EAR SURGERY– An Overview

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OVERVIEW

Most ear procedures are performed to restore or improve hearing, although surgeries to relieve vertigo are also common.

This article will begin with an overview of ear anatomy and the physiology of hearing, followed by a presentation of the equipment, instruments and supplies typically used in ear surgeries. The focus of the article will then turn to a discussion of five common procedures: myringotomy with tympanoplasty tube insertion, tympanoplasty, ossicular reconstruction, tympanomastoidectomy and stapedectomy.

ANATOMY OVERVIEW

The ear consists of three anatomic regions: the external, middle and inner ear. With the exception of the auricle, the ear structures are contained within the temporal bones on each side of the skull and are surrounded by the mastoid air cells, which are part of the temporal bones.

Below the mastoid is the sigmoid sinus, which is filled with venous blood and drains into the internal jugular vein. The facial nerve (cranial nerve VII) travels through the temporal bone and exits in front of the ear to innervate the face. The facial nerve has two branches in the middle ear: one branch innervates the stapedius muscle, which moves the stapes, and the other branch (the chorda tympani) is a taste sensor for the tongue.

EXTERNAL EAR

The external ear is composed of the outer appendage, called the auricle or pinna, and the external auditory canal. There is a small, protruding cartilaginous outgrowth (tragus), which protects the opening of the external auditory canal.

Glands that produce cerumen are embedded in the walls of the canal. Cerumen acts as a lubricant and also traps dead skin cells and foreign matter, which are then expelled from the canal with the help of cilia. The external ear ends at the lateral aspect of the tympanic membrane.

MIDDLE EAR

The middle ear begins at the medial aspect of the tympanic membrane or eardrum, which lies across the inner aspect of the external auditory canal. The tympanic membrane is cone-shaped, with its convexity facing downward and outward toward the auditory canal.

The three auditory ossicles within the middle ear are the malleus, incus and stapes. The handle of the malleus rests against the tympanic membrane, causing its conical protrusion. Ligaments attach its head to the body of the incus.

The incus articulates with the head of the stapes, and the base—or footplate—of the stapes rests in the oval window. The eustachian tube drains fluid from the middle ear to the nasopharynx and allows for pressure equalization within the middle ear.

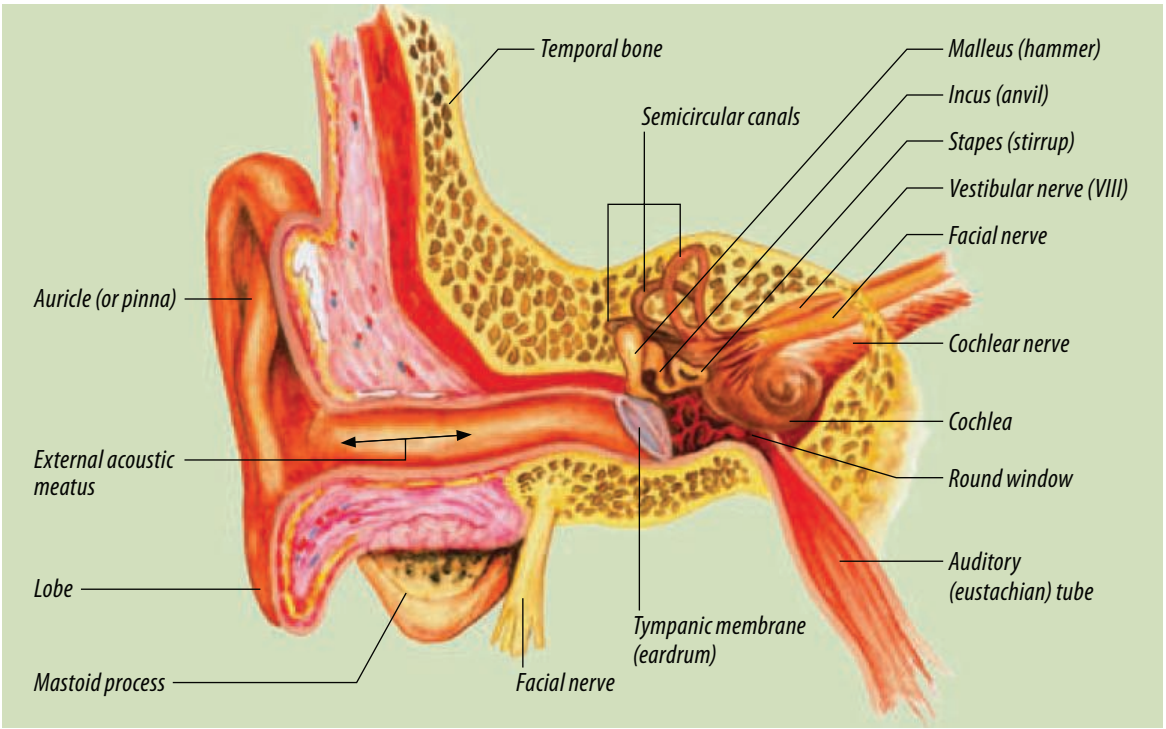
INNER EAR

The oval window is one of two membranes separating the middle and inner ear. The oval window transmits sound waves from the footplate of the stapes to the fluid contained within the vestibule of the inner ear. The vestibule contains the utricle and saccule—the sense organs for balance—and connects the two divisions of the inner ear.

The first division consists of the semicircular canals that function in the maintenance of balance, and the second division consists of the cochlea, which contains the organ of Corti that functions in hearing. Branches of the vestibulocochlear nerve (cranial nerve VIII) transmit information concerning sound and balance to the brain for interpretation.

The round window is the second membrane that separates the middle and inner ear. This window relieves pressure in the inner ear by bulging outward (into the middle ear) when necessary.

FIGURE 1:
Anatomy of the ear.



PHYSIOLOGY OF HEARING

Hearing, which is a mechanoreceptive sense, is made possible by the ear's response to the mechanical vibrations of sound waves through the exter-

nal auditory canal toward the tympanic membrane. Sound is funneled into the external auditory canal by the pinna to the tympanic membrane and amplified as it moves through the narrowing canal. Sound waves strike the tympanic membrane, causing it to vibrate, which subsequently causes the ossicles of the middle ear to vibrate.

The ossicles are suspended by ligaments that allow the malleus and incus to act as a single lever, with its fulcrum approximately at the border of the tympanic membrane. The head of the malleus, which is opposite its handle, balances the other end of the lever, so that changes in body position do not cause fluctuations in tension on the tympanic membrane.

The handle of the malleus is held in a constant state of being pulled inward by ligaments and by the tensor tympani muscle, which keeps the tympanic membrane tense. Such conditions allow vibrations acting on any portion of the tympanic membrane to be transmitted to the malleus. The incus moves in concert with the malleus because the two are tightly bound to one another by ligaments.

The articulation of the ossicles with one another is such that the stapes presses on the fluid of the inner ear each time the incus moves inward. When the malleus moves outward, the stapes pulls on the fluid within the cochlea. As the fluid moves, hair cells within the cochlea are stimulated and send nerve impulses from the cochlear branch of the vestibulocochlear nerve to the temporal lobe of the brain—culminating in the sensation of hearing.

COMMONLY USED EQUIPMENT, INSTRUMENTS AND SUPPLIES

The following three sections present a general list of items commonly used in ear surgeries. As in all procedures, consult each surgeon's preference card.

EQUIPMENT

A microscope is used in most ear procedures. A 250-mm lens is most commonly used, but some surgeons may use a 300-mm lens as well. Consult the preference card to see if the surgeon uses angled or straight eyepieces for the microscope. In some hospitals, the microscope is connected to video equipment, enabling the surgical technologist to view the procedure and anticipate the surgeon's needs more effectively.

Some surgeons use an adjustable, hydraulic chair when looking through the microscope. A facial nerve monitor may be used to prevent injury to the facial nerve, particularly during stapedectomies and cochlear implant procedures.

Several different sizes of round cutting and diamond burrs should be available to give the surgeon options. Lasers may be used for stapedectomies or to remove scar tissue and cholesteatoma from the middle ear.

INSTRUMENTS

Most hospitals have a general ear set with larger instrumentation, such as ear specula (all sizes), a specula holder, retractors (eg, angled or hinged Weitlaner, mastoid (Jansen) and Senn), House suction tips (usually 3, 5 and 7 Fr and 20 and 22 ga), scalpel handle, tissue forceps, hemostats, needle holders, periosteal elevator and dissecting scissors. Some hospitals have surgery-specific instrument sets, and some surgeons have their own sets of instruments.

Some of the microsurgery instruments have dedicated trays to prevent damage. Ear picks also may have a special tray, which can be placed on the Mayo stand for convenience.

It is important to clean off the instrument tips with a microwipe sponge after they are handed back to you. This helps the surgeon see the end of the instrument more clearly through the microscope and thus determine more accurately the depth to which it should be inserted.

There are numerous ear picks available, so they should chosen according to surgeon preference.

Micro-cup and alligator forceps are typically used. Many surgeons use a small, smooth alligator forceps to prevent damage during placement of prostheses. Bellucci and Glasscock scissors also may used.

Some surgeons, especially for stapedectomies, prefer a special speculum holder that attaches to the operating table.

Photo courtesy of Mary Sutton, CST, CFA

FIGURE 2: Myringotomy set-up.

SUPPLIES

If a microscope is used for a sterile procedure, then a sterile drape is needed. Cotton balls may be used either as a dressing or as a sponge. Occasionally, a hemostatic agent may be applied with a portion of a cotton ball. An absorbable gelatin sponge may be used as a hemostatic agent or as packing to secure graft material.

Commonly used medications include topical adrenaline, lidocaine (with or without epinephrine) and an antibiotic otic suspension.

TYMPANOSTOMY TUBE INSERTION

Myringotomy with insertion of tympanostomy tubes is the most common operation in the United States with approximately two million procedures per year.

INDICATIONS FOR SURGERY

The most common indication for placement of tympanostomy tubes is chronic otitis media with effusion. Other indications include recurrent otitis media, retraction of the tympanic membrane, and a collapsed eustachian tube.

TUBE SELECTION

Several factors influence the choice of tympanostomy tubes: surgeon preference, the size of the child's ear canal, the length of time the tubes are expected to remain in position, the condition of the eardrum, and the condition of the ossicles. Most tubes stay in the eardrum approximately four months and then fall out, after which time the tympanic membrane heals.

T-tubes are designed for long-term use, and grommet tubes are designed for short-term use. Once tympanostomy tubes are placed, the patient must take care to prevent water from entering the ear canal and traveling to the middle ear.

INSTRUMENTATION

A myringotomy set usually includes a myringotomy blade handle; large and small alligator forceps; a Rosen needle or middle ear pick; House suction tips in sizes 5 and 7 Fr and 20 ga; a cerumen loop or curette; and a set of ear specula, usually in sizes 4, 4.5 and 5 mm.

Equipment needed includes a microscope with a 250-mm lens, suction tubing, towels and cotton balls.

Myringotomy is considered a clean procedure. No patient preparation is performed, and draping is optional. If a drape is used, it may be a small fenestrated sheet or towels.

Author's tips: 1. Suction tips can become clogged easily. It's a good idea to have two suction tips in each size on your set-up, as well as some saline and a syringe to remove serous fluid build-up. 2. When selecting specula, keep in mind that some physiological conditions affect ear canal size. For example, some patients with Down syndrome have small ear canals and thus require smaller specula.

PROCEDURAL OVERVIEW

This procedure may be performed with sterile gloves but without a sterile gown, according to hospital policy. Surgeons should remove the powder from their gloves before handling the instruments to prevent the introduction of powder into the ear.

The surgeon drapes per individual routine and places the speculum in the ear canal. The microscope is focused on the tympanic membrane. A cerumen loop or curette or a large suction tip is used to remove wax or debris from the ear canal.

An incision is made in the tympanic membrane with a myringotomy blade, and a smaller suction is placed through the incision to remove any fluid in

the middle ear. In some cases, a thick serous fluid, called "glue," is found, and then a larger suction tip may be necessary to evacuate this fluid.

Once the middle ear is clear, the tympanostomy tube is placed into the incision with a small alligator forceps. The tube is then seated properly with a Rosen needle or middle ear pick, and the speculum is removed. If necessary, antibiotic otic suspension is applied to the ear canal, and a small cotton ball is placed in the external canal to prevent drainage.

The patient is repositioned, and the surgeon moves to the other side of the table to repeat the procedure on the contralateral side, if necessary.

POTENTIAL COMPLICATIONS

The most frequent complication following tympanostomy tube insertion is otorrhea, characterized by serous fluid draining from the ear, often due to water contamination of the middle ear. Other complications include tympanosclerosis (often due to repeated tube placement), persistent tympanic membrane perforation (the incidence of which increases with long-term tube placement), and cholesteatoma.

TYMPANOPLASTY

Reconstruction of the tympanic membrane is usually indicated in cases of membrane perforation. Initially, full- or split-thickness skin grafts from the postauricular area were used to repair perforations. The major disadvantages of using this type of graft were excessive desquamation and reperforation, therefore creating the need for an alternative grafting material as well as a second operation.

Surgeons then tried ear canal skin and various connective tissue grafts, with the connective tissue grafts becoming extremely prevalent in the early 1960s. Most surgeons today use the temporalis fascia as a graft.

INSTRUMENTATION

Equipment typically needed includes a microscope with a 250-mm lens, adjustable chairs for the seated team members, and a video monitor placed where the surgical technologist can see it clearly. A rotating drill and facial nerve monitor are commonly used, according to surgeon preference. A variety of burrs for the drill and a speculum holder should be available.

Typically, a general ear set and a microsurgery ear set with ear picks are used. Beaver blades are commonly used and are selected according to surgeon preference.

Supplies include nonsterile and sterile preparation items, appropriate basins and drapes (including drapes for the microscope and the back of the hydraulic chair), electrosurgical pencil with dispersive electrode and holster, suction tubing, ear bulb syringe, razor and hair restraint (eg, a bouffant cap secured with tape).

Author's tip: In the author's experience, a 3-cc syringe with a 27-ga needle is often used to inject medications, and a 12-cc syringe should be on the field to unclog suction tips, if necessary.

Other supplies commonly used include absorbable gelatin, lidocaine, epinephrine and antibiotics.

PROCEDURAL OVERVIEW

A nonsterile setup is prepared according to surgeon preference. The patient is placed in the supine position with the head turned so that the operative ear is turned upward. The operating table may be turned 90 to 180 degrees to accommodate the surgical team and equipment.

Author's tip: The blood pressure cuff should not be placed on the same arm as the affected ear, because the inflating and deflating may cause unwanted movement.

The patient is prepped and draped according to surgeon preference. Drape the microscope as soon as possible, because it will be used immediately. After gowning and gloving, make sure that powder is removed from the gloves of all surgical staff.

The surgeon will place the speculum in the canal and excise a "vascular strip," typically with a beaver blade and a local anesthetic. The vascular strip is a section of tissue taken from the ear canal or ear drum and placed over the temporalis fascia graft later on in the procedure to improve healing.

If tissue is taken from the ear drum, the remaining tympanic membrane usually is dissected, or the perforation is trimmed (or rimmed).

Some surgeons perform a tympanoplasty through the ear canal, while others use a postauricular approach. Surgeon preference and the pathology of the area determine the approach.

With both approaches, a small incision will be made from near the top of the ear to the temporalis fascia to retrieve the graft. The tissue is removed and prepared according to surgeon preference, and the incision is closed.

In some cases, the tissue is compressed with a fascial press or flattened on a Teflon® block with a sponge. The fascia may be left in the press or removed to dry until placement.

The graft is cut to fit and placed in the ear canal with a small, smooth alligator forceps and an ear pick. The vascular strip removed earlier is laid over the temporalis fascia graft. Cut pieces of moist, absorbable gelatin may be used to secure the graft and to create a bed that supports the graft.

To prevent drainage, additional gelatin may be placed in the ear canal, usually with a small alligator forceps or with a small suction tip and ear pick. A cotton ball is often placed in the external ear canal to prevent liquid from leaking out.

While placing the graft in the ear canal, the surgeon may ask the anesthesia provider to stop using nitrous oxide, which can cause pressure on the eardrum which may cause the graft not to seat properly on the membrane or vascular strip.

If the patient has a small ear canal, the surgeon may do a Sheehy tympanoplasty, which involves removing the ear canal skin and enlarging the canal with an ear drill. A full thickness skin graft may be placed in the canal if extra skin is needed to supplement the existing skin. When using the ear drill, make sure appropriate irrigation is done, so that the bone will not become overheated and damaged.

POTENTIAL COMPLICATIONS

The most common complication of tympanoplasty is reperforation. Other complications include hemorrhage, infection and unsuccessful restoration of the patient's hearing. In rare cases, a patient may have to undergo several procedures before the graft epithelializes.

ABOUT THE AUTHOR

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Editor's note: *This article will continue in next month's issue. In Part II, the author will continue her overview of aural surgeries by focusing on three procedures: ossicular reconstruction, tympanomastoidectomy and stapedectomy.*

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