degree endoscopy [1,11]. With 30 degree endoscopy, just one case was visualized. However, with 70 degree endoscopy, five cases were visualized, and this was statistically significant compared to microscopy.

The sinus tympani was not visualized with either the microscope or 0 degree endoscope. Yet, when comparing the 30 degree endoscope with the microscope, statistical significance was present. On the other hand, the 70 degree endoscopy versus microscopy exhibited high statistical significance.

Toth et al. employed the transtympanic approach and studied detailed anatomical descriptions of the medial wall, the auditory ossicles, stapedius muscle and the pyramid with 30 degree endoscopes [12]. In their study, the pyramid was not visualized with either microscopy or the 0 degree endoscope. With 30 degree and 70 degree endoscopy, 10 cases were visualized for both versus microscopy. Of relevance is that Neri et al., in their studies, demonstrated pyramidal eminence and pyramidal crest with a 30 degree rigid endoscope and compared it with virtual endoscopy [13].

We found that the stapedius tendon was not visualized with both microscopy or 0 degree endoscopy, though 30 and 70 degree endoscopy showed high statistical significance when compared to microscopy. Previously, Neri et al. demonstrated that the stapedius tendon could be visualized by means of rigid endoscopy rather than virtual endoscopy [13].

The auditory ossicles were evaluated using a transtympanic and transmastoid approach with 0 and 30 degree endoscopes, inferring that the transmastoid approach had the least clinical importance for viewing the ossicles, according to Toth et al. [12]. Visualization of the handle of malleus exhibited no statistical significance with the 0 degree endoscope versus the microscope. However, both the 30 and 70 degree endoscope yielded statistical significance. Klug et al. and Livi et al. had stated that the long process of incus and the whole of the medial wall was better evaluated with a 0 degree endoscope [1,10]. The comparison of otomicroscopy with 0 degree endoscopy of the long process of incus in this study found no statistical significance, whereas with 30 degree endoscopy, compared to microscopy, statistical significance was achieved. Similarly, 70 degree endoscopy had an advantage over microscopy.

Klug et al. and Livi et al. put forth that the incudo stapedial joint is best viewed with a 0 degree endoscope [1,10]. Incudostapedial joint visualization in this study showed no significance during comparison with microscopy and 0 degree endoscopy. With this, both 30 and 70 degree endoscopy had a statistically significant advantage over microscopy.

The Eustachian tube opening when visualized with a microscope and 0 degree endoscope showed no statistical significance. Meanwhile, both 30 and 70 degree endoscopy showed statistical significance when compared with the microscope. Klug et al. and Karhuketo et al. described that the tympanic orifice of the tube can be seen better with a 70 degree endoscope [10,14]. We did not find any significance with microscopy or 0 degree endoscopy when visualizing the hypotympanum. Yet, both 30 and 70 degree endoscopy showed high statistical significance.

In cases of the unsafe type of CSOM, the mouth of the retraction pocket was visualized with the microscope and 0 and 30 endoscopes in the same number of patients. With the 70 degree endoscope, only 12 could be visualized, and for the remaining cases, it was difficult to maneuver the scope because of patient noncompliance secondary to pain. This was a disadvantage that evolved with 70 degree endoscopy.

Horlbeck mentioned that the use of an endoscope has been extended beyond its use as a tool for diagnosing middle ear disease [9]. Middle ear endoscopes have been utilized in place of the operating microscope for management of deep retraction pockets with attic cholesteatoma. In Aoki's study on endoscopically-assisted cholesteatoma surgery, it was concluded that total resection of cholesteatoma was possible by transcanal atticotomy combined with the use of a rigid endoscope [15].

In the work presented here, lateral attic wall destruction visualized with a microscope and in comparison with all the three endoscopes showed no statistical significance. Eight cases were equally well-visualized with all modalities. As the lateral attic wall is on the same visual axis as that of the microscope, unless and until there is a narrowing of canal, there need be no difficulty in viewing it, hence being no different from the endoscopes. In cases of a posterosuperior pathology, the angled endoscopes are definitely better for visualization as the area to be explored is in parallel to the axis of the scope, not possible with a microscope without repeatedly repositioning the patient [16].

Conclusion

The results of this study concluded that zero degree endoscopy was better than microscopy in all parameters despite not being statistically significant. The microscope was better for visualization of the mouth of retraction pocket than a 70 degree endoscope when taking into account that only 20 cases of unsafe CSOM were evaluated in this study. Middle ear structures were better evaluated with both 30 and 70 degree endoscopes (highly statistically significant) than a microscope.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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