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Original article

Management and outcome of traumatic epidural hematoma in 41 infants and children from a single center☆

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ABSTRACT

Background: Traumatic brain injury (TBI) is a frequent cause of mortality and acquired neurological impairment in children.
Hypothesis: We hypothese that due to adequate treatment of EDH in children and adolescence excellent clinical and functional outcome can be reached.
Purpose: To evaluate retrospectively our treatment process of EDH and to elucidate the relationship between trauma mechanism, injury pattern, radiological presentation, subsequent therapy and functional outcome.
Patients and methods: Hundred and twenty infants and children with traumatic brain injuries (TBI) were treated between 1992 and 2009 at a single level-one trauma center. Data regarding accident, treatment and outcomes were collected retrospectively. To classify the outcomes the Glasgow Outcome Scale (GOS) scores at hospital discharge and at follow-up visits were used. EDH was classified according to the Rotterdam score.
Results: Finally, 41 cases were diagnosed with an EDH and therefore included in our study. Twenty-one cases were treated surgically; however of these in 11 patients delayed surgery was necessary. Twenty patients were treated conservatively. Two patients (5%) died within 24 hours, 39 patients (95%) survived. One of the operatively treated patients (2%) presented in a vegetative state, another one had severe disability, and however, 32 patients (78%) showed good recovery at latest follow-up.
Discussion: Age, severity of TBI, and neurological status were the main factors influencing outcome after TBI due to acute EDH. We found that immediate as well as delayed surgical evacuation of EDH resulted in excellent outcomes in most cases. Conservative treatment was started in 76% of our cases – however needing in 35% delayed surgical intervention. Overall in all groups excellent final clinical and neurological outcomes could be reached.

1. Introduction

Traumatic brain injury (TBI) is a frequent cause of mortality and acquired neurological impairment in children [1]. TBI is a leading type of pediatric trauma [2] and in children, it is present in a greater proportion of all injuries than in adults [3]. Still, it seems that pediatric TBI is investigated only infrequently, and physicians are often left to call upon their clinical experience when making treatment decisions [4].

Acute epidural hematoma (EDH) in children is relatively uncommon, accounting for 2–3% of all TBI cases in this population [5–9]. Due to the atypical occurrence [10,11] pediatric EDH poses a significant challenge for diagnosis and is not directly comparable to adult EDH [9]. Mortality after pediatric EDH varies across studies and has been shown to be in the range of 0–12% [9,12–17].

The implementation of computed tomography (CT) as a standard diagnostic device enables prompt and accurate detection of EDH. However, it remains unclear whether surgical treatment

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(craniotomy and evacuation) should be the standard treatment to ensure rapid and complete recovery in children with EDH [18], or whether non-operative management may be possible in special cases [19]. Variations in outcome and management make it difficult to impart a clear picture of traumatic EDH in children and infants.

Therefore the aim of this study is to present the severity and outcome of traumatic EDH in children admitted to a level-one trauma center and to analyze possible differences between patients treated surgically or conservatively. We hypothese that due to adequate treatment of EDH in children and adolescence excellent clinical and functional outcome can be reached.

2. Methods

2.1. Data collection

Data for this study was obtained retrospectively from the records of pediatric patients (age below 16 years) admitted with TBI to a level-one trauma center between 1992 and 2009. Acute EDH was diagnosed in a total of 41 patients. Data on demographic characteristics of patients (age, sex), cause of injury, injury severity (Injury Severity Score [ISS] [20], Glasgow Coma Scale [GCS] [21], and additional injuries), CT findings (Rotterdam Score), treatment modalities (surgical vs. conservative, types of surgery, additional treatment) and outcomes (Glasgow Outcome Scale [GOS] [22]) at discharge and at latest follow up were recorded.

2.2. Scores

The ISS attempts to quantify the impact of multiple injuries on mortality using the AIS (Abbreviate Injury Scale) system. It derives a summary score on the basis of the 3 most severely injured body regions. The sum of the squares of the severity score in these 3 regions is then used to determine the ISS score [20].

The Rotterdam computed tomography (CT) score was developed for prognostic purposes in traumatic brain injury (TBI) refining features of the Marshall score and designed to categorize traumatic brain injury (TBI) type and severity. It was developed by Maas et al. [23] and represents a modification of the Marshal CT score.

The GCS is a neurological scale, which aims to score the level of consciousness in a person following a TBI [21]. The GOS is a scale that allows standardized descriptions of the objective degree of recovery after TBI [22].

2.3. Treatment procedures

All admitted patients underwent a rapid examination by an emergency physician, which included the documentation of pediatric GCS and pupillary reactivity. Further medical treatment included rapid-sequence intubation, ventilation, treatment of hemorrhage, treatment of associated substantial extra cranial injury and fluid resuscitation, as appropriate.

Each patient underwent a CT scan and an examination by a trauma team (consisting of anesthesiologists, trauma surgeons and/or neurosurgeons, radiologists, and nurses). Depending on the results of the CT scan (location and volume) patients underwent surgery and/or were admitted to the ICU or pediatric ward. Admission to ICU followed criteria described by Balmer et al. [24] and accepted in literature [25–27].

Trauma surgeons provided neurosurgery in consultation with neurosurgeons for complicated issues. Anesthesiologists in cooperation with trauma surgeons and neurosurgeons were responsible for the intensive care.

Trauma surgeons, neurosurgeons, and radiologists in cooperation interpreted CT scan findings. Data regarding duration of various treatments, complications and outcomes were collected at hospital discharge and at follow-up.

2.4. Data analysis

The primary goal was to compare surgically treated to conservatively treated cases. Patients were assigned to the "operated" group if they underwent immediately at least one cranial surgery during their stay at the hospital; if not, they were assigned to the "conservative" group. Patients were added into the "delayed surgery" group if first treated conservatively and treated surgically after at least 4 hours.

Demographic factors, injury causes, trauma characteristics and severity and outcome were compared between the two groups. In case of continuous variables medians with respective interquartile ranges were calculated and used as central measures. In case of categorical variables total values with corresponding percentages were calculated as measures of frequency. In order to estimate the population proportions 95% confidence intervals were calculated wherever percentages were used. All analyses were done using the R project statistical environment.

3. Results

Demographic factors and injury causes are presented in Table 1. The median age of the patients were around 8 years (7.5: 8.5: 8) and quite similar in all treatment groups. Male sex was somewhat more prevalent in the 'conservative' and 'operative group'. Different major causes of injury were identified: falls from over 150 cm were most prevalent in the 'operated group' and falls from 50–150 cm were more common in the 'conservative group'. Traffic accidents were the major cause in the 'delayed surgery' group. Table 2 presents the injury severity patterns. Nearly all operated patients (operated group and delayed surgery group) presented with additional severe injuries. Their ISS was significantly higher compared to the 'conservative group' (25 vs. 12.5; 27 vs. 12.5). Over 90% of the 'operated' group and 64% of the 'delayed surgery' group presented with a Rotterdam CT score of 3 or higher. Only in 10% of the 'conservative' group a Rotterdam Score of greater than 3 was found (Fig. 1, Table 2).

Treatment factors are shown in Table 3. Patients in the operative group and delayed surgery group were significantly more often transported by helicopter, had significantly more often field intubation (60% vs. 15%; 55% vs. 15%) and spent significantly longer time at the ICU compared to conservative patients treated. About half of the operated patients were operated within 1 hour after admission, the other half was delayed, about one quarter of them underwent 2 surgical interventions. Delayed surgery was performed in patients where additional injuries presented a more serious threat and therefore needed to be addressed first (Table 2) or conservative management has failed. ICP was additional monitored in 82% of patients with delayed surgery and in 70% of the patients with immediate surgical intervention (Table 4). ICP monitoring represents a standard of care at our University hospital in severely head injured patients. In the remaining patients it was a decision of the operating surgeon do not implant an ICP. Secondary ICP was not carried out at our patient collective.

Elevated ICP > 20 mmHg was found in 39% of cases (Fig. 2). ICP monitoring was removed when ICP values did not exceed > 10 mm Hg for a period of at least 24 hours.

We found no statistically significant differences in outcome between the three groups (Table 5). At discharge and at latest follow-up most patients showed a favorable outcome (moderate