ORIGINAL ARTICLE

Incidence and outcome of traumatic brain injury in paediatric population of Bosnia and Herzegovina: a single centre experience

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ABSTRACT

Aim To evaluate the incidence, modalities of treatment and outcome in paediatric patients with traumatic brain injury (TBI).

Methods A retrospective cross-sectional study including 353 paediatric patients with head injury was carried out in the Department of Neurosurgery of University Clinical Centre Sarajevo during the period 1 July 2006 – 30 June 2012 (72 months). For each patient the lowest Glasgow Coma Scale (GCS) was established and the patient was accordingly classified as suffering from mild, moderate or severe TBI. Neuroimaging data included computer tomography (CT). Survival rates and method of treatment were compared according to age group, and matched with the total number of patients examined.

Results A total of 353 children with head trauma were identified. A severe TBI (GCS < 8) was found in 33 (out of 353) children, mostly in the age group 11-18. Falls were the most common cause of trauma, followed by traffic accidents. Falls were the most common mechanism in the infants, preschool, and school children up to 10 years old; children aged 11-18 showed a higher rate of traffic accidents comparing to children younger than 3 years. Of 353 patients, 49 (13,9%) required surgical procedure, 304 (86.1%) were threated conservatively. Survival rate was 96.6 %.

Conclusion The majority of hospitalized patients qualify for medical treatment and surgical intervention is reserved for selected cases. Thus, the adequate pre-hospital care is essential.

Keywords: head trauma, children, surgical management

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INTRODUCTION

Head injuries are mostly mild and not associated with long-term consequences, but traumatic brain injury (TBI) still leads to hospitalization of 0.2%, and represents a major cause of death and severe disability in young people (1). The incidence of traumatic head trauma and brain injury among children not older than 14 years in the United States has been estimated to be 475 000 each year (1995-2001) (2).

Traumatic brain injury can be categorized as primary and secondary. Primary brain injury results from linear and rotational forces to brain tissue at the time of impact. Linear acceleration is considered the least injurious force and typically is associated with coup and contrecoup contusions, while rotation of the brain occurs when the head is struck in an asymmetric manner, and it can induce widespread injury (3). Primary injuries can be extra-axial (e.g. epidural hematoma, subdural hematoma, subarachnoid haemorrhage, and intraventricular haemorrhage), intra-axial (e.g. diffuse axonal injury, cortical contusion, and intracerebral hematoma), or vascular (e.g. vascular dissection, carotid cavernous fistula, arteriovenous dural fistula, and pseudo aneurysm) (4).

Following primary brain injury, a cascade of cellular, molecular, and biochemical events occurs in the minutes to hours and days to weeks leading to "secondary" traumatic axonal injury (TAI) and neuronal cell damage (secondary brain injury). Secondary injury occurs because of alterations in cerebral blood flow (CBF) and the development of cerebral oedema, which may ultimately lead to neuronal cell death. The longer secondary injury phase lasts, the more likely the child will suffer from long-term disabilities (5).

The biomechanics of paediatric patients differs from adults because of two important reasons: decreased mineralization of bone that offers less protection to structures in the central nervous system (CNS), and decreased muscle strength that diminishes protection of the cervical spine (6,7).

The TBI is most commonly classified into mild, moderate and severe according to Glasgow Coma Scale (GCS) results (8). In children, however, the defining ranges may vary between authors (9).

Management of these patients requires a multidisciplinary approach where the main role of the neurosurgeon is to monitor for signs of intracranial hypertension, identify and respond to changes in GCS, organize appropriate imaging and decide on surgical intervention. Surgical management comprises inserting an extra-ventricular drain (EVD), evacuation of any extra-axial lesions or performing uni- or bilateral decompressive craniectomy (DC), which shows promising results in paediatric patients (10).

In Bosnia and Herzegovina there were no reports relating to TBI.

The aim of this study was to evaluate the incidence, modalities of treatment and outcome in paediatric patients with traumatic brain injury.

PATIENTS AND METHODS

Patients and study design

A cross-sectional study was carried out in the period 1 July 2006 – 30 June 2012 in the Department of Neurosurgery in University Clinical Centre Sarajevo. Modalities of treatment of 353 hospitalized patients with paediatric TBI were retrospectively analysed. Paediatric is defined as <18 years of age.

The study protocol was approved by the Ethic Committee of the University Clinical Centre Sarajevo, and it was conducted in accordance with all ethical standards of medical research and the Declaration of Helsinki.

Inclusion criteria were all children presenting within 24 h of head trauma. Exclusion criteria were trivial injury mechanisms defined by ground-level falls or walking or running into stationary objects, and no signs or symptoms of head trauma other than scalp abrasions and lacerations. Patients were also excluded if they had penetrating trauma, known brain tumours and preexisting neurological disorder.

Data were collected based on patient history, injury mechanism, symptoms and signs on a standardised data form before obtaining imaging results. Clinical examination included physical and detailed neurologic examination.

Those with severe head injuries were admitted into the Intensive Care Unit (ICU). Others were admitted into the Neurosurgery ward. Those with mild head injuries without radiological abnormalities and neurological deficits were observed for 24 h and discharged.

Methods

Data of 353 hospitalized patients were analysed. The children were divided into three age groups: infants under the age of 2 years, children aged 3-10 and adolescents aged 11-18 years of age. For each patient the lowest GCS was established according to Glasgow Coma Scale (GCS) (8), and the patient was classified as suffering from mild for a GCS of 14-15, moderate for a GCS of 9-13 and severe for GCS of 8 and lower TBI.

Neuroimaging data included computer tomography (CT) images. CT scans were obtained at the Emergency Department, with radiographic slices separated by 10 mm or less, and interpreted by a neuroradiologist and neurosurgeon. Survival rates and method of treatment according to the age group were further compared and matched these rates with the total number of patients examined by neurosurgeons.

Statistical analysis

Standard descriptive methods of statistics and $\chi2$ test were used. The significance level of $p<0.05$ was used.

RESULTS

During the 72-month period, a total of 4380 children with head injury were admitted to our department and examined by neurosurgeon, of whom 353 (8.1%) were hospitalized, 49 (1.12%) required urgent surgical treatment, 12 (0.27%) died at admission. The rest of the children were stable and discharged after observation.

Head trauma was identified in 353 children, of whom 190 (53.8%) were males, and children 3-10 years of age, 164 (46.5%) (Table 1).

Minority of patients presented with a severe TBI of GCS <8, 33 (9.3%), mostly in the age group 11-18, 18 (18.2%) (Table 1).

Table 1. Severity of traumatic brain injury according to age groups

Age (years) (No of patients)	No (%) of patients		
	GCS 14-15	GCS 9-13	GCS 3-8
0-2 (90)	86 (95.6)	1 (1.1)	3 (3.3)
3-10 (164)	127 (77.4)	25 (15.2)	12 (7.3)
11-18 (99)	73 (73.7)	8 (8.1)	18 (18.2)
Total (353)	286 (81.0)	34 (9.6)	33 (9.3)

GSC, Glasgow Coma Scale;

In terms of the mechanism of TBI, falls were the most common cause, followed by traffic accidents, 195 (55.2%) and 94 (26.6%), respectively. By age, falls were the most common mechanism in school children up to 10 years of age and the infants, 96 (49.2%) and 82 (42.1%), respectively; children in the age group 11-18 years showed the highest rate of traffic accidents, 45 (45.5%) (Table 2).

Table 2. Mechanism of trauma brain injury according to age groups

Age (years)	No (%) of patients				
	Falls	Traffic accidents	Sports	Abuse	Unspecified
0-2	82 (42.1)	8 (8.5)	0	0	0
3-10	96 (49.2)	41 (43.6)	20 (44.4)	2 (50)	5 (33.3)
11-18	17 (8.7)	45 (47.9)	25 (55.6)	2 (50)	10 (66.7)
Total	195 (55.2)	94 (26.6)	45 (12.8)	4 (1.1)	15 (4.3)

Of 353 patients, 49 (13.9%) required surgical procedure, and majority of the patients were threated conservatively, 304 (86.1%); 341 out of 353 (96.6%) hospitalised patients survived and 12 (3.4%) had lethal outcome (Table 3).

Table 3. Survival and methods of treatment of patients with trauma brain injury

Age (years) (No of patients)	No (%) of patients			
	Survived	Dead	Surgery	Conservative
0-2 (90)	87 (78.3)	3 (3.3)	3 (3.3)	87 (78.3)
3-10 (164)	161 (98.1)	3 (1.9)	24 (14.6)	140 (85.3)
11-18 (99)	93 (93.9	6.(6.0)	22 (22.2)	71 (71.7)
Total (341	341 (96.6)	12.(3.4)	49 (13.9)	304 (86.1)

DISCUSSION

It is important to highlight the difference between head injury and traumatic brain injury. Head injury is a nonspecific term that includes apparent external injuries that may or may not be associated with brain damage, while traumatic brain injuries represent an insult to the brain due to direct trauma from an external force, a penetrating object, blast waves, or a jolt to the head (11,12).

The incidence of paediatric traumatic brain injury (TBI) is increasing worldwide, currently ranging from 12 to 486 per 100,000 children (13). Epidemiological data are indicating a concerning growing trend in developing countries (14). European data report 57,000 TBI-related deaths and 1.5 million TBI-related hospital admissions every year costing a total of about 3 billion Euros (15,16).

Various mechanisms result in TBI severe enough to require hospitalization. In our study, we found higher prevalence of traumatic brain injury in male patients, which is consistent with the results of other authors, and often explained by higher interest for physical activities in boys, rather than girls (17,18). Also, we found the highest prevalence of head injury among the children 3-10 years of age. In the United States, the highest prevalence of paediatric brain trauma was observed in children not older than 4 years, while other studies reported the highest prevalence in children older than 12 years (11,19).

In the age group of 0-10, falls are the most commonly described reason for hospitalization of TBI patients, followed by motor vehicle accidents (14). In infants (less than one year of age), inflicted or non-accidental TBI must always be considered. Accidental TBI in this age is mainly due to motor vehicle crashes and falls from parents' arms. It must be noted that estimating the accurate incidence of inflicted TBI is challenging due to the fact that many children may not present for treatment or may have an extended interval between injury and presentation for medical care (20).

According to our results, falls were the most common mechanism of traumatic brain injury in whole sample, followed by traffic accidents. Similar results were obtained by other authors (17-19, 21). With aging, the incidence of falls decreased and traffic accidents were the leading cause of trauma in children older than 10 years.

Children with apparently minor head trauma are the group most frequently assessed. The precise criteria for minor head injury are not consistent in the literature, but this usually refers to a patient with normal or near-normal post event mental status; in paediatric studies, minor is often defined by the Glasgow Coma Score (GCS) of >13 (8). Approximately 3-5% of children with minor head trauma have abnormalities identifiable by imaging, and typically <1% require neurosurgical intervention (22-24). Among all children presenting to the Emergency Department in one prospective series, 98% had the Glasgow Coma Scale (GCS) score of 15, suggesting that most head injuries were minor (25). In our study, 81% of the patients had the GSC score higher than 13, and only 13.9% required surgical procedure. Many traumatic brain injuries identified on CT do not need acute intervention, and some are false positives or non-traumatic findings. Furthermore, injuries which need neurosurgery are very uncommon in children with GCS scores of 14–15 (26). The highest paediatric morbidity and mortality is reported in children younger than four years of age, and in those with hypotension, low GCS scores at initial presentation, coagulopathy, or hyperglycemia (13,22,27). Overall mortality among children with TBI, who were treated in emergency departments or require hospital admission, is 4.5% (compared with 10.4% among adults) (23).

Luerssen et al. (28) reported that the age of the children themselves acted as a prognostic factor for outcome of paediatric brain injury, but Berger et al. (29) found that age and prognosis were not related. In this study, there was no difference in clinical outcome according to age. Mortality rates in paediatric TBI patients ranged from 0.06–7.3% in different reports (20,23), and we found a similar rate.

In B&H there is no register of head injuries, so it is not possible to compare our data on a country level. It is known that children with severe TBI are more likely to survive if treated in paediatric or adult trauma centres specially equipped and staffed to accommodate paediatric patients. During the initial evaluation and stabilization of the injured child (primary survey) priority is given to the maintenance of airway patency, oxygenation, ventilation, cardiovascular support, and the management of immediate life-threatening injuries according to the principles of Advanced Trauma Life Support. In children with severe traumatic brain injuries, rapid stabilization is also important to prevent secondary brain injury due to hypoxia and shock. Data to guide clinical decision making for children with head trauma are urgently needed, however, in B&H there is no official and accepted national prevention program or protocol of pre-hospital care for paediatric TBI patients. We showed that the majority of hospitalized patients are qualified for medical treatment, and surgical intervention is reserved for selected cases. Thus, resuscitation and stabilization of the cardiovascular and respiratory system in the field, during transfer, and in the hospital need to be emphasized in an effort to optimize outcome from severe paediatric brain injury.

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TRANSPARENCY DECLARATION

Conflicts of interest: None to declare.

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