CASE REPORT

Reconstruction of Complicated Skull Base Defects Utilizing Free Tissue Transfer

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ABSTRACT

We managed five patients with large skull base defects complicated by complex infections with microvascular free tissue transfer. The first patient developed an infection, cerebrospinal fluid (CSF) leak, and meningitis after undergoing a translabyrinthine resection of an acoustic neuroma. The second patient had a history of a gunshot wound to the temporal bone, with a large defect and an infected cholesteatoma that caused several episodes of meningitis. The third through the fifth patients had persistent CSF leakage and infection refractory to conventional therapy. In all cases prior attempts of closure with fat grafts or regional flaps had failed. Rectus abdominis myofascial free flap, radial forearm free flap or a gracilis muscle free flap was used after debridement of the infected cavities. The CSF leaks, local infections, and meningitis were controlled within a week. In our experience, microvascular free tissue provides the necessary bulk of viable, well-vascularized tissue, which not only assures a mechanical seal but also helps clear the local infection.

KEYWORDS: Free flap, skull base, reconstructive surgery

Closing large skull base defects challenges skull base surgeons. Closure is especially problematic in the setting of complex infections, cerebrospinal fluid (CSF) leakage, or meningitis. Traditional methods of managing complicated skull base defects have included intravenous antibiotics, debridements, and obliteration with fat or regional flaps. When the above complications are present,

these traditional methods sometimes fail to eliminate infection and CSF leakage.

Reconstruction of skull base defects requires well-vascularized tissue to seal the dura, to cover the bone, to fill dead space, and to cover the skin.¹ The traditional modes of reconstructing the skull base have included primary closure and local or regional flaps. With the advent of free tissue transfer, new

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possibilities have been introduced to reconstruct skull base defects refractory to treatment with traditional methods. We have used free-tissue transfer to manage complicated skull base defects in several patients when other methods of closure have failed.

ILLUSTRATIVE CASES

Patient 1

A 67-year-old male had sustained a gunshot wound to the face in 1944. The bullet had traversed the temporal bone and destroyed the function of cranial nerves VII and VIII. The patient did well until March 1988 when he developed an infratemporal fossa abscess, which was incised and drained emergently. In December 1988 the patient underwent skull base resection and a fat graft was placed in the defect. In February 1990 the patient underwent resection of an extensive cholesteatoma involving the carotid canal and the temporomandibular joint, and a fat graft was placed in the defect. Five months later, a postauricular abscess was incised and drained. In June 1991 the residual cholesteatoma was resected, and a temporalis flap was used for reconstruction. Again the treatment failed. The patient received intravenous antibiotic therapy for two months for continued infection in the area presumed to be osteomyelitis. In June 1992, the patient underwent resection of the cholesteatoma, and a gracilis muscle free flap was anastomosed to the facial artery and vein. A skin graft was used to cover the gracilis muscle. At the patient's last follow-up examination in June 2001, he showed no evidence of recurrent infection or cholesteatoma.

Patient 2

A 64-year-old male was referred to the University of Minnesota with mucinous cystadenocarcinoma of the ethmoid sinus. In December 1992, he underwent craniofacial resection of the tumor and the an-

Figure 1 Postoperative T1-weighted sagittal MR image of Case 2 demonstrating the rectus abdominis muscle flap lying on the floor of the anterior fossa.

terior fossa floor. The defect was reconstructed with split calvarial bone grafts and a pericranial flap. Postoperatively, the patient underwent neutron beam radiation therapy. Several months after he completed radiation therapy, the patient developed a dehiscence with a chronic infection involving the left medial canthus area with exposure of the bone grafts. Multiple courses of antibiotics failed to resolve the chronic infection. In April 1994 the patient underwent a bicoronal approach to the anterior fossa to remove bone grafts. A rectus abdominis free flap was anastomosed to the superior thyroid artery and vein (Fig. 1). After the free-tissue transfer, the infection resolved completely.

Patient 3

On December 14, 1995, a 45-year-old male underwent a translabyrinthine approach for resection of a 1-cm acoustic neuroma. Fat grafting and a tem-

Figure 2 Postoperative axial T1-weighted MR image of Case 3 demonstrating the rectus abdominis flap in place with good support of the temporal lobe.

poralis muscle flap were used to close the defect. Postoperatively, the patient developed CSF leakage and *Pseudomonas aeruginosa* meningitis. On January 5, 1996, the defect was explored. Again fat was grafted in the defect, and a lumbar drain was placed. Despite the drain and antibiotics, the CSF leak and meningitis continued. On January 16, 1996 the lumbar drain was removed, and a rectus muscle free flap was anastomosed to the facial artery and vein to close the defect (Figs. 2 and 3). The CSF

Figure 3 Rectus abdominis flap with overlying split thickness skin graft in place at the patient's 2-week follow-up examination.

leak stopped and the meningitis resolved. The patient was discharged to home 8 days after surgery.

Patient 4

In July 2000 a 65-year-old male was presented to our medical center with meningitis and pneumocephalus. He had undergone three resections of an esthesioneuroblastoma and its recurrences in early 1970s and finally in 1980 with postoperative external beam radiation therapy, all at outside institutions. Because of active CSF leakage, on July 31, 2001 the patient underwent a frontal craniotomy and pericranial closure of the 1.5-cm dural defect. In September 2000 the patient presented with meningitis and an infection of the frontal craniotomy bone flap, which necessitated a frontal craniectomy. In April 2001, the craniectomy defect was repaired with a cranioplasty, which required removal in a month because of meningitis and an infection of the cranioplasty. On May 29, 2001 the dural ethmoidal roof defect was repaired endoscopically using abdominal fat. The patient presented five months later with a CSF leak and pneumocephalus. On December 20, 2001 a frontal craniotomy was performed, and reconstruction was performed with a 5-cm x 7-cm radial forearm free flap. The size of the cutaneous paddle used to close the defect in the ethmoidal roof was 2 cm x 2 cm. The patient was discharged to home one week after surgery. At his last follow-up examination on June 10, 2002 there was no evidence of further CSF leakage.

Patient 5

In early 2000 a 45-year-old male underwent stereotactic radiosurgery and then resection of a malignant meningioma using the suboccipital approach in October 2001. A translabyrinthine approach was used to resect the rapid recurrence, and the defect was reconstructed with an abdominal fat graft in February 2002. On March 1, 2002 the patient presented with a wound abscess. The abscess was incised and drained and intravenous (IV) antibiotics were administered

to treat the heavy growth of *Staphylococcus aureus*. Four weeks after the start of the IV antibiotics, the patient developed increasing leakage of CSF through the nose and wound. Cultures from the wound continued to be positive. Because of the continued CSF leakage and contamination of the wound, on April 4, 2002 the wound was debrided and a radial forearm fasciocutaneous free flap was used to seal the area of dural exposure. The patient was discharged to home on postoperative Day 5 and had no CSF leakage or wound infection at his last follow-up examination on June 4, 2002.

DISCUSSION

A number of papers have discussed the management of skull base defects after a primary resection. However, reports on the management of failed or complicated primary closures are scarce. We have presented our experience with the use of free-tissue transfer for the treatment of complicated skull base defects. A rectus abdominis flap was used in two patients with large defects, a radial forearm flap was used for defects requiring a thin pliable vascularized tissue, and a gracilis muscle flap was used in a patient who required filling of a smaller defect. In all cases, local infection, CSF leakage, meningitis, or all three resolved within 1 week of closing the defect with a vascularized free flap.

Several authors have compared the complication rate associated with various methods of managing large skull base defects. Wornom et al² found a 20% to 22% rate of wound complications when scalp flaps and split thickness skin grafts or pedicled myocutaneous flaps were used to close craniofacial defects after tumor resections. No complications were associated with free tissue transfers in these patients. Neligan et al³ reported a 14.8%, 11.8%, and 5% rate of CSF leakage for local, pedicled, and free flaps, respectively. Meningitis occurred in 3.7% of patients with local flaps and in 5.9% of those with pedicled flaps. An abscess formed in 9.3% of patients with a local flap and in 17.6% of

those who received a pedicled flap for reconstruction. No patient with a free flap for reconstruction of their defect developed meningitis or an abscess.³

Based on their data, Wornom et al² suggested that using local tissue for reconstruction of large defects would lead to an excessively high rate of wound complications. In contrast to other published series, our patients all had a complicated defect before closure. All but one of our patients had received a local flap that had led to continued complications. Their problems resolved within a week of free-tissue transfer.

A rectus abdominis flap is a versatile flap for reconstructive surgeons managing complicated skull base defects. Technically, this flap is uncomplicated to harvest. It has a large caliber and a long vascular pedicle. It is reliable and associated with a low rate of morbidity at the donor site.⁴ This flap can be used as a muscle flap, a myocutaneous flap, or a de-epithelialized flap depending on the nature of the defect. The skin paddle can be designed in an oblique, transverse, vertical, or boomerang manner to suit the defect.^{4,5} A disadvantage of the rectus abdominis flap is its bulk. Therefore, in Patients 1, 4, and 5 who had a smaller defect a gracilis muscle flap was used to fill the defect.

Another useful flap for reconstructing skull base defects is the radial forearm free flap (RFFF). This flap is especially useful when a smaller, thinner flap is needed and a large flap (e.g., rectus abdominis free flap) would be too bulky for the reconstruction. The RFFF is a very thin, highly vascular fascial or fasciocutaneous flap that can suit different dural or skull base defects.⁶ The RFFF can be used in anterior and lateral skull base reconstructions with good results.⁶ Lorenzini et al⁷ have reported the use of RFFF to reconstruct refractory post-traumatic anterior skull base defects. One of their patients had recurrent meningitis from an ethmoidal encephalocele, and the other had a persistent CSF leak after a gunshot wound. The symptoms of both patients resolved after reconstruction with the RFFF. Although RFFFs are practical for some skull base defects, they cannot easily be used to reconstruct large lesions. The thinness

and small volume of the RFFF compared to the rectus abdominis free flap provide less support and render it less reliable than the larger and bulkier rectus abdominis flap.^{3,6}

In our experience, a vascularized regional flap is invaluable in expediting the resolution of other complicated head and neck infections. Because of their distance from traditional rotational muscle flaps, these flaps are limited for closing skull base defects, especially the distal aspect of the flap, which has the most tenuous blood supply. In the setting of CSF leakage, a vascularized free flap provides the necessary bulk to obtain a mechanical seal. The dependability and well-vascularized nature of free tissue transfer help control local infection, which is usually the source of meningitis. When tissue bulk is needed, a rectus abdominis flap is more appropriate. A RFFF is useful when a thin pliable flap is needed and bulk is not as important. The bulk of the gracilis free flap is between that of the rectus abdominis and the RFFF. Therefore, the gracilis free flap is useful for filling small to medium-sized deep defects. A myocutaneous flap is useful for separating the cranial cavity from the upper respiratory cavity, where the cutaneous aspect faces the upper respiratory cavity. When traditional methods of closure for skull base defects have failed and active CSF leakage and local infection are present, a vascularized free tissue transfer will consistently resolve the CSF leakage and infection.

CONCLUSION

Reconstruction of complicated, infected defects of the cranial base is challenging for skull base surgeons. We successfully reconstructed complicated

or infected skull base defects that were refractory to other reconstructive methods. Local infection, CSF leakage, or both resolved within 1 week of free tissue transfer to the area. Rectus abdominis flaps and RFFFs are both reliable and versatile for treating defects of different sizes.

EDITORS' NOTE

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