Assessment of mortality associated with mild head injury in the pediatric age group

Received: 17 May 1994
Revised: 31 October 1994

Presented in part as a platform presentation at the XXI Annual Scientific Meeting of the International Society for Pediatric Neurosurgery, Phoenix, Arizona, 23-29 October 1993

I. S. Keskill (✉) · N. Çeviker · M. Kaymaz
Department of Neurosurgery, Gazi University Medical School, Beşevler, Ankara, Turkey
M. K. Baykaner
Division of Pediatric Neurosurgery, Department of Neurosurgery, Gazi University Medical School, Beşevler, Ankara, Turkey

Mailing address:
Fethiye Sokak No: 4/6, Gazi-Gazişmanpasa, TR-06700, Ankara, Turkey
Tel.: 9-312-446 45 94
Fax: 9-312-212 90 04

Abstract Reducing mortality among accident and trauma patients requires careful attention to monitoring those regarded as being at low risk. We hospitalized almost 1600 head-injured patients in the period between 1979 and 1992 at the Neurosurgery Department of Gazi University Medical School, Ankara, Turkey. These patients were selected from among the numerous patients admitted to our emergency unit and treated with the same protocol in the same department. Among the hospitalized children, there were three patients defined as having a mild head injury on the basis of Glasgow Coma Scale scores of 15 who later had unfavorable outcomes. Clinical signs that might identify potentially endangered patients with mild injury were gathered; these included the presence of post-traumatic amnesia, somnolence, irritability, anisocoria, local evidence of trauma to the head, associated injuries, history of altered consciousness, and skull fracture. The study was designed to identify features by which patients who are in real danger can be distinguished among the many with trivial trauma that we face every day. We did not find any identifying clinical features and concluded that computed tomographic scanning is the only reliable answer. This will reduce avoidable mortality and morbidity by identifying the patients who are at higher risk than is at first evident.

Key words Head injury · Computerized tomography · Outcome · Skull fracture · Risk factor · Glasgow Coma Scale · Mortality · Children

Introduction

The overwhelming majority of patients with head injuries who are seen in hospital emergency departments are fully conscious [11, 21]. Klauber et al. [14] and Servadei et al. [26] showed that reduced mortality rates result not from saving high-risk patients in certain well-equipped hospitals, but rather from preventing deterioration in patients with minor or moderate head injuries who initially appear to be at low risk. The management of such mild injuries is centered on the risk of development of an intracranial hematoma and the need for successful early detection and evacuation of the clot [17, 24]. The large number of patients with these mild injuries and the associated low incidence of intracranial complications has led to much debate about how they should be managed; in particular, the indications for skull radiography, admission for observation, and referral for neurosurgical assessment and computed tomographic (CT) scanning.

Previous guidelines for evaluation of head injury established for emergency room and trauma physicians primarily stressed serial neurological observation and relied less on cranial CT scanning for patients with mild injuries [20]. The development of the Glasgow Coma Scale (GCS) and its widespread use remains a major milestone in head injury evaluation, prognosis, and clinical research [11, 32]. The relationship between outcome after head injury and the GCS is one of the strongest relationships in all of medicine. This scale, however, is of limited use in children, par-
particularly younger ones. Therefore, in patients under 36 months of age we use the Children’s Coma Scale [9, 27], which modifies the “best verbal response” portion of the GCS using the same 3-15 scale. Moreover, several investigators, citing a lack of sensitivity of the GCS within the mild range of impaired consciousness, suggest that additional criteria (e.g., radiological) should be established to differentiate further among head injuries that will not produce coma [19, 36].

We have reviewed a large series of patients admitted to the Emergency Medical Services of Gazi University Medical School and subjected to the same diagnostic and therapeutic protocol in the period from 1979 to 1992 inclusive, in order to identify the patients who developed a significant traumatic injury despite having been recorded as alert and oriented when they were first seen. Abnormalities on CT scans were so common in patients with a GCS score of 13 that we determined to classify such head injuries as “moderate” rather than “mild” in severity and risk [29]. Most of the current literature suggests evaluating the different age groups separately, as the epidemiology, mechanisms, and consequences of head trauma are quite diverse among them. Therefore, statistical comparisons were made only with the pediatric population. Our aim was to determine more reliably the incidence of delayed deterioration of consciousness, and the mortality after trivial head injuries, which was reported as varying between 0.4% and 4% among children [13, 28].

**Patients and methods**

For the major head injury survey we reviewed the records of over 1600 patients who were admitted to our institution during the 14-year period from 1979 to 1992, inclusive. Patients with chronic subdural hematomas were excluded from the analysis unless there was a significant coexisting acute subdural hematoma (requiring craniotomy for evacuation) or a history of acute injury. Other patients who were excluded were those who were dead on arrival at the hospital and who were diagnosed as brain-dead in the emergency room. Twenty-four patients with gunshot wounds were also excluded, because this injury is significantly different from other head injuries with regard to pathophysiology and outcome. Of the 1142 remaining eligible patients, a total of 494 were aged 15 years or younger were entered into the pediatric head injury survey. There was a predominance of male children (58%); interestingly, this was so even in the youngest age group.

We identified a cohort consisting of 257 patients who were recorded as having performed normally or presented with full recovery - after a brief loss of consciousness (< 20 min) [35] and/or a history of post-traumatic amnesia - with a total GCS score [32, 33] of 14 or 15 when first seen in the hospital. Admission was initially either to beds provided for this purpose in the emergency department or to the neurosurgery department. Data collection procedures, scoring, and neurological and radiological investigations have been described in the review of moderately injured children [3] and elsewhere. The patients were questioned as to any temporary loss of consciousness and to ascertain the length of retrograde and post-traumatic amnesia. When available, witnesses were asked to verify and to supplement these data. No attempt was made to follow patients beyond their discharge unless they were admitted for control examinations at their own request.

The mean and standard deviation were employed as measures of the central tendency and dispersion of scores, respectively. The effect of variables - potential predictors - such as GCS score, skull X-ray, and CT findings were first analyzed separately on the outcome groupings using cross-tabulation, and statistical significance was assessed using the $\chi^2$ or, if expected values were too small, Fisher’s exact test. Stepwise logistic and linear regression were used to analyze the relationship between neurological variables and outcome. A $P$ value of 0.05 or less was considered statistically significant.

**Results**

**Patients**

As reported before, mild injuries account for half of all head injury hospitalizations [35]. Among the 257 patients who had a GCS score of 14 or 15 when they were first seen at hospital, 58% were male, the median age was 11 years, and 69 patients (27%) were less than 4 years of age. Table 1 summarizes the demographic and clinical features of the patients. As is generally reported, falls were the most common cause of injury among the 0- to 4-year-old patients, while pedestrian/motor vehicle accidents were most common among the 4- to 15-year-old children.

**Time intervals**

The time of injury could be determined in 213 of the patients. Seventy-seven percent of them were seen at the emergency department within 5 h of injury and 94% within 24 h. In the case of 44 patients, it was not possible to say exactly when the injury had occurred.

**Clinical features**

Clear data about subjective minor symptoms - such as vomiting, nausea, diplopia, vertigo, headache, blurred vision, dizziness, irritability, tinnitus, and seizures - were not available on most of the case files, so they were not taken into account, although we believe that such minor symptoms can sometimes be the only guide for performance of a CT scan. Moreover clinical signs such as hemiparesis, hemotympanum, otorrhea, dysphasia, or cranial nerve abnormality were not encountered in any patient of this series and so not included in the final analysis. As a result, only signs such as somnolence and/or irritability, anisocoria, and scalp lesion were noted and assessed.

**Skull fractures**

A report on the skull radiographs was available in all cases. A fracture had been identified in 109 patients (42%), a