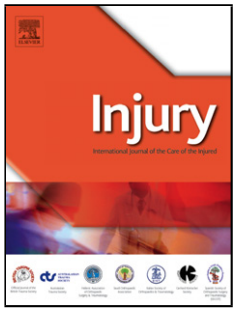

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Computed Tomography Findings in Young Children with Minor Head Injury Presenting to the Emergency Department Greater than 24hrs Post Injury

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Abstract

Background: Large studies which developed decision rules for the use of Computed tomography (CT) in children with minor head trauma excluded children with late presentation (more than 24 hours).

Objective: To assess the prevalence of significant traumatic brain injury (TBI) on CT in infants with head trauma presenting to the emergency department (ED) more than 24 hours from the injury.

Methods: A retrospective chart review of infants less than 24 months old referred for head CT because of traumatic brain injury from January 2004 to December 2014 in

Assaf-Harofeh medical center was conducted. We used the PECARN definitions of TBI on CT to define significant CT findings.

Results: 344 cases were analyzed, 68 with late presentation.

There was no significant difference in the age between children with late and early presentation (mean 11.4 (SD 5.6) month Vs 10. 5 (SD 7.0) month, P=0.27). There was no significant difference between the groups in the incidence of significant TBI (22% Vs 19 %, p=0.61). Any TBI on CT (e.g. fracture) was found in 43 (63%) patients with late presentation compared with 116 (42%) patients with early presentation (p=0.002, OR 2.37, 95% CI 1.37 to 4.1).

Conclusion: A similar rate of CT-identified traumatic brain injury was detected in both groups. There was no significant difference in the incidence of significant TBI on CT between the groups. Young children presenting to the ED more than 24 hours after the injury may have abnormal findings on CT.

Keywords: Emergency department; Pediatrics; Traumatic brain injury; Computer tomography

Introduction

Blunt head trauma in children results in more than 500,000 emergency department (ED) visits annually in the United States (1, 2). Although pediatric head injury is relatively common, pediatric traumatic brain injury (TBI) requiring neurosurgical intervention is far less frequent (3-6). Computed tomography (CT) scans must be used judiciously in children with minor head injury, balancing the need to identify important TBIs and the risks of radiation-induced malignancy (7-11).

Large studies which developed decision rules for the use of CT in children with minor head injury included children with injury within the previous 24 hours (3, 5). It is unclear whether the time of presentation to the ED after head injury correlates with an altered likelihood of intra-cranial pathology, and how well the guidelines identify significant injuries in patients presenting later than 24 hours following the injury.

A systemic review (12) found relatively sparse data available. The limited data discussed in the article suggests a lower incidence of traumatic intra-cranial pathology for patients, most of them adults, presenting 24 h or more after injury. Hamilton M. et al. (13) demonstrated that a delayed presentation >6 hour after injury of a significant traumatic brain injury was exceedingly rare in children. On the contrary, a recent

cohort research (14) has identified adults with head injury presenting >24 h following an injury as a significant clinical population. In children, Mandera et al (15) presented 6 cases of children with delayed pericerebral hematoma discovered 12 hours or more after injury. Sellin1 et al. (16) recently published data on 78 children ≤24 months of age presenting with scalp swelling more than 24 hours following a head trauma. Over half of the patients had significant TBI on CT but none of them required surgery.

Children younger than 24 months are more vulnerable to TBI and are more likely to be missed due to verbal immaturity and minor signs on physical exam even in the presence of significant TBI. The aim of this study was to assess the prevalence of significant traumatic brain injury (TBI) diagnosed on CT in infants with head injury presenting to the ED more than 24 hours following the injury

Methods

Study design

This was a retrospective chart review performed at the pediatric emergency department of a university-affiliated hospital in Israel. The hospital is a level II trauma center for both pediatric and adult patients. The hospital ethics board approved the study protocol.

Subjects

All files of children younger than 24 months with head injury who underwent CT from January 2004 to December 2014, were retrospectively reviewed.

The study group included children with late presentation, i.e. their injury occurred at least 24 hours prior to CT performance. Patients evaluated by a physician immediately after head injury who presented to the ED later, and those who were admitted without initial CT and underwent CT later, were also included.

The control group included children with early presentation, who underwent CT within 24 hours of their injury.

Exclusion criteria

Children with non-trauma indication for head CT, highly suspected non-accidental trauma, penetrating trauma, and those with pre-existing neurological disorders complicating assessment, were excluded. Files with no documentation of the time of injury were also excluded from the study.

Measurements

Head CTs were reviewed by a senior radiologist. Charts were reviewed for findings on CT and clinical significance and compared between the two groups. Data regarding age, gender, injury mechanism, findings on physical examination and outcome features were also recorded and compared between the groups.

Outcome measures

The primary outcome measure was the presence of significant traumatic brain injury (TBI) on CT in infants with head trauma presenting to the ED later than 24 hours from the injury.

The secondary outcome measures were the presence of any traumatic brain injury (TBI) findings on CT, and of clinically-important traumatic brain injury, in infants with head trauma presenting to the ED later than 24 hours from the injury.

Definitions

Using PECARN (Pediatric Emergency Care Applied Research Network) (3) definitions we identified three distinct groups: Those with a significant TBI on CT, any TBI on CT and clinically important TBI.

Significant TBI on CT includes any of the following descriptions: any intracranial bleeding, pneumocephalus, cerebral edema, skull fracture depressed by at least the thickness of skull, or diastasis of the skull.

We defined any TBI on CT as any finding on CT related to the injury (e.g. linear skull fracture).

Clinically-important traumatic brain injury (ciTBI) is defined by any of the following descriptions: death from traumatic brain injury, neurosurgical intervention for traumatic brain injury (intracranial pressure monitoring, elevation of depressed skull fracture, ventriculostomy, hematoma evacuation, lobectomy, tissue debridement, dura repair, other), intubation of more than 24 h for traumatic brain injury, and hospital admission of 2 nights or more associated with the traumatic brain injury on CT.

Data analysis

Descriptive statistics were used to describe the study population. Patients with late presentation were compared with all other patients by the Fisher Exact or Chi square test (as appropriate) for categorical variables and the student t test or Mann- Whitney test (as appropriate) for continues variables.

A logistic regression model was used to determine the effect of different variables (including time of presentation) on the risk for significant TBI. Demographic and clinical variables were included in the model based on data from previous studies.

The level of significance for all tests was set at 0.05. Statistical analysis was conducted using the SPSS (SPSS 21st edition; IBM Corp Armonk, NY) computer program.

Results

In the study period, the overall number of infants aged 0-2 years presenting with head injury was 4142. In the same period, CT scans were obtained on 637 children in that group age. Data were available for 636 of them. Two hundred eighty-three cases (44%) were excluded from the study because either they had a non-trauma indication for CT or were older than 24 months.

The remaining 353 cases were eligible for the study. Eight cases were excluded because duration from injury could not be determined. One case was a highly suspected non-accidental trauma. Of the 344 included CT scans, 68 were for patients presenting after 24 hours from injury (study group).

The characteristics of patients with late presentation and early presentation are presented in table 1. There were no significant differences in age and gender between children with late and early presentation. Significant differences between the groups were found in the frequency of scalp hematoma (OR 2.18, CI 1.17-4.06), severe mechanism (OR 0.20, CI 0.10-0.39), as well as in type of injury. Difference in frequency of readmission to ER was also found to be significant, but with a very wide CI (OR 23.62, CI 5.04-110.66).

Outcome measures and features

As mentioned, a total of 344 CT scans were available for the study. Overall, 159 scans demonstrated any TBI, from which 68 were significant. There were no significant differences between the groups in the incidence of significant TBI (22% Vs 19 %, p=0.61), ciTBI and neurosurgery intervention (table 2). Any TBI on CT were found in 43 (63%) patients with late presentation compared with 116 (42%) patients with early presentation (p=0.002, OR 2.37, 95% CI 1.37 to 4.1).

There was no significant difference in hospitalization duration between children with late and early presentation (mean 2.5 (SD 2.4) days vs 2.3 (SD 3.3) days, p=0.84).

There was borderline significant difference in intensive care unit admission between the groups (15% vs 26%, p=0.057, OR 0.47 (CI 0.23-0.98)).

Variables associated with increased risk for TBI

Logistic regression was used to explore the relationship between patient characteristics and significant TBI on CT. In the model, younger age, presence of scalp hematoma and GCS (Glasgow Coma Scale) <15 predicted significant TBI on CT (table 3), while time of presentation following injury did not. Exploring the relationship between patient characteristics and any finding on CT by logistic regression demonstrated that late presentation, as well as the three characters mentioned above, predicted any TBI on CT (table 4).

Discussion

In the current study, we identified children with head injury presenting after 24 h of injury as being a clinically significant population that accounted for 22% of cranial CT scans for children head trauma. A similar rate of CT-identified traumatic brain injury was detected in this group as in infants presenting earlier. Similarly, there was no significant difference in ciTBI or neurosurgery intervention between the groups. Any TBI (e.g. fracture) was more prevalent among the children with late presentation (63% vs 42%, p=0.002). Logistic regression analysis was undertaken and its results support these findings. These findings suggest that patients need to be treated on their merits (history, physical examination and so forth) rather than necessarily the timing of their presentation.

There is a paucity of research regarding patients who present late to the ED following head injury. In their systemic review, Marincowitz C. et al (12) suggests a lower incidence of traumatic intra-cranial pathology among patients who present in a delayed fashion to the ED. Only three studies were eligible for inclusion (17-19). Contrary to our study two studies defined late presentation as above 4 or 12 hours from injury and most of their patients were adults.

Recently, a small retrospective cohort study (14) compared delayed presentation head-injury adults patients to a non-delayed comparator population. The prevalence of traumatic intracranial pathology and neurosurgery intervention was similar in both groups. They also considered any skull fracture as an intracranial injury and anticoagulation therapy was not addressed at all. Mandera M. et al (15) presented 6 cases of children with delayed hematoma discovered 12 hours or more after injury. Those children had primary CTs which were interpreted as normal and the study

included a population at high risk for traumatic brain injuries on CT, i.e. all children had neurological symptoms and a high percentage with a significant mechanism.

We decided to exclude children with highly suspected non-accidental trauma, i.e. those who referred for this reason, since in those cases there is a clear indication for imaging, not related to time of presentation. Only a single case was excluded from the study for this reason. Obviously, the possibility of non-accidental trauma was examined in each case on a basis of history and physical examination. Similarly, we excluded children with pre-existing neurological disorders complicating assessment since the decision to perform imaging in those cases cannot be based on clinical guidelines only. No child was excluded in our study for this reason. There were 10 patients in the late presentation group that were readmitted to ER with the same injury. Of these, none had undergone CT head imaging at their first presentation. Only one of them had significant TBI and another two patients had linear fracture. Although returning patients with head injury have previously been identified as a high-risk group (20), the low prevalence of imaging findings in this subgroup probably prevent influence on results.

Limitations

This study has several limitations. The small study group presenting after 24 h with traumatic CT findings makes it difficult to arrive at clear conclusions. The nature of the retrospective review makes it difficult to ensure that all of the desired data points are present on each patient chart, and some important data may be missing. Documentation of time of injury was lacking in several cases, and was estimated by the author. However, we included only cases in which we could determine if the injury occurred within 24 hours to presentation or later. Because of the retrospective nature of the study and the fact that most of the files are not computerized, we could not split the total 4142 patients who presented to our ED with head trauma during the study period into early and late presentation. Consequently, the rate of clinically important TBI couldn't be calculated in the overall pediatric head injury population presenting early or late.

In this study, we included only children with a late presenting head injury that underwent CT and not those who did not receive imaging studies. That makes those who were chosen to undergo CT a selected high-risk group. Additionally, children that did not have CT scans preformed may have had serious intracranial pathology

that failed to present to the ED and may have been missed. We did not follow children that had an initial negative CT, or did not have a CT at all, to see if they presented to other ED's or suffered late complications. However, as this is a regional hospital, patients tend to readmit it in case they need to be reevaluated, rather than referring to other hospitals.

Conclusion

A similar rate of CT-identified traumatic brain injury was detected in both groups. There was no significant difference in the incidence of significant TBI on CT between the groups. Young children presenting to the ED more than 24 hours after the injury may have abnormal findings on CT. Further study in a large cohort is required to define the prevalence of significant TBI in children with late presentation, and to investigate whether application of existing guidelines to this group can define those at risk of important intra-cranial injuries.

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Table 1:

Characteristics of patients by time of presentation after injury

Factor		**After 24 h (n=68)**	**Within 24 h (n=275)**	**P value**
Age, months (mean (SD))		11.4 (5.6)	10.5 (7.0)	0.278
Gender (n (%) male)		34 (50%)	171(62%)	0.075
GCS* <15 (n (%)		10 (15%)	49 (18%)	0.595
Hematoma (n (%)		53 (78%)	170 (62%)	**0.015**
Severe mechanism of injury (n (%)		14 (22%)	157 (58%)	**<0.001**
Type of Mechanism	Fall (n (%)	63 (98%)	238 (88%)	**0.035**
	motor vehicle accident	0 (0%)	21(8%)	
	other	1 (2%)	12(4%)	
Readmittance to Emergency Room		10 (15%)	2 (1%)	**<0.001**

* GCS: Glasgow Coma Scale

Table 2:

Prevalence of CT findings and clinical important TBI in patients with late presentation versus early presentation

Factor	**After 24 h (n=68)**	**Within 24 h (n=275)**	**P value**	**OR (95% CI)**
Significant TBI* on CT	15 (22%)	53 (19%)	0.612	1.19 (0.62-2.27)
Any TBI on CT	43 (63%)	116(42%)	**0.002**	2.37 (1.37-4.10)
ciTBI**	2 (3%)	15 (5%)	0.541	0.52 (0.11-2.36)
Neurosurgery Intervention	1 (2%)	10 (4%)	0.700	0.39 (0.05-3.14)

* TBI: Traumatic Brain Injury

** ciTBI: Clinical Important Traumatic Brain Injury

Table 3:

Variables associated with increased risk for significant TBI on CT

Factor	**OR (95% CI)**
Age, months	**0.91 (0.86-0.96**)
Male gender	1.34 (0.72-2.49)
GCS* <15	**5.88 (2.69-13.02)**
Hematoma	**4.39 (1.91-10.10)**
Duration from injury>24h	1.63 (0.79-3.44)

* GCS: Glasgow Coma Scale

Table 4:

Variables associated with increased risk for any TBI on CT

Factor	**OR (95% CI)**
Age, months	**0.90 (0.86-0.94**)
Male gender	1.51 (0.89-2.58)
GCS* <15	**2.44 (1.17- 5.26**)
Hematoma	**7.69 (4.00-14.26**)
Duration from injury>24h	**2.77 (1.40-5.55)**

* GCS: Glasgow Coma Scale