ORIGINAL ARTICLE

The Role of Intracranial Pressure (ICP) Monitoring in Severe Traumatic Brain Injury (TBI)

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ABSTRACT

The management of patients with severe head injury is a prodigious task for any neurosurgical team. After the initial life support, the management plan of patient with traumatic brain injury rest on the findings of a cranial CT scan. The treatment options of TBI differ with severity of trauma. Osmotic diuretics in the acute phase can be helpful. Hyperventilation is a method to be used in conjunction with other options in certain situations. Normal values of intra cranial pressure (ICP) vary with age, being 10 to 15 mm Hg in an adult. Intra cranial pressure (ICP) values of 20 to 30 mm Hg shows mild intracranial hypertension, while sustained intra cranial pressure (ICP) values more than 40 mm Hg indicate life threatening malignant intracranial hypertension which should be lowered immediately. Measuring the intra cranial pressure of severe traumatic brain injury patients is now mandatory as it allows an effective and control way of lowering the raised ICP with very good outcome results.

Objective: *To adjust the ICP lowering mechanics according to the reading obtained via the ICP monitor in patients after severe head injury so as to minimize the need of ventilatory support and decrease the patients' stay at hospital.*

1. *To measure the value of ICP by using ICP monitoring in severe head injuries (GCS score below or equal to 8).*
2. *To assess the outcome of the conservative measures in patients in whom ICP was monitored, on the basis of Glasgow Outcome Scale.*

Study Design: *Prospective descriptive study.*

Setting: *Department of Neurosurgery, Lahore General Hospital, Lahore.*

Duration of Study: *One year from July 2012 to July 2013.*

Material and Methods: *Thirty patients of traumatic brain injury were included in this study. ICP monitoring was done via Integra intra parenchymal Camino bolt and Integra ICP monitors.*

Results: *Out of 30 patients, there were 21 (70%) male patients and 9 (30%) female patients.The male to female ratio was 2.33:1. In 20 (67%) patients the ICP ranged from 25-34 mmHg. There were 10 (33%) patients having ICP of 35 – 50 mm Hg. The mean intracranial pressure was 29.5 ± 6.96. The Glasgow coma scale of our patients was such that there were2 (6.6%) patients had GCS 5. In GCS 6 there were 20 (66%) patients. There were 3 (10%) patients who had a GCS of 7. In GCS 8 there were 5 (16.6) patients. The ventilation duration was 5 – 15 days. The frequency of hospital stay in our patients 10-30 days. There were 2 (7%) patients of Glasgow outcome scale of grade – I. In grade – II, there were 3 (10%) patients, no patient in Glasgow outcome scale grade – III. There were 10 (33%) patients in grade – IV while 15 (50%) patient were in grade – V. In the follow up cases, after 1 month, there were no patient in grade – I. There were 3 (10%) patients of GOS grade – II, in grade – III there were 4 (13%) patients, there were 8 (27%) patients grade – IV. 15 (50%) patients of grade – V. After 3 month, there was 1 (3%) patient in grade – I. There were 2 (7%) patients of GOS grade – II, in grade – III there*

were 2 (7%) patients, there were 10 (33%) patients grade – IV. 15 (50%) patients of grade – V.

Conclusion: *It is concluded that ICP monitoring is useful for improving the outcome of traumatic brain injury patients. Most of the patients were in young age. Majority of the patients had a low Glasgow coma scales. In our study most of the patients were male. In this study there is short duration of ventilation in patients and a short hospital stay in patients of TBI in which ICP is monitored and addressed promptly.*

Keywords: *Glasgow coma scale, Glasgow outcome scale, Intra cranial pressure, Traumatic Brain Injury.*

Abbreviations: *ICP = Intracranial Pressure. TBI = Traumatic Brain Injury. GCS = Glasgow Coma Scale. GOS = Glasgow Coma Outcome Scale.*

INTRODUCTION

Intracranial pressure (ICP) is a reflection of the relationship between alterations in craniospinal volume and the ability of the craniospinal axis to accommodate added volume (Giuseppe Citerio, Peter J D Andrews 2004).

The outcome of patients with head injury depends upon several factors and most important among them is the raised intracranial pressure. An increasing evidence supports the concept that raised intracranial pressure (ICP) produces slow B waves, which represent the auto regulatory response of spontaneous fluctuations of cerebral perfusion pressure. A relationship between cerebral auto regulation and clinical outcome in patients with traumatic brain injury has been established (Kostas N Fountas et al, 2005).

Moreover, raised ICP is the most common cause of death, in patients with head injury. Uncontrolled intracranial hypertension produces secondary damage by reducing cerebral blood flow. However, surprisingly routine ICP monitoring in head injury still continues to be a subject of controversy (Marshall LF et al, 1979, Miller JD 1987, Marmarou A et al, 1991). Lundberg was the first person to introduce ICP monitoring. Today ICP monitoring has gained a place in neurosurgical ICU management and become an integral part of ICU care. ICP monitoring is extensively studied in head injury patients in last three decades (Marshall LF et al, 1979, Miller JD 1987, Narayan RK et al, 1982, Lundberg N 1960, Miller JD 1981) either to establish its practical value for therapy or as a prognostic factor (Miller JD 1987, Narayan RK et al, 1982, Mahapatra AK, Bansal S 1998). Several studies linked high level of ICP with high mortality and morbidity. Persistent raised ICP has a direct effect on the brain tissue in spite of cerebral perfusion pressure being normal. ICP monitoring is routinely carried out in severe head injury patients, patients with good coma scale, CT scan brain showing multiple small hematomas not meriting surgery, patients with good coma scale with single large intracranial hematoma diagnosed on CT scan, patients with diffuse brain swelling those who need aggressive management and for postoperative ICP monitoring following evacuation of hematoma. Till 1996, there were 146 articles published on ICP monitoring in head injury, 41% publications on head injury and ICP monitoring and of these 27 articles have dealt with indications for ICP monitoring. The correlation between high ICP and poor outcomes has been well reported by many authors (Johnston IH et al 1970, Marmarou A et al 1991, Becker DP et al, 1977, Marshall LF et al, 1991). Narayan et al reported 53 – 63% raised ICP in severe closed head injury patients with abnormal CT scan while patients with normal CT scan had 13% incidence of raised ICP. The risk of raised ICP in moderate head injury is 10 – 20% especially more so in the presence of mass lesion. Most studies recommend ICP monitoring for 48 – 72 hrs, as the intracranial hypertension is maximum between 48 – 72 hours following traumatic recording not only helps inguiding therapy, but also helps in predicting the outcome.

MATERIAL AND METHODS

In this study, 30 cases of traumatic brain injury were admitted to our unit from 2012 to 2013 and subjected to intracranial pressure monitoring using Integra Camino bolt intra **parenchymally** were evaluated (Figure 1 and 2). The age range was 6 – 60 years (21 males and 9 females). There were 2 patients with GCS 5, 20 patients in GCS 6, 3 patients had a GCS of 7, while GCS of 8 in 5 patients. The ventilation duration was 5 – 15 days. The frequency of hospital stay in our patients 10 – 30 days with decongestants / ventilatory support, nasogastric feeding and continuous ICP monitoring using subdural Richmond bolt system for 7 days.

Integra Camino ICP bolt was placed subdurally under local anesthesia when a decision for conservative management and to electively monitor / ventilate the patients was taken.

Figure 1: *ICP monitoring Camino bolt and hand twist drill for making fenestration.*

Figure 2: *ICP monitoring probe placed into subarachnoid space and ICP monitoring recording the readings.*

After head shaving and cleaning, Camino bolt was inserted into the subdural space after making a twist drill burr hole at a point 1.5cm anterior to coronal suture and 3 cm lateral to the midline. Dura was pierced with the bolt tip and with the help of cannula the subarachnoid space was confirmed via the emergence of CSF.

ICP monitoring was done for 3 – 7 days in 30 patients in the present series. All patients had elective ventilatory care and received decongestants (intravenous mannitol and frusemide) and underwent CT scanning in the event of clinical deterioration / persistent intracranial hypertension (> 20 mm Hg). There was no technical failure in any patients and opening pressure readings were obtained in all patients. Intracranial pressure ranged from 15 – 25 mm Hg in patients having GCS of7 and 8, while patients had 20 – 45 mm Hg when GCS was below 7.

RESULTS

Out of 30 patients, there were 21 (70%) male patients and 9 (30%) female patients. The male to female ratio was 2.33:1. In 20 (67%) patients the ICP ranged from 25 – 34 mm Hg. There were 10 (33%) patients having ICP of 35 – 50 mm Hg.

The Glasgow coma scale of our patients was such that there were 2 (6.6%) patients had GCS 5. In GCS 6

Figure 3: *Patient in ICU with ICP monitoring and elective ventilation.*

Figure 4: *Patient in ICU with ICP monitoring going on but is weaned off from ventilatory support.*

there were 20 (66%) patients. There were 3 (10%) patients who had a GCS of 7. In GCS 8 there were 5 (16.6) patients. The ventilation duration was 3 – 15 days. The frequency of hospital stay in our patients 10 – 30 days.

At time of discharge, there were 2 (7%) patients of Glasgow outcome scale of grade – I. In grade – II, there were 3 (10%) patients, no patient in Glasgow outcome scale grade – III, There were 10 (33%) patients in grade – IV while 15 (50%) patient were in grade – V.

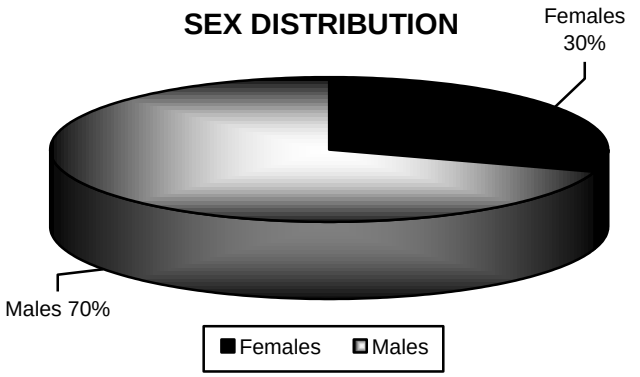

Figure 5: *Male and female ratio.*

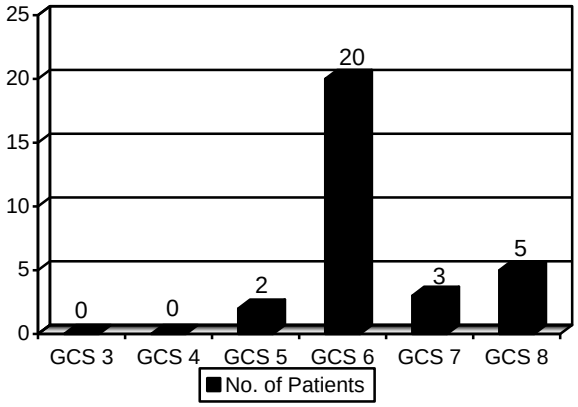

Figure 6: *Glasgow Coma Scale of our patients at time of presentation.*

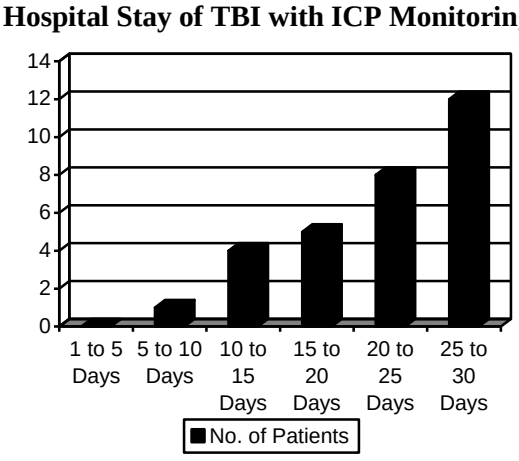

Figure 7: *Hospital stay of patients sustaining severe head injury with ICP monitoring.*

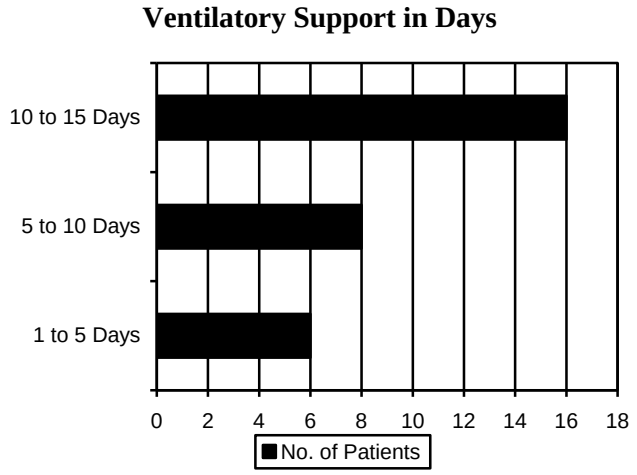

Figure 8: *Number of days of ventilatory support of severe head injury patients with ICP monitoring.*

In the follow up cases, after 1 month, there were no patient in grade – I. There were 3 (10%) patients of GOS grade – II, in grade – III there were 4 (13%) patients, there were 8 (27%) patients grade – IV. 15 (50%) patients of grade – V. After 3 month, there was 1 (3%) patient in grade – I. There were 2 (7%) patients of GOS grade – II, in grade – III there were 2 (7%) patients, there were 8 (27%) patients grade – IV. 17 (59%) patients of grade – V.

DISCUSSION

Intracranial pressure monitoring is reported to improve mortality from head injury. In 1977, Jennett et al reported nearly 50% mortality in severe head injury (Jennett B et al, 1977). Subsequently other authors reported lower mortality with aggressive treatment (Marshall LF et al 1979, Miller JD et al 1977, Becker DP et al 1977, Miller JD et al 1981). Aggressive management means ICU care, ventilation and ICP monitoring. Saul and Duckertreated two groups of severe head injury with mannitol and CSF drainage. In the patients in whom ICP was between 20 – 25 mm Hg had 46% mortality as compared to 28% mortality in patients in whom ICP was 15 mm Hg (Saul TG, Ducker TB 1982). Intracranial hypertension was noted in 17 severe head injury patients, 13/17 (76%) cases expired. Normal intracranial pressure was observed in 35 cases and of these 21 patients expired (60%). In our series we also found that ICP was greater in patient having GCS below 6 that was 20 – 45 mm of Hg. Similarly patient having GCS of 7 and 8showed good outcome results. Mahapatra et al, noted raised ICP in 65% of cases, overall 52% patients with raised ICP had good outcome and only 15% had good outcome in their series (Mahapatra AK, Bansal S, 1998). In the absence of intracranial role of invasive ICP monitoring in patients with traumatic brain injury: An Experience of 98 Cases hypertension, good outcome (GOS of 4 or 5) was noted in 25.5% cases while only 8.2% had good outcome in the presence of intracranial hypertension and this difference was significant. The determination of cerebral perfusion pressure is regarded as vital in monitoring patients with severe traumatic brain injury. Besides indicating the status of cerebral blood flow, it also reveals the status of intracranial pressure. The abnormal or suboptimal level of CPP is commonly correlated with high values of ICP and therefore with poor patient outcomes. Isa R et al studied outcome of severe traumatic brain injury and compared three monitoring approaches: ICP alone, CPP and CBF and conservative methods during two different observation periods. The authors noted that only time between injury and arrival was statistically significant. There was a statistically significant difference in the proportions of good outcomes between the multimodality group compared with the group of patients that underwent a single intracranial based monitoring method and the group that received no monitoring based on a disability rating scale after a follow up of 12 months (Isa R et al, 2003). In Mahapatra et al, series, 65% of their patients had raised ICP (Mahapatra AK, Bansal S, 1998).

In our current series, 20 (67%) patients had ICP ranged from 25 – 34 mm Hg. There were 10 (33%) patients having ICP of 35 – 50 mm Hg. Over all 59% patients with raised ICP had excellent outcome and only 21% had a good outcome. Poor outcome in the presence of raised ICT was noted in 11% patients while we encountered 9% mortality. Diffuse axonal injuries were seen in all cases, ICP more than 20 mm Hg was seen in 100% of these cases.

CONCLUSION

It is concluded that ICP monitoring is improving the outcome of traumatic brain injury patients. Most of the patients were in young age. Majority of the patients had a low Glasgow coma scales. In our study most of the patients were male. In this study there is short duration of ventilation in patients and a short hospital stay in patients of TBI in which ICP is monitored and addressed promptly.

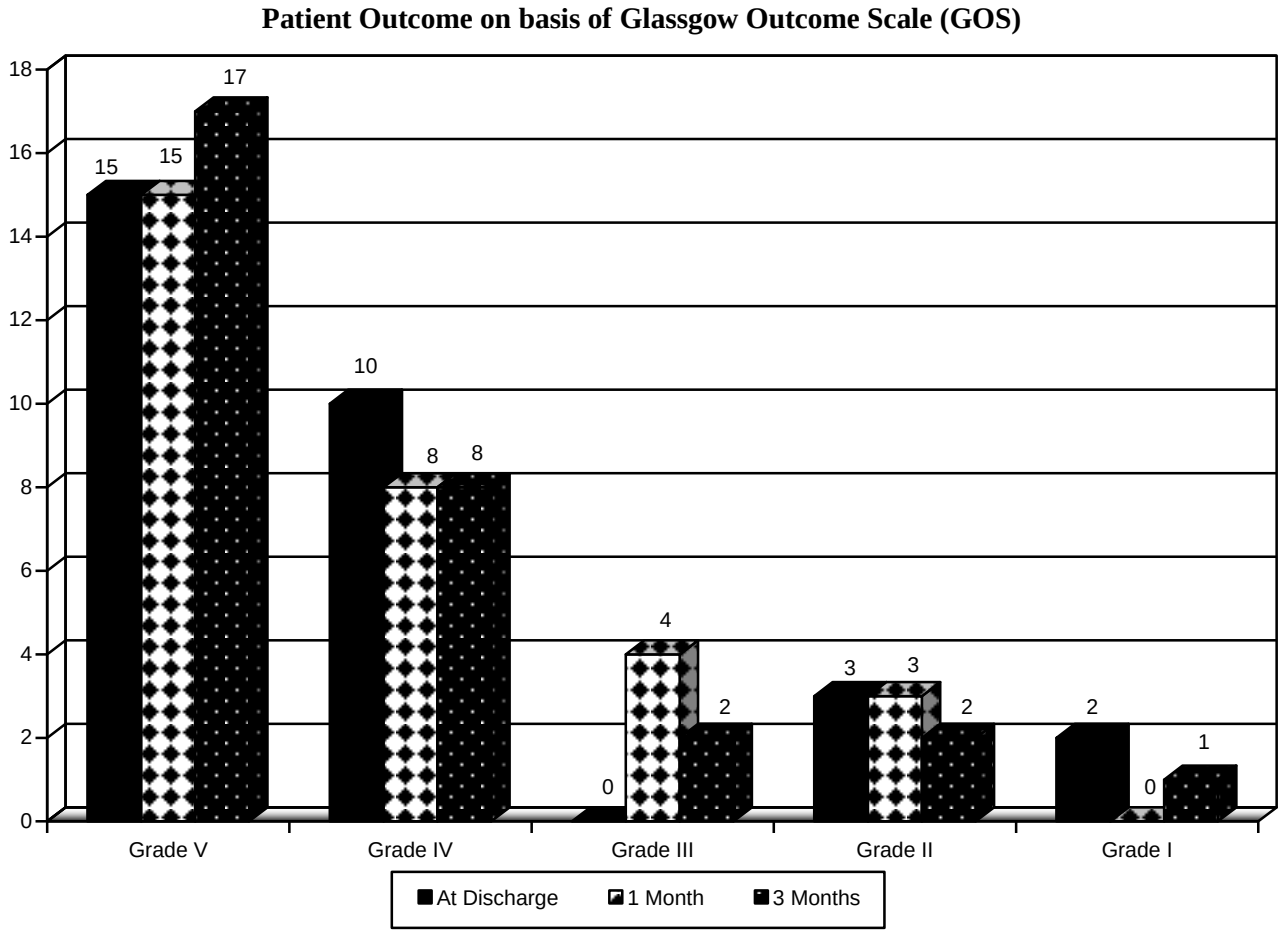

Figure 9: *Outcome of 30 patients on the basis of GOS at discharge, 1 month and 3 months.*

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