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JINJ 7602 No. of Pages 6

ARTICLE IN PRESS

Injury, Int. J. Care Injured xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Incidence of intracranial injury in orbital wall fracture patients not classified as traumatic brain injury

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ARTICLE INFO

Keywords:
Orbital wall fracture
Traumatic brain injury
Computed tomography
Facial injury
Decision rule

ABSTRACT

Objective: The detection of intracranial injury in patients with facial injury rather than traumatic brain injury (TBI) remains a challenge for emergency physicians. This study aimed to evaluate the incidence and risk factors of intracranial injury in patients with orbital wall fracture (OWF), who were classified with a chief complaint of facial injury rather than TBI.
Methods: This retrospective case-control study enrolled adult OWF patients (age ≥18 years) who presented at the hospital between January 2004 and March 2016. Patients with definite TBI were excluded because non-contrast head computed tomography (CT) is recommended for such patients.
Results: A total of 1220 patients with OWF were finally enrolled. CT of the head was performed on 677 patients, and the incidence of concomitant intracranial injury was found to be 9% (62/677). Patients with definite TBI were excluded. Symptoms raising a suspicion of TBI, such as loss of consciousness, alcohol intoxication, or vomiting, were present in 347 of the patients, with 44 of these patients (13%) showing a concomitant intracranial injury. Of the 330 patients without such symptoms, 18 (6%) demonstrated a concomitant intracranial injury. In OWF patients, superior wall fracture (odds ratio [OR], 4.15; 95% confidence interval [CI], 2.06–8.34; $P < 0.001$), associated frontal bone fracture (OR, 4.38; 95% CI, 2.08–9.23; $P < 0.001$), and older age (decades) (OR, 1.03; 95% CI, 1.01–1.04; $P = 0.002$) were independent risk factors for concomitant intracranial injury.
Conclusions: Emergency physicians should maintain a high degree of suspicion of TBI, even when their primary concern is facial trauma with OWF. Head CT is recommended for OWF patients with a superior OWF, frontal bone fracture, or increased age.

Introduction

Traumatic brain injury (TBI) is a common reason for patients to seek emergency department (ED) treatment, and accounts for more than 1 million ED visits per year in the United States [1,2]. The majority of these are classified as mild TBI, with the patients presenting at the ED with a Glasgow Coma Scale (GCS) score of 14 or 15 [1–3]. In such patients, the detection of intracranial injury remains a challenge for the emergency physician, especially when a patient presents with facial injury, as they may then be classified with a chief complaint of facial injury rather than TBI [4]. Although many clinical decision rules such as the New Orleans Criteria and the Canadian CT Head Rule have been developed to help physicians determine which mild TBI patients should undergo non-contrast computed tomography (CT) of the head [5–8], physicians frequently miss the diagnosis of TBI, or may not even realize the possibility of TBI in patients presenting with facial fractures [4,9].

Some previous studies investigated the association between facial bone fractures and intracranial injury, but the small number and heterogeneous nature of the study patients and the lack of specific outcomes have limited the generalization of their findings [10,11]. Orbital wall fracture (OWF) is one of the most common facial fractures, and accounts for about a quarter of all facial bone fractures [12,13]. It also frequently presents alongside various concomitant injuries, including other facial bone fractures and

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https://doi.org/10.1016/j.injury.2018.02.025
0020-1383/

intracranial injury [10]. However, there have only been a few studies on the incidence and risk factors of intracranial injury in OWF fracture patients presenting with mild TBI [14].

Thus, the objectives of this study were (1) to identify the incidence of concomitant intracranial injury in OWF patients, and (2) to evaluate the risk factors for intracranial injury in such patients. The findings should help the physician to evaluate whether or not to perform non-contrast head CT on OWF patients.

Materials and methods

Study design and population

This report covers a retrospective case-control study performed at the ED of Asan Medical Center, a university-affiliated tertiary referral center located in an urban area. Approximately 110,000 patients present at the ED annually, and this study investigated patients presenting at the ED between January 2004 and March 2016. All orbital fractures, defined as fractures to one or more of the walls of the orbit (the frontal bone, sphenoid bone, zygoma, maxillary bone, and ethmoid bone), the orbital rim, or both, were confirmed by CT scan.

The inclusion criteria for the study included presentation at the ED within 24 h of injury, examination by a facial bone CT scan at our hospital, and a specific International Classification of Diseases 10th revision (ICD-10) code at the ED. These patients were able to walk and were classified with a chief complaint of facial injury rather than TBI. In our ED, modified clinical criteria based on the Canadian CT head rule were used for the patients with facial or head trauma to select those required non-contrast head CT during the study period [5,6,8,15]. Patients with a GCS score <15 on arrival at the ED, suspected of an open or depressed skull fracture, any sign of a basal skull fracture, neurologic deficit, seizure, drug intoxication, presence of a bleeding disorder, anticoagulants use, or a dangerous mechanism of injury such as a pedestrian struck by a motor vehicle, an occupant ejected from a motor vehicle, or a fall from an elevation of 3 or more feet or five stairs, were classified as patients with a high suspicion of TBI, who were required non-contrast head CT. In our study patients, all the patients with anticoagulants use took warfarin rather than other new oral anticoagulants. Our modified criteria were similar to the Canadian CT head rule, but the presence of vomiting or old age was not an indication for non-contrast head CT. Patients with a high suspicion of TBI were excluded, as several CT head rule guidelines recommended non-contrast head CT for such patients. Patients who refused to undergo diagnostic testing for TBI were also excluded because of the uncertainty of the diagnosis. Because of incomplete medical records, patients who were transferred from other hospitals after an OWF diagnosis were also excluded. The hospital institutional review board approved the review of patient data and waived the requirement for informed consent (IRB number 2016-0534).

Data collection

The clinical and demographic characteristics of patients were retrieved from the Asan Biomedical Research Environment (ABLE), an anonymized clinical data warehouse [16,17]. These characteristics included age, sex, history, clinical characteristics, and formal interpretive reports of the CT scans made by radiology specialists. Neurosurgery visits and intracranial lesions on later non-contrast head CTs performed within 1 month of the initial ED visit were also investigated in patients who did not undergo an initial non-contrast head CT. There was considered to be a loss of consciousness (LOC) for the traumatic event if a patient could not recall the entire traumatic event. Vomiting included any emesis after the traumatic event. The mechanisms of injury were categorized into five groups: falls from heights within 3 feet or five stairs, ground level falls or slips, motor vehicle accidents, violence, and other causes [8,18,19]. The presence of any acute intracranial injury (including skull fracture) on the non-contrast head CT scan was chosen as the primary outcome. Skull fracture was included as an intracranial injury, as patients with a skull fracture needed hospitalization.

Statistical analysis

Data are expressed as mean (standard deviation) for continuous variables, and as percentages for categorical variables. Comparisons between variables were made using Student's *t*-tests for continuous variables and Pearson's chi-square tests or Fisher's exact tests for categorical variables. Backward stepwise logistic regression analysis with a limit of 0.10 was used to calculate the odds ratio (OR) and 95% confidence intervals (CI). Variables were tested for goodness of fit using the Hosmer-Lemeshow method. Statistical analyses were performed using SPSS version 20 (SPSS Inc., Chicago, IL) with a significance level set at $P < 0.05$.

Results

From January 2004 to March 2016, 1363 patients were diagnosed with OWF at our hospital (Fig. 1). Of these patients, 143 were initially judged to have a definite TBI and were excluded from this study. Of the remaining 1220 patients, 443 were accompanied by one of the following: vomiting, LOC, or alcohol intoxication. In this group of 443 patients, 347 underwent a non-contrast head CT, and 44 of these 347 patients had an intracranial lesion, while 303 were free of any brain lesion. In the group of 777 patients without the aforementioned symptoms, 330 underwent a non-contrast head CT, with 18 having an intracranial lesion and 312 being free of any such lesion. We performed the analysis in two steps.

Firstly, we analyzed the 677 patients with OWF who had undergone non-contrast head CT, regardless of symptoms such as vomiting, LOC, and alcohol intoxication (Table 1). Among these patients, 62 (9%) had an intracranial injury and 615 (91%) had no intracranial injury. The demographic and clinical characteristics of these two groups are presented in Table 1. The mean ages of the patients with OWF were 48.5 years in the intracranial injury group and 42.3 years in the no intracranial injury group ($P = 0.007$). The age distribution of the patients was different between two groups (Supplement Table 1). In both groups, the majority of patients were men (78.7%). Traffic accident was the most common cause of OWF in the intracranial injury group (intracranial injury, 40% vs. no intracranial injury, 23%, $P = 0.002$). The clinical features, which included periorbital swelling, ecchymosis, alcohol intoxication, emphysema, diplopia, vomiting, and enophthalmos, showed no significant differences between groups. However, LOC was more frequent in the intracranial injury group (50% vs. 26%, $P < 0.001$).

The most common site of OWF in the intracranial injury group was the superior wall, which was a relatively infrequent site in the no intracranial injury group (40% vs. 9% respectively, $P < 0.001$). The frequency of multiple OWF was not significantly different between the groups (intracranial injury, 40% vs. no intracranial injury, 32%, $P = 0.159$), although, in general, patients in the intracranial injury group had more associated facial bone fractures (71% vs. 52%, $P = 0.005$). Frontal bone fractures (36% vs. 8%, $P < 0.001$), maxilla fractures (45% vs. 27%, $P = 0.002$), and multiple facial bone fractures (50% vs. 24%, $P < 0.001$) were all significantly more frequent in the intracranial injury group.

Multivariable logistic regression analysis identified a number of independent risk factors for intracranial injuries in OWF patients (Table 2). Frontal bone fractures showed the highest OR (4.38; 95%