Experience with severe head injury and role of intracranial pressure monitoring in Eastern Saudi Arabia

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ABSTRACT

Objectives: Severe head injury is the leading cause of death in the younger age group and it is an epidemic health problem in Saudi Arabia. Several factors contribute to this observation. These include socio-economic prosperity, poor driving behavior and attitudes. The study was conducted to determine the magnitude of severe head injury in the Eastern Province of the Kingdom of Saudi Arabia (KSA) and to emphasize the importance of application of intracranial pressure (ICP) monitoring in severe head injury.

Methods: A retrospective study of 178 patients admitted to King Fahad Hospital of the University, Al-Khobar, KSA during the period from 1992-2002 with severe head injury Glasgow coma score (GCS) ≤ 8 included the analysis and correlation of clinical and radiological factors such as age, sex, nationality, cause of the trauma, epilepsy, alcohol intake, extracranial injuries, x-ray findings, CT scan findings, surgical intervention, and application of the ICP monitor to the outcome. The data were subjected to detailed analysis using the Statistical Package for Social Sciences version 10.

Results: The study group was divided into 2; the first group consisted of patients treated without the application of the ICP monitor and consisted of 126 patients, and the outcome was satisfactory (good recovery or moderate disability) in 38% and 62% had poor outcome (severe disability or death). The second group was 52 patients where ICP monitor was used. Two thirds of them showed high ICP. The outcome in this group was satisfactory in 77% and poor in 23%.

Conclusion: Severe head injury is a major health hazard leading to a high rate of morbidity, disability and death. The benefit of an ICP monitor should be clearly illustrated to all neurosurgical centers in KSA in order to consider routine and early applications of ICP monitoring as one of the basic measures in severely head injured patients.

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Head injury is the leading cause of traumatic death being responsible for 50-60% of fatalities.[1] Severe head injury is the single most common cause of death among those under the age of 40 years.[2] In the Kingdom of Saudi Arabia (KSA), the prevalence of head injury especially the severe type, seems to be high. Several factors contribute to this observation. These include socio-economic prosperity, poor driving behavior and attitudes, inadequate legislative orders and regulation. Most of the hospitals in KSA depend entirely on the clinical evaluation of signs and symptoms to detect an increase in intracranial pressure (ICP) in severe head injured patients such as nausea, vomiting and headache which are non-specific and unreliable in clinically ill patients. We, therefore, undertook a retrospective study to determine the magnitude of severe head injury and

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to emphasize the importance of application of an ICP monitor in severe head injured patients in KSA.

Methods. A retrospective study of 178 patients admitted to King Fahd Hospital of the University, Al-Khobar, KSA during the period from 1992-2002 with severe head injury (Glasgow coma score [GCS] ≤ 8) was conducted. All patients admitted to the intensive care unit (ICU), intubated, ventilated, paralyzed and sedated after a full clinical and radiological evaluation and or requiring an urgent surgical intervention were included in the study. An analysis and correlation of clinical and radiological factors such as age, sex, nationality, cause of the trauma, epilepsy, alcohol intake, extra cranial injuries, x-ray findings, CT scan findings, surgical intervention, application of the ICP monitor to the outcome was made. The data were subjected to detailed analysis using the Statistical Package for Social Sciences version 10.

Results. The total number of patient's studied was 178; their mean age was 26.4 years (range 2-82 years). There were 13 females (mean age 22.4 years) and 165 males (mean age of 26.7 years). The majority of the patients were adult ≥13 years, 113 (63%) while there was 65 (37%) children. The number of Saudis was 96 (54%) and non-Saudis 82 (46%). One hundred and twenty-one patients (68%) were directly admitted to the emergency room of King Fahad Hospital of the University, the rest from other hospitals. The study consisted of 2 groups, the first group included 126 patients treated without the application of the ICP monitor and the second group consisted of 52 patients treated with the usage of the ICP monitor.

Clinical and radiological evaluation on admission. Most of the head injuries resulted from motor vehicle accidents [148 patients (83%)] followed by fall from height in 23 patients (13%) and due to other causes in 7 patients (4%). Sixteen patients (9%) presented with generalized tonic clonic convulsions. Twelve patients (6.6%) had evidence of alcohol intake on admission while 145 patients (81.6%) were free of alcohol and 21 patients (11.8%) had no records on their status on admission. Glasgow coma score on admission for 94 patients (53%) ranged between 7 and 8, out of these 40 were children (43%) and 54 were adults (57%), 37 patients (21%) ranged between 5 and 6 out of these 9 were children (24%) and 28 were adults (76%) and the remaining 47 patients (26%) ranged between 3 and 4, out of these 16 were children (33%) and 31 were adults (67%). Eighty patients (45%) had associated extracranial injuries on admission. Most of patients presented with limb fractures (30, 38%) followed by patients presenting with multiple systemic injuries (26, 32%) and the rest had chest trauma, spinal injuries, vascular injury, abdominal trauma, and others, ranging between 3-15%. All patients had a skull x-ray and CT scan carried out on admission. The skull x-ray showed a skull fracture in 103 patients (58%). The most common type was a linear fracture as seen in 37 (36%) patients followed by those who had more than one type in 28 (27%) patients, then a skull base fracture in 24 patients (23%) and the least was depressed skull fracture in 14 patients (14%). Brain CT scan on admission showed brain edema in 109 patients (61%), the majority had diffused edema (91%) and the rest had localized edema (9%). Brain contusion was seen in 48 patients (41%) and the location of the contusion was mostly at multiple sites in 25 patients (52%). Intracranial hemorrhage was seen in 109 patients (61%). The most common site was intracerebral in 31 patients (28%).

Management. A total 84 patients (47%) had surgical intervention among the study group. Urgent craniotomy was performed in 60 patients (72%), urgent burr hole was carried out in 18 patients (22%) and the remaining 6 patients (6%) had elective burr hole. Out of those who needed surgical intervention, 49 patients (58%) had the surgery carried out within the first 3 hours from admission, 7 patients (8%) within 3-6 hours, 14 patients (17%) within 6-12 hours, 9 patients (11%) within 12-24 hours and 5 patients (6%) had it after 24 hours from admission. All patients of the second group had an ICP monitor applied, which was of the ventricular type. Thirty-two patients (64%) had high ICP, out of these 16 (50%) had more than 10 occasions where the ICP monitor recorded more than 20 mm of Hg for 15 minutes. The ICP monitor was disconnected after 3 days in 24 patients (46%) and in 16 patients (30%) the ICP monitor was kept for more than 7 days. Two patients had evidence of ventricular catheter obstruction, but there was no evidence of intracranial hemorrhage, infection or any other complications.

Outcome. In the whole study group, 72 (42%) patients had good recovery, 18 (10%) had moderate disability, 9 (5%) severe disability, 5 (3%) were vegetative and 70 (40%) patients died. In the pediatric age group (<13 years) of 65 patients, 23 (35%) had satisfactory outcome (good recovery and moderate disability) and 42 (65%) had poor outcome (severe disability, vegetative or death). In the adult age group of 113 patients, 67 patients (59%) had satisfactory outcome and 46 patients (41%) had poor outcome. The difference in outcome between the pediatric and adult age group was statistically significant (*p* value 0.004). In the first group (patients treated without the application of ICP monitor), the outcome in this group was satisfactory in 44% of patients and poor in 56% **(Table 1)**. In comparison, the correlation of outcome

Table 1 - Correlation of outcome to Glasgow coma score in the first group (without application of intracranial pressure monitor [n-126]).

Glasgow coma score	Outcome					
	Good recovery	Moderate disability	Severe disability	Vegetative	Death	Total
7+8	32	7	2	2	16	**62**
5+6	10	3	2	1	11	**30**
3+4	1	3	1	1	28	**34**
Total	**43 (34%)**	**13 (10%)**	**6 (5%)**	**4 (3%)**	**60 (48%)**	**126 (100%)**

Table 2 - Correlation of outcome to Glasgow coma score in the second group (intracranial pressure monitor used [n-52]).

Glasgow coma score	Outcome					
	Good recovery	Moderate disability	Severe disability	Vegetative	Death	Total
7+8	34	2	0	0	0	**36**
5+6	2	0	1	0	1	**4**
3+4	0	0	1	2	9	**12**
Total	**36 (69%)**	**2 (4%)**	**2 (4%)**	**2 (4%)**	**10 (19%)**	**52 (100%)**

Table 3 - Effect of brain edema on outcome.

CT scan findings	Outcome					
	Good recovery	Moderate disability	Severe disability	Vegetative	Death	Total
Local	5	0	2	0	3	**10**
Diffuse	35	8	5	3	48	**99**
No edema	31	14	4	1	19	**69**
Total	**71**	**22**	**11**	**4**	**70**	**178**

Table 4 - Effect of different intracranial hemorrhages on outcome

Type of hematoma	Outcome					
	Good recovery	Moderate disability	Severe disability	Vegetative	Death	Total
EDH	18	1	0	0	2	**21**
SDH	6	1	1	0	11	**19**
SAH	5	0	2	1	1	**9**
ICH	13	4	6	3	5	**31**
>One type	7	2	2	2	16	**29**
Total	**49**	**8**	**11**	**6**	**35**	**109**

EDH - extradural hemorrhages, SDH - subdural hemorrhage, SAH - subarachnoid hemorrhage, ICH - intracranial hemorrhage

to GC score in the second group was satisfactory in 73% of patient and the rest had poor outcome **(Table 2)**. The difference between the 2 groups was statistically highly significant (*p* value 0.0002).

A total of 109 patients showed evidence of brain edema on admission (3-6 hours from injury), 10 patients were of the localized type and 50% resulted in a satisfactory outcome. Ninety-nine patients were of the diffuse type and 43% resulted in a satisfactory outcome, 69 patients had no brain edema and 66% of them had satisfactory outcome and the difference between the patients with brain edema of both types and the patients without brain edema was statistically significant with *p* value of 0.04 **(Table 3)**. Intracranial hemorrhage was found in 109 patients, 57 (52%) had satisfactory outcome and the remainder (52 patients, 48%) had poor outcome. The effect of different types of intracranial hemorrhage on the outcome is illustrated in **Table 4.** Brain midline shift was seen in 73 patients, 45% of them had satisfactory outcome, while the rest of patients (105 patients) had no evidence of brain midline shift and 59% resulted in satisfactory outcome but the difference was statistically insignificant with *p* value of 0.06. Eighty-four patients (47%) had surgical intervention; out of these 41.7% showed no change and 5.6% become worse. Seventy patients (40%) of the whole study group died, most of them died within the first 2 weeks from admission (67%) and the most common cause of death were overwhelming brain damage (56.7%), followed by multiple causes (26.7%), then the systemic complications (10%) and the least was intracranial hemorrhage (6.7%).

Discussion. Head injury has been known since the ancient times. Surgical intervention was documented by the discovery of trephined skull at Neolithic sites in different countries more than 2000 years ago.[3] Nowadays, head trauma is internationally recognized as a major cause of death and disability. Head injury is the leading cause of traumatic death, being responsible for 50-60% of fatalities.[1,4] Indeed, severe head injury is the single most common cause of death among those under the age of 40 years.[2] In Saudi Arabia, the prevalence of head injury, especially the severe type seems to be high. Road traffic and motor vehicular accidents are the leading causes of head injuries. Several factors contribute to this observation. These include socio-economic prosperity, poor driving behavior and attitudes, inadequate legislative orders and regulation. These factors are now under meticulous governmental investigations and observations, and they are not the subject of our study.

Motor vehicle accident is the leading cause of severe head injury all over the world, but there is a significant difference noted in the incidence between our study (83%), in comparison to previous studies conducted in the Kingdom (56-78%)[5-8] and other studies carried out in Western Countries (58%).[1,4,9] Sixteen patients (9%) presented with generalized tonic clonic convulsion. Out of these, 11 had intracranial hemorrhage or contusion. A similar incidence for posttraumatic seizures (10%) was reported in previous studies.[10]

Seventy-seven percent of patients with GCS 7 + 8, 44% with GCS 5 + 6 and 9% with 3 + 4 had satisfactory outcome. Since GCS reflects the severity of brain injury, so it is clearly seen that outcome is directly proportional to GCS (the higher the score the better is the outcome) and consequently, the severity of brain injury, which correlates with previous studies.[11] Forty-five percent of the patients had extracranial injuries which is almost similar to the figures calculated in the study conducted in the Netherlands (44%).[4] Lower than the figures published by Sarrafzadeh et al[12] and higher than the figures obtained from other regions (Glasgow, 30% and Los Angeles, 37%).[4]

The most common extracranial injury in our study was limb fractures. Skull fracture was detected by plain x-rays in 58% of patients, and the most common type was linear fracture which was seen in 36%, followed by more than one type 27%, then skull base fracture 23% and the least was depressed type 14%.

In our study, 61% of patients showed brain edema on admission, which was mostly of the diffuse type. Out of these 43% ended up with satisfactory outcome while in those who did not show brain edema, 66% of them resulted in satisfactory outcome and the *p* value is 0.001 which is statistically significant and this emphasizes the prognostic value of brain edema in severely brain injured patients.

Cerebral contusion is a common sequelae to severe brain injury and it was reported that the incidence of post traumatic cerebral contusion was 40% and commonly located at multiple intracranial sites, and the lowest incidence was in the occipital lobe.[13] In our study, the figures obtained were almost identical to that found (40%) and the majority were located at multiple sites. Intracranial hemorrhage was seen in 61% of the patients, and the most common site was intracerebral while the least was subarachnoid space. Most of the patients had medium size hematoma. Eisenberg et al[14] conducted a study on 753 severely head injured patients and found that the most common site of intracranial hemorrhage was the subarachnoid space (39% of the total study population) which, includes subarachnoid hemorrhage with other intracranial hematomas while in our study, calculations were made for pure subarachnoid hematoma.

Forty-seven percent of the study group had surgical intervention for their intracranial hemorrhage, mostly conducted within 3 hours from

admission (50%) and the majority had urgent craniotomy (72%), followed by urgent burr hole (22%) and the rest had elective burr hole. Fifty-two percent of patients with intracranial hemorrhage had satisfactory outcome. The outcome among these patients varied according to the site of intracranial hemorrhage, where the best outcome was seen in patients with epidural hematoma (89%) and the worst was in patients with subdural hematoma (37%). These findings were observed in previous studies.[15,16] Brain midline shift of ≥3mm was seen in 40% of patients and 55% of them had poor outcome, while those who did not have midline shift, 41% had poor outcome. The *p* value is 0.06, which is not statistically significant, but in previous studies[17] midline shift was correlated significantly with the outcome (the more midline shift, the worse the outcome).

In the whole study group, 42% of patients had good recovery, 10% had moderate disability, 5% had severe disability, 3% vegetative and 40% died. Out of those 65 patients were in the pediatric age group (<13 years), 35% had satisfactory outcome and 65% had poor outcome; 113 patients were adult, 59% had satisfactory outcome and 41% had poor outcome. The outcome in the whole study group was similar to most international studies on severe head injury.[18-20] It is well known from previous studies that the outcome in the pediatric age group is much better if compared with adults. The reverse was seen in our study and that can be attributed to the GCS, which was in our group worse from the start.

As mentioned before, the study is divided into 2 groups, the first group where patients treated without the application of the ICP monitor, which covers 126 patients with a 38% satisfactory outcome and 62% with poor outcome. In the second group of 52 patients, where ICP monitor was used 77% resulted in satisfactory outcome and 23% with poor outcome. The *p* value was 0.004, which is statistically significant, and suggests the value of proper monitoring and control of ICP. As we can see from the results, outcome in the second group appears to be much better in comparison to the first group. As it appears from this study that the use of ICP monitoring had produced, in our limited experience, statistically significant better results and produced minimal complications, we feel justified to continue this approach without resorting to a prospective randomized study to properly scientifically document the superiority of adding ICP monitoring to the armamentarium of severe head injury management. The ICP monitor used was of the ventricular type, only because of unavailability of other types in our hospital, and in the majority of the patients (69%) it was applied within 3 hours from admission. Most of the patients (64%) had high ICP, out of these 50% had more than 10 occasions where the ICP monitor recorded more than 20 mm Hg for 15 minutes. Discontinuation of the ICP monitor was recommended after 3 days of no recorded high ICP reading to avoid risk of complications. But in 30% of our patients, the ICP monitor was kept for more than 7 days because of continuous high ICP. Only 2 patients, who were admitted with evidence of brain herniation, massive subdural hematoma and uncontrollable high ICP developed complications in form of ventricular catheter obstruction and eventually, died.

From our experience through this study, another advantage for the ICP monitor is the proper and accurate monitoring of treatment response and even in certain cases, the ventricular type which we used helped to reduce the ICP through drainage of the cerebrospinal fluid, which minimizes the use of unnecessary doses of drugs and also aids in washing out the ventricular hemorrhage which might reduce the incidence of hydrocephalus. Even in cases where there was no increase in ICP, namely, patients with post traumatic otorrhea, and surgical craniectomy the patient will still gain benefit through avoiding the risk of receiving unnecessary drugs blindly, for example, mannitol, Lasix, and so forth.

In conclusion, severe head injury in Saudi Arabia is a major health hazard leading to high rate of morbidity, disability and death. In this study, emphasis was made on the importance of application of ICP monitors in severely head injured patients for early detection, monitoring and proper management of high ICP to improve the final outcome. This study has clearly shown a statistically significant better outcome in severely head injured patients treated with ICP monitoring, therefore, the benefit of ICP monitor should be clearly illustrated to all neurosurgical centers in the Kingdom in order to consider routine and early application of ICP monitor as one of the basic measures in severely head injured patients.

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