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CASE REPORT

Cranioplasty with custom made alloplastic prosthetic implant: A case report

Lokendra Gupta, IN Aparna, Dhanasekar Balakrishnan, Lingeshwar Deenadayalan, Puneeth Hegde, Priyanka Agarwal

Lokendra Gupta, IN Aparna, Dhanasekar Balakrishnan, Puneeth Hegde, Department of Prosthodontics, Manipal College of Dental Sciences, Manipal 576104, India
Lingeshwar Deenadayalan, Flat No. 5 Purushotam Flat No. 64, Second Main, Gandhi Nagar, Chennai 20, India
Priyanka Agarwal, Department of Pedodontics, Manipal College of Dental Sciences, Manipal 576104, India
Author contributions: Agarwal P helping in manuscript preparation; Gupta L, Aparna IN and Balakrishnan D contributed to devise the treatment planning and prosthesis fabrication; Deenadayalan L and Hegde P helped Neurosurgeons for prosthesis adjustment and fitting, during surgical rehabilitation.
Correspondence to: Dr. Lokendra Gupta, Assistant Professor, Department of Prosthodontics, Manipal College of Dental Sciences, Karnataka, Manipal 576104, India. lokinse@gmail.com
Telephone: +91-820-2922183
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Abstract

Cranial defects often occur due to trauma. The treatment of such defects is a challenge to the skill and knowledge of the practitioner. This article presents one such case, where a 15-year-old boy had suffered extensive loss of the right cranium following a road traffic accident. The patient required rehabilitation of the right fronto-temporal cranial anatomy and was managed using a custom made heat polymerized acrylic alloplastic implant.

Key words: Cranioplasty; Cranial implant; Acquired defect; Heat cure poly methyl methacrylate resin

Core tip: Prefabricated heat-polymerized acrylic prosthesis, offers the benefits of reducing the tissues to residual monomer or the heat of polymerization. The other advantages are low content of residual monomer in prosthesis because of long curing cycle and prolonged immersion in water. Old orthopantomogram films were used during impression. It is an easy and economical method for recording the defect. In order to reduce the bulk of the prosthesis, the defect area was contoured with plaster. After try in, the wax pattern was covered with an aluminum foil, to check the contour radiographically. Gutta percha points were incorporated as radiopaque marker.

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INTRODUCTION

The loss of a body part reflects significantly on a patient's life. Not only does it have a huge influence on their physical and mental state, it makes social integration difficult; often dampening their expectations to return to normalcy.

Cranial defects may result from trauma, disease or due to congenital malformations. Repair of cranial defects is indicated to protect the underlying brain tissue, provide pain relief at the defect site, improve aesthetics and minimize patient anxiety[1,2]. Humans lack the ability to regenerate a lost body part, but reconstruction can be achieved through prosthetic means and a multidisciplinary approach.

Cranioplasty is one of the oldest known neurosurgical procedures, dating back to 3000 B. C.[3,4]. For centuries, various materials have been tried for covering bony de-

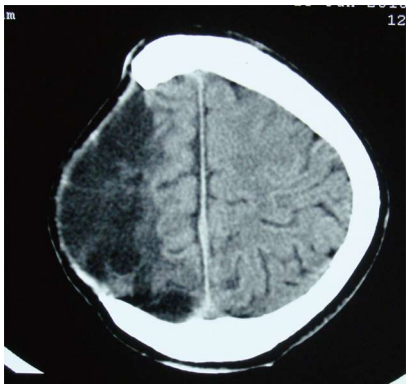

Figure 1 Computed tomography scan showing right cranial defect.

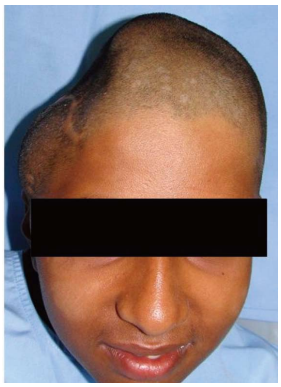

Figure 2 Frontal view of the cranial defect.

fects, including coconut shells, bones from both human and non-human donors, metals[5,6] and more recently, biosynthetic materials such as resins and ceramics.

Cranioplasty can be performed using a range of procedures. When plastic materials are used, the main requirement for an effective cranioplasty, is the preoperative shaping of the implant to fit the bony defect precisely[7]. Acrylic cranioplasty is frequently used for patients who have a cranial defect after trauma or an infected craniotomy or meningiomas[8,9]. Two basic methods of cranioplasty are widely accepted - osteoplastic reconstruction and restoration with alloplastic material. This article describes a patient whose cranial defect has been restored with a prefabricated acrylic resin prosthesis.

CASE REPORT

A 15 years old male patient was referred to the Department of Prosthodontics, from the Department of Neurosurgery for the management of an acquired cranial defect. The patient had a significant medical history of a road traffic accident (RTA), resulting in an open head injury with right temporo-parietal contusion and a fracture of the squamous part of the temporal bone. The patient was treated immediately with a right fronto-temporo parietal craniotomy by the neurosurgeons (Figure 1). Postoperatively it was found that the patient had a lateral hemiplegia on the left side and a large bony defect on the

Figure 3 Patient preparation before impression making.

right side of the skull (Figure 2). On examination, the defect was found to be 15 cm × 12 cm in size. The defect that was to be restored was large and a CAD/CAM or a metal prosthesis would have been the most probable option, but considering the economic background of the patient, a custom-made heat-cured acrylic resin cranial prosthesis was planned.

Procedure

The construction of any maxillofacial prosthesis with alloplastic material consists of four stages, each of which is equally important to the success of the rehabilitation effort. These stages include moulage impression and working cast fabrication, Sculpture and formation of the pattern, mould fabrication, and processing of the prosthesis[10]. Patch testing for acrylic was done prior to the prosthesis fabrication to rule out any acrylic allergy[11]. (1) The patient preparation for impression was done by covering the eye and the external auditory meatus with gauze to prevent the ingress of material into the palpebral fissure and the ear canal respectively (Figure 3): (2) Because of the large defect, old orthopantomograms were used as a tray, to confine the impression material during the impression procedure; (3) The defect was outlined and an impression of the defect was made with irreversible hydrocolloid (Dentsply Zelgan Plus irreversible hydrocolloid, India). L-shaped paper clips were inserted for the stabilization of plaster of Paris which was used for reinforcement of the impression material; (4) 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 (Figure 4); (5) The outline of the defect was marked for the fabrication of onlay type of cranial prosthesis. The marked stone cast was contoured with plaster of Paris so as to obtain the arbitrary shape of the cranium, and a wax pattern (Hindustan dental product, Hyderabad, India) was fabricated over the contoured cast. The wax pattern was then tried on the patient (Figure 5); (6) The contour of the wax pattern was corrected from all sides viz. the frontal, sagittal and occipital, to restore the normal contour and appearance. After the try-in of the wax pattern on the defect, the contours were verified radio-

Figure 4 Tissue surface of the impression with defect marking.

Figure 6 Radiographic verification of the wax pattern.

Figure 5 Wax pattern try in.

Figure 7 Try in of final heat cure alloplastic cranial implant.

graphically, by covering the wax pattern with aluminum foil. (Caremate Aluminium foil, Maharashtra India) (Figure 6); (7) The contoured wax pattern was then invested in a maxillofacial flask, using plaster of paris. It was dewaxed using boiling water for 4 min[12]; (8) Following this, clear heat cure acrylic resin (Trevalon, denture base materials, Dentsply India) was packed in the mold space and was then cured using a constant temperature water bath at 74 ℃ for 10 h[13]. A long curing cycle was selected in order to reduce the residual monomer content of the cured prosthesis; (9) The processed prosthesis was removed from the flask carefully. The excess was trimmed and the prosthesis was polished, using pumice and cotton buff. Trial of the contoured and polished prosthesis was done on the patient and checked from all the anatomical aspects (the frontal, sagittal and occipital) (Figure 7); (10) The prosthesis was sterilized with ethylene oxide gas prior to the insertion; (11) The surgical procedure involved the preparation of the scalp with an antiseptic solution and the reflection of the scalp with a U shaped incision to completely expose the bony margins of the defect; (12) Adjustment of the prosthesis was done with an acrylic trimmer so as to fit as closely as possible in the cranial defect. The prosthesis was then secured with titanium plates and screws (Surgiwear, Sharjahanpur, India) to the surrounding bony margins and the defect was then closed (Figure 8); (13) The closed system suction drain (Hemovac, Zimmer United States) was placed immediately after the surgery to reduce the postoperative hematoma; (14) The drain was removed on the 2nd postoperative day and the patient had a good recovery (Figures 9 and 10); (15) The patient and parents were instructed for the care of the reconstructed area; and (16) During the follow-up visits (6 mo, 1 year and 1½ years), the contour of the defect was satisfactory from all the anatomical aspects (Figures 11-13).

DISCUSSION

Cranioplasties have been performed since the early 1950s[10]. Acrylic resin materials have been used as bone substitutes in dentistry, neurosurgery and orthopedic surgery for decades. Interest in acrylic resins among neurosurgeons increased considerably following Spence's 1954 report of a simple method for fabricating implants at the time of surgery, using auto polymerizing methyl methacrylate[14]. Acrylic implants are dimensionally stable, non-conductive, inexpensive, and can be easily modified and placed[15]. Acrylic resin has some advantages over metal substances; it is easy to shape, lighter in weight, radiates less heat, and radiolucent[16]. In a study, Kumar *et al*[17] in 2011, have proved that large defects, like war defects, can be successfully restored with alloplastic materials. A prefabricated implant can save valuable time in the operating room and better cosmetic results can be achieved, since any adjustments required can be made before the patient

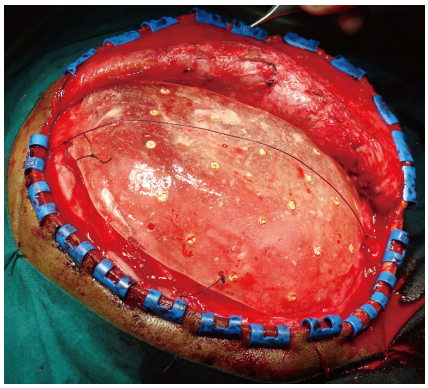

Figure 8 Placement and suturing of the final prosthesis.

Figure 11 Restored cranial defect.

Figure 9 Post-operative postero-anterior view.

Figure 12 Frontal view of the restored cranial defect.

Figure 10 Post-operative lateral view.

Figure 13 Follow up frontal profile.

undergoes surgery. Fabricating cranial implants before surgery, using moulds and heat-polymerized methyl methacrylate, offers the benefits of using auto polymerizing acrylic resin, without exposing the tissues to residual monomer or the heat of polymerization[18,19]. Heat-polymerized resin is 50% stronger than auto polymerizing resin[20] and contains less than 0.3% residual monomer. Excess free monomer is removed because of the long curing cycle and preparation before implantation. Apart from these advantages, in the present case report, old orthopantomogram films were used during impression. This was an easy and economical method for recording the defect. In order to reduce the bulk of the prosthesis, the defect area of the master cast was contoured with plaster. After try in, the wax pattern was covered with an aluminum foil, which made it possible to check the contour of the prosthesis radiographically. Gutta percha points were incorporated in the final PMMA prosthesis so as to serve as a radiopaque marker. A patch test was performed to rule out any allergic reactions to PMMA. Lee *et al*[21] in 2009 suggested that the infection rate associated with prefabricated PMMA prostheses was lower than that for intra-operatively molded PMMA prostheses and was comparable to that for auto graft bone flaps. Complications such as swelling, infection[18,22] headache, hemianopia were not seen during the follow up period

of one and a half years duration for the same patient Other complications such as implant mobilisation[23] were also not reported by the patient. Recently, CAD CAM generated cranial prostheses or titanium plates have been introduced for a precise fit[24-28] however, the high cost of these prostheses makes their use rare in patients, due to economic reasons.

Prefabricated custom made craniofacial prostheses simplify the restoration of complex cranial defects, reduce the surgical time necessary for implant placement and decrease the risk of contamination that can occur when large implants are shaped intraoperatively. Cranioplasty with prefabricated poly-methyl methacrylate prosthesis is inexpensive and enables shorter operative time with good esthetic results.

COMMENTS

Case characteristic

Patient had a lateral hemiplegia on the left side and a large bony defect on the right side of the skull.

Clinical diagnosis

Fifteen cm × 12 cm size cranial defect after right fronto-temporo parietal craniotomy.

Imaging diagnosis

Computed tomography, Orthopantomogram showed right fronto-temporo parietal craniotomy defect

Treatment

Prosthetic rehabilitation of the cranial defect with custom made alloplastic heat cure acrylic implant.

Related reports

A 15 years old male patient was referred to the Department of Prosthodontics, from the Department of Neurosurgery for the management of an acquired cranial defect. The patient had a significant medical history of a road traffic accident (RTA), resulting in an open head injury with right temporo-parietal contusion and a fracture of the squamous part of the temporal bone. The patient was treated immediately with a right fronto-temporo parietal craniotomy by the neurosurgeons. Post-operatively it was found that the patient had a lateral hemiplegia on the left side and a large bony defect on the right side of the skull. On examination, the defect was found to be 15 cm × 12 cm in size. The defect was restored with a custom-made heat-cured acrylic resin cranial prosthesis.

Term explanation

Craniotomy-surgical removal of a portion of the skull. Cranioplasty is a surgical repair of a defect or deformity of a skull. Alloplastic: graft of a relatively inert synthetic material. Generally metal, ceramic or polymeric material. Facial Moulage: face impression

Innovations and breakthroughs

A prefabricated implant can save valuable time in the operating room and better cosmetic results can be achieved. Fabricating cranial implants before surgery, using moulds and heat-polymerized methyl methacrylate, offers the benefits of using auto polymerizing acrylic resin, without exposing the tissues to residual monomer or the heat of polymerization. Heat-polymerized resin is 50% stronger than auto polymerizing resin and contains less than 0.3% residual monomer. Excess free monomer is removed because of the long curing cycle and preparation before implantation. In the present case report, old orthopantomogram films were used during impression. This was an easy and economical method for recording the defect. In order to reduce the bulk of the prosthesis, the defect area of the master cast was contoured with plaster. After try in, the wax pattern was covered with an aluminum foil, which made it possible to check the contour of the prosthesis radiographically. Gutta percha points were incorporated in the final PMMA prosthesis so as to serve as a radiopaque marker.

Peer review

This case report provided a good example of the method being used in clinical practice with 18 mo clinical follow-up. The case is particularly well documented with extensive figures and photographs.

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