Titanium Mesh Reconstruction to Maintain Scalp Contour after Temporalis Musculofascial Flap Reconstruction of the Floor of the Middle Cranial Fossa: A Technical Note and Report of Two Cases

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ABSTRACT

Objective: Temporalis musculofascial rotational flaps can provide excellent tissue for reconstruction of defects in the floor of the middle cranial fossa. This technique can, however, result in cosmetic deformity of the temporal fossa with an asymmetric contour of the head. We report a technique that uses titanium mesh and autologous abdominal adipose to maintain a normal scalp contour. **Clinical Presentation:** Two patients, one with a large middle cranial fossa and infratemporal schwannoma, and another with penetrating trauma secondary to a rifle accident, required surgical repair of defects of the floor of the middle cranial fossa. **Intervention:** The repair was achieved in both cases using a temporalis musculofascial rotational flap. Normal contour of the scalp was maintained with titanium mesh and autologous abdominal adipose reconstruction. **Conclusion:** The temporalis musculofascial flap, combined with titanium mesh and autologous adipose reconstruction, provided excellent closure of defects of the floor of the middle cranial fossa while preserving normal cosmetic scalp contour.

KEYWORDS: Temporalis, musculofascial flap, titanium mesh, rotational flap

Temporalis musculofascial flaps can provide excellent closure of various cranial floor defects.^{1–3} With its arterial pedicle maintained,

the temporalis musculofascial flap provides a vascularized tissue useful for a wide range of indications.⁴ Potential disadvantages of using

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this flap include possible asymmetry of mastication and occlusion, as well as cosmetic defect of scalp contour reflecting the vacant temporal fossa due to the transposition in of the muscle beneath the temporal lobe.⁵ Several methods have been described to address the resultant cosmetic defect, including the use of polyethylene and acrylic implants.⁶⁻⁹ The use of titanium mesh for reconstruction of skull defects has been described in the literature.^{10,11} Here we present a novel and simple technique using titanium mesh shaped to mimic the natural contour of the scalp, along with implantation of autologous abdominal

adipose tissue to obliterate the potential dead space.

Following are two case reports of patients with defects of the floor of the middle cranial fossa requiring surgical repair. One defect was due to removal of a large schwannoma of the middle cranial and infratemporal fossae, and the other was due to a penetrating injury from a hunting accident with a rifle. In both cases, defects of the middle cranial fossa floor were repaired with rotational temporalis musculofascial flaps, and normal scalp contour was maintained using a combination of titanium mesh and autologous adipose.

Figure 1 Preoperative magnetic resonance imaging (MRI) (A–C) showing right trigeminal schwannoma extending from the middle fossa into the infratemporal fossa. Postoperative MRI (D–F) demonstrates tumor resection and reconstruction with rotational temporalis musculofascial flap, titanium mesh, and autologous adipose (arrow).

CASE 1: TRIGEMINAL SCHWANNOMA

History and Examination

A 28-year-old woman presented with long-standing nasal obstructive symptoms, a feeling of fullness in the right ear, and discomfort around her right eye. On examination, she was found to have a large mass obstructing the nasopharyngeal-parapharyngeal region, extending into the posterior maxillary sinus and superiorly into the middle cranial fossa. Her neurological examination was normal except for some subtle facial weakness and decreased spontaneous blinking on the right. Magnetic resonance imaging (MRI) revealed a large right parapharyngeal pterygopalatine mass, posterior to the maxillary sinus, extending into the clivus region, the sphenoid sinus, the middle cranial fossa, the infratemporal fossa, and through the clivus to the posterior cranial fossa (Fig. 1A–C). Preoperative cerebral angiogram and temporary balloon occlusion (TBO) were performed. The mass was shown to be avascular, and the patient tolerated the TBO demonstrating adequate angiographic collateral supply to the cerebrum, stable neurological exami-

nation during the TBO, and symmetric spontaneous positive end expiratory pressure (SPECT) imaging after the TBO. Histopathological examination of endoscopic transnasal biopsy tissue was consistent with neoplasm, possibly chordoma.

Treatment

The mass was approached through a right frontotemporal incision using frameless stereotaxy. The scalp was elevated separately from the temporal frontoparietal fascia and pericranium, which were elevated as a separate musculofascial flap. A frontotemporal craniotomy was performed, and further bone was removed from the lateral sphenoid wing and middle cranial fossa. Using an extradural approach, the temporal lobe dura was reflected superiorly and posteriorly until the mass could be identified in the anteroinferior aspect of the middle cranial fossa (Fig. 2). The mass had a firm, tan capsule, with fibers from the trigeminal nerve coursing over it. The ~4-cm dome of the tumor was circumferentially dissected and removed. The central core was then debulked using ultrasonic

Figure 2 Intraoperative photograph showing the extradural surgical exposure of the tumor through the frontotemporal approach.

aspiration and suction. Preservation of trigeminal nerve fibers was attempted when possible, but some of the smaller attenuated fibers were sacrificed to enter the tumor capsule. Small fragments of tumor were left adherent to the petrous portion of the internal carotid artery to preserve the vessel. Dissection of the mass continued into the nasopharyngeal cavity. There was some abnormal clival bone in the depths of the resection, which was further removed with a small cutting bit on a high-speed drill. Endoscopy was used transnasally and through the resection cavity directly to provide exposure for completion of the tumor resection.

The temporalis musculofascial flap was then rotated into the floor of the middle cranial fossa to obliterate the space between the middle cranial fossa dura and the nasopharynx and to cover the exposed petrous internal carotid artery. This flap was sutured to the native dura in several locations to anchor it in position.

The bone flap was then secured with plates and screws from the Synthes Neuro Fixation System (West Chester, PA). The inferior edge of the squamous temporal portion of the bone flap was removed to minimize possible compression of the temporalis musculofascial flap. To overlay this, a piece of titanium mesh was placed to reconstitute the contour of the head where the temporalis muscle has been rotated into the middle cranial fossa. Beneath this titanium mesh, a buttress of autologous adipose from the abdominal harvest site was placed.

The patient had good postoperative recovery with some persistent numbness in the trigeminal nerve distribution, particularly the first and second divisions. She had a mildly asymmetric bite, but mastication function was normal. Early postoperatively she had right facial nerve paresis, which resolved by 3 months postoperatively. Additionally, she had partial sixth nerve palsy postoperatively that was largely resolved at the 4-month follow-up visit. Magnetic resonance imaging 4 months and 10 months postoperatively showed no definitive evidence of residual tumor (Fig. 1D–F). Long-term follow-up is planned.

CASE 2: HUNTING RELATED TRAUMA

History and Examination

A 50-year-old man presented with injuries sustained in a hunting accident involving an older black-powder rifle with a muzzle ball casing spring mechanism requiring loading by the hunter before each firing. The weapon backfired, propelling an ~5-cm spring through the right infraorbital region with portions of spring lodging in the orbital apex, middle cranial fossa floor, and right temporal lobe, producing a complex comminuted skull base fracture. Computed tomography (CT) revealed the foreign body, associated fractures, right temporal lobe contusion, and small amount of subarachnoid hemorrhage (Fig. 3A–D). The accident resulted in the man falling from an ~25 foot deer stand resulting in a T11 burst fracture with limited bony retropulsion without spinal cord injury, as well as a left pneumothorax and a right thumb fracture.

Catheter angiogram demonstrated stenosis of the petrous segment of the right internal carotid artery due to a bony fragment impinging on the canal (Fig. 3E). A TBO with continuous neurological assessments and postangiography nuclear medicine perfusion testing demonstrated good collateral arterial supply to the cerebral circulation and tolerance to the temporary arterial occlusion.

Before surgery, the patient was awake, alert, and talking, although confused. The right pupil was fixed and dilated, and there was partial limitation of all ocular movement as well as impaired visual acuity on the right. Initially, rhinorrhea was clear and tested positive for β -2 transferrin, confirming suspicions of leakage of cerebrospinal fluid from the skull base. The clear rhinorrhea spontaneously resolved in the first 48 hours.

Treatment

A right cervical incision was made, and the common, internal, and external carotid arteries were secured with Silastic vessels to establish proximal

Figure 3 Computed tomography (CT) scans (A–C) and skull x-rays (D) demonstrating the spring foreign body, associated fractures, right temporal lobe contusion, and small amount of subarachnoid hemorrhage. Cerebral angiogram (E) demonstrates stenosis of the petrous internal carotid artery (arrow). Postoperative CT (F) demonstrates removal of the foreign body and reconstruction with rotational temporalis musculofascial flap, titanium mesh, and autologous adipose (arrow).

control in case arterial bleeding was encountered on decompression of the petrous internal carotid artery. A right frontotemporal incision was made to expose the scalp. Next, a temporalis musculofascial flap was elevated, and a frontotemporal craniotomy flap was made. Exploration of the epidural space identified multiple fractures of the floor of the middle fossa and multiple dural lacerations. The dura was further opened and reflected. Intradural dissection in a subfrontal fashion permitted identification of the supraclinoid internal carotid artery, thereby establishing distal arterial control. Further exploration of the middle fossa floor revealed multiple bony fragments and direct communication with

the maxillary and sphenoid paranasal sinuses. The spring was identified having assumed a bent “U” shape with the intervening portion “unwound.” The two portions of the spring were disconnected with heavy wire cutters, facilitating gentle removal of the portion of the spring embedded in the temporal lobe and the floor of the middle fossa. A Doppler probe was used to confirm the location of the petrous internal carotid artery. Several bone fragments were easily removed from the region of the carotid canal of the petrous temporal bone. The internal carotid artery was identified to be intact, and no arterial bleeding was encountered. The second portion of the spring remained in its coiled

Figure 4 Intraoperative photographs demonstrating the spring after removal. One half of spring with embedded bone, brain, and soft tissues (A), the entire spring after being cut into to pieces for removal (B), and skull reconstruction with titanium mesh (C) are shown.

formation and was embedded in the orbital apex. This was gently turned until it rotated out of the orbital apex, where there were multiple fractures in the lateral orbital wall (Fig. 4). Loose bone fragments were removed.

The temporalis musculofascial flap, which had been harvested at the beginning of the operation, was then rotated down into position to fill the defect in the floor of the middle cranial fossa and into the paranasal sinus region. Before the craniotomy bone flap was replaced, an inferior portion of the squamous temporal bone was removed to allow the temporalis musculofascial flap to situate without compression. To augment the curvature of the skull to a more anatomically correct shape, a large piece of titanium mesh was secured to the frontotemporal and orbital zygomatic regions. Below the mesh, a buttress of autologous adipose tissue harvested from the abdominal region was placed (Fig. 3F).

RESULTS

The temporalis musculofascial rotational flap provided excellent closure. No subsequent cerebrospinal fluid leakage or infections were identified. Masticator function was preserved with some mild asymmetry

of the patient's bite. The titanium mesh reconstruction provided a normal scalp contour. The patient later underwent further decompression of the right facial nerve via a transmastoid approach. Limited right facial nerve recovery was achieved, and later a tarsorrhaphy was performed. Later a posterior instrumented fusion was performed for the thoracolumbar fracture. At 1 year follow-up, the patient had residual partial trigeminal and facial nerve deficits. The contour of the skull was symmetrical.

DISCUSSION

Successful closure of middle cranial fossa defects is crucial to reduce the risk of cerebrospinal fluid leak and infection.^{1,3,12,13} The temporalis musculofascial rotational flap is a safe, effective, and readily available option for the obliteration of these defects, and provides robust vascularized tissue.^{2,4} Because the temporalis muscle is not denervated during the procedure, it should not be subject to significant atrophy.⁴ Limitations to the use of the temporalis musculofascial flap include a narrow arc of rotation, relatively small size, and the cosmetic deformity of the temporal fossa defect.¹³ The titanium mesh and adipose skull reconstruction technique presented in

this report provides an acceptable aesthetic and functional closure.

Closure of cranial floor defects has been achieved using a variety of methods documented in the literature.^{14,15} The use of temporalis musculofascial flaps specifically for this purpose is also well documented.^{1,2} Although the use of the temporalis flap is well established, repair of the temporal contour defect left at the donor site has received less attention. This deformity is defined as a concavity or depression in the temporal region located superior to the zygomatic arch and immediately posterior to the lateral orbital rim.⁵ Although the defect itself does not usually cause functional impairment, the cosmetic deformity can be significant. Several methods of repairing temporal contour defects have been described, most relying on synthetic implants, including moldable acrylics^{7,8,16} and porous polyethylene implants.^{6,9} Other methods for repair of scalp defects have used free muscle flaps^{17,18} and artificial dermis.¹⁹ Titanium has been described for the reconstruction of other types of skull defects,^{10,11} Here we present an alternative method, using titanium mesh with underlying autologous adipose tissue for successful repair of temporal fossa defects with good long-term outcomes in two patients.

CONCLUSION

Reconstruction of the temporal fossa defect with titanium mesh and autologous adipose after use of a temporalis musculofascial rotational flap repair of the floor of the middle cranial fossa provides a straightforward technique to maintain normal scalp and skull contour.

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