Cranioplasty: A Single Institute Retrospective Descriptive Study

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Abstract

Introduction: Decompressive craniectomies are among the most common procedures in neurosurgery, performed for conditions such as stroke or trauma. Patients who survive the initial insult require cranioplasty to cover the defect initially created to decrease intra cranial pressure. This study explores the common indication, types and potential complications of cranioplasty.

Materials and Methods: A retrospective descriptive study was performed at a tertiary neurosurgical referral hospital. It included all patients who underwent cranioplasty over a five-year period. Data was collected on the demographics, type of cranioplasty, indication and complications. It was tabulated and studied using Microsoft excel.

Results: Total of 162 patients (67.5%) underwent cranioplasty out of 240 decompressive craniectomies. The patients ranged in age from 12 to 72 years, with twice as many men undergoing cranioplasty compared to women. The most common indication were craniectomies for trauma, followed by ischemic stroke. Acrylic cranioplasty was performed in 110 patients, autologous in 39 and titanium in 4 patients. Infection was the most common complication, occurring in 2.5% of cases, followed by seizure in 1.2%.

Conclusion: Cranioplasty is a common and generally safe procedure for patient who have undergone craniectomies for various conditions. The most frequent complications are infections and seizures.

Key words: Cranioplasty, Craniectomy, Decompressive

Introduction

Decompressive craniectomy is one of the most common neurosurgical procedures performed for cases of trauma and stroke.[1] Not all patient undergoing this procedure survive. The one-year survival rate following decompressive hemicraniectomy can reach up to 73%2, though it is lower for trauma cases, at 49.7%.3 Other indications of decompressive craniectomies include intraoperative brain swelling during procedures such as neurovascular surgery or tumor resection.[4] Also, this procedure is done as a lifesaving procedure. The functional recovery following this procedure is determined by multiple factors.[5]

Decompressive hemicraniectomy is not final procedure as patients who survive this emergency insult to the brain require cranioplasty to cover the skull defect, which can be performed using various types of materials. It can be autologous- bone saved from the patient insitu or in special refrigerators.6 Other material can be polymethylmethacrylate (commonly called acrylic cranioplasty), titanium, ceramic, polyetheretherketone, hydroxyapatite etc.[7]

However, cranioplasty is not without its complications. The most common reported ones are infection, bone resorption, epidural/subdural collection and seizure.[8] This study reviews the various types of cranioplasty performed at a single tertiary referral center and their associated indications.

Methodology

A retrospective descriptive study was conducted at Upendra Devkota Memorial, National Institute of Neurological and Allied Sciences, a tertiary referral neurosurgical hospital. It included all patients who underwent cranioplasty between 2020-2024. Data on demographics, type of cranioplasty, indication and complications were tabulated and studied using Microsoft excel.

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Results

Over the period of study, a total of 240 decompressive craniectomies were performed. Out of these,162 cases (67.5%) underwent cranioplasty. The male-to- female ratio was 2:1. The youngest patient was 12 years old, while the oldest was 72. The mean age was 42.41±14.22. Age distribution is presented in table 1.

Table 1: Age Distribution

Age	Frequency
0-10	1
11-20	8
21-30	28
31-40	42
41-50	35
51-60	28
61-70	18
71-80	2
>80	0
Total	162

The indication and types of decompressive craniectomy in these cranioplasties are shown in table 2 and table 3 respectively.

Table 2: Indication of Decompressive Craniectomy

Indication	Frequency	Percentage
Malignant Infarction	62	38.3%
Hemorrhage/Vascular	19	11.7%
Trauma	71	43.8%
Tumor	10	6.2%

Table 3: Types of Decompressive Craniectomy

Type of Decompressive Craniectomy	Frequency
Frontotemporoparietal	125
Bifrontal	26
Temporoparietal	8
Frontal	3
>80	0
Total	162

The most common material for cranioplasty was acrylic, either 3D printed or hand molded. The types of cranioplasty performed are outlined in Table 4. Also figure 1, 2 and 3 shows autologous, acrylic and titanium cranioplasty respectively.

Table 4: Material of Cranioplasty Performed.

Material for Cranioplasty	Frequency (Percentage)
Acrylic	119 (73.5%)
Autologous	39 (24.0%)
Titanium	4 (2.5%)
Total	162
>80	0
Total	162

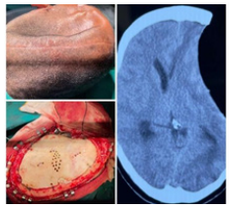

Figure1: Autologous

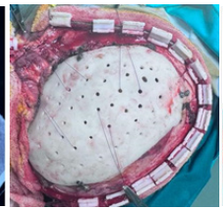

Figure 2: Acrylic

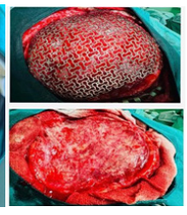

Figure 3. Titanium

The complication rate was 3%. The most common complication was infection, observed in 4 patients (2.5%). Seizures were the second most frequent complication, occurring in 2 patients (1.25%).

Discussion

The survival rates of decompressive craniectomy vary depending on the underlying cause, whether for ischemic or traumatic. In cases of malignant ischemic stroke, the average survival rate is 78%, based on pooled data of three landmark studies in this category, the DECIMAL, HAMLET and DESTINY trials.[9] The average survival rate after decompressive craniectomy for trauma is approximately 70%. [10] The combined overall survival rate for decompressive craniectomies for both trauma and stroke in this study was 67.5%.

The mean age of patients undergoing cranioplasty was 42±14.22 years. This is likely because this age group are better able to overcome the initial insult of stroke or trauma.11 Additionally, relatives of patients in this age group are more inclined to opt for surgery compared to those of elderly patients.[11,12] Male to female ratio in our study was 2:1. Males are more prone to both head injuries and stroke, leading to a higher incidence of cranioplasty if they survive, with roughly double the number of cases compared to females. [12,13] Furthermore, males, are in general, more likely to undergo surgery. [12,13,14]

The type of cranioplasty at our center was influenced by three factors: the availability of autologous stored bone in abdomen, the presence of infection and patient preference. In our study 119 underwent acrylic, 39 underwent autologous and 4 underwent titanium cranioplasty. Typically, for unstable patients with high surgical risk, the bone flap was discarded to shorten the surgical duration of decompressive cranioplasty. In cases of trauma where the bone was open and comminuted, it was also discarded. These patients then underwent acrylic cranioplasty. Initially acrylic cranioplasties were hand molded, but later, with availability of 3D printing technology, these were

printed. While both methods yield similar clinical outcomes, 3D printed cranioplasties offer better cosmetic results.[15,16] In cases where infection occurred at the scalp site after the use of acrylic cranioplasty, titanium cranioplasty was performed in 4 patients. This was done because titanium cranioplasties have a lower risk of infection.[17] However, titanium cranioplasties are more expensive than autologous or acrylic cranioplasty in Nepal and our center. This issue is less common in the West.[18]

Infection requiring removal of the implanted bone flap was seen in 2.5% of patients in our study. The rate can be as high as 12-29%in some studies.19 Our protocol post-surgery is antibiotic coverage for 10 days till sutures are removed. Use of antibiotics to reduce infection is also suggested in similar study.[20]

Seizure occurred in 1.25% of patients in our study, with rates in similar studies ranging from 7-26%.21 Anti-seizure medication is used for at least two years. Similar studies showed decrease in seizure rate without increase in side effect following cranioplasty.[22]

Bone resorption was not seen in our study as we prefer doing autologous cranioplasty as early as 6 weeks of performing craniectomy. Studies show bone resorption is less than 30% if done within 24 weeks of craniectomy.[23]

Collections below the graft in the epidural or subdural space is also listed complication, which was not seen in our study. Also, hydrocephalus following cranioplasty was not present in our case series. This is likely because of we keep swing the cranioplasty flap 2 centimeters from midline. It has been seen than closeness of craniotomy within1cm of midline is independent predictor of hydrocephalus.[24]

Conclusion

Cranioplasty is a common and generally safe procedure for patient who have undergone craniectomies for various condition. The most frequent complications are infections and seizures.

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