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The Frequency of Brain CT-Scan Findings in Patients with Scalp Lacerations Following Mild Traumatic Brain Injury; A Cross-Sectional Study

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ABSTRACT

Objective: To determine the frequency of the brain CT-scan findings in patients with mild traumatic brain injury (TBI) and scalp lacerations.
Methods: This cross-sectional study was conducted during a 1-year period from March 2016 to March 2017 in Level I trauma center in Shiraz, Southern Iran. We included all the adult patients (≥18 years) admitted to our emergency room with mild TBI (GCS on admission of 15) and scalp lacerations. All the patients underwent Brain CT-Scan and the scans were reviewed by two radiologists who were unaware of the patients' clinical findings. The results are reported as proportions and frequencies.
Results: Overall we included a total number of 94 patients with minimal TBI who had a scalp laceration on admission. The mean age of the patients was 30.78±8.01 (ranging from 18 to 47) years. There were 58 (61.7%) men and 36 (38.3%) women among the patients. The most common finding of the Brain CT-Scan was subgaleal hematoma in 76 (80.9%) patients followed by base skull base fracture in 7 (7.4%), linear skull fracture in 7 (7.4%), brain contusion in 3 (3.2%) and subdural hematoma in 1 (1.1%).
Conclusion: The results of the current study indicate that scalp lacerations are associated with intracranial injuries in about 20% of the patients with mild TBI. Thus brain CT-scan is recommended in all the patients with mild TBI and scalp lacerations.

Keywords: Traumatic brain injury; Minimal; Scalp laceration; Brain CT-scan; Subdural hematoma.

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Introduction

Traumatic brain injury (TBI) of all severities is one of the greatest health care–related problems facing our country and the entire world today [1-4]. The majority of the 1.7 million estimated TBIs occurring in the United States each year are mild [5]. Mild TBI accounts for the majority of the emergency

department referrals due to the injuries to the head and neck [6]. Overall the head and neck are among the most injured organs through the trauma leading to high mortality and morbidity. Currently there are several clinical guidelines available for diagnosis and management of mild TBI [6]. However, there is a paucity of information and clinical direction for evaluation and management of patients with mild TBI and scalp laceration. Current guidelines focus on the sign and symptoms of the mild TBI including the loss of consciousness, amnesia, vomiting, or diffuse headache while the role of the external findings of the head have not been taken into consideration [6, 7]. In addition, the external findings of the head including the scalp laceration, bruising and contusions are usually not adequately documented in a clinical setting [8]. On the other hands, detection of the scalp lacerations is necessary for early debridement and reconstruction in the setting of trauma in order to avoid complications related to the retention of poorly or non-vascularized tissue, such as infection, and the need for more extensive delayed surgery secondarily [9, 10].

Currently, the laceration of the scalp is classified as the medium risk of category of the TBI in which the risk of surgical hematoma is 1-3%: 100 which requires a brain CT-scan or skull x-ray if the CT-scan is not available [6, 7]. However, it has been demonstrated that there is no correlation with the clinical findings and the CT-scan findings in mild TBI especially in children [11]. The correlation between the scalp lacerations and the intracranial findings is yet to be investigated. Thus, the aim of the current study was to determine the frequency of the brain CT-scan findings in patients with mild TBI and scalp lacerations in a large level I trauma center in southern Iran.

Materials and Methods

Study Population

This cross-sectional study was conducted during a 1-year period from March 2016 to March 2017 in Rajaee hospital, a Level I trauma center affiliated with Shiraz University of Medical Sciences located in Southern Iran receiving referrals form the whole province and southern provinces of Iran with an estimated coverage population of 5 million. The study protocol was approved by the intuitional review board (IRB) and the medical ethics committee of the Shiraz University of Medical Sciences. All the patients or their guardians provided their informed written consents before inclusion in the study. We included all the adult patients (age>18 years) with mild TBI defined as on admission Glasgow coma scale (GCS) of 15 who had scalp and forehead laceration due to an acute trauma. We excluded those who had decreased level of consciousness any time after the recent injury, those with previous history of head injuries and cranial surgeries, those with previous foreign bodies in head and neck, those with intoxications and those who needed immediate neurosurgical or general surgery interventions. We also excluded those with penetrating head injuries. All the included patients were hemodynamically stable and did not have any alarming sign of TBI including the amnesia, loss of consciousness, vomiting, and diffuse headache.

Study Protocol

All the included patients underwent complete history evaluation and physical examination by an emergency medicine resident. The baseline characteristics including the demographic information, timing of the trauma, the mechanism of injury and the comorbidities were recorded. We GCS and the pupil reactivity was also checked by a neurosurgery resident. The external examination of the head and face involved detailed documentation of the localization and morphological wound characteristics of the soft tissue injuries of the head using body charts by the emergency medicine resident.

All the included patients underwent a brain CT-scan using a multislice computed tomography (MSCT) at the Department of Radiology at the Rajaei hospital using an 8-multislice CT scanner (General Electrics, Boston, Massachusetts, United States). The field of view included the complete head (from the vertex to the chin) including the scalp. Reconstructed axial (ST01.5 mm/0.5, bone kernel, ST03 mm/1.5 soft tissue kernel) and coronal (ST01.5 mm/0.5, bone kernel) images were stored and used for the radiologic report. Archiving of the cranial CT data was performed according to the clinical standard process. All the images were reviewed by a radiologist who was blinded toward the clinical findings of the patients.

Statistical Analysis

All the data were entered into a computer-based database and they were further analyzed using the statistical package for social sciences (SPSS Inc., Chicago, Illinois, USA) version 18.0. All the data are presented as mean±SD and proportions as appropriate. In order to determine the risk factors for presence of intracranial pathology in patients with mild TBI, we compared the variables between two study groups. independent t-test was used to compare the parametric variables and the chi-square test was used to compare the proportions. A 2-sided p-value of less than 0.05 was considered statistically significant.

Results

Overall we included a total number of 94 patients with minimal TBI who had a scalp laceration on admission. The mean age of the patients was 30.78±8.01 (ranging from 18 to 47) years. There were 58 (61.7%) men and 36 (38.3%) women among the

patients. The most common mechanism of injury was the road traffic accidents followed by the falls (Table 1). Overall 76 (80.9%) patients had subgaleal hematoma and 18 (19.1%) had intracranial pathology. The most common intracranial pathology was the skull base fracture in 7 (7.4%) patients followed by the linear skull fracture in 7 (7.4%) and brain contusions in 3 (3.2%). Only 1 (1.1%) patient had subdural hematoma. Overall 14 (14.9%) patients had skull fractures. The baseline characteristics and the brain CT-scan findings are summarized in Table 1.

Table 1. The baseline characteristics of the 94 patients with mild traumatic brain injury included in the current study.

Variable	Value
Age (years)	30.78±8.01
Gender	
Men (%)	58 (61.7%)
Women (%)	36 (38.3%)
Mechanism of injury	
Fall (%)	43 (45.7%)
Road traffic accident (%)	29 (30.9%)
Assault (%)	22 (23.4%)
Comorbidities	
Hypertension (%)	29 (30.8%)
Ischemic heart disease (%)	12 (12.7%)
Diabetes Mellitus (%)	8 (8.51%)
Thyroid disease (%)	2 (2.1%)
Injuries	
Long bone fractures (%)	42 (44.6%)
Abdominopelvic injuries (%)	21 (22.3%)
Chest injuries (%)	16 (17.1%)
Renal injuries (%)	6 (6.4%)
Scalp laceration	
Width (cm)	4.12±1.87
Length (cm)	7.63±2.72
Scalp Laceration Location	
Parietal (%)	32 (34.1%)
Frontal (%)	28 (29.6%)
Occipital (%)	18 (19.2%)
Temporal (%)	16 (17.1%)
Brain CT-Scan findings	
Subgaleal hematoma (%)	76 (80.9%)
Skull base fracture (%)	7 (7.4%)
Linear skull fracture (%)	7 (7.4%)
Brain contusion (%)	3 (3.2%)
Subdural hematoma (%)	1 (1.1%)
Skull fracture	
Yes (%)	14 (14.9%)
No (%)	80 (85.1%)

We determined the risk factors for intracranial pathology in these 94 patients with mild TBI who had scalp lacerations. We found that the mean age was comparable between the two study groups (p=0.492). The gender distribution was also comparable between the two study groups (p=0.177). We also found no significant difference between the two study groups regarding the frequency of the skull fractures (p=0.191). The risk factor analysis of the patients for intracranial pathologies is summarized in Table 2.

Discussion

In this study we tried to determine the frequency of intracranial pathologies in patients with mild TBI who had scalp lacerations. We found that only 19.1% of the patients had intracranial pathologies and the others had only subgaleal hematoma. In addition, the risk factor analysis revealed no positive findings in these patients. The skull fracture was not associated with the intracranial pathology. Taking all these findings together, it could be said that the risk of intracranial pathologies in patients with mild TBI and scalp lacerations is high and a brain CT-scan should be performed in these patients. The risk of intracranial pathology in patients with mild TBI and scalp laceration is approximately 20% and thus an imaging is required in these patients. This is in line with the previous studies [8, 9].

Primary screening in the emergency department of the patients with mild TBI is a necessary step in order to classify the patients to different categories based on the risk of intracranial pathology. However, emergency department evaluations for patients with mild TBI have not been sufficiently described [12]. It has been demonstrated that both the standard clinical interview and CT scans have limited sensitivity for diagnosing mild TBI [13]. Bazarian *et al*., [14] found

Table 2. The risk factors for presence of intracranial pathology in patients with mild traumatic brain injury and scalp laceration.

	Intracranial pathology (n=18)	Extracranial pathology (n=76)	*p*-value
Age (years)	29.61±8.99	31.06±7.80	0.492
Gender			
Men (%)	14 (77.8%)	44 (57.9%)	0.177
Women (%)	4 (22.2%)	32 (42.1%)	
Mechanism of injury			
Fall (%)	9 (50.0%)	34 (44.7%)	0.668
Road traffic accident (%)	4 (22.2%)	25 (32.9%)	
Assault (%)	5 (27.8%)	17 (22.4%)	
Skull fracture			
Yes (%)	1 (5.6%)	0 (0.0%)	0.191
No (%)	17 (94.4%)	76 (81.7%)	

that trained research assistants administering a structured clinical interview based on the American Congress of Rehabilitation Medicine's definition of TBI to patients or available witnesses identified more than twice as many TBIs as were diagnosed with TBI at

Emergency department discharge. Yuh *et al*., [15] reported that 27% of mild TBI patients with normal head CT scans had trauma-related abnormalities on magnetic resonance images. Thus, it is likely that a significant fraction of patients evaluated in the emergency department for TBI but did not ultimately receive a diagnosis did in fact sustain TBI. In addition, Korley *et al*., [12] determined that of the approximately 3.9 million head CT scans obtained in emergency departments each year to evaluate TBI, 91% did not reveal a traumatic intracranial abnormality. The number of negative head CT scans represents high-volume, high-cost, but low-value testing—not to mention increasingly recognized radiation risk [16]. According to a 2012 report from the Institute of Medicine, an estimated $210 billion per year of unnecessary services constitute excessive healthcare costs that yield no benefits to patients [17]. Overuse of head CT scans contributes to this problem [18].

The point that should kept in mind that although the cost and radiation exposure are among the adverse effects of the performing brain CT scans in emergency departments for evaluation of the mild TBI, but the advantage of detecting intracranial pathology would be more important. The result of the current study demonstrates that about 20% of the patients with mild TBI and scalp lacerations have intracranial pathologies which could be diagnosed in brain CT-scan. Thus we recommend performing brain CT scans in patients with mild TBI and scalp lacerations as the risk of intracranial pathologies in these patients is approximately high. This is in concordance with previous reports [6, 8, 11]. However, the role CT scan in evaluating the outcome of the patients with mild TBI has been a debate. Although valuable for the identification of the individual mild TBI patient at risk for deterioration and eventual neurosurgical intervention, CT characteristics are imperfect predictors of outcome after mild TBI [19, 20]. It was further demonstrated that psychological factors (ie, emotional distress and maladaptive coping experienced early after injury) in combination with pre-injury mental health problems, education, and age are important predictors for recovery at 6 months following mild TBI [21].

We note some limitations to our study. First the number of included patients was limited and thus the power analysis was limited. Further studies including larger study populations is warranted in order to determine the role of brain CT-scan in patients with mild TBI and scalp laceration. The other limitation of the study was that we did not follow the patients and neuropsychiatry evaluation was not performed in order to determine the correlations between the CT scan findings and the outcome of patients with mild TBI and scalp lacerations.

In conclusion, the results of the current study indicate that scalp lacerations are associated with intracranial injuries in about 20% of the patients with mild TBI. Further studies are required to comment of the role of CT-Scan in management of patients with mild TBI and scalp lacerations.

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