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ENDOSCOPY IN OTOTOLOGY – IN RETROSPECT AND PROSPECTS

Abstract:

Role of endoscopes in otology as a diagnostic, a surgical and a teaching tool is increasingly being recognized because of its superior optical properties and its capacity to visualize hidden areas with minimal invasion of tissues as compared to a microscope. Its use both as an exclusive equipment and as an adjunct to microscope in otology practice though growing very slowly appears promising. With its application anatomy of middle ear compartments are being revisited, physiology and pathology of pathological processes are being provided with new insights; management of otological processes is undergoing a revolutionary change. However, its indications and approaches are still evolving and are yet to obtain universal acceptance.

Key words: Endoscopic tympanoplasty, Endoscopic ear surgery, Otoendoscopy

INTRODUCTION:

The microscope revolutionized the surgical management of the diseases of ear but the basic optical properties of microscope have remained the same for the last 30 years.¹ Meanwhile endoscopes with better optics and magnification with angled lenses have witnessed numerous application in medicine. Endoscopes have replaced even some of the traditional approaches within our subspecialty of nose, sinuses and skull base.² This led to otologists also to experiment with endoscopes. Attempts are being made to approach middle ear cleft either transcanally or through mastoid by endoscopes. During the early days some authors tried to look into the middle ear through trans Eustachian approach but these procedures could not sustain the tide of time.³ Initially endoscopes were used only for diagnostic and photographic purposes but endoscopes are now being used more and more for surgery of ear, IAM and petrous apex. Now it has been established beyond doubt that endoscopes make a difference positively in surgery of ear but ironically the difference is not yet enough to gain worldwide popularity.⁴

ADVANTAGES:

Most important advantage of endoscopes in otology is its direct, natural, quick and easy access to least accessible nook and corners of middle ear cavity which are hidden to the surgeons view even with the use of microscope.⁵ These areas which are the areas for surgical failure are sinus tympani, anterior epitympanic area, supra-tubal recess, medial attic, hypotympanum, tubal area, facial recess etc. Endoscopes help in eradication and complete removal of disease leading to less occurrence of residual and recurrence of disease. Even a large posterior tympanotomy which can endanger facial nerve and stapes does not offer a convincing adequate access to a deep sinus tympani.⁶ With the incorporation of endoscopes as an adjunct in mastoidectomies there is no need for posterior tympanotomy. Cases needing canal wall down are now being operated using canal wall up technique with endoscope. If the endoscope is available in experienced hands, the choice of surgical approach could be altered.⁷ Endoscopes bringing surgeon's eye to the tip of endoscope provide wide angle and thus the entire area of operation can be seen in one field. This is especially very advantageous when we are spreading and tucking the graft in myringoplasty. This also allows us to better appreciate relations between structures. Visualization by endoscopes provides detailed description of anatomic structures. Even the smallest structure like middle ear folds and ligaments are visible distinctly.¹

Minimal invasion is another major advantage of endoscopes. Microscope needs exposure with incisions and drilling, which at times may still be not an adequate one. Being conservative surgery endoscopic operations can avoid even mastoidectomy in some cases and in those case where mastoidectomy is needed preservation of large amount of healthy mastoid tissue is possible. In low lying dura and forward lying sinus in sclerotic mastoid visualization of antral, periantral and epitympanic region may be possible which may be difficult if operated with microscope. Such endoscopic approaches also avoid injury to facial nerve and lateral semicircular canal.⁸ Middle ear endoscopic techniques may increase the likelihood of ossicular chain preservation during cholesteatoma surgery.⁹

Exclusive endoscopic procedures require no incisions, no curettage of posterior canal wall, no canoplasty and no meatoplasty. This results in less operation time, less bleeding and less cautery, less post-operative pain, early recovery and less hospital stay and better cosmesis.¹⁰ Endoscopes can past the tortuosity, stenosis and overhangs of external auditory canal needing no manipulation of head of the patient and no retractions of tissues. Intense light, excellent image, good resolution, rapid change of field and higher magnification than that of microscope when close to objects are other points favouring use of endoscopes in ear surgery.¹⁰ Set up time and cost of endoscopes are comparable to that of microscope¹¹, or it may be even less if sinus endoscopic set up is already available. Endoscopes may prove ideal for camps in remote hilly areas of a country like Nepal.

DISADVANTAGES:

Main limitation of endoscopic ear surgery is that this is an one hand cumbersome surgery that may lead to left arm fatigue and may also cause neck and back strain.¹¹ Potentially long and steep learning curve¹¹ through the hassles and tribulations of adapting a newer technique and mastering difficult handling of instruments is another use limiting issue of endoscopes in otology. It is said that monocular vision of endoscope is associated with inferior depth perception as compared to a microscopic vision.^{12, 14} Meticulous haemostasis is essential in endoscopic ear surgery as a drop of blood can obscure the field.¹³

Accidental patient movement if occurs during endoscopic surgery under local anaesthesia there can be secondary direct trauma by the tip of the endoscope to external auditory canal, middle ear, ossicles, dura, facial nerve etc.⁵ Safety of savlon in middle ear used for defogging

of endoscopes is questioned¹ and excessive heat dissipation if xenon light source is used can be damaging to the middle ear.⁴

The Equipment:

Rigid otoendoscopes come in a wide array of lengths, diameters and angulations. Lengths range from 6 cm to 20 cm. Longer endoscopes are difficult to stabilize and shorter one do not allow adequate space for negotiations of instruments. Diameters also vary from 2.7 mm to 4 mm. The larger the diameter the better the field of view and the better the illumination delivered by the light bundles carried side of the lenses.¹⁴ Illumination is provided either by halogen or xenon cold light source which is connected with a fiberoptic light cable.⁷ Video equipment consists of three chip video camera⁸ connected to either a monitor or PC with an image capture which can be stored for later retrieval.¹⁶ Endoscope used for endoscopic sinus surgery can be used for otoendoscopy also.

The instruments needed are the same as those needed in routine middle ear surgery. Some special instruments may also be needed such as angled picks, curettes, forceps, and elevators with 20 degree deflection at one cm from the tip of the instruments.⁴ The surgeon operates by looking at the monitor stationed on the other side of the table across from the patients head. An absorbent pad soaked with antifog solution is pasted on the drapes above the patients head. For evaluation of middle ear, Kakehata has been using 50 mm long micro fiberoptic endoscopes with outer diameter of 1 mm enveloped with a working channel.^{17,18} Semi rigid sialoendoscopes with an outer diameter of 0.75 mm and 3000 pixels were used for trans Eustachian evaluation of middle ear by some authors. Micro otoendoscopes are used for research surgery of inner ear.¹⁹

As a Teaching tool:

In an endoscopic procedure all the structure can be seen in the same field. Anatomical structures and relationship between them can be better appreciated.²⁰ So it is a better tool than the microscope in demonstrating the surgical steps and documentation of these findings. Anatomy of middle ear spaces and folds are being revised through endoscopic studies of temporal bones. Subtle details and variations of sinus tympani, facial recess and hypotympanum have now been described.²¹ Boundaries of these spaces have been precisely demarcated by endoscopic studies. These have led to developments of newer concepts in the physiology and surgical pathology of middle ear conditions.²⁰ Consequently, more complete removal of diseases is possible resulting in better surgical outcome and lesser incidence of residual and recurrent disease. Some authors are using more and more use of endoscopes for staging of retractions and their more objective record to improve validity of therapeutic interventions undertaken.²²

As a Diagnostic tool:

Preoperative examination and investigations including audiometry, tympanometry and CT scans at times cannot make exact diagnosis of middle ear diseases and exploratory tympanotomy thus becomes necessary for this purpose. Some authors argue that endoscopic evaluation of middle ear can replace exploratory tympanotomy for the diagnosis of middle ear conditions like, ossicular discontinuities, immobility and other abnormalities, congenital cholesteatoma¹⁷, conductive hearing loss^{18,23} perilymph fistula, dehiscent high jugular bulb, trauma of tympanic segment of facial nerve etc.⁸ Kakehata has found laser assisted myringotomy very effective in the diagnosis of such conditions. He claims, myringotomy of less than 2mm size made heals in about 2 weeks' time in this procedure.¹⁸

Exclusive Endoscopic Surgical Procedure:

Myringoplasty with temporal fascia or with cartilage grafts can be done with endoscopes with similar results to that of a microscopic procedure. The endoscopic transcanal cartilaginous myringoplasty is a minimally invasive, effective and reliable procedure in the management of the tympanic membrane perforations.²⁵ Ventilation tube insertion, ossiculoplasties and stapedectomies²⁶ have been performed by some authors. By an exclusive endoscopic transcanal approach surgical treatment of attic retraction pockets, preserving as much as possible the ventilation routes, physiology, and anatomy of the middle ear is possible. In future it may be possible to lift up attic retraction pockets by reestablishing ventilation pathways of attic without much dissection.²¹

An exclusive trans meatal endoscopic approach can be used for the resection of a cholesteatoma in primary endoscopic ear surgery. This is indicated for cholesteatoma confined to the tympanic cavity and not involving the mastoid. A cholesteatoma was defined as being endoscopically accessible when it did not extend beyond the level of the lateral semicircular canal.¹¹ In selected patients with sclerotic mastoid and antral or periantral involvement of cholesteatoma, an endoscopic tympanoplasty should be considered as an alternative, particularly by surgeons with sufficient expertise in endoscopic techniques. By drilling the bone over the short process of the incus, it is possible to reach the antrum. This procedure can be performed having direct control over the important anatomical structures lying in the posterior and medial wall of the tympanic cavity. Facial nerve and the lateral semicircular canal can be visualized directly. The tympanic part of facial nerve can be thoroughly visualized using an exclusive endoscopic trans canal approach, even in poorly accessible regions such as the second genu and geniculate ganglion, avoiding mastoidectomies. This may possibly have clinical significance, for example, in post-traumatic facial nerve decompressions.⁸ A trans tympanic endoscopic procedure for round window fistula repair is feasible.²⁷

Revision surgery of an accessible cholesteatoma in the post-mastoidectomy cavity can be done with the endoscopes so there is no need of second look tympanotomy.²

Endoscope Assisted Surgical Procedure:

Now-a-days, endoscopy is mostly done to verify the quality of excision in regions inaccessible to the microscope. Otoendoscopy has made it possible to reveal a residual lesion after excision under otomicroscopy in the epitympanum and the retro tympanum.⁶ Endoscopically assisted surgeries reduce residual cholesteatomas and the indications of later tympanotomy. The use of the endoscope raises the surgeon's confidence level about total removal and thus encourages the surgeon to keep the canal wall in-tact while removing cholesteatoma in hidden areas. Therefore, the use of endoscope could be considered not only an additional but also an essential tool that may affect decision-making in cholesteatoma surgery.^{11,15,24,28} It is also said that middle ear endoscopic techniques may increase the likelihood of ossicular chain preservation and effectiveness of ossiculoplasty during cholesteatoma surgery.^{8,29}

Some authors prefer endoscopic technique as a primary and universal approach to cholesteatoma with the initial objective of exploring the extent of the disease. The choice of the ultimate surgical management approach is made during the procedure. Other surgeons who are less inclined toward the endoscopic technique might want to rely on CT to select patients with limited cholesteatoma.⁴

Uses in Inner Ear:

Endoscopic work in inner ear has taken place as part of cochlear implant research. Microscopic endoscopes to research hair cell physiology are also in use. Recent advances in endoscopic technology have allowed for small diameter endoscope suitable for inner ear surgery. These endoscopes are narrow enough to fit through small openings into the otic capsule. They have optical and working channels and are the prototype surgical instruments for atraumatic entry into the inner ear. Preserving cochlear and vestibular function using endoscopic surgery may be applicable in some cases of intralabyrinthine schwannoma.¹⁹

Application in Otoneurology:

Endoscopy assisted microsurgery represents modern trend of treatment of the cerebellopontine angle pathologies including vestibular schwannoma. Endoscopic exploration of the internal auditory canal and endoscopically controlled dissection of the intrameatal portion of schwannoma is helpful to achieve radical tumor removal, preserve neurovascular structures and structures of the labyrinth while minimizing cerebellar retraction. Improved identification of the opened air cells potentially decreases the incidence of cerebrospinal fluid leaks.⁹ Endoscopes have also proved beneficial in approaching difficult area of the petrous apex.²⁷

SUMMARY:

Endoscopic instrumentation, techniques, and knowledge have really improved during the last few years, and their introduction may

dramatically change the classic surgical technique of middle ear surgery in the future. However, there being certain limitations in the use of endoscopes we all need to master working with both instruments at present to better understand and treat pathologies of the ear.

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