The use of head CT scanning in mild head injury

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ABSTRACT

Objectives: To determine the number of brain CT scans carried out in patients with mild head injury (MHI) during 13 months of trauma registry, and to investigate means of reducing the rate of unnecessary scans.

Methods: During a trauma registry (from August 23, 1999 to September 21, 2000) in 6 general Hospitals (Imam Hussein, Moayer, Sina, Hafteteer, Imam Khomeini and Shariatti) in Tehran, Iran, 1209 cases with Glasgow Coma Scale (GCS) score ≥13 underwent brain CT scan. To be included in the study, patients must have sustained their injury within one week prior to presentation to Emergency Rooms, and were hospitalized for more than 24 hours. The attending physicians formally reported all brain CT scan findings.

Results: For 1209 patients, there were the following characteristics: mean age was 29.4 years; the main cause of injury was traffic accidents (60.1%), followed by falls (28.5%), fights (7.2%), and other reasons (4.2%). Seventy-seven cases (6.4%) had a GCS score of 13, 212 (17.5%) had a score of 14, and 920 (76%) had a score of 15. A total of 481 abnormalities on CT scan were reported for 405 patients (33.5%) with positive report of brain CT scan, while 804 cases (66.5%) did not report abnormalities. The most common intracranial lesion was epidural hemorrhage with 146 cases (30.3%). The rate of negative reporting of brain CT scan in patients who had GCS score of 15 was 72.2%.

Conclusion: Patients who have GCS score of 13 or 14 on admission should be considered to have a moderate rather than a mild head injury. For reduction of unnecessary brain CT scan performance in MHI patients, we must define the appropriate criteria.

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Head injury is a significant cause of mortality and morbidity in trauma patients,[1] and closed head injury is one of the most common reasons for hospital admission following injury.[2] Because of different study methods, case definitions, time periods, and geographic locations, the reported annual incidence of head injuries has varied widely from 114-295 injuries per 100,000.[3] The majority of head injuries presenting to hospital services have a minor injury and only a small proportion of these cases will be admitted.[4] Rimel et al[5] defined minor head injury as the group of head trauma patients with a Glasgow Coma Scale (GCS) score of 13-15. Computed tomographic scanning of the head is an excellent imaging modality to identify acute intracranial injury, and to identify those patients requiring neurosurgical intervention.[6] Utilization of brain CT scan has increased since its availability and sensitivity has elevated.[7,8] In some instances, use of this imaging technique may offer a cost-effective and safe substitute for hospital admission and observation.[7,8] This study aims to assess the frequency of utilization, and the results of brain CT scans that were carried out during a trauma registry in Tehran, and to evaluate the appropriation of CT utilization.

Methods. The study was based on a retrospective review of 1209 selected cases with GCS score ≥13

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admitted to 6 general hospitals in Tehran, during a trauma registry (from August 23, 1999 to September 21, 2000) that underwent brain CT scan. These hospitals are situated in different regions of the city: Imam Hussein Hospital in the western part, Moayer, and Sina Hospitals in the central part, Hafteteer Hospital in the Southern part, and finally Imam Khomeini and Shariatti Hospitals, in the Eastern part. Patients who sustained head injury within one week before presenting to Emergency Rooms (ERs), and were hospitalized for more than 24 hours were included in this study. A valid and reliable questionnaire, designed in the Sina Trauma Research Center, was used for the study. Trained physicians visited trauma patients in the ERs and wards around the clock and completed a structured questionnaire for them. Data obtained included: patients demographics, prehospital care, medical and operative procedures performed in the ER and wards, GCS score at the time of presentation to the ER, Injury Severity Score (ISS), radiological procedures, length of hospital stay, outcomes, and source of reimbursement. Injury severity was scored using the ISS, derived from the abbreviated injury scale version 1990. The injuries and mechanisms of accidents were grouped based on the ICD-9 (International classification of disease and related health problems). The CT scan findings were categorized as normal and abnormal. An abnormal CT scan was defined as one showing an acute traumatic intracranial lesion (diffuse and focal brain injury, subdural hemorrhage, epidural hemorrhage, subarachnoid hemorrhage or other traumatic brain injuries) or a fracture of the skull base. The attending physicians formally reported all of these findings.

The SPSS for windows (version 10) and EpiInfo version 6 were used for data analysis; a=0.05 was considered as the level of statistical significance.

Results. Minor head injuries accounted for 15.1% (1209/8000) of all studied patients. This group consists of 914 (75.6%) males and 295 (24.4%) females. The mean age was 29.4 ± 19.9 years with a range from 1-106 years. Males outnumbered females in all of age groups, and patients of 20-30 years of age had the largest rate of brain CT scan examination. The main cause of injury was traffic accidents in 727 (60.1%), followed by falls in 344 (28.5%), fights 87 (7.2%), and other reasons in 51 (4.2%). The places of accident occurrence were streets in 657 (54.3%), homes in 240 (19.9%), roads in 148 (12.2%), work places in 109 (9%) and other places in 55 (4.5%). Of the 1209 patients, 77 cases (6.4%) had a GCS score of 13, 212 (17.5%) had a score of 14, and 920 (76%) had a score of 15. Skull x-ray films were only obtained for 242 (20%) patients. The films were read as normal in 172 cases (71.1%) and a fracture was detected in 70 patients (28.9%). Brain injuries were reported in brain CT scan of 35.7% (25/70) of patients who had fracture on skull x-ray. Brain CT scan was reported positive for 27.8% of patients that had a GCS score of 15, meanwhile, more than 50% of patients with GCS score of 13 or 14 had positive report of brain CT scan (**Table 1**). From our patients, 405 cases (33.5%) had a total of 481 abnormalities on brain CT scan, and for 804 (66.5%) no abnormalities were reported. The different types of reported abnormalities are listed in **Table 1**. Isolated head injury was found in 192 cases, while extra cranial injury (mainly fracture of skull base) was detected in 143 patients (29.7%). The most common intracranial lesion in patients that were operated upon was epidural hemorrhage (59.9%). In addition, 93 patients with positive CT scan (22.9%) underwent craniotomy; the percentage of patients who underwent craniotomy was highest in patients with GCS score of 13 (**Table 1**). A history of dizziness, headache, amnesia or unconsciousness less than 15 minutes was recorded only in 455 (37.6%) of patients that were awake on admission or initial

Table 1 - Frequency of utilization and results of brain CT scans in patients with GCS ≥13.

Variable	GCS No. (%)			Total
	13	14	15	
Brain CT scan				
Negative	37 (48)	103 (48.6)	664 (72.2)	**804 (66.5)**
Positive	40 (52)	109 (51.4)	256 (27.8)	**405 (33.5)**
Total	**77 (6.4)**	**212 (17.5)**	**920 (76.1)**	**1209 (100)**
Craniotomy	14 (18.2)	25 (11.8)	54 (5.9)	**93 (7.7)**
Type of abnormality				
Diffuse brain injury	5 (10.2)	8 (6)	19 (6.3)	**32 (6.7)**
Focal brain injury	5 (10.2)	28 (21.2)	69 (23)	**102 (21.2)**
Epidural hemorrhage	19 (38.8)	37 (28)	90 (30)	**146 (30.3)**
Subdural hemorrhage	5 (10.2)	6 (4.6)	21 (7)	**32 (6.7)**
Subarachnoid hemorrhage	1 (2)	3 (2.3)	10 (3.4)	**14 (2.9)**
Others	0 (-)	3 (2.3)	4 (1.3)	**7 (1.5)**
Unspecified	0 (-)	0 (-)	5 (1.7)	**5 (1)**
Skull fracture	14 (28.6)	47 (35.6)	82 (27.3)	**143 (29.7)**
Total	**49 (10.2)**	**132 (27.4)**	**300 (62.4)**	**481 (100)**

GCS - Glasgow Coma Scale

observation. The number of positive reports of brain CT scan significantly increased with a reduction in the patient's GCS score (chi square for trend = 47.57, $p<0.001$, OR = 1 in GCS = 15, OR = 2.69 in GCS = 14, OR = 2.8 in GCS = 13). Brain CT scanning examinations of 1142 patients (94.5%) were obtained within 24 hours from trauma occurrence. The average hospital stay was 5.7 days. Twelve patients died due to severity of injuries.

Discussion. Minor head injury comprises a large proportion of head trauma patients,[4] and brain CT scan is widely used as a scanning test in these patients, although this can be expensive. Numerous studies concerning utilization of CT scan have focused on patients with minor head injury to reduce negative reports, and consequently savings for the health-care system. Accordingly, we tried to define criteria based on the recorded history, physical examination, or skull x-ray film reports. There are considerable disagreements about indications for CT in patients with minor head injury. While in the USA some experts, especially neurosurgeons, feel that CT is necessary for all patients with minor head injury regardless of clinical findings,[1,4] others recommended a very selective approach in the use of CT in minor head trauma.[9,10] The Italian neurosurgeons' study group on head injury believed that there are no indications for carrying out radiological examination in patients who are alert (GCS=15) and have not suffered loss of consciousness, amnesia, headache or vomiting, but have pain limited to the impact zone, contusion or associated dizziness. They recommended that in patients who are alert (GCS=15) but have at least one of the following symptoms: loss of consciousness, post-traumatic amnesia, worsening headache or vomiting and patients with GCS score of 14, a CT scan must be performed.[11] Miller et al,[12] reported that the use of 4 simple clinical criteria (severe headache, nausea, vomiting, and depressed skull fracture) in minor head trauma patients with GCS=15 would allow a 61% reduction in the number of head CT scans performed, and still enable us to identify all patients who require neurosurgical intervention, and the majority of patients with an abnormal CT scan. Borczuk,[10] reported identification of 92% of patients with positive scans on the basis of the presence of cranial soft tissue injury, evidence of a basilar skull fracture, abnormality on neurological examination, or an age over 60 years. For the majority of authors, a combination of clinical findings as predictors of positive CT scans has been important in minor head injury patients.[9,13,14]

The majority of our patients had a GCS score of 15, and the majority of most negative brain CT scans, with 664 cases (72.2%), belonged to this group. Whereas, patients with GCS score of 13 and 14 comprised 23.9% of our patients and among them, the report of brain CT scan was negative in 140 cases (48.4%). As mentioned above, 99 (18%) of our patients underwent craniotomy, 14 of them had GCS score of 13 and they consisted of 18.2% of all patients with GCS score of 13 in this study. This number for other groups of GCS score was 25 (11.8%) for GSC 14 and 45 (5.9%) for GCS 15. Our study has shown that patients who had GCS score of 15 comprised a greater proportion of MHI patients, sustaining lesser injuries and subsequent craniotomy.

We were not able to compare the result of our study with others, since there are differences in the method and the aim of studies. We only reported results of CT examination in patients with MHI in order to show how many negative CT scans took place during the trauma registry. Unfortunately, there are no exact criteria for ordering brain CT scan for MHI patients in our hospitals. We need to define appropriate criteria for carrying out brain CT scans in MHI patients. In addition, these criteria must be evaluated systemically.

There are at least 2 limitations to our study. First, this is a retrospective study, so we cannot report some of the detailed information. Conducting a prospective research in this field would add more to our knowledge regarding the clinical observation of MHI patients. Secondly, our study does not include information on patients who were discharged sooner than 24 hours after admission, as we did not have access to brain CT scan reports of these patients.

Our study demonstrated that patients with an admission of GCS score of 13 and 14 were significantly more likely to have intracranial injury. In consequence, if the patient's GCS score on admission is 13 or 14, the patient should be considered to have a moderate rather than a mild head injury. Finally, the design of a protocol based on the clinical findings is necessary for improvement of brain CT scan performance in MHI patients.

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