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Clinical Article

The experience of cranioplasty outcome, management and its complication in neurosurgery.

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Abstract

Background: Head trauma is the most common case encountered in neurosurgery, and it is on the rise daily; head trauma sometimes requires the removal of skull bone which leads to another set of complications and associated issues related to cranioplasty. The study's objective was to share the single-center tertiary care hospital experience of cranioplasty, including outcomes, management, and associated complications.

Methodology: Patients who underwent reconstructive cranioplasty at the study site from 2015-2020 were examined in this retrospective descriptive study conducted at the department of neurosurgery, Jinnah postgraduate medical center, Karachi. Patients aged 18 to 60 years were considered for cranioplasty procedures, preceded by the decompressive post-craniotomy for brain trauma, skull fracture, intractable intracranial hypertension, brain tumor, and infected post-craniotomy bone flaps were included in the study.

Results: A total of 68 patients who presented to the study center with cranial defects were included in this study. The frequent cause of cranioplasty was the traumatic injury to the brain in 38(55.88%), followed by brain tumors in 321(0.4%) and cerebrovascular injury in 9(13.23%) cases. In our study, no patient required more than one cranial procedure. The anatomical regional wise division of defects was temporal 29(42.64%), frontal 15(22%), and parietal 24(35.39%).

Conclusion: Indications for cranioplasty, type of bone graft, associated comorbidities, and complications have been addressed that are potentially preventable.

Keywords

Cranioplasty, Craniectomy, Decompression, Glasgow Outcome Scale.

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Introduction

Cranioplasty is the procedure used for the closure repair of a bony skull defect which, under given conditions, becomes necessary to save a patient's life leading to the decompressive craniectomy. There are many indications for the such procedure to perform, such as refractory raised intracranial pressure secondary to malignant infarction spontaneous, intracranial hemorrhage or cerebral swelling due to epidural hematoma, subdural hemorrhage, and contusion, the main role of all of this leads to control cerebral perfusion and raised intracranial pressure[1-3]. The main reason behind cranioplasty is to safeguard the brain matter from further insult, plus the cosmetic issues related to defects, such as the syndrome of the trephined[4]. Cranioplasty improves cerebrospinal fluid dynamics, accelerates neurologic recovery, and improves patient cognitive function[5,6].

Cranioplasty is a procedure that can be subdivided into early and late cranioplasty after decompression. The procedure, either early or late, has pros and cons; the average duration is 2 or 3 months[7]. This is believed that cranial defects can result in neurologic deterioration of patients, as it is believed to influence the atmospheric pressure and is best managed by resetting the cranial compartment as a closed compartment. The majority of patients who present with complications such as a syndrome of trephined craniectomy flap resulting from a different neurologic deficit showed improvement after cranioplasty of the cranial defect[8].

There is a considerable difference between surgical replacement of the bone as a part of practice, cranioplasty is delayed until brain edema subsides, and the neurological state of the patient improves to a considerable level, plus improvement of the wound. It must also be considered that hydrocephalus can improve in later stages of post-cranioplasty. Some studies suggest that early cranioplasty may minimize complication rates and improve overall outcome[9]. While in contrast, some studies have stated that early surgical cranioplasty may lead to more complications compared to late cranioplasty, so it depends on the school of thought and policy of the hospital and the experience of the surgeon to decide the best time of surgery[10,11]. This single-center study reports the experience of cranioplasty after decompressive craniectomy related to their neurological presentation, management, outcomes, and relevant complication.

Methodology

A retrospective descriptive study was conducted at the neurosurgery department, Jinnah postgraduate medical center, Karachi, after obtaining ethical approval (IRB No: 43973) from the institutional ethical committee. Patients who underwent reconstructive cranioplasty at the study site from 2015-2020 were enrolled, and non-probability sampling was done.

Sixty-eight patients of age groups 18 years to 60 years were considered for cranioplasty procedures which are preceded by the decompressive post-craniotomy for brain trauma, skull fracture, intractable intracranial hypertension, brain tumor, and infected post-craniotomy bone flaps were included in the study and the reconstructive material considered for cranioplasty was polymethylmethacrylate (PMMA), autologous bone. In exclusion criteria, patients with surgical site infection, those with GCS < 13, and those in a vegetative state or intensive care were not considered for surgery. X-ray skull, CBC, ESR, and CRP, and clinical evaluation of all the patient was used to rule out any predisposing factor of infection before performing the reconstructive surgery. The abdominal wall anteriorly was used for autologous bone flaps, or they were kept in a deep freezer.

All case summaries, medical records, and patient investigations were recorded in a pre-designed questionnaire. The complications such as extradural hematoma [EDH], subdural hematoma [SDH], osteomyelitis, and neurological deficits were considered. The SPSS version 25.0 was used to analyze the data; descriptive statistics were used for data presentation. Mean and standard deviation was used to display continuous variables,

while frequency and percentage were used for categorical variables.

Results

The most frequent cause of cranioplasty was the traumatic injury to the brain, 38(55.88%), followed by brain tumors and cerebrovascular injury. In our study, 64 (93.44%) cases were unilateral, and no patient required more than one cranial procedure for cranioplasty. The anatomical regional-wise division of defects, temporal 29(42.64%), frontal 15(22%), and parietal 24(35.29%). The flap was preserved in 32(47.05%) cases, while in other cases, the bone flaps were discarded as they were not reusable, and if usable, the reconstruction bone flap was autoclaved before use. In the case of autologous graft, Polymethyl methacrylate was secured as silk and proline (Table 1).

Table 1: Demographic presentation, its outcome, and management.

Variables		n=68
Gender	Male	54(79.41%)
	Female	14(20.58%)
Age Group	20-40	42(61.76%)
	41-60	25(36.76%)
	>60	1(1.4%)
Location of cranial defect	Bifrontal	4(5.8%)
	Right-Sided Defect	36(52.94%)
	Right-Sided Defect	28(41.17%)
Indication for Cranioplasty	Traumatic Brain Injury	38(55.88%)
	Brain Tumors	21(30.88%)
	Cerebrovascular Injury	9(13.23%)
Material Used	Polymethyl Methacrylate	31(45.58%)
	Titanium	5(7.35%)
Type of Bone Graft	Bone Flap (Autologous)	32(47.05%)
	Titanium Mesh (Allograft)	5(7.355%)
	PMMA	31(45.58%)
Intraoperative	Mean Operative Time	122.2±21.3
	Transfusion	42(61.76%)
Time Delay Post Craniectomy	Early cranioplasty (3 months)	41(60.29%)
	Late cranioplasty (> 4 months)	27(39.7%)
Associated Comorbidities	Diabetes Mellitus	6(8.8%)
	Hypertension	8(11.76%)

Associated complications were showed in table 2. Those patients who were given the chance of early reconstructive surgery gave patients relief from long-term neurological issues like headache, depression, and sense of anxiety even though the wound is clean and the patient's brain edema has subsided, added that patient must have good Glasgow coma scale.

Table 2: Associated complications in cranioplasty.

Complications	Early (3 months)	Late (> 4 months)
Headache	6(8.8)	19(27.9)
Seizure	2(2.9)	12(17.64)
Neurological Deficit	01(1.47)	07(10.29)
Hydrocephalus	06(8.85)	12(17.64)
Wound Infection	01(1.47)	02(2.9)

Discussion

In emergency cases, the craniectomy is the procedure of choice, especially in trauma, brain tumor, and vascular insult cases patients; this is a study presenting the population from a public sector hospital, as patient attends good healthy condition then the defect needs to be filled with autologous bone, polymethylmethacrylate or titanium plate. In our study, we have seen that craniectomy is more common in males than in females (that could be due to more outdoor activity by a male in Pakistani society); for cranioplasty, the status of the patient was kept in mind, like the Glasgow Coma Scale, Glasgow (GCS), wound status, and neurological status of the patient before surgery.

Our study showed the difference between early and late cranioplasty was the difference in the complication rate that early surgery gave patients relief from long-term neurological issues like headache, seizures, and hydrocephalus; added that patients must have a good Glasgow coma scale at the time of cranioplasty. In studies, the complication rate may appear high due to the superficial wound infection in inclusion criteria, while no pre-surgery was required in any case. However, some studies comparing early and late cranioplasty found an increased risk of infection in early cranioplasty, which was not found in our case[12].

The assumed mechanisms to improve functional outcome neurological status post cranioplasty included normalizing the cerebrospinal fluid function and improving the cerebral blood flow post-reconstruction of the cranial defect[13-15]. They can be minimized by early augmentation of bone and reduce depression. In our study of neurological outcomes comparing the early and late cranioplasty patients, early surgery showed better results, which varies from patient to patient; associated injuries are not marked.

To evacuate the relation between post cranioplasty infection in relation cranioplasty showed different results between early cranioplasties (< 30 days) (7.1%) and compared the late timing > 60 days (0.7%), as suggested by the study by Kim et al.[16] and Cheng et al. [17]. This study showed that wound infection rate 1.4% in early and 2.9% in late craniotomy, so the extra measures must be taken to assure that patient has no any infections before performing early cranioplasty. In our case, we performed an x-ray skull, CBC plus ESR and CRP, and clinical evaluation of the patient before the study.

Aydin et al. studied the material with polyetheretherketone implants, methyl methacrylate, bone grafts, hydroxyapatite, and ceramics[18]. Neurosurgeons have to be mindful and keep an eagle's eye on changes in trends of surgical procedures to have a better understanding of this procedure and how it has been adapted. The decision for craniectomy for decompressive does not allow the preplan, but they are made on the spot at the time of initial presentation by a team after consultation with a senior neurosurgeon; the size of craniectomy is variable depending on the underlying pathology[19,20].

The limitations of our study were retrospective study with a single center, so for a better result, we need a multicenter study with different experiences and clarity in choosing material. Multiple hospitals

can perform such a study included so that a comparative study can be given.

Conclusion

Indications for cranioplasty, type of bone graft, associated comorbidities, and complications have been addressed that are potentially preventable. It is recommended that early cranioplasty, vigilant use of antibiotics, and good postoperative care can minimize neurological complications, which is especially needed in public sector hospitals in Pakistan.

Conflicts of Interest

None.

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