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Case Series

Custom Made Cranial Prosthesis, Using Craniectomy Bone Flap as Template- A Case Series

Amanda Nadia Ferreira[1]*, Manjita Parab[2], Godwin Clovis Da Costa[1], Meena Aras[3] and Vidya Chitre[4]

[1]Lecturer, Department of Prosthodontics and Crown and Bridge at Goa Dental College and Hospital, Bambolim, Goa, India

[2]Senior Resident, Department of Prosthodontics and Crown and Bridge at Goa Dental College and Hospital, Bambolim, Goa, India

[3]Head of Department. of Prosthodontics and Crown and Bridge at Goa Dental College and Hospital, Bambolim, Goa, India

[4]Professor, Department of Prosthodontics and Crown and Bridge at Goa Dental College and Hospital, Bambolim, Goa, India

***Corresponding Author:** Amanda Nadia Ferreira, Lecturer, Department of Prosthodontics and Crown and Bridge at Goa Dental College and Hospital, Bambolim, Goa, India.

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Abstract

Decompressive craniectomies (DC) warrant future cranioplasties. A wide number of biomaterials are available for this purpose each with their own merits and demerits. Titanium cranioplasty is the most wildly established technique. In this paper we present a novel method for making titanium cranioplasty plates using the craniectomy bone flap as a template.

Keywords: *Cranial implant; Neuroprosthetic Rehabilitation; Titanium; Cranioplasty*

Abbreviation

DC: Decompressive Craniectomy

Introduction

Cranial defects can arise from trauma, disease or congenital malformations. The surgical management and prosthetic rehabilitation of these defects are a challenge to the practitioner. Rehabilitation of cranial defect is essential to minimize patient apprehension, protect the underlying brain, provide pain relief at the site, and improve esthetics [1,2].

Cranioplasty is a surgical procedure to repair the defects in the cranium. It usually is done after a craniectomy or a craniotomy[3]. Different types of materials have been used to repair the cranial defects. This case series presents a simplified technique in the rehabilitation of three patients with an acquired skull defect using custom made titanium prosthesis using the bone flap as a template.

Case Series

Case 1

A 28-year-old female patient reported to the Department of Prosthodontics, with an acquired skull defect following a road traffic accident. The patient was referred from the Department of Neurosurgery, following a decompressive craniectomy (DC). At the time of initial DC, the removed bone flaps were thoroughly irrigated with saline solution, cleaned from tissue debris and cryopreserved in a bone bank.

On examination, a skull defect of 12 x 10 cms was present in the fronto-parietal area of the skull (Figure 1). It was decided to fabricate a titanium cranial prosthesis for rehabilitating the skull defect using the bone flap as a template.

Procedure

The patient's scalp was completely shaved so as to enable the margins of the defect to be palpated.it was then traced with an indelible pencil. The bone flap was inspected and tried on the defect. It was noticed to be approximately 2 mm short at the margins. The thin areas of the bony flap were augmented with wax in the deficient areas so as to approximate the margin defect (Figure 2). The modified bone flap was invested, a mould formed and a pure titanium sheet (medical grade) was used to fabricate a titanium plate (Jayon Implant Pvt Ltd. Lab, Kanjikode, Palakkad, Kerala). Holes (2 mm in diameter) were drilled throughout the plate. The titanium plate was then tried on the patient (Figure 3) and then autoclaved. Under general anesthesia, flap is raised and dissected from the dura. The defect's borders are freed from any adjacent tissue (Figure 4). The prosthesis is put in place and secured utilizing miniplates (CranioPlate). The patient was advised to avoid direct impact on the site of cranioplasty and to maintain the hygiene around the surgical site. Follow up was done at 72 hours, 1 week, 3 months and yearly basis. The patient still showed excellent esthetics at the end of 2 years (Figure 5).

Figure 1: *Case 1: Pre-operative view.*

Figure 2: *Modified bone flap as template.*

Figure 3: *Titanium implant in situ.*

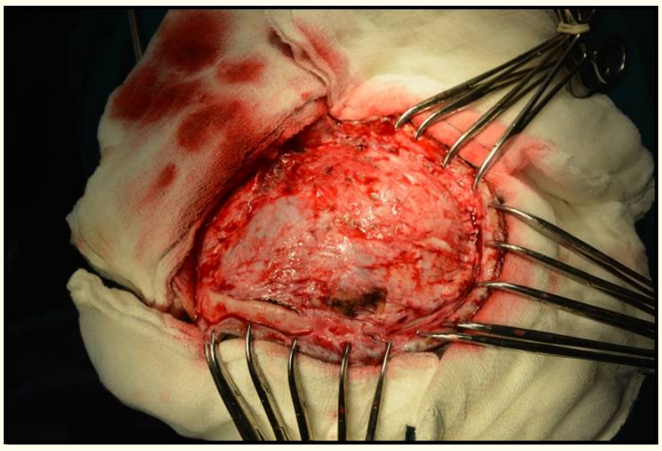

Figure 4: *Neurosurgical placement of titanium implant.*

Figure 5: *Post-operative view.*

Case 2

A 37-year-old male patient reported to the department of prosthodontics for the correction of fronto-parietal defect. A detailed history revealed that the patient had a road traffic accident 1 year back which led to cranial defect of 12 ×10 cms in dimensions (Figure 6). As discussed in the previous case, the original bone flap was used as a template for defect area. Minor augmentations were made using impression compound (Figure 7). The reconstructed template was duplicated in titanium and tried on the patient (Figure 8). The same procedure was carried out, as described in the previous case. The patient showed excellent esthetics even after 1 year (Figure 9).

Figure 6: *Case 2: Pre-operative view.*

Figure 7: *Modified bone flap as template.*

Figure 8: *Titanium implant in situ.*

Figure 9: *Post-operative view.*

Case 3

A 45-year-old male patient reported to the department of prosthodontics for the correction of a frontal defect. Case history elicited a history of assault and battery one year ago. The cranial defect measured 4 × 5 cms (Figure 10). As discussed in the previous case, the original bone flap was used as a template for the defect area (Figure 11). The reconstructed template was duplicated in titanium. The same procedure was carried out, as described in the previous cases. Patient was followed up after 6 months (Figure 12).

Figure 10: *Case 3: Pre-operative view.*

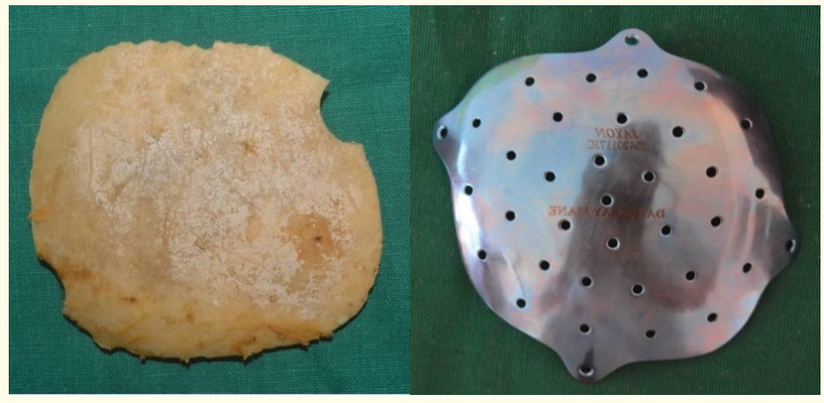

Figure 11: *Bone flap duplicated in titanium.*

Figure 12: *Post operative view*

Discussion

Obtaining good esthetic result during cranioplasty is often challenging. Several materials have been used as cranial implants of which methyl methacrylate and titanium are the most widely used [4]. Compared to methyl methacrylate, titanium is expensive and difficult to pre-fabricate. However, methyl methacrylate can cause exothermic reactions, which may damage the surrounding tissues and lead to subgaleal exudative fluid and infection [5,6]. Titanium has low modulus of elasticity, low density, and a very low rate of corrosion. It is non-toxic, elicits no inflammatory reaction and has an infection rate of under 2% [7]. 2 mm holes were drilled in the titanium implant to reduce the chances of an epidural hematoma, allowed in-growth of fibrous connective tissue to assist in stabilization and permitted escape of underlying fluid and its absorption by the lymphatics of the scalp. The holes were counter sunk on both inner and outer surface to prevent its sharp margins from cutting the retaining sutures. They also help in securing the cranial prosthesis to the bony defect [8]. The fabrication of a cranial prosthesis typically includes various stages such as moulage impression and working cast construction, sculpture and making of the wax pattern, mold fabrication and processing of the prosthesis [2]. When the bone flap is available, one can fabricate the definitive prosthesis as an exact copy of the missing bone. Additional steps such as impression making, working cast construction, and wax pattern fabrication can be avoided. In some instances, when the complete flap may not be available, it can be additionally augmented (in the case of skull fractures, large bone fragments can still be joined together for prosthesis fabrication). Following cranioplasty improvement in electroencephalographic abnormalities, neurological dysfunction, seizures and cerebral blood flow abnormalities have been reported [9].

Conclusion

Custom made titanium cranial prostheses can be fabricated using the bone flap as a template. This simplified technique reduces the prosthesis fabrication time as well as adjustment time during the cranioplasty surgery.

Conflict of Interest

The authors declare no conflict of interest.

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