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"A Prospective Study To Assess Hemodynamic Parameters In Patients Undergoing Cranioplasty In Tertiary Health Centre"

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Abstract
Background*: Decompressive craniectomy (DC) is a crucial procedure for managing intracranial hypertension (ICHT) refractory to medical treatment. The increasing utilization of DC has led to a growing demand for subsequent cranioplasty, particularly among patients with traumatic brain injury (TBI), spontaneous subarachnoid haemorrhage, and malignant cerebral infarction. Hemodynamic changes following cranioplasty play a pivotal role in patient outcomes, necessitating comprehensive monitoring to ensure perioperative stability and minimize neurological complications. This prospective observational study aimed to assess hemodynamic parameters in patients undergoing cranioplasty at a tertiary health center.*
Material & Method*: The study was conducted at Sri Aurobindo Institute of Medical Sciences, Indore, M.P., over one year. Patients with traumatic brain injuries or hypertensive bleeds were included, while those aged less than 10 years, with MCA infarcts, CVA, or depressed skull fractures were excluded. Assessment of hemodynamic parameters was performed preoperatively and 2 months on follow-up. CT scans were conducted based on cerebral and hemodynamic status, with elevated ICP managed according to Brain Trauma Foundation guidelines.*
Results*: Statistically significant differences were observed in peak systolic volume ($p<0.05$) before and after cranioplasty, with improvements noted postoperatively and at two weeks. Similarly, mean volume showed significant improvement ($p<0.05$) following cranioplasty and at the two-week mark.*
Conclusion*: Cranioplasty enhances haemodynamic status and postoperative improvements are associated with increased peak systolic and mean blood flow volumes. It significantly improves cerebral blood flow in ipsilateral cerebral hemispheres. Transcranial Doppler ultrasound emerges as an effective, non-invasive, and cost-efficient method for monitoring cerebral hemodynamics.*
Keywords: *Cranioplasty, Traumatic brain injury, Cerebral blood flow, Transcranial Doppler ultrasound*.

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I. Introduction

Decompressive craniectomy (DC) is a critical procedure used to address intracranial hypertension (ICHT) that does not respond to medical interventions. Conditions like traumatic brain injury (TBI), spontaneous subarachnoid haemorrhage, and malignant cerebral infarction can elevate intracranial pressure, necessitating DC. The increased utilization of DC and enhanced survival rates have resulted in a rising demand for subsequent cranioplasty among affected patients.[1,2]

Changes in blood flow to the brain following a serious head injury are strongly associated with both the initial injury itself and the subsequent development of additional brain damage. The specific type of damage plays a crucial role in predicting the outcome of such injuries. Often, contusions resulting from the trauma are accompanied by bleeding in the brain. These contusions may expand, leading to increased pressure within the

skull and reduced blood supply to brain tissue, contributing to the worsening condition often observed in these patients.[3,4]

Assessment of hemodynamic parameters in patients undergoing cranioplasty is of paramount importance for ensuring perioperative hemodynamic stability, preserving cerebral perfusion, and minimizing the risk of adverse neurological events. By employing comprehensive hemodynamic monitoring protocols and adopting a multidisciplinary approach involving neurosurgeons, anaesthesiologists, and critical care specialists, healthcare providers can enhance the safety and efficacy of cranioplasty procedures and improve overall patient outcomes. Present study aimed to assess hemodynamic parameters in patients undergoing cranioplasty in tertiary health centre

II. Material & Method

A prospective observational study design was conducted at Sri Aurobindo Institute of Medical Sciences, Indore, M.P. for 01 Year. Study included patients with traumatic or hypertensive or tumors. Patients with age less than 10 years, MCA infarcts or CVA and depressed skull fractures were excluded from the study.

The assessments were done during the presurgical period evaluation and two months during the follow up**.**The CT scans of the patients were performed according to the cerebral and hemodynamic status of the patients on the following days. The control of elevated ICP was considered according to the guidelines of the Brain Trauma Foundation.

Statistical analysis: All the data were entered in excel sheet and analysed using SPSS v26.0 operating on windows 10. The data were summarised as mean, standard deviation, frequency and percentage. The mean difference between the follow-up data were compared using paired t-test. For all statistical purpose, a p-value of less than 0.05 was considered statistically significant.

Result: Present study included total 42 patients with mean age of 38.83±11.53yrs of age. The time of cranioplasty was with mean of 4months 6days.

Table 1: Showing age and time of cranioplasty.

	Mean	SD
Age	38.83	11.53
Time of cranioplasty from date of decra months	4.00	3.36
Time of cranioplasty from date of decra days	6.10	5.35

Table 2: Showing basic demographic and surgical detail of patients

		Count	N %
Gender	Female	12	28.6%
	Male	30	71.4%
DSIS	BG bleed	10	23.8%
	Trauma	32	76.2%
Flap abdomen	No	5	11.9%
	Yes	37	88.1%
Material_used	Endogenous	38	90.5%
	Exogenous	4	9.5%
Pre-Op intervention	Lumbar puncture	13	31.0%
	No	24	57.1%
	VP shunt	5	11.9%
Graft fixation	Plates	11	26.2%
	Suture	31	73.8%

Among included patients, 71.4% were male patients and 28.6% were female. 76.2% were due to trauma, 23.8% were with BG bleeding. Graft fixation was done with suture in 73.8% and 26.2% with plates.

Table 3: Comparison of mean level of peak systolic volume among patients

Peak Systolic Volume (CM/S)		Mean	SD	P-value
Pair 1	Pre-Op	80.95	5.0	0.01*
	Post-Op	89.64	6.07	
Pair 2	Pre-Op	80.95	5.0	0.01*
	2weeks	100.97	5.98	
Pair 3	Post-Op	89.64	6.07	0.01*
	2weeks	100.97	5.98	

Statistical different mean level in peak systolic volume was noted before and after cranioplasty procedure. ($p<0.05$) there was improvement in the peak systolic volume after cranioplasty and also 2weeks period.

Table 4: Comparison of mean volume among patients				
Mean Volume (CM/S)		Mean	SD	P-value
Pair 1	Pre-Op	54.12	4.07	0.01*
	Post-Op	58.01	5.93	
Pair 2	Pre-Op	54.12	4.07	0.01*
	2weeks	60.73	3.3	
Pair 3	Post-Op	58.01	5.93	0.01*
	2weeks	60.73	3.3	

Statistical different mean level in mean volume was noted before and after cranioplasty procedure ($p<0.05$) there was improvement in the mean volume after cranioplasty and also 2weeks period.

III. Discussion:

Traumatic brain injury (TBI) stands as one of the leading causes of mortality, often resulting in markedly elevated intracranial pressure (ICP) leading to cerebral ischemia and subsequent complications. Managing such elevated pressure solely through medical interventions can be challenging. The adverse effects of this intracranial hypertension stem from brain compression, which impedes cerebral blood flow and can cause further damage. To mitigate additional harm from heightened ICP, neurosurgeons resort to decompressive craniectomy (DC), a procedure aimed at improving clinical outcomes.[5,6]

DC involves temporarily removing a portion of the skull to alleviate severe intracranial pressure that is unresponsive to other treatments. Conditions such as cerebral oedema, intracranial haemorrhage, or space-occupying hematoma can result in dangerously high ICP, potentially leading to secondary brain damage, herniation, or fatality. By reducing pressure, DC may attenuate ischemic damage by enhancing cerebral blood flow and tissue oxygenation. Performing DC early on has been shown to decrease mortality rates and improve overall outcomes. Nonetheless, it is typically considered a last-resort option when all other attempts to manage ICP have been exhausted.[7] Richaud et al. (1985) proposed that the neurological improvement observed after cranioplasty could be attributed to the restoration of cerebral hemodynamics.[8] In 1987, Hatashita et al. investigated the impact of craniectomy on the biomechanics of the healthy brain in animal studies.[8]

Present study documented with Statistical different mean level in peak systolic volume was noted before and after cranioplasty procedure.($p<0.05$) there was improvement in the peak systolic volume after cranioplasty and also 2weeks period. Also there is statistical different mean level in mean volume was noted before and after cranioplasty procedure.($p<0.05$) there was improvement in the mean volume after cranioplasty and also 2weeks period. In concordance to present study, Reddy R et al., also documented improvement in the mean blood flow velocity and peak systolic volume among the patients who underwent the cranioplasty.[9] It is observed that cranioplasty performed from 3 to 6 months after DC may significantly improve hemodynamic recovery.[10]

IV. Conclusion:

The cranioplasty improves postoperative improvement in patients with improvement in peak systolic volume and mean blood flow volume. Cranioplasty will significantly improve cerebral blood flow both on ipsilateral cerebral hemispheres. Transcranial Doppler ultrasonogram is an effective, non-invasive and inexpensive method of detecting changes of cerebral hemodynamics.

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Reference:

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