Spectrum and outcome of traumatic brain injury in children <15 years: A tertiary level experience in India

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ABSTRACT

Background: Though, traumatic brain injury (TBI) has been documented as the single most common cause of morbidity and mortality in infancy and childhood, the exact incidence is unavailable in India. Moreover, modes of injury, mechanisms of damage, and management differ significantly from that of an adult.

Aims and Objectives: To analyze the epidemiological factors, the spectrum of TBI, modes of injury, types of injury, and the outcome in the children <15 years with TBI.

Materials and Methods: This is a retrospective study from August 2012 to May 2013 at Department of Neurosurgery, S.C.B. Medical College, Cuttack, Odisha, India. All the pertinent details from case records of hundred and forty-seven children <15 years with TBI were analyzed. Follow-up was done for 6 months at outpatients department.

Results: Age wise, incidence and severity of TBI is more common in 10–15 years. Males outnumber females with a male: female ratio 2.19:1. Overall, road traffic accident (RTA) is the commonest mode of injury. Assault is not uncommon (7.48% cases). Falls is common in <5 years while RTA is common in 5–15 years. The extradural hematoma was the most common injury pattern; however, surgical consideration was maximal for fracture skull. Overall mortality was 7.48%. Diffuse axonal injury has the maximum individual potential for mortality. We noticed excellent recovery in 68.7%, disabilities in 17.68%, and persistent vegetative state in 5.45% cases.

Conclusion: TBI in children carries good outcome, if resuscitated and referred early to a neurotrauma center, and managed subsequently on an individualized basis with a well-organized team approach. Severe TBI in children has a poor outcome.

Key Words: Craniotomy, extradural hematoma, Glasgow coma scale, Glasgow outcome scale, head injury, loss of consciousness, pediatric age group, road traffic accident, traumatic brain injury

INTRODUCTION

Traumatic brain injury (TBI) is an insult to the brain, not of a degenerative or congenital nature, but caused by an external physical force that may produce a diminished or altered state of consciousness, which results in an impairment of cognitive abilities or physical functioning. Profound disturbances of cognitive, emotional, and behavior functioning after TBI may produce permanent impairments that result in partial or total functional disability and...
psychosocial maladjustment. In India, children <15 years constitute 35% of the total population[1] and contribute to 20–30% of all head injuries.[2,3] Head injury in infancy and childhood has been documented as the single most common cause of death.[4] Moreover, the modes of injury, the mechanisms of damage, and the management of specific problems differ significantly between the adult and pediatric populations. Most of the road traffic accidents (RTAs) are in fact pedestrians and majority of them are children.[5,6] The mortality rate varies from 10% to 60%,[7-9] Poor prognosis is noticeable in age group <4 years with better outcomes in the age group of 5–15 years.[10] Management focuses on limiting the progression of the primary brain injury and minimizing secondary brain injury. In this study, we attempted to analyze epidemiological factors, management, and outcome of TBI.

MATERIALS AND METHODS

This retrospective study (August 2012–May 2013), conducted at our institution, includes all children <15 years with TBI reporting to the neurosurgical emergency department and excludes children with polytrauma. All the case records were reviewed and the pertinent data (clinical history, age, sex, mode of injury, computed tomography (CT) scan findings, interventions, morbidity, and mortality) analyzed. We categorized them into mild, moderate, and severe head injury based on Glasgow coma scale (GCS) at the time of admission. Mild TBI is a trauma to the head that results in a confused state or a loss of consciousness (LOC) of <30 min, the initial GCS of 13–15, and posttraumatic amnesia (PTA) lasts <24 h. Moderate TBI is a trauma to the head that results in an LOC of 30 min to 24 h, an initial GCS of 9–12. PTA can last 24 h to 7 days. Severe TBI is a trauma to the head that results in an LOC of >24 h, an initial GCS of 3–8, and a PTA period of >7 days. Initially, all the cases were primarily resuscitated and evaluated at casualty then shifted to neurotrauma ward. Treatment was individualized at par with CT scan of brain findings and the neurological status. We assessed the outcome of TBI at the time discharge using Glasgow outcome scale (GOS). GOS is a 5scaled tool. The outcome with GOS-5 is classified as good recovery, GOS-4 as moderate disability, GOS-3 as severe disability, GOS-2 as persistent vegetative state, and GOS-1 as death. After the discharge from our institution, regular follow-up was done at our outpatients department for 6 months.

RESULTS

Out of total 1434 cases of TBI admitted during the period of August 2012–May 2013, 147 (11.43%) were children <15 years with 101 males (69%) and 46 females (31%) with male: female ratio 2.19:1. Out of 147 children with TBI, 56.47% were of mild, 29.25% moderate, and 14.28% severe TBI [Table 1]. Overall, RTA (55.1%) is the most common mode of injury followed by fall from height (37.41%). Fall of heavy objects (fall of coconut, moving fan, television set, and piece of broken asbestos) overhead was found in 5 cases (3.4%). Assault (7.48%) is not uncommon [Table 2]. Clinical evaluation revealed, LOC in 124 (84.35%) patients, vomiting in 116 (78.91%) patients, neurological deficit in 21 (14.28%) patients, ENT bleeding in 16 (10.89%) and seizure in 13 (8.85%) cases [Table 3]. CT scan findings revealed extradural hematoma (EDH) (29.93%), fracture skull (19.45%), contusion (14.29%), diffuse axonal injury (DAI), (12.24%), subdural hematoma (SDH), (12.24%), diffuse brain edema (8.84%), concussion (6.80%), and brain hemorrhages (5.44%) as the radiological injury patterns [Table 4]. Out of 147 cases, 118 (80.28%) cases managed conservatively, and surgical intervention was done in 29 (19.72%) cases. Of 29 surgical cases, debridement followed by duraplasty of fracture skull was done in 8/19 (42.10%) cases, evacuation of EDH in 18/44 (40.90%) cases, evacuation of acute SDH in 03/18 (16.67%) cases. We found GOS-5 in 101 (68.7%) patients, GOS-4 in 14 cases (9.52%), GOS-3
in 13 cases (8.85%), GOS-2 in 8 cases (5.45%), and GOS-1 in 11 cases (7.48%). Overall mortality was 7.48%. The maximum death occurred in severe head injury (7/21, 33.34%), followed by moderate head injury (3/43, 6.97%), and the least in minor head injury (1/83, 1.20%) [Table 5]. Age wise death occurred maximum in the age group of 10–15 years (7 cases, 4.76%), followed by children under 5 years (4 cases, 2.72%). Causes of death in children <5 years were DAI (n = 3), SDH (n = 1). In the age group of 10–15 years, death was due to DAI (n = 4), EDH (n = 2), and contusion (n = 1). Considering both the age group DAI was the single most common cause of death. However, individual mortality risk for DAI was 28.57% (04/44), for EDH 11.64% (05/44), for SDH 5.56% (1/18), and for contusion 4.76% (1/21).

**DISCUSSION**

In India, children between 1 and 15 years constitute about 35% of the total population.[11] Head injury in infancy and childhood has been documented as the single most common cause of death.[4] Moreover, the modes of injury, the mechanisms of damage, and the management of specific problems differ significantly between the adult and pediatric populations.[8] Globally, TBI is a burning issue with an annual incidence of about 200 per 1 lakh per year, and mortality of 20 per 1 lakh per year.[11] In India, Gururaj G. et al. (2005) reported the incidence, mortality and case fatality rates due to TBI were 150/1 lakh, 20/1 lakh, and 10%, respectively.[12] While assessing children with TBI, depth and duration of impaired consciousness, presence of diffuse cerebral edema, cerebral hypoperfusion, brain infarction, and degree of parenchymal injury are the determinants for poor outcome.[13-15] Sambasivan has reported an equal incidence of males and females in his series on the pediatric head injury.[16] Chiaretti et al. hypothesized that the higher incidence of TBI in boys might be due to larger head circumference, more muscular and physical activities in comparison to girls.[17] In our study, boys outnumber girls in the incidence. We do believe the hypothetical factors, described by Chiaretti et al., might contribute to the higher incidence of TBI in boys in our study.

Falls form the most important cause of pediatric head injury, and slight carelessness on the part of parents can help avoid disastrous consequences for the children. Several literature reported fall from a height as the commonest mode of injury in TBI followed by RTA in children.[2,7,8] Fall from a height, fall from the unprotected roof, fall from staircase account for the most common mode of TBI in infancy and childhood.[7,8] However, Osmond et al. found a higher incidence of RTA while reviewing severe pediatric TBI over a period of 4-year.[18] We found RTA as the most common mode of TBI in the pediatric population because of a large proportion of children of 10–15 years in our study. We think the teenage passion for bicycling, bike riding, and vulnerability for physical assault might be the possible factors contributing to the higher incidence of RTA in the age group of 10–15 years. Children with TBI due to RTA are in fact pedestrians as observed in several studies.[4,5,7,19] In our study, we found RTA being more common in children beyond 5 years age, the maximum in the age group of 10–15 years of which 59.25% were pedestrians. Fall of heavy objects can also contribute to some extent as reported by Sambasivan.[20] We observed fall of heavy objects overhead in 5 cases (3.4%). Assault in children, not uncommon, is commonly caused with a blunt wooden object than iron objects, probably due to easy availability of wooden objects, i.e., stick.[2,7] We found assault as the mode of injury in 7.48% comparable with other studies.

Biochemical and biomechanical consequences of isolated brief LOC without any other symptoms or signs of TBI are somehow less in comparison to documented LOC for few seconds while assessing the outcome of traumatic head injury in children. Vomiting per se in children is a nonspecific symptom. Many children...
with vomiting as presenting symptom do not have an intracranial injury, but a history of any vomiting the following trauma to head increases the subsequent risks. We found LOC as the commonest presenting symptom followed by vomiting similar to other studies.[21,22] EDH occurs from focal impact injuries, whereas SDH almost always results from angular deceleration of the head, in which the brain continues to rotate relative to the more stationary skull and dura, associated with some form of diffuse parenchymal damage.[23] In infancy and children, falls <1.5 m rarely result in EDH.[24] In adolescence, motor vehicle collisions are the primary cause of EDH.[24] In our study, EDH was the most common CT scan finding followed by contusion, whereas Mahapatra reports contusion as the most common; a similar observation has been reported by Bhargava et al.[25] Normal CT scan finding was seen in 16.32% cases in our study; comparable to the finding of 13.48% normal CT scans in the study by Mahapatra et al.[2]

Various sequels can be seen following traumatic brain injury in children e.g. early (transient cortical blindness, seizures, cranial nerve palsy, diabetes insipidus, SIADH, cortical venous occlusion, hemiparesis) and late (post traumatic epilepsy, post traumatic aneurysm, meningitis, hydrocephalus, memory loss, disability, muscle contractures).[17] In our study, conservave management far exceeds cranietomies owing to a large number of cases of mild TBI (GCS 13–15). In our series, we achieved good recovery in 92.51% cases with an overall mortality of 7.48% similar to other Indian studies.[7,8] The seizure was seen in 8.85% of our patients; a similar incidence has been reported by others also.[8,25] A mortality of 20–50% has been reported for severe head injury.[3] The severity of head injury is directly related to mortality and inversely to a better outcome.[7,8] We found the highest mortality in children with DAI owing to the severity of the injury. Mortality in our study is attributable to late arrival to our institute, unpreparedness for the surgery in time, last but not the least the low socioeconomic status.

CONCLUSION

TBI in children generally carries a good outcome, if referred early to a pediatric neurotrauma center and subsequently managed on an individual basis to treat the primary lesion with the objective to prevent the ongoing biomechanical, physiological, and pathological sequels owing to TBI. Severe head injury is a predictor of poor outcome. Most of these injuries are preventable in infancy and childhood by ensuring proper vigilance, tender care by the parents and the caretaker, and in adolescence by pursuing safe driving with helmet and counselling for maladaptive behavioral patterns. Timely investigation to establish intracranial pathology and early surgical intervention can lead to a good outcome. Even within the immature brain, there seems to be age-dependent responses following TBI in children.

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Conflicts of interest
There are no conflicts of interest.

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