Original Article

International Journal of Neurology and Neurosurgery
Volume 9 Number 2, July - December 2017
DOI: http://dx.doi.org/10.21088/ijnns.0975.0223.9217.11

A Study to Predict Outcome and Analysis of Factors Affecting Outcome in Pediatric Population with Severe Head Injury

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Abstract

Context: Study of outcome and analyzing various factors is important in various settings to identify factors that can lead to serious sequel but at the same time if identified early, are preventable, thereby leading to better management and good outcome in children. *Aims:* To study the outcome and analyze factors that affect outcome in children with severe head injury. *Settings and Design:* A hospital based prospective study was carried out at Osmania Medical College and General Hospital, Hyderabad. *Methods and Material:* A hospital based prospective study was carried out among 764 eligible children less than 14 years of age with head injury. *Statistical Analysis:* The data was entered in Microsoft Excel Worksheet and analyzed using proportions. Appropriate statistical test was applied wherever necessary. *Results:* Maximum cases were seen in children less than three years of age. But the proportion of severe head injuries was more among older children of 9-14 years. Most common mode of head injury was fall from height. Mild head injury was most common. Linear type of skull fracture was most common finding. Extradural hematoma was the most common intracranial hematoma. Vomiting was the most common presentation. Conservative management was carried out in maximum number of cases. Poor GCS score of 3-5, presence of pupillary abnormality, and presence of diffuse cerebral edema were found to be significant predictors of poor outcome among children ($p < 0.05$). *Conclusion:* Endotracheal intubation, elective ventilation for patient with poor GCS and early tracheostomy when necessary have shown good outcome in children with diffuse brain injury. Poor GCS at presentation, presence of shock, presence of diffuse cerebral edema on CT scan were the factors associated with poor prognosis.

Keywords: Outcome; Factors; Head Injury; Children; Prognosis.

Introduction

Accidents are the leading cause of death in children younger than 14 years of age. In this group, head injury is most common cause of mortality. With increasing industrialization and more rapid methods of transport, the incidence and severity of head injuries is increasing. India accounts for six percent of road accidents and has the highest accident rate in the world with fatality rate of 55 deaths per 10,000 vehicles. Exact incidence of head injuries in India is not available but in USA incidence are 200 cases per one lakh population. The most common cause of head trauma in children is fall. The common cause of severe head injuries is vehicle related trauma. If brain injuries are groped based on age of occurrence, different patterns emerge for children younger than 36 months, the most common cause of brain injury is fall (75%) for children between 0-4 years of age and only 23% of head injuries increase in incidence i.e. 47% in 5-9 years of age and 65% in 10-14 years of age group. All these seem to be preventable [1,2].

One of the unique characteristics of the pediatric brain is that it is undergoing a process of maturation and development. So, the brain of the child reacts differently to similar injuries depending on the age of the child when the injury occurs. There is a variation in the amount of gray matter, brain water content and the consistency and the size of the skull. As the child ages, the gray matter expands due to dendritic expansion and branching of the astrocytes until the

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Received on 20.09.2017, **Accepted on** 23.10.2017

second year of life. Maturation of white matter occurs at a slower rate, with myelination occurring rapidly in the first two years of life and then spreading more slowly through the first decade [3].

Because of the frequency of this condition in pediatric population, it is important than it should be handled appropriately and effectively. The outcome in head injury, in many cases is directly related not only to the severity of injury, but also to how well the injury is managed [4].

The outcome in these patients is distinctive because of unique biophysical properties of the child's skull and brain [5]. The factors affecting the outcome in children with head injuries have been studied by various authors [6]. Several studies have highlighted the importance of age and clinical factors such as Glasgow Coma Scale (post resuscitation) score, ocular movements, pupillary size etc in the prediction of outcome in these patients [7].

However the outcome in these studies varies widely with a mortality ranging from 9-75% in cases of severe head injury. The various outcome in pediatric population with severe head injuries are transient cortical blindness, seizures, cranial nerve palsy, diabetes insipidus, syndrome of inappropriate secretion of ADH, Cortical venous occlusion, and hemiparesis. The late sequels are post traumatic epilepsy, post traumatic aneurysm, meningitis, hydrocephalus, memory loss, disability, and muscle contractures [7].

Study of outcome and analyzing various factors is important in various settings to identify factors that can lead to serious sequel but at the same time if identified early, are preventable, thereby leading to better management and good outcome in children. Hence present study was planned to study the outcome and analyze factors that affect outcome in children with severe head injury.

Material and Methods

A hospital based prospective study was carried out among 764 eligible children less than 14 years of age with head injury at Osmania Medical College and General Hospital, Hyderabad from August 2004 to December 2006.

Institutional Ethics Committee permission was sought before the initiation of the study. Written informed consent was taken from the parents of the children regarding inclusion of their ward in the present study after explaining them the nature of the study.

Inclusion Criteria

Children who have not completed 14 years of age with head injury.

Parents of such children willing giving consent.

Exclusion Criteria

Children with history of birth injuries.

Children with significant extra cranial injuries.

Methodology

Total number of head injury cases during the study period encountered was 7080. Out of this, 764 (10.79%) were children less than 14 years of age. All these children were found to be eligible for the present study and all parents gave consent. Hence using universal sampling method, all 764 children were included.

The data was recorded in the pre designed, pre-tested, semi structured. In all children, variety of clinical and radiological parameters were collected and analyzed. Factors affecting outcome of head injury like age, sex, mode of injury and clinical presentation was recorded. Clinical presentation was concentrated on findings like vomiting, loss of consciousness, convulsions, ear, nose bleeding, altered scalp surface anatomy (laceration, scalp contusion, deformities), altered level of consciousness, focal neurological deficits, shock, and severity of injury.

In any child with multiple traumas, a quick primary and secondary survey was carried out with prompt attention to airway, breathing and circulation. All cases were presumed to be full stomach and oxygen therapy was initiated. Comatose patients were intubated with rapid sequence intubation technique with due attention to cervical spine stabilization. Jaw thrust maneuver was performed during bag mask ventilation. A cervical spine collar was placed.

For clinical evaluation, considering the anatomical, physiological and developmental differences of pediatric age group, a modified Glasgow Coma Scale (GCS) was used [8].

Radiological investigations like skull X ray AP and lateral view was taken. CT scan was done in all cases. In indicated cases, MRI scan was done. A C-spine X ray was obtained to rule out cervical bony injury or dislocation.

In all cases, depending upon the severity, conservative management was tried. But as and when

indicated neurosurgery was performed. Neurosurgery included removal of extradural (epidural) hematoma, subdural hematoma or compound depressed fracture as soon as possible after the diagnosis was made. Intra cranial pressure monitor was placed in most cases to monitoring and further management in pediatric intensive care unit (PICU).

Phenytoin was given in patients with post traumatic seizures. In sedated patients with muscle relaxed, EEG monitoring was done. Midazolam was used to control seizures in patients with status epilepticus. All other required measures were taken to stabilize the patients as per standard protocol. Patient was asked to follow up at three months after discharge. At follow up detailed examination was carried out.

Statistical Analysis

The data was entered in Microsoft Excel Worksheet and analyzed using proportions. Appropriate statistical test was applied wherever necessary.

Results

A total of 7080 patients were admitted with head injury to acute neurosurgical ward during the study period. Among them children below 14 years were 764 (10.76%). The incidence of head injuries among children was 10.76%. Among children, the incidence of severe head injury was 20.41% i.e. a total of 156 cases.

Table 1 shows age and sex distribution of head injuries among children. Among the total cases of head injury, maximum were seen in children less than three years of age (42.9%) followed by 3-8 years of age.

But the proportion of severe head injuries was noted among the older children of 9-14 years of age in more than half of the total cases of severe head injury. Total cases of head injury as well as proportion of severe head injuries were more common among males as compared to females.

Table 2 shows mode, severity and nature of head injuries among children. Most common mode of head injury was fall from height in 63.3% of cases followed by road traffic accidents in 27.2% of cases. Mild head injury was the most common in 51.8% of the cases followed by moderate injury in 27.8% of the cases. Linear type of skull fracture was the most common finding in 67.9% of cases followed by compound depressed skull fracture in 16.9% of the cases. Extradural hematoma was the most common intracranial hematoma in 38.1% of the cases. Diffuse brain injury was seen in 56 cases.

Table 3 shows distribution of cases as per the clinical presentation. Vomiting was the most common presentation in 57.9% of the cases followed by altered scalp surface anatomy (laceration, scalp contusion, deformity) in 41.4% of the cases. The least recorded clinical presentation was shock in 1.6% of the cases.

Table 4 shows distribution of cases as per their management protocol. Conservative management was carried out in maximum number of cases i.e. 132 while only 30 cases underwent surgical management. Among the patients who underwent conservative management, diffuse brain injury was the commonest presentation. Among the patients who underwent surgical management, depressed fracture patients were common (60%).

Table 5 shows predictors of outcome of severe head injury among children. It has been observed that poor GCS score of 3-5, presence of pupillary abnormality, and presence of diffuse cerebral edema were found to be significant predictors of poor outcome among children ($p < 0.05$).

Table 6 shows Glasgow outcome scale in children at discharge and follow-up. It was seen that there was good recovery at the end of three months of follow up among the children. The number of grade III and grade IV has reduced and the number of grade V increased.

Table 1: Age and sex distribution of head injuries among children

Parameter		Total Cases of Head Injury		Severe Head Injury	
		Number	Percentage	Number	Percentage
Age (years)	< 3	328	42.9	20	12.8
	3-8	196	25.7	48	30.8
	9-14	240	31.4	88	56.4
	Total	764	100	156	20.4
Sex	Male	504	65.9	100	64.8
	Female	260	34.1	56	35.2

Table 2: Mode, severity and nature of head injuries among children

Parameter		Number	Percentage
Mode of injury	Fall from height	484	63.3
	Hit by object	052	8.1
	Road traffic accident	208	27.2
	Assault	020	2.6
	Total	764	100
Severity of injury	Mild (GCS = 13-15)	396	51.8
	Moderate (GCS = 9-12)	212	27.8
	Severe (GCS < 8)	156	20.4
	Nature of head injury based on CT scan findings		
Skull fractures (N = 106)	Linear	106	67.9
	Compound depressed	18	16.9
	Basal, orbital	12	11.3
Intracranial hematomas (N = 84)	Extradural hematoma	32	38.1
	Acute subdural hematoma	30	35.7
	Intracerebral hematoma/contusions	14	16.7
	Subarachnoid hemorrhage	08	9.5
Diffuse brain injury		56	100

Table 3: Distribution of cases as per the clinical presentation

Clinical Presentation	Number	Percentage
Vomiting	442	57.9
Loss of consciousness	294	38.5
Convulsions	124	16.2
Ear, nose bleeding	74	9.7
Altered scalp surface anatomy (laceration, scalp contusion, deformity)	316	41.4
Altered level of consciousness	140	18.3
Focal neurological deficits	64	8.4
Pupillary abnormality	24	3.1
Shock	12	1.6

Table 4: Distribution of cases as per their management protocol

Management Protocol	Type of Injury	Number	Percentage
Conservative	Diffuse brain injury	56	42.4
	Small sub dural hemorrhage	28	21.2
	Small epi-dural hemorrhage	24	18.2
	Contusions	12	09.1
	Sub-arachnoid hemorrhage	08	06.1
	Skull fracture	04	03.0
	Total	132	100
Surgical	Depressed fracture	18	60
	Epidural hemorrhage	08	26.6
	Subdural hemorrhage	02	06.7
	Contusion	02	06.7
	Total	30	100

Table 5: Predictors of outcome of severe head injury among children

Risk factors		Number of patients with severe head injury	Mortality		Chi square value	P value
			Number	Percentage		
Age (years)	< 3	20	06	60	0.8742	> 0.05 (not significant)
	3-8	48	10	20.8		
	8-12	88	16	18		
GCS (post resuscitation)	3-5	36	15	41.7	7.6072	< 0.05 (significant)
	6-8	120	17	14.2		
Pupillary abnormality	Present	24	14	58	3.4773	< 0.05 (significant)
	Absent	32	38	28.7		
Shock	Present	12	08	66.7	8.367	< 0.05 (significant)
	Absent	144	24	16.7		
Diffuse cerebral edema	Present	56	22	40	11.805	< 0.05 (significant)
	Absent	100	10	10		

Table 6: Glasgow outcome scale in children at discharge and follow-up

GCS grade	At discharge		At the end of 3 months	
	Number	Percentage	Number	Percentage
Grade I (death)	32	20.5	00	00
Grade II (vegetative state)	06	3.9	06	3.9
Grade III (severe disability)	10	6.4	08	5.1
Grade IV (moderate disability)	20	12.8	12	7.7
Grade V (good recovery)	90	57.7	100	64.1

Discussion

Present study analyzed 764 children with head injury who were treated in Osmania General Hospital, Hyderabad over a period of two and half years. The study has shown an overall mortality of 20.5%. The newly born infant certainly faces the risk of head injury, either from being dropped or being battered. Play ground and domestic environment are not safe and have their own hazards for children in 1-5 years age group.

In next five years, as the range of activity increases the risk of head injury also increases. The risk of road traffic accident (RTA) is much higher after nine years of age. Behrman [9] supported this domestic predominance followed by RTA. Sieben et al, [10] Pande CD et al, [11] Mayer et al, [12] Chadwick et al, [13] Musemeche et al [14] have studied the etiology of pediatric head injury and found that fall from height was responsible for most of the pediatric head injuries. In the present study we found that fall from height was the common cause of head injury in 63.4% followed by RTA in 27.2% of cases. Fall from height was common in 0-3 years and RTA was common in 9-14 years of age.

We found that severe head injury was more common among male children (64.1%) compared to 35.9% among female children. Male predominance was also reported by Behrman, [9] Sieben et al, [10] Pande CD et al, [11] and Chadwick et al. [13]

We observed that mortality was 30% in less than three years of children with severe head injury and it decreased as the age increased, but this difference was statistically not significant. Higher number of deaths in less than three year of age may be due to higher incidence of diffuse brain injury, subdural hematoma, and hypotension among them compared to their older counterpart. Behrman, [9] Sieben et al, [10] and Chadwick et al [13] reported higher mortality in 0-5 years of age. Semple PL et al [15] also found that age less than three years is associated with poor prognosis. Suresh et al [16] observed in their study that the mortality in less than two years of age was 27%.

We found 41.7% mortality in children with GCS 3-5 and 14.2% mortality in children with GCS 6-8 ($p < 0.01$) showing significant impact of GCS on outcome. Those patients in coma with a GCS score of eight or less have a significant probability of death or major neurological deficits. Decerebration carries 60% mortality. Semple PL et al [15] shown GCS 3-4 following resuscitation is associated with poor outcome. Suresh et al [16] also found that more number of children (58.5%) with GCS 3-5 were either died or persisted in vegetative state whereas higher proportion of children with GCS 6-8 attained a good recovery.

In the present study we found that mortality was 58% among children with presence of pupillary abnormality compared to only 28.7% among those without pupillary abnormality. Suresh HS et al [16] observed that 14.3% of children with abnormality of pupillary size and reaction had poor outcome.

We observed that among children with diffuse cerebral edema, the mortality was 40% compared to only 10% among those without diffuse cerebral edema. Suresh HS et al [16] reported similar findings with mortality rate of 25% with diffuse cerebral edema. Semple HJ et al [15] in their study have shown that diffuse brain swelling was associated with poor outcome.

Zucarallo E et al [17] in their study of 62 children found a mortality rate of 32%. Feichert JH et al [18] reported a mortality of 22%. In their study, 39.3% had severe neurological impairment. They noted that primary areflexia, secondary brain edema and a low GCS score were prominent risk factors for poor outcome. Kimberly S et al [19] found good recovery inn 59% of the cases.

Conclusion

Most common mode of injury was fall from height. Males were commonly affected. Vomiting was the most common presentation. Surgical management requirement was less required than conservative management. Conservative management has to be

aggressive to reduce morbidity and mortality. Endotracheal intubation, elective ventilation for patient with poor GCS and early tracheostomy when necessary have shown good outcome in children with diffuse brain injury. Poor GCS at presentation, presence of shock, presence of diffuse cerebral edema on CT scan were the factors associated with poor prognosis.

Key Messages

Though surgical management required may be less but conservative management has to be aggressive to reduce morbidity and mortality. Most of the accidents and deaths from head injury are preventable, what we need is caution, prevention is the best way to decrease this morbidity.

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