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Original Article

Indications for brain CT scan in patients with minor head injury

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Abstract

BACKGROUND: Minor head injury is the most common type of head injury. Despite its high prevalence and a lot of studies, there is much controversies about the management of these patients. We performed this study to find indications for brain CT scan according to clinical signs and symptoms.

METHODS: We did this prospective cohort study in two university hospitals (Alzahra and Kashani) for one year enrolling 682 consecutive patients with minor head injury (GCS = 15) and recording all clinical signs and symptoms to find which could be used as predictors for brain injuries. X^2 and logistic regression with 95% confidence interval were used for analysis.

RESULTS: Of 682 patients, 46 (6.7%) had brain injuries in CT scan. All patients with abnormal CT scans had at least one of the following risk factors: post traumatic amnesia, post traumatic unconsciousness, post traumatic seizure, headache, confusion, vomiting, focal neurological deficit, skull fracture, coagulopathy or history of taking anticoagulants and age more then 60 years. We didn't find any abnormality in brain CT scan of patients who did not have any of these factors on admission. Confusion, Vomiting, skull fracture and age > 60 years had significant correlation with brain injuries. We also found those patients who had more than one risk factor had more abnormalities in CT scan.

CONCLUSION: Not all patients with minor head injury need brain CT scan. Clinical factors can be used as indications for brain CT scan in these patients.

KEY WORDS: minor head injury, brain CT scan.

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Head injury is a common complaint in emergency rooms and the most common type is minor head injury (84%) [1]. Different definitions are proposed for minor head injury (MHI); some authors believe that MHI is equal to 13<GCS<15 [1, 2, 3] and the others think GCS = 14 or 15 is MHI [4]. However, the more common belief is that only head injury patients who's GCS scores are 15 are minor head injury patients [5, 6], so we considered GCS score of 15 as minor head injury. There are very few controversies about the management of head injury patients with GCS<14 [7], but much controversies exist regarding the management of minor head injuries especially indication of brain CT scan [2].

Most of these patients don't need any treatment and will be discharged without any complication. But, a small number of them have intracranial hemorrhage which may need surgery [7]. This small percentage of complications have led to major controversies, that even in developed countries no consensus exists about the management of these patients. In North America opinions are divided into three groups. The first group believes that CT scan is indicated for all minor head injury patients [1]. The second group recommends very selective use of CT scan in these patients [8] and the third group offers no clear recommendation for using CT scan in minor head injury cases [9]. The same is true in the rest of the world. A study

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in 1997 in Germany on head inquiry practice of 130 neurosurgeons showed a mainly inhomogeneous picture [10]. In Italy CT scan is only done for minor head injury patients who have skull fractures on plain X-Ray [11,12]. In Denmark, CT scan is rarely ordered for these patients and will be done only by neurosurgeons [13]. In Spain and Sweden the situation is more or less similar [14,15]. We don't have many documents in our country but it seems that the emergency room physicians use different approaches to these patients and most of them order CT scan for minor head injury patients as a routine practice. Since the invention of CT scan in early 1970s, using CT scan for minor head injury has become increasingly common, while most of the performed CT scans were normal [1]. Also, we don't know how many CT scans are performed in our country, but we can see obviously that ordering CT scan for minor head injury patients has increased continually while most of them are normal.

The Glasgow Coma Scale is a widely used triage score for head injury, but is less useful in identifying which patients with minor head injuries have intracranial pathologies [16]. Thus, we should use other predictors (i.e. clinical signs and symptoms) to point out those patients with minor head injury who have significant risk of intracranial lesions. The aim of current study was to provide reliable guidelines to allow physicians to be more selective in using CT scan without compromising care of patients with minor head injury. It is clear that such guidelines reduce treatment costs and are great help for managing minor head injury patients in centers without availability of CT scanner.

Methods

This was a prospective cohort study which performed in two university hospitals (Alzahra and Kashani) for one year (June 2003 to June 2004). First, we reviewed all previous studies and obtained those clinical signs and symptoms which could be probable risk factors and potential indicators for intracranial lesions in patients with minor head injury. These factors included definite post traumatic amnesia, witnessed post traumatic unconsciousness, post traumatic seizure, confusion, focal neurological deficit, headache, vomiting, skull fracture, coagulopathy or history of tacking anticoagulants and age more than 60 years.

We enrolled consecutive patients who presented to one of the emergency rooms after acute minor head trauma (GCS = 15). We excluded patients if they came more than 24 hours after head trauma, were less than 6 year old, had no clear history of trauma (e.g. primary seizure or syncope) or had an obvious penetrating skull injury or obvious depressed fracture. Since we didn't have a uniform protocol for ordering CT scan for head injury patients in our hospitals and nearly all patients with minor head injury were evaluated with brain CT scan, no additional costs were charged to patients. Admission and primary assessment of patients were made by neurosurgery residents in emergency rooms. These residents were unaware of the study. Then, a senior resident evaluated the patients again to confirm their level of consciousness (GCS) and clinical findings. CT scans were performed without contrast with 10 mm cuts from foramen magnum to vertex. CT scans were interpreted by staff radiologists and all suspicious scans (both normal and abnormal) were interpreted again by another radiologist. None of these radiologists knew anything about our study and patients clinical findings. We considered all abnormal CT findings as brain injuries. Patients with normal brain CT scan discharged from hospital after a few hours observation in emergency room. All of these patients received enough information about delayed symptoms and were emphasized to return if they had one. We followed all patients by telephone interview a week later to be sure of no delayed complication. Patients with abnormal CT scans were hospitalized for treatment (surgical or nonsurgical) and they were visited 2 weeks and 1 month after discharge from hospital at the neurosurgery outpatient clinic.

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A data sheet was prepared for each patient to register the following information: sex, age, kind of trauma, findings of physical exam, CT scan report and final outcome when patient was discharged from hospital. We analyzed our data using SPSS software (version 11.5). Patients were separated into two groups: those who had at least one of ten probable risk factors and those who had none. We used univariant analysis (X^2 test) to determine the strength of association between each factor and brain injuries. Then, using multivariant technique (logistic regression) we tried to find the best combination of factors highly sensitive for detecting brain injuries.

Results

Between June 2003, and June 2004, 682 consecutive minor head injury patients were admitted to emergency rooms. All patients were examined completely and scanned in order to find intracranial injuries. A total of 468 patients had at least one of the probable risk factors and 214 didn't have any abnormal symptom or sign. Most patients had 20 to 30 year old (mean age of 29 years). Motor vehicle accident was the most common cause of trauma. Table 1 shows characteristics of patients. Among 468 patients with probable risk factors in exam, 401 (58.7%) had one, 61 (8.9%) had two and 6 (0.8%) had three risk factors. From 682 performed CT scans, 46 (6.8%) were positive (had abnormal intracranial findings) and 636 (93.2%) were normal (table 1). Four patients of 46 had significant intracranial injuries which needed surgical intervention (table 2) and the other brain injuries were minor including localized subarachnoid hemorrhage with less than 2 mm thickness, small contusion with less than 5 mm diameter, subdural hematoma with less than 3 mm thickness and isolated pneumocephalus (table 1).

Table 3 shows the association between probable risk factors and brain injuries as determined by univariate analysis (X^2 test). Logistic regression (table 3) provided a combination of most important risk factors. Interestingly, PTU, PTA and headache despite a very high univariate X^2 value did not contribute to the final model.

There was direct correlation between the number of probable risk factors and intracranial lesions; i.e. more risk factors patients had, more intracranial lesions were found in their brain CT scans (figure 1).

Table 1. Characteristics of patients with MHI*.

Characteristics	Number of Patients
Male	534 (78.2%)
Female	148 (21.0%)
Mean age (year)	29
Age range (year)	6-85
Mechanism of trauma	
Motor vehicle accident	602 (88.2%)
Fall	49 (7.1%)
Assault	21 (3%)
Other	10 (1.4%)
Normal CT Scan	636 (93.2%)
Abnormal CT Scan	46 (6.8%)
SAH (<2 mm)	7 (15.2%)
Contusion (<5 mm)	8 (17.3%)
SDH (<3 mm)	16 (34.7%)
Pneumocephalus	11 (23.9%)

*MHI: Minor Head Injury

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Table 2. Characteristics of patients who underwent surgery.

Number of Patients	Risk Factor	Brain Injury	Final Outcome
1	FND*	Depressed fracture	Foot paresis
2	Vomiting + PTU** + Vomiting	Epidural hematoma	Complete recovery
3	Headache + PTA*** + Vomiting	Contusion	Complete recovery
4	Headache	Depressed fracture	Complete recovery

* FND: Focal Neurological Deficit
**PTU: Post Traumatic Unconsciousness
***PTA: Post Traumatic Amnesia

Table 3. Results of statistical analysis (X^2 and logistic regression)

Probable risk factor	Number of patients	Normal CT scan	Abnormal CT scan	X^2 value	Odds ratio (95% CI)
PTU*	78	74 (94.87%)	4 (5.12%)	0.01	2.371 (.970 – 5.797)
PTA**	44	40 (90.9%)	4 (9.09%)	0.000	2.654 (.899 – 7.838)
Seizure	2	2 (100%)	0	?	-
Confusion	90	85 (94.44%)	5 (5.55%)	0.01	3.940 (1.758 – 8.830)
FND***	1	0	1 (100%)	0.000	-
Vomiting	39	31 (79.48%)	8 (20.51%)	0.000	8.333 (3.996 -17.375)
Headache	94	92 (97.87%)	2 (2.12%)	0.032	2.125 (.841-5.372)
Skull fracture	12	10 (83.33%)	2 (6.66%)	0.000	8.873 (1.711- 46.008)
Age > 60 Y	40	35 (87.5%)	5 (12.5%)	0.000	4.971 (2.064-11.972)
Coagulopathy	1	1 (100%)	0	?	-

*PTU: Post Traumatic Unconsciousness
**PTA: Post Traumatic Amnesia
***FND: Focal Neurological Deficit

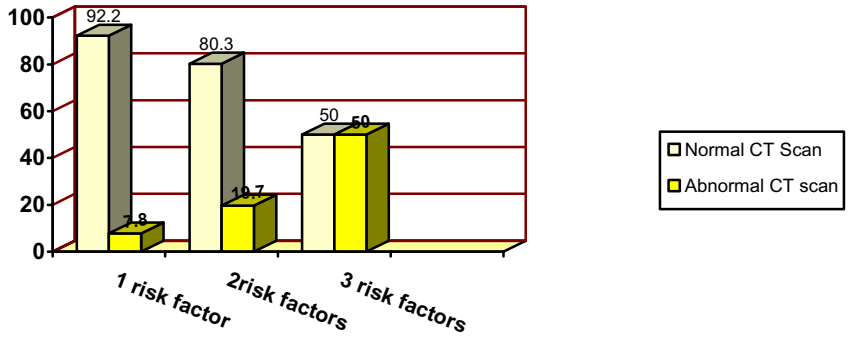

Figure 1. Prevalence of normal and abnormal CT sans in patients with different number of risk factors.

Discussion

Minor head injury is one of the most common traumatic injuries. In one study, approximately two thirds of patients with head trauma were classified as having minor head injury; less than 10 percent of patients with minor head injury had positive findings on CT scan, and less than 1 percent required surgery [2]. There is much controversies about the management of these patients, especially about ordering brain CT scan. Dealing with many minor head injury patients in every where, unavailability of CT scan in all hospitals and far distances between small cities and villages and referral centers, have led us to do this study, in order to find indications of brain CT scan according to clinical findings in patients with minor head injury.

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Table 4. Importance of risk factors of brain injury in previous studies.

Risk Factor / Study	PTU*	PTA**	ANE***	Vomiting	Headache	Seizure	Confusion	Skull fracture	Coagulopathy	Age > 60
Our study	$P > 0.05$	$P > 0.05$	$P < 0.05$ (?)	$P < 0.05$	$P > 0.05$	?	$P < 0.05$	$P < 0.05$	?	$P < 0.05$
Haydel et al [2]	$P < 0.05$	-	-	$P < 0.05$	$P < 0.05$	$P < 0.05$	-	-	-	$P < 0.05$
Stiell et al [3]	medium risk	$P < 0.05$	-	$P < 0.05$	-	-	-	$P < 0.05$	-	$P < 0.05$
Borczuk [18]	-	-	$P < 0.05$	-	-	-	-	$P < 0.05$	-	$P < 0.05$
Hung et al [19]	$P > 0.05$	$P < 0.05$	-	-	-	-	-	$P < 0.05$	-	-
Morshid [20]	-	$P > 0.05$	$P < 0.05$	$P < 0.05$	$P < 0.05$	-	-	$P < 0.05$	-	-
Nee et al [21]	$P > 0.05$	-	-	-	-	-	-	-	-	-
Gomez et al[22]	-	$P > 0.05$	$P < 0.05$	-	-	-	-	$P < 0.05$	$P > 0.05$	-
Shiomi et al [23]	-	-	-	$P < 0.05$	nonsignificant	-	-	$P < 0.05$	-	-
Servadi et al [24]	medium risk	-	-	-	-	-	-	$P < 0.05$	-	-
Servadi et al [25]	$P > 0.05$	medium risk	$P < 0.05$	medium risk	medium risk	-	-	$P < 0.05$	$P < 0.05$	$P < 0.05$
Miller et al [26]	$P < 0.05$	$P > 0.05$	-	-	-	-	-	-	-	-
Stein et al [27]	-	$P < 0.05$	-	-	-	-	-	-	-	-
Sacco et al [28]	-	$P < 0.05$	$P < 0.05$	-	-	$P < 0.05$	-	$P < 0.05$	$P < 0.05$	$P < 0.05$
Romner et al [29]	-	$P < 0.05$	-	-	-	-	-	-	-	-
Falimirski et al [30]	-	$P > 0.05$	-	-	-	-	-	-	-	-
Viola et al [31]		$P > 0.05$	-		$P > 0.05$	-	-	$P < 0.05$	-	-

*PTA: Post Traumatic Amnesia; **PTU: Post Traumatic Unconsciousness; ***ANE: Abnormal Neurological Exam.

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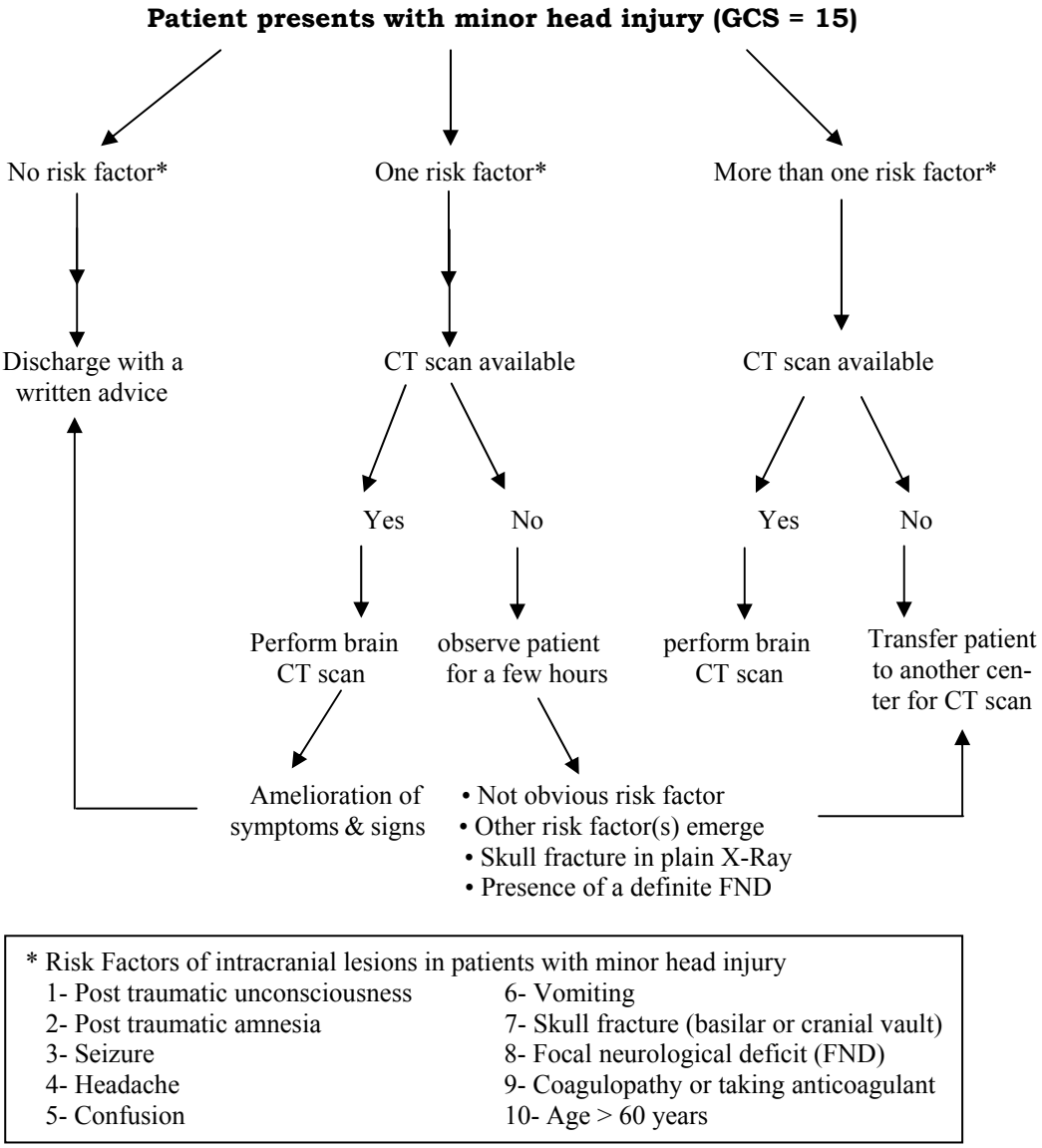

Figure 2. Guideline for performing brain CT scan in minor head injury patients.

According to X^2 test, all of our probable risk factors had significant correlations with abnormal findings in CT scan (brain lesions). We had few patients with coagulopathy or seizure; so statistical tests were not able to give us any relationship for these factors. Focal neurological deficit was found in only one patient. More analysis with logistic regression showed that confusion, vomiting, skull fracture and age more than 60 years had more correlation with brain injury in minor head injury patients than other risk factors.

In most of similar studies, "confusion" was not evaluated as an independent risk factor. Probably the authors have considered "confusion" the same as "disorientation" and though GCS score of patients were 14 and consequently they were not classified in minor head injury category. Only in Feuerman's study "abnormal mental state" was considered as an indication for CT scan [17], and probably this was equal to confusion in our study. Anyway, we had patients with GCS score of 15 and normal orientation but with giddiness, and brain lesions in this group of patients were signifi-

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cantly more common compared with asymptomatic patients. Table 4 compares the results of some other studies with our results which are not similar [12,18-30]. Alcohol intoxication was considered as an indication for CT scan in some studies [2,24]. We did not evaluate this factor because of very low consumption of alcohol in our society and also due to other reports that have shown alcohol intoxication is not an important risk factor in this issue [3,31].

Interestingly the number of risk factors in patients, apart from its type, was directly related to the number of abnormalities in CT scans. Patients with one risk factor, had 7.7% abnormal CT Scans but abnormalities in patients with two risk factors were more than 2.5 fold (19.7%) and in patients with three risk factors were nearly 7 fold (50%) (figure 1). So, more risk factors patients have, more abnormalities will be found in their CT scans. Table 2 shows that 3 of 4 patients who were operated had more than one risk factor. On the other hand, all brain lesions in patients with one risk factor were subtle, non significant and none of them needed surgery. CT Scans in all 214 asymptomatic patients were normal. In other words, all patients with brain lesion in CT scan had at least one risk factor in history or clinical exam (specificity = 100%).

Reviewing previous studies showed different and in some cases opposite results. Some authors believe that significant brain injury and the need for CT scan can't be excluded in patients with minor head injury despite a GCS of 15 and normal complete neurological examination on presentation [32,33]. On the other hand, a study by Klassen et al reported a significant difference in the rate of ordering CT scans among the participating hospitals, but found no significant difference in the rate of abnormal CT scans [34]. Then, it is possible to determine clinical criteria that are predictive of a head injury in patients with minor head trauma. Appointed guidelines for management of patients with minor head injury not only have not missed patients but have had a significant impact on management practice too [35]. Interestingly all cases of initially missed hematomas occurred at institutions with high rates of CT use, demonstrating that frequent use of CT does not necessarily translate to a high detection rate [36].

On the whole, considering our results and also results of previous studies, we propose our guidelines for management and indications of CT scan in patients with minor head injury in figure 2. We believe that widespread use of this guideline will lead to better management of these patients, prevention of doing unnecessary CT scans and reducing hospital costs. Application of this guideline in remote areas with unavailability to CT scan and neurosurgical facilities helps physicians decide more easily and safely about patients and prevents unnecessary patients transfer to other centers.

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