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PERSISTENT TRAUMATIC PERILYMPH FISTULAS*

MICHAEL E. GLASSCOCK, III, MD, FACS
KEVIN X. MCKENNAN, MD SAMUEL C. LEVINE, MD
Nashville, TN

ABSTRACT

Thirty-four ears have been explored to rule out perilymph fistulas resulting from ear trauma. Eight ears (24%) were identified with a fistula, often persisting months (average 7.5 months) after the precipitating injury. Repair of fistulas, even if done relatively late, markedly reduces vestibular symptoms and may improve low and middle frequency sensorineural hearing. Complications from negative explorations are rare.

A perilymph fistula (PLF) is a leakage of perilymph out of the otic capsule, where it is normally enclosed. Typically, this leakage occurs at one of the interfaces between the middle and inner ear, namely the round window membrane or at the stapedial vestibular junction in the oval window. PLFs in the semicircular canal system will not be addressed in this paper because the nature, location, and causes are different.

There are different types of perilymphatic fistulas. Table I reviews a common classification of these types. Iatrogenic PLFs occur primarily after stapedectomy. It remains one of the more common serious complications of this procedure. Several authors, including a recent report by Seltzer and McCabe,[1] have noted that prior otologic surgery is the most common cause of a PLF. Traumatic PLFs occur with direct or indirect trauma to the ear or with a rapid change in barometric pressure, as during scuba diving or flying. Congenital PLFs have been reported in the literature,[2] but are quite rare. There also is a poorly-understood category of patients that may have a spontaneous development of a PLF.

There has been considerable controversy in the otologic literature about the management of PLF-suspected patients. This should be to no one's surprise. Making the diagnosis of a fistula can be difficult. There are some patients that have an obvious injury with an absent round window membrane or subluxed stapes with a large perilymph fistula. Other patients have much less obvious injuries. There probably exist patients that have microfistulas that are difficult to document because of their small size and intermittent nature. Seltzer and McCabe[1] have recently addressed this diagnostic difficulty. They contend that a repeated change in the light reflex at one of the windows represents a fistula. The author questions that this is adequate criterion for diagnosing a fistula. This report considers the explorations as positive only when an indisputable dehiscence in the oval or round window is seen.

Patients with PLF present with a variety of symptoms. They may have fluctuating or nonfluctuating hearing loss. Others present with primary vestibular symptoms. The vestibular symptoms run the gamut from mild unsteadiness to severe incapacitating vertigo. A third class of patients in the pediatric age group is now being recognized. They present with recurrent episodes of meningitis, progressive sensorineural hearing loss, or vertigo.[2] Although a pediatric PLF is unusual in our experience, a high index of suspicion must be maintained to prevent disabling sequelae.

The purpose of this report is to present some of the findings in a group of 32 patients who have been operated on over the past 10 years by the senior author (M.E.G.). We will discuss our approach to managing these patients, our indications for surgery, and the differences we have been able to elucidate between patients with proven perilymphatic fistulas and those without. We have specifically not included patients who have undergone middle ear explorations for PLF due to prior otologic surgery. By doing so we hope to clarify the more difficult issue of managing patients suspected of having traumatic PLFs.

Review of the Literature

There have been numerous papers during the past 28 years published on perilymphatic fistulas. In 1968, Fee[3] reported on three cases where he identified an oval window fistula resulting from trauma. During that same year, Simmons[4] described 15 pa-

TABLE I.
Common Types of PLF.

Iatrogenic (prior otologic surgery)	
Traumatic	— Direct (penetrating)
	— Indirect (blunt head injury)
	— Barometric (implosive, explosive)
	— Acoustic
Congenital	
Erosive (infectious, neoplastic)	
Spontaneous	

*From the Department of Surgery (Otology and Neurotology), Vanderbilt University School of Medicine, Nashville; and The Otology Group, P.C., Nashville.

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Send Reprint Requests to Michael E. Glasscock, III, MD, FACS, The Otology Group, PC, 1811 State St., Nashville, TN 37203.

TABLE II.
Epidemiology.

	Fistula	No Fistula
Number	8	26
Sex: M:F	50:50	37:63
Side: R:L	50:50	54:46
Age	37.3 years	39.1 years

tients suspected of having a double membrane rupture as the cause of sudden hearing loss. In 1970, Stroud and Calcaterra,[5] discussed four patients that had spontaneous development of PLFs. In 1973, Goodhill[6] reported on a group of 15 patients with round or oval window fistulas causing sudden hearing loss and vertigo. In 1976, Healy[7] described 40 cases of perilymphatic fistulas, 21 of them resulting from trauma. In 1979, Pullen[8] reviewed his results with 17 patients all of whom had significant barotrauma, usually from scuba diving or flying-related barotrauma.

At the 1980 Sixth Shambaugh/Shea Inner Ear Symposium, there was considerable debate about the nature and management of patients with perilymphatic fistulas. A number of differing opinions were voiced. Shea[9] advised immediate exploration. Simmons[10] advised a 10-day to 14-day waiting period, pointing out that the severity and type of initial injury determined prognosis for hearing return rather than surgical repair of a PLF. In 1986, Seltzer and McCabe described 106 PLFs found in 214 exploratory tympanotomies. Their article reviews the largest number of PLFs to date, although the report includes cases due to prior otologic surgery. They advise a fairly aggressive approach to the diagnosis and treatment of PLFs. Despite all these reports, there is still no established method of treating patients with suspected PLFs, especially those not due to prior ear surgery.

METHODS AND MATERIALS

Records of patients seen between January 1975 and December 1985, who underwent exploratory tympanotomy to rule out a perilymph fistula, were reviewed. A total of 34 ears were explored in 32 patients. Data from the history, exam, electronystagmogram, and operative findings were collected from each chart. Audiograms were performed preoperatively and within 3 months postoperatively on all patients. All computations were performed by the junior authors.

SURGICAL TECHNIQUE

If possible, the surgery of the middle ear exploration is done under local anesthesia, except in those cases where this is not possible because of the patient's age or level of anxiety. After adequate premedication, local anesthesia is achieved in the external auditory canal. One percent xylocaine with 1:100,000 epinephrine is infiltrated into the tragus and ear lobe so that a perichondrial or fat graft can be obtained. One percent lidocaine with 1:10,000 epinephrine is then injected into the external auditory canal in four quadrants. The ear canal is then lavaged with Betadine® solution followed by normal saline to help cleanse and sterilize the surgical field. The canal is then suctioned dry so that no moisture will escape into the middle ear to mimic a perilymphatic fistula. An angled canal knife (*i.e.*, Beaver #12) is then used to create a tympanomeatal flap. Gelfoam® soaked in 1:1,000 topical epinephrine is packed onto the tympanomeatal flap prior to entering the middle ear so that hemostasis is optimal. A #1 House knife is then used to raise up the annulus and enter the middle ear. A stapes curet is used to remove part of the posterior scutum so that the entire oval window niche can be visualized. The ossicular chain is tested for normal mobility, and observation of both oval and round window niches is done to observe any leakage of perilymph. Care is taken initially not to lyse mucosal adhesions in either window, as this may result in a serous fluid ooze that would mimic a small fistula. Later in the procedure this should be done to improve exposure. Several maneuvers can be performed to help unveil a fistula. These include placing the patients in Trendelenburg, compressing both jugular veins so as to increase the intracranial pressure, and by having the patient perform a Valsalva maneuver. It has been our practice to use fat to obliterate both the oval and round windows even if no fistula is identified. It seems reasonable, considering the history and clinical findings of "negative fistula" patients, that some microfistulas are not identified despite manuevers to bring them out. This may be due to the minute size or intermittent nature of the leak. As a result, both oval and round windows are packed with fat or perichondrium in all cases. After packing each niche, the tympanomeatal flap is returned to its normal position. The ear canal is then filled with oint-

TABLE III.
Patients with PLF.

No.	Cause	Time (Months) From Injury to Surgery	Symptoms	Site of Fistula	Pre-Op PTA	Post-Op PTA
1	Fist fight	5	Vertigo	RW	17	23
2	Hit by wave	1.5	Vertigo/HL	OW	110	110
3	Weight lifting	36	Vertigo/HL	RW	28	23
4	Skin diving	.75	Vertigo/HL	RW	110	73
5	Racquetball injury	3	Vertigo	OW	7	23
6	Heavy lifting	2	Vertigo/HL	OW	65	15
7	Water-skiing accident	8	Vertigo/HL	RW	45	60
8	Heavy lifting	4	Vertigo/HL	RW	55	57

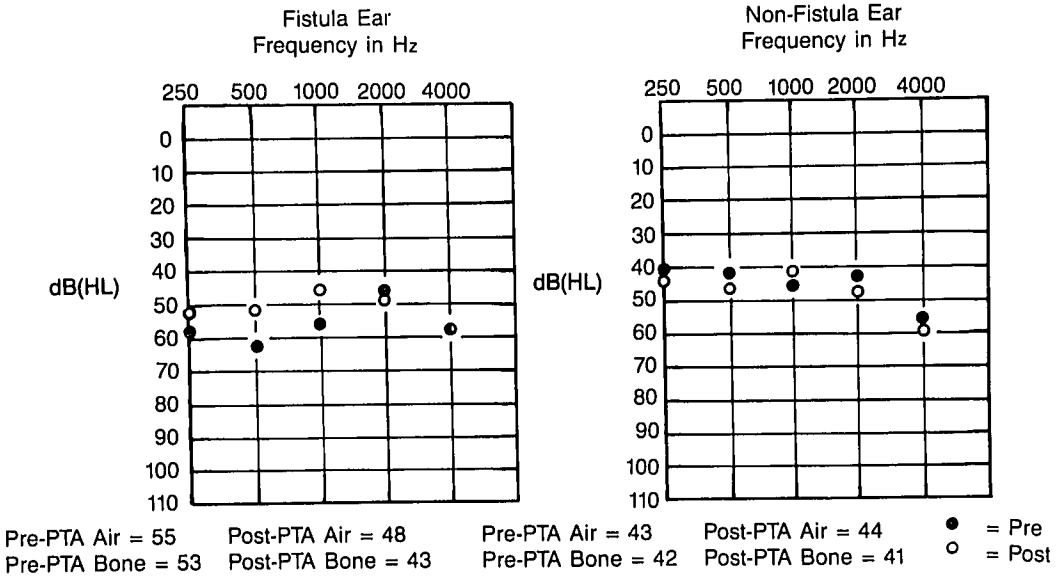

Fig. 1. Composite audiograms of fistula and nonfistula cases.

ment (*i.e.*, Kos-House®) to help maintain the position of the flap during healing.

RESULTS

During the period January 1975 to December 1985, there were 34 operations performed on 32 patients. Of the 34 operations, a total of eight patients were identified with a fistula. We will review and contrast the data on two groups of patients, those with a fistula and those without. We have not included any patients explored for possible fistulas as a result of prior surgery.

Epidemiology

Table II reviews the basic patient population data of our review. The patient's sex, age, and side of ear are not of diagnostic value.

History of Trauma

All positive fistula patients sustained a direct injury, either traumatic or barometric, to the ear prior to the onset of their symptoms (Table III). Similarly, 22 out of 26 patients that had negative explorations gave a history of trauma thought to have caused the symptoms. This data exemplifies our present philosophy of performing exploratory tympanotomies only if significant injury immediately preceded the onset of symptoms. We do not believe middle ear exploration for unexplained long-standing hearing loss or vertigo is justified except in unusual cases.

Symptoms

All eight fistula patients complained of vertigo and 75% also had sensorineural hearing loss (SNHL). The two patients that had normal hearing both had a fistula of the round window. Similarly, 91% of "negative fistula" patients complained of vertigo and 86% sustained SNHL. Judging from these results, it is difficult to predict, based on symptoms alone, which patient will have a PLF.

Duration of Symptoms Prior to Operation

Patients with proven PLF sustained the precipitating injury an average of 7.5 months before surgery (Table III). Patients in whom no fistula was identified sustained the precipitating injury 22.7 months prior to surgery.

Audiometry

The audiometric pattern (*i.e.*, downsloping, upsloping, flat) appeared with approximately equal frequency in patients with or without a fistula. The severity of hearing loss (Fig. 1) was slightly greater in the fistula patients (PTA 55 dB) than in the nonfistula patients (PTA 43 dB). Neither the severity nor the pattern of hearing loss predict which patients will have a PLF.

The composite audiogram is the result of the average of the hearing test results for each patient at each frequency. We did not perform audiometry at 8 kHz in enough patients to include this data. The audiogram demonstrates that patients with a fistula had an overall improvement in the low and middle frequency hearing (less than 2 kHz). We could not establish statistical significance because the sample population was small (N=8). There was no change in the nonfistula patient population.

A breakdown of the fistula cases (Fig. 2) reveals some interesting points. Cases 4 and 6 had a fistula closed 3 weeks and 8 weeks past injury, respectively. Both had a dramatic hearing recovery within 1 month after the repair. The hearing of four patients (cases 1, 2, 3, 8) did not change more than 10 dB postoperatively. Two patients (cases 5 and 7) sustained a mild conductive hearing loss (15 dB and 17

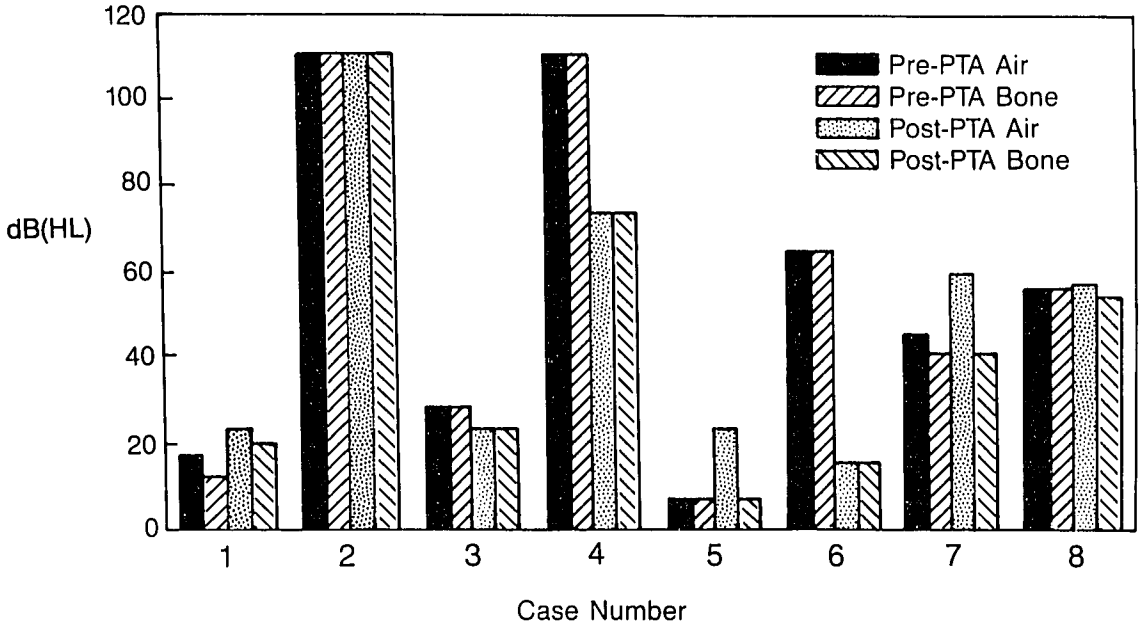

Fig. 2. Pure tone averages of patients with fistulas.

dB respectively) postoperatively, possibly due to the obliteration of each of the niches with fat. Overall only 2 of 8 (25%) had dramatic hearing improvement from the surgery.

Electronystagmography

ENGs were performed on 7 of the 8 patients with proven fistulas. As reported by several other authors,[11,13] the most reproducible finding was reduced vestibular response to bithermal caloric testing. In 4 of the 7 patients tested, a significantly reduced vestibular response (RVR) occurred. Similarly, 10 of 18 patients with negative explorations had an RVR. Spontaneous and positional nystagmus, both toward and away from the affected ear, were frequently detected but no discernible pattern was evident in either group. An ENG fistula test, as recommended by Daspit,[14] was performed only sporadically in our series such that we cannot make a valid analysis. We believe that the fistula test, like many of the other pieces of data that are accumulated on patients, is another useful piece of information, but the decision of whether to operate on the patient is not determined by the outcome of this test or any other information obtained from the ENG.

Relief of Vertigo

The surgical repair of a perilymph fistula was associated with an excellent relief of vertigo. Seventy-one percent of those patients repaired were completely cured of their vertigo, and 29% were improved. None of the fistula patients were worse or had no change in their symptoms. Vertigo improved in all patients within 1 month postoperatively, although several resolved within 24 hours of closure of the fistula. On the contrary, 37% of the negative fistula patients were cured, 26% were better, 37% had no change, and none were worse. It is possible that some of these patients improved because of closure of microfistulas that were not detected at surgery.

Location of Fistula

We found more round window than oval window fistulas (5:3). In no case were fistulas identified in both locations. These figures are somewhat different than previous studies[1,13] which have found a higher incidence of oval window fistulas. Many studies, however, include patients with perilymph fistulas secondary to prior otologic surgery, which skews the data toward more oval window fistulas.

Complications

There were no significant complications in any patient. More specifically, there were no postoperative infections, allergic reactions, tympanic membrane perforations, or ossicular disruptions. Two of the eight fistula patients sustained a mild increased conductive hearing loss (17 dB and 15 dB) in the postoperative period, possibly due to the placement of fat in each of the niches. In case 5, the patient had no preoperative conductive loss but at surgery was found to have an oval window fistula and a fractured stapes foot plate. Follow-up 7 and 11 months later has confirmed that this mild conductive loss has persisted. None of the nonfistula patients, however, sustained a postoperative conductive loss more than 10 dB, even though all were also treated with fat.

DISCUSSION

Our review demonstrates the difficulty in preoperatively identifying PLFs. Demographic data, symptoms, history of trauma, ENG, and audiometric

data are too similar to be relied on to select patients for middle ear exploration. We simply cannot tell who will have a post-traumatic fistula and who will not.

It has been our philosophy to operate on patients if a history of trauma preceded the onset of symptoms. Using this criterion, we identified 8 of 34 ears with fistula persisting months (7.5 months average) after injury. This delay in surgery is the result of the senior author's (M.E.G.) referral type of practice rather than a philosophy of delaying surgery for months after injury. It seems logical that earlier exploratory surgery will identify a higher percentage of fistulas and result in less otologic morbidity. The two fistula patients who experienced a significant hearing improvement were operated on 3 weeks and 2 months after injury. Earlier surgery on the others may have saved their hearing.

One point that needs reemphasis is that fistulas can remain open for many months without total hearing loss occurring. A post-traumatic patient with persistent cochlear or vestibular symptoms should be explored to rule out a fistula. Closure of a fistula alleviates vestibular complaints in nearly all patients and may improve sensorineural hearing, even if the fistula has been open for months.

The actual technique of closure of a fistula is debatable. It has been reported by Singleton[11] and more recently by Seltzer and McCabe[1] that autogenous fascia or areolar tissue is superior to fat in repairing perilymphatic fistulas. It also appears that connective tissue grafts, either perichondrium, areolar tissue, or temporalis fascia, are superior to fat in obliterating the oval window during stapedectomy. As a result, connective tissue grafts may evolve as the superior plug to repair fistulas.

The complications of exploration are rare. In 34 explorations there were only two cases of an increased conductive loss (15 and 17 dB). Both of these cases were in the fistula group. Unfortunately, the mild conductive loss has persisted in both of these patients.

SUMMARY

Middle ear exploration should be considered in patients with post-traumatic labyrinthine dysfunction, persisting more than 1 to 2 weeks. Repair of fistulas alleviates vestibular symptoms and may improve sensorineural hearing.

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