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Correlation of CT Scan Findings with the Level of Consciousness in Acute Head Trauma

Background/ Objective: The purpose of this study was to determine CT scan findings in acute craniocerebral trauma and the relation between these findings and the level of consciousness.

Patients and Methods: In this retrospective study, 800 pati ents with acute (less than 24 hours) craniocerebral trauma were studied over a period of three years. The patients' level of consciousness (GCS) were determined and a brain CT scan without contrast agent was performed. A third generation General Electrics (GE) CT scanner was utilized and 10-mm and 5-mm sections were obtained for the supratento rial and infratentorial parts, respectively.

Results: From 800 patients studied, 641 (80.1%) were males and 159 (19.9%) were females. The peak age was 25 and the mean age was 26.80 ±18.30. The most common mechanism of head trauma was motor vehicle accidents (60.1%).80. M ild head injury was seen in 75% of patients, while 14% and 5.25% had moderate and severe head injuries, respectively. In 14.1%, the CT scan was normal. The most common lesions were as follows: epidural hematoma (EDH) 27.1%, subdural hematoma (SDH) 13.3%, subarachnoid hemorrhage (SAH) 11.4%, contusion 32.9% and pneumocephalus 12.1%. Intracranial hemorrhage, IVH and subdural hygroma were seen in less than 10 percent of patients. The presence of mixed lesions and midline shift regardless of the background lesions were related to statistically significant decreases in GCS.

Conclusion: As one of the leading causes of mortality in Iran, craniocerebral trauma needs more considration. This is true especially for road accidents, which are the main cause of multiple traumas. In lower levels of consciousness, one should consider more complicated lesions and probable surgical inter vention. The presence of m ixed lesions and midline shift regardless of the underlying le sion on CT scan were accompan ied by lower GCS, which may be due to major energy transmission and diff use brain tissue damage and compression of the brain stem.

Keywords: craniocerebral trauma, Computed Tomography, level of consciousness

Introduction

Trauma is the leading cause of death among those aged 1-24 years.[1] In patients with multiple trauma, head is the most common organ involved.[2] The annual incidence of head trauma is estimated to be 200 in 100,000 population. Head trauma is a very brief event, which occurs in less than 200 milliseconds, and often in less than 20 milliseconds.[3] In adults, the leading causes of craniocerebral trauma are motor vehicle accidents (MVA) and falling down.[3] In children (10-18 years), falling down is the most common cause followed by MVA.[3]

CT scanning, which evaluates the skull structures noninvasively, is the procedure of choice for diagnosis, evaluation and determination of the prognosis of patients with acute head trauma. After its first use in 1978, the usage of skull x-ray, angiography and surgical intervention have been reduced by 24%, 84%, and 58%, respectively.[1] Axial CT scan with high-resolution scanners provides pictures with excellent details that are sufficient in emergencies.[1]

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Received September 6, 2004;
Accepted after revision April 27, 2005.

June 2005; 2:125-129

Lesions determined by CT scan in acute head trauma include epidural hematoma (EDH), subdural hematoma (SDH), subarachnoid hemorrhage (SAH), ICH, contusion, and skull fractures .[1, 3]

An important factor in deciding about initial treatment and long-term complications following head trauma is the patients' level of consciousness, whose most common method of determination is GCS (Glasgow Coma Scale).

Lower GCS and special CT scan findings including SAH, midline shift of more than 3 mm, and mass lesions are poor prognostic indicators after closed head injury.[3]

By determining the patients' level of consciousness on arrival and CT scan findings, we can evaluate the patients' current medical condition, make the appropriate intervention, and predict the long-term outcome.

Road accidents have a high annual incidence and are the most common cause of head trauma in Iran. Therfore, this study was oriented to determine the mechanisms, severity, and CT scan findings of head trauma and to evaluate the relation between CT scan findings and level of consciousness.

Patients and Methods

In this retrospective analytical research, which was carried out from September 2000 to September 2003, 800 patients admitted to the neurosurgery ward of Imam Hossein Hospital due to acute (less than 24 hours) craniocerebral trauma, were studied. Patients suffering from trauma to other parts of body, which could influence the level of consciousness, were excluded from the study. Patients referred to the emergency ward were visited by neurosurgery residents, their GCS was determined on arrival to the emergency ward, and if necessary, a brain CT scan without contrast was performed. The criteria for CT scanning were the followings:

(1) GCS equal to or less than 14; (2) GCS equal to 15 with at least one of the followings: documented loss of consciousness, amnesia for injury, focal neurological deficit, signs of basal or calvarial fracture. [3] Standard CT scanning technique includes 10-mm slices without gap with a 15-20-degree angle to the canthomeatal line and parallel to the skull base .[2]To reduce the beam-hardening artifacts and increase the conspicuousness of the posterior fossa small lesions, from C1 through the level of posterior clinoids and from sella through vertex is studied with 5- and 10-mm slices, respectively .[2] Although references recommend hard copies to be printed in three different windows [2], in our study, hard copies were printed in the following two windows: brain soft tissue for infarction and hemorrhage and bone window for fractures.

A third generation General Electrics (GE) CT scanner was applied for the procedure. During scanning, patients were in supine position. The information was collected from the medical documents and CT scans which were reported by three different radiologists who followed the same routine protocol for CT scan reporting.

The data were analyzed by SPSS. The correlation between CT scan findings and the level of consciousness was evaluated by using Mann-Whitney test, which is a non-parametric test.

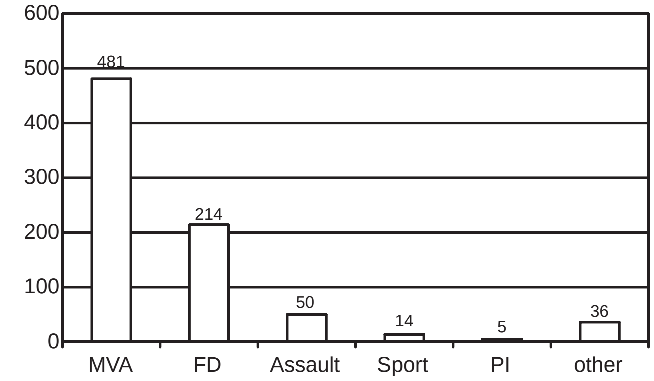
Results

From 800 patients studied, 641 (80.1%) were males and 159 (19.9%) were females. (The male/ female ratio was 4.03). The mean age was 26.8 ±18.30 (1-90 years old) and the peak incidence was at the age of 25. Thirty-eight percent of patients were between 16 and 30 years old, i.e. in socially active ages. The frequencies of mechanisms of craniocerebral trauma are shown in Figure 1, showing motor vehicle accidents to be the most common cause (60.1%).

Considering total pathologies among 800 patients, the most common findings were contusion (248, 31%), followed by epidural hematoma (217, 27.1%) (Table 1). In this regard, a total of 215 patients (26.9%) had more than one lesion in their CT scans (consisting mixed lesion group) (Table 2,3).

Considering the anatomical distribution, most lesions were more frequent in frontal location, except for SDH and ICH, which were more frequently present in parietal and temporal regions, respectively. In addition, the most common locations of linear and depressed fractures were occipital and frontal areas, respectively (Table1).

However, the most prevalent isolated findings were



MVA: motor vehicle accident
FD: falling down
PI: penetrating/ perforating

Figure 1. The frequency of mechanisms of craniocerebral trauma.

EDH (132, 16.5%) and contusion (125, 15.6%) (Table 2).

Mild head injury (GCS≥13) was seen in 80.75% (646), moderate head injury (9≤GCS≤12) in 14% (112), and severe head injury (GCS ≤8) in 5.25% (42) of patients (Table 2). For each specific lesion, the frequency of patients classified in severity levels of head traumas (based on their GCS) is shown in Table 2. In all lesions, most of the patients presented with mild head injury (GCS≥13), except for IVH, whose total number of patients was six (Table 2).

The most common mixed lesions are shown in Figure 2.

Ninety-one patients (11.38%) had midline shift. Table 3 describes the severity of head trauma in patients with single, mixed lesions and midline shift. As shown, 71.2% (153) of patients with mixed lesions and 60.4% (55) of patients with midline shift had

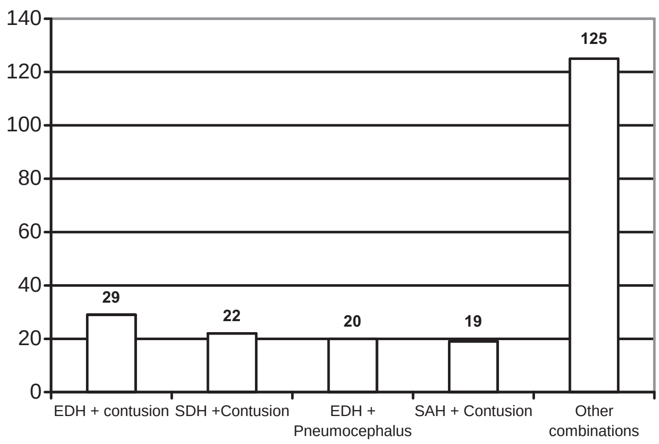


Figure 2. The most common mixed lesions

mild head injury. From among patients with contusion, 55.5% (146) had hemorrhagic contusions.

The presence of midline shift regardless of the underlying lesion(s) and mixed lesions were accompanied with statistically significant decrease in GCS (P<0.01). Patients having mixed lesions with midline shift versus patients having mixed lesions without midline shift, patients with single lesion and midline shift versus patients with single lesion without midline shift, and patients with mixed lesions without midline shift versus patients with single lesions without midline shift showed statistically significant lower GCS (P<0.01) for all three situations.

Discussion

Early and precise determination of craniocerebral lesions in acute head trauma is of great importance because of the high mortality caused by these lesions and the fact that early diagnosis and treatment will significantly reduce the complications. After the invention of CT scan in the late 70s, as a noninvasive and accessible method, the outcome of patients has been revolutionized greatly. [3]

CT scan is now the primary modality for evaluation of patients with acute head trauma .[4-8]Following acute craniocerebral trauma, a brain CT scan without contrast will generally suffice, because it demonstrates depressed fractures and acute hematomas, which may need immediate surgical intervention .[3] An important factor in decision making about the initial treatment and long term complications is the initial GCS of patients .[2] In a study of 3000 patients in a hospital, the annual incidence was 2.2 in 1000. The peak age was between 18-20 years and the male/ female ratio was 2.19 .[9] In the present study, the male/ female ratio was 4.03:1, which can be explained by the higher social activity of men in Iran. Motor vehicle accidents were the leading cause of head trauma (32.9%).[9] The most common CT scan findings were contusion (20.6%) and SDH (19%).[9] In a prospective study, SAH (36%), SDH (24%) and contusion (20.7%) had the highest frequencies. The most common localizations of ICH and contusion, EDH, and SDH were in frontal, temporal and parietal parts, respectively.[8] In other studies, it is mentioned that the most common localization of EDH is in the temporal areas and that of

ICH is in temporal and frontal regions .[10-12] Similar results for mechanisms and severity of head trauma, CT scan findings and localizations of lesions were obtained in our study. Motor vehicle accidents were the leading mechanism (60.1%), followed by falling (26.8%).In addition, 113 patients (14.1%) had normal CT scans, similar to the results of other studies.[13] Contusion (32.9%) and EDH (27.1%) were the most frequent findings located more commonly in frontal locations. We had 367 (45.9%) skull fractures, which showed a higher prevalence in comparison with other studies.[8] The exact mechanism of pneumocephalus was not clear, but it might be due to skull fracture lines. Significant volumes of pneumocephalus may cause mass effect.[14-16] In our study, 91.4% (32/35) of patients with pneumocephalus had skull fractures. Fracture types (calvarial versus basilar), the subtypes of basilar fractures, and their localizations have not been mentioned in literature, previously. Special attention has been paid to the indirect signs of basilar fractures, which is a valuable key to diagnosis. Some 19.3% of basilar fractures involved the petrous

Table 1. Frequency and anatomic distribution of the most common pathologies in patients.

	Occipital	Temporal	Parietal	Frontal	More than 1 location	Total
EDH	36 (16.6%)	31 (14.3%)	22 (10.1%)	66 (30.4%)	62 (%28.5)	217 (100%)
SDH	4 (3.8%)	16 (15.1%)	32 (30.2%)	17 (16.1%)	37 (%34.9)	106 (100%)
ICH	2 (3.5%)	16 (28.6%)	3 (5.4%)	11 (19.6%)	16 (%33.3)	48 (100%)
Contusion	15 (5.7%)	66 (25.1%)	21 (8%)	98 (37.3%)	48 (%19.3)	248 (100%)
Pneumocephalus	10 (10.3%)	15 (15.5%)	5 (5.2%)	51 (52.6%)	9 (10%)	90 (100%)
Subdural hygroma	2 (6.1%)	1 (3%)	2 (6.1%)	22 (66.7%)	6 (%18.1)	33 (100%)
Fracture						
Linear	42 (19%)	39 (17.6%)	28 (12.6%)	35 (15.8%)	77 (34.8%)	221 (100%)
Depressed	7 (5.4%)	8 (6.2%)	23 (17.8%)	40 (31%)	51 (39.5%)	129 (100%)

Table 2. The frequency of severity of head injuries (based on GCS) in lesions demonstrated on CT scan.

Severity (GCS) / CT scan finding	Mild (GCS≥13)	Moderate (9≤GCS≤12)	Severe (GCS≤8)	Total
Normal	93 (82.3%)	19 (16.8%)	1 (0.9%)	113 (100%)
EDH	107 (81.1%)	16 (12.1%)	9 (6.8%)	132 (100%)
SDH	28 (73.7%)	7 (18.4%)	3 (7.9%)	38 (100%)
SAH	16 (84.2%)	2 (10.5%)	1 (5.3%)	19 (100%)
Contusion	106 (84.8%)	17 (13.6%)	2 (1.6%)	125 (100%)
Pneumocephalus	35 (100%)	0 (0%)	0 (0%)	35 (100%)
ICH	14 (82.4%)	2 (11.7%)	1 (5.9%)	17 (100%)
IVH	2 (33.3%)	2 (33.3%)	2 (33.3%)	6 (100%)
Subdural hygroma	6 (75.3%)	2 (25%)	0 (0%)	8 (100%)
Mixed lesion	153 (71.2%)	39 (18.1%)	23 (10.7%)	215 (100%)
Fracture	86 (93.5%)	6 (6.5%)	0 (0%)	92 (100%)
Total	646	112	42	800

Table 3. The severity of head trauma among patients with single and mixed lesions, and midline shift.

Severity (GCS) / CT scan finding	Mild (GCS≥13)	Moderate (9≤GCS≤12)	Severe (GCS≤8)	Total
Single lesions	314 (82.6%)	48 (12.6%)	18 (4.8%)	380 (100%)
Mixed lesions	153 (71.2%)	39 (18.1%)	23 (10.7%)	215 (100%)
Midline shift	55 (60.4%)	19 (20.9%)	17 (18.7%)	91 (100%)

bone. This finding shows that facial and vestibulocochlear nerves should be evaluated for possible injuries in head trauma patients. Analysis of correlation between CT scan findings and the level of consciousness has not been reported in the literature so far. By using Mann-Whitney test, this correlation was studied. The presence of midline shift regardless of the underlying lesion(s) and mixed lesions was accompanied with a statistically significant decrease in GCS ($P<0.01$). Patients having mixed lesions with and without midline shift, single lesion with and without midline shift, and single or mixed lesions without midline shift were compared. Patients with IVH had significantly lower levels of consciousness (average GCS=10.33). Due to the limited number of this group of patients, precise statistical analysis could not be performed. However, future studies may clarify the influence of traumatic IVH on the level of consciousness.

The imaging criteria in determining whether an epidural hematoma may be treated conservatively include: (1) a diameter of less than 1.5 cm, and (2) a minimal midline shift of less than 2 mm. The patient must be neurologically intact without focal deficit.[17,18] Detailed information concerning midline shift and hematoma diameters, brain edema and tissue infarction size was not available in medical documents of the patients. Due to this limitation in our study, the impact of the diameter of the lesions, midline shift, brain edema and tissue infarction size on GCS could not be evaluated. The assessment of correlation between the size of the lesions and the level of consciousness can be a topic for future studies.

Detailed and precise imaging reports will form a valuable basis for upcoming research.

Conclusion

As a major cause of mortality in our country, craniocerebral trauma needs more considration. In lower levels of consciousness, one should consider more complicated lesions and probable surgical intervention. In this study, the prevalence of CT scan findings was similar to the results of the vast researches performed previously. The presence of mixed lesions and midline shift regardless of the background lesion was accompanied with lower GCS, which may be due to major energy transmission, diffuse brain tissue damage and compression of brain stem structures.

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