Vascularized temporalis muscle flap for the treatment of otorrhea

Technical note

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The surgical treatment for cerebral spinal fluid (CSF) fistulas provides closure of the bone and dural defects and prevents the recurrence of brain herniation and CSF fistula. The two main approaches used are the transmastoid and middle fossa ones. The authors review the results of performing a modified middle fossa approach with a vascularized temporalis muscle flap to create a barrier between the repaired dural and bone defects.

Fifteen consecutive cases of CSF fistulas treated at the authors’ institution were retrospectively reviewed. All patients presented with otorrhea. Eleven patients had previously undergone ear surgery. A middle fossa approach was followed in all cases. The authors used a thin but watertight and vascularly preserved temporalis muscle flap that had been dissected from the medial side of the temporalis muscle and was laid intracranially on the floor of the middle fossa, between the repaired dura mater and petrous bone. The median follow-up period was 2.5 years. None of the patients experienced recurrence of otorrhea or meningitis. There was no complication related to the intracranial temporalis muscle flap (for example, seizures or increased intracranial pressure caused by muscle swelling). One patient developed hydrocephalus, which resolved after the placement of a ventriculoperitoneal shunt 2 months later.

The thin, vascularized muscle flap created an excellent barrier against the recurrence of CSF fistulas and also avoided the risk of increased intracranial pressure caused by muscle swelling. This technique is particularly useful in refractory cases.

KEY WORDS • cerebrospinal fluid • fistula • otorrhea • middle fossa approach • temporalis muscle flap

CEREBROSPINAL fluid fistulas originating from the temporal bone have been recognized since the beginning of the 20th century (Fig. 1 upper). They can be spontaneous (childhood or adult onset), related to chronic otitis media (with or without cholesteatoma), or posttraumatic (including postsurgical). Their presentation ranges from incidental findings at surgery to meningitis, brain abscesses, or temporal lobe seizures. Surgical treatment provides closure of the bone and dural defects and prevents the recurrence of brain herniation and CSF fistula. The two main approaches used are the transmastoid and the middle fossa ones. We developed a modified middle fossa approach together with a vascularized temporalis muscle flap as a barrier between the dural and bone defects (Fig. 1 lower).

Clinical Material and Methods

Patient Population

We retrospectively reviewed 15 consecutive cases of CSF fistulas treated at our center. There were 11 female and four male patients, whose ages ranged from 7 to 82 years (mean 43.7 years). The time for follow up ranged from 5 months to 5 years (mean 30 months).

All patients presented with otorrhea as their chief symptom. Eleven patients had previously undergone ear surgery, and four of these had undergone multiple attempts at surgical repair of the CSF fistula (five, three, two, and two attempts, respectively). These patients presented with new onset or persistence of drainage from the affected ear. The remaining four patients had spontaneous CSF fistulas together with the typical history of chronic drainage of clear fluid from the ear, which was refractory to medical treatment; one of these patients also experienced recurrent episodes of meningitis.

Diagnostic procedures included fine-slice CT scanning (Fig. 2 upper) and/or MR imaging to identify the size and location of the bone defect as well as the degree of brain involvement.

All patients had functional hearing. Each was evaluated for a possible mastoid infection (physical examination of the mastoid area, visual inspection of the eardrum, temporal bone CT scanning, and/or MR imaging). If an infection was suspected, antibiotic treatment was administered; if this regimen failed, a concomitant mastoidectomy was performed at the time of surgery for CSF fistula repair.

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computerized tomography; MR = magnetic resonance.
The middle fossa approach was used if the bone defect was situated at or anterior to the level of the ossicular chain and/or if the transmastoid approach had been attempted in the past and had failed.

**Surgical Procedure**

Perioperatively, all patients received anticonvulsant agents. Also, intravenous antibiotic medications were administered in the immediate pre- and postoperative period, and topical bacitracin solution was used to irrigate the wound during the surgery.

Preoperatively, a lumbar drain was inserted after general anesthesia had been induced. Also, a two-channel facial nerve monitor was placed to prevent misinterpretation caused by single-channel artifacts.

Each patient’s head was stabilized with Mayfield head points during brain retraction. The skin incision was U-shaped, with the pedicle toward the ear. Superior retraction of the incised edges of the flap facilitated the incision of the temporalis muscle and fascia close to their superior insertions, to create a larger muscle flap. The frontal branch of the facial nerve was preserved by conducting the dissection.

**Fig. 1.** Upper: Illustration depicting an encephalocele impinging on the ossicles. Lower: Illustration depicting an encephalocele repair with hydroxyapatite and a vascularized temporalis muscle flap.
in the plane beneath the superficial layer of the temporalis fascia as it passed over the zygomatic arch.

The temporalis muscle was then detached in the subperiosteal plane, down to the zygomatic root and the edge of the bone ear canal. Following pericranial elevation of the temporalis muscle, an incision was made through the medial fold of the deep temporalis fascia near the periphery of the muscle. Tenotomy scissors were then used to separate bluntly the medial one third of the muscle, down to the level of the middle fossa skull base, thus creating the muscle flap. The bone window must allow for good exposure of the aerated portion of the middle fossa skull base. Therefore, the bone flap was created two-thirds anterior and one-third posterior to the external acoustic canal. Care was exercised to leave the dura mater intact while separating it from the bone flap. The craniotomy was then extended inferiorly with a Leksell rongeur or a high-speed drill, down to the level of the skull base.

After this, the dura mater was gently elevated off the skull base from the lateral to the medial direction. The entrance of the greater superficial petrosal nerve was carefully identified from posterior to anterior, and the greater superficial petrosal nerve itself was dissected from the dural leaves. Dural elevation proceeded medially until all bone and dural defects were identified. Sometimes resection of the middle meningeal artery and the superior petrosal vein was necessary to facilitate surgical exposure.

Our surgical repair proceeded in three layers: bone, dura mater, and interposed vascularized temporalis muscle flap. The small bone defects were repaired with a split calvarial graft. We also successfully used hydroxyapatite or its analogs for larger defects (Fig. 2 lower). Repair of the dura mater depended on the size of the dural defect. If this was small, a primary approximation of the dural edges was performed. For larger defects, we used dural allograft, DuraGen, or fascia lata from a cadaver. The herniated brain was examined and resected if deemed nonviable by the neurosurgeon. Finally, between these two layers we interposed a vascularized temporalis muscle flap. This flap was dissected from the medial side of the temporalis muscle and was laid intracranially over the entire bone defect. The flap was large, thin, and watertight (Fig. 3). Vascularization was preserved by leaving the flap attached to the temporalis muscle through a 1-cm inferior pedicle. The bone flap was reattached to the skull, with perfect approximation both superiorly and anteriorly. The small inferior bone defect was large enough to accommodate the pedicle of the muscle flap. The bulk of the temporalis muscle was then reattached extracranially in its normal anatomical position.

As a general rule, all patients were placed in the intensive care unit postoperatively until the lumbar drain was removed.

Results

The median follow up was 2.5 years. None of the patients suffered a recurrence of otorrhea or meningitis. Although we did not quantify the degree of hearing loss, none of the patients experienced subjective worsening of their hearing. There were no complications related to the intracranial vascularized temporalis muscle flap (for example, seizures or increased intracranial pressure caused by muscle swelling). One patient developed hydrocephalus, which resolved after a ventriculoperitoneal shunt was inserted 2 months later.

Discussion

Cerebrospinal fluid fistulas are rare, but their repair is
Vascularized temporalis muscle flap for otorrhea

often challenging and marked by recurrences. Once the diagnosis of a CSF fistula is made, several surgical options are available. The goals of surgery are to repair the defects in the petrous bone and dura mater, and to create a barrier that will prevent recurrence of the brain herniation and CSF fistula.

The two surgical approaches most commonly used are the middle fossa and the transmastoid ones. The transmastoid approach, especially when performed using hydroxyapatite, has certain advantages: shorter hospital stay, no temporal lobe retraction, and no need for lumbar drainage. Using this approach for bone defects located at or anterior to the tegmen timpani, however, is likely to damage the ossicular chain and lead to hearing loss. Although the ossicular chain can be reconstructed, the hearing outcome is likely to be worse than that following a middle fossa approach.

The middle fossa approach does require brain retraction (with the potential for postoperative brain edema and seizures) as well as placement of a lumbar drain, at least for medial defects. In difficult cases, however, this approach offers direct access to the bone and dural defects, as well as the herniated brain. In tegmen timpani defects, the herniated brain can be retracted under direct visualization and the bone defect can be sealed off without damaging the ossicular chain, therefore preserving hearing. Furthermore, if the herniated brain is pedunculate and appears devascularized and nonviable, it can be resected under direct visualization. Finally, the middle fossa approach should be used when a previous transmastoid approach fails to aid the cure of the CSF fistula, to avoid operating through scar tissue.

The two approaches can be combined for maximal access to both anterior and posterior sides of the petrous bone, or when a mastoid infection is suspected and would benefit from surgical drainage.

Our technique maximizes the chances for permanent healing by closing the defect in three layers: bone, dura, and interposed temporalis muscle flap.

Repair of the bone defect can be achieved using split calvarial graft, hydroxyapatite, or analogs. One must not place the bone within the mucosa containing air cells, because this could lead to a chronic inflammatory reaction. Hydroxyapatite has the advantage of malleability, given that it can be compressed into the microscopic defects within the temporal bone.

The use of a vascularized, thin temporalis muscle flap has multiple advantages. Some surgeons use interposed fascia lata, bone harvested from the craniotomy flap, bone pate, or combinations of these. In our opinion, a nonvascularized graft adds a scar to the one already present. Vascularized flaps are stronger and contract less; there is less infection and better survival.

The arterial supply of the temporalis muscle comes predominantly from the posterior deep temporal artery that branches from the internal maxillary artery at the level of the midzygoma. After careful elevation of the flap, the vascular pedicle can sometimes be visualized in this area, just superficial to the deep fascia of the temporalis muscle. Also, in some patients, there may be a contribution from the middle temporal artery, which is a branch of the superficial temporal artery as it passes over the zygomatic root. Careful splitting of the medial one third of the temporalis muscle will spare at least some of the deep branches, because of their close proximity to the medial fold of the deep temporal fascia.

Another important characteristic of the muscle flap is its thinness. The flap is dissected from the medial aspect of the temporalis muscle and placed intracranially over the petrous bone defect, while the bulk of the temporalis muscle is placed extracranially in its normal anatomical position. Thus, the potential increase in intracranial pressure caused by muscle swelling is avoided.

Postoperative MR imaging (Fig. 3) can demonstrate the relative thickness of the muscle graft as well as the blood flow in the flap with the aid of Gd enhancement.

Attention to detail is important in this particular surgical approach. The detachment of the temporalis muscle should be done in the subperiosteal plane and should be as wide as possible, to provide a large muscle flap. One must avoid violating the ear canal, because doing otherwise can result in a CSF fistula. Bone flap elevation should be performed without lacerating the dura. The small craniectomy at the base of the craniotomy flap should be wide enough to accommodate the pedicle of the muscle flap.

In the one case of a complication, normal opening CSF pressure was established on placement of the lumbar drain. It is most likely that the patient’s CSF fistula was compensating for a communicating hydrocephalus, which became patent after a tight closure of the fistula.

It is noteworthy that 11 of our cases involved repeated operations. The lack of postoperative recurrence of the CSF fistulas proves the efficacy of this surgical procedure.

The described technique can probably be used prophylactically in any middle fossa surgery in which there is a risk of postoperative CSF fistula.

Conclusions

We describe a modified middle fossa approach for the treatment of CSF fistulas. The bone and dural defects were repaired in layers. The bone defect could be repaired with a split calvarial flap, hydroxyapatite, or its analogs. The dural defect could be closed primarily or with grafts (fascia lata or dural allografts). We used an interposed vascularized temporalis muscle flap that was thin and watertight and dissected from the medial side of the temporalis muscle. It creates an excellent barrier against the recurrence of CSF fistulas and also avoids the risk of increased intracranial pressure caused by muscle swelling. This technique is particularly useful in refractory cases in which multiple attempts have been made to close the CSF fistulas surgically and in which there is increased scar formation.

Disclaimer

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References


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