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RESEARCH ARTICLE

VERSATILITY OF POLYMETHYLMETHACRYLATE (PMMA) IN SECONDARY CORRECTION OF POST-TRAUMATIC FRONTO-ORBITAL DEFECTS

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ABSTRACT

The Objective of this study is to show the versatility of polymethylmethacrylate (PMMA) in secondary correction of craniofacial defects. The goal of secondary correction is permanent cerebral protection in an esthetically acceptable fashion. Reconstruction of cranial defects can be performed with several different materials and methods. Alloplastic materials, such as poly eth-methacrylate, is an alternative frequently used at our institution. We have shown cased case reports of 4 patients who has underwent secondary correction using polymethylmethacrylate. We have show cased case reports of who have underwent the use of intraoperative fabricated PMMA and prefabricated PMMA. Three patients underwent intraoperative fabricated PMMA correction while one had prefabricated PMMA. The esthetic results and post-surgical outcome were excellent. All though recent advances in CAD/CAM assisted implants have come, PMMA has proved to be cost-effective and highly versatile when it comes to surgical correction of craniofacial skeleton.

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INTRODUCTION

Reconstruction of post traumatic Fronto-Orbital defects is a challenge for a surgeon as far as the selection of material/ method for reconstruction. The options ranges from autogenous bone grafts to CAD/CAM stimulated alloplastic Implants. Each method has its own advantages and disadvantages. First introduced by Zander in 1940, PMMA is an alloplastic material available for repair of bone defects. This material can be fabricated intraoperative and can also be prefabricated. This case reports show case the versatility of this material in reconstruction fronto-orbital defects. Several alternative substances have been proposed in the literature throughout the years. Apart from autogenous bone grafts alloplastic options include calcium phosphate bone cement, PMMA, polyethylene or polydioxanone sheets, hydroxyapatite blocks, and titanium mesh. The 7 proposed characteristics of an ideal material for cranial defect correction are that it 1) is available, 2) is biocompatible, 3) reproduces skull contour, 4) provides cerebral protection,5) has osteogenic potential, 6) is compatible with imaging, and 7) avoids donor site problems (Rawlings, 1988; Solheim, 1992; Yamashima, 1989). PMMA is an alternative frequently used at our institution. This inert, inexpensive material fills all the goals of an ideal cranioplasty material with the exception of osteogenic potential. Complications of acrylic cranioplasty have been reported in the literature with varying results (Chang, 2010; D'Urso, 2000; Foustanos, 1983; Goh, 2010; Marchac, 2008; Moreira-Gonzalez, 2003; Sahoo, 2010; Stephens, 2010; Van Gool, 1985). This paper is a specific review of reconstruction of fronto-orbital region with prefabricated and intraoperative fabricated PMMA. Many surgeons have used the technique of intraoperative fabrication of PMMA. This technique is more widely used for small skull defects. Intraoperative fabrication of PMMA has several inherent disadvantages. Firstly, this requires more intraoperative time to fashion the implant, shape it, and allow it to cure. Secondly, the surface characteristics are rough compared with a polished preformed implant. Lastly, preformed fabrication of the implant can allow the technician to place multiple small holes to allow fluid exchange and tissue integration as necessary. However, small defects, intraoperative fabrication of PMMA is a straightforward and time-tested technique.

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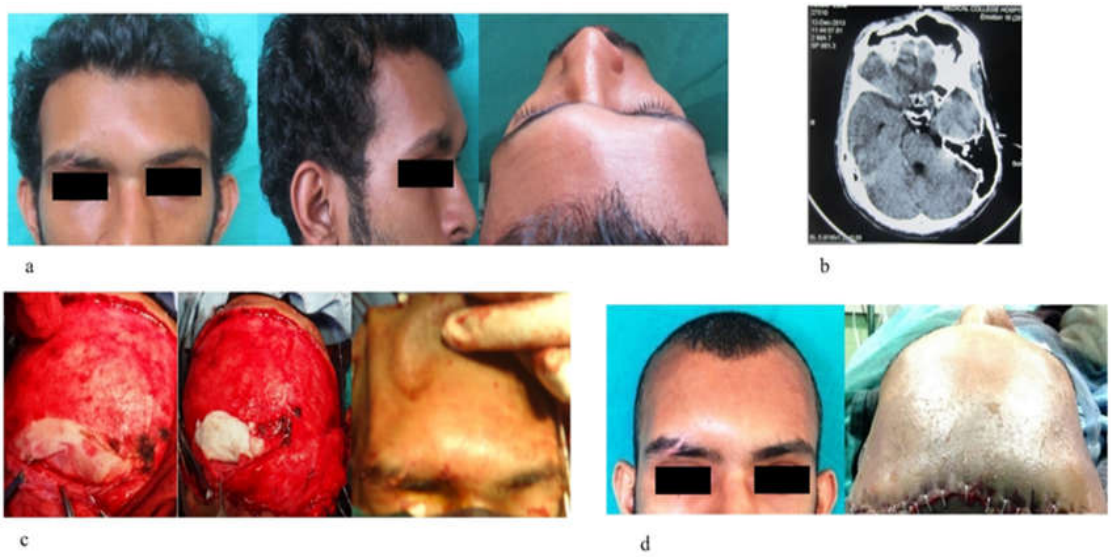

a b c d

Fig 1: Case 1. a. pre-op photographs , b. pre-op CT, c. intra- Op photographs, d. post-op photographs

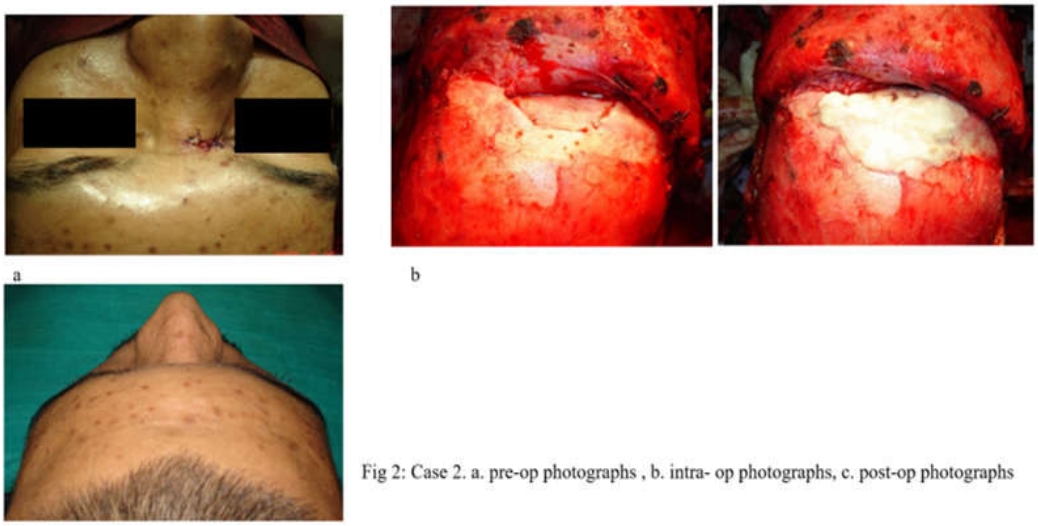

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Fig 2: Case 2. a. pre-op photographs , b. intra- op photographs, c. post-op photographs

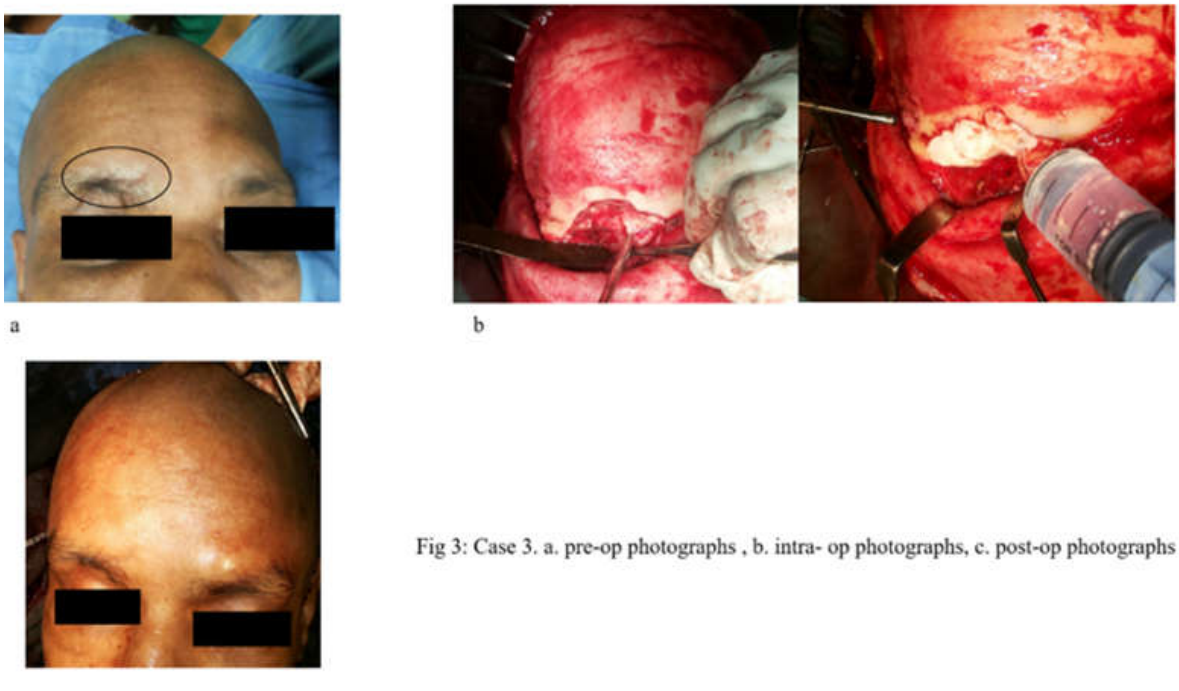

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Fig 3: Case 3. a. pre-op photographs , b. intra- op photographs, c. post-op photographs

MATERIALS AND METHOD

Four cases which reported to department between 2013 -2015 with fron to - orbital defect following trauma was treated with PMMA were selected. All cases had reported for a secondary correction since there was a delay in presentation to department following trauma. There was a time delay ranging more than 1 to 4 months from the time of initial trauma in operating. For three cases intraoperative fabricated PMMA were used, while one case was corrected using prefabricated PMMA. All cases had associated anterior table of frontal sinus fracture and one case having posterior table fracture along with a fronto-orbital skull defect. All cases were operated under general anesthesia with a bicoronal approach to the site.

Defect was corrected with PMMA. Manual contouring of the cement before setting was done and copious saline irrigation given to counter the exothermic reaction.

CASE 2 (INTRAOPERATIVE PMMA)

A 21-year-old male patient presented to dept for correction of defect of fronto-orbital defect following an RTA. The defect had involved anterior wall of frontal sinus extending to left supraorbital rim. Bicoronal approach followed by intraoperative fabrication of PMMA was done for correction.

CASE 3 (INTRAOPERATIVE PMMA)

A 34-year-old male patient presented to dept for correction of defect of fronto-orbital defect following an RTA.

Fig 4: Case 4. a. pre-op photographs , b. pre-op CT, c. fabrication of prefabricated PMMA d. intra- op photographs, e. post-op photographs

Case Reports

CASE 1 (Intraoperative fabricated PMMA)

A 23-year-old male patient had reported with a history of RTA 2 months back. He had suffered from a fracture of anterior table of frontal sinus extending to right orbital rim. No trauma related intracranial pathology was present. Surgical approach through a bicoronal incision was done.

The defect had frontal bone fracture in relation to right supraorbital rim. Bicoronal approach followed by intraoperative fabrication of PMMA was done for correction.

CASE 4 (PREFABRICATED PMMA)

A male patient of age 21 was referred to department of OMFS for an opinion regarding reconstruction option for a cranioplasty involving right fronto-orbital region.

Patient had met with an RTA 4 months back and had suffered from an open comminuted fracture right fronto-orbital region. Neurosurgical intervention was done and debridement and dural repair was done. Patient had a leaf shaped defect in relation to right fronto-orbital region of size 8cm X 7cm X 4cm. A large cranial defect was associated with the supraorbital rim defect. A prefabricated PMMA was planned for correction of the defect. The maxillofacial prosthetist made an alginate impression of the patient's defect. The alginate impression was then poured up in type III yellow stone and a wax template was created to reconstruct the skull. Titanium miniplates were incorporated into the wax template. The template was then placed into a metal acrylic-processing flask. Additional stone was added around the wax template. A separator was applied between the 2 halves of the flask. This wax was then boiled out, and the separator was placed on both halves of stone to prevent adherence of the acrylic to the stone. Heat processed PMMA, which is processed in the flask for 22 hours at 160 degrees Fahrenheit, was then added. The acrylic cranioplasty was removed, trimmed, and polished. Holes were placed in the cranioplasty at random intervals to allow for tissue ingrowth. Once sterilized, the implant was ready for use.

DISCUSSION

Reconstruction of cranial defects using preformed PMMA cranioplasties have a good cosmetic outcome, as none of our patients reported any unsatisfactory cosmetic result. Complications of secondary correction of frontal sinus fracture are best avoided by this method. In 2003, Moreira-Gonzalez et al. (2003) in one of the largest recent reviews of autogenous bone repair, saw an overall complication rate of 21% and an infection rate of 7% in 312 procedures. This study also included analysis of 75 PMMA and 58 hydroxyapatite cement cranioplasties, in which they saw an infection rate of 13% and 22%, respectively.

They stated that the best outcome was achieved with use of PMMA, followed by autogenous bone, and then hydroxyapatite cement. This was due to the 32% incidence of bone resorption, contour irregularities, and an unacceptable cosmetic result that occurred with autogenous bone. They concluded that autogenous bone was the most reliable, safe, and cost-effective material, despite the resorption, and that bone grafts and PMMA are the best materials for calvarial reconstruction.

In 2013 Joby Jaberi et al. (2013) has studied Long-Term Clinical Outcome Analysis of PMMA Cranioplasty for Large Skull Defects. The results of previous studies have shown that infection and complication rates of cranioplasties accomplished with bone cement are substantially higher, that titanium-based implants may obscure follow-up imaging for tumor patients, and that the outcomes regarding hydroxyapatite-based ceramics, although similar to PMMA, are associated with a much higher cost. PMMA remains a cost-effective and proven method to repair cranial defects that fulfills the goals of cranial reconstruction for skull defects.

Conclusion

PMMA during earlier years of cranial vault reconstruction was a safe and effective method for providing contour and cranial protection to the brain when autogenous bone was not used. Subsequently, the development of bone cement materials was thought to provide a similar functional and esthetic outcome; however, the predictability was questionable and many surgeons ran into difficulty with failure of the material and erosion through the scalp. In our view, preformed PMMA correction provides a safe, affordable, cosmetically acceptable alternative for fronto-orbital repair.

Smaller Defect with no intracranial communication can be corrected using intraoperative fabricated PMMA. While larger defects and those requiring a cranioplasty can be corrected using prefabricated PMMA. Availability of a skilled maxillofacial prosthetic technician is needed to ensure fabrication in a timely manner. The esthetic results and post-surgical outcome were excellent in all cases with an advantage of less operative time, no donor site morbidity, simpler procedure when compared to autogenous grafting.

Conflict of Interest: None.

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List of Abbreviations:

PMMA: Polymethylmethacrylate

CAD/CAM: Computer aided designing/ computer aided milling

RTA: Road traffic accident

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