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Clinical Symptoms of Minor Head Trauma and Abnormal Computed Tomography Scan

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Abstract

Background: Minor head trauma accounts for 70% to 90% of all head traumas. Previous studies stated that minor head traumas were associated with 7% - 20% significant abnormal findings in brain computed tomography (CT)-scans.

Objectives: The aim of this study was to reevaluate clinical criteria of taking brain CT scan in patients who suffered from minor head trauma.

Patients and Methods: We enrolled 680 patients presented to an academic trauma hospital with minor head trauma in a prospective manner. All participants underwent brain CT scan if they met the inclusion criteria and the results of scans were compared with clinical examination finding.

Results: Loss of consciousness (GCS drop or amnesia) was markedly associated with abnormal brain CT scan ($P < 0.05$). Interestingly, we found 7 patients with normal clinical examination but significant abnormal brain CT scan.

Conclusions: According to the results of our study, we recommend that all patients with minor head trauma underwent brain CT scan in order not to miss any life-threatening head injuries.

Keywords: Craniocerebral Trauma, Clinical Markers, Abnormalities, CT Scan

1. Background

There are almost 0.8 to 1.2 million patients with head injury in United States annually (1, 2), that 70% - 90% of them categorize as minor head trauma (3). In several studies, it is estimated that intracranial lesions following a brain computed tomography (CT) scan of these patients is as high as 7% - 20% (4-7).

Brain CT scan is extensively used for screening patients with minor head injuries although it is often normal (8). About one million patients with head trauma undergo brain CT scan every year (6). Which patient with head trauma should undergo a CT scan is still controversial. At first CT scan was used only for patients with major injuries due to resource limitations, after that by common access to CT scan it also used for patients with minor head trauma, and it was found retrospectively that about 17% - 20% of patients with minor head trauma had pathologic findings in their CT scans (8).

As most of these patients do not require special medical treatments, some physicians do not have tendency to request a brain CT scan for minor head traumas. Unlike them, others believe that in order to reduce dramatic consequences of ignoring brain pathologies, CT scans should be used freely during patient evaluations (9).

Minor head trauma will be diagnosed by history of loss of conciseness (LOC), amnesia and Glasgow coma scale (GCS) 13 to 15. There are some differences in determining minor injury and based on some studies patients with minor head trauma may not have LOC or neurologic changes (10).

Indications and overuse of computed tomography in minor head trauma (11). Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury (12).

A number of clinical decision rules have been developed to identify high-risk patients in the minor head trauma category to predict intracranial pathologies that need CT scan and decrease unnecessary imaging for these patients (13, 14). A 10% decrease in brain CT requests for

minor head trauma would result in saving $20 million in US (15). It would also lead to saving time and less crowded emergency department (ED) (3, 16). While the sensitivities of these algorithms range from 80% to 100%, (2, 14, 17, 18) and their specificities have been suboptimal, emergency physicians tend to use brain CT scan for all the patients not missing any potential finding which is an expensive screening test (8).

2. Objectives

Considering the high number of head trauma cases in our country and taking into account that 80% of them have minor head trauma, we designed a study to evaluate and confirm clinical criteria suggested in previous studies to determine those with minor head trauma that do not need to undergo brain CT scan in ED.

3. Patients and Methods

This cross-sectional study was performed in an urban academic trauma center of Tehran university of medical sciences from April 2010 to April 2011.

In this study, 3 - 65 years old patients with blunt head trauma and GCS ≥ 13 without focal neurologic finding were evaluated. All the patients with minor head trauma underwent brain CT scan as soon as possible during the first two hours after ED arrival without using any special screening rule and pathologic findings were recorded. An expert radiologist reported the findings of the imaging.

Our exclusion criteria consisted patients with other serious injuries, unstable patients and suspicion to malingering. Recorded variables included LOC, GCS, amnesia, age, sex, sign or symptoms of skull base fracture, seizure, nausea and vomiting, headache, and brain CT scan findings. Statistical analysis performed with SPSS version 13 using chi-square and t-tests.

4. Results

In this study, 680 patients (75.7% men) were evaluated. The mean age of the participants was 30.6 ± 16.1 years. Our results showed that 85.7% of the patients had GCS equal to 15 and the most frequent mechanism of injury was car accident; 12.1% had skull fracture and 8.4% showed any sign or symptom of skull base fracture including raccoon eye, otorrhea, otorragia or rhinorrhea (Table 1).

Positive findings of brain CT scan include cerebral hemorrhage (contusion, epidural hematoma, subdural hematoma and subarachnoid hematoma) which are recorded in 14.3% of subjects.

Data analysis showed that 7.9% of patients with GCS = 15 had positive findings in brain CT scan and statistical analysis showed that there was a significant relation between brain CT finding and GCS (Chi-square ; P = 0.000) (Figure 1).

Vomiting, headache, loss of conciseness and amnesia were the most frequent symptoms among the patients with minor head trauma and posttraumatic seizure was the least recorded sign. Except for seizure, other findings showed a significant relation with brain CT findings and skull base fracture showed the strongest relation (Table 2). As shown in Figure 2, increase in number of clinical findings would significantly increase the probability of having abnormal CT scan (chi-square; Asymp sig. = 0.000). Interestingly, seven patients (2.6%) had no symptom or sign while presenting the ED, but had abnormal CT scan.

Among children aged 3 to 12 years old, patients' GCS score and presence of skull fracture are statistically related with abnormal brain CT scan findings while in teens and adults, LOC, number of clinical findings prior to performing a brain CT scan, GCS score, amnesia, vomiting, headache, skull fracture or signs of skull base fracture can be a predictor of abnormal findings in brain CT scan (Table 3) (Figure 2).

One of the patients the day after discharge was SDH and LOC, because of taking warfarin and one patient a week after discharge with rebleeding admitted to ICU.

The sensitivity, specificity, positive predictive value and negative predictive value for clinically important brain injury in CT according to the Canadian CT Head Rule (CCHR) were as follows for two age groups: 3-12 years old (87.5%, 43.5%, 15.2%, 96.8%, respectively) and 13 - 65 years old (93.3%, 45.3%, 22.8%, 97.5%, respectively).

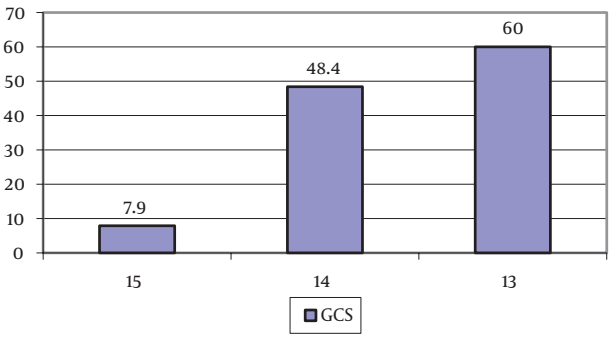

Figure 1. Presence of Abnormal Computed Tomography Scan According to Patients' Glasgow Coma Scale

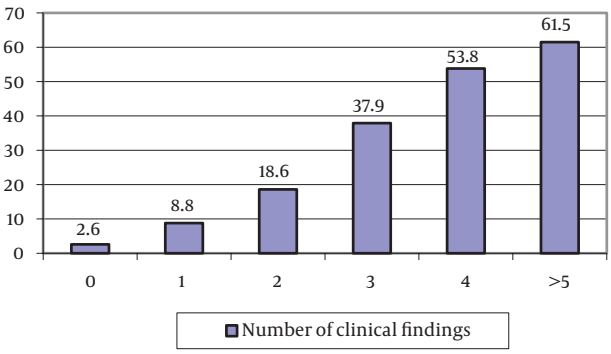

Figure 2. Presence of Abnormal Computed Tomography Scan According to the Number of Clinical Findings Before Performing Brain CT Scan

Table 1. Demographic Data of the Participants

Variables	Values[a]
Gender	
Male	515 (75.7)
Female	165 (24.3)
GCS	
15	583 (85.7)
14	62 (9.1)
13	35 (5.1)
Mechanism of trauma	
CA	239 (35.1)
MVA	195 (28.7)
FALL	104 (15.3)
Pedestrian	83 (12.2)
Hard objects blow	51 (7.5)
Sport	4 (0.6)
Syncope	3 (0.4)
Other	1 (0.1)
Abnormal CT scan	97 (14.3)
Skull fracture	82 (12.1)
Skull base fracture	57 (8.4)

Abbreviations: CA, car to car accident; CT, computed tomography; GCS, Glasgow coma scale; MVA, motorcycle to car or other vehicle accident.
[a]Data are presented as No. (%).

Table 2. Clinical Findings of the Patients With Minor Head Trauma

	Total	With Abnormal CT scan	Odds	P Value
Amnesia	149 (21.9)	41 (27.5)	3.22	.000[a]
Seizure	7 (1.0)	3 (42.9)	4.62	.064[b]
Vomiting	162 (23.8)	38 (23.5)	2.38	.000[a]
Raccoon Eye	23 (3.4)	13 (56.5)	8.86	.000[a]
Otorrhea	3 (0.4)	0 (0)	NA	.630[b]
Otorragia	23 (3.4)	16 (9.9)	16.25	.000[a]
Rhinorrhea	1 (0.1)	0	NA	.857[b]
Base of skull fracture [c]	57 (8.4)	30 (52.6)	9.21	.000[a]
Headache	161 (23.7)	45 (28.0)	3.48	.000[a]
Loss of consciousness	161 (23.7)	39 (24.2)	2.54	.000[a]

Abbreviation: NA, not available.
[a]Chi-square tests.
[b]Fisher's exact test.
[c]Any sign or symptom (≥ 1).

Table 3. Clinical Findings of the Patients With Minor Head Trauma by Age Group

Variable	3 - 12 Years			13 - 65 Years		
	CT Scan			CT Scan		
	Normal	Abnormal	P	Normal	Abnormal	P
LOC			.032			.000
No	59	4		402	54	
Yes	10	4		112	35	
Number of clinical findings			.030			.000
0	30	1		233	6	
1	28	2		138	14	
2	8	3		88	19	
3	1	1		35	21	
4	1	1		11	13	
5	1	0		9	16	
GCS			.000			.000
15	63	4		474	42	
14	5	2		27	28	
13	1	2		13	19	
Amnesia			.603			.000
No	62	7		413	49	
Yes	7	1		101	40	
Seizure			.896			.045
No	68	8		511	86	
Yes	1	0		3	3	
Vomiting			.554			.000
No	48	6		411	53	
Yes	21	2		103	36	
Headache			.551			.000
No	63	7		404	45	
Yes	6	1		110	44	
Skull fracture			.000			.000
No	63	2		489	44	
Yes	6	6		25	45	
Base skull Fx			.361			.000
No sign	66	7		490	60	
Any sign	3	1		24	29	

Abbreviations: CT, computed tomography; GCS, Glasgow coma scale; LOC, loss of consciousness.

5. Discussion

According to our results on 680 patients with minor head trauma, there were a significant relation between all signs and symptoms (except for seizure) and positive findings of brain CT scan; and increase in number of clinical complaints would increase the risk of presence of cerebral pathologies.

Less than 10% of patients with minor head trauma have positive findings in their brain CT scan and less than 1% would need a neurosurgery intervention (8). There are varieties of choices to manage minor head trauma like performing brain CT scan, brain MRI or close observation of the subjects for few hours. Limited studies reported that patients with initial normal brain CT scan showed intracranial findings during subsequent imaging studies (19). Although many studies suggest that patients with normal neurologic examinations and brain CT scan can surely leave ED (9, 14), findings of recent studies show that we cannot confidently say that there is no cerebral injury in these patients.

Although decision rules such as CCHR are widely validat-

ed and cost-effective for adults, they need further validation for children (20). As seen in our study, LOC, amnesia, vomiting, headache, signs of skull-base fracture, the number of clinical findings prior to performing a brain CT scan are not statistically related to abnormal brain CT scan findings among children aged 3 to 12 years old; these results are somehow challenging with CCHR criteria about signs of basal skull fracture, vomiting and amnesia (21).

Use of CT scans can be limited to children with ongoing specific symptoms and/or focal neurological signs. The implementation of guidelines in the management of head injuries in children could have a substantial effect on clinical practice and health-care costs (22).

Lots of studies have examined accompaniment of clinical findings to probability of positive brain CT scan in patients with minor head trauma but none of them had 100% sensitivity. Adjusting our data to identify clinically important brain injury using the CCHR rule showed that CCHR rules had 87.5% sensitivity and 43.5% specificity for 3 - 12 year-old patients, while these were 93.3% and 45.3% for 13-65 year-old patients, respectively. These results are similar to other studies which ranged 80% to 100% for sensitivity and 39% to 50% for specificity in general population (2, 14, 17, 18).

In previous studies, clinical findings such as headache (13), nausea and vomiting (13, 14), amnesia (23, 24) and seizure (14, 25) had positive relation with abnormal brain CT scan among patients with minor head trauma which is comparable to our results, except for seizure. In a study on 448 patients, 92% of those who had positive brain CT scan were found based on findings such as soft tissue injury, evidence of skull base fracture, abnormal neurologic examinations and age over 60 years old (26). In the study conducted on 373 patients, 90% of the subjects with positive brain CT scan were found based on findings such as alcohol abuse, abnormal neurologic examination and amnesia (24). As abnormal brain CT scan had been related to headache, vomiting, LOC or amnesia and alcohol intoxication, it is suggested that patient with any of these indicators must be considered a high-risk minor head trauma (27). However, in our study, 2.8% of the patients had abnormal CT scan without having any sign or symptom. Some researchers believe that it worth ignoring some patients with minor head trauma who had positive findings in brain CT without neurosurgical intervention for performing selective brain CT scan (13). On average, about 37% of the patients with MHT referring to the EDs had no indication of CT and approximately 86.5% of CT results were normal. Improving this situation can result in a significant saving in health care costs (11).

However, others believe that because of susceptibility of potential morbidity, no risk is acceptable (28).

In view of the results of this study, we believe that considering probability of unwanted consequences of ignored patients with positive brain CT scan, a method with 100% sensitivity should be administered.

We recommend revising the clinical criteria for using brain CT scan among patients with minor head trauma to reduce the risk of ignoring positive finding.

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Footnote

Authors' Contribution: Study concept and design: Mohammadreza Maghsoudi and Tooraj Asadi; analysis and interpretation of data: Saghi Maghsoudi, and Tooraj Asadi; drafting of the manuscript: Mehdi Samadzadeh; critical revision of the manuscript for important intellectual content: Bita Shahbazzadegan, Mehdi Samadzadeh and Mohammadreza Maghsoudi; statistical analysis: Saghi Maghsoudi and Khatereh Isazadehfar.

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