The journal of
PROSTHETIC AND IMPLANT DENTISTRY
Official Publication of Indian Prosthodontic Society
Kerala State Branch

REHABILITATION OF ACQUIRED SKULL DEFECT USING CUSTOM MADE TITANIUM CRANIAL PROSTHESIS- CASE REPORT.

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Introduction

Cranioplasty is a surgical intervention utilizing an implant material to repair cranial defects both functionally and aesthetically. The cranial implant not only protects the brain but also provide cosmetic results. The most important advantage of cranioplasty is it improves the neurological deficit by decreasing local intracranial pressure besides improving the dynamics of CSF changes[1]. Cranioplasty can also aid in postural blood regulation, cerebrovascular reserve capacity and glucose metabolism within the brain. This article presents the rehabilitation of a patient with acquired skull defect using custom made titanium implant prosthesis.

Case report

A 32 year old male patient reported to the Department of Prosthodontics, Government Dental College, Kottayam referred from the Department of Neurosurgery Government Medical College, Kottayam for the management of an acquired cranial defect. The patient had a previous history of road traffic accident (RTA), resulting in an open head injury with right temporo-parietal contusion and fracture of the squamous part of 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 lateral hemiplegia on the left side and a large bony defect of 15cm × 12 cm size on the right side of the skull [Fig-1]. It was planned to close the defect using custom made titanium cranial prosthesis.

Procedure

The construction of any maxillofacial prosthesis with an alloplastic material consists of several stages, each of which is equally important to the success of rehabilitation. These stages include moulage impression, working cast fabrication, sculpturing the pattern, mould fabrication and processing of the final prosthesis[2]. Impression procedure was planned at the first scheduled appointment. Patient was instructed to report after shaving off hair from the face and head to facilitate impression procedure. Accuracy of delineating margins of the cranial defect is an important step in impression procedure. This was achieved by palpating the margins of the defect and marking 2-3 mm beyond the outermost borders of the cranial defect using an indelible pencil. Once the margin of the defect was established, modeling wax (MAARC-MODELLING WAX) was adapted along the periphery to limit the flow of irreversible hydrocolloid impression material. (DPI- NEW ALGITEX) [Fig-2]. Petrolatum jelly was painted on the tissue further for ease of removal of impression material. A thin mix of (DPI- NEW

ALGITEX) impression material was then carefully poured onto the defect area taking care to avoid air trap [Fig. 3]. After placing cotton tufts onto the setting impression material, a second pour of lightly mixed plaster of Paris was placed over it to provide support to the impression material [Fig. 4].

Once the impression material was set, it was removed carefully, evaluated and poured with type 3 dental stone (GOLD STONE-GREEN STONE PLASTER) to obtain the master cast. Outline of the defect marked on the tissue which was transferred on the impression was highlighted with indelible pencil, so that this marking could be transferred to master cast, for fabrication of wax pattern [Fig. 5]. The master cast was painted with separating medium for ease of removal of wax pattern.

The design of the final cranial prosthesis was discussed with the neurosurgeons, and the wax pattern was fabricated following the contours of the skull on the master cast. On the second scheduled appointment wax pattern was tried on to evaluate the fit along the margins of the defect. The contour of the wax pattern was corrected from all the three sides(frontal, sagittal and occipital) to restore the normal contour and appearance [Fig. 6]. A titanium cranial prosthesis was fabricated from the wax pattern [Fig. 7]. The patient was again recalled for trial of the custom made titanium


Fig 1


Fig 2


Fig 3


Fig 4


Fig 5


Fig 6


Fig 7

cranial prosthesis to check for shape and fit of the prosthesis from all the anatomical aspects [Figs. 8, 9].

The surgical procedure involved the preparation of 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, titanium screws were used to secure the titanium prosthesis into the exact position and the defect was closed [Figs. 10, 11, 12]. A closed system suction drain was placed immediately after surgery to reduce the postoperative hematoma. The drain was removed after 48 hours following which the patient had a good recovery. The patient and his parents were instructed for the care of the reconstructed area. Post surgically the contour of the defect was satisfactorily reconstructed from all the anatomical aspects.

Besides protection of the underlying brain, the prosthesis helped to repair the contour of the vaults providing satisfactory esthetics [Figs. 13].

Discussion

Cranioplasties have been performed since the early 1950s[1]. Many different types of materials were used throughout the history of cranioplasty. The advancement in biomedical technology, have

Fig 8

Fig 9

Fig 10

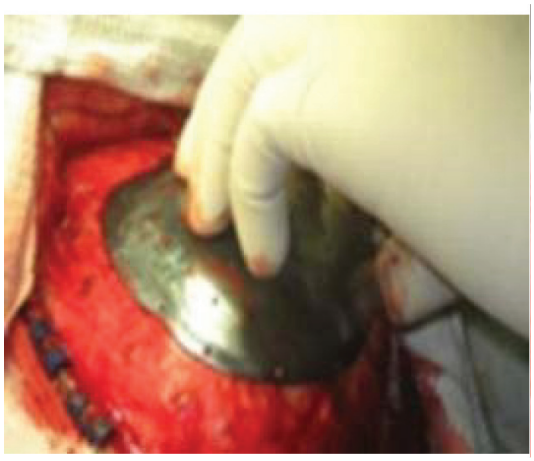

Fig 11

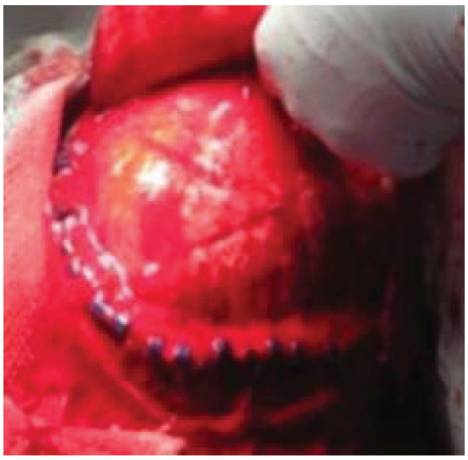

Fig 12

Fig 13

provided new materials for prosthetic rehabilitation

An ideal cranioplasty material must have the following features[5].

1. It must fit the cranial defect and achieve complete closure
2. Radiolucency
3. Resistance to infection
4. Negligible thermal expansion
5. Strong to biomechanical processes
6. Easy to shape
7. Low cost
8. Ready to use

More importantly, a cranioplasty material that fulfills all these characteristics is yet to arrive.

Common materials used in the field of cranioplasty are[4], autografts (cranium, tibia, rib, scapula, fascia, sternum, ilium), allograft, xenograft, nonmetal allograft (celluloids, methyl-methacrylate, hydroxyl apatite, polyethelene,silicon, choral, cortoss, ceramic), metal allograft (aluminium, gold, silver, tantalum, stainless steel, titanium, lead, platinum, vitallium, ticonium) and polyether ether ketone (PEEK) etc.

Developments in endoscopic equipment have given the surgeons the opportunity of minimally invasive cranioplasty technique called endoscopic cranioplasty. With endoscopic tools materials such as acrylic and hydroxyapatite can be administered through small incisions. Although minimal invasiveness is an advantage, there is still lack of evidence from large patient group to support this method.

Interests 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[3]. Advantages of acrylic implants are dimensional stability, non-conductivity, lower cost and ease of modification and placement[4]. However methyl methacrylate can cause exothermic reactions, which may damage the surrounding tissue and lead to subgaleal exudative fluid and infection[6,7]. The major advantages of titanium over methyl methacrylate are low modulus of elasticity, low density and very low rate of corrosion. Besides this it is nontoxic, elicits no inflammatory reactions and has an infection rate under 2%[7,8,9]. Moreover, it is robust enough to resist secondary trauma while providing maximal stability of the cranial vault[5]. Holes of 2mm dimensions were drilled onto the surface of the titanium prosthesis to prevent the development of epidural hematoma and allow for ingrowth of fibrous connective tissue to assist in stabilization. Furthermore, the holes help to secure the prosthesis to the bony defect[10].

Although computer aided design and manufacturing (CAD-CAM) generated titanium cranial prosthesis have been introduced, the cost of this prosthesis is a major concern.

Researches on both biologic and non-biologic substitutes for cranioplasty are going on worldwide. Stem cell experiments and development of morphogenic proteins are expected to take place in the short-term future[4].

Conclusion

Cranioplasty is one of the most common surgeries performed in trauma settings. Rehabilitation of cranial defects using custom made titanium cranial prosthesis will reduce adjustment of prosthesis during the surgery. This case report describes an effective, economical and simple technique for rehabilitation of a person with acquired skull defect using a custom made titanium cranial prosthesis.

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