Restoration of Large Cranial Defect for Cranioplasty with Alloplastic Cranial Implant Material: A Case Report

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Abstract Cranial defects result either from trauma or after intentional osteocraniotomies or external decompression craniectomies. These defects occur most frequently during wartime, but their incidence during peacetime, as a result of accident or disease, makes knowledge of cranioplasty useful to the interested practitioner. Most cranial defects will have some variable proportion of cosmetic and mechanical aspects, and the decision regarding cranioplasty must be influenced by the patient’s age, prognosis, activity level and the specific conditions of the scalp and calvarium. This case report is oriented towards post-traumatic restoration of large cranial defect with alloplastic heat-cure poly methyl methacrylate resin material.

Keywords Cranial defect · Alloplastic · Cranioplasty · Cranial implant · Heat-cured poly-methyl methacrylate

Introduction

Cranial defects result from trauma or after intentional osteocraniotomies or external decompression craniectomies [1]. Subsequent cranioplasty is needed to compensate for mechanical vulnerability of the brain, esthetic disfigurement, and transmission of vibrations and pulsation of the brain that cause disconcerting sensations to the patient. Cranioplasty may be required to compensate for the defect and alleviate various signs and symptoms. This case report describes restoration of a cranial defect in a post-traumatic patient with alloplastic heat polymerizing methyl methacrylate resin.

Case Report

A 17-year-old male patient with large cranial defect, reported to the postgraduate clinic with chief complaint of loss of esthetic due to a head injury about 6 years back leading to complex multiple fractures of cranial, orbital and nasal bones. Cranial compression resulted in hemiplegia of the left side that necessitates decompressive cranial surgery. Preoperative the offending piece of frontal, superior border of the orbital rims, and nasal bone had to be removed, and sternocleidomastoid muscle graft was placed for deficiency. Following which, the patient recovered almost completely from hemiplegia. Patient developed swan-neck deformity within 3 years and was kept under regular observation and physiotherapy for the muscle recovery. Five years after normalization, cranioplasty was advised and a protocol was worked out by the neurosurgeon and the prosthodontic team. On examination, the patient was found to have a palpable frontal bone defect and orbital rim margins bilaterally (Fig. 1). Patient was informed about the treatment protocol and written consent was obtained.

For making an impression of the skull, scalp of the patient was shaved, the outer and inner tables of the defect were marked with an indelible pencil and a mark was made on the middle of the head to orient the cast. Beading of the
areas to be recorded was performed with type II impression compound (Fig. 2). Irreversible hydrocolloid (Tropicalgin chromatic, Zhermack, Italy) was mixed vigorously with cold water to extend working time, loaded in a 25 ml disposable syringe and then syringed out over the scalp areas, starting at the highest point to allow the mixture to flow downward and avoid trapping air. Cotton gauze pieces and staple pins were partially embedded into the surface of the partially setting material to lock it with the outer layer of plaster of Paris. After setting, 2–3 layers of quick setting plaster was poured to achieve a firm base of thickness of around 1 cm. After the plaster had set the impression was removed (Fig. 3), and poured in type III dental stone (Kalabhai, Karskarson Pvt. Ltd.) in three layers such that each pour had partially set before the next to avoid compression of the alginate with interlocking of the layers ensured by creating grooves (Fig. 4). The cast was blocked out to its half depth to minimize weight of the prosthesis. The cast was painted with a suitable separating media; molten wax was poured into the defect for the fabrication of a wax pattern. The outer contour of the wax pattern was confirmed with the skull of same age. A 7–8 mm lip of wax was created on unaltered outer table of defect to ensure proper fit of prosthesis. Wax pattern was carved out from inside to simulate the thickness of the bone. The wax pattern was retrieved, invested, heat cured with polymethyl methacrylate (DPI-heat cure, Dental Products of India Ltd., India), trimmed and polished conventionally. The implant was then perforated using no. 8 round bur, to prevent fluid accumulation beneath the prosthesis, to ensure growth of fibrous connective to assist in stabilization and holes around edges were countersunk on external surface to allow placement of twisted wire ends (Fig. 5).
Sterilization of implant was done by ethylene oxide gas at room temperature for 48 hours followed by aeration for 24 hours.

Surgical Placement

Preoperative, after reflection of flap and exposure of the bony defect, bone wax was used as a pressure indicating paste to identify portions of the implant that were preventing proper seating. Points of premature contacts were removed either by reducing the implant surface or by nibbing the bone. The implant was made to seat in the defect properly and hitching of dura was done to bring dura in close proximity to bone to prevent extradural hematoma formation. Holes were then drilled into the bone using surgical drill bits to secure the implant in place by means of titanium wires, which were twisted into place. The margins of the prosthesis were made in continuity with the bony defect and to restore natural anatomy. Bone-filing was done to reduce any projections or disharmony to obtain smooth one surface without any step. The flap was sutured back into position. Sutures were removed on the seventh postoperative day and the patient was discharged with uneventful healing and completely recovered from symptoms in 6 months (Fig. 6). Inflammatory extrude were drained out with surgical syringe at regular interval to reduce post-operative edema.

Discussion

Implants are of value in cases where the fractured piece of skull is short of fit in the defect because of intractable small pieces, or where the bone got infected. Autogenous bone grafts are not commonly indicated because of complications such as absorption and loss of contour. Alloplastic implant materials like metals, auto-polymerizing and heat polymerizing methyl methacrylate, silicone and polyethylene have been reported [1]. Metals such as titanium, austenite stainless steel, and vitallium carry the advantage of being hard, malleable, and readily available, but their high thermal conductivity may precipitate headaches and other neurological symptoms. Silicones and polyethylene are tissue compatible but their flexibility compromises protection in cranial defects. Auto-polymerizing acrylic resin is relatively inert, strong, noncarcinogenic, readily available in sterilized form, and has poor thermal and electrical conductivity, but it has the disadvantage of exposing the tissue bed to heat of polymerization and monomer. Heat polymerizing acrylic resins overcome the disadvantages of auto-polymerizing acrylic resins and are stronger, rigid, and more inert with good reproduction of contours [1]. Today, 3D modeling is revolutionizing cranioplasty [2] with detailed and accurate reproductions of the human skull possible using computed tomography and stereolithography. Rapid prototyping technology is used for creating intricate structures more accurately, whereby model fabrication is done as a removal process by carving away material from a solid block or sheet.

Local discomfort at the site of cranial defect may be an indication for cranioplasty, which may result particularly in large defects upon rapid movements or periods of exertion and could be precipitated by intracranial tissues coming into contact with bony margins of the defect [3]. Surgical stabilization of the cranial implants can be done either by surgical wires, mini-plates and screws. Vibrations and pulsation of brain may be disconcerting to the patient. Some clinicians believe that the cranial implant “splints”
the brain, decreases its mobility, and thereby relieve the symptoms [4], with correction of esthetic disfigurement [5].

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References

1. Beumer J III, Firtell DN, Curtis TA (1979) Current concepts in cranioplasty. J Prosthet Dent 42:67–77
2. Spence WT (1954) Form fitting cranioplasty. J Neurosurg 11:219–225
3. Fodstadt H, Eksedt J, Friden H (1979) CSF hydrodynamic studies before and after cranioplasty. Acta Neurochir Suppl 28:514–518
4. Timmons RL (1982) Cranial defects and their repair. In: Youmans JR (ed) Neurological surgery, 2nd edn. W.B. Saunders Co., Philadelphia
5. Shaw RC, Thering HR (1975) Reconstruction of cranial defects. Clin Plast Surg 2:539–549