Office-Based Otology Procedures

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KEYWORDS

• Office-based otology • Endoscopic ear surgery • Myringoplasty
• Intratympanic injection

KEY POINTS

- The scope of office-based otologic procedures has broadened with the incorporation of endoscopic techniques.
- Endoscopy is particularly useful to inspect anterior perforations, retraction pockets and ears with narrow or stenotic ear canals.
- Use of endoscopy allows inspection of deep retraction pockets whose depth cannot be fully visualized under microscopy, potentially modifying the criteria for surgical intervention.
- Repair of simple, uncomplicated tympanic perforations can be performed in-office using autologous or heterologous tissue-engineered grafts.
- Intratympanic injections are an effective, low-risk options for the treatment of sudden sensorineural hearing loss and intractable Meniere's Disease.

Video content accompanies this article at http://www.oto.theclinics.com.

INTRODUCTION

Of the otolaryngology subspecialties, otology may appear as the field with the fewest innovations in the office-based setting. One may think that the otology practice remains centered on the microscopic ear examination, cerumen cleaning, mastoid debridement, myringotomy with tube placement, and fat graft myringoplasty. However, new optics, high-definition digital monitors, tissue-engineered grafts, and evidence-based protocols for transtympanic perfusions have entered the contemporary office practice of otology, not only changing the way we treat common otologic problems but also the way we select patients for surgical intervention.

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The objective of this article is to describe the most recent innovations in office-based otologic procedures for the treatment of the most common otologic conditions.

IN-OFFICE OTOENDOSCOPY

Traditionally, the microscope is considered the tool of choice to examine the tympanic membrane. In the past decade, endoscopes have been incorporated by otologic surgeons as an important adjunct tool not only in the surgical setting but also in office practices.

The wider angle of view and high-quality image provided by otoendoscopy allows the visualization of certain pathologies, the examination of which is challenging under microscopy. Endoscopy increases the ability to inspect the depth of retraction pockets, potentially changing the indication for surgical intervention. Similarly, the ability to visualize a very anteriorly based tympanic perforation can change the criteria for in-office myringoplasty.

Choice of Endoscopes for the Office

The first endoscopes used specifically for otoscopy were short, rigid scopes 6 cm in length. These short endoscopes are useful for the inspection and photographic documentation of the tympanic membrane. However, their use in office-based otologic procedures is limited because the short shaft places the camera hand in the way of the instrument hand. Longer endoscopes allow the surgeon's hands to be staggered so that procedures can be performed without hand collision.

In our office, we prefer rigid sinus scopes (Karl Storz Endoscopy-America, El Segundo, CA) 16 cm in length and 4 mm in diameter to inspect the tympanic membrane as they are already common tools for sinus endoscopy. For most ear examinations, 0-degree endoscopes are used; 30-degree endoscopes are useful for visualization of retraction pockets and inspection of anterior tympanic membrane perforations obscured by a prominent anterior canal wall. Pediatric rigid sinus scopes 2.7 mm in diameter and 16 cm in length are used for narrow ear canals, exostosis, or pediatric ear examinations. In the author's experience, children as young as 3 years of age have been cooperative in allowing endoscopic ear examination by being allowed to watch the screen. The endoscope is connected through the light source to a camera and to a high-definition screen monitor.

Patient Positioning

The otoendoscopic examination is best performed with the patient slightly reclined in the examining chair and the surgeon in a sitting position. The screen monitor is positioned directly across from the surgeon and at a close distance to avoid strain from neck turning (**Fig. 1**).

Endoscopic Examination of Retraction Pockets

Traditionally, the distinction between retraction pocket and cholesteatoma has been based on microscopic examination. Retraction pockets can be classified from grade 0 through V for pars flaccida retraction and from grade I through IV for pars tensa retraction.[1,2]

Currently, the decision to recommend surgery is a clinical judgment based on the microscopic examination and radiologic findings. Retraction pockets whose debris cannot be fully cleaned and whose depth cannot be visualized fulfill the definition of cholesteatoma and should be surgically explored.[3]

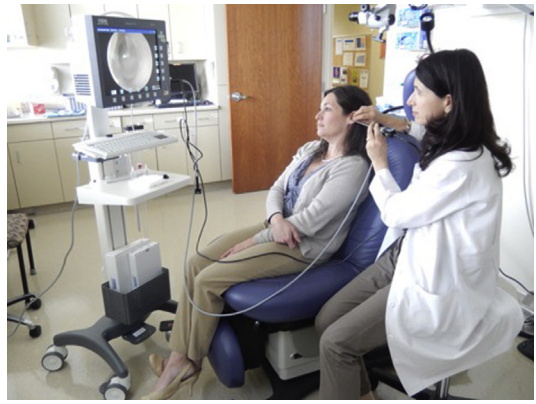

Fig. 1. In-office otoendoscopy setup with a Karl Storz Telepak unit. (*Courtesy of* Karl Storz Endoscopy-America, El Segundo, CA, ©2018; with permission.)

The progressive use of endoscopes in the otologic setting will eventually change our parameters to surgically intervene. The endoscopic inspection of retraction pockets provides an expanded view of the depth of the retraction beyond the scutum. Thus, deep retraction pockets can be fully monitored under endoscopy and may no longer fit the current criteria for surgical intervention.

A clean pars tensa retraction with development of myringo-stapediopexy with limited conductive hearing loss can be followed clinically (**Fig. 2**, Video 1). Similarly very extensive, grade V pars flaccida retraction with a wide orifice and exposure of the head and neck of the malleus and no evidence of keratin accumulation can also be observed clinically (**Fig. 3**).

As endoscopic proficiency is gained, it is possible not only to inspect but also to suction and clean debris within a retraction pocket not accessible with the microscope. This is particularly useful in the setting of an epitympanic retraction with a very narrow ear canal or a mesotympanic retraction with a prominent scutum.

Endoscopic Examination of Tympanic Perforations

Pre-operative endoscopy of tympanic perforations provides important information for surgical planning. Many perforations are small in size, but full visualization may not be

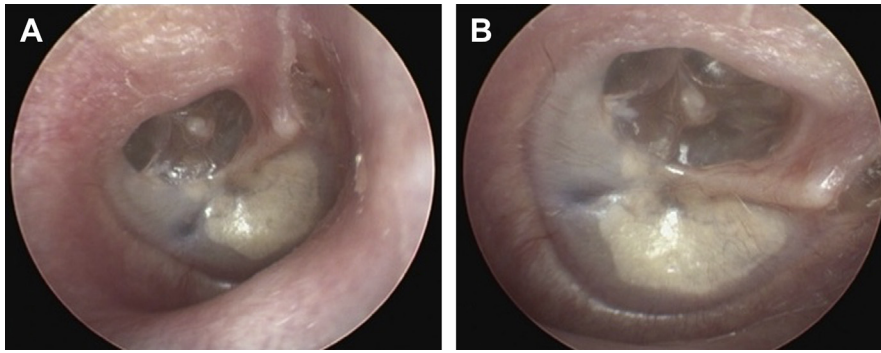

Fig. 2. Pars tensa retraction with incus erosion and myringo-stapediopexy examined with 0-degree (*A*) and 30-degree (*B*) scopes.

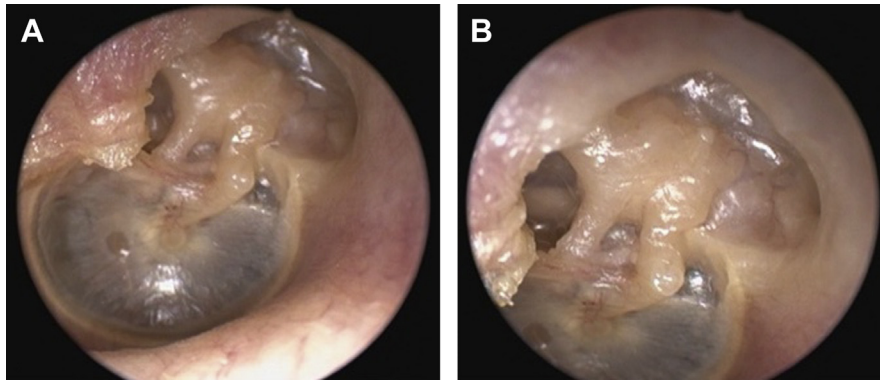

Fig. 3. Extensive grade V pars flaccida retraction of the right ear examined with 0-degree (*A*) and 30-degree (*B*) rigid scopes.

possible under microscopy because of an anterior canal bulge or a prominent tragus. Endoscopy offers the advantage of visualizing the anterior tympanic annulus and the entire margin of the perforation.

For posterior tympanic perforations, endoscopy can provide useful information on the status of the ossicular chain. A 30-degree endoscope angled in the posterior aspect of the perforation can reveal erosion or tapering of the long process of the incus or presence of epithelium adherent to the ossicles. Epithelial migration under the medial surface of the tympanic membrane may be overlooked under microscopic examination but may be detected by advancing the endoscope close to the perforation. The detection of such findings pre-operatively are extremely important when counseling the patient for surgery, as any otologic surgeon with experience knows how an apparently innocent looking tympanic perforation may reveal occult cholesteatoma or unexpected ossicular discontinuity.

In-Office Transtympanic Middle Ear Endoscopy

Transtympanic middle ear endoscopy requires much thinner endoscopes to be inserted in the middle ear cavity through a small myringotomy. Endoscopes 2 mm in diameter are used. This surgical technique has been described to inspect the middle ear space for ossicular chain pathology, presence of cholesteatoma in the middle ear cavity, and perilymphatic fistula.[4,5] The endoscopic detection and removal of obliterative fibrous tissue over the round window in patients refractory to transtympanic perfusion for Meniere's disease has been described as well.[6]

In-Office Endoscopic Examination of Post-surgical Results

Endoscopy is an excellent way to document and follow post-operative healing. Photography does not replace the need for a thorough and concise description of the physical examination in the patient record, but adding photographs to progress notes makes this nearly foolproof. This is especially useful in practices in which a patient may see multiple providers.

Another advantage of otoendoscopy is the wide-angled view of the external ear canal that is otherwise covered by the speculum under microscopy. Small post-operative inclusion pearls along the posterior ear canal can be missed under microscopic examination and, if not detected and enucleated, may progress to canal cholesteatoma. Another more unusual complication that can be obscured by the

speculum is the development of a sinus tract between the site of the transcanal incision and the mastoidectomy cavity. These cases typically present with intermittent drainage and no obvious source seen on the tympanic membrane.

Endoscopic Inspection and Debridement of Mastoid Cavities

Every surgeon knows the challenges of debriding a mastoid cavity with a small, stenotic meatoplasty or a mastoid cavity with a high facial ridge and low tegmen. Endoscopic examination of challenging mastoid cavities may reveal areas of granulation tissue, mucositis, or recurrent cholesteatoma in previously hidden areas. With the endoscope in the non-dominant hand and an instrument in the dominant hand, the cavity can be inspected, debrided and suctioned, and granulation tissue cauterized.

High-Definition Digital Monitors, Data Management, and Digital Photodocumentation

When included in a patient's chart, serial photography taken during office visits can be useful to compare the size of perforations and retraction pockets over time. It is important to develop a consistent methodology when taking photographs of the ear, as the angle and lighting can make a difference in the assessment of size and depth of the pathologic ear findings. The size of the tympanic membrane perforation can be deceiving even under endoscopic examination. Because of the oblique position of the tympanic membrane in the ear canal, perforations are often viewed from an angle, making them seem smaller.

The ability to show patients their ear on a screen is an indispensable tool when counseling patients on the need for surgery. There is no better visual aid than a photograph of the patient's ear. Endoscopy can also present good teaching opportunities for students and residents, as anatomy and pathology can be easily pointed out on the screen.

The use of endoscopy in the clinic does not stop at examination and documentation; it can also be used as the primary tool to repair tympanic membrane perforations.

IN-OFFICE ENDOSCOPIC MYRINGOPLASTY

Indications and Patient Selection

We define office-based myringoplasty as the transcanal repair of tympanic membrane defects without the use of sedation or general anesthesia and without elevation of a tympanomeatal flap. Because of the delicate manipulation of the tympanic membrane, not all adult patients may be comfortable or cooperative enough to undergo repair under straight local anesthesia. For the same reason, general anesthesia is recommended for younger patients.

Traditionally, indications for in-office myringoplasty have been limited to small, dry perforations, the margins of which are fully visible under microscopic examination. The inability to visualize the anterior margin can preclude not just the in-office repair but even a transcanal microscopic approach under general anesthesia and may require a posterior auricular approach. Endoscopy improves visualization of the anterior rim of the tympanic membrane, thus expanding the indications for in-office myringoplasty for anterior perforations the margins of which are not fully visible under microscopic technique.

Marginal perforations, wet perforations, and suspected ossicular pathology are better suited for tympanoplasty under general anesthesia with elevation of a tympanomeatal flap and middle ear exploration.

A relative contraindication to in-office repair is the presence of extensive myringosclerosis. Thick plaques may be lined by thin atrophic epithelium and may require extensive excision that is more appropriately performed under general anesthesia.

In general, perforations less than 25% to 30% can be repaired in the office; however, some authors report success with larger perforations.[7] Larger perforations require not only a larger graft but also more complex underlay techniques to prevent graft displacement or graft failure. In addition, larger size perforation cannot be adequately repaired solely with a fat patch because of the tendency for fat to reabsorb or to possibly displace in the middle ear space.

There are few reports of long-term results after in-office myringoplasty; however, with appropriate patient selection, most closure results are reported around 80% to 90%, which is comparable with outcomes of tympanoplasty performed under general anesthesia and with elevation of a tympanomeatal flap.[8] In the senior author's practice, endoscopy has facilitated a shift toward repairing more perforations in the office.

Choice of Graft Materials

In addition to fat, cartilage, and fascia grafts, new tissue-engineered grafts such as porcine small intestinal submucosa (SIS) (Biodesign; Cook Biotech, West Lafeyette, IN) and hyaluronic acid discs (Epidisc Otologic Lamina; Medtronic, Jacksonville, FL) are available.

In the senior author's experience, the use of porcine SIS grafts has provided similar results to those of fat myringoplasty, with the advantage of avoiding an external incision and decreasing post-operative pain. In addition, this tissue-engineered material is embedded in fibroblast growth factor, which promotes graft revascularization. Furthermore, its acellular composition results in a transparent appearance of the healed graft (**Figs. 4** and **5**). We limit the use of SIS to perforations less than 30% in size. Early results of myringoplasty using porcine SIS have shown comparable results with autologous fascia grafts.[9,10] Hyaluronic acid discs placed as an overlay over fat myringoplasty have also shown good results.[8]

For patients with perforations greater than 30%, or in those with objections to porcine-based materials, we place a composite cartilage-perichondrium button graft (Video 2).

Methods and Surgical Technique

Written informed consent is obtained and the patient is positioned supine with the head slightly elevated. The outer ear canal is prepped with betadine and the ear is draped with surgical towels. Optimal hemostasis and the administration of local anesthesia is essential for the success of the procedure. The ear canal is injected with 2 mL

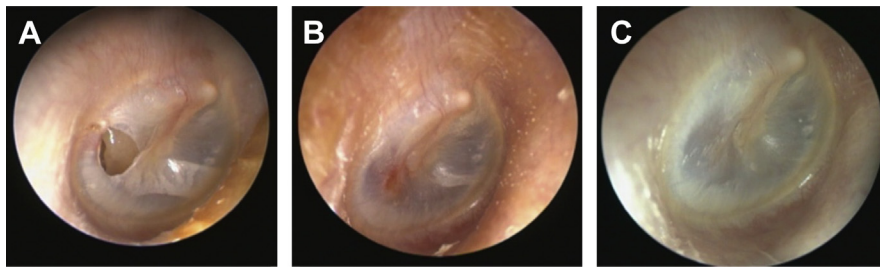

Fig. 4. Porcine small intestinal submucosa myringoplasty: pre-operative (*A*), 10-week post-operative (*B*), and 6 months post-operative(C).

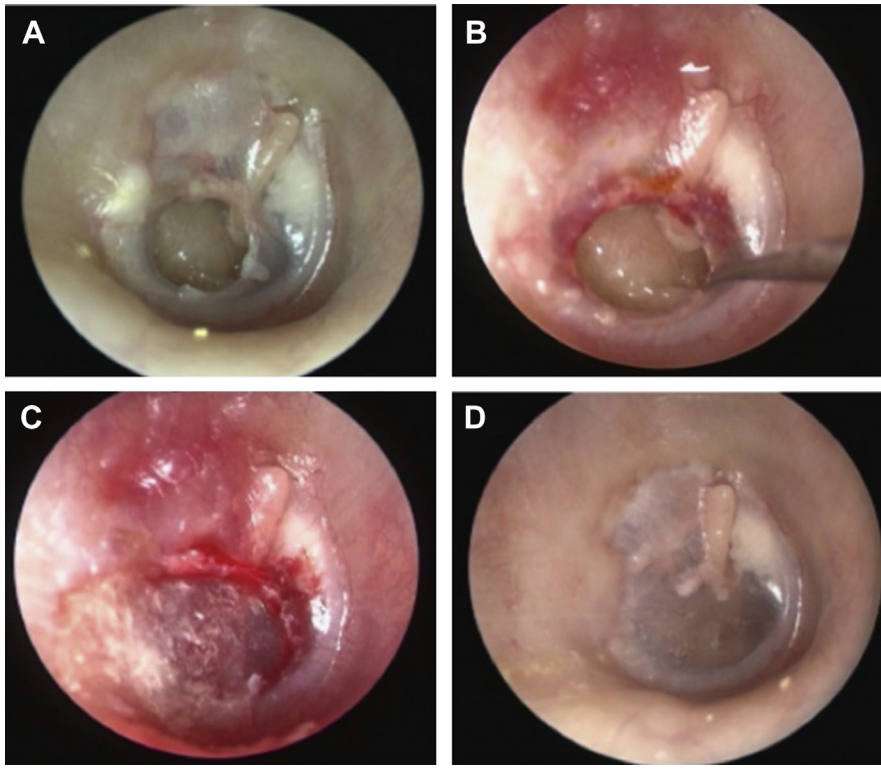

Fig. 5. Porcine small intestinal submucosa myringoplasty: pre-operative examination (*A*), rimming of perforation margins (*B*), inset as an inlay (*C*), and 3 months post-operative (*D*).

of 1% lidocaine with 1:100,000 epinephrine. Blanching of the tympanic membrane indicates adequate infiltration of the anesthetic. Extreme care is used to avoid leaking of anesthetic solution into the middle ear, as this can result in post-operative vertigo. It is advisable to wait 10 minutes before beginning to ensure that the anesthetic has appropriately infiltrated the tissue. The screen monitor is placed directly across from the surgeon so that the surgeon can easily see the screen without straining the neck. This also allows the patient to observe the procedure and reinforces the importance of not moving their head. For most cases, a 0-degree rigid endoscope of 4 mm diameter is sufficient for visualization of the perforation margins. Narrow ear canals may require a pediatric 4-mm rigid sinus scope, and very anterior perforations may require a 30-degree angled scope.

The perforation is then gently de-epithelialized circumferentially by teasing the margins with a Rosen needle and everting the margins outward, stripping less tissue than with a postage-stamping technique.

Fat grafts are positioned as a dumbbell across the perforation. Cartilage button grafts are harvested via a small incision in the tragus or the conchal bowl. A disposable skin punch (3, 4, or 5 mm) may be used to cut a disc-shaped graft 1 mm larger than the perforation. The graft is harvested along with perichondrium. A groove is cut in the edge of the cartilage and the graft is positioned with the perichondrium laterally and the tympanic membrane in the cut groove (see Video 2).

When utilizing porcine SIS, a small piece of Gelfoam is placed in the middle ear to support the graft. The porcine SIS graft is cut into 2 discs of slightly larger dimensions

than the size of the perforation. One disc is placed medially to the perforation and the second disc is placed laterally. This sandwich-type scaffold favors epithelial regrowth.

Role of Nasal Endoscopy in the Contemporary Otology Practice

In today's office-based practice, the otologist has been trained to perform flexible naso-pharyngo-laryngoscopy in patients with ear pain and/or adult onset of otitis media with effusion to rule out upper airway malignancy or nasopharyngeal masses as a cause of referred otalgia or middle ear effusions. Traditionally, chronic pathologies of the ear such as chronic suppurative otitis media with perforation, cholesteatoma, or chronic otitis media with retraction are not considered routine indications for nasal endoscopy. However, new studies on the role of the eustachian tube (ET) in the pathogenesis of chronic ear disease and new ET dilation techniques are changing the way we approach and examine patients with chronic ear disease.[11] In patients with chronic ear conditions, nasopharyngoscopy has an important diagnostic role.

Adult onset of chronic mucoid otitis media is often related to chronic sinus pathologies affecting the respiratory epithelium of both middle ear and paranasal sinuses, and warrants nasal endoscopy to diagnose and treat possible concomitant sinus pathology.[12] Nasopharyngoscopy may also reveal a pathology localized to the ET orifice. Inspection of the ET orifices may reveal collapsed, narrow, edematous, or lymphoid hyperplastic appearance. Nasopharyngoscopy may reveal mulberry hypertrophy of the inferior turbinates directly obstructing the ET lumen, obstructive adenoid hypertrophy, or unexpected synechiae from previous adenoidectomy scars restricting opening of the ET orifice. Nasopharyngoscopy in the setting of atrophic pars tensa atelectasis may reveal patulous ET. In these patients habitual sniffing to alleviate ear symptoms resulted in chronic atelectasis and an ET dilation procedure would be contraindicated.

In sum, the role of nasopharyngoscopy for the otologist has expanded. A careful examination of the nasopharynx and ET orifice is an essential part of the complete otologic examination in patients with chronic ear pathologies.

TRANSTYMPANIC INNER EAR PERFUSION

Transtympanic perfusion permits drug delivery directly to the middle and inner ear structures. After instillation in the middle ear, drugs pass through the round window membrane and oval window annular ligament, and diffuse throughout the perilymph and endolymph.[13] This can achieve high concentrations of the drug within the cochlea and vestibular apparatus while avoiding systemic side effects. In-office intratympanic (IT) injections are used for the treatment of sudden sensorineural hearing loss and refractory Meniere's disease. Despite innumerable trials, there is no consensus on the optimal regimen for either disease.

INTRATYMPANIC STEROID INJECTIONS FOR TREATMENT OF SUDDEN SENSORINEURIAL HEARING LOSS

Indications and Patient Selection

For patients with confirmed sudden sensorineural hearing loss, initiation of either oral or IT steroids is recommended as a rescue therapy. IT steroids are indicated for those patients who cannot tolerate systemic steroids or for those patients who have not responded to oral steroids.[14] Recent studies have demonstrated non-inferiority in hearing recovery between oral and IT steroids.[15] Intratympanic steroids have more focal side effects—pain (27%), transient vertigo 27%, tympanic membrane perforations (3.9%), and otitis media (4.7%)—compared with oral steroids.

Sudden profound sensorineural hearing loss carries a poor prognosis for hearing recovery.[16] For these cases we recommend simultaneous oral and IT steroid injection to maximize all the possible chances for hearing recuperation.[17] Although many studies exclude patients with onset of symptoms greater than 2 weeks, we treat patients up to 4 weeks after symptom onset. If the patient has less than complete recovery with oral steroids, we then offer the IT steroid injections modality as a salvage.

Surgical Technique and Dosage

After obtaining informed consent, the patient is positioned supine with the head elevated 30° and the neck turned with the affected ear facing upward. Topical phenol 89% (Apdyne Phenol Applicator Kit; Apdyne Medical, Denver, CO) is used to provide anesthesia to the posterior inferior quadrant of the tympanic membrane. A pressure-release puncture hole is first made using a tuberculin syringe with a 1.5-inch-long 25-gauge needle. Using the same needle and syringe, 0.4 mL of 40 mg/mL methylprednisolone is injected just inferior to the release hole. Because of the small volume of the middle ear space and the patient tendency for swallowing, we inject 0.2 mL into the middle ear followed by an additional 0.2 mL 15 minutes later. The patient is instructed to remain in the same position for 30 minutes and to avoid frequent swallowing. The patient is assessed for vertigo before discharging home with follow-up arranged for the next 3 injections, performed twice weekly. An audiogram is obtained 1 week after the fourth and final injection to assess improvement and discuss further evaluation of their sudden SNHL if not already completed.

Choice of Steroid Solution (Methylprednisolone versus Dexamethasone)

Initially, methylprednisolone (MP) was preferred over dexamethasone (DX) after one animal pharmacokinetic study showed higher and more prolonged levels of MP in the endo- and perilymph.[18] However, subsequent studies have shown no difference in recovery rates between IT DX and IT MP when used for primary treatment.[19] Methylprednisolone has shown to cause more pain and burning than DX.[19] However, given the inconclusive evidence, the choice of steroid is physician dependent.

Intratympanic injections for treatment of Meniere's disease

For Meniere's disease refractory to diuretics and salt restriction, intra-tympanic steroid injections may be offered as a minimally invasive, vestibular-sparing treatment. The exact mechanism of action is unknown, and, because there are few high-quality studies, the benefit is similarly unknown.[20] However, given the low side-effect profile and potential for benefit, IT steroids have been used in the treatment of Meniere's disease refractory to medical treatment.[21] If IT steroid injections fail, vestibular-sparing surgery (such as endolymphatic sac decompression) can be offered.

Alternatively, IT gentamicin may be offered as a minimally invasive vestibular-ablative therapy to patients with no serviceable hearing, significant surgical risk, or failed endolymphatic sac decompression. Gentamicin is preferred over other aminoglycosides owing to its higher affinity for vestibular hair cells than cochlear hair cells, theoretically reducing the risk of hearing loss. There is a wide literature base in IT gentamicin therapy, but there is no consensus on optimal dosing protocol.[20]

If IT gentamicin fails, then more invasive surgical options may be offered, such as vestibular nerve section or total labyrinthectomy.

Before beginning IT perfusion, a baseline audiogram and videonystagmograpghy is strongly recommended.

Steroids: Indications and Dosing Protocol

Intratympanic steroid perfusions for intractable Meniere's disease have been indicated for patients who have failed 6 months of conservative medical treatment.[21] The literature has shown mixed results for vertigo control, hearing loss, aural fullness, and tinnitus.[22] One randomized, placebo-controlled trial reported significant symptom improvement using a DX solution of 4 mg/mL injected once daily for 4 days followed by a period of observation.[23]

The frequency and dosage of IT steroid injections for Meniere's disease remains physician dependent. We perform weekly IT steroid perfusion of MP on a weekly basis for a maximum of 4 injections. The injection technique is the same as described for sudden sensorineural hearing loss.

Vestibulotoxic Drugs: Indications and Dosing Protocol

Dosing protocols for vestibulotoxic drugs can be characterized as "low-dose fixed" and "titration." In low-dose fixed protocols, a set number of injections are performed over the course of days to weeks. Titration protocols involve an initial injection, followed by additional injections over weeks to months until a stopping point is reached. Some studies report better vertigo control, less tinnitus, and better quality of life with titration protocols, although the evidence is not definitive.[20] The injection is performed in a similar manner to the methods above. Some protocols involve aspirating the gentamicin out of the middle ear at the end of the dwell time and some administer gentamicin via a pressure equalizer tube.[6] We perform one IT injection of 0.5 mL of gentamicin 40 mg/dL. If there are persistent symptoms after 1 month, we administer another injection.

SUMMARY

Recent advancements in otology have expanded the practice toward more minimally invasive treatments. Endoscopy allows greater visualization and access to portions of the tympanic membrane and middle ear cavity. Intratympanic therapy offers more non-surgical options. All of these implementations allow the surgeon to manage more patients in the office rather than the operating room, potentially avoiding risks, improving outcomes, and decreasing cost.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.otc.2019.02.004.

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