COMPLIANCE WITH CATCH RULES IN ADMINISTERING COMPUTERIZED TOMOGRAPHY SCANS TO CHILDREN ADMITTED TO THE EMERGENCY DEPARTMENT WITH MINOR HEAD TRAUMA

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ABSTRACT

Background: *Traumatic brain injury (TBI) is a major health problem frequently encountered in children. Although TBI-associated acute brain damage is frequently observed in children, the need for neurosurgical intervention is rare. In many centers, it has become standard practice to assess children with minor TBI (Glasgow Coma Scale [GCS], 13-15) using head computerized tomography (CT). Therefore, preventing unnecessary CT imaging in children with minor TBI is important. The Canadian Assessment of Tomography for Childhood Head injury (CATCH) guidelines comprise precise rules aimed at reducing CT imaging in pediatric patients with minor TBI. In this study, we retrospectively investigated pediatric patients with head trauma who presented to our emergency clinic and assessed CATCH compliance in cases where CT scans were administered.*

Methods*: This study was performed by retrospectively investigating children 0–18 years of age who had a record of head trauma and underwent brain CT imaging at the emergency clinic of a tertiary city hospital with an annual patient population of approximately 245.000. Children with minor TBI who met the CATCH criteria for CT imaging, including a decrease in GCS to <15 within 2 h following trauma, evidence of an open or depression fracture, irritability during examination, basal skull fracture, large or boggy hematoma on the scalp, fall from a height of 3 feet or down five steps, motorized vehicle accidents, and fall from a motorcycle without a helmet, were included in this study. The findings regarding compliance with CATCH rules were analyzed statistically.*

Results: *A total of 2.253 children with head trauma presenting over 1 year were examined, and 731 children (32.4%) who underwent CT scans were included because they conformed to the CATCH rules. Approximately 20% (n = 148) of these cases were asymptomatic. Indications for CT imaging included a dangerous trauma mechanism (77.2%, n = 564), a linear fracture without acute brain damage (5.6%, n = 127), and acute brain damage (1.6%, n = 36). Four patients (0.2%) with depression fractures underwent surgery.*

Interpretation*: It was difficult to reach a consensus on the decision for brain CT imaging for minor head trauma in the pediatric age group. The CATCH criterion related to falling from a height of >3 feet was the most frequent indication for CT imaging in our study. However, the trauma mechanism of simply falling from a height 3 feet was insufficient to justify a decision to perform a CT scan.*

Key words*: ??????????????*

Received *Septemper 12, 2013;* ***Accepted*** *Septemper 20, 2013*

Introduction

Traumatic brain injury (TBI) is a major health problem frequently encountered in children[1]. TBI is an impairment of brain function as a consequence of mechanical force. This functional impairment may be temporary or permanent, depending on the underlying changes in structural systems[2,3,4]. In the US, an annual average of 631.146 emergency department visits, 35.994 hospitalizations, and 6.169 deaths due to TBI are been reported in children 0-19 years of age[5]. Among the causes of trauma, falling, motorized vehicle accidents, and child neglect and abuse are the most common[6-8]. Based on the Glasgow Coma Scale (GCS), TBI is classified as serious (GCS 3-8), medium (GCS 9-12), and mild (GCS 13-15). Clinical findings range from slight dizziness to coma. The acute symptoms of mild TBI are loss of consciousness, anterograde and retrograde amnesia, headache, nausea, vomiting, and dizziness or disorientation[3,9]. Although acute brain damage associated with TBI is frequently observed in children, the need for neurosurgical intervention is quite rare[10,11]. It has become standard practice in many centers to assess children with minor TBI by head computerized tomography (CT). Therefore, it is important to prevent unnecessary CT imaging in children with mild TBI. Many different guidelines have been used for the diagnosis and management of TBI in patients undergoing CT scans[10,12,13,14]. The Canadian Assessment of Tomography for Childhood Head injury (CATCH) rules are a compilation of precise rules aimed at reducing CT imaging in cases of pediatric minor TBI. These rules divide TBI incidents into categories of high, medium, and low risk. The presence of at least one of the seven elements in the medium- and high-risk categories is adequate to meet the criteria for CT imaging[14]. In this study, we retrospectively examined pediatric patients with head trauma who presented at our emergency clinic and evaluated characteristics of the patients who underwent CT imaging according to the CATCH criteria.

Study design and population

This study was carried out at the emergency clinic of a tertiary city hospital with an annual population of approximately 245.000 patients. The study included a retrospective investigation of children 0–18 years of age who presented at the clinic from January 1, 2009, to December 31, 2010, whose records indicated head trauma according to the International Classification of Diseases, Tenth Revision, and who underwent brain CT imaging. The medical documents on the children were examined for the mode of occurrence of the incident, GCS score, observed loss of consciousness, short-term memory loss, amnesia, post-traumatic seizure, nausea, headache, evidence of external trauma on the clavicles, confusion, disorientation, and neurological deficits. The patients were divided into three categories based on the GCS score: serious TBI (GCS ≤8), medium TBI (GCS 9-12), and mild TBI (GCS 14-15). Cases with loss of consciousness, amnesia, confusion, witnessed disorientation, persistent vomiting (more than two vomiting episodes within 15 minutes), irritability in children <2 years of age, GCS scale of at least 13 on presentation to the clinic, and occurrence of the trauma within the last 24 h witnessed in patients assessed with minor TBI were included. High-risk minor TBI according to CATCH rules (decrease in GCS to <15 within 2h following trauma, presence of open or depression fracture, irritability during examination) and medium-risk minor TBI (basal skull fracture, large or boggy hematoma on the scalp, fall from a height of 3 feet or down five steps, motorized vehicle accident, and fall from a motorcycle without a helmet) were accepted as indications for CT imaging. Child abuse, pregnancy, and return visits were excluded. The CT findings of all patients were recorded, and the differences among the groups were assessed.

Analyses were conducted using SPSS 20.0 statistics software (SPSS, Inc., Chicago, IL, USA). Frequency, percentage distribution, average, standard deviation, and range values are presented.

Results

Of the 32.251 pediatric patients presenting at our emergency trauma unit between May 2009 and June 2010, 2.253 presented due to head trauma. CT scans were performed for head trauma in 36% (n=810) of these 2253 patients. The average age of the patients was 7.01±4.42 years (median, 6 years; range, 5 months to 18 years), and 64% (n=1442) were males. In total, 550 of the patients (24.4%) were ≤2 years old. The patients presented to the emergency service within 3.15 ± 1.7 h (median, 3 h; range, 20 minutes to 8 h) of the incident.When the etiology of the head trauma was examined, falls ranked first, being cited as the cause of the trauma in 60.2% (n=1356) of the cases (Table 1).

	n = 2253
Fall	1356 (%60.2)
Fall from height ≤ 3 ft or ≤ 5 stairs	936 (%41.5)
Fall from height ≥ 3 ft or ≥ 5 stairs	420 (%18.6)
Head struck or hit by object	175 (%7.8)
Sport	170 (%7.6)
Bicycle-related	170 (%7.6)
Motor vehicle collision	165 (%7.3)
Assault	80 (%3.6)
Pedestrian struck	75 (%3.3)
Other	62 (%2.6)

Table 1: Mechanism of injury.

When the GCS score was examined, 99.8% (n = 2249) of the patients had minor TBI, and 0.2% (n=4) had medium or serious TBI. Most patients had symptoms of headache (65%, n=1465) and nausea (36%, n=810), but many (24.3%, n=547) were asymptomatic. The physical examination findings and symptoms of the patients are provided in Table 2.

Characteristic	n = 2253
Initial score on Glasgow Coma Scale	
15	2116 (94%)
14	90 (4%)
13	43 (1.8%)
≤ 12	4 (0.2%)
Large, boggy hematoma of the scalp	75 (3.3%)
Simple hematoma of the scalp	850 (37.7%)
Laceration of Scalp	350 (15.5%)
Maxillofacial injures	460 (20.4%)
Thorax and abdominal injuries	31 (1.3%)
Orthopedic disorders	650 (28.9%)
Headache (n=1856)	1365 (72.7%)
Vomiting (n=2150)	810 (37.7%)
Disorientation or confusion (witnessed) (n=1950)	640 (32.8%)
No symptoms	547 (24,3%)
Loss of consciousness (witnessed) (n=2150)	420 (19.5%)
Amnesia(n=2043)	320 (15.7%)

Table 2: Physical examination signs and clinical symptoms.

A total of 810 patients (36% of all head trauma patients) underwent CT imaging and were reassessed according to the CATCH rules. In total, 806 of these patients were considered minor TBI. Of these, 731 (32.4% of all head trauma patients) were included, as they conformed to the CATCH rules, 75 (3.3%) were excluded due to the patient exclusion criteria and deficiencies in the records (Table 3). Of the 731 patients included in the study, 18.6% (n=139) were children ≤2 years of age, and 20.3% (n=148) were asymptomatic. Of the four patients with medium or serious TBI, the initial GCS was determined in two. Dense brain edema and subarachnoid hemorrhage were observed in one of these patients, and the second had dense brain edema. The GCS score of the third patient was 8, and the CT imaging findings suggested subdural hematoma. The GCS score of the fourth patient was 3, and the CT finding was dense edema and a shifted subdural hematoma.

Appropriate Cases According to CATCH rules	(n=731)
Glasgow Coma Scale score < 15 at two hours after injury	18 (2.5%)
Suspected open or depressed skull fracture	25 (3.4%)
History of worsening headache	75 (10.3%)
Irritability on examination	30 (4.1%)
Any sign of basal skull fracture *(e.g., hemotympanum,"raccoon" eyes, otorrhea or rhinorrhea of the cerebrospinal fluid, Battle's sign)*	5 (0.7%)
Large, boggy hematoma of the scalp	142 (19.4%)
Dangerous mechanism of injury *(e.g., motor vehicle crash, fall from elevation ≥ 3 ft [≥ 91 cm] or 5 stairs, fall from bicycle with no helmet)*	564 (77.2%)

Table 3: Distribution of the Cases Conformed to Canadian Assessment of Tomography for Childhood Head Injury Rules.
CATCH: Canadian Assessment of Tomography for Childhood Head Injury (CATCH)

Minor TBI CT outcomes	731 (100%)
Skull fracture	152 (20.8%)
Lineer / isolated	137 (18.7%) / 127(17.3%)
Depressed skull fracture / isolated	14 (1.9%) / 8(1.1%)
Basis cranii fracture	1 (0.14%)
Acute brain lesion	27 (3.7%)
Epidural hematoma	7 (0.96%)
Subdural hematoma	7 (0.96%)
Intracerebral hematoma	4 (0.55%)
Subarachnoid hemorrhage	5 (0.68%)
Cerebral contusion	4 (0.55%)
Both skull fractures and ABL	163 (22.3%)
Isolated Lineer fracture	127(17.3%)
Isolated depressed skull fracture	8(1.1%)
Isolated basis cranii fracture	1 (0.14%)
Acute brain lesion	27 (3.7%)
Hospitalization	52 (7.1%)
Surgical therapy	4 (0.6%)
Mortality	0

Table 4: CT Findings of Minor TBI Cases Conformed to Canadian Assessment of Tomography for Childhood Head Injury Rules.
ABL: Acute Brain Lesion

No intracranial lesions or bone fractures were encountered in the 75 (9.3%) patients excluded from the study. While linear fractures without acute brain damage were observed in the largest (17.4%, n = 127) number of patients, acute brain damage was detected in 3.7% (n=27) (Table 4). About 0.6% (n=4) of the patients with depression fractures underwent surgery, and the other depression fractures were judged to not require surgery. Isolated linear fractures were detected in 32.4% (n=45) of the 139 children ≤2 years of age, and acute brain damage was identified in 3.6% (n=5). Of the 163 (22.3%) patients with skull fractures and acute brain damage, 21.5% (n=35) were asymptomatic. Not only 57% (n=20) of these asymptomatic patients had isolated linear fractures and were ≤2 years of age but also 28.5% (n=8) had acute brain damage (Table 4). Patients with acute brain damage were determined not to be candidates for surgery and were discharged following intensive observation.

Discussion

The decision to perform a CT scan in pediatric patients with TBI has always been problematic for emergency physicians because TBI may be asymptomatic, particularly in children <2 years of age, and may emerge after a completely normal neurological examination. Gruskin et al. identified isolated skull fractures in 17% and intracerebral hemorrhage in 5% of 227 children <2 years of age with minor head trauma, yet they reported no loss of consciousness, vomiting, seizure, or behavioral change in 62% of the children with isolated skull fractures and 58% of the children with intracerebral hemorrhage[15]. Ros and Cetta detected isolated skull fractures in 9% of 35 children <1 year of age with asymptomatic minor head trauma[16]. In our study, the rate of isolated linear fractures was 17.3%, and the rate of acute brain damage was 3.7% across all pediatric age groups. Isolated linear fractures were detected in 32.4% and acute brain damage in 3.6% of the patients <2 years of age. In our study, 44.4% of the linear fractures observed in children <2 years of age were asymptomatic. We believe that the difference between the proportion of asymptomatic patients our study and those in other studies will be clarified by actual figures from larger epidemiological studies.

The controversy associated with performing CT imaging has been reduced by various guidelines, and strikingly significant reductions in CT imaging are observed when such guidelines are successfully applied. Haydel et al. investigated indications for head CT imaging in adult patients with minor TBI in 2000 and identified positive CT findings in 6.9% of 520 patients. The criteria for minor TBI were presence of headache, vomiting, >60 years of age, medication and alcohol intoxication, short-term memory loss, evidence of trauma on the clavicles, and seizure[17]. Following Haydel et al., the CATCH rules, reported by Stiell et al. in 2001, pioneered the guidelines established for the pediatric age group[13]. In 2003, the same criteria as those used in the study by Haydel et al. were reviewed in 175 children >5 years of age with GCS scores of 15, and positive CT findings were detected in 15 patients[18]. A study by Palkchak et al. (2003) investigated 2.043 children <18 years of age with head trauma and evaluated the histories and examination findings such as loss of consciousness, amnesia, vomiting, and headache, indications for head CT imaging. Ninety-eight patients with positive intracranial pathology and clinical findings of abnormal mental status and skull fractures, vomiting history, and symptoms and findings of scalp hematoma (<2 years of age) and headache who underwent CT imaging were reviewed, and the findings revealed 98% sensitivity (95% confidence interval [CI], 93–100%) (19). Dunning et al. examined 22.772 children with head trauma in 2006 and presented the CHALICE rules. In that study, 99% (22,579) had minor TBI, 421 (1.9%) had skull fractures, and 281 (1.2%) had abnormal CT findings. Only 137 (0.6%) patients underwent neurosurgical operations, and 15 (0.1%) children died. The CHALICE rules include 14 comprehensive items, and the most apparent feature is that the height taken as the threshold for falling from a height is >3 meters (vs. 3 feet in the CHART rules). The sensitivity of these rules was 98% (95% CI, 86–87%), and specificity was 87% (95% CI, 96-100%) (10).

In a study published in 2007, Beaudin et al. assessed 417 children with minor head trauma. Fifteen skull fractures were detected in these children (average age, 3.8 months), all of whom had fallen from a height of >1 meter. Thirteen children underwent CT imaging, and positive CT findings were observed in three[12]. Following all of these studies, the CATCH rules were presented by Osmond et al. in 2010 and are a compilation of quite precise rules to reduce CT imaging in pediatric minor TBI cases[14]. The CATCH rules divide minor TBI cases into three categories of high, medium, and low risk. The presence of at least one of the seven items in the medium- and high-risk categories is sufficient to order a CT scan. In presenting these rules, Osmond et al. assessed 3.866 children with head trauma; 2.043 (52.8%) underwent CT imaging, and the rest were monitored over the telephone. They found that the most prevalent trauma mechanism was falling in 1737 (44.9%) of the incidents, followed by sports injuries in 872 (22.6%). Of the 2.043 (52.8%) children who underwent CT imaging, skull fractures were detected in 192 (4.9%), and acute brain lesions in 159 (4.1%). Neurological interventions were conducted on 24 (0.5%) children. In light of these data, they determined four high-risk factors (decrease in GCS to <15 within 2 h following trauma, suspicion of an open skull fracture, worsening headache, and irritability) and three medium risk factors (large, boggy hematoma of scalp; signs of basal skull fracture; and dangerous mechanism of injury). They demonstrated that the presence of one or more of the high-risk factors had 100% sensitivity (95% CI, 86-100%) and 70.2% specificity (95% CI, 69-72%) and that the presence of one or more of the seven risk factors had 98.1% sensitivity (95% CI, 95-99%) and 50.1% specificity (95% CI, 49-52%)[14].

In the present study, CT imaging was performed in 36% (n=810) of all patients who presented with head trauma based on the CATCH rules. This proportion was quite low compared with the CT imaging percentage reported by Osmond et al.[12]. The ranking of trauma mechanisms was similar. However, in our study, the number of falling incidents was greater. Based on the presence of any medium- or high-risk factor, 6.6% (n = 148) of the children had at least one high-risk factor, and 25.9% (n=583) had at least one medium-risk factor in our study. Osmond et al. identified the proportion of children with at least one risk factor as 30.2% (n=1168) and the proportion of children with at least one medium-risk factor as 22.6% (n=875)[12]. Whereas the proportion of patients who underwent CT imaging due to a high risk according to the CATCH rules in our study was 20.2% (n=731), this proportion was 57% (n=2.043) in the study by Osmond et al.[12]. When the CT findings in our study were examined, skull fractures were identified in 6.8% (n=152), and acute brain lesions in 1.2% (n=27) of 2253 children. These linear fracture percentages were higher than those reported by Osmond et al., and the percentage for acute brain damage was considerably lower. Additionally, our surgical intervention percentage was also much lower. The primary difference between the percentages reported by Osmond et al. and those in our study, is that the proportions of medium- and high-risk factors in our study were reversed compared with those of Osmond et al. We believe that this is due primarily to the considerably higher percentage of injuries caused by falling from a height.

Limitation: First, our retrospective study examined use of the CATCH rules in our emergency clinic and determined the proportion of positive CT findings. The records of all children with minor head trauma who presented to our clinic were examined. Incomplete records were excluded. Although we were able to examine the follow-up records of patients who underwent CT scans, we were unable to determine their visits to other hospitals. Furthermore, patients who did not undergo CT imaging were excluded. The exclusion of patients who did not undergo CT scans may have allowed us to achieve significant findings such as those for sensitivity, specificity, and negative predictive value.

Conclusion

It seemed quite difficult to reach consensus on the decision for brain CT imaging in cases of minor head trauma in the pediatric age group. Falling from a height of 1 meter was taken as the CT imaging indication in our study. This trauma mechanism alone was not adequate to determine the need for brain CT imaging. Thus, new clinical observation-based studies are required.

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