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Immediate titanium mesh cranioplasty for treatment of post-craniotomy infections

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Abstract

OBJECTIVE—Post craniotomy infections have generally been treated by debridement of infected tissues, disposal of the bone flap, and delayed cranioplasty several months later to repair the resulting skull defect. Debridement followed by retention of the bone flap has also been advocated. Here we propose an alternative operative strategy for the treatment of post craniotomy infections.

METHODS—Two patients presenting with clinical and radiographic signs and symptoms of post craniotomy infections were treated by debridement, bone flap disposal, and immediate titanium mesh cranioplasty. The patients were subsequently administered antibiotics and their clinical courses were followed.

RESULTS—The patients treated in this fashion did not have recurrence of their infections during three-year follow-up periods.

CONCLUSIONS—Surgical debridement, bone flap disposal and immediate titanium mesh cranioplasty may be a suitable option for the treatment of post craniotomy infections. This treatment strategy facilitates the eradication of infectious sources and obviates the risks and costs associated with a second surgical procedure.

Keywords

cranioplasty; post-craniotomy infection; titanium mesh

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Introduction

Post-craniotomy infections are relatively infrequent but known complications of cranial surgery. Their incidence is approximately 0.5% for first-time craniotomies and rises to 1.1% for repeat craniotomies in glioma patients [1]. In addition to repeat surgery, the risk of post-craniotomy infection is increased by duration of surgical procedure and prior radiation therapy [2, 3]. When they occur, they can manifest as superficial scalp infections or deeper infections including osteomyelitis, epidural abscesses, subdural empyemas, meningitis and/or intradural abscesses.

Historically, the management of non-superficial post-craniotomy infections has involved debridement of the operative cavity and removal of the bone flap, with delayed cranioplasty performed several months later [4]. If the bone flap is of a significant size, this strategy has several significant drawbacks including a cosmetic defect that can be disfiguring, increased susceptibility to brain injury requiring use of a protective helmet, and an additional surgery for a delayed cranioplasty. Treatment regimens to avoid a delay period have included suction-irrigation antibiotic systems and retention of the infected bone flap after debridement [5, 6].

In cases where an infected bone flap has been removed and a subsequent cranioplasty is necessitated, there are a number of cranioplasty materials available. Polymethylmethacrylate is an acrylic resin which can be molded and when cured, offers strength and protection similar to that of native skull [7]. Polymethylmethacrylate, however, is associated with infection rates similar to that of autogenous/autoclaved bone cranioplasty [7]. Hydroxyapatite, a calcium based bone cement that offers benefits of increased osteoconduction and osteointegration, is also an option. It to, however, can become infected and has also been described to cause an intense foreign body inflammatory reaction and extrusion [8–10]. Another alternative, dynamic titanium mesh, has the favorable qualities of high tensile strength and biologic inertness. Multiple studies have demonstrated lower rates of infection in titanium mesh cranioplasties [7, 11–17]. Titanium spinal implants have been used in the setting of spinal pyogenic and tuberculous osteomyelitis and discitis without becoming sources of ongoing infections [18–23].

We present two cases of post-craniotomy infections in which the bone flaps were discarded and immediate titanium mesh cranioplasties were performed as alternatives to delayed cranioplasties.

Methods

Surgical Technique

Following clinical and radiographic diagnoses of post-craniotomy infections, patients were taken to the operating room for debridement and irrigation of infected tissues as well as removal of the bone flap. Using the original bone flap as a template, a single piece of titanium mesh was fashioned such that it mimicked the curvature of the original flap, completely covered the craniotomy defect, and also radially overlapped the surrounding bone edge by approximately 5 mm (Figure 1). Different thicknesses of mesh (0.4 or 0.6 mm) can be used depending on the size of the defect and larger defects over a rounded part of the skull can be covered with a double layer of mesh if there is concern about possible later flattening of the implant curvature. The bone flap was then discarded and the mesh was gently scrubbed with a chlorhexidine-alcohol solution followed by a rinse with normal saline. The cut edges of the mesh were carefully turned down toward the bone so as not to project into the overlying scalp. Titanium microscrews were inserted through the mesh and into the underlying bone circumferentially approximately every 1.5 to 2.0 centimeters to

secure the mesh (Figure 2). The wound was closed using a single layer of monofilament suture material. Patients were administered broad spectrum antibiotics which were later tailored based on the results of intraoperative cultures.

Illustrative Patients

Case 1

A 70-year-old male underwent a right frontal craniotomy for resection of a convexity meningioma. His dural defect was repaired with a free pericranial graft. Three months postoperatively, he developed purulent drainage from his incision. Magnetic resonance imaging revealed subgaleal and epidural fluid collections.

The patient was taken to the operating room and a re-opening of his prior incision revealed purulent material in the subgaleal and epidural spaces. He underwent washout of his wound, disposal of the bone flap, and immediate cranioplasty with a piece of titanium mesh 7 by 6 cm. His intraoperative cultures revealed methicillin-resistant coagulase-negative *Staphylococcus* species, and he was treated with intravenous vancomycin for four weeks. He had no further postoperative complications and no evidence of recurrent infection over a follow-up period of greater than 3 years.

Case 2

A 30-year-old female underwent a right parietal craniotomy for resection of a grade II astrocytoma. One month postoperatively, she presented with dehiscence of her incision. Magnetic resonance imaging revealed subgaleal and epidural fluid and tissue collections.

The patient was taken to the operating room for debridement of her wound. Necrotic tissue in the subgaleal space was debrided. The bone flap was removed and additional necrotic tissue in the epidural space was debrided. A 6 by 5.5 cm. immediate titanium mesh cranioplasty was performed. Intraoperative cultures revealed methicillin-resistant *Staphylococcus aureus* and coagulase-negative *Staphylococcus* species. She was treated with intravenous vancomycin for six weeks. She had no evidence of recurrent infection at last follow-up of 3 years.

Discussion

There are limited guidelines in the neurosurgical literature regarding the management of bone flaps in the setting of post-craniotomy infections [4]. Most authors recommend disposal of bone flaps in anything more serious than a very superficial wound infection. This recommendation is particularly strong when there is evidence of cranial bone osteomyelitis [24]. Retention of the bone flap has, however, been recently advocated by Bruce and Bruce. They reported excellent results in which only two of the thirteen patients in their series ultimately required bone flap removal, and both patients had initially undergone craniofacial procedures involving the para-nasal sinuses [25]. A persistent infectious source in even 15% of patients can, however, be worrisome. In contrast, removal and disposal of the bone flap, without immediate cranioplasty, is associated with different drawbacks, namely an increased risk for trauma related brain injury and a cosmetic deformity.

The patients presented above demonstrate the potential results that can be achieved with bone flap disposal and immediate titanium mesh cranioplasty. Titanium mesh reconstruction at the time of bone flap removal avoids the creation of a postoperative skull defect as well as the need for a subsequent operation to repair the defect. This is particularly important in patients who may become lost to follow-up. Immediate titanium mesh cranioplasty also

avoids the risks and costs associated with a second surgical procedure that is typically performed under general anesthesia.

Bone flap removal and immediate titanium mesh cranioplasty should be evaluated in a larger number of patients to better determine its utility. We believe it to be a cost effective operative strategy that maximizes the chances of eradicating a post craniotomy infection and minimizes the risks attendant with having a skull defect. It is also a preferred strategy for patients who are at risk for becoming lost to follow-up.

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Figure 1.

Photograph demonstrating the titanium mesh that has been cut to a size just larger than the craniotomy defect. The cut edges have been turned down to avoid projection into the overlying scalp and the central portion has been contoured to approximate the curvature of the original bone flap.

Figure 2.
Photograph demonstrating the titanium mesh once secured to the skull defect. The screws are not visible as they are underneath the thickened and inflamed scalp.