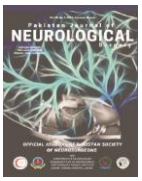

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Original Article (BRAIN)

Outcomes of Cranioplasty after Craniectomy

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ABSTRACT

Objective: Craniectomy is a widely used procedure in neurosurgery that results in more cranioplasties to repair skull defects. The complication rate after cranioplasties seems to be higher than elective craniotomies so this study was conducted to determine the outcome of cranioplasty after craniectomy.

Materials & Methods: The patients included in this study had craniectomy and cranioplasty for any indication. Patients included had variables, such as age, sex, underlying pathology, craniectomy and cranioplasty dates, the material used for cranioplasty (autologous bone or methyl methacrylate), and methods of cranioplasty flap fixation (sutures or titanium plates and screws) follow up period and complications.

Results: It was concluded that patients in the age group of 41 – 60 years (5 cases), males (7 cases), cranioplasty performed after 6 months (5cases) with autologous bone graft (8cases) were associated with more complications.

Conclusion: The overall rate of complications associated with cranioplasties is not negligible, however, early cranioplasty in young patients with the use of polymethyl methacrylate may be associated with less complication rate.

Keywords: Decompressive, Craniectomy, Cranioplasty, Autologous, Polymethyl Methacrylate.

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INTRODUCTION

Craniectomy has long been used in neurosurgical treatment. This can include frontal, temporal, parietal, or a mix of these areas for various purposes. This is most typically done for excessive intracranial pressure (ICP) in traumatic brain injury.[1-2] It has been demonstrated that large craniectomies in severe traumatic brain injury reduce mortality.[3,4] The same is true for controlling malignant edema caused by a Middle Cerebral Artery (MCA) infarct.[5-8] This has also

been shown to protect individuals with subarachnoid hemorrhage (SAH) and cerebral hematoma caused by burst cerebral aneurysms. There are several reasons for this treatment, which may increase as more positive evidence becomes available. Cranioplasties are necessary after decompressive craniectomies to seal the resulting defect.[9-12] Craniectomy is a common operation in neurosurgery that leads to an increase in cranioplasties to repair skull abnormalities. Because the complication rate following cranioplasties appears to be greater than that of elective craniotomies, this study was carried out to establish the result of cranioplasty after craniectomy.

MATERIALS & METHODS

Study Design & Setting

From November 2004 to October 2020, 53 patients were included in this prospective study, who had craniectomy and cranioplasty for any indication. A nonprobability sampling technique was used. This study was carried out in multiple neurosurgery departments of Lahore including both governments as well as private sector hospitals (Lahore General Hospital, Services Hospital Lahore, Mayo Hospital Lahore, and Surgimed Hospital).

Data Collection & Surgical Techniques

Patients included in the study had a variety of variables, including age, gender, underlying pathology, craniectomy and cranioplasty dates, cranioplasty material (autologous bone or methyl methacrylate), cranioplasty flap fixation methods (sutures or titanium plates and screws), follow-up period, and complications. All patients were extensively monitored for four weeks following surgery to discover problems in time for better treatment alternatives. Craniectomy sizes varied amongst patients with various underlying pathologies. Patients with severe traumatic brain injury had a 15x15 cm fronto-temporo-parietal craniectomy.

Bone defects in patients having a brain tumor, aneurysm, or abscess surgery varied in size based on the requirement at the time of surgery. The bone flaps that had been removed were given to the families. These were cleaned, packaged, and autoclaved before being sent to relatives with the advice to store them in the refrigerator or freezer. They were then apprised of its utility for cranioplasty. It was then autoclaved again before being utilized to measure the size and shape of the cranioplasty intraoperatively. Sutures or miniplates and screws were used to secure these flaps. Suction drains were utilized postoperatively in all cases.

Inclusion Criteria

All patients of both genders above 20 years of age, who underwent craniectomy due to any reason, were included in this study.

Exclusion Criteria

Those patients not fit for general anesthesia or those who refused to participate in the study were excluded.

Statistical Analysis

SPSS version 25 was used to enter and analyze the data. Quantitative variables like age and duration between craniectomy and cranioplasty were analyzed as mean, median, and standard deviation. Categorical (qualitative) variables like complications (including infection, collection of epidural or subdural hematomas, epilepsy & drugs used for seizures) were analyzed as frequency and percentage. The Chi-square test was applied to see the significant/insignificant difference between different groups of clinical variables.

RESULTS

Age & Gender Distribution

In our study, we included 53 patients with a mean age of 45.28 ± 13.32 years (age range = 21 – 75 years). There were 22 (41.5%) cases of age 15 – 40 years, 24 (45.3%) cases belonged to age 41 – 60 years while 7 (13.2%) cases had age > 60 years. There were 21 (39.6%) females while 32 (60.4%) were males.

Time Lapse Distribution

The mean time lapse was noted as 6.11 ± 1.71 months, with 32 (60.4%) cases requiring 3 – 6 months while 21 (39.6%) required 6 – 9 months for the lapse.

Etiology Based Case Distribution

There were 31 (58.5%) cases who had trauma at presentation, 6 (11.3%) had ischemic CVA while 2 (3.8%) had hemorrhagic CVA. 12 (22.6%) cases had a tumor and 2 (3.8%) cases had brain abscess and required cranioplasty.

Descriptive Analysis of Surgery Related Variables

During surgery, in 49 (92.5%) cases, the drain was used while in 4 (7.5%) cases, no drain was placed. In 41 (77.4%) cases bone material was used while in 12 (22.6%) cases methyl methacrylate was used. For flap securing, in 30 (56.6%) cases, miniplates were used while in 23 (43.4%) cases flap securing was done with sutures only (Table 1).

Table 1: Complications related to cranioplasty.

Variable Factors	No. of Cases	Complications	p-value
Age:	45.28±13.32		
20-40 years	22 (41.5%)	2 (9.1%)	0.388*
41-60 years	24 (45.3%)	5 (20.8%)	
>60 years	7 (13.2%)	2 (28.6%)	
Sex:			
Female	21 (39.6%)	2 (9.5%)	0.241*
Male	32 (60.4%)	7 (21.9%)	
Time Lapsed:	6.11±1.71		
3-6 months	32 (60.4%)	4 (12.5%)	0.283*
6-9 months	21 (39.6%)	5 (23.8%)	
Diagnosis:			
Trauma	31 (58.5%)	6 (19.4%)	
CVA:			
• Ischemic	6 (11.3%)	1 (16.7%)	0.606*
• Hemorrhagic	2 (3.8%)	0 (0%)	
Tumor	12 (22.6%)	1 (8.3%)	
Brain Abscess	2 (3.8%)	1 (50%)	
Vacuum Drain:			
Yes	49 (92.5%)	9 (18.4%)	0.347*
No	4 (7.5%)	0 (0%)	
Material used:			
Bone			0.364*
Methyl	41 (77.4%)	8 (19.5%)	
methacrylate	12 (22.6%)	1 (8.3%)	
Material for flap securing:			0.944*
Miniplates	30 (56.6%)	5 (16.7%)	
Sutures	23 (43.4%)	4 (17.4%)	

*insignificant results

Complications

In cases of age 15 – 40 years, 2 (9.1%) had complications, 5 (20.8%) cases of age 41 – 60 years and2 (28.6%) cases of age > 60 years had complications. Among males, 7 (21.9%) had complications while only 2 (9.5%) females had postoperative complications. Of the patients who had time-lapse of 3 – 6 months, 4 (12.5%) had complications while in the patients who had lapse times 6 – 9 months, 5 (23.8%) had complications. Among traumatic cases, 6 (19.4%) developed complications, while 1 (16.7%) case of ischemic CVA developed complications however, no case of hemorrhagic CVA showed complications. In tumor cases, 1 (8.3%) had complications while 1 (50%) case of brain abscess developed postoperative complications. Among cases in which a vacuum drain was used, 9 (18.4%) had complications while no case without a vacuum drain showed

any complications. In cases in whom bone material was used 8 (19.5%) had postoperative complications while 1 (8.3%) case of methyl methacrylate had postoperative complications. With titanium plates 5 (16.7%) cases had postoperative complications while with sutures 4 (17.4%) cases had postoperative complications (Table 1).

DISCUSSION

The decision to do decompressive craniectomy is not usually preplanned but has to make at the time of the initial procedure.[10,13] This decision is based on an individual surgeon with the consent of a senior surgeon. This made the procedure relatively standard. The size of the craniectomy varied to match the need of the patient for underlying pathology & response of the brain at the time of surgery. The overall complication rate was 16.98% for cranial repair. The factor which influenced the rate of complications was adult age. Was 49% in the age higher than 40 years had higher post-operative complications but most of the trauma patients in our setup are in this age group which is contrary to the reported results by V. Chang et al.[9] These are the patients who are young but belong to poor strata of the community, most of them having poor nutritional status thus resulting in high complications. Patients with tumors & CVA had elective craniectomy& then cranioplasty. They were operated in better operative facilities and thus had fewer complications 12.5% & 25% respectively as compared to 38.7% in trauma patients.

It appears that age & operative facility are major contributing factors for outcomes in different diseases leading to cranial repair. Intraoperative techniques also make difference in the outcome & incidence of complications. Patients who had methyl methacrylate instead of autologous bone graft had fewer complications, 8.3% as compared to 19.5% but there was very little difference between the fixation material used, sutures & miniplates, 17.4% & 16.7% respectively. This shows higher complication rates when foreign bodies are introduced into the procedure. It was thought that autologous bone kept outside the body for several months, will act as a foreign body with a high risk of infection and body rejection but some studies showed that autologous bone graft had fewer complications compared to polymethyl methacrylate.[12] In patients where the drain was used, the collection of fluid &hematoma was less, but 18.4% of these cases showed complications compared to no complications in four patients without a drain. As the drain reduces the chance of fluid & hematoma collection so the risk of fluids collection & infection was less which was noted by V. Chang et al[9] but there are other studies where drain insertion was associated with more cases of infection.[13]

The time between the initial procedure and cranioplasty was fixed up to 6 months but nearly 40% came back after 6 months but before 9 months of their craniectomy. It was reported that symptoms get reversed after cranioplasty.[14-18] Some authors have observed deranged CSF dynamics & cerebral perfusion with cranial bone defects.[9-10] This observation prompted us to convince patients for early cranioplasty but this appeared to be not in control to bring patients back in time for cranioplasty. The complication observed was 12.5% &23.8% in group I (3 – 6 months) & group II (6-9 months) respectively. Generally, this procedure has more complications than routine elective cranial procedures. Age more than 40 years, time-lapse more than 6 months, use of no drain & methyl methacrylate for cranioplasty, showed a high risk of complications.

CONCLUSION

Craniectomy is a procedure that is going to live so is the cranioplasty for a variety of indications.

Patients have to undergo two surgeries and so double the risks of anesthesia and operation but it is to save lives and to reduce neurological complications. Certain factors associated with the better outcome as per our study are young age, early cranioplasty, and polymethyl methacrylate as a graft. However, the use of drain is also supported for a better outcome as it prevents hematoma accumulation, however, it was associated with a more complication rate compared to patients with no drain but authors suggest further studies in this regard as only four patients were operated on without drain in this study.

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Additional Information

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Ethical Review Board Approval: The study was conformed to the ethical review board requirements.

Human Subjects: Consent was obtained by all patients/participants in this study.

Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Ajmal khan	1. Study design and methodology.
2.	Samra Majeed, Ajmal khan	2. Paper writing and data calculations.
3.	Samra Majeed, Muhammad Irfan	3. Data collection and calculations.
4.	Shahzaib Tasdique	4. Analysis of data and interpretation of results etc.
5.	Azam Niaz, Waqar Azim	5. Literature review and referencing.
6.	Anjum Habib Vohra	6. Analysis of data and quality insurer.