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Monitoring of Intracranial Pressure in Severe and Moderate Head Injury and Clinicoradiological Correlation

KEYWORDS: ICP, Head-injury

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ABSTRACT *ICP monitoring is useful in head injury, poor grade subarachnoid hemorrhage, (SAH), stroke, intracerebral hematoma, meningitis, acute liver failure, hydrocephalus, benign intracranial hypertension, craniosynostosis etc. Information which can be derived from ICP and its waveforms, includes cerebral perfusion pressure, regulation of cerebral blood flow and volume, CSF absorption capacity, brain compensatory reserve, and content of vasogenic events. In head injury ICP monitoring is indicated in all patients with severe head injury (GCS 3-8) and those patients with moderate head injury (GCS 9-12) at increased risk or who cannot be followed with serial neurological examination (eg. anaesthetized for other procedure). Our study has confirmed the findings of earlier studies that intracranial pressure monitoring is a useful tool in the management of head injury. ICP monitoring can also identify patients who are initially managed conservatively but raising ICP may indicate need for surgery. Hence it is recommended that ICP monitoring should be an essential tool in managing TBI cases.*

INTRODUCTION

ICP monitoring is useful in head injury, poor grade subarachnoid hemorrhage, (SAH), stroke, intracerebral hematoma, meningitis, acute liver failure, hydrocephalus, benign intracranial hypertension, craniosynostosis etc. Information which can be derived from ICP and its Waveforms, includes cerebral perfusion pressure, regulation of cerebral blood flow and volume, CSF absorption capacity, brain compensatory reserve, and content of vasogenic events. The purpose of this study is to monitor ICP in case of severe and moderate head injury and analyse its relation with clinicoradiological findings and further to correlate the ICP values with eventual outcome of patients and see if ICP values can be used for prognostication. The study was conducted upon 30 traumatic head injuries case with post resuscitation GCS below 13 enrolled for the study between Sep 2011 and Mar 2013. All the patients of traumatic head injuries of GCS 13 or above were excluded from the study. The patients having polytrauma (abdomen, chest, long bone injuries) were excluded. NCCT head was done in all cases on admission and it was repeated whenever required during treatment. After obtaining informed consent parenchymal transducer were placed in ICU who were managed conservatively and in operation theatre who were posted for surgery immediately after admission. ICP reading was recorded for 5 days and it was correlated with clinico-radiological findings. All patients were followed up and their outcome was assessed as per Glasgow Outcome Scale at 6 month. ICP readings were correlated with clinicoradiological findings and outcomes were compared with ICP readings and CT scan findings by using chi-square tests, pearson correlation or Student's t-test, as appropriate. A p value <0.05 was considered significant. In my study age of the patients varies from 2 years to 72 years out of which 17 are between 15-40 year and 12 are above 40 years. These all includes 20 male and 10 female patients. Road traffic accidents were the most common mode of injury. RTA was the cause of head injury in 18 patients (60%) and due to fall in 7 patients (23%). Other injuries were due to assault in 2 patients (7%) and sports injury in 3 patients (10%). All patients had history of loss of consciousness and 14 (46.67%) had history of seizure. Besides this 4 (13.33%) peritraumatic amnesia. On initial examination 24 (80%) were normotensive. 5 (17%) cases had hypertension and 1 (3.33%) case had hypotension (80 mm Hg). On admission GCS of 7 (23%) were 5-6, 13 (43%) patients were 7-8, 5 (16.67%) patients were 9-10 and that of 5 patients were 11-12. The Pupils of 16 (53.33%) patients were non synchronous and abnormally reacting to light. NCCT head on admission showed SDH in 11 (37%) cases, EDH in 7 (23%) cases, diffuse cerebral edema in 12 (40%) cases, SAH in 7 (23%) cases, intra parenchymal contusion in 13 (43%). There was significant midline shift in 10 (33%) cases. Besides these 8 (27%) patients had skull bone fracture. NCCT findings of most of the patients were associated with SDH, EDH, SAH with or without mid line shift and diffuse cerebral edema and only 2 patients showed normal CT Scans. All patients were admitted in ICU and placed on ICP monitoring. ICP of 14 (47%) cases were more than 25 mm Hg and ICP of 15 (50%) cases were between 20-24.9 mm Hg. Only 1 (3%) case was monitored ICP below 20 mm Hg. Out of 30 patients 12 (40%) underwent initial surgery. There were patients with significant midline shift on admission CT and intracranial haematomas. These underwent evacuation of haematoma with or without decompressive craniectomy. Six patients underwent surgery after ICP monitoring showed raised ICP and repeat CT Scan showed evidence of midline shift/ raised ICP. These 6 patients underwent decompressive hemicraniectomy with or without evacuation of freshly evolved haematomas. Outcome of all these cases were variable based on Glasgow outcome scale. Out of 30 patients 7 (23%) died and 11 (37%) had good recovery while 7 (23%) were severely disabled and 5 (17%) were moderately disabled. Age showed significant correlation neither with ICP nor with the outcome . In my study 47% cases of age group 15-40 years showed functional recovery whereas 67% cases of age group above 40 years had functional recovery. Out of 30 patients 11(37%) had SDH in which 7 (64%) had poor recovery. Whereas total 7 (23%) had EDH out of which 6 (86%) had functional recovery after surgical evacuation of hematoma. All 7 (23%) patients who had SAH showed

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poor recovery suggesting highly significant P value (0.001). 12 (40%) patients having diffuse cerebral edema showed significant poor recovery in 11 (92%) patients. 10 (33%) patients having head injury with midline shift showed significant poor recovery in 8 (80%) patients. Out of 13 (43%) patients having contusion showed poor recovery in 8 (62%) patients. Only 8 (27%) patients had skull bone fracture but 6 (75%) patients had poor recovery. Outcome of the patients who underwent decompressive craniectomy showed poor recovery in 56% and good recovery in 44% cases. One of the most important pathophysiologic phenomenons encountered by the neurosurgeon is that of increased intracranial pressure (ICP). In earlier days increased ICP was diagnosed by monitoring changes in vital signs. In the last 20 years intense research into the pathophysiologic effects of ICP on brain function, metabolism, blood flow, and other parameters has been undertaken. The first systemic recordings of intraventricular pressure were undertaken by Guillaume and Janny and Landberg. The cranium can be thought of as a hollow, rigid sphere of constant volume which contains three main components brain, cerebrospinal fluid (CSF) and blood (normal brain volume-1400 ml, CSF-75-100ml,cerebral vascular volume-75 ml). Monroe Kellie doctrine states that because of the rigidity of the vault and the essential incompressibility of the intracranial constituents, a change in the volume of brain causes a reciprocal change in the volume of one of the other intracranial components i.e. either blood or CSF. **Normal ICP:** Normal ICP is pulsatile owing mainly to intracranial arterial pulsation that reflects the cardiac and respiratory cycles. The generally accepted normal lower limit of CSF pressure via lumbar puncture is 5 mm Hg and the upper limit is 15 mm Hg. **Methods of measurement of ICP:** ICP can be measured by placing a transducer in intraventricular, intraparenchymal, subdural or epidural space. **Incidence and significance of increased ICP:** ICP may not be elevated after head injury and a normal ICP is not necessarily a favorable prognostic sign. Langfitt found that about one-third of the patients had moderate to severe increase in ICP (>30 mm Hg) after head injury. Patients with severe brain stem injury frequently have normal ICP but eventually die from their brain injury. However, selective and judicious use of ICP monitoring can provide valuable clinical and predictive information about a patient without increasing morbidity significantly. It has been found that elevated ICP is much more common in head injured patients with space-occupying masses than those without such lesions and indeed those patients who have very high or uncontrollable ICP (> 40mm Hg) have a very poor survival rate. Traumatic brain injury remains one of the most important clinical situations in which raised ICP may be present and in which aggressive therapy may prove most beneficial. A recent study from the multicentre Traumatic Coma Data Bank determined that an ICP > 20 mm Hg was the most significant predictor of increased mortality. Therefore it sounds logical that monitoring of ICP during management of head injuries patients may help in making management decisions and prognosticate the patient outcome.

MATERIALS AND METHOD

Study design: After the approval of the ethics committee of the institution, the study was carried out prospectively upon the patients admitted in the Intensive Care Unit of Army Hospital Research and Referral, Delhi Cantt, and informed consent was taken from the NOK after explaining the procedure in detail. The study was conducted upon all traumatic head injuries case with post resuscitation GCS below 13. **Selection of subjects:** A total of 30 traumatic head injuries case with post resuscitation GCS below 13 were enrolled for the study between Sep 2011 and Dec 2012. Detailed history, clinical examination and evaluation with routine investigations was done and recorded wherever indicated. ICP value was measured by placing a parenchymal transducer. **Inclusion criteria:** All the patients of exclusive traumatic head injuries of GCS below 13 were selected for the study whether they were managed surgically or conservatively. **Exclusion criteria:** All the patients of traumatic head injuries of GCS 13 or above were excluded from the study. The patients having polytrauma (abdomen, chest, long bone injuries) were excluded. **Study protocol:** All the patients were admitted in ICU and placed on monitor and vitals were recorded 2 hourly. NCCT head was done in all cases on admission and it was repeated whenever required during treatment. After obtaining informed consent parenchymal transducer were placed in ICU who were managed conservatively and in operation theatre who were posted for surgery immediately after admission. ICP reading was recorded for 5 days and it was correlated with clinico-radiological findings. All patients were followed up and their outcome was assessed as per Glasgow Outcome Scale at 6 month. The same was correlated with the ICP readings using Pearson correlations and compared with the final outcomes using Pearson Chi-square test.

OBSERVATION AND RESULTS

30 patients of exclusive head injury of post resuscitation GCS <13 were selected in this study who were admitted in Army Hospital (Research and Referral), Delhi Cantt during Sep 2011 to Dec 2012. Polytrauma patients were excluded. The follow-up period ranged from Sep 2011 to Mar 2013. The data were analyzed with SPSS 11.0. ICP readings were correlated with clinicoradiological findings and outcomes were compared with ICP readings and CT scan findings by using chi-square tests, pearson correlation or Student's t-test, as appropriate. A p value <0.05 was considered significant. Age of the patients varies from 24 month to 72 years out of which 17 are between 15-40 year and 12 are above 40 years. These all includes 20 male and 10 female patients. Road traffic accidents were the most common mode of injury. RTA was the cause of head injury in 18 patients (60%) and due to fall in 7 patients (23%). Other injuries were due to assault in 2 patients (7%) and sports injury in 3 patients (10%). All patients had history of loss of consciousness and 14 (46.67%) had history of seizure. Besides this 4 (13.33%) had peritraumatic amnesia. On initial examination 24 (80%) were normotensive. 5 (17%) cases had hypertension and 1 (3.33%) case had hypotension (80 mm Hg). Post resuscitation GCS of 7 (23%) were 5-6, 13 (43%) patients were 7-8, 5 (16.67%) patients were 9-10 and that of 5 patients were 11-12.The Pupils of 16 (53.33%) patients were non synchronous and abnormally reacting to light. NCCT head on admission showed SDH in 11 (37%) cases, EDH in 7 (23%) cases, diffuse cerebral edema in 12 (40%) cases, SAH in 7 (23%) cases, intra parenchymal contusion in 13 (43%). There was significant midline shift in 10 (33%) cases. Besides these 8 (27%) patients had skull bone fracture. NCCT findings of most of the patients were associated with SDH, EDH, SAH with or without mid line shift and diffuse cerebral edema and only 2 patients showed normal CT Scans. All patients were admitted in ICU and placed on ICP monitoring. ICP of 14 (47%) cases were more than 25 mm Hg and ICP of 15 (50%) cases were between 20-24.9 mm Hg. Only 1 (3%) case was monitored ICP below 20 mm Hg. Out of 30 patients 12 (40%) underwent initial surgery. There were patients with significant midline shift on admission CT and intracranial haematomas. These underwent evacuation of haematoma with or without decompressive craniec-

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tomy. Six patients underwent surgery after ICP monitoring showed raised ICP and repeat CT Scan showed evidence of midline shift/ raised ICP. These 6 patients underwent decompressive hemicraniectomy with or without evacuation of freshly evolved haematomas. Outcome of all these cases were variable based on Glasgow outcome scale. Out of 30 patients 7 (23%) died (GOS-1) and 7 (23%) were vegetative/severely disabled (GOS-2-3) while 5 (17%) were moderately disabled (GOS-4) and 11 (37%) had excellent recovery (GOS-5). **AGE AND OUTCOME :** Age showed significant correlation neither with ICP nor with the outcome. In my study 47% cases of age group 15-40 years showed functional recovery whereas 67% cases of age group above 40 years had functional recovery. **SDH AND OUTCOME:** Out of 30 patients 11(37%) had SDH in which 7 (64%) had poor recovery. **EDH AND OUTCOME:** Whereas total 7 (23%) had EDH out of which 6 (86%) had functional recovery after surgical evacuation of hematoma. **SAH AND OUTCOME:** All 7 (23%) patients who had SAH showed poor recovery suggesting highly significant P value (0.001).**DIFFUSE CEREBRAL EDEMA AND OUTCOME:** 12 (40%) patients having diffuse cerebral edema showed significant poor recovery in 11 (92%) patients. **HEAD INJURY WITH MIDLINE SHIFT AND OUTCOME:** 10 (33%) patients having head injury with midline shift showed significant poor recovery in 8 (80%) patients. **CONTUSION AND OUTCOME:** Out of 13 (43%) patients having contusion showed poor recovery in 8 (62%) patients. **SKULL BONE FRACTURE AND OUTCOME:** Only 8 (27%) patients had skull bone fracture but 6 (75%) patients had poor recovery. **DECOMPRESSIVE CRANIECTOMY AND OUTCOME:** Outcome of the patients who underwent decompressive craniectomy showed poor recovery in 56% and good recovery in 44% cases. **ICP AND OUTCOME:** ICP of 14 (47%) cases were more than 25 mm Hg and ICP of 15 (50%) cases were between 20-24.9 mm Hg; Only 1 (3%) case was monitored ICP below 20 mm Hg on the first day of ICP monitoring. Outcome of the patient significantly negatively correlated with the ICP. The patients who had poor recovery were recorded mean ICP between 26.1(SD 2.9) to 24.3 (SD 3.8) while those of patients of good recovery varied between 24.9 (SD 1.6) and 13.5(SD 1.4) with a significant P value (<0.001) from 3rd day onward. **PUPIL AND OUTCOME:** 16 (53%) cases were detected abnormal pupil on admission out of which 10 (63%) showed poor recovery. Mortality was 38% with abnormal pupil. **GCS AND OUTCOME:** The mean post resuscitation GCS of both the cases resulting into poor and good recovery were 8 (SD-2.5) and 8.2 (SD 1.7) suggesting insignificant mean difference (P- 0.81). and post resuscitation GCS did not correlated significantly with the outcome **ICP OF SDH CASES AND OUTCOME:** ICP in cases of SDH ranged from 23.3 to 28.8 (mean – 26.5). 5 (46%) cases were associated with diffuse cerebral edema and midline shift who all were operated but showed poor outcome in all cases. 2 died within 5 days and 2 died later. 5 (46%) cases were without diffuse cerebral edema and midline shift in which 4 were operated and 1 managed conservatively and showed good recovery in 3 (60%) cases. **ICP OF EDH CASES AND OUTCOME:** 7 (23%) cases of EDH were detected in which initial ICP of 3 cases were more than 25 mm Hg. All underwent surgical evacuation of haematoma with marked fall in ICP readings and showed good recovery in 6 (86%) cases. One patient died on 2nd day with ICP readings > 28 mm Hg and was associated with SDH, diffuse cerebral edema and midline shift. **CEREBRAL EDEMA WITH MLS AND ICP & OUTCOME:** Initial ICP readings varied from 18.4 to 29.3 (mean - 25.9) to those cases who had diffuse cerebral edema or MLS or both. Out of 14 cases 9 needed surgical intervention immediately or when there were drift in ICP readings and enhancement in CT findings with clinical deterioration. It showed poor recovery in 78% cases and had 67% mortality. 5 cases were managed non operatively based on ICP monitoring and showed poor recovery in 80% cases and 20% mortality.

DISCUSSION & CONCLUSION : My thesis topic is "MONITORING OF INTRACRANIAL PRESSURE IN SEVERE AND MODERATE HEAD INJURY AND CLINICORADIOLOGICAL CORRELATION". The purpose of this study is to monitor ICP in case of severe and moderate head injury and analyse its relation with clinicoradiological findings and further to correlate the ICP values with eventual outcome of patients and see if ICP values can be used for prognostication. The study was conducted upon 30 traumatic head injuries case with post resuscitation GCS below 13 enrolled for the study between Sep 2011 and Mar 2013. All the patients of traumatic head injuries of GCS 13 or above were excluded from the study. The patients having polytrauma (abdomen, chest, long bone injuries) were excluded. NCCT head was done in all cases on admission and it was repeated whenever required during treatment. After obtaining informed consent parenchymal transducer were placed in ICU who were managed conservatively and in operation theatre who were posted for surgery immediately after admission. ICP reading was recorded for 5 days and it was correlated with clinico-radiological findings. All patients were followed up and their outcome was assessed as per Glasgow Outcome Scale at 6 month. The same was correlated with the ICP readings using Pearson correlations and compared with the final outcomes using Pearson Chi-square test. In my study age of the patients varies from 2 years to 72 years out of which 17 are between 15-40 year and 12 are above 40 years. These all includes 20 male and 10 female patients. Road traffic accidents were the most common mode of injury. RTA was the cause of head injury in 18 patients (60%) and due to fall in 7 patients (23%). Other injuries were due to assault in 2 patients (7%) and sports injury in 3 patients (10%). All patients had history of loss of consciousness and 14 (46.67%) had history of seizure. Besides this 4 (13.33%) peritraumatic amnesia. On initial examination 24 (80%) were normotensive. 5 (17%) cases had hypertension and 1 (3.33%) case had hypotension (80 mm Hg). On admission GCS of 7 (23%) were 5-6, 13 (43%) patients were 7-8, 5 (16.67%) patients were 9-10 and that of 5 patients were 11-12. The Pupils of 16 (53.33%) patients were non synchronous and abnormally reacting to light. NCCT head on admission showed SDH in 11 (37%) cases, EDH in 7 (23%) cases, diffuse cerebral edema in 12 (40%) cases, SAH in 7 (23%) cases, intra parenchymal contusion in 13 (43%). There was significant midline shift in 10 (33%) cases. Besides these 8 (27%) patients had skull bone fracture. NCCT findings of most of the patients were associated with SDH, EDH, SAH with or without mid line shift and diffuse cerebral edema and only 2 patients showed normal CT Scans. All patients were admitted in ICU and placed on ICP monitoring. ICP of 14 (47%) cases were more than 25 mm Hg and ICP of 15 (50%) cases were between 20-24.9 mm Hg. Only 1 (3%) case was monitored ICP below 20 mm Hg. Out of 30 patients 12 (40%) underwent initial surgery. There were patients with significant midline shift on admission CT and intracranial haematomas. These underwent evacuation of haematoma with or without decompressive craniectomy. Six patients underwent surgery after ICP monitoring showed raised ICP and repeat CT Scan showed evidence of midline shift/ raised ICP. These 6 patients underwent decompressive hemicraniectomy with or without evacua-

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