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Review Article

Ear, Nose and Throat Section

Value of Endoscopy in Cholesteatoma Clearance: A Systematic Review

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ABSTRACT

Introduction: The primary goal of cholesteatoma surgery is to eradicate it from the middle ear cleft. However, due to linear axis of illumination of the microscope, in some of the recesses or hidden areas in middle ear are not visualised. To overcome this, many studies have been done on the complimentary use of endoscopes in visualising these hidden areas.

Aim: To assess the outcome of complimentary use of endoscopes in addition to microscope on improved access to hidden areas in the middle ear and resultant cholesteatoma clearance.

Materials and Methods: In this systematic review, literature search was conducted using the keywords both manually and electronically in PubMed, Google scholar and Directory of Open Access Journals for articles published till December 2021 at ESIC Medical College and PGIMSR, Bengaluru, Karnataka, India. The primary inclusion criteria used was all full text original, both prospective and retrospective, articles in which endoscopes were used as an adjunct to microscope for cholesteatoma clearance from middle ear cleft. Retrieved articles were reviewed by two independent authors for their eligibility for inclusion in the study. The selected original papers were analysed. Data was entered in Microsoft Excel 2007 and analysed for descriptive statistics like frequency and proportions.

Results: A total of 48 studies were identified initially. After removing duplicates, screening was done for title, abstracts and full text retrieval to check for inclusion criteria being met. Six studies were found using complimentary endoscopes for cholesteatoma surgery and were analysed. Of these, four were prospective and two were retrospective studies. Total 604 patients underwent endoscopic examination after microscopic clearance. Residual cholesteatoma was seen in 105 patients (17%), which were cleared with endoscopic assistance.

Conclusion: Complimentary endoscopy detects residual cholesteatoma in significant number of cases during primary cholesteatoma surgery. In cholesteatoma surgery, they are predominantly used as observational tools.

Keywords: Mastoidectomy, Middle ear, Otoendoscopy, Sinus tympani

INTRODUCTION

The word “cholesteatoma” was coined by Johannes Muller in 1838, meaning it is a tumour of adipose tissue. It is a misnomer as it is neither a tumour nor adipose tissue. Schuknecht described it as collection of foliated keratin in the middle ear cleft originating from keratinised epithelium. It is abnormal three dimensional, non neoplastic, usually one sided mass or structure seen in the pneumatised parts of the temporal bones. They are formed by desquamated keratin and squamous debris accumulation with peripheral fibrous matrix and inflammatory area [1,2].

Cholesteatoma is of two types, congenital and acquired. Congenital is one which is usually seen behind the intact drum in infants and young children. Whereas acquired is one which is associated with retraction pocket and middle ear disease. This abnormal structure is locally invasive and it can result in destruction of structures in and around the middle ear cleft by osteolytic properties. Because of this it can cause morbidity and mortality, especially in underdeveloped countries [3].

Surgery is the treatment of choice for cholesteatoma. Principle of the surgery is to eradicate the disease, preserve the auditory mechanisms and if possible retain the anatomy of temporal bone. Canal Wall Down Mastoidectomy (CWDM) is used more often than Canal Wall Up Mastoidectomy (CWUM) with almost similar hearing results. Concern in both these procedures is the recurrence of the cholesteatoma. Canal wall down mastoidectomy gives better cholesteatoma clearance but has cavity problems [1,2,4]. Canal wall up mastoidectomy is more physiological but carries higher risk of cholesteatoma recurrence, almost three times more than canal wall down mastoidectomy [5].

Traditionally these mastoid surgeries are done under operating microscope. Concern in either of the procedures is the risk of residual disease because of failure to clear the cholesteatoma from middle ear cleft. Incidence of residual cholesteatoma is in the range of 10 to 42% [6,7].

Many studies were done on the use of endoscopy as complimentary tool to visualise and clear cholesteatoma from hidden deep recesses in the middle ear cleft. Majority of these studies indicate complimentary endoscopy is useful in detecting the residual cholesteatoma in hidden areas in the middle ear cleft, though in varying percentage of cases. Some papers also report that this complimentary endoscope helped in removing the disease from hidden areas and in some cases reduced the extent of dissection. Most of the studies published are non randomised and non comparison studies [6-11]. Aim of this review was to evaluate the results of such studies to determine the value of this adjuvant endoscopy in cholesteatoma clearance.

MATERIALS AND METHODS

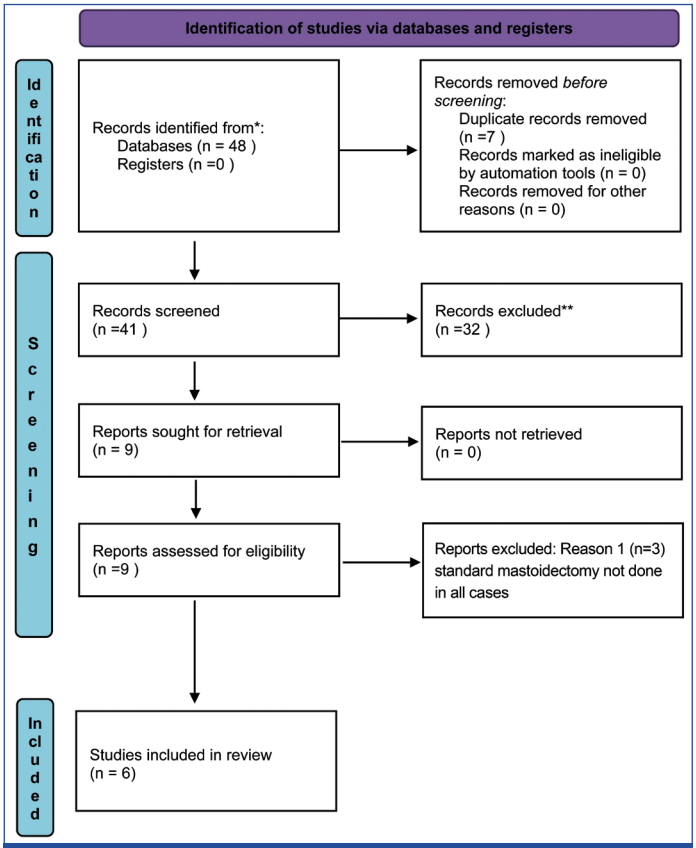
In this systematic review, literature searches were carried out between January 2022 and February 2022 on PubMed, Google Scholar and Directory open access journals databases at ESIC Medical College and PGIMSR, Bengaluru, Karnataka, India. The search strategy included the use of key words as follows: otoendoscopy, residual cholesteatoma, otoendoscopy in cholesteatoma. Priority was given to studies on the application and impact of ear endoscopy as an ancillary method in the management of cholesteatoma. The search was limited to papers published till December 2021.

Inclusion criteria: All full text original (randomised controlled trials, non randomised controlled trials, cohort studies/articles published till December 2021 in which endoscopes were used as an adjunct to microscope for cholesteatoma clearance from middle ear cleft.

Exclusion criteria:

- Articles not in English language
- Animal studies

Retrieved articles were reviewed by two independent authors for their eligibility for inclusion in the study. Both the reviewers agreed with the articles included in the study. The present study included original papers on the use of endoscopy as complimentary tool to visualise and clear cholesteatoma from hidden deep recesses in the middle ear cleft. Case reports, letters to the editor, papers published in meeting proceedings, and papers in which the analysed sample was not statistically significant were excluded. The selected original papers were analysed for compliance with the criteria described above [Table/Fig-1].



[Table/Fig-1]: Search and selection process of the studies.

Data on authors, clinical diagnosis, and number of participants enrolled, participant age range, number and sites of residual cholesteatoma detected with endoscopy during surgery were summarised for the selected papers.

STATISTICAL ANALYSIS

Data was entered in Microsoft Excel 2007 and analysed for descriptive statistics like frequency and proportions.

RESULTS

After the initial search 48 articles were identified. On removing duplicates, 41 articles remained. After screening the title and abstracts, nine articles were selected. Full text retrieval of these articles was done. Three papers,which met the selection criteria, but where standard mastoidectomy was not done in all cases were excluded [Table/Fig-2] [4,12,13]. Finally, six articles where endoscopy was done to look for residual cholesteatoma after its apparent clearance under operating microscope were included in the study [Table/Fig-3] [6-11].

Study	Reason for exclusion
Badr-El-Dine M et al., (2013) [12]	Standard mastoidectomy not done in all the cases.
Ayache S et al., (2008) [13]	Standard mastoidectomy not done in all the cases.
Abtahi SH et al., (2015) [4]	Endoscopy done before standard mastoidectomy.

[Table/Fig-2]: Reason for paper exclusion after applying selection criteria [4,12,13].

In these studies, there were a total of 604 patients who underwent endoscopic examination after microscopic clearance. Residual cholesteatoma was seen in 105 patients (17%), which were cleared with endoscopic assistance. Percentage of residual cholesteatoma detected by endoscopy after obvious cholesteatoma clearance under operating microscope varied from 11% to 30% between different studies. Common areas of residual cholesteatoma were sinus tympani, facial recess, and anterior epitympanic space [6-11].

DISCUSSION

Introduction of operating microscopein otology has revolutionised the field of ear surgery. It gives bright illumination along with magnification and binocular vision, which is very important to have depth perception. Microscope can be moved in different directions as per need, and then it can be fixed in the desired position. This will leave both hands of the surgeon free for carrying out the fine surgery. In surgery under microscope, hand eye coordination is better as both visual axis and movements of the hands are inline. However, microscope also has some shortcomings. Illumination of the microscope traverses in straight line, so it will not be able to visualise the deep recesses in the temporal bone [6,7].

To overcome this linear axis of illumination of the otologic operating microscope various procedures were tried, like Buckingham mirror, flexible and rigid endoscopes. Endoscopes were introduced two centuries ago by German physician Philippi Bozzini. From then endoscopes were primarily used in urologic surgeries. Mer in 1967 was the first to advocate endoscope for middle ear surgery.

Study variables \ Authors	Elfeky AEM et al., (2019) [6]	Good GM and Isaacson G, (1999) [7]	Biswas D et al., (2014) [8]	Gupta N et al., (2019) [9]	Verma B et al., (2017) [10]	Sajjadi H, (2013) [11]
Total number of patients	150	29	40	20	116	249
Age range (years)	15-55	3-18	9-58	25-55	18-55	4-82
Study design	Prospective	Retrospective	Prospective	Prospective	Prospective	Retrospective
Residual cholesteatoma (n, %)	27 (18)	7 (24)	5 (12.5)	6 (30)	13 (11)	47 (19)
Sites of cholesteatoma						
Sinus tympani	24	6	5	6	7	29
Facial recess	15	0	0	0	4	0
Anterior epitympanic space	5	0	0	6	2	18
Supratubal recess	5	0	0	0	0	0
Tubal area	4	0	0	1	0	0
Hypotympanum	4	0	0	0	0	0
Oval window area	0	1	0	0	2	0

[Table/Fig-3]: Characteristics and outcomes of the study reviewed [6-11].

They used fiber-optic endoscopes to visualise the recesses [8]. Since then significant improvements in technology has resulted in availability of smaller diameter and angled endoscopes with high resolution camera systems. These improvements have enabled them to be used in small spaces to visualise the deep recesses in the complex middle ear cleft. They give magnified panoramic view of the deeper structures so that surgeon can address the disease in them [5,14]. With all these advantages some surgeons are using solely endoscopes for cholesteatoma clearance from the middle ear cleft.

However, endoscopes do have some limitations like, one of the operating surgeons hand will be engaged in holding endoscopes all the time. So, surgeon has to operate with one hand only. So, it is not possible to clear the disease from certain areas like facial nerve, ossicles where two handed technique is required. Some of the space will be occupied by the endoscope in the ear, limiting the movement of the surgical instruments, affecting the quality of the work. With endoscopic method there will be difficulty in achieving haemostasis within the narrow filed, if there is bleeding during the procedure. In endoscopic surgery, surgeon has to operate looking at the monitor which is not line with the operating motor axis. It requires training and time for surgeon to get used to this kind of procedure. There will be frequent fogging of the endoscope tip, which requires repeated removal to clear the tip and application of defogging solution. This increases the duration of the surgery. Then there is long learning curve for surgeons to get used to the endoscopic ear surgery, during which complications tend to happen [12,15,16]. Because of all these reasons, it is difficult to do the cholesteatoma surgery solely with endoscopes. Majority of the work can be carried out under operating microscope, while endoscopes can be used as complimentary to operating microscope to visualise and clear the disease from hidden areas or deep recesses, which are otherwise not visible under it.

Recidivism of cholesteatoma may be because of incomplete clearance during surgery (residual) or development of cholesteatoma again after complete clearance in the primary surgery (recurrent). Residual cholesteatoma, which is due to incomplete clearance in the primary surgery, is usually due to failure to visualise the cholesteatoma in the deep recesses of the complex middle ear cleft, also called as hidden areas. The rate of residual cholesteatoma depends on the type of mastoidectomy done. In canal wall up procedure the residual rate it is 20-70%, while it is 12-21% in canal wall down mastoidectomy [1,17,18]. Endoscopes with distal illumination and panoramic view will enable the surgeon to observe these deep recesses and help in clearing the disease from these areas without need of much dissection and bone removal, resulting in reduced healing time.

Common areas of recurrence are sinus tympani, facial recess, between stapes crura and anterior epitympanic space [12,19,20]. Among these sinus tympani is the most common site, accounting for 35% of the all residual cases. Sinus tympani can be seen in all cases with angled endoscopes while seen only in 20% of the cases with microscope [12,21]. All these areas located in the tympanic cavity, highlighting the need to examine these areas, rather than mastoid air cells, to reduce the chance of residual disease.

Badr-El-Dine M et al., found that sinus tympani was the commonest site of residual disease (35%), followed by facial recess (25%) and anterior attic space (10%). From their study, they also concluded that some cases which needed canal wall down mastoidectomy for disease clearance were managed with intact canal wall mastoidectomy after the introduction of complimentary endoscopy during the procedure to inspect the hidden areas. So, endoscopy helps in decision making during the surgery [12].

Wide angled 30° and 45° endoscopes give a clear vision of the sinus tympani, facial recess and oval window area, without removal of the posterior canal wall or need for posterior tympanotomy [8].

Biswas D et al., operated 40 cases cholesteatoma with complimentary endoscopy. The 23 patients underwent intact canal wall and 17 patients canal wall down mastoidectomies under microscope. Complimentary endoscopy showed residual disease in five cases, all in sinus tympani. They also reported no recurrent cholesteatoma in the six months follow-up period in all the cases. They removed the residual disease from sinus tympani under endoscopic vision. They concluded that complimentary endoscopy gives significantly better disease clearance [8].

Shelton C and Sheehy JL, have opined that complimentary endoscopy dose not eliminate the chance of recurrent disease, nonetheless these recurrences will be like small pearls. Excision of these small pearls will be easier in the later stage. They attributed this to better quality of excision under otoendoscope [22].

Gupat N et al., concluded that endoscopic assistance in cholesteatoma clearance improves disease removal from hidden areas in the middle ear cleft. They found residual disease most commonly in sinus tympani followed by anterior attic space and protympanum [9].

Verma B et al., found residual cholesteatoma after microscopic clearance in 11.2% of their study. Sinus tympani was the most common site followed by facial recess. They concluded that complimentary endoscope not only positively affects the disease clearance but also helps in reducing the mastoid cavity size by limiting the extent of bone drilling [10].

There is wide variation in the residual cholesteatoma detection with otoendoscope among different studies. We believe this could be because of multiple factors like extent of the disease, experience of the surgeon, depth of the middle ear recesses among different patients and type of mastoidectomy performed. [Table/Fig-4] shows the type of mastoidectomy done in different papers included in the present study [6-11]. Nevertheless, all studies show significant detection of residual disease under endoscopy after apparent clearance under microscope. Outcome of these studies indicates that endoscopy following microscopic clearance minimises residual disease in hidden areas such as sinus tympani, facial recess. Randomised controlled trials are needed to evaluate late cholesteatoma recurrence among cases with adjuvant endoscopy and cases without it.

Authors	Elfeky AEM et al., (2019) [6]		Good GM and Isaacson G, (1999) [7]		Biswas D et al., (2014) [8]		Gupta N et al., (2019) [9]		Verma B et al., (2017) [10]		Sajjadi H, (2013) [11]	
Type of mastoidectomy	Closed cavity	Open cavity	Closed cavity	Open cavity	Closed cavity	Open cavity	Closed cavity	Open cavity	Closed cavity	Open cavity	Closed cavity	Open cavity
No. of cases	64	86	Not divided		-	17	2	18	55	61	182	67
Residual cholesteatoma percentage	23.38	14	NA		-	12	Did notmention residual disease percentage in these different procedures separately		Did not mention residual disease in these different procedures separately		22	10

[Table/Fig-4]: Type of mastoidectomy performed in various papers [6-11].

Limitation(s)

Inclusion of non English journals may give different results. None of the articles included are randomised trials. Studies were aimed at intraoperative detection of residual cholesteatoma. Long term follow-up studies are required to know the ability of endoscopy in reducing the late recurrences.

CONCLUSION(S)

It appears that intraoperative ancillary endoscopy helps in visualising as well as clearing the disease from deep recesses of the middle ear cleft, which are otherwise would not be seen by operating microscope. It even appears that, ancillary endoscopy may help in reducing the need for canal wall down mastoidectomy in many cases. This may reduce the chances of residual disease significantly. However randomised controlled trials with long term follow up studies need to be done to determine the true long term benefit of this procedure. Due to some limitations of endoscopes, they can be used as adjuvant to microscope rather than for pure endoscopic surgery. So, endoscopes are complimentary rather than competitive to microscope for cholesteatoma surgery.

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