



## Early Cranioplasty in Patients With Posttraumatic Decompressive Craniectomy and Its Correlation with Changes in Cerebral Perfusion Parameters and Neurocognitive Outcome

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■ **BACKGROUND:** Decompressive craniectomy is a life-saving procedure in many patients after traumatic brain injury. Delayed recovery in such patients can be attributed to various causes. Cranioplasty (CP) helps in early improvement of neurocognitive function along with better brain protection and cosmesis. The mechanism responsible for this functional improvement and the ideal time to perform cranial reconstruction is less understood.

■ **METHODS:** We studied 16 patients who underwent CP after decompressive craniectomy (DC) for traumatic brain injury. These patients were divided in 2 groups, early and late CP, depending on the interval between DC and CP. Three months was the cutoff time for early CP. Neurocognitive status was assessed by Glasgow Coma Scale, Glasgow Outcome Scale, and Mini-Mental State Examination scores prior to and after CP. Computed tomography (CT) perfusion was done to correlate the improvement in neurologic status and CT perfusion parameters.

■ **RESULTS:** We observed that there was a positive influence of CP on neurologic and psychologic function in all of the patients. The neurocognitive improvement after CP was more remarkable in the early CP group. More complications were noted in patients in the late CP group. Brain perfusion after CP showed improvement in all parameters in both of the groups, both on the operated and contralateral side.

■ **CONCLUSIONS:** Neurocognitive improvement is noted after CP in all of the patients. CP should be offered once the

brain edema subsides, at the earliest. Improved cerebral perfusion may be the key factor for the improved functional outcome.

### INTRODUCTION

Traumatic brain injury is a significant public health problem worldwide and is predicted to surpass many diseases as a major cause of death and disability by the year 2020.<sup>1</sup> Patients with traumatic brain injury after decompressive craniectomy (DC) show a wide range of neurocognitive and psychologic deficits. Recovery is delayed after DC because of sinking phenomenon, effect of direct atmospheric pressure, reduced blood supply, and altered cerebrospinal fluid (CSF) dynamics. Traditionally, cranioplasty (CP) is done after 6 months of DC, which has its benefit in terms of anatomic, functional, and cosmetic aspects. It was previously believed that CP only helped in cosmesis and brain protection. Recent studies have reported improvement in cerebral blood flow (CBF) and metabolism after CP, leading to possible neurologic improvement.<sup>2</sup> The objectives of this study were 1) to establish the ideal time for CP after DC in traumatic brain injury and 2) to establish the possible mechanisms of neurocognitive and psychologic improvement.

### MATERIALS AND METHODS

This prospective study was conducted on 16 patients who underwent CP between January 2012 and December 2013 in the Department of Neurosurgery, Sri Aurobindo Institute of Medical

#### Key words

- Cranioplasty
- CT perfusion
- Decompressive craniectomy
- Neurocognition

#### Abbreviations and Acronyms

- CBF:** cerebral blood flow
- CBV:** cerebral blood volume
- CP:** cranioplasty
- CSF:** cerebrospinal fluid
- DC:** decompressive craniectomy
- GCS:** Glasgow Coma Scale
- GOS:** Glasgow Outcome Scale

**MMSE:** Mini-Mental State Examination

**MTT:** mean transit time

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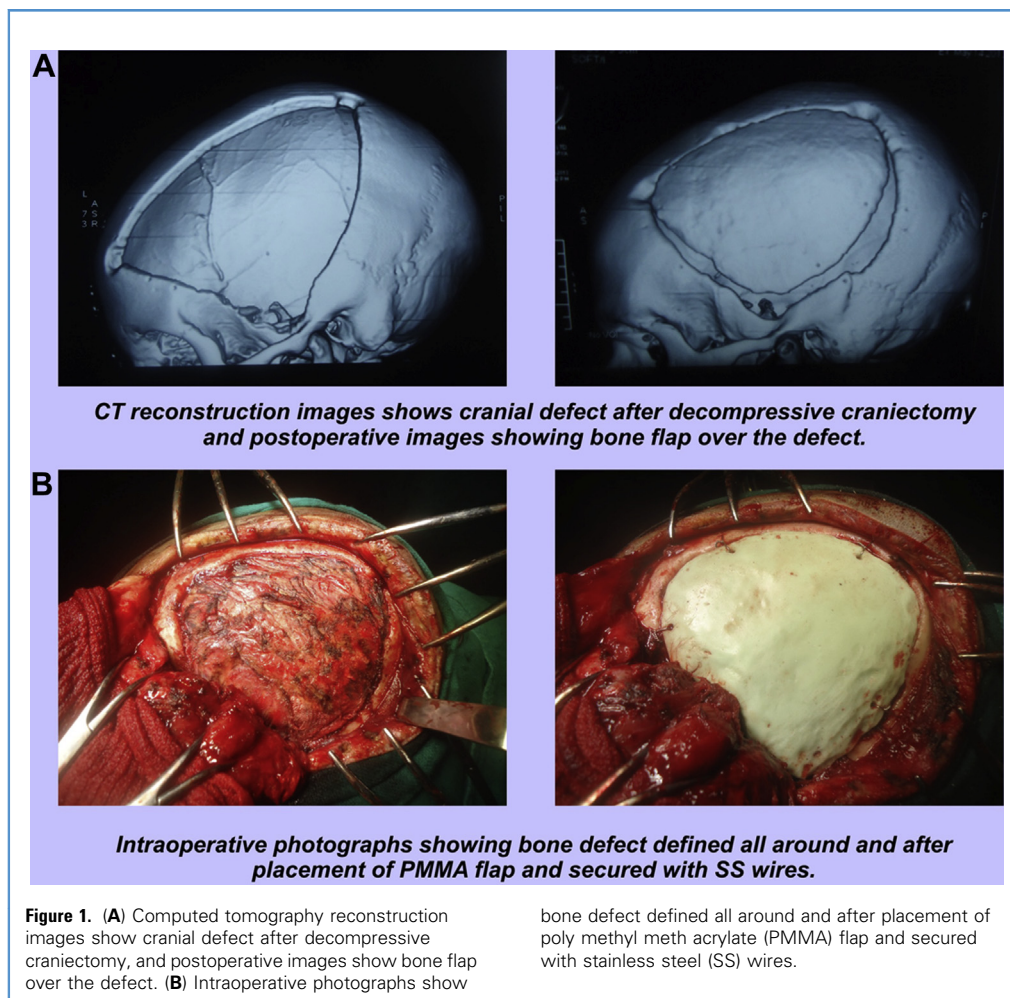
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Patients of all age groups were included in whom decompressive hemicraniectomy was done for traumatic brain injury. All of the patients were divided in 2 groups: the early group ( $n = 6$ ) in which CP was done within 3 months of the DC and the late group ( $n = 10$ ) in which CP was done after 3 months of DC.

**Figure 1** showing the appearance of decompressive craniectomy site on CT reconstruction images and intra-operatively before and after cranioplasty.

Neurologic status was assessed by Glasgow Coma Scale (GCS) score<sup>3</sup> and Glasgow Outcome Scale (GOS) score,<sup>4</sup> and cognitive status was assessed by Mini-Mental State Examination (MMSE) score<sup>5</sup> prior to CP and 1 week and 1 month after CP.

Computed tomography perfusion scan was done in 8 patients before and 1 week after the CP to note the CBF, cerebral blood volume (CBV), and mean transit time (MTT) on the operated side and contralateral side.<sup>6-8</sup> Computed tomography perfusion scan was performed on a 64 slice VCT machine (GE Healthcare, CHL Hospital Indore, Madhya Pradesh, India), and data were analyzed on an AW 4.5 work station (GE Healthcare) using Volume Share 2

software (GE Healthcare). This tool was used in our study to correlate the improvement in the neurologic and cognitive function with change in CBF, CBV, and MTT after CP (**Figure 2**). Statistical analysis was done by Student t test and paired t test to calculate the P value.

## RESULTS

Among the 16 patients studied, 14 were men and 2 were women, with ages ranging from 18 to 62 years. The mean age in the early group was 34.5 years, whereas in the late group it was 38.7 years. In our study, complications were seen in 5 patients, all belonging to the late CP group. Out of these 5 patients, 2 patients developed hydrocephalus, 2 patients developed seizures, and 1 patient sustained trauma to the operative site. These complications occurred in the interval between the DC and CP. No complication was observed in the early CP group. Patients with sinking flap were associated with more neurologic deficit compared with the flat skin flap.

There was gradual improvement in the GCS scores both in the early and late CP groups, which was statistically significant when compared after 1 month of CP (**Table 1**).

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