Original Research Paper

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POST OPERATIVE INTRACRANIAL PRESSURE MONITORING FOLLOWING EARLY DECOMPRESSIVE CRANIECTOMY IN SEVERE TRAUMATIC BRAIN INJURY PATIENTS – OUR INSTITUTIONAL EXPERIENCE.

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ABSTRACT **BACKGROUND:** ICP monitoring after early decompression in post operative period serves as a valuable tool in diagnosing post operative intracranial hypertension/ raised ICP which guides for more appropriate medical treatment to reduce ICP or even subsequent surgery which ultimately decides the outcome of the patients. **METHODS AND MATERIALS:** It is a prospective analysis from january 2022 to january 2023 in the Dept of Neurosurgery, Madurai medical college . This study includes 32 patients with severe traumatic brain injury with a GCS score of < 8 who underwent early decompressive craniectomy. Finally 32 patients were included in this study and were divided into two groups. The following parameters were analysed age, sex, initial GCS, pupillary response,blood pressure, pulse rate, respiratory rate two week mortality. Two week time frame was selected because in our institute 75% of deaths occur in the first two weeks after injury. **RESULTS:** The Statistical analysis was performed by STATA 11.2 (College Station TX USA).Students independent sample t-test is used to find the significance difference between the parameters and GCS score between the treatment groups **CONCLUSION:** The present study suggests that ICP monitoring, in conjunction with postoperative treatment after early Decompressive craniectomy , is associated with a significantly reduced risk of death. This is the first study that statistically evaluated two-week mortalities in patients who had ICP monitoring as part of their postoperative treatment, compared to patients treated without ICP monitoring.

KEYWORDS : Trauma, subdural probe, RTA, ICP monitoring, Decompressive craniectomy.

INTRODUCTION

Traumatic brain injury is the leading cause of death and disability around the globe , inspite of all the improvements made in emergency care, critical care, surgical,medical treatment, rehabilitation.

India is rather distinct of having highest rate of head injury in the world, more than 100000 lives are lost every year with over 1 million suffering from serious head injury. Road traffic accidents are the leading cause accounting for 60%, followed by fall 25% and violence 10-15%. Rehabilitation needs of traumatic brain injury patients is significantly increasing every year. Developing nations face major challenges of prevention, hospitalization, rehabilitatiion in this environment to reduce the burden .

The main goal in treating traumatic brain injury patients is the reduction of elevated intracranial pressure and the maintanence of adequate cerebral blood flow and oxygenation. Deccompressive craniectomy is the cornerstone in treating elevated/ uncontrolled intracranial pressure. Earlier the decompressive craniectomy from the time of injury was one of the major factor that decided the outcome of TBI patients. Several studies suggest that DC should be performed as early as possible after initial trauma. Even after early decompression and intensive care with medical management there occurs uncontrolled raise in ICP which is due to post traumatic cerebral edema which may need subsequent decompression on the other side of brain as well.

ICP monitoring after early decompressive craniectomy in post operative period serves as a valuable tool in diagnosing post op intracranial hypertension/ raised ICP which guides for more appropriate medical treatment to reduce ICP or even subsequent surgery which ultimately decides the outcome of the patients.

The main objective of this study is to evaluate the use of ICP monitoring placed subdurally in post operative patients with severe traumatic brain injury against two week mortality rate.

MATERIALS AND METHODS:

Prospective analysis was made from january 2022 to january 2023 in Dept of neurosurgery Madurai medical college . This study included 32 patients with severe traumatic brain injury with a GCS score of <8 who underwent early decompression craniectomy.

INCLUSION CRITERIA:

Severe traumatic brain injury cases from january 2022 – january 2023.
Age group 18-70 years.

Pt with Gcs score <8 who underwent early decompressive craniectomy. Marshall ct grading III and above No associated visceral, solid organ, long bone injury.

EXCLUSION CRITERIA

Age <18 and >70 years.
Severe heart, lung , kidney disease.
Patients with Gcs>8.
Patient with coagulopathy, altered blood parameters.

Finally 32 patients were included in this study and were divided into two groups.

Group I -16 patients who were managed post operatively without icp monitoring.

Group II -16 patients who were placed with subdural icp probe during decompression craniectomy.

The following parameters were analysed age, sex, initial GCS, pupillary response,blood pressure, pulse rate, respiratory rate two week mortality. Two week time frame was selected because in our institute 75% of deaths occur in first two weeks after injury.

MARSHALL GRADING:

Table 1 : grading

GRADE	CT FINDINGS
I	No visible intracranial pathology
II	Midline shift of 0-5mm Basal cisterns remain visible No high or mixed density lesion >25cm^3
III	Midline shift of 0-5mm Basal cisterns compressed/completely effaced No high or mixed density lesion >25cm^3

IV	Midline shift of >5mm No high or mixed density lesion >25cm3
V	Any lesion surgically evacuated
VI	High or mixed density lesion >25cm3 Not surgically evacuated.

SURGICAL PROCEDURE:
Under general anaethesia and patient in supine position and head turned to lateral aspect based on side to be operated, parts painted and draped with aseptic precautions. A questionmark/ reverse question mark skin incision made, skin, subcutaneous tissue and temporalis muscle flap raised . 6 burrhole craniotomy made and free boneflap removed and dural tack up (poppen) sutures taken with 3'0 silk interrupted sutures. Dura opened in c-shaped manner with its base towards sylvian fissure, evacuation of SDH clot along with removal of contused tissue was done in meticulous manner and hemostasis ensured using surgicel and gelfoam.

PLACEMENT OF SUBDURAL PROBE:
After obtaining absolute hemostasis a subdural ICP monitoring catheter CAMINO INTEGRA zeroed relative to atmospheric pressure and placed temporoparietal/ frontoparietal region, dura repositioned free bone flap not replaced, temporalis muscle repositioned and wound closed in layers with 2'0 vicryl interrupted subcutaneous and 2'0 ethilon interrupted skin sutures, sterile dressing applied.

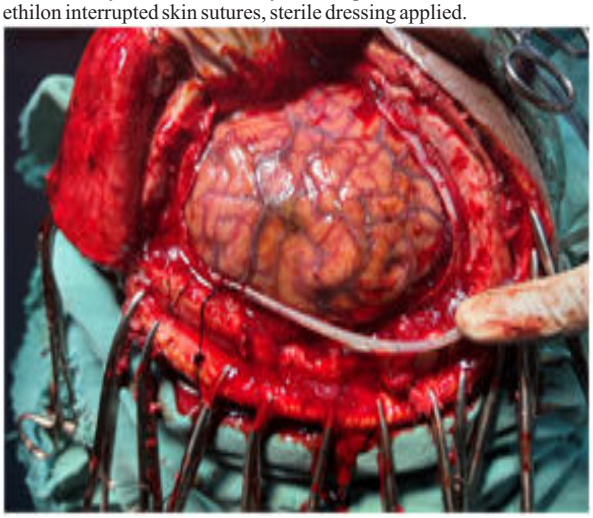


Fig 1 : placement of subdural probe

POST OPERATIVE MONITORING:
All patients were primarily stabilized in trauma triage. Patients are transferred to neurosurgery intensive care unit, Patients were assessed based on the parameters and radiological imaging.Decompressive craniectomy was performed in indicated cases within a time frame 6 hours.

Group 1:
After decompressive surgery patients were managed by conventional medical therapies including Hyper-osmotic agents (mannitol 0.5-1g/kd/day) Sedation (midazolam infusion (10-15 mcg/kg/day, fentanyl infusion1-2 mcg/kg/hour) Antiepileptics (phenytoin loading dose 10-15mg/kg over 25-50mg/min,maintanence 100mg iv 8th hourly sodium valproate , levipill) Antibiotics (cephalosporins, carbapenem, beta lactams) Fluid management as needed to reduce intracranial hypertension (NS/RL at 100ml/hr) Muscle relaxants (atracurium loading dose 0.5 mg/kg, maintanence 0.1 mg/kg,) On and off hyperventilation

Group 2:
Conventional medical management same as group 1 with hourly ICP monitoring Cut off value >25 mm hg was considered significant. Time period of monitoring 72 hours. CPP= MAP – ICP < 60 suggestive of reduced cerebral perfusion pressure.

ICP MONITORING:
Lundberg outlined the basics of ideal ICP monitor. It should be reliable, easy to handle with minimal trauma during placement ,negligible risk of infection and csf leak. CAMINO INTEGRA ICP MONITOR with SUBDURAL PROBE was utilized in this study.

Fig 2: camino integra monitor

Fig 3: post op patient

WAVEFORMS:
P1 = percussion wave represents arterial pulsation and reflects cerebral blood flow.

P2 = Tidal wave due to retrograde jugular pulse against cortical veins represents intracranial compliance

P3 = Dicrotic wave represents venous pulsation.

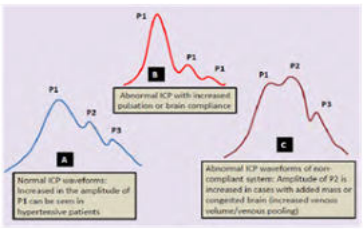


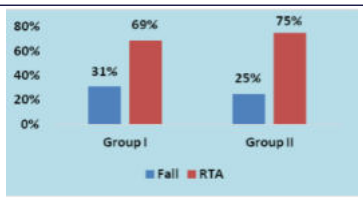
Fig 4: icp waveforms

Statistical data:
Table 2: comparison of groups

	Group I	Group II	P-Value
	Mean ± SD	Mean ± SD	
Age (In years)	43.68 ± 13.05	47.44 ± 12.52	0.414
Systolic Blood Pressure	152.50 ± 10.0	153.12 ± 11.95	0.874
Diastolic Blood pressure	84.34 ± 5.12	85.62 ± 6.29	0.542
Pulse rate	59.50 ± 2.48	59.12 ± 2.19	0.653
Respiratory rate	10.94 ± 0.85	11.34 ± 1.26	0.258
GCS	5.56 ± 1.03	5.63 ± 1.15	0.872

Table 3: Analysis of 32 patients predicting 2 week mortality

	Group I	Group II	Total	P-Value
Gender				
Male	10 (62%)	11 (69%)	21	0.710
Female	6 (38%)	5 (31%)	11	
Marshall Grading				
IV	16 (100%)	16 (100%)	32	
Pupils				
NTRL	2 (13%)	4 (22%)	6	0.367
RTL	9 (56%)	10 (65%)	19	
STRL	5 (31%)	2 (13%)	7	
Mode of Injury				
Fall	5 (31%)	4 (25%)	9	0.694
RTA	11 (69%)	12 (75%)	23	
Morality at 2 Weeks				
Alive	4 (25%)	10 (62%)	14	0.033
Death	12 (75%)	6 (38%)	18	



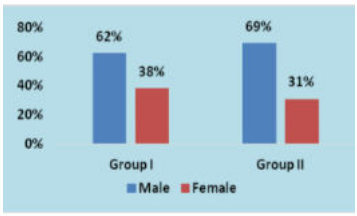
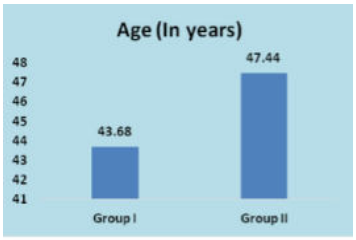


Fig 5 & 6 Case distribution male vs female and mode of injury



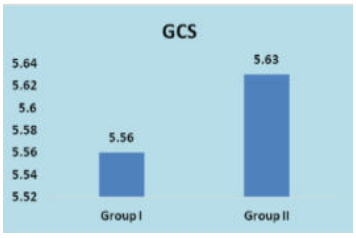


Fig 7 & 8 case distribution age in years and GCS

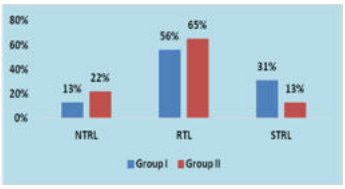


Fig 9 pulse rate and respiratory rate & pupillary response

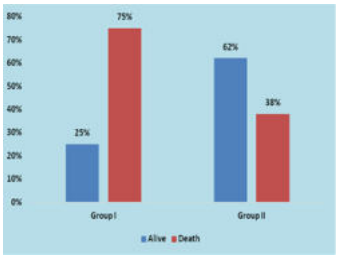


Fig 10 Mortality

RESULTS :

The Statistical analysis was performed by STATA 11.2 (College Station TX USA).Students independent sample t-test is used to find the significance difference between the parameters and GCS score between the treatment groups (Group I and Group II) and it is expressed as mean and standard deviation. Chi square test for goodness of fit were used to measure the association between the gender, mode of injury and mortality at two weeks between the treatment groups and it is expressed as frequency and percentage. $P<0.05$ considered as statistically significance.

DISCUSSION:

SIGNIFICANCE OF EARLY DECOMPRESSION:

DC has become a valuable tool in managing severe head injury since Kocher first introduced decompressive surgery to alleviate intracranial hypertension. The role of DC in severe neurotrauma has not been proven scientifically, as the pathophysiological process of post-traumatic brain swelling is complicated and not fully understood. Neurosurgical guidelines, indication for DC includes dilated and unresponsiveness papillary response to light, ICP values (greater than 25 mm Hg) for a period longer than 15 minutes and failure to respond to medical management. DC is often perceived as a last resort for treating uncontrollable ICP, which restricts many of its positive effects. Several clinical trials suugest that early decompression reduce mortality. Additional evidence shows that very early decompression significantly reduces secondary brain injury. Thus in patients with a severe brain injury, an early decompression may prevent secondary injuries that would occur during unsuccessful ICP treatment with conventional methods. Thus patients given early decompression will have a better outcome than those that have a later decompression. In this study, we performed early DC in severe TBI patients who had abnormal findings in their CT scans with in a time period of 6 hours.

POSTOPERATIVE ICP MONITORING:

According to evidence-based guidelines of the Brain tumor foundation , using an ICP monitor is recommended for all patients with head injuries with GCS of 3 to 8 after resuscitation and an abnormal head CT scan according to marshall grading , as well as in patients with severe TBI and normal head CT scans, if two or more of the following features are present on admission : age greater than 40, unilateral or bilateral posturing, or systolic blood pressure less than 90 mm Hg. when icp monitors used in a protocol-based manner in neurosurgical intensive care units, leads to improved outcomes in TBI. There is still debate over the effect of ICP monitoring on outcomes, despite increasing evidence that its implementation leads to improved outcomes. The findings of this study suggest that post-decompression treatment with subdural ICP monitoring improves outcome, as measured by the two-week adjusted mortalities. Two-week mortality was chosen as the end point of this study because this early time point accounts for over 75% of all TBI-related mortality. Later time points such as 30-day mortality include complications or associated comorbidities due to ICU and hospital length of stay. The age and GCS of the patient are major factors that influence the DC effectiveness. Patients with age of <50 and gcs >6 had more favourable outcome when compared to older patientsor pt with gcs <6. The characteristics of the patients in this study that were treated for intracranial hypertension with monitoring, versus those treated without a monitor did not differ with regard to age, sex, initial GCS score, or pupillary response. The two-week mortalities, however, were significantly improved if the post-decompression treatment was coupled with the use of an ICP monitor. The main reason for improvement is that ICP monitoring ensures that the patients receive treatment with a better speed and accuracy.

CONSECUTIVE SURGERY:

After primary Decompressive craniectomy, persisting intracranial hypertension in GROUP 2 patients were treated with:
External ventricular drain (EVD) – 2 patients
Decompressive Craniectomy opposite side – 2 patients
Removal of newly formed hematomas – 1 patient.

Bilateral DC was first described by Miyazakib et al in 1966, and was popularized in 1971. For patients with diffuse brain swelling or global brain edema who fail to respond to more conservative medical treatments, bilateral DC may be the ideal treatment. After unilateral decompressive surgery, several mechanisms such as vasogenic and cytotoxic edema, as well as cerebral auto-regulatory dysfunction, may still contribute to post traumatic brain swelling following severe TBI. Thus, additional DC on the other side of the brain should be considered as a last-resort therapy for patients at risk of developing brain swelling or edema, after unilateral decompressive surgery, to interrupt this vicious cycle and hopefully avoid further complications.

LIMITATIONS OF THIS STUDY:

This study has some limitations mostly stemming from its small sample sizeand time period . Methodological weaknesses include 1) lack of selection parameters influencing the decision to monitor, 2) baseline differences between groups in other disease characteristics and therapeutic factors known to affect outcome following TBI. Besides, Two-week adjusted mortality rather than 6-month Glasgow Outcome Scale score was used as the primary outcome measure. Although our data indicate that ICP monitoring after early DC yields good outcomes, short term outcome are prone to bias. Therefore, future research of corresponding randomized controlled trials and outcome assessment to include long-term functional status is warranted to

further explore the role of this procedure.

CONCLUSION:

The present study suggests that ICP monitoring, in conjunction with postoperative treatment after early DC, is associated with a significantly reduced risk of death. This study that statistically evaluated two-week mortalities in patients who had ICP monitoring as part of their postoperative treatment, compared to patients treated without ICP monitoring. In addition, we speculate that consecutive DC on the other side may be a favorable treatment for patients who show high ICP's of greater than 25 mm Hg, and fail to respond to maximal medical treatment after early DC.

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