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Cranioplasty: Perspectives from Bauchi, North-East Nigeria

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Abstract

Introduction: Cranioplasty is a reconstructive procedure designed to repair skull defects or restore skull continuity following a previous operation or injury. Reconstruction with cranioplasty may be required after craniectomy to manage aesthetic disfigurement, increased intracranial pressure due to traumatic brain injury, ischemic stroke, or brain tumors.

Materials and Methods: This was a retrospective study carried out on 51 patients with cranial defects of different etiologies, sites and sizes who had cranioplasty in our hospital from January 2019 to December 2022.

Results: Fifty one patients included in the study, majority were in the age group of 21-30 years (37.3%). Mean age of the patients was 27.3 years. All patients had artificial material, polymethylmethacrylate (PMMA). The outcome of the procedure was good. The overall complication rate of 9.8% and reoperation rate of 3.8% were seen among our patients.

Conclusion: Cerebral protection and aesthetic contour of the cranium were achieved in all our patients. Cranioplasty is not without complications; however, good results are achievable in most of the patients.

Keywords: cranioplasty; craniectomy; trauma; brain

Introduction

Cranioplasty is a well-known procedure in modern neurosurgery. It is a reconstructive procedure designed to repair defect in the skull and/or to restore skull continuity following and injury or previous operation [1]. The two main indications for cranioplasty in all climes are brain protection and cosmetics [2]. Cranioplasty has equally confers some benefits on the patients with skull defect; restoring cerebrospinal fluid flow and dynamics, provide relief to psychological mindset associated, improves social performance and interaction and reduce the incidence of seizure disorder associated with skull defect [2, 3].

Despite its low risk procedure, complication rates, as high as 34% and as low as 6.8% have been reported in the literatures [4-8]. The identified known complications include; heamorrhage, fluid collection/seroma, infections, cosmesis and death [8, 9, 10]. Several techniques for the repair of the cranial defects are now available, which can be broadly divided according to the graft used into autologous bone cranioplasty and allograft cranioplasty.

The materials for cranioplasty includes; autologous bone, polymethylmethacrylate (PMMA), titanium, porous hydroxyapatite (HA), polyetheretherketone (PEEK) and 3-D prosthesis. Though autologous bone has been the most commonly used materials following decompressive craniectomy to fill the cranial defects [11, 12]. However, it is biocompatible and cost-free, but more likely to have bone flap resorption BFR) in the later time. In comparison with synthetic biomaterials, the use of autologous for cranioplasty is significantly associated with increased odd ratio for reoperation [13]. Bone flap resorption has been the only reason for reoperation [14].

Polymethyl methacrylate (PMMA) is a common synthetic material for cranioplasty and it can be used as PMMA liquid or PMMA solid implants. Additionally it is antibiotics-impregnated, which makes it effective and affordable against surgical site infection. Liquid PMMA takes 10 to 20min to be turned into a moldable viscous paste, which is then applied to the cranial defect. This process is an exothermic reaction from which the brain and the meninges need to be shielded. Liquid PMMA is non-absorbable, radiolucent, and inert [15].

This study was conducted to evaluate the indications and outcomes of cranioplasty using polymethylmethacrylate (PMMA) materials in our facility.

Materials and Methods

A retrospective study carried out in the department of surgery, Abubakar Tafawa Balewa University Teaching Hospital Bauchi between January 2019 and December 2022. Fifty-one patients had cranioplasty for skull defects with varying etiologies, sizes and locations during the study period. All our patients had polymethylmethacrylate (PMMA) as the synthetic material for coverage.

Patients' data were capture from their case notes with structured proforma. Ethical approval was obtained from our institutions' research and ethical committee.

Data obtained includes; demography, etiology, neurological status, site, and surgical outcome. The analysis was done using SPSS 22.0. The results are expressed in mean and percentages.

Results

A total of 51 patients were included in the study. Age and gender distribution of the studied patients is shown in Table 1. Of the 51 patients included in the study, majority were in the age group of 21-30 years, 37.3%. Mean age of the patients was 27.4 years. Among all the patients, 78.4% (n = 40) were males and 21.6% (n = 11) were females. Mean age of males was 32.2 years and of females was 22.1 years.

Age range (years)	*Male*	*Female*	*Total*
	N (%)	*N (%)*	*N (%)*
0-10	2 (3.9)	1 (2)	3 (5.9)
11-20	9 (17.7)	3 (5.8)	12 (23.5)
21-30	19 (37.3)	5 (9.8)	24 (47.1)
31-40	6 (11.8)	2 (3.9)	8 (15.7)
41-50	3 (5.9)	0 (0)	3 (5.9)
51-60	1 (1.9)	0 (0)	1 (1.9)
Total	40 (78.4)	11 (21.6)	51(100)

Table 1: Age and Gender distribution.

Aetiology	*Number (%)*
Road traffic accident	14 (27.5)
Physical assault	9 (17.7)
Infection/inflammatory	6 (11.7)
Gunshot injury	9 (17.7)
Decompressive craniectomy	13 (25.4)

Table 2: Aetiology of the cranial defect.

The causes of cranial defects were from trauma, infections and post-surgical. Trauma from RTA accounted for the most causes (27.5%) and the least cause was from infection/inflammatory conditions (11.7%) as shown in Table 2.

Thirty-nine percent of the cases were frontal defect in location. Other locations of the cranial defect were; fronto-parietal, frontal, fronto-temporal, temporal and occipital. Most of the cranial defects were unilateral (96%) and 4% were bifrontal as seen in Table 3.

Most of the patients, 56.9% (n = 29) were operated between 12 and 24 weeks after the primary procedure. Complications were most commonly seen in patients (5.9%, n = 3) who had undergone cranioplasty between 12 to 24 weeks of the initial primary procedure.

Complications also were most commonly seen in patients (18.29%, n = 15) who had undergone cranioplasty after 6 months of the initial primary procedure. The overall complication rate of 9.8% and reoperation rate of 3.8% as shown in Table 4.

Variable	*Number (%)*
Site	
Frontal	8 (15.7)
Parietal	20 (39.2)
Temporal	4 (7.8)
Occipital	2 (3.9)
Fronto-parietal	10 (19.7)
Fronto-temporal	7 (13.7)
Laterality	
Unilateral	42 (96)
Bilateral	0 (0)
Bifrontal	9 (4)

Table 3: Region of the skull defect.

Timing of Cranioplasty	*Total number of patients n %*	*Patients with complication n %*	*Patients with reoperation n %*
≤ 12 weeks	8 (15.7)	0 0	0 0
12 – 24 weeks	29 (56.9)	3 5.9	1 1.9
≥ 24 weeks	14 (27.4)	2 3.9	1 1.9

Table 4: Timing of cranioplasty and complication.

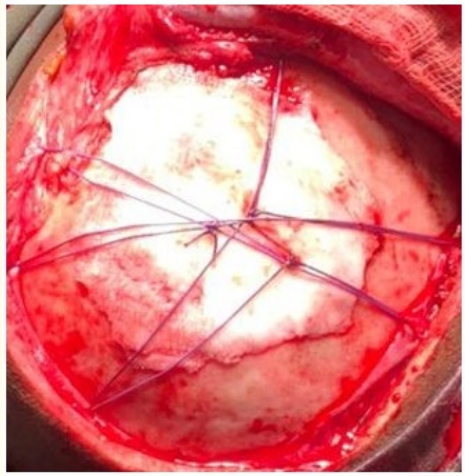

Figure 1: Intraoperative picture with PMMA fashioned to cover the bony defect.

Discussion

Many centuries ago, cranioplasties were performed by Incas. Cranioplasty is considered one of the earliest neurosurgical procedures along with cranial trephinations [16, 17]. The first report of cranioplasty was recorded in 1668 by Job Janszoon van Meekeren many centuries later [17]. The principal indication for cranioplasty are to restore aesthetic contour and protect brain. Cranioplasty has been shown to restore altered conditions and improved patient's neurological conditions [18, 19]. It can also increase the cerebral blood flow by increasing blood flow velocities of the ipsilateral middle cerebral and internal carotid arteries, as well as improve the cardiovascular functions [21]. Syndrome of trephine characterized by headaches, dizziness, irritability, epilepsy, discomfort, and psychiatric symptoms observed in patients with cranial defects and with increasing evidence showing that cranioplasty helps in the prevention or recovery of the trephine syndrome [21].

Of the 51 patients included in the study, most were in the age group of 21-30 years, i.e., 37.3% (n = 19). Forty of our patients (78.4%) were males, and the remaining eleven patients (21.6%) were females. The male prevalence seen in our study had also been noted in many studies across the globe (22, 23). Regards the demographic distribution. Similar findings were reported in other studies [22, 24]. The most common etiology of the defect in this study was post-traumatic (32% of the patients) and this is the common trend in all reported studies on cranioplasty [25, 26].

Regarding laterality of the defect, the most common cranial defect was unilateral (96%, n =42). Various studies on cranioplasty have shown that unilateral defect is the most common cranial defect. Basheer et al. in their study of 114 patients reported that 90.35% (n = 103) were unilateral, 5.26% (n = 6) were bilateral and this is similar to our study [27]. The most common site of the skull defect noted in our study was found to be parietal region followed by fronto-parietal, this location varies in different studies and this may be due to prevalent etiological factors in each locality. Authors like Andrea Mareira et al and VanGool et al reported frontal region as the most common site in their studies, which is in discordant with our findings [22, 25].

Fifty-seven percent of the patients were operated between 12 and 24 weeks, though this timing was mostly due to patients' factor. Cranioplasty is commonly performed 3 months after craniectomy or cranial defect created; if the patient has a history of intracranial infection or open cranio-cerebral injury, the procedure can be delayed for at least 6 months after the first surgery. However, some authors have advanced the idea of early cranioplasty after decompressive craniectomy to alleviate complications from craniectomy [18].

Early cranioplasty is safe and assisted in improving patient's neurological function and prognosis. Also early cranioplasty performed before massive scar formation reduces operative time by facilitating soft tissue dissection. In addition, early cranioplasty provides satisfactory securing good dissection plane during operative procedures compared with later cranioplasty, without causing additional complications, including infection, subdural hygroma, and brain parenchymal damage [27].

Complications were noted in 9.8% of the patients and wound infection rate of 5%, which was the most common complication encountered. Other complication encountered was post-operative hematoama. Our re-operation rate was 4.8% and this was as a result complications and was seen among the patients who had their cranioplasties from 12 weeks and above.

Conclusion

Cerebral protection and restoration aesthetic contour of the head are the main aims of cranioplasty for our patients. Though for most our patients, aesthetic restoration was their main aim for the procedure. Some advantage of the cranioplasty includes improved cerebral blood flow and cerebral perfusion. The earlier the cranial defect is restored, the better the outcome and prevention of complications.

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Conflict of interest

None declared by the authors.

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