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A Clinical Study on Cranioplasty - Early and Late In Our Institute

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Abstract: *A Clinical study on Cranioplasty-early and late in our institute. Cranioplasty is an increasingly common procedure performed in neurosurgical centres following a decompressive craniectomy, however, timing of the procedure varies greatly.*

Objectives: *The aim of this study is to compare the surgical outcomes of an early compared to a late cranioplasty procedure.*
Methods: *Fourty adult patients who underwent a cranioplasty between 2016 and 2019, in KGH / AMC, Visakhapatnam were studied retrospectively. Timing of operation and perioperative complications were assessed. Early and late cranioplasties were defined as less or more than 3 months since craniectomy respectively.*

Results: *Of the 40 patients, 70%, 28 received a late cranioplasty and 30%, 12 received an early cranioplasty. Complications were seen in 10 patients (25%). These included wound or cranioplasty infection, symptomatic pneumocephalus and cosmetic issues. The complication rate was 24% in the early group and 25% in the late group. There was no significant difference in the rate of infection between the two groups.*
Conclusion: *The outcome of early and late cranioplasty is same and complication rate is same in both the groups.*
Key Words: *Cranioplasty,Early,Late,*

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I. Introduction

Cranioplasty is a common neurosurgical procedure performed to reconstruct a skull defect. It is most commonly performed following a decompressive craniectomy (DC), a procedure performed for raised intracranial pressure (ICP), which can occur following traumatic brain injury (TBI), cerebral infarction, subarachnoid haemorrhage, intracerebral haemorrhage, encephalitis and venous sinus thrombosis [14]. Other indications for cranioplasty include following the removal of bone-invading tumours or an infected bone-flap [14].

An increasing number of cranioplasty procedures have been performed in recent years due to the rising popularity of DC to manage raised intracranial pressure following traumatic brain injury and malignant ischaemic stroke [14]. One recent large

randomised controlled trial has demonstrated reduced mortality in TBI patients with refractory raised ICP following DC [11]. Several large randomised controlled trials have demonstrated reduced mortality and improved outcomes following DC in malignant ischaemic stroke [1, 9, 13, 24, 29], and decompression is now part of the national guidelines for stroke management [1]. All of this has resulted in a growing cohort of patients who subsequently require a reconstructive cranioplasty.

The aim of a cranioplasty is to restore cosmetic appearances, protect the underlying brain from further injury and facilitate neurological recovery and rehabilitation [21]. A number of mechanisms have been proposed for reversible neurological disability following craniectomy—this includes cerebrospinal fluid flow disruption, venous sinus congestion, abnormal atmospheric pressures which can lead to 'syndrome of the trephined' and alterations in cellular metabolism [4, 15]. There is evidence for reduction in cerebral blood flow following DC, demonstrated by perfusion CT and transcranial Doppler ultrasound, which is attributed to the effect of atmospheric pressure on the decompressed area of brain [8]. Consequently, cranioplasty has been shown to resolve the cerebral blood flow and lead to improvement in neurological function [8, 10, 18, 23, 25].

There is a considerable variation in practice in terms of timing of cranioplasty following DC [7, 21, 25]. Traditionally, a cranioplasty would be delayed to allow for cerebral oedema to resolve and for the patient's neurological status to improve, and to reduce the chance of wound infection and delayed hydrocephalus [14].

There is evidence from a number of retrospective studies suggesting that an early cranioplasty procedure may lead to similar or reduced complication rates [2, 3, 6, 12, 20, 22, 28], with an improvement in overall neurological outcome [18, 20, 23, 28]. This has been supported by two systematic reviews [18, 27]. On the contrary, there is also evidence that infection and the devel-opment of hydrocephalus are more prevalent when cranioplasty is performed later [5, 17, 19, 26]. Notably, these studies varied in their definition of 'early' cranioplasty ranging from 6 weeks to 3 months, however, both of the systematic reviews used 3 months as the divider between early and late. Another study looked at preoperative CT findings and found that the brain sunken ratio was a stronger predictor of postoperative complications [16], suggesting that cranioplasty timing should take into account individual patient factors rather than having a set time for all patients. Overall, there does not seem to be a clear consensus on whether cranioplasty can safely be performed early and whether it may confer additional benefits in terms of neurological recovery.

In our neurosurgical unit, a cranioplasty is traditionally performed at 6–12 months to allow the wound to heal and for the patient to recover from the acute insult. However, the growing evidence in support of an earlier cranioplasty has led to some surgeons electing to perform the cranioplasties at an earlier date. This allows a direct comparison between the groups to assess outcomes and complications.

We present a retrospective study of patients undergoing cranioplasty following DC. We compare the effect of timing of cranioplasty on complications and also demonstrate how an early cranioplasty procedure can be safely performed during the initial hospital admission, with reduction in the overall length of hospital stay.

Table 1 Demographics and surgical factors

Sex male/female	30 M: 10F
Median age (years)	52 (range 16-70)
Indication for craniectomy	Number of patients (%)
TBI	30 (70%)
Non Traumatic	10 (30%)
Material	Number of patients (%)
Autologous bone flap	30 (70%)
PMMA	10 (30%)

This table shows the demographic details collected on the patients, the different diagnoses requiring craniectomy and the prosthetic material used for cranioplasty

II. Methods

A retrospective review was performed on all patients who underwent a reconstructive cranioplasty in our institution over a 26-months period between October 2016 and Jan 2019.

Information analysed included patient age and sex, indication for craniectomy, cranioplasty material and interval between craniectomy and cranioplasty, perioperative complications and time since last follow-up.

Two groups were identified—those who had received an 'early' cranioplasty, defined as less than 3 months from craniectomy, and those who received a 'late' cranioplasty, defined as more than 3 months from craniectomy. Perioperative complications were compared across the two groups

III. Results

Patient and surgical factors

Fourty patients were included in the study. Thirty (70%) were male and 10 (30%) were female. Median age was 52 years, range 16–70 years. (Table 1).

Indications for craniectomy included Traumatic Brain Injury 30 (70%), Non Traumatic 10 (30%)

Table 2: Timing of cranioplasty

	Number of patients (%)
Early group	12 (30%)
Late group	28 (70%)

Timing of cranioplasty:

Of 40 patients, 28 patients (70%) received a late cranioplasty and 12 (30%) received an early cranioplasty. All patients were readmitted electively for cranioplasty. Timing of the cranioplasty was determined by surgeon preference. At this time, most surgeons were continuing with traditional practice of waiting at least 6 months before performing cranioplasty. However, some surgeons would con-sider performing a cranioplasty earlier than 3 months based on the degree of recovery from their initial injury and operation and patient wish for cosmetic defect repair.

Any significant preoperative disorders were recorded. Two patients were noted to have developed 'syndrome of the trephined'.

Table 3 Complications—early and late group

	Early	Late	Total
Number of patients	12	28	40
Number of patients with complications	3(25%)	7(25%)	10
Infection (total)	2(19%)	6(20%)	8
Pneumocephalus	0	1	1
Cosmetic issues	0	1	1

Complications:

Overall, complications were seen in 10 patients (25%). This included wound or cranioplasty infection (8 patients), symptomatic pneumocephalus (1 patients), cosmetic issues (1 patient).

The complication rate was 3/12 in the early group (25%) and 7/28 in the late cranioplasty group (25%). There was no significant difference between the two groups. Infection was defined as either superficial (requiring antibiotics only) or deep infection (requiring bone flap / PMMA flap removal). Overall rate of infection (including superficial and deep infection) occurred in 19% of the early group and 20% of the late group (no significant difference).

IV. Discussion

This study provides further evidence that early cranioplasty performed at less than 3 months post-craniectomy does not lead to an increased risk of complications. We chose 3 months as the cut-off between early and late, as this is consistent with the recent major systematic reviews on this topic [17, 18, 26, 27].

In our study, there was no significant difference in compli-cation rate between the early and late cranioplasty groups (24% and 25% respectively). There was similarly no significant difference in the rate of specific complications between the two groups. We have collected thorough and comprehensive data on complications in order to accurately reflect the morbidity associated with cranioplasty.

Several retrospective studies which also compared early and late cranioplasty have reported similar findings, however one retrospective study found an increased risk of infection in early cranioplasty [5], and two systematic reviews found an increased risk of hydrocephalus in early cranioplasty compared to late [17, 26]. These results are contradicted by a further review which did not find any increase in complications with early cranioplasty [27]. All of the reviews were limited by the retrospective nature of all papers included and differing definitions of the timing of the early and late cranioplasties. This suggests that further high quality evidence is needed to determine the risk of complications in early and late cranioplasty.

An additional benefit to an early cranioplasty procedure is the neurological improvement that is associated with cranioplasty. Several studies and a systematic review have demonstrated an improvement in

neurological function following cranioplasty [8, 10, 15, 18, 23] and these improvements may be enhanced by an early cranioplasty. This is demonstrated in a systematic review which looked at eight separate studies and found early cranioplasty is associated with greater neurological recovery across all outcome measures

[15]. Proposed mechanisms for improvement in neurological function following cranioplasty include the restoration of normal CSF dynamics and normal cerebral blood flow following reconstruction of the skull defect [4, 8, 10, 15, 18, 23]. This raises the tantalising prospect that early cranioplasty can augment the rehabilitation potential of patients, reducing the time required for recovery and improving outcomes. Our study did not assess neurological outcomes comparing the early and late cranioplasty patients, however, this would be a useful area for further research.

The limitations of this study include its retrospective nature and relatively small sample size. All series of this sort are likely to suffer from selection bias given the complexity of rehabilitation following severe TBI and needs continuation of study

V. Conclusion

We propose that early cranioplasty performed less than 3 months from decompressive cranioplasty can be as safe as delayed cranioplasty. The patients may benefit from enhancement of their neurological rehabilitation following the early cranioplasty and also avoid any direct injury during the intervening period.

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