Stapedectomy with Fascia Graft

Joanne Gallogly, cst

The ear is an intricate anatomy made of three sections each responsible for an essential role in hearing. The external ear refers to two structures: the auricle (pinna) and the external auditory meatus. The auricle is composed of flexible cartilage enclosed with skin. The external auditory meatus is slightly curved and contains sebaceous and ceruminous glands that secrete sweat and cerumin, or "ear wax."

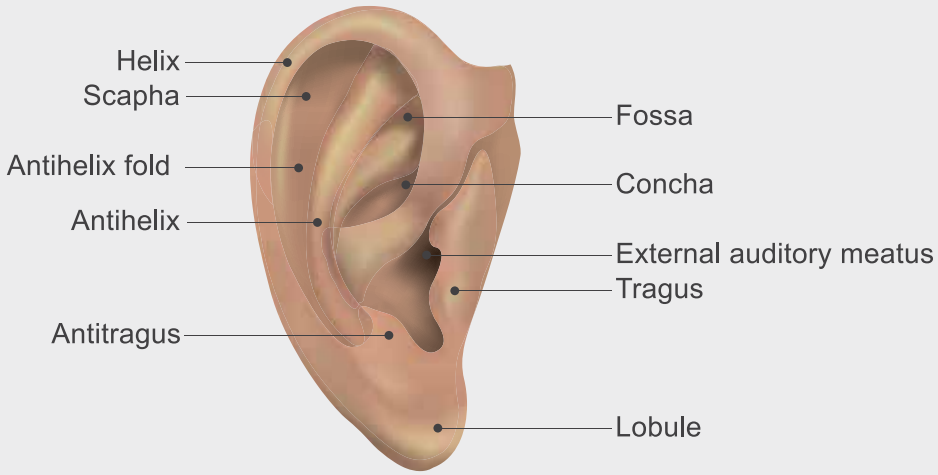
The middle ear houses several structures. The tympanic membrane (eardrum), three tiny bones referred to as the auditory ossicles, and two thin membrane-covered openings called the oval window and the round window. Located medially on the auditory meatus, the tympanic membrane separates the external and middle ear and vibrates when hearing. The tympanic cavity houses the auditory ossicles and is situated between the medial part of the eardrum and the bony wall of the inner ear, where the membrane-covered opening of the oval window and round window are located.

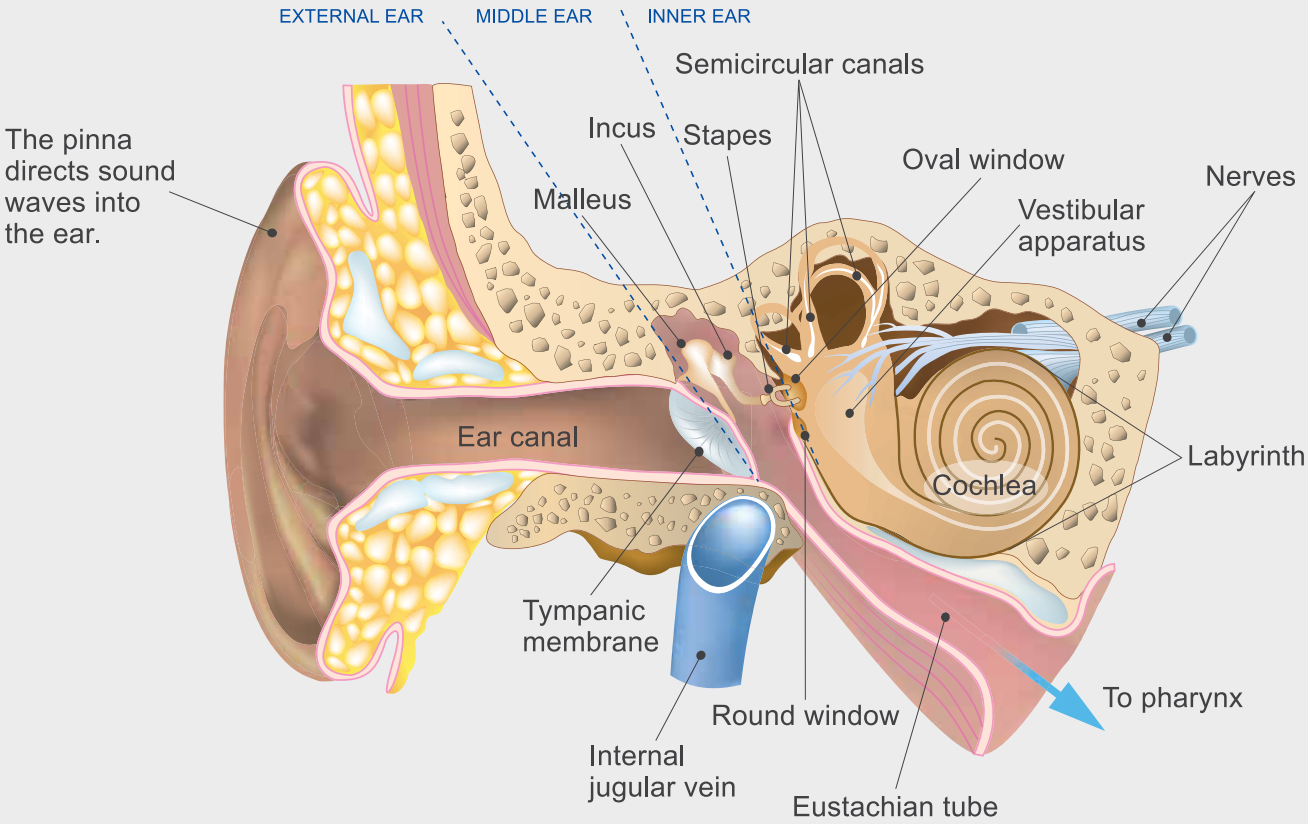
The three auditory ossicles are known as the malleus, incus, and stapes. The incus is shaped like an anvil and is the largest ossicle. It articulates with the hammer-shaped malleus head in the epitympanum, also known as the "attic." The incus is the most superior portion of the tympanic cavity and is a movable joint. The stapes is the smallest ossicle,

LEARNING OBJECTIVES

- Review the anatomy of the ear
- Describe how otosclerosis affects the stapes
- Explain how a diagnosis of the disease is confirmed
- Study the procedural steps used in a stapedectomy
- List prosthetics that may be used during a stapedotomy

ANATOMY OF THE EAR





as well as the smallest bone in the human body. It is a stirrup-shaped bone, and the footplate fits into the oval window while its head articulates with the incus at the tip of the long process of the incus, also referred to as the "lenticular process." The eustachian tube connects the middle ear to the nasopharynx and is located just beyond and below the tympanic membrane. The eustachian tube is about 4 cm in length and travels downward and maintains an equal amount of pressure on both sides of the tympanic membrane, allowing air to flow from the nasal cavity to the middle ear.

Otosclerosis is an abnormal growth of bone that hardens at the base of the stapes in the middle ear resulting in hearing loss due to the inability to vibrate.

The inner ear is made of two main structures: the bony labyrinth and the membranous labyrinth. Within the bony labyrinth is a series of hollow channels filled with perilymph, a liquid made of plasma and cerebrospinal fluid. It is similar to extracellular fluid, which is high in sodium and low in potassium. Within the posterior portion of the bony labyrinth, the vestibule and the three semicircular canals are located and are associated with equilibrium. The main hearing organ is the cochlea, a spiral-shaped organ embedded into the temporal bone and connected to the cerebrum by the vestibulocochlear nerve. The cochlea is divided into three spiral fluid-filled chambers. First, the scala vestibuli – filled with perilymph – communicates with the second chamber (the scala tympani), and ends at the round window of the tympanic cavity. The third chamber is called scala media, or the cochlear duct. It contains endolymph, a plasma-like fluid similar to intracellular fluid, that is high in potassium and low in sodium. The cochlear duct is located between the scala vestibuli and the scala tympani. It is separated from the scala vestibuli by the vestibular membrane and separated from the scala tympani by the basilar membrane. The basilar membrane holds the organ of Corti, which is formed with receptor auditory cells that receive and conduct sound stimulus. It is an organized structure of hair cells and supporting cells. These hair cells have tiny sensory projections that are specialized microvilli.

Sound is a series of vibrations often referred to as sound waves. Sound is collected in the outer ear, and funneled toward the middle ear. The vibrations move the malleus and incus, causing the stapes to move in and out of the oval window. This area of the ear acts as the conductive mechanism. As sound waves travel, they enter the inner ear as they reach the cochlea. Nerve impulses are converted into information for the brain to process in the cochlea; this is known as the sensorineural mechanism. When sound reaches the tympanic membrane, it is carried through perilymph to the endolymph in the scala media. The basilar membrane vibrates when it receives these waves of fluid. The hair cells in the organ of Corti bend and stimulate the cochlear nerves. These nerve impulses travel the common vestibule to the auditory area of the central nervous system located in the temporal lobe.

DISEASE

Otosclerosis is an abnormal growth of bone that hardens at the base of the stapes in the middle ear resulting in hearing loss due to the inability to vibrate. This condition was discovered by Antonio Maria Valsalva, who conducted numerous autopsies to study bone health and disease. Valsalva had a particular interest in the middle and internal ear, and his postmortem dissection of a deaf patient revealed the fixation of the stapes (now known as otosclerosis) as the cause of hearing loss. He first described the structure and function of the eardrum, muscles, nerves of the ear as well as the eustachian tube and named it after the Italian anatomist Bartolomeo Eustachi, that discovered it. Valsalva was the first to describe the ear in three sections and published "De aure humana tractatus" (Treatment of the Human Ear") in 1704. Many years later, a member of the Royal College of Surgeons Joseph Toynbee published an article confirming the link between deafness and stapes fixation in 1841. He dissected 1,659 temporal bones and found stapes fixation in 39 of them, concluding it was a common cause of deafness.

A diagnosis of otosclerosis is confirmed with hearing tests to determine if the hearing loss is conductive or if it

is sensorineural. Conductive hearing loss is due to either a lesion or disorder affecting the ear canal or middle ear. Sensorineural hearing loss is due to a disorder of the inner ear or affecting of the vestibulocochlear nerve also known as the 8th cranial nerve. Two common hearing tests used to determine the type of hearing loss are the Rinne test and the Weber test. These hearing tests are performed with tuning forks and are often used in an initial consult. Etiology is then confirmed by an audiogram and/or CT scan.

Otosclerosis affects more than three million Americans, or about 10 percent of the population. Caucasian and Asian Americans are more likely to develop otosclerosis than African Americans, and it usually occurs between the ages of 10 and 30. Women are more likely to be affected, and pregnancy sometimes is a catalyst for onset or an increase in symptoms. The risk of developing otosclerosis increases by as much as 25 percent if the gene is inherited by one parent, and as much as 50 percent if both parents have been affected. Surgical intervention, a stapedotomy, is necessary to treat the condition to improve hearing.

TREATMENT

Originally, the entire stapes was removed during the procedure. Currently, the entire removal of the stapes is only performed in select cases depending on the severity of damage to the stapes. A less traumatizing stapedotomy is now the most common surgery for otosclerosis. The procedure has evolved considerably since the first stapedectomy was performed by Dr. John Shea in 1956. The surgeon creates a hole using a micro drill or a laser in the footplate of the

Basic Instrumentation
Instruments/Equipment
CO2 Laser
Drill
Electric hair clippers
Preparation Table
Alcohol wipe
Fenestrated plastic drape
Marking pen
1% lidocaine with epinephrine
Speculum
Cerumen spoon
Betadine
Drapes
Blue towels
Stapler
ENT drape

Harvesting Graft
15 blade and handle
Small sharp Weitlaner
Hemostat
Elevator
Small Metzenbaum scissors
Tissue press
Goldenberg cutting block
Cautery
3-0 polyglactin 910
3-0 nylon suture and bacitracin or tissue adhesive and steri-strips (depending on surgeon's preference)

Ear Canal
Speculum holder
Various sizes of speculums
Small and large round knife
Tab double-edge flap elevator
House elevator
Rosen pick
Straight pick
Curettes, various sizes
Bellucci scissors, straight, curved and upturned
SI joint knife
Fish ear forceps
#3, 5, 7 suction tips
Dressing
Bacitracin
Cotton ball
Eye pad or 4x4 gauze
Glasscock dressing
Implants
Implant of surgeon's preference

stapes, then places a prosthesis to gain function and movement of the stapes to restore hearing. A laser is often preferred to minimize vibrations onto the footplate. Vibrations occur when drilling even with the smallest of drill bits, and are greatly magnified under the microscope during surgery thus leaving room for error. Prostheses have also changed in size, shape and material. Prostheses can be categorized as either hooked or handled; the hook resembles a Shepherd's hook and the handle is similar to a bucket handle. Three of the most common are a variation of the wire loop, piston and bucket handle prosthetics. Materials used to make these prosthetics include Teflon, stainless steel, platinum, gold and nitinol. The most-used prosthetic is comprised of a piston with the wire loop on the end. A laser is used to crimp the wire loop around the incus. Since the surgeon is operating through a microscope while using a laser inside the ear, this is the most critical part of the procedure. If the loop is crimped too tightly, there is a risk of tissue necrosis. If it is too loose, there is a risk of displacement and deterioration of hearing.

Indications for surgery include reasonably good health (to tolerate anesthesia) and conductive hearing loss (due to fixation of the stapes). A contraindication may include lateral ossicular chain fixation. Possible reasons why the surgery may not be recommended includes an active external or middle ear infection, a pre-existing perforation of the tympanic membrane, a patient's anatomy such as inner ear malformations, poor physical health or if it is the only hearing ear with serviceable hearing.

Studies of thousands of patients have shown an extremely high success rate exceeding 95% for primary cases and 50-70% for revisions. The failure rate is 5-10%, which is most commonly due to improper position of the prosthesis. The second most common cause of failure is necrosis of the incus. Other possible complications may include bleeding, infection, vertigo, increased chance of total hearing loss in the operative ear, facial nerve injury, perforation of the eardrum and changes in taste.

PROCEDURE

The patient is placed in the supine position and the head is turned to the non-operative side. General anesthesia is administered, and the patient's eyes are taped for protection. The circulator places a grounding pad onto the patient's thigh. The surgical technologist drapes the microscope. The surgeon shaves a small amount of hair behind the ear using clippers and the postauricular area is marked with a one-centimeter incision line. A dose of 1% lidocaine with 1:100,000 epinephrine is injected post auricularly as well as into the ear canal. The patient is prepped with betadine and draped with an aperture drape followed by a large sterile ENT split drape.

The circulator connects the suction tubing and the electrosurgical unit (ESU) and sets the cut and coagulation setting to 20/20. The surgeon begins with a one centimeter postauricular incision with a #15 blade. A mosquito is used to dissect through the thin wispy fool's fascia down to the true temporalis fascia and a small sharp Weitlaner is placed for exposure. Hemostasis is obtained with the cautery pencil and a 1 cm x 1 cm piece of fascia is harvested using small black handled Metzenbaum scissors. The tissue is then pressed and spread out on a cutting block and set aside on the back table in a secure location to dry out.

The wound is closed using a 3-0 polyglactin 910 suture, tissue adhesive and steri-strips. Attention is then turned to the stapedotomy part of the procedure.

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To begin the stapedotomy, a speculum is placed for visualization. Some surgeons prefer to use a self-retaining speculum holder that can be positioned to ensure it does not slide or move during surgery.

Under the operating microscope, a small amount of saline is used to irrigate the canal and suctioned with a #5 Frazier suction tip. The tip is then exchanged for a #3 Frazier tip. Two incisions are made halfway down the bony canal with the sickle knife. A tympanomeatal flap is elevated using a House elevator. The chorda tympani nerve is identi-

fied and preserved, and the ossicles are observed. The stapes is then separated from the incus using a SI joint knife. A wet towel is introduced to the sterile field for safety and the surgical technologist loads the laser fiber and drapes the laser in a sterile fashion. The circulator places eye protection onto the scrub nurse and makes sure everyone dons their own laser glasses before the laser is activated. The laser is set to the recommended settings and is used to cut the stapedial tendon. The laser is then used to cut the arch of the stapes bone. The rest of the stapes suprastructure is removed using the laser and various picks may be used to help remove other remnants of bone. A measurement of the length from the underside of the incus to the hole made in the footplate is made for the prosthesis using a measuring rod. An implant of the surgeon's choosing is attached to the incus bone and secured using the laser to crimp it around the incus bone. Once the implant is crimped, the temporalis fascia graft is ready to be placed. The surgeon will trim the graft to fit the opening and the area surrounding the prosthesis using a Rosen curved pick and straight pick for placement. The surgical technologist will either pass absorbable gelatin powder of various sizes soaked in ofloxacin on a pick to the surgeon, or the surgical technologist may be asked to drop it into the speculum so the surgeon may place it appropriately around the wound. The tympanomeatal flap is then placed back into position and more absorbable gelation powder is used. Wicks soaked in saline may be placed for any drainage and bacitracin may also be injected into the ear. Finally, a cotton ball covered in bacitracin is placed into the ear and a dressing is applied and then fastened around the head.

RECOVERY

Postoperatively patients should not drive for at least one week to avoid inflammation and possible displacement of the implant. The patient will receive antibiotic drops for the following week, and the packing and suture is usually removed from the ear after seven additional days. Patients also should not lift heavy objects, ride in an airplane, blow their nose, or swim for three weeks. Extreme care should be taken not to get the ear wet because moisture at the site may lead to an inner ear infection and cause hearing loss. The patient should avoid loud noises due to increased auditory sensitivity following the procedure. An audiogram is usually performed between one and four months after the

procedure. The timing of the audiogram depends on how long it takes for the patient to regain their hearing. If it is a revision surgery, the audiogram will not be performed until three to six months postoperatively to allow time for full recovery. Patients will receive yearly audiograms for the first five years after the surgery.

Because otosclerosis is usually inherited, it is not likely it will ever go away. Stapedectomy, and stapedotomy procedures, implants, materials and surgical tools have changed through the years and will continue evolving. Hearing restoration is incredibly valuable to patients and the successful stapedotomy has proven to be greatly beneficial to the patient's quality of life.

ABOUT THE AUTHOR

Joanne Gallogly, CST, graduated in 2005 earning an associate degree and certification in surgical technology. She has worked in the hospital setting for 10 years and served as a clinical resource specialist in the gynecological and ophthalmic surgical specialties, as well as a CST in Labor and Delivery for two years. She is currently the lead ENT surgical technologist at an ambulatory surgical center and enjoys scrubbing a variety of procedures. She recently completed level one of the clinical ladder program and is working on level two. She plans on advancing her career by completing her degree in nursing, and will begin classes in July of 2020.

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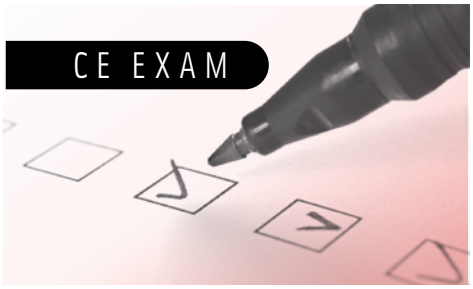

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Stapedectomy with Fascia Graft

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1. **The main hearing organ is the _____.**
a. Stapes
b. Cochlea
c. Organ of Corti
d. Incus

2. **Which bone is stirrup-shaped, and its footplate fits into the oval window?**
a. Incus
b. Malleus
c. Stapes
d. None of the above

3. **What stimulates the cochlear nerves?**
a. Hair cells
b. Nerve impulses
c. Basilar membrane
d. Tympanic membrane

4. **Sensorineural hearing loss is due to a disorder of the inner ear or affecting of the _____.**
a. Ear canal
b. Middle ear
c. Organ of Corti
d. Vestibulocochlear nerve

5. **The first stapedectomy was performed in:**
a. 1948
b. 1956
c. 1962
d. 1968

6. **The most-used prosthesis for a stapedotomy include which of the following:**
a. Piston
b. Wire loop
c. Bucket handle
d. A and b

7. **A measurement of the length from the underside of the _____ to the hole made in the footplate is made for the prosthesis using a measuring rod.**
a. Incus
b. Stapes
c. Malleus
d. Ear canal

8. **This procedure has an extremely high success rate for primary cases. What is the second most common cause of failure?**
a. Vertigo
b. Total hearing loss
c. Necrosis of the incus
d. Improper position of the prothesis

9. **The bony labyrinth is a series of hollow channels filled with:**
a. Extracellular fluid
b. Perilymph
c. Endolymph
d. Intracellular fluid

10. **What is comprised of receptor auditory cells that receive and conduct sound stimulus?**
a. Scala media
b. Scala vestibuli
c. Organ of Corti
d. Membranous labyrinth

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