

Reconstruction of Post Traumatic Frontal Bone Depression Using Custom Made Alloplastic PMMA Implant – A Case Report

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Conflicts of Interest: Nil

Abstract

Article discusses about rehabilitation of cranial defect in the right frontal bone region with customised PMMA implant. Patient is a 23-year-old young man who suffered a road accident, and needs rehabilitation for aesthetic reasons. In literature autografts, allografts, and various synthetic biomaterials are comprehensively reviewed. Tho Autologous flaps are most ideal substitute,¹ but after weighing all aspects for present case decision was made to complete the rehabilitation with customised PMMA bone implant. It was observed that good contours were achieved with this technique and patient was satisfied with the cosmetic result.

Keyword: Cranioplasty, Cranial Implant, Skull Defect, Reconstruction, Allograft, Heat Cure Polymethyl Methacrylate Prosthesis.

Introduction

Cranioplasty is surgical intervention for skull defects. The aim of cranioplasty can be repair of skull defect, protective or therapeutic role, relief from psychological drawbacks and increase in social performance.¹ There has been evolution of materials from autologous grafts, allografts and xenografts to a broad spectrum of synthetic materials (metals and acrylics) used for cranioplasty over time.²

Clinical Finding

A 23 years old male patient was referred to the Department of Prosthodontics, NIMS Dental College and Hospital from the Department of Neurosurgery, NIMS Medical college for the management of an acquired cranial defect. Patient underwent road accident in the month of September 2022. The patient was treated immediately with a right frontal craniotomy by the neurosurgeons. Postoperatively it was found that the patient had a bony defect on the right frontal bone. On examination, the defect was found to be 5.5cm × 5.4 cm in size (Fig 1a). As a part of surgical intervention CT and 3D CT were performed (Fig 1b). A custom-made heat-cured acrylic resin cranial prosthesis was planned 3 months later to restore the defect.

Therapeutic Intervention

The construction of any maxillofacial prosthesis with alloplastic material consists of four stages: moulage impression and working cast fabrication, sculpture and formation of the pattern, mould fabrication, and processing of the prosthesis.³ Prior to the surgical intervention patient was clearly explained the procedure and the expected outcomes, and written consent was obtained. Patient preparation for impression was done (Fig 2a), an impression of the defect was made with irreversible hydrocolloid (Dentsply Zelgan Plus irreversible hydrocolloid, India) (Fig 2b). Plaster of Paris was used for reinforcement of the impression material (Fig 2c).

Once the impression material was set, it was removed carefully and poured with dental stone (Kalstone, laboratory stone, Kalabhai, Mumbai, India) to obtain a cast of the defect (Fig 3a). Wax pattern (Hindustan dental product, Hyderabad, India) was fabricated over the contoured cast (Fig 3b).

The contoured wax pattern was then invested in a flask, using plaster of paris. Clear heat cure acrylic resin (Trevalon, denture base materials, Dentsply India) was packed in the mold space obtained after dewaxing and was then cured using a constant temperature water bath at 74 °C for 10 hrs. A long curing cycle was selected in order to reduce the residual monomer content of the cured prosthesis (Fig 4a). Trial of the contoured and polished prosthesis was done on the patient and checked from all the anatomical aspects. The prosthesis was sterilized with ethylene oxide gas prior to the insertion.

The surgical procedure involved the preparation of the scalp with an antiseptic solution and the reflection of the scalp with a bicoronal incision to completely expose the bony margins of the defect (Fig 4b); The prosthesis was fixed by two titanium plates in Y, with three holes and 2.0 system and fixed by cortical screws and six millimetres in length (Fig 4c). Surgical wound closure was done by simple stitch sutures using nylon 3.0 threads (Fig 4d).

Routine procedures for elective surgeries such as prophylactic antimicrobial (2 g of cefazolin via EV for a 48- hour period), analgesics (dipyrone 2 mL via EV, if necessary) anti-inflammatory (tenoxican 20 mg EV at 12x12 hour intervals), antiemetic (bromopride, 2 ml EV every 12 h) and gastric protector (ranitidine at 50 mg EV every 6 hours or if necessary).

Discussion

Cranioplasty is a critical procedure as skull integrity protects the brain. Cranial reconstruction also contributes to the preservation of the esthetic aspects of the head and restores an individual's quality of life.⁴

PMMA is one of the inert materials which best meets most of these requirements.^[5,6] Spence first reported the simple method of intraoperative fabrication of autopolymerizing methyl methacrylate implant in 1954.

Since then, acrylics are most widely used implant materials.^[7,8]

We presented cranioplasty with custom made PMMA bone implant where chairside adjustment was performed and was made to precisely fit the skull defect. Normal skin contours were obtained in the post op CT with fusion of PMMA bone graft (Fig 5). This was a simple and effective method for reconstruction of skull defects. On 1week follow-up (Fig6a, 6b) and 3month follow-up (Fig7a,7b) no postoperative complication was observed and good healing was noted in the presented case.

Although early cranioplasty is preferred in recent year, optimal timing remains a topic of discussion.¹ In a meta-analysis, there was no difference in the chances of developing postoperative infection between early and late cranioplasty.⁹

As modern materials - biomimetic materials used for cranioplasty with more suitable biomechanical properties, better biodegradability, and better osteoconductive. Mineralized collagen bone substitute material is a pioneer of biomimetic concept for repairing cranial bone defects.¹⁰ By means of rapid prototype techniques in translational medicine, customized cranial substitutes could be provided for the patients.¹ The repair of cranial defect seemed to offer patient clear benefits in term of quality of life.

Conclusion

The aim of cranioplasty is not only a cosmetic issue; also, the repair of cranial defects gives relief to psychological drawbacks and increases the social performances. The principal reason that the frontal area is more difficult to manage is its visibility. Patients with a frontal defect may develop mental problems which are only indirectly associated with the defect and more directly related to psychologic trauma of the injury and resultant disfigurement. In the frontal region, however,

even small defects can be obvious. Therefore, cranioplasty becomes more desirable when the patient is able to undergo the procedure.

Case provides clear evidence of possibility of recovery of cognitive, behavioural function after acquired skull defect as a result of trauma, this recovery being partially related to an adequate cranioplasty. The repair of cranial defect seemed to offer patient clear benefits in term of quality of life.

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Legend Figures

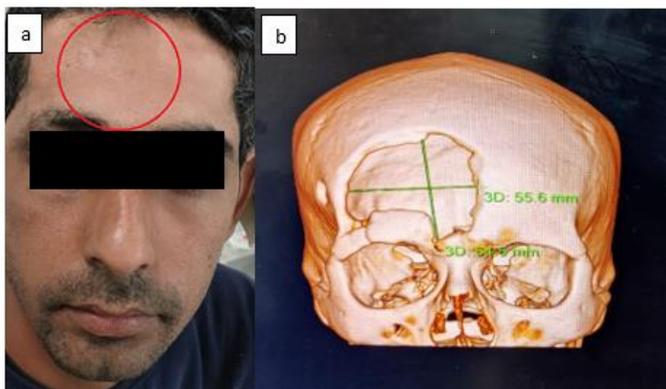


Figure 1: a) Extraoral defect marking, b) Computed tomography 3D, highlighting the limits of bone fracture

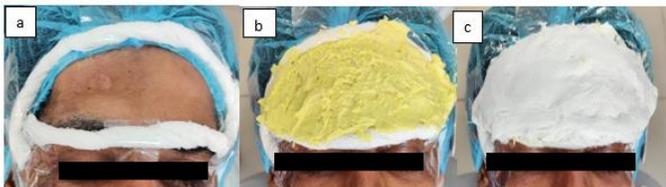


Figure 2: a) Preparation for impression, b) alginate impression c) reinforce with Plaster of Paris

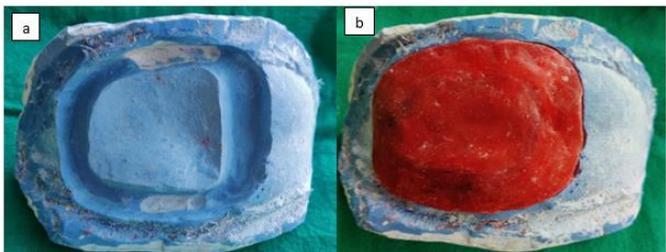


Figure 3: a) Cast, b) adapted wax pattern

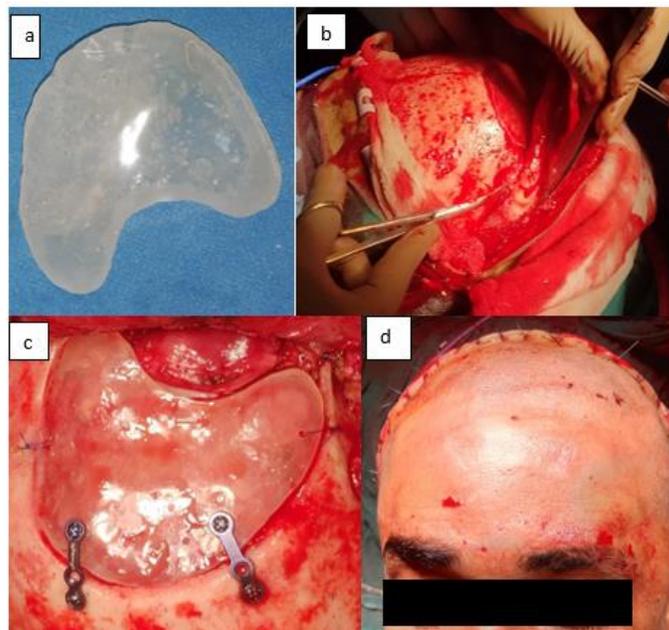


Figure 4: a) Alloplast PMMA implant, b) Derailment and exposure of dura mater, c) adaptation and fixation of the plate by means of two titanium plates, in Y, with three holes and system 2.0 and fixed by cortical screws and six millimeters in length d) Immediate post-op.

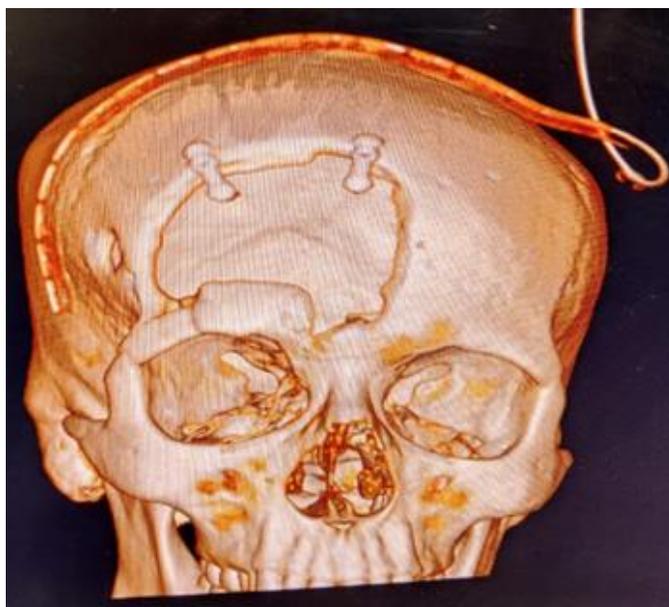


Figure 5: Post-op 3D CT: adaptation with bone edges



Figure 6: a) postoperative photographs on 1 week follow up: profile view, b) frontal view



Figure 7: a) Postoperative 3 month follow up: profile view, b) frontal view with return of the aesthetics and function