The use of hydroxyapatite cement and a pericranial/deep temporal fascia graft for cranioplastic reconstruction of translabyrinthine craniectomy defects

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Abstract
Most translabyrinthine temporal bone defects are reconstructed with free abdominal fat grafts, with or without the use of hydroxyapatite cement. However, these procedures are associated with considerable morbidity at the graft donor site, with a 6 to 15% incidence of cerebrospinal fluid (CSF) leaks, and with postoperative headaches. We have developed a new technique for reconstructive cranioplasty that involves the use of hydroxyapatite cement and a pericranial/deep temporal fascia graft. This technique obviates the need for an abdominal fat graft and therefore circumvents the morbidity associated with it; it may also significantly reduce the incidence of CSF leaks and postoperative headaches. We describe the results of our use of this technique in a series of 10 patients. Based on our early findings, we believe that this technique holds great promise for reconstructive cranioplasty following translabyrinthine craniectomy.

Introduction
For several decades, most translabyrinthine temporal bone defects were reconstructed with abdominal fat grafts. Complications of this surgery include significant morbidity at the graft donor site, an incidence of cerebrospinal fluid (CSF) leaks in the range of 6 to 15%, and postoperative headaches. In 2002, Arriaga and Chen described a modification of this technique that involved the use of hydroxyapatite cement and a pericranial/deep temporal fascia graft. Although their technique was an improvement over the traditional technique in that it provided rigid reconstruction, it too remains associated with considerable morbidity at the graft donor site, CSF leaks (incidence: 3.7%), and headaches.

The senior author (A.H.) had already enjoyed a satisfactory experience with hydroxyapatite cement while performing mastoid cavity reconstruction. This experience prompted us, like Arriaga and Chen, to explore its use in reconstructive cranioplasty. But unlike Arriaga and Chen, we chose to use a pericranial/deep temporal fascia graft rather than an abdominal fat graft. We believed that our technique would not only circumvent the morbidity associated with abdominal fat grafts, but might prevent some or all CSF leaks and postoperative headaches. We also believed that it would result in solid reconstruction and a satisfactory aesthetic outcome.

In this article, we report our early experience with this technique in 10 patients.

Patients and methods
Between July 5, 2002, and July 29, 2003, we performed reconstructive cranioplasty with hydroxyapatite cement and a pericranial/deep temporal fascia graft on 7 men and 3 women, aged 27 to 65 years (mean: 54.3).

Indications for surgery: Nine of the 10 patients underwent primary reconstruction following a translabyrinthine craniectomy for removal of a vestibular schwannoma. The other patient underwent a secondary repair of a CSF leak following a failed abdominal fat graft reconstruction performed by another surgeon.

Surgical technique: All procedures were performed by a neurosurgeon and a neurotologist. With the patient under general anesthesia, a Mayfield skull clamp was used to secure the head, which was rotated away from the surgeon. The pins were inserted as far posteriorly as possible to allow for a large donor site.

The pericranial/deep temporal fascia free graft was harvested through a C-shaped postauricular incision, which was placed at least 4 cm posterior to the hairline (figure 1). This provided for a large anterior flap, which could be...
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easily retracted to achieve wide exposure of the underlying pericranium and fascia. Anterior and posterior flaps were elevated in the subgaleal plane. All the exposed pericranium in the surgical field was harvested from posterior to anterior and left attached to the deep temporal fascia, a segment of which was also included in the anterior part of the graft. Three small strips of temporal muscle were harvested at the same time. The larger anterior flap was retracted toward the face with the appropriate retractors.

The harvested graft was placed in a sterile saline swab until it was needed for reconstruction (figure 2). The remainder of the procedure was completed in the standard fashion.

Reconstruction began with a thorough irrigation of the surgical site and absolute hemostasis. The muscle strips were used to plug the defect in the posterior canal wall, the atticoantral area, and the vertical portion of the facial canal. A cone-shaped basket (figure 3) was created with the pericranial graft and glued to the edges of the defect with Tisseel. The dura itself was not repaired with sutures.

The hydroxyapatite cement was prepared in accordance with the manufacturer’s recommendation until the substance attained a puttylike consistency. Small cork-like plugs of cement (figure 4) were used to fill the defect from deep to superficial until the level of the cortical bone was reached. The remainder of the defect was filled with a larger piece of cement that was flattened so that its contour matched that of the surrounding skull (figure 5). A piece of Gelfoam large enough to cover the entire cemented area was placed lateral to it (figure 6). This prevented direct contact between the cement and the undersurface of the scalp flap. It is essential that the cement not be soiled by blood or moisture from the surgical site because soiling can cause the cement to fragment into free particles. This maneuver allowed us to replace the flap without having to wait for the cement to solidify.
The incision was closed in two layers with absorbable sutures and staples. A pressure dressing was applied for 48 hours. No drains were placed.

Patients were discharged 1 week after surgery and re-evaluated at 2 weeks, 3 weeks, 3 months, and 6 months postoperatively. At each follow-up visit, patients were asked to assess their reconstruction subjectively. In addition, the neurosurgeon and the neurotologist assessed the status of the surgical site with respect to aesthetic appearance and the presence or absence of both CSF leak and headache, as well as healing and tenderness.

Results
All 10 patients and both members of the surgical team were pleased with the aesthetic appearance. In fact, we felt that the cosmetic outcome was superior to that achieved with abdominal fat graft reconstruction.

No case of CSF leak was recorded, and no patient complained of postoperative headaches.

Only 1 case of local wound discharge was observed. The discharge was caused by a remnant of cement particulate, and the patient responded well to its removal.

All patients were able to sleep on the operated site soon after surgery.

Two patients who had experienced House grade II facial palsy recovered completely. Their paralysis had been related to the removal of their tumor rather than to the cranial reconstruction.

Discussion
Hydroxyapatite cement is a bioactive material that is becoming more widely used for augmenting or replacing lost tissue during the reconstruction of craniofacial defects. Long-term studies have revealed no evidence of implant resorption, encapsulation, inflammation, or foreign body reactions. It is considered to be osteoconductive and osteointegrative.

We believe that our technique offers several distinct advantages over the previously reported techniques with respect to CSF leaks, headaches, and the type of graft material.

CSF leaks. We observed no case of postoperative CSF leak. However, we acknowledge that the size of our series was small and the follow-up was short.

Headaches. In reconstructive cranioplasty, it is commonly believed that postsurgical headaches are caused by the attachment of the dura to the muscle and subcutaneous tissue. The interposition of a pericranial graft between the dura and the hydroxyapatite cement would prevent such adhesions, and we believe that this might prevent postsurgical headaches. This is only conjecture, however, and we plan to study this further.

Graft material. Pericranial material is thin, pliable, readily accessible, and plentiful at the surgical site. Its pliability allows for the creation of the cone-shaped basket that extends down to the dural defect. Pericranial material also conforms well to the contours of the bony defect. The filling of the basket with cement from deep to superficial allows for a watertight repair without sutures. Because there are no holes in the graft basket, the CSF and the cement do not come into contact, and therefore the possibility that the cement will fall intracranially is eliminated. The absence of contact between the CSF and the cement reduces the fragmentation of the cement while it is solidifying.

In conclusion, reconstructive cranioplasty with hydroxyapatite cement and pericranial/deep temporal fascia graft is a technically simple and efficient technique that we found to be effective in achieving satisfactory aesthetic outcomes and in eliminating postoperative CSF leaks and headaches. It also obviates the need for a distant donor site, thereby...
reducing the morbidity associated with traditional reconstructive techniques. Finally, our technique involves the use of a combination of autologous and synthetic materials, which enhances soft-tissue reconstruction and solid repair. Based on our satisfactory experience, we highly recommend this technique. We plan to further study its use in a larger number of patients and with long-term follow-up.

References