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Evaluation of Mild Head Injury in a Pediatric Population

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Head injury, mild · Linear skull fracture

Abstract
Approximately 5 million children present to emergency departments, seeking care for head injuries, each year, and 80% of these children are classified as cases of mild head injury. Due to the huge number of patients and low frequency of intracranial lesions in this group, obtaining a computed tomography scan for each and every patient is a significant economic problem. This study was conducted to identify the clinical parameters and the radiographic findings that may be associated with intracranial lesions in children with mild head injury. 421 patients, with a Glasgow Coma Scale score of 15 and without any focal neurological deficit, were studied. Intracranial lesion was noted in 37 cases (8.8%). Sensitivity of a plain radiogram was 43.2%, and specificity was 93%. An intracranial pathology was demonstrated in 28.9% of the patients with a linear skull fracture. The only clinical parameters associated with an increase in the frequency of detection of intracranial lesions were posttraumatic seizures and loss of consciousness. Age, sex, headache, vomiting and scalp lacerations were not associated with a higher frequency. Even when patients with a history of loss of consciousness or posttraumatic seizure were subtracted from the study group, intracranial lesions were noted in 4.1% of the cases, and in 1.8% neurosurgical intervention was required. Computed tomography is the gold standard in the evaluation of pediatric patients with mild head trauma, and every child who has experienced a head injury should undergo a cranial computed tomography evaluation, even if he or she appears in perfect health.

Introduction

Head trauma is the most common cause of death in childhood [1]. Approximately 5 million children present to emergency departments, seeking care of head injuries, each year [2]. About 80% of these children are classified as cases of mild head injury, which is defined as a Glasgow Coma Scale (GCS) score of 13–15, loss of consciousness (LOC) lasting less than 20 min and requiring hospitalization for less than 48 h [3]. Due to the huge number of patients and low frequency of intracranial lesions in this group, obtaining a computed tomography (CT) for each and every patient is both a public health dilemma and a significant economic problem. Clinical factors that may indicate intracranial lesions have been studied, and guidelines for evaluation of mild head injury have been pub-

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lished for both general and pediatric populations from different countries [4–8].

Although there is much less debate regarding the patients with a GCS score of 13 and 14, there is no consensus for appropriate diagnostic assessment for children with a GCS score of 15 and without any focal neurological deficit [9]. This prospective study was conducted to identify the clinical parameters and the radiographic findings that may be associated with intracranial lesions in children with mild head injury, a GCS score of 15 and without any focal neurological deficit.

Patients and Methods

All the pediatric patients (up to the age of 16) presenting to our emergency department due to head trauma, within a 1-year period, have been noted. Patients with a GCS score of 15 and without any focal neurological deficit have been included in the study. Patients with penetrating skull injury, gunshot wounds and multiple trauma have been excluded.

History was taken from both the patient, when possible, and the parents. Mechanism of injury, posttraumatic seizure, LOC following trauma, presence of headache, nausea and vomiting were questioned. Both a general and a neurological examination were performed. All the patients underwent both plain radiography of the skull and a CT scan of the cranium. Soft tissue swelling and linear skull fractures, if not associated with an intracranial lesion, were not considered as pathological findings on CT scans. Additional investigations were performed, if needed. All the patients with linear skull fractures were hospitalized for 24 h, even if there was no associated intracerebral injury, and CT scanning was repeated prior to discharge. Statistical analysis was performed with SPSS 12.0, using the χ^2 test.

Results

Five hundred and forty-seven pediatric patients were admitted to the emergency room, due to head injury, during a 1-year interval. Patients with a GCS score lower than 15, focal neurological deficit, penetrating skull injury or gunshot wound and multiple trauma were excluded; the remaining 421 patients were included in the study, which constitutes 78% of all the pediatric head injury cases. 239 patients were male and 182 patients were female. The mean age of the patients was 5.1 years. In most of the cases, trauma was due to a fall (table 1).

CT scan was defined as positive in 37 cases (8.8%). Findings are listed in table 2. Among these, 16 cases required neurosurgical intervention (3.8%). Plain radiograms were defined as positive in 43 cases (10.2%). There were 3 depressed fractures, 2 complex fractures and 38 linear fractures. Linear skull fractures were associated with an intracranial lesion in 11 of the cases (28.9%), 10 of which were identified on the initial scan, and 1 identified at a repeat CT scan obtained at the 8th hour of hospitalization. Sensitivity of plain radiograms was 43.2%, and specificity was 93% (table 3).

When male and female patients were compared, the difference in the frequency of intracranial lesions was not significant ($p = 0.488$). No significant difference was noted between the age groups. 23 patients had LOC, and in 14 of these cases, an intracranial lesion was detected (60.9%). 6 patients had posttraumatic seizures, and in 5 of these cases, an intracranial lesion was detected (83.3%).

Table 1. Demographic features of the patients

	Patients	CT+ patients
Sex		
Male	239 (56.8)	23 (9.6)
Female	182 (43.2)	14 (7.7)
Age groups		
<1 year	31 (8.3)	2 (6.5)
1–3 years	177 (42)	14 (7.9)
4–6 years	138 (32.8)	17 (12.3)
7–9 years	56 (13.3)	3 (5.4)
10–16 years	19 (4.5)	1 (5.3)
Mechanism of injury		
Fall	168 (39.9)	15 (8.9)
Involved in a motor vehicle accident	67 (15.9)	5 (7.5)
Hit by a motor vehicle	92 (21.9)	16 (17.4)
Bicycle injury	39 (9.3)	1 (2.6)
Sports injury	24 (5.7)	0 (0)
Other	31 (7.4)	0 (0)

Figures in parentheses indicate percentages.

Table 2. CT findings

	Patients
Cerebral contusion	16 (43.2)
Epidural hematoma	11 (29.7)
Subdural hematoma	5 (13.5)
Depressed skull fracture	3 (8.1)
Skull base fracture with pneumocephalus	2 (5.4)
Total	37

Figures in parentheses indicate percentages.

Table 3. Sensitivity and specificity of plain radiography

	CT-positive	CT-negative	Total
X-ray-positive	16	27	43
X-ray-negative	21	357	378
Total	37	384	421

Sensitivity: 43.2%; specificity: 93%.

In patients with a history of LOC ($p < 0.001$) or posttraumatic seizure ($p < 0.001$), intracranial lesions were significantly more frequent. Such an association could not be demonstrated for headache or vomiting. Also scalp lacerations were not associated with an increased frequency of intracranial lesions ($p = 0.370$).

When the patients with a history of LOC or posttraumatic seizure were subtracted from the study group, 392 patients remained. Intracranial lesions were noted in 16 of these cases (4.1%), and in 7 cases (1.8%) neurosurgical intervention was required.

Discussion

Mild head injury, as a term, was first mentioned by Rimel et al. [3] in an article published in 1981. It was defined as a picture in which the GCS score is 13–15, there is no LOC or there is LOC lasting less than 20 min and there is no need for hospitalization or the period of hospitalization is less than 48 h. Since then, the term has been redefined many times by different authors [10, 11]. The reason for so much emphasis on this topic relies on the fact that 5 million children per year present to emergency departments, seeking care for head trauma, and about 80% of these patients belong to this group [12]. On the other hand, the frequency of intracranial lesions, in the mentioned patients, is relatively low, ranging between 4 and 10% [13]. CT is the gold standard in the evaluation of head injury. But it is expensive, not always readily available, sometimes requires sedation, and skilled interpretation is mandatory [2]. Therefore, obtaining a CT scan for each and every patient with mild head trauma is a significant economic burden. As a result, clinical factors that may indicate intracranial lesions have been studied, and guidelines for the evaluation of mild head injury have been published for both general and pediatric populations from different countries [4–8].

The GCS score is the most reliable among all clinical parameters [14]. The frequency of detecting a lesion on CT in patients with a GCS score of 13 is 67–72%, and in patients with a GCS score of 14 it is 13–18% [15–18]. Therefore each and every patient with a GCS score of less than 15 deserves a CT scan. The frequency of intracranial lesions in patients with a score of 15 varies between 4 and 10% [13]. Therefore, the main goal is to identify the subgroups in patients with a GCS score of 15, who have a higher risk of having an intracranial lesion.

The first subgroup is the patients with focal neurological deficits. The frequency of intracranial lesions in this group is reported to be 11% [19]. Therefore, these patients should be considered as a high-risk group. The next subgroup contains patients with penetrating head injury and gunshot wounds. These patients should always undergo a CT scan, regardless of their GCS score [9, 15]. In this paper, patients admitted to the emergency room due to head trauma, with a GCS score of 15 and without any focal neurological deficit were studied. Patients with penetrating skull trauma, gunshot wounds and multiple trauma were excluded. In the defined group, the frequency of intracranial lesions was 8.8%, and the frequency of lesions requiring neurosurgical intervention was 3.8%.

Sex was not found to be an important determining factor, and this finding is comparable with the previous studies [14]. Children with an age of 4–6 years seemed to have a higher frequency of intracranial lesions, but the difference was not significant compared to other age groups. In a study by Murgio et al. [20], it was stated that the children with an age of 3–9 years are at higher risk for having an intracranial lesion. No such relation could be demonstrated in this study.

Headache and vomiting are among the most common complaints encountered following head trauma. They were reported to be unassociated with the frequency of intracranial lesions in previously published studies [9, 21]. They were also found to be insignificant in the present study. Also, scalp lacerations were not associated with a higher frequency of intracranial injury.

LOC has been recognized as an important clinical parameter for a long time [22]. The only problem with this parameter is the part of history taking. Sometimes the patient, or the parents, describe even the dizziness as LOC. Posttraumatic seizure is also an important clinical parameter, and the frequency of intracranial lesions in this group was reported to be 21% [16]. Both parameters were shown to be important factors in this study. Homer and Kleinman [13], in an extensive review, concluded that the frequency of intracranial lesions in children with a GCS score of 15, without any focal neurological deficit and without any history of LOC or posttraumatic seizure after mild head injury is <1%. In the present study, the frequency was calculated as 4.1% in the defined group. The frequency of lesions requiring neurosurgical intervention was 1.8%. Although seemingly low in figures, it indicates that approximately 1 child in every 50 requires a neurosurgical intervention, although he or she has a completely normal neurological picture. In a previous study, Schunk et al. [23] also concluded that the intracerebral injury was not associated with clinical signs and it was present in about 5% of the children with an apparently normal neurological picture. Therefore, in our opinion, each and every child with mild head injury requires a CT scan.

Another issue in the evaluation of these children is the plain radiographs. In this study, sensitivity of plain radiographs was calculated as 43.2%, and specificity was calculated as 93%. Reported percentages of sensitivity of plain radiographs vary between 50 and 73% [13]. It can be concluded that, if CT is readily available, plain radiograms are not a part of the diagnostic evaluation in these children. In this manner, both unnecessary exposure to radiation can be avoided and a great deal of money can be saved [24].

On the other hand, if CT is not available or the patient has already got plain radiograms, the finding of a linear skull fracture is closely related to an intracerebral injury. The frequency of intracranial lesions in patients with linear skull fractures was 28.9% in this study. A tendency towards discharging the patients with linear skull fractures with no associated intracerebral injury on CT scans, without any hospitalization, can be noted in the literature [25]. In this study, all the 28 children with linear skull fracture and without any associated intracerebral injury were hospitalized for 24 h, and another CT scan was performed prior to discharge. In one of the children (3.6%), who had a linear temporal fracture, a decreased level of consciousness was noted 8 h after hospitalization, and a repeat CT scan revealed an epidural hematoma which was promptly evacuated. Therefore, in our opinion, every child with a linear skull fracture, even if not associated with an intracerebral injury, should be hospitalized for 24 h. Physicians should be especially alert for linear temporal fractures, crossing the anatomical pathway of the middle meningeal artery [26].

In conclusion, every child who has experienced a head injury should undergo a cranial CT evaluation, even if he or she appears in perfect health.

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