Case Report

# Fronto-orbital reconstruction using polymethyl methacrylate implant


## ABSTRACT

The objective of this article is to show a case of fronto-orbital reconstruction with prefabricated polymethyl methacrylate prosthesis. A 35-year-old male with alleged history of trauma following road traffic accident 3 months back reported with unaesthetic scar and deformity in right supraorbital region to us. As there was no functional deformity, the management was aimed at correcting the contour and esthetic only. The correction was achieved by overlaying the defect with a polymethyl methacrylate implant fabricated over a three-dimensional stereolithographically printed rapidly prototyped model. Postoperative phase was uneventful and esthetic outcome was satisfactory. The patient after 4-year follow-up reported with no discomfort and definite improvement in facial contour.



**Keywords:** Fronto-orbital reconstruction, polymethyl methacrylate implant, stereolithographic model


## INTRODUCTION

Fronto-orbital reconstruction is indicated for patients with a skull bone defect. Autografts available are dermal fat grafts, rectus abdominis muscle grafts, and allografts available are bone cements, stainless steel/titanium mesh, silicone implant, and polymethyl methacrylate (PMMA) implant.[1-8] One of the most popular alloplastic materials utilized for this purpose is PMMA, introduced in the 1940s. There is a paradigm shift in prefabrication of PMMA prostheses on gypsum models derived from conventional skin surface level impressions to stereolithographic models from CT scan imaging of the patients' craniofacial defects.[9] Unfortunately, limited economic and logistical resources preclude the extensive use of such technology in the developing and third world countries.

## CASE REPORT

A 35-year-old male patient reported with the complaint of a scar and hollowing on the right side of forehead, following road traffic accident 3 months back. He had received conservative treatment only. On examination, there was a "S-" shaped concavity present at the junction of lateral one-third and medial two-third of right eyebrow extending upward, approximately of about 6 cm × 4 cm in size, in the right lateral forehead [Figure 1a-c]. Computed tomography scan revealed comminuted frontal bone fracture in the right side without any dural tear [Figure 2a-c]. Thus, a cosmetic correction of the defect was planned.

A stereolithographic model of the defect area of the skull was reconstructed. The undercuts were blocked with modeling clay. An impression of addition silicone impression material in light body consistency was made and poured in Type III dental stone. A wax pattern was fabricated with base plate wax so as to provide proper bony contour of the depressed defective area alongside covering the gaping bony defect


**Samiran Ghosh, Debolina Pramanick, Amit Ray, Richi Burman, Ashistaru Saha[1]**

Department of OMFS, Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, [1]Department of Prosthodontics, New Horizon Dental College, Chhattisgarh, India

**Address for correspondence:** Dr. Debolina Pramanick, Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, India.
E-mail: drdebolina.pramanick198@gmail.com



| Access this article online | |
|---|---|
| **Website:** www.njms.in | Quick Response Code |
| **DOI:** 10.4103/njms.NJMS_10_17 | |





**How to cite this article:** Ghosh S, Pramanick D, Ray A, Burman R, Saha A. Fronto-orbital reconstruction using polymethyl methacrylate implant. Natl J Maxillofac Surg 2017;8:153-6.

[Figure 3a and b]. Care was taken to match the external bony contour of the affected region with that of the unaffected contralateral side. The wax pattern was then acrylized with double heat-cured medical grade PMMA of the colorless variety. Due to its less residual monomer, it is supposed to cause least tissue irritation [Figure 3c and d].

Care was taken to gradually blend the margins of the acrylic fabrication with the edges of the defect. Holes were drilled around the edges of the acrylic fabrication and on the surface with a number 8 round bur which would be helpful to secure the prosthesis with screws to the underlying bone. Once satisfactory fit was achieved, the prosthesis was finished and polished and made ready for surgical placement.

Oroendotracheal intubation was done. Coronal flap was elevated. Dissection was done to the pericranium. Disposable Raney clips aid in hemostasis. After definite reflection of the temporal region, the PMMA implant was tried in and was fixed with two 2 mm × 8 mm screws and two 2 mm × 11 mm screws. These screws were placed without damaging the dura. One screw was placed at the edge of the implant while the others were placed at the center. Few holes were kept open for fibrous encapsulation of the implant with the pericranium. Proper flushing of the implant margins with the cranium was ensured before closure. Closure was done in layers [Figure 4a and b].

## DISCUSSION

Cranial defects can be divided into congenital or acquired defects, the latter being the most common due to trauma and the frontal region being the most common site of cranial reconstruction. Small defects, covered by muscle (except in the frontal region), may not require cranioplasties.[10] Neither is it indicated for areas supporting loads. Skull reconstruction techniques are proposed for two clear motives:

1. Esthetic considerations
2. Protection against trauma.

A minimum delay of 3 months is recommended in posttraumatic cases and a minimum of 6 months for cases with local infection to establish chronic antibiotic treatment.[11,12]

Autogenous bone has been historically preferred over alloplastic materials.[13,14] On unavailability of autogenous bone, alloplastic materials are required.[15] The ideal implant material should fit the cranial defect and achieve complete closure, be biocompatible, inert, nonthermal conducting, radiotransparent, nonmagnetic, lightweight, rigid, simple to shape, easily applicable, and inexpensive.[16,17] Nowadays, both titanium and PMMA are the most widely used alloplastic materials.[13,18,19] Reduced surgical time, use of simple technique, and excellent long-term esthetic results [Figures 5 and 6] have still kept PMMA as an option apart from being less expensive, more readily accessible, and easier to handle and contour for specific craniofacial defects.[20,21] PMMA is a biocompatible material used as intraocular lenses, bone cement, and implant as tested by the WHO in association with National Health Systems Resource Centre.[20]

Discovered in 1939, PMMA, the most used biomaterial due to high resistance to external stress, low cost was first used in human by Zander 1940. The tensile strength of PMMA is 47–79 MPa. To withstand forces, the structure, in which it is placed, should have the tensile strength approximately near about the same of itself. Studies have shown tensile strength

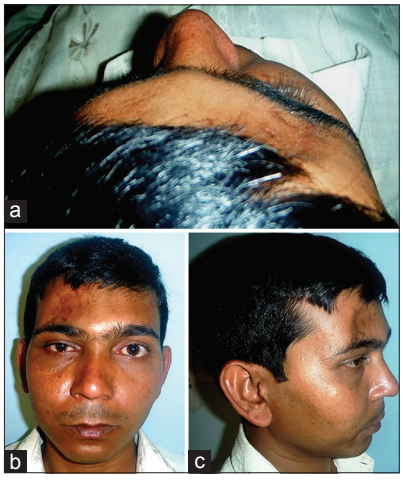


Figure 1: (a) Preoperative bird's eye view. (b) Preoperative frontal view. (c) Preoperative lateral view

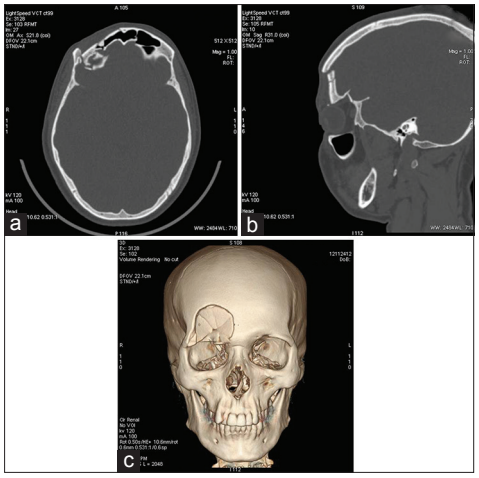


Figure 2: (a) Computed tomography scan showing the defect in axial section, bony window. (b) Computed tomography scan showing the defect in sagittal section, bony window. (c) Three-dimensional computed tomography showing the defect

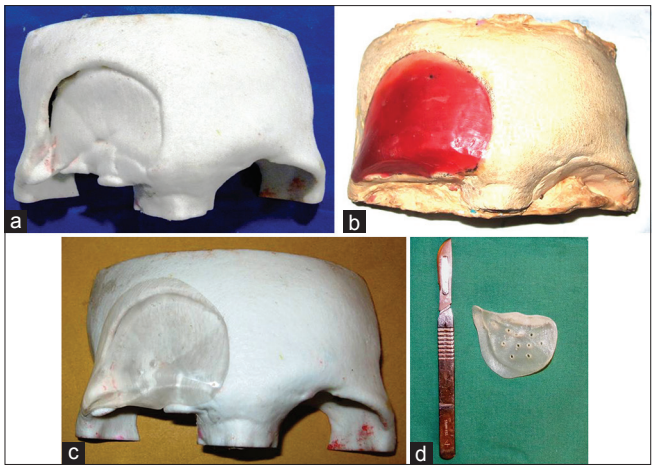

Figure 3: (a) Stereolithographic model showing the defect. (b) Wax pattern fabricated. (c) Polymethyl methacrylate on the stereolithographic model and (d) Polymethyl methacrylate implant

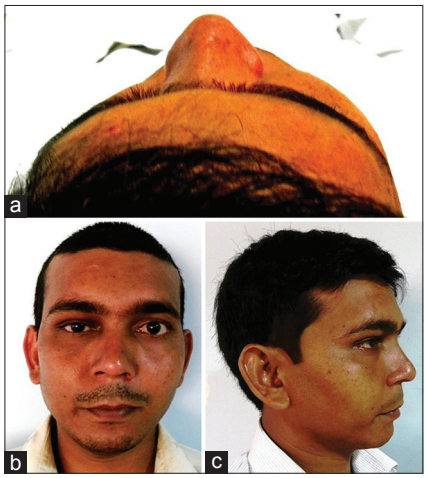

Figure 5: (a) Postoperative frontal view. (b) Postoperative bird's eye view. (c) Postoperative lateral view

of human skull bone is 53 ± 4.9 MPa. Therefore, PMMA has an impact resistance comparable to human skull bones in resisting any normal stress or impact.[22,23]

Hard tissue replacement, a polymer of PMMA polyhydroxymethylmethacrylate, has micropores of 250–300 microns, which allow the initial invasion of fibrovascular tissue. It has a layer of hydrophile on its surface with negative charges that avoids bacterial adhesion and reduces the risk of infection.[2]

Although PMMA is very cost-effective and easily workable material, it cannot be used in stress bearing areas and during the growth phase.

The use of three-dimensional models in oral and maxillofacial surgery significantly improved predictability of clinical outcomes and reduction in operating and wound exposure

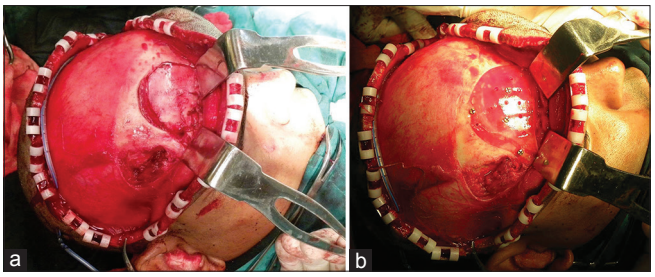

Figure 4: (a) Preoperative exposure of the defect. (b) Placement of the implant

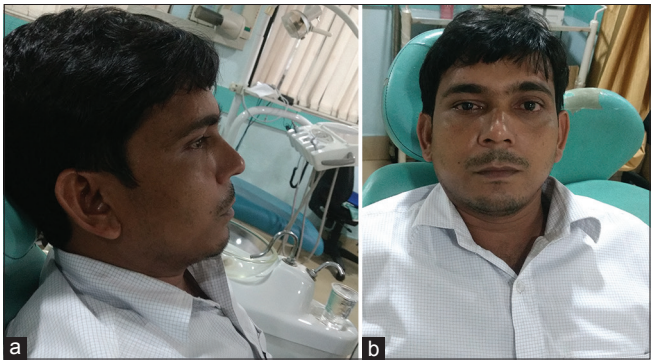

Figure 6: (a) Four-year postoperative lateral view. (b) Four-year postoperative frontal view

time. The models were also useful in the design and fabrication of custom prostheses, sizing of bone grafts, and allowed for manufacturing of scaffolds for bone regeneration.

The sites of screw insertion are to be selected very carefully without any damage to the underlying structure. Stress concentration over the implant is avoided. Flushing of the implant margin is mandatory to eliminate any dead space. The rate of global infection is around 5% according to different studies. However, Manson's[24] series of 42 cranioplasties with methyl methacrylate was completely successful and there were no infections. Patients with simultaneous cranial, orbital, or nasal reconstruction had an infection rate of 23%. The patients that developed implant infection had experienced previous infection of the area where the methyl methacrylate had been placed. This is the material of choice, according to Manson, for those adult patients with good quality soft tissues and with no previous history of local infection. Osseointegration of PMMA increases if submerged in poly-gamma-glutamic acid gel.[25]

The future of cranioplasty materials lies in patient-specific implant. It provides better anatomic fit. Operating time is reduced with satisfying esthetic result. Two biocompatible materials are available - polyetheretherketone and titanium. The main advantage of titanium over PMMA is its soft tissue reaction and better adaptation to the body. However,

weighing the cost-benefit ratio, it does not gain popularity yet in the Indian market.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Ducic Y. Titanium mesh and hydroxyapatite cement cranioplasty: A report of 20 cases. J Oral Maxillofac Surg 2002;60:272-6.
2. Eppley BL. Craniofacial reconstruction with computer-generated HTR patient-matched implants: Use in primary bony tumor excision. J Craniofac Surg 2002;13:650-7.
3. Feith R. Side effects of acrilic cements implanted into bone: A histological, angiografic, fluorescence-microscopic and autoradiografic study in the rabbit femur. Acta Orthop Scand 1975;161:3.
4. Gosain AK, Riordan PA, Song L, Amarante MT, Kalantarian B, Nagy PG, *et al.* A 1-year study of osteoinduction in hydroxyapatite-derived biomaterials in an adult sheep model: Part II. Bioengineering implants to optimize bone replacement in reconstruction of cranial defects. Plast Reconstr Surg 2004;114:1155-63.
5. Hollier LH, Stal S. The use of hydroxyapatite cements in craniofacial surgery. Clin Plast Surg 2004;31:423-8, vi.
6. Janecka IP. New reconstructive technologies in skull base surgery: Role of titanium mesh and porous polyethylene. Arch Otolaryngol Head Neck Surg 2000;126:396-401.
7. Kuttenberger JJ, Hardt N. Long-term results following reconstruction of craniofacial defects with titanium micro-mesh systems. J Craniomaxillofac Surg 2001;29:75-81.
8. Losee JE, Karmacharya J, Gannon FH, Slemp AE, Ong G, Hunenko O, *et al.* Reconstruction of the immature craniofacial skeleton with a carbonated calcium phosphate bone cement: Interaction with bioresorbable mesh. J Craniofac Surg 2003;14:117-24.
9. Abdulai A, Iddrissu M, Dakurah T. Cranioplasty using polymethyl methacrylate implant constructed from an alginate impression and wax elimination technique. Ghana Med J 2006;40:18-21.
10. Sahoo N, Roy ID, Desai AP, Gupta V. Comparative evaluation of autogenous calvarial bone graft and alloplastic materials for secondary reconstruction of cranial defects. J Craniofac Surg 2010;21:79-82.
11. Booth PW, Eppley BL, Schmelzeisen R. Maxillofacial Trauma and Esthetic Facial Reconstruction. 2nd ed. St. Louis, Missouri: Elsevier; 2012.
12. Rodríguez IZ, Aniceto GS, Moreno JJ. Cranial reconstruction with biomaterials. Historical revision and current state. Rev Esp Cir Oral Maxilofac 2007;29:79-89. [©2007 ergon].
13. Marchac D, Greensmith A. Long-term experience with methylmethacrylate cranioplasty in craniofacial surgery. J Plast Reconstr Aesthet Surg 2008;61:744-52.
14. Cho YR, Gosain AK. Biomaterials in craniofacial reconstruction. Clin Plast Surg 2004;31:377-85, v.
15. Moreira-Gonzalez A, Jackson IT, Miyawaki T, Barakat K, DiNick V. Clinical outcome in cranioplasty: Critical review in long-term follow-up. J Craniofac Surg 2003;14:144-53.
16. Blake DP. The use of synthetics in cranioplasty: A clinical review. Mil Med 1994;159:466-9.
17. Chiarini L, Figurelli S, Pollastri G, Torcia E, Ferrari F, Albanese M, *et al.* Cranioplasty using acrylic material: A new technical procedure. J Craniomaxillofac Surg 2004;32:5-9.
18. Sanan A, Haines SJ. Repairing holes in the head: A history of cranioplasty. Neurosurgery 1997;40:588-603.
19. SIMPSON D. Titanium in cranioplasty. J Neurosurg 1965;22:292-3.
20. Lemperle G, Ott H, Charrier U, Hecker J, Lemperle M. PMMA microspheres for intradermal implantation: Part I. Animal research. Ann Plast Surg 1991;26:57-63.
21. Yaszemski MJ. Biomaterials in orthopedics. Boca Raton, Florida: CRC Press; 2003.
22. Roberts JC, Merkle AC, Carneal CM, Voo1 LM, Johannes MS, Paulson JM, *et al*. Original research article published: 24 October, 2013 development of a human cranial bone surrogate for impact studies. Laurel, MD, USA, Baltimore, MD, USA: Applied Physics Laboratory, The Johns Hopkins University, The Johns Hopkins University; 2013.
23. Eppley BL. Biomechanical testing of alloplastic PMMA cranioplasty materials. J Craniofac Surg 2005;16:140-3.
24. Manson PN, Crawley WA, Hoopes JE. Frontal cranioplasty: Risk factors and choice of cranial vault reconstructive material. Plast Reconstr Surg 1986;77:888-904.
25. Dean D, Topham NS, Rimnac C, Mikos AG, Goldberg DP, Jepsen K, *et al.* Osseointegration of preformed polymethylmethacrylate craniofacial prostheses coated with bone marrow-impregnated poly (DL-lactic-co-glycolic acid) foam. Plast Reconstr Surg 1999;104:705-12.