ENDOSCOPIC REPAIR OF POSTTRAUMATIC CEREBROSPINAL FLUID FISTULAE OF THE ANTERIOR CRANIAL FOSSA

YADRANKO DUCIC, M.D., F.R.C.S.(C)
PETER A. HILGER, M.D., F.A.C.S.

INTRODUCTION

Cerebrospinal fluid (CSF) rhinorrhea arises as a consequence of abnormal communication between the intracranial compartment and the nasal cavity. It may arise directly from a defect in the floor of the anterior cranial fossa or indirectly via the remainder of the cranial base by draining through the eustachian tube (Figure 1). Traumatic disruption, iatrogenic injury arising during sinus or neurosurgical procedures, and spontaneous leakage represent the most common etiological sources of this problem. Surgical intervention may be required in the case of persistent leakage. Failure to control such leakage may be a source of meningitis, pneumocephalus, and severe symptomatic headaches in a majority of afflicted patients. Trauma accounts for greater than 90% of CSF rhinorrhea, with approximately 5% of skull base fractures demonstrating evidence of CSF leakage. The majority of these occur at the level of the anterior cranial fossa, where the dura mater is tightly adherent to the thin bone of the cribriform plate and the ethmoid roof.

CSF fistulae of the anterior cranial base have been recognized since the time of Galen, who first described their occurrence in the second century AD. However, it was not until 1926 that Walter Dandy undertook the first successful intracranial closure of these fistulae. Surprisingly, the results of craniotomy repair of CSF leaks have often been disappointing, with success rates reported as low as 60%. This provided the impetus to the development and wide utilization of a number of open (transnasal, naso-orbital) extracranial approaches, which have been reasonably successful over the past 40 years. Wigand was the first to describe consistently successful endonasal closure of CSF leaks achieved with the assistance of endoscopes. As experience with endoscopic sinus surgery has progressed, a number of surgeons have been able to achieve surgical closure of anterior cranial base leaks in more than 90% of cases.

In this chapter, we review our standard technique for endoscopic endonasal closure of CSF leaks.

PATIENT EVALUATION

The initial evaluation of a patient with a suspected CSF fistula needs first to focus on the confirmation of the diagnosis and then to determine the site of leakage. The most specific diagnostic study available to document the presence of CSF is the positive identification of beta 2-transferrin from a sample of suspected fluid. This test is able to be accurately and reliably performed on even one drop of CSF admixed with blood. A chloride level greater than 120 mEq/liter (in the presence of a normal serum chloride) in a sample of rhinorrhea is an inexpensive and rapid method that may be considered adequate to form a presumptive diagnosis while confirmatory beta 2-transferrin studies are pending.

Figure 1. Pathways for egress of cerebrospinal fluid rhinorrhea.

Plain radiographs have little, if any, role in localizing the site of CSF leakage and are thus not routinely utilized. Magnetic resonance imaging does not generally demonstrate the site of a leak unless it is associated with either a meningocele or an encephalocele. Likewise, the injection of a radioactive isotope (such as indium DPTA) into the subarachnoid space followed by scintigraphy of intranasally placed pledgets may demonstrate the presence of an active leak but is not useful for localizing the site. The fluorescein dye test is a practical and inexpensive study that, if performed properly, is safe and accurate in determining the side and site of leaks from the anterior cranial base. However, the most definitive test is contrast computed tomography (CT) cisternography. Iohexol, which has replaced metrizamide as the contrast agent of choice in most centers, is injected into the subarachnoid space and subsequently imaged with CT in the coronal and axial planes. Unfortunately, in 30% of cases, even with provocative measures such as the Valsalva maneuver and intrathecal saline infusion, cisternography will fail to demonstrate the site of a leak. In the presence of negative cisternography and fluorescein dye tests, and confirmed CSF rhinorrhea, surgical exploration may be required to localize the site of the leak.

INITIAL TREATMENT

One of the mainstays of nonoperative treatment of acute traumatic CSF leaks is bed rest with elevation of the head of the bed 30 degrees from horizontal, thus decreasing the intracranial pressure (ICP) and reducing the pressure gradient driving CSF through the fistula tract. Adjunctive measures such as bed rest and stool softeners are useful initial basic measures to avoid increases in ICP as noted with straining or Valsalva maneuvers. With these simple measures, greater than 85% of traumatic CSF fistulae are expected to close. If the leak persists beyond 1 week, lumbar drain decompression of the subarachnoid space for a further five to seven days is recommended. Failure of this treatment algorithm should be followed by operative intervention, as further observation is not likely to have beneficial effects.

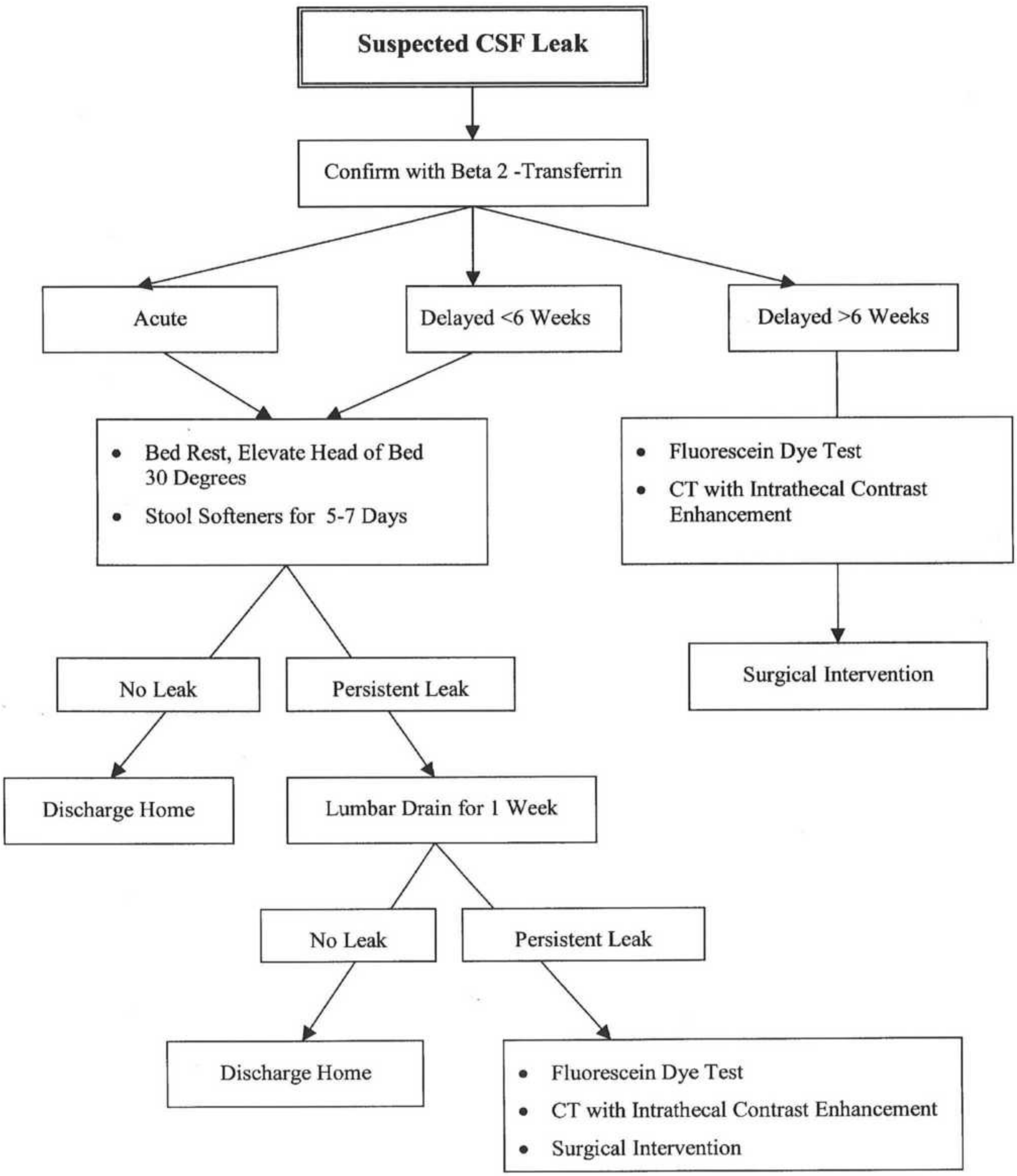

Figure 2. Algorithm for treatment when a cerebrospinal fluid leak is suspected.

Delayed CSF leaks that are removed less than 6 weeks from the time of the initial injury are treated in the same manner as acute leaks. Fistulae that are first observed beyond this period often consist of well-formed tracks that are unlikely to close with conservative treatment alone. In these cases, site localization should be followed by timely operative intervention (Figure 2). Endoscopic closure of CSF leaks is likely the most appropriate for use in defects that are smaller than 1.5 cm in maximum diameter. Larger defects are best approached via a traditional extracranial open approach or an intracranial repair.

SURGICAL TECHNIQUE

The patient is brought to the operating room, and a general anesthetic is administered. The patient is placed supine onto the operating table with the head set securely on a headrest (Figure 3). The intranasal mucosa is infiltrated with 1% lidocaine with 1:100,000 epinephrine solution followed by a topical application of 4% cocaine soaked on 0.5-inch cottonoid patties. After an adequate amount of time has elapsed to allow for maximum mucosal decongestion, a 4-mm rigid endoscope (angled either 0 degrees or 30 degrees) is utilized to thoroughly inspect the nasal cavity (Figures 4 and 5). It is sometimes possible to directly visualize the site of the CSF leak. If the leak cannot be positively identified at this point, 0.2 cc of 5% fluorescein mixed with 10 cc of CSF is slowly re-injected into the lumbar subarachnoid space via the lumbar drain over a period of 5 minutes. It takes approximately 30 minutes before the yellow-green color of the fluorescein is visualized intranasally (standard cold light sources are generally adequate for this purpose). As most leaks occur through the fovea ethmoidalis rather than the cribriform plate, the dye is usually visible only in the superior or middle meatus areas. It may be necessary to open the ethmoid air cell system to allow for adequate exposure of the dural defect.

Once the site of the fistula has been identified with the endoscope, the integrity of the neighboring bone is tested by careful probing with a fine elevator. Any devitalized mucosal remnants are removed using a small-cupped microforceps. A small angled probe is then used to elevate the mucosa immediately surrounding the defect for a distance of 3 or 4 mm. Once the size and location of the fistula have been conclusively visualized, we proceed to harvest a free temporalis fascia graft (Figure 6A). After local Betadine prep and infiltration of 1% lidocaine with 1:100,000 epinephrine solution, a vertical incision is made in the immediate supra-auricular area well within the hair-bearing temporal scalp. This incision is utilized to access the superficial layer of the deep temporal fascia (Figure 6B). A graft of temporalis fascia that measures twice the diameter of the defect to be repaired is then harvested with a #15 scalpel and maintained in a saline-soaked gauze until ready for insertion (Figure 6C). The donor site is closed in layers with 3-0 Vicryl sutures for the subcutaneous closure and 5-0 Prolene sutures for the skin. Fascia lata, temporalis muscle, fat, or other similar autogenous material are also suitable.

At this point, a standard septoplasty-type approach is utilized to allow the formation of a vascularized, pedicled septal mucosal flap. A Killian hemitransfixion incision is made in the mucoperichondrium overlying the caudal septum ipsilateral to the side of the previously identified leak. A Cottle elevator, or equivalent, is then utilized to develop a plane of dissection immediately superficial to the osseocartilaginous septum (submucoperichondrial and submucoperiosteal) (Figure 7). A sickle knife or beaver blade is used to delineate either a superoposteriorly or an inferoanteriorly pedicled septal mucosal flap (actually, a mucosal and perichondrial/periosteal flap) (Figure 8). The determination of which flap to utilize is best made intraoperatively based upon the exact location of the defect. The flap is outlined to allow for tension-free transfer into the recipient bed (the fistula site). The flap dimensions are typically 2 cm wide × 4 cm long.

At this point, the temporalis fascia is soaked in fibrin glue and securely placed into the defect, paying attention to place it beneath the undermined edges of mucosa surrounding the fistula. The previously fashioned septal flap is rotated into position over the autograft and reinforced along its edges with fibrin glue (Figure 9). Pressed Gelfoam soaked in Cortisporin solution is applied to the septal flap to further aid in the maintenance of its position (Figure 10). Gelfoam sheets are supported by the placement of an intranasal trumpet (flexible nasopharyngeal

Figure 3. Patient's head positioned supine on a headrest.

Figure 4. Inspection of the floor of the anterior cranial fossa and nasal cavity using a sinus endoscope.

Figure 5. Coronal view through the osteomeatal complex.

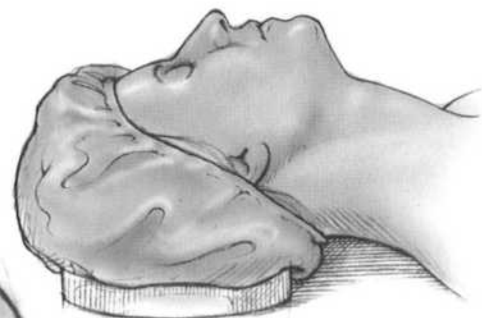

Figure 3.

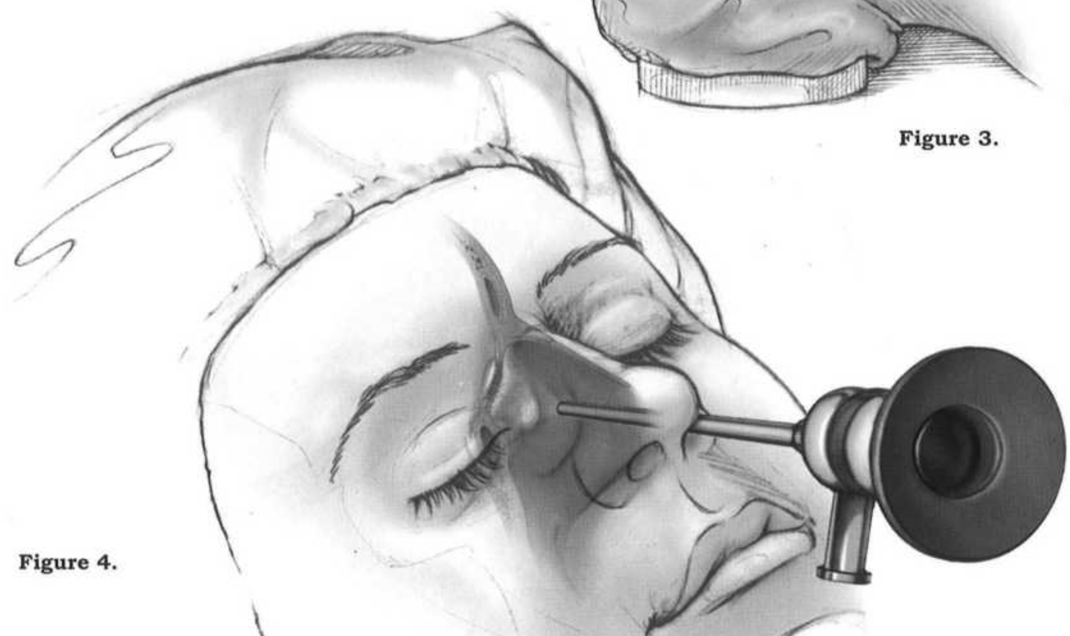

Figure 4.

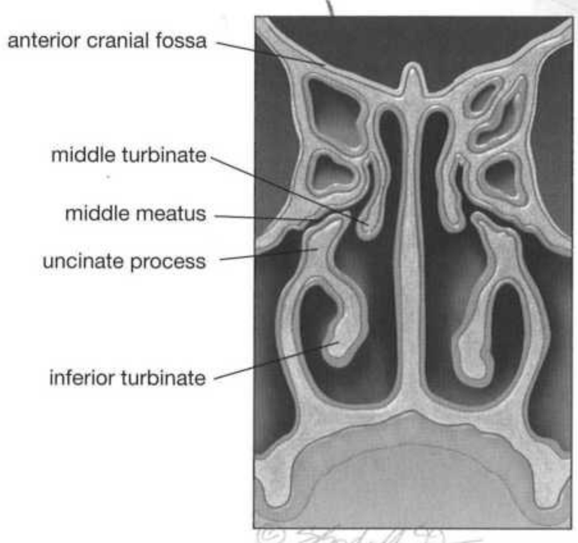

Figure 5.

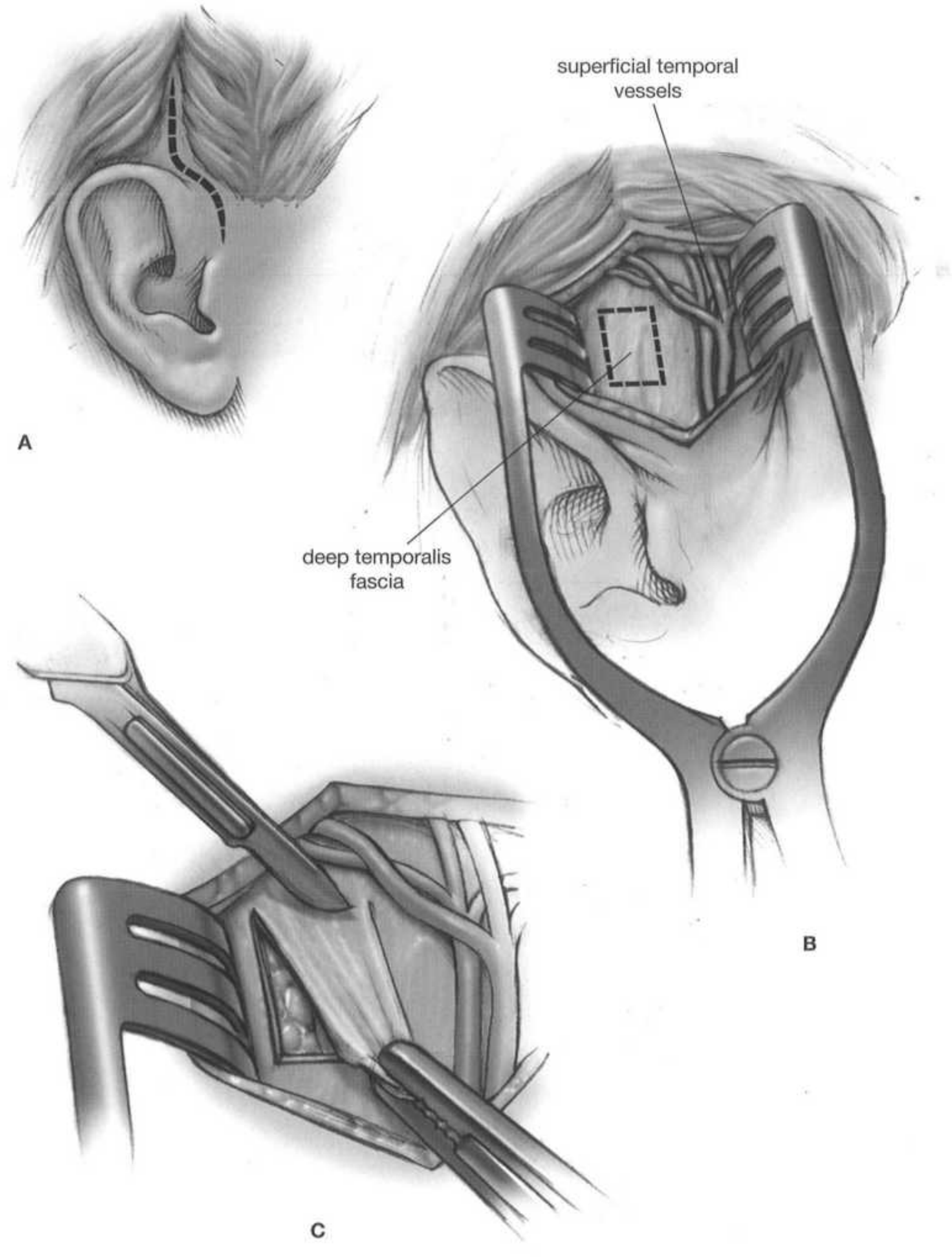

Figure 6. A, access incision for the harvest of the temporalis fascia. **B,** the deep temporal fascia is exposed. **C,** harvesting of the temporalis fascia using a #15 blade.

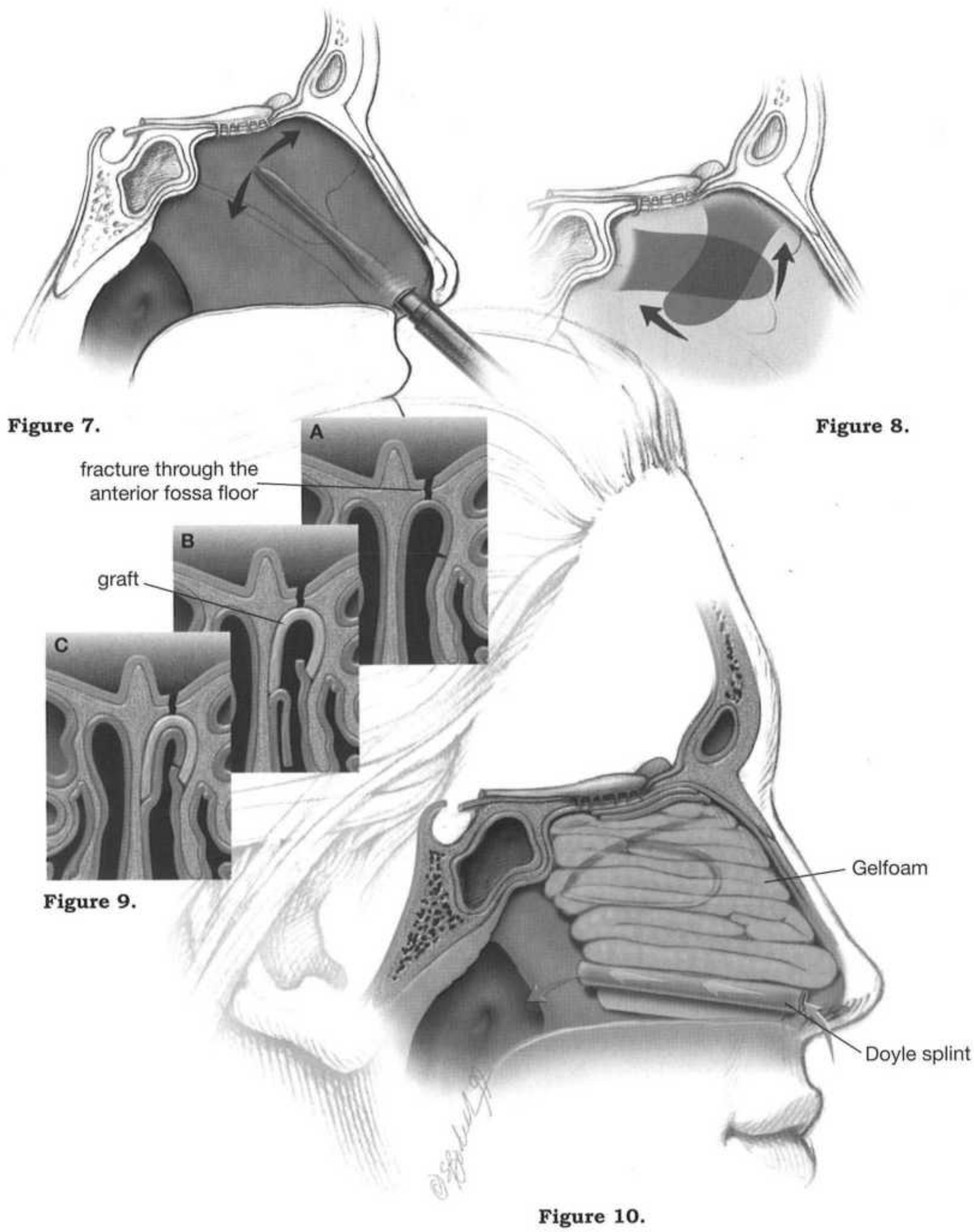

Figure 7. Elevation of a septal mucoperichondrial flap using a Freer elevator.

Figure 8. Posteriorly and anteriorly based septal flaps.

Figure 9. A, the septal flap is delineated. **B,** the flap is raised and the graft inserted. **C,** the flap is reapplied to hold the graft in position.

Figure 10. Nasal packing is applied for early postoperative stabilization.

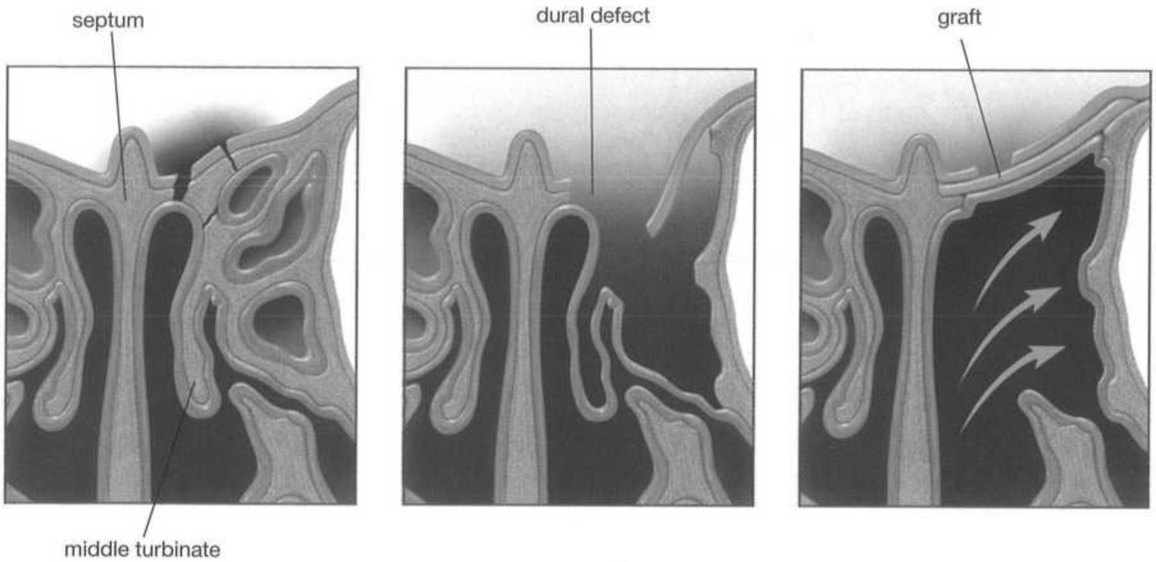

Figure 11. Alternate technique utilizing mucosa from the middle turbinate to cover a dural defect and control a cerebrospinal fluid fistula.

airway or Silastic nasal stent), which is maintained for 5 days postoperatively.

Alternatively, in the case of a prominent middle turbinate and a laterally placed cribriform plate defect, the osseous portion of the middle turbinate (concha) may be removed and a middle turbinate mucosal flap utilized in place of a septal flap (Figure 11).

The adequacy of closure is then tested by requesting that the anesthesiologist administer a large sustained breath while continuously monitoring the fistula site with the endoscope.

POSTOPERATIVE CARE

The need for perioperative antibiotics has not been prospectively studied. As a consequence of potential nasal contamination of the grafted site, we prefer to administer a first-generation cephalosporin, or equivalent, for 1 week postoperatively. Generally, the lumbar drain is left *in situ,* for a period of 5 days, to reduce the pressure on the grafted fistula site. During this period, strict bed rest, head elevation to 30 degrees, and stool softeners are continued. If no further leakage is evident, the nasal trumpet and lumbar drain are removed on the fifth postoperative day. The patient is also instructed to abstain from blowing his/her nose for a period of 1 month postoperatively. Bothersome intranasal crusting is adequately controlled by generous repeated saline spray nasal irrigation that is commenced 1 week following surgical closure of the fistula.

CONCLUSIONS

The endoscopic closure of traumatic CSF fistulae is successful in greater than 90% of cases. In cases of recurrent CSF leakage following unsuccessful initial endoscopic closure or in the presence of fistulae that are >1.5 cm in greatest dimension, we prefer open approaches (extracranial or intracranial). Proper patient selection and accurate determination of the site of CSF leakage continue to remain the essential factors in assuring continued success with this simple procedure.