Chapter 119 – Perilymphatic Fistulas

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Perilymphatic fistulas (PLFs) define a communication from the inner ear to the middle ear that occurs as a result of disruption of the natural bony or soft tissue barrier between the perilymphatic and middle ear spaces. It can be through the round or oval windows, fractures, neoplastic erosion, microfissures of the otic capsule, or disruption of the endosteal membrane after a fenestration procedure. Despite this clear definition, the existence of PLF as a spontaneous event remains a controversial issue in otology.

The clinical features of PLF became evident as experienced otolaryngologists correlated patients' symptoms with operative findings during middle ear surgery. Three different types of otologic findings have brought PLF into the differential diagnosis when acute auditory or vestibular dysfunction occurs. One form of PLF became recognized in the early era of otosclerosis surgery. On rare occasion, sudden onset of rapidly progressive hearing loss and dizziness would develop after stapedectomy. Middle ear exploration in these patients often revealed an opening in the oval window. A greater incidence of oval window PLFs was observed when a wire–Gelfoam prosthesis had been used. Likewise, polyethylene prostheses were found to erode through the oval window membrane and create a PLF. After repair of the PLF, the symptoms were frequently controlled. A second clinical entity described was erosion of the otic capsule by tumors of the middle ear or cholesteatoma and creation of a PLF, also eliciting symptoms of hearing loss or vertigo. A third clinical situation in which PLF was identified occurred with implosive or explosive injury to the inner and middle ear. Fee proposed this concept in 1968.[1] Patients subjected to significant barotrauma followed by hearing loss or dizziness were found to have a tear in the round window membrane or disruption of the stapes footplate.

PLFs may be categorized as *spontaneous* (idiopathic) or *post–traumatic.* A spontaneous PLF, by definition, has no predisposing events or factors that would induce a leak. It is often associated with congenital anomalies of the inner ear.[2] The incidence of spontaneous PLFs without an inner ear anomaly is apparently quite low. Post–traumatic PLFs include those that occur as a result of erosive tumors or cholesteatomas, secondary to iatrogenic leaks after otologic surgery, or subsequent to head trauma, barotrauma, or acoustic injuries.

The differential diagnosis should include a PLF when patients have hearing loss and vertigo, as well as a recent history of otologic surgery, head trauma, or barotrauma or evidence of middle ear pathology. Skepticism regarding the incidence of spontaneous PLF abounds because of isolated reports of large series of patients undergoing middle ear exploration for this diagnosis. We do not believe that spontaneous PLF is a cause of constant disequilibrium, tinnitus, aural fullness, and cognitive defects. Thus, PLFs in most adult patients can typically be categorized as post–traumatic in origin. In contrast, children and adolescents would be more likely to have spontaneous PLFs. It was shown that pediatric patients evaluated for hearing loss or vertigo had a higher incidence of congenital inner and middle ear anomalies. This group of patients had a significantly higher incidence of β_2-transferrin present in fluid samples collected at the time of exploratory tympanotomy.[2] Symptoms related to congenital anomalies of the temporal bone should become apparent in the earlier years rather than after the third decade of life.

An astute physician must have a high index of suspicion in rendering a diagnosis of PLF. The patient's immediate history is critical in linking the onset and activities with the symptoms of hearing loss, tinnitus, and vertigo. It is also imperative to know the patient's past history of otologic diseases and surgery, any congenital malformations that may be present, previous ear or head trauma or barotrauma, or a history of recurrent meningitis.

Trauma is the leading cause of PLF. It may be in the form of barotrauma, head trauma, or a penetrating injury. The latter is often associated with vertigo and routinely requires surgical repair. We have had clinical experiences with unusual forms of ear trauma. One involved a metal choker necklace and the other a branch of a tree entering the middle ear and extracting and subluxating the stapes, respectively. A similar report described a patient with severe itching; penetration of the ear with a paint brush resulted in perforation of the tympanic membrane, anacusis, and severe vertigo. The vestibular symptoms are often relieved once the fistula is sealed.[3]

It may be difficult to differentiate the symptom complex of Meniere's disease (fluctuating hearing loss, vertigo, tinnitus, and aural fullness) from those of a PLF. Loss of perilymph may result in a relative increase in endolymph with resultant secondary endolymphatic hydrops. Fitzgerald proposed a diagnostic strategy to manage surgical intervention. Simultaneous repair of a PLF and performance of an endolymphatic sac procedure may incur an unnecessary operation. A positive fistula test or immediate onset of Meniere's disease symptom complex after

head or ear trauma points toward the pathology being a PLF, and surgery should be directed to the middle ear alone.[4]

There are other rare causes of PLF. An unusual form of trauma is from a lightning strike. Perforation of tympanic membrane is a known complication in this setting. If otorrhea should occur, the discharge, especially if watery and clear, should be assayed for β_2-transferrin. Exploration for a PLF should be considered when mixed hearing loss is identified.[5]

A formidable problem inherent in making the diagnosis of PLF is that there are no specific tests diagnostic of PLF, including both preoperative assessment and intraoperative determination. The current “gold standard” method of diagnosing a PLF is based on subjective interpretation of the surgeon's observations at the time of exploratory tympanotomy. The surgeon looks for reaccumulation of clear fluid in the round or oval window niche, especially after suction aspiration, or for a microfissure of the otic capsule. Identification of clear fluid can be falsely interpreted as perilymph in that a serous transudate or injected lidocaine may also pool in niches in the middle ear. Unless a unique marker for perilymph is identified, PLF at the time of exploration may be overdiagnosed.

In summary, based on our experience with exploration of the middle ear, we do acknowledge that PLFs exist but the incidence is low. It is important to consider a PLF in the differential diagnosis of sudden or rapidly progressive hearing loss or disequilibrium. However, one's criteria for exploring an ear must be defined and understood.

PATIENT SELECTION

Given that most cases of presumed PLF in adults can be categorized as post–traumatic, a critical feature necessary to entertain a diagnosis of PLF is the history given by the patient. In contrast, progressive hearing loss in children cannot be assumed to be hereditary in origin. The physician must extract and synthesize a complete otologic history. Complaints of aural fullness, hearing loss or dizziness, vertigo, or disequilibrium suggest the need for further information. The present history must clarify the onset of symptoms along with predisposing factors or associated physical activities. The duration and frequency of symptoms are the most important to ascertain. A history of episodic hearing loss with aural fullness, tinnitus, and vertigo lasting a few hours is more suggestive of Meniere's disease than PLF. Sudden hearing loss after an upper respiratory infection is probably a postviral loss unless violent sneezing or coughing preceded the acute event. Consideration of the diagnosis of PLF requires that if hearing loss is present, its onset be sudden, fluctuating, or rapidly progressive. Vestibular complaints may range from symptoms as vague as episodic lightheadedness or mild disequilibrium to unsteadiness, vertigo with nausea and vomiting, or ataxia.

Sudden auditory or vestibular symptoms may develop after abrupt changes in middle ear or subarachnoid space pressure. Injury to membranes of the scala tympani, media, or vestibuli (intracochlear fistula) or to the round or oval windows may occur as a result of severe barotrauma, acoustic trauma, or extreme physical exertion. Patients would be considered at risk for having a PLF if symptoms developed within a day or two after barotrauma from a poorly pressurized air flight; swimming pool or scuba diving; closed compressive ear trauma (hand slap to the ear); violent sneezing; forceful straining from constipation, labor and delivery, or weightlifting; or a blast injury.

Patients are questioned about whether they have recently or previously undergone any otologic surgery. Attempts are made to extract information regarding the precise nature of any procedure and whether any untoward complications occurred. In particular, it is helpful to determine whether the surgery was for otosclerosis, cholesteatoma, or other tumor of the middle ear and mastoid. The differential diagnosis for patients describing episodic dizziness or fluctuating progressive hearing loss after stapedectomy includes serous labyrinthitis, reparative granuloma (in the early postoperative period), or PLF (see Chapter 117).

Patients complaining of unrelenting vertigo should be examined for nystagmus. A spontaneous vestibular (horizontal) nystagmus may be identified. It can be observed on gross eye examination or by limiting visual fixation by having the patient wear Frenzel's lenses or infrared video goggles with display on a monitor. Another method for identifying nystagmus is via ophthalmoscopy. One looks for rhythmic retinal movement when examining the fundus. Assessment of hearing status is essential. Interpretation of tuning fork testing in the immediate postoperative period after otologic surgery may be difficult, depending on the hearing status of the contralateral ear. Complete closure of the air–bone gap may not be evident because of canal packing or middle ear fluid. Tuning fork lateralization to the operative ear confirms that cochlear function is preserved. Lateralization to the contralateral ear may indicate contralateral conductive hearing loss (bilateral otosclerosis) or significant ipsilateral sensorineural loss. The packing should be removed from the ear canal, and the tympanic membrane should be carefully inspected. The integrity of the tympanic membrane and the presence of middle ear fluid should be confirmed.

A fistula test with a pneumatic otoscope is performed to look for pneumatic–induced nystagmus (Hennebert's sign) or pneumatic–induced vertigo (Hennebert's symptom). Gentle pneumatic otoscopy may elicit horizontal nystagmus with positive or negative pressure. However, these findings must be interpreted cautiously in the immediate postoperative setting. The presence or absence of nystagmus does not confirm that a fistula does or does not

exist. An audiogram will provide helpful information by identifying the type and degree of hearing loss present. Erythema of the tympanic membrane with a mild conductive hearing loss may be treated medically with antibiotics, steroids, and close observation. Another possibility is that this manifestation of hearing loss or disequilibrium may be a result of serous labyrinthitis. Significant progressive change in sensorineural hearing levels or speech discrimination scores in the face of new–onset dizziness is strongly suggestive of a PLF or possible reparative granuloma. Despite the surgeon's reluctance to re–explore a recently operated ear, the history and findings warrant intervention.

Indirect injuries to the tympanic membrane by an open hand slap to the ear often result in rupture of the tympanic membrane. A similar injury could occur with significant acoustic trauma, such as a blast injury. Blunt trauma to the tympanic membrane may also result in direct damage to the ossicular chain. In all three types of injuries, the compressive energy could be transmitted through the ossicular chain with subluxation of the stapes footplate into the oval window or explosive rupture of the round window. Progressive hearing loss or persistent disequilibrium in these settings is strongly suggestive of a traumatic PLF. Complete examination of the ear is necessary in patients experiencing these types of injuries. The integrity of the tympanic membrane is established. A pneumatic fistula test is performed to look for nystagmus. In this setting, observing nystagmus with pneumatic compression is suggestive of a PLF. Positional testing (Hallpike's maneuver) is also useful in patients complaining of position–induced vertigo. Vestibular tests entail electronystagmography (ENG) and an ENG fistula test. The ENG fistula test is monitored by recording electrodes placed horizontally near the lateral canthus of the eyes. Eye movements are recorded while positive and negative pneumatic tympanic membrane massage is applied with a Siegle otoscope or tympanometry bridge. The tracing is examined for nystagmus that is timed to manipulation of ear canal pressure (Fig. 119-1). Movement of the eyes can also be assessed with infrared video goggles placed over the eyes. This eliminates visual fixation and allows direct observation of eye deviation.

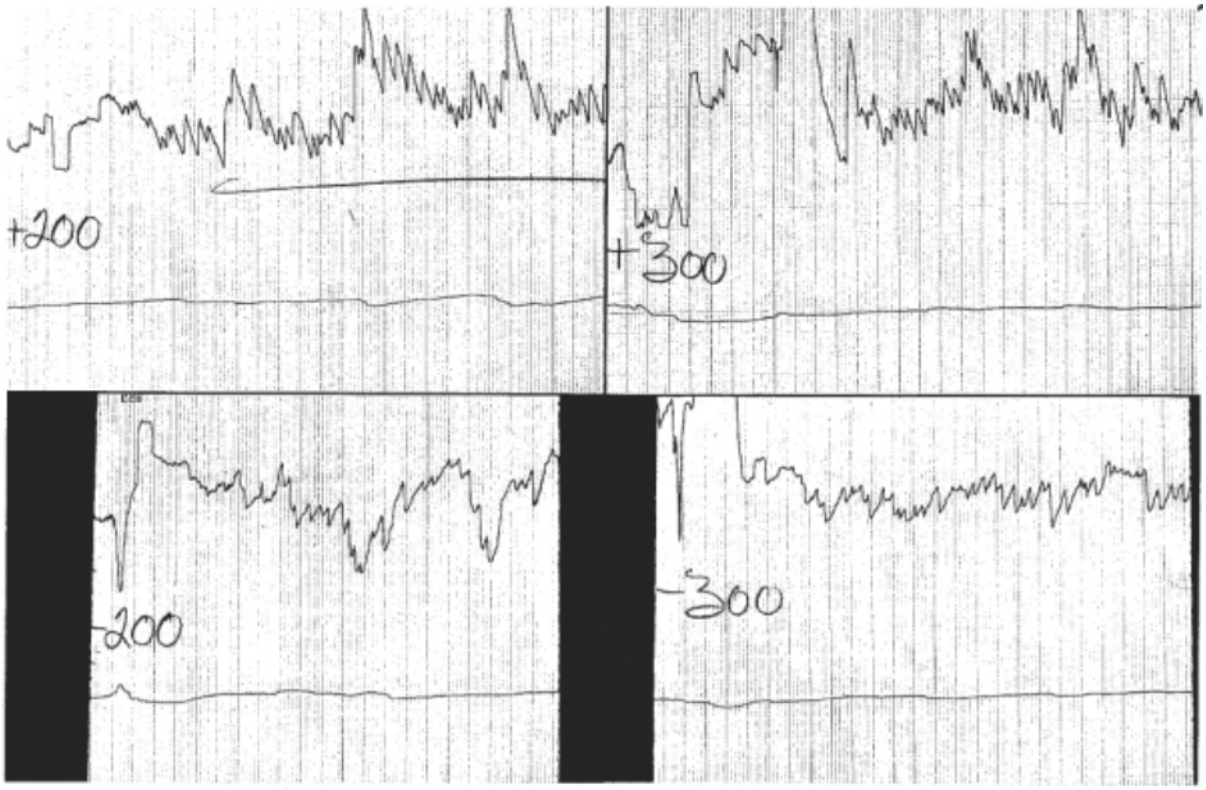

Figure 119-1 Electronystagmographic tracing of a positive fistula test. The *top row* shows that positive pneumatic pressure induces right–beating nystagmus at 200 and 300 mm H_2O. The *bottom row* demonstrates that negative pressure in the same ear reverses the direction of the nystagmus to left beating. Note the increase in beat frequency with greater pressure.

Unfortunately, the results of preoperative auditory and vestibular tests are variable and not specific to PLF. A positive pneumatic or ENG fistula test is certainly helpful in diagnosing a PLF, but negative explorations have been reported despite demonstrated affirmative preoperative findings. Conversely, PLFs have been identified in some patients despite normal preoperative test results.

Identification of the protein β_2-transferrin in perilymph has been offered as a diagnostic marker of PLF. Obtaining an adequate liquid sample of the middle ear fluid in question can be difficult. The volume may not be sufficient to aspirate and collect. Gelfoam has been used as an absorbent material from which the protein may be eluted. However, in a study of 20 samples of known perilymph collected at the time of cochlear implantation or

labyrinthectomy, only 1 tested positive for β_2-transferrin. None of the control specimens demonstrated the protein.[6] This adds to the dilemma of confirming that a perilymph leak is truly present during middle ear exploration.

It was anticipated that communication between the scala tympani (perilymph) and cerebrospinal fluid (CSF) from the subarachnoid space through the cochlear aqueduct may provide a means to detect whether an active fistula is present. Fluorescein was injected by lumbar puncture in the CSF of 28 patients with suspected traumatic, idiopathic, iatrogenic, or inflammatory PLF. A few hours later the oval and round window niches were microscopically and endoscopically examined with white and blue light. Only two patients (7%) demonstrated fluorescence behind the round window membrane with blue light. Direct observation of perilymph in the setting of stapedectomy and semicircular canal fistulas revealed no staining. Despite the lack of reported neurologic complications from intrathecal fluorescein, this method for evaluating PLF was not recommended.[7]

There has been evidence that spontaneous PLFs may be associated with other congenital anomalies of the temporal bone.[2] Patients with abnormalities such as Mondini's dysplasia have a higher incidence of middle ear abnormalities and PLFs. Whether finding plus repairing a PLF halts the progressive nature of these anomalies or the PLF simply represents an epiphenomenon is unclear. In pediatric and young adult patients with progressive hearing loss and vestibular symptoms, radiographic imaging of the temporal bone is warranted. Demonstration of bilateral changes in hearing implies either metabolic, structural, or neural pathology. Although a demyelinating process is more effectively detected with magnetic resonance imaging, computed tomography (CT) better identifies anomalies of the otic capsule (Fig. 119-2). Because PLFs have been identified with congenital anomalies of the inner or middle ear, a patient with progressive hearing loss and an abnormal CT scan of the temporal bone may be a candidate for PLF exploration.

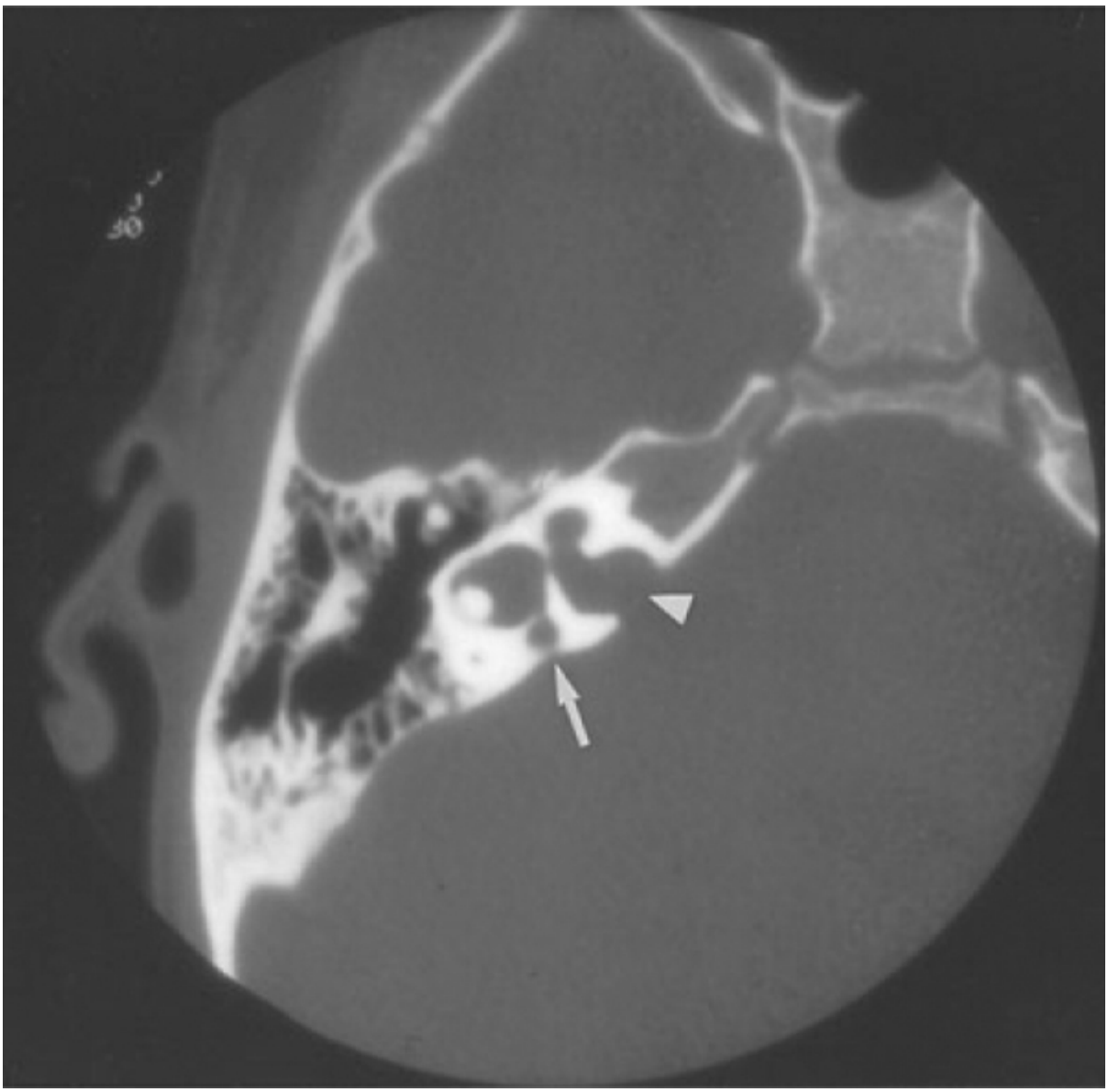

Figure 119-2 Bone–windowed computed tomography scan of a patient with progressive and fluctuating sensorineural hearing loss. Note the otic capsule abnormalities, including the bulbous vestibular aqueduct *(arrow)* and the dilated vestibule and internal auditory canal *(arrowhead)*.

Physicians have varied opinions regarding the source of sudden, progressive, or fluctuating hearing loss in children. There is controversy as to whether PLF can be a possible cause. A retrospective study investigated hearing and vestibular outcomes in 160 ears of pediatric patients undergoing middle ear fistula surgery for sudden, progressive, or fluctuating hearing loss of great than 20 dB in three frequencies. Of the 103 ears with a fistula confirmed by visual inspection of leaking or reaccumulating fluid, 92% demonstrated stabilization or improvement of hearing after surgical repair of the leak. In the 57 ears in which a fistula was not identified but the oval and round windows were packed with muscle or connective tissue, 95% had stabilized or improved hearing. Based on observations from their parents, 70% of children with a positive fistula exploration for vertigo and disequilibrium had improvement in their symptoms after surgical repair.[8]

It is difficult to reach a meaningful conclusion about the potential role that a congenital PLF may have in causing sensorineural hearing loss in children. Why hearing levels may stabilize in ears in which a fistula is not identified yet still treated surgically is unclear. A plausible explanation is that at the time of exploration the leak is intermittent or not evident because the operative ear is facing up and thus perilymph is required to drain against gravity. It is reasonable to conclude that surgical repair (packing of tissue in the round and oval windows) does not result in a significant risk for postoperative hearing loss.

Our understanding of the etiology of hearing loss or vestibular problems, or both, has significantly expanded since the first edition of this textbook. Lloyd Minor is credited with characterizing the auditory and vestibular signs and symptoms associated with dehiscence of the superior semicircular canal (SCC).[9] Many of the symptoms, such as noise-induced dizziness, hearing loss, and disequilibrium precipitated by heavy lifting, belching, coughing, sneezing, or straining, are common to both PLF and dehiscence of the SCC. Similarly, a positive fistula test (nystagmus seen with pneumatic otoscopy) can occur in both clinical entities. An audiogram may show conductive hearing loss, but acoustic reflexes should still be present in SCC dehiscence. Vestibular evoked myogenic potentials are typically elicited at lower thresholds and can show enhanced amplitude responses. CT showing dehiscence of the SSC is critical in making the diagnosis. By using a multirow CT scanner, images of the temporal bone can be reconstructed parallel and perpendicular to the superior canal. We have shown that coronal images usually suffice in identifying the dehiscent canal (Fig. 119-3).[10]

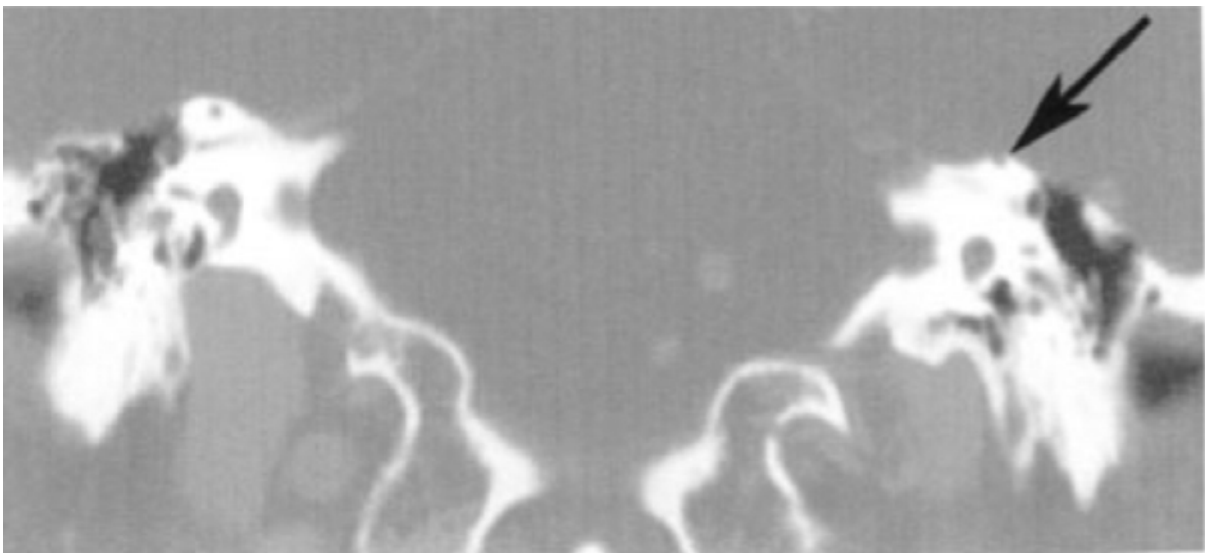

Figure 119-3 Coronal bone–windowed computed tomography scan showing dehiscence of the left superior semicircular canal *(arrow)*.

PREOPERATIVE PLANNING

Patients in whom a PLF is suspected should undergo preoperative audiography to determine whether there has been a change from previous levels or to establish the baseline of hearing. Vestibular testing may be helpful if a unilateral paresis is identified or a positive PLF test (pneumatic otoscopy) is obtained. Imaging of the temporal bone may be informative after blunt or penetrating head trauma but provides limited additional information in cases of barotrauma or acoustic trauma. Imaging may be helpful after recent otologic surgery if a displaced prosthesis is of concern.

The choice of anesthesia is dependent on the age of the patient and the cause of the suspected PLF. Having the patient awake provides two benefits to the surgeon. First, the patient is able to follow commands, such as performing a Valsalva maneuver (breath holding with forceful straining against a closed glottis). It can be argued that similar results can be achieved with the patient under general anesthesia by having the anesthetist deliver sustained positive end–expiratory pressure (PEEP). Maintaining PEEP increases venous resistance, which causes increased intracranial pressure. Just as with a Valsalva maneuver, increased intracranial pressure may enhance transmission of fluid pressure to the inner ear perilymph fluid compartment and augment visualization of a latent PLF. However, iatrogenic injury to the inner ear cannot be readily ascertained under general anesthesia. The second benefit of having an awake patient is that it provides immediate feedback regarding the patient's subjective sensation of vertigo and dizziness. This is particularly beneficial in cases of recent otologic surgery or limited temporal bone trauma. Injudicious manipulation of a footplate that is subluxated or an oval window graft with fibrous adhesions to the saccule or utricle is detrimental to inner ear function. An awake, although sedated patient can directly communicate any feelings of disequilibrium to the surgeon.

Despite the cause of the suspected PLF, it is very difficult to perform exploratory ear surgery on children under local anesthesia. A young teenager or mature adolescent may tolerate this procedure with sedation. The surgeon, along with the parents, must decide which method of anesthesia is best for the patient and the surgeon. General anesthesia is generally necessary for exploratory tympanotomy performed on a child.

SURGICAL TECHNIQUES

The patient is positioned supine on the table with the involved ear up. A small area of postauricular hair may need to be shaved to provide access to suitable material for grafting or obliteration. Surgeons who routinely use a vein graft for stapedectomy would prepare and drape the dorsum of the hand if the integrity of the stapes footplate is in question. After adequate preoperative sedation or narcoleptic anesthesia is obtained, the operating microscope is positioned over the ear. Local anesthetic (2% lidocaine with 1:100,000 epinephrine) is infiltrated into the external meatus in four–quadrant fashion after inspection of the ear canal and tympanic membrane (Fig. 119-4). Local anesthesia with controlled vasoconstriction is necessary when exploring an ear for a PLF. Hemostasis is mandatory to minimize any confusion that may occur as a result of serum leaking into the middle ear. It is recognized that some of the infiltrated local anesthetic may diffuse into the middle ear and appear as clear fluid welling up in the oval or round window niches.[11] The observer could falsely call this a PLF. Nonetheless, local injection is necessary to both anesthetize the ear canal and curtail bleeding. A tympanomeatal flap is elevated to enter the middle ear (Fig. 119-5). It is usually necessary to remove bone from the posterosuperior canal wall to achieve complete exposure of the oval window niche. Depending on the vascularity of the bone and middle ear, bleeding into the middle ear space may occur. Methods of controlling bleeding include placement of small Gelfoam pledgets impregnated with a topical vasoconstrictive solution from the local anesthetic, small pieces of Surgicel, or rarely, bipolar electrocautery. Once complete exposure is obtained, management, which is described later in this chapter, is dictated by the findings during surgery. The status of the middle ear mucosa and ossicular chain is examined.

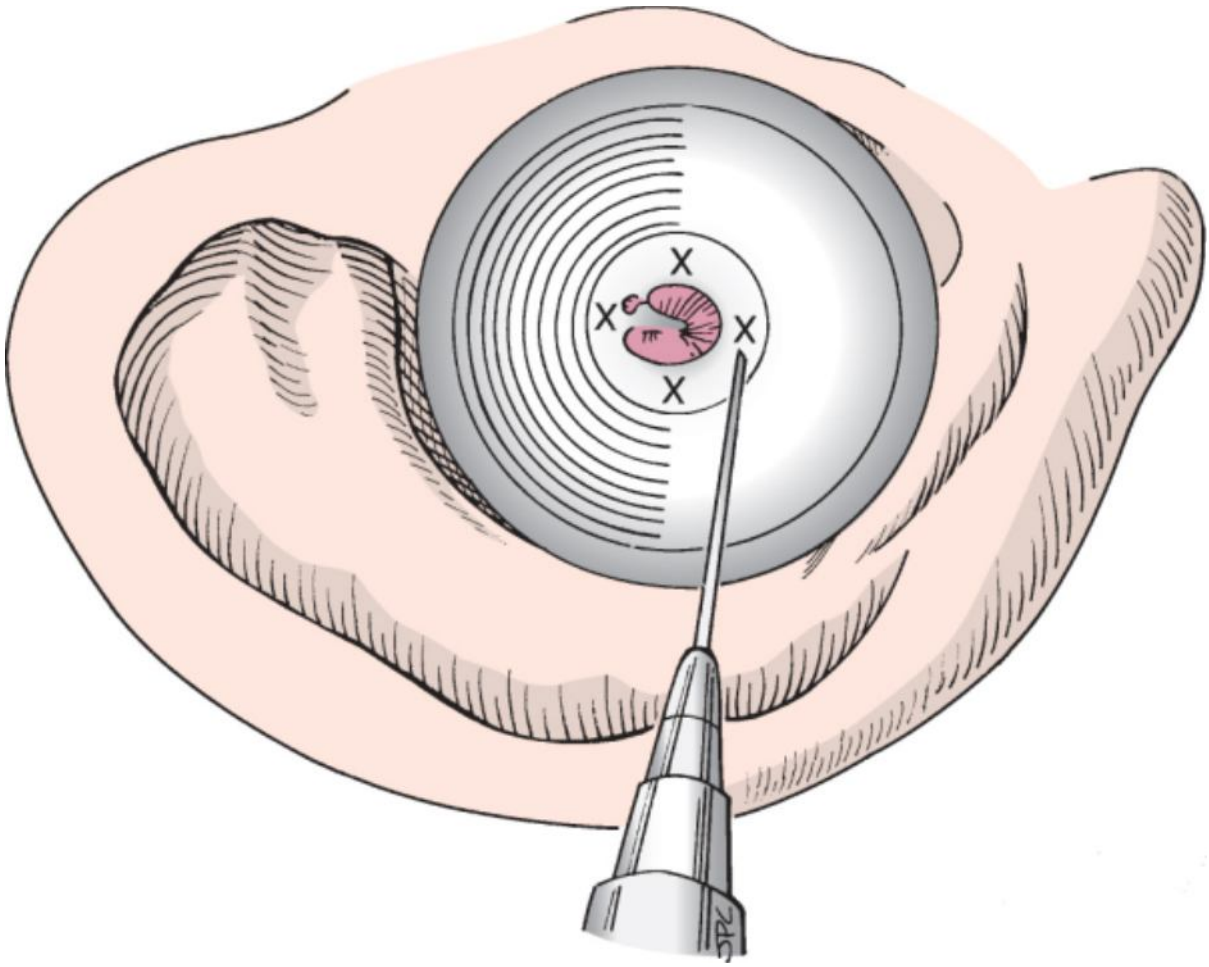

Figure 119-4 Local anesthetic solution is injected into the external auditory canal in four–quadrant fashion.

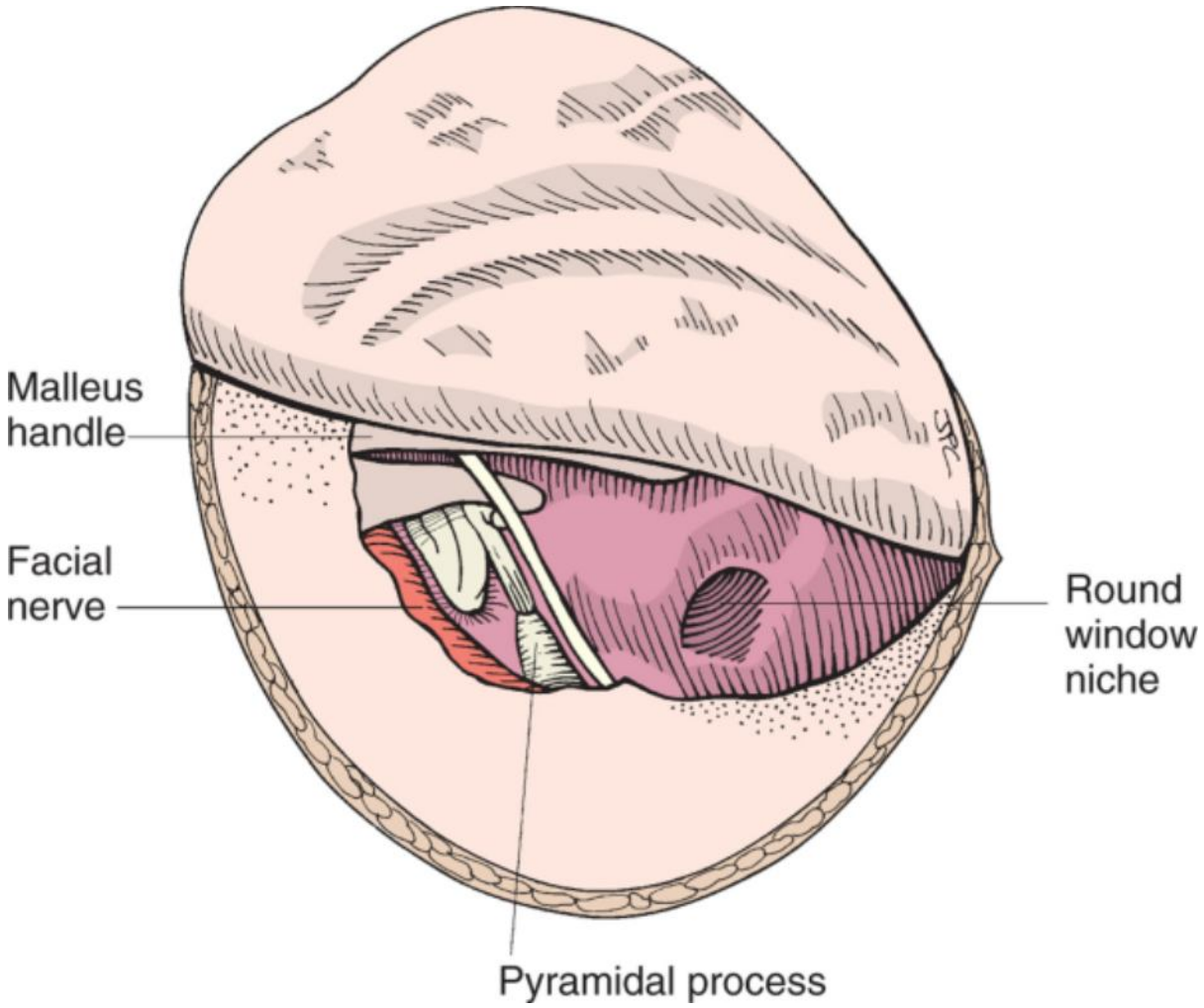

Figure 119-5 A tympanomeatal flap has been elevated. Bone from the posterosuperior canal wall has been removed by curette to maximize exposure of the oval and round window niches.

Usually, the round window niche can be visualized by repositioning the microscope or the operating table without having to curette the posterior bony canal wall. The round and oval window niches are examined to look for reaccumulation of clear fluid despite repeated suctioning. A PLF may also be identified by recognizing a shifting light reflex from the operating microscope. Identifying a perilymph leak is facilitated by increasing intracranial pressure. If clear fluid is not noted, the patient is asked to perform a Valsalva maneuver. Other techniques used to enhance identification of a latent PLF include compression of the ipsilateral jugular vein, palpation of the ossicular chain to facilitate leakage, or placement of the patient in the Trendelenburg position.

At present, the diagnosis of a PLF is based on seeing reaccumulation of clear fluid or a change in the light reflex from the operating microscope. A more objective laboratory assay of the identified fluid would certainly help in understanding PLFs. There is ongoing investigation of the use of β_2-transferrin as a marker for perilymph fluid. Pieces of Gelfoam or Merocel are placed in each niche, and separately labeled samples are absorbed and collected. Electrophoresis with Western blot staining can identify isoforms of β-transferrin. Results of the assay are currently available in a minimum of 3 hours. Unfortunately, this information is not immediately available at the time of surgery to influence operative management. In addition, the true sensitiv–ity and specificity of the assay have yet to be determined.[12]

Patients being explored for sudden or progressive hearing loss or vestibular symptoms after stapedectomy require specific management. Surgeons using tissue graft or vein graft for routine stapedectomy should be prepared to harvest a new graft before re–exploring an ear that has previously undergone otosclerosis surgery. The oval window niche is examined for a reparative granuloma in patients with rapidly progressive hearing loss and recent stapes surgery. If a granuloma is present, the prosthesis is removed and a new tissue seal is placed. If a granuloma is not present, the position of the prosthesis is inspected. If a tissue seal was used, its integrity and the covering of the vestibule are confirmed. Appropriate placement of the prosthesis is verified by palpation of the ossicular chain. Careful inspection to search for incomplete oval window coverage is undertaken (Fig. 119-6). The oval window niche is carefully examined for clear fluid. If concern exists regarding the integrity of the tissue seal, the prosthesis is removed and the tissue graft is replaced. Likewise, if a stapedotomy piston was used,

displacement of the prosthesis from the fenestration site should be determined.

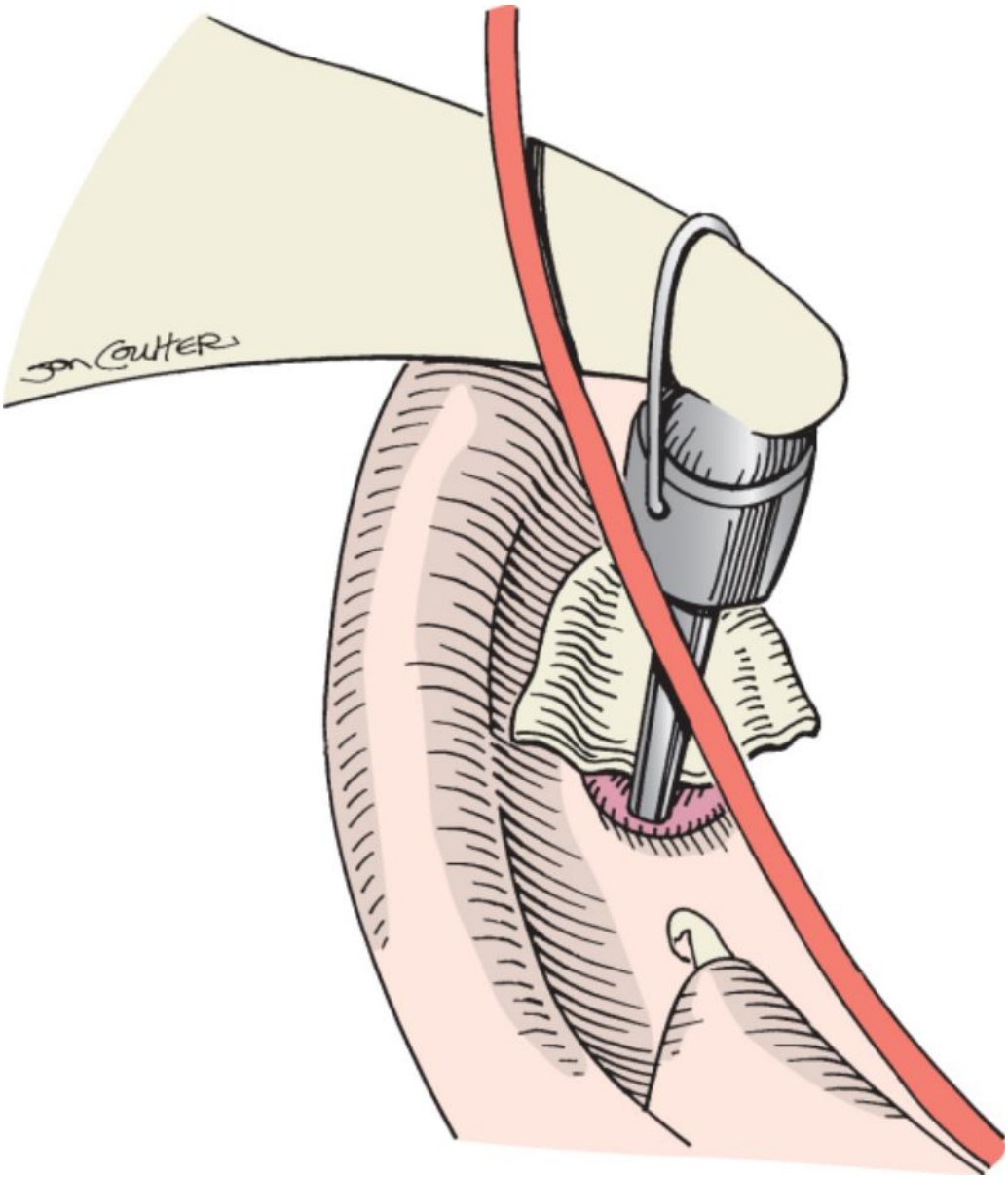

Figure 119-6 A cause of a perilymphatic fistula is a dehiscence in the tissue graft sealing the oval window after stapedectomy. The graft incompletely covers the posterior aspect of the oval window niche.

Patients subjected to blunt or penetrating trauma to the ear with ongoing dizziness and hearing loss are managed similarly. The integrity of the ossicular chain is assessed. The incudostapedial joint may be compromised and the stapes footplate fractured, depressed, or subluxated into the vestibule. If this is determined, the incudostapedial joint is disarticulated. The dependent portion of the footplate is carefully elevated out of the vestibule. Should the patient complain of excessive vertigo or nausea, manipulation of the footplate is terminated. Potential tissue grafts that can be harvested include a vein from the hand, temporalis fascia, or tragal perichondrium. Our preference is areolar tissue or fascia overlying the temporalis muscle. After the mucosa is elevated from the margins of the oval window, the vestibule is sealed with the graft (Fig. 119-7).

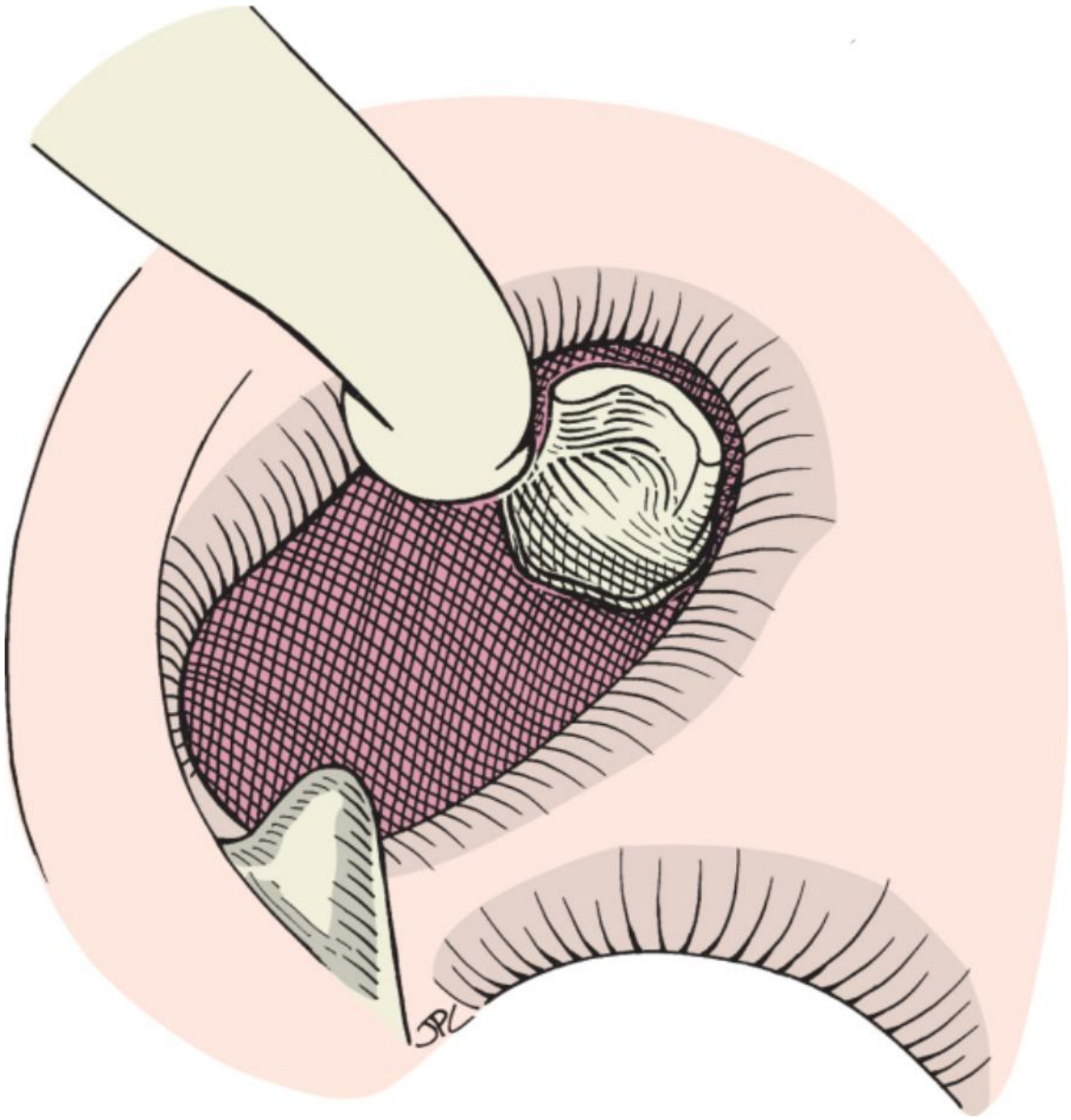

Figure 119-7 A portion of the anterior stapes footplate remains subluxated within the vestibule after trauma. A vein graft will be placed to completely cover the oval window niche.

Spontaneous PLFs are handled in a similar manner. The oval and round windows are inspected for clear fluid. If clear fluid is found, the mucosa near the stapes footplate is elevated (Fig. 119-8). The round window may have an overhang that should be removed with a curette or middle ear microdrill for better visualization. The mucosa is also elevated if a PLF is found in this area. The preferred material for sealing PLFs is fibrofascial tissue harvested from the postauricular area. Perichondrium from the tragus may also be used. Adipose tissue is purposely avoided because of its inherent properties of atrophy and resorption. Small pieces of fibrofascial tissue are placed in the oval or round windows and between the crura of the stapes (Fig. 119-9). Similarly, the round window niche is sealed after the surrounding bone is denuded of mucosa. Methods to fix the tissue in place and promote scarring include the use of Avitene, Surgicel, or fibrin glue placed lateral to the tissue graft.

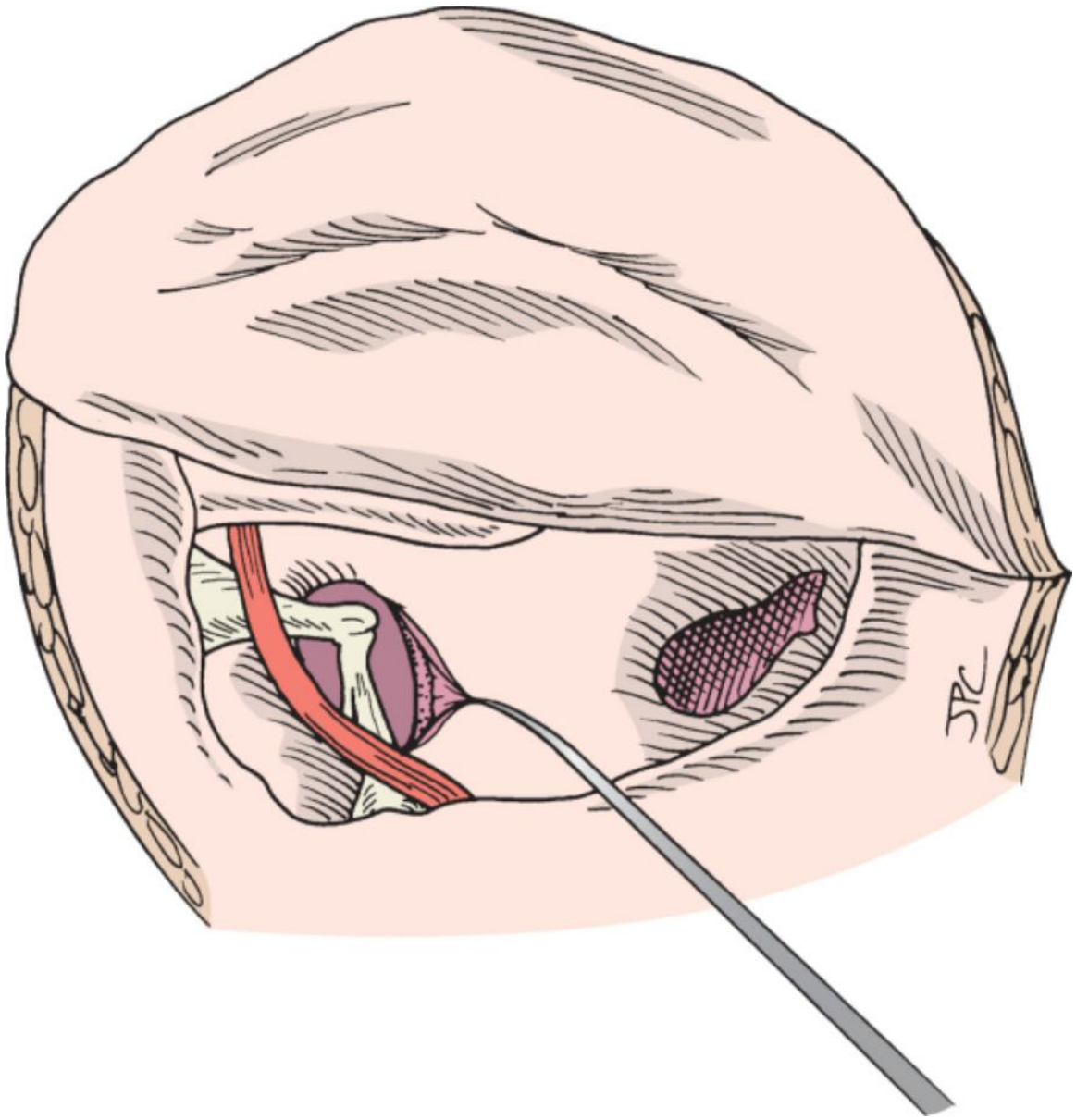

Figure 119-8 Using a fine pick, the mucosa surrounding the oval window niche is elevated to promote scarification with fibrous tissue grafts.
(From Bluestone CD, Stool SE: Atlas of Pediatric Otolaryngology. Philadelphia, WB Saunders, 1995, p 115.)

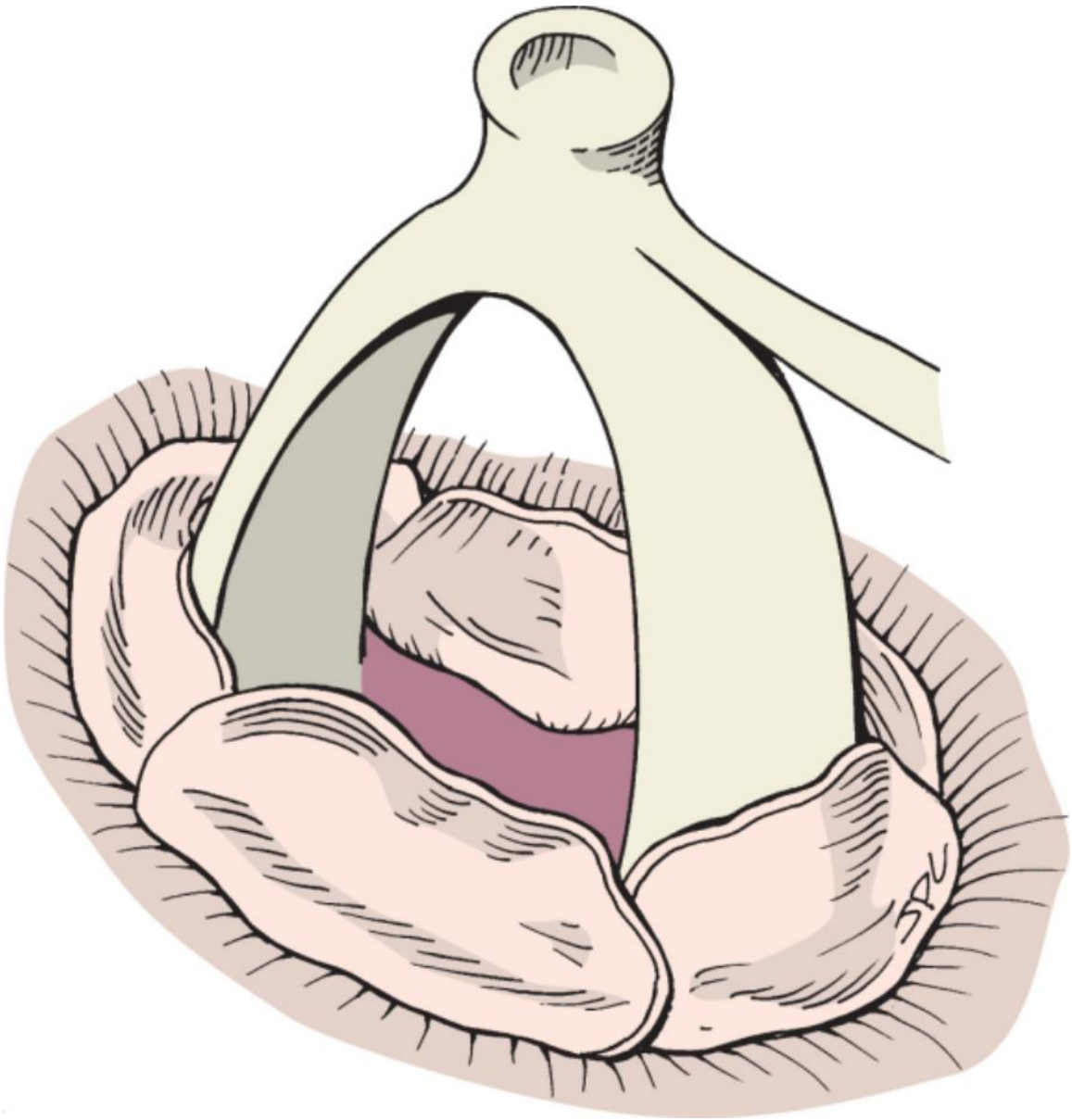

Figure 119-9 Small pieces of fibrofascial tissue are placed around the oval window niche to promote closure of a perilymphatic fistula.

Another method of sealing the annular margin of the footplate is with a contoured graft. Fascia or perichondrium cut in the shape of a pair of pants or narrow U can be positioned around the anterior crux of the stapes with the limbs extending along the superior and inferior footplates. This provides a good seal of the anterior footplate and fistula ante fenestram (Fig. 119-10).

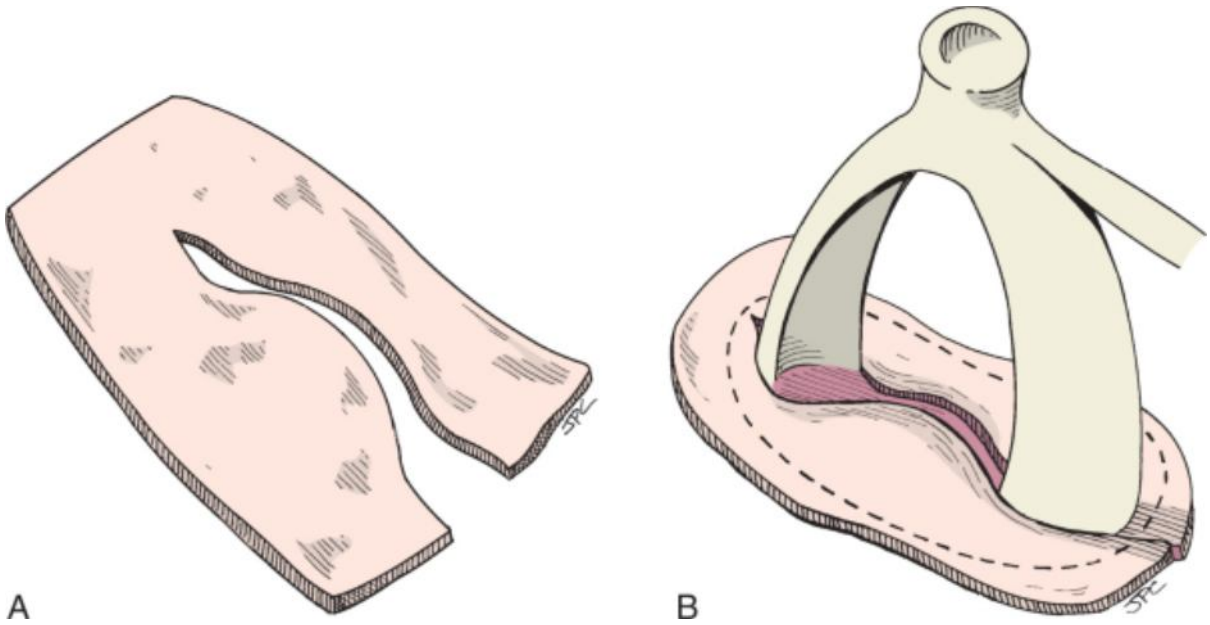

Figure 119-10 **A,** A fascia graft cut like a pair of pants has been prepared for the footplate area. **B,** The graft is placed around the stapes crura.

Along with the oval and round window niches, other areas should be inspected, including the area anterior to the footplate at the fistula ante fenestram and the area inferior to the round window niche, where microfissures have been reported.[13]

One of the more difficult decisions that one faces is what to do in the event that no PLF is identified. If clear fluid is not observed, it can certainly be argued that a PLF does not exist and that packing the niches is not warranted. There are anecdotal reports of hearing returning to normal in patients with negative explorations in which packing was not performed. Proponents of this philosophy argue that if routine packing is performed, one will never know whether the treatment was justified. On the other hand, one could argue that PLFs may be intermittent or difficult to identify when the involved ear is facing up at the time of surgery. The effects of gravity and minimal inner ear fluid pressure may hamper leakage of perilymph. In fact, authorities remain divided about what direction to take in the situation of negative exploration. Some surgeons pack routinely; others pack only if a PLF is identified. We recommend placing fascia (packing) at the time of exploration.

Management of a subluxated footplate can be difficult. Recent injuries, which limit the time for fibrous adhesions to develop, permit attempts at elevating the stapes from the vestibule. Should the patient complain of increasing vestibular symptoms during operative manipulation, further efforts are aborted. A similar approach is taken for an ear that is re–explored after stapes surgery. If a PLF is strongly suspected and none is obviously seen, the surgeon must decide whether the prosthesis should be replaced and the oval window regrafted or the symptoms should be ascribed to serous labyrinthitis. If surgery is being performed for unresolving vestibular problems in the presence of severe hearing loss, more aggressive intervention is warranted. Along with attempting to alleviate the vestibular symptoms, repairing communicating pathways from the middle ear to the perilymph and CSF may prevent potential otic meningitis. This approach is particularly applicable to younger patients with congenital otic capsule anomalies.

Recurrent symptoms after PLF repair are difficult to interpret and manage. Review of the patient's history and physical findings is necessary. A higher incidence of recurrent PLF has been reported when adipose tissue is used for grafting, presumably because of progressive atrophy of the adipose tissue graft. It is for this reason that we advocate fibrofascial tissue, muscle, or perichondrium for PLF repair.

Once the middle ear procedure is completed, the tympanomeatal flap is returned to its original position. The flap is secured with ointment, antibiotic–impregnated Gelfoam, or a silk sleeve compressed with small cotton balls and ointment. The tissue donor site is closed with 5-0 fast–absorbing suture and covered with a Steri–Strip.

POSTOPERATIVE MANAGEMENT

Patients can usually be discharged the same day unless severe nausea or vertigo is experienced. Oral narcotic analgesics are provided if needed. It is rarely necessary to provide wound care to the tissue donor site. A cotton ball in the external auditory meatus is changed as needed. Some serosanguineous drainage should be anticipated. Exposure of the ear to water, bending with heavy lifting, and sneezing with the nares occluded are to be avoided.

The patient is seen 7 to 10 days postoperatively for removal of the Steri–Strips and packing. Restriction from water exposure is maintained for 3 more weeks. An audiogram is obtained 4 to 6 weeks after surgery to assess and document the status of auditory function.

COMPLICATIONS

The operative morbidity associated with surgical exploration of the middle ear for a PLF is minimal, especially in patients with significant preoperative hearing loss. Careful elevation of the tympanomeatal flap avoids potential tears in the tympanic membrane. The chorda tympani nerve is dissected carefully to minimize stretch and desiccation. Theoretically, packing of the round or oval windows should produce a conductive hearing loss. In reality, however, such packing does not lead to a significant clinical or audiometric deficit.

Packing of the round and oval windows should effectively prevent fluid from both exiting and entering the inner ear. As mentioned, symptoms, signs, and the diagnosis of PLF and Meniere's disease may overlap. Should intratympanic therapy with either an aminoglycoside (gentamicin) or steroid be necessary for subsequent intervention, access to the inner ear by injection into the middle ear may effectively be obstructed by the tissue graft. The subsequent treating physician should be aware of the patient's past medical history and details of the previous surgical procedures.

PEARLS

- Patients with sudden hearing loss or dizziness who have a history of recent barotrauma, physical ear injury, or otologic surgery should be suspected of having a PLF.
- Exploration of the middle ear should be carried out in patients in the pediatric age group who have sudden or fluctuating hearing loss and dizziness and middle or inner ear anomalies confirmed by CT.
- Identification of nystagmus elicited by pneumatic otoscopy may be enhanced by using infrared video goggles instead of directly observing the eyes for movement.
- Observation of a PLF is enhanced by having the patient perform a Valsalva maneuver if awake or having the anesthetist apply positive pressure ventilation if under general anesthesia.
- Because a fistula may be intermittent or difficult to elicit with the involved ear facing up at the time of middle ear exploration, both the oval and round windows should be packed with a tissue graft.

PITFALLS

- The symptoms and signs of pressure-induced vertigo and nystagmus are similar with acute endolymphatic hydrops, a stapes prosthesis located too deep in the vestibule, a PLF, and dehiscence of the superior semicircular canal.
- Complications of middle ear exploration should be rare, but great care should be taken to avoid a tear in the tympanic membrane or injury to the chorda tympani nerve.
- Excess fluid from injection of the local anesthetic and vasoconstrictor may permeate into the middle ear and be mistaken for perilymph.
- Adipose tissue should not be used for packing the PLF because it is more likely to atrophy and no longer occlude the area of PLF.
- Laboratory markers for identifying perilymph, such as β2-transferrin or fluorescein, can be unreliable and their absence misleading.