Prefabricated acrylic cranial implant for the reconstruction of skull defect: a clinical report

ABSTRACT
Acrylic resin has been used as a substitute for bone in dentistry, neurosurgery, and orthopedic surgery for three decades. Cranial defects resulting from trauma, disease or congenital malformations lead to pain, unesthetic appearance, and anxiety to the patient. Cranioplasty with preformed heat-cured acrylic resin results in a stronger prosthesis, minimal tissue reaction, and marked improvement in esthetics. This article presents a clinical report on the restoration of a cranial defect with a prefabricated acrylic implant, which procedure was not only simple but also cost-effective.

Key words: Methylmethacrylates; Prosthesis and implants; Skull/surgery

Introduction
Cranioplasty is one of the oldest known neurosurgical procedures, dating from the year 3000 B.C., when the Paracas Indians in Peru performed procedures to correct large cranial defects. Across the centuries, many materials have been used for covering bony defects, including coconut shells, bones from both human and non-human donors, metals including gold, silver, tantalum, titanium and more recently, biosynthetic materials such as resins and ceramics 1.

Repair of cranial defects, resulting from trauma, disease, and congenital malformations 2, is indicated to protect underlying brain tissue, provide pain relief at the site, improve cosmesis, and minimize patient’s anxiety 2-4. Most neurosurgeons agree that cranioplasty should be delayed from 6 to 12 months to allow appropriate organization and revascularization of scalp flaps. This delay is critical to ensure absence of infection and the establishment of a mature tissue bed to help prevent further injury to the brain during the procedure 2,4.

Acrylic resin implant has been advocated for cranioplasty because of its ease of use, availability, radiolucency, dimensional stability, chemical inertness, nonconductivity, ease of modification, and low cost. Autopolymerizing acrylic resin may be applied and adapted directly into a cranial defect, using saline irrigation to reduce the heat of polymerization. However, presurgical fabrication of the cranial prosthesis with heat-polymerized acrylic resin is more desirable 1,4. Heat-polymerized resin is 50% stronger than autopolymerizing resin, and contains less than 0.4% residual monomer following a 1-hour terminal boil 6.
It also simplifies the restoration of complex cranial defects, reduces the surgical time needed for implant placement, and decreases the risk of contamination that can occur when large implants are shaped intra-operatively. A preformed implant surface can also be polished, which can further reduce the risk of inflammatory tissue reactions.\textsuperscript{1-5}

Several methods exist for the fabrication of acrylic resin cranial prostheses. Gordon and Blair\textsuperscript{7} advocated making an impression with irreversible hydrocolloid material applied directly on the bone at the time of surgery. Although this reduces marginal discrepancies, the technique delays surgical procedures. A computer-generated model of the defect may be developed and used to fabricate a wax pattern\textsuperscript{2,5,8,9}. Alternatively, if available, a bone flap may be invested, flaked, and duplicated directly. However, computer-generated models are expensive, and the bone flaps with irregular shapes may be difficult to invest and retrieve from the stone mold.\textsuperscript{3}

This article presents a clinical report, in which a less time-consuming and inexpensive method was used to rehabilitate a cranial defect with a preformed heat-cured acrylic resin cranial implant.

**Case report**

In August 2008 a 26-year-old woman was referred to the Department of Prosthodontics and Maxillofacial Prosthetics at the K.L.E.V.K. Institute of Dental Sciences, Belgaum, India, from the department of plastic surgery for the fabrication of cranial implant. The patient had met with a road accident around 1 year ago. There was contusion of her frontal bone extending from the medial one third of the right supra-orbital ridge to 1 cm below the hairline. The patient was treated for evacuation of frontal bone contusion, thereby leaving a bony defect in the forehead.

On examination, the defect extended from medial one third of the right supra-orbital ridge inferiorly, extending on the forehead obliquely, till 1 cm below the hairline on left side. The defect was about 1 cm deep, 2 to 2.5 cm wide, thereby leading to esthetic deformity (Figure 1). Taking into account the advantages, rehabilitation of the defect with a preformed heat-cured acrylic resin implant was opted for.

**Procedure**

The most crucial step for any cranioplasty is proper identification of the defect. Careful palpation was performed to locate the margins, which were marked with an indelible pencil. A facial impression was made to include the defect and surrounding bone with an irreversible hydrocolloid impression material (Figure 2). After placing L-shaped pins, plaster of Paris was applied over the alginate to prevent distortion. When the plaster had set, the impression was removed and poured with dental stone.

The defect was marked on the stone cast and the wax
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pattern fabricated to fit the defect on the stone cast (Figure 3). The contours of the wax pattern were viewed and adjusted from all the angles (frontal, lateral, superior, and inferior) to restore normal anatomy and appearance. The pattern was invested by conventional means and was processed overnight with heat-cured acrylic resin. The prosthesis was deflasked and polished. A No. 8 round bur was used to place holes throughout the implant (Figure 4) to achieve the following: (1) enable accumulated fluid to flow out of the subganglial space and minimize subdural hematoma formation; (2) permit adhesion and migration of connective tissues, which enhances stabilization of the prosthesis; (3) provide an adequate blood supply to the overlying scalp; and (4) allow suturing.

Following this the implant was tried onto the defect to confirm that the contour and margins were acceptable. The implant was then gas-sterilized and degassed 3 days prior to insertion. This was because gas could be a potential source of irritation.

At the time of surgery, a bicoronal incision was designed. This was to prevent any scar formation following surgery. With the sharp dissection the flap was raised, exposing the defect site. Fibrous tissue overlying the defect was freed and the prosthesis was placed in the exposed defect (Figure 5). Marginal discrepancies were noted, and overextensions were marked. The acrylic resin implant was adjusted to fit the defect as closely as possible, and secured with non-resorbable sutures. The defect was then closed. Postoperatively, the patient had good recovery with markedly improved esthetics (Figure 6).

Discussion

Many materials have been used as implants for cranial defects, and their role in cranioplasty has been mainly to replace the missing bone part and improve esthetics of the affected area. Although autogenous bone grafts are the materials of choice for cranioplasties, their acquisition usually requires another incision and discomfort. Bone flaps
also stand the risk of being resorbed, transmitting diseases (from bone bank), and often result in only fair cosmetic outcomes \(^1,11\).

Of the several materials used in cranioplasty, methyl methacrylate and titanium are the most viable current alternatives. However, titanium is expensive, difficult to prefabricate, and hardly affordable by many patients in our environment \(^2,12\). Self- or cold-curing methyl methacrylate can be used directly to fabricate a plastic implant at the time of surgery. This material can cause exothermic reactions, which may damage surrounding tissues and lead to massive subgaleal exudative fluid and infection. This threat of thermonecrosis of tissue exposed to the exothermic curing of methyl methacrylate at the implant site can be eliminated by fabricating a custom acrylic implant, using the wax elimination technique preoperatively \(^1-5\).

**Conclusions**

Prefabricated heat-cured acrylic resin cranial implant constructed from an alginate impression and using the wax elimination technique has several advantages. They include: complete polymerization resulting in non-permeability to body fluids, and assured improvement in physical properties such as compressive, impact, and sheer strength \(^13\). The technology involved is simple and easily accessible. Apart from being affordable, it facilitates shorter operation times and good esthetic results.

**References**