Original Investigation

Incidence of Concussion in Patients With Isolated Mandible Fractures

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**IMPORTANCE** This study examines the association between isolated mandible fractures and mild traumatic brain injury (mTBI).

**OBJECTIVE** To determine the rates of mTBI in patients who have sustained isolated mandible fractures.

**DESIGN, SETTING, AND PARTICIPANTS** A prospective study was conducted among patients who sustained isolated mandible fractures within 24 hours of presentation. Patients were administered the Military Acute Concussion Evaluation (MACE). Recorded data included demographics, time since injury, use of alcohol or illicit drugs, nonfacial pain, and mechanism of injury. All patients were evaluated in the emergency department of a level I trauma center between June 20, 2013, and June 20, 2014. In addition, discharge data from the Nationwide Inpatient Sample database was analyzed to identify current rates of patients with a diagnosis of both mandible fractures and concussions.

**MAIN OUTCOMES AND MEASURES** Rates of concussion. Patients with a MACE score of less than 25 were considered to have mTBI.

**RESULTS** Sixteen patients met the study criteria over a 1-year period. Fourteen patients (88%) were male, and mean age was 27.5 years. The mean time since injury was 11.25 hours (range, 3-21 hours). The mechanism of injury was assault in 12 patients (75%), sports in 2 patients (13%), all-terrain vehicle crash in 1 patient (6%), and biking in 1 patient (6%). Eight patients (50%) admitted to the use of alcohol, and none reported the use of illicit drugs. Eleven patients (69%) reported loss of consciousness. Twelve patients (75%) met criteria for concussion according to the MACE. Among these 12 patients, 7 (58%) admitted to the use of alcohol at the time of injury. There was no relationship between the rates of concussion and the use of alcohol.

**CONCLUSIONS AND RELEVANCE** Mandible fractures are often sustained after high-force impacts during altercations between men. In our study, a 75% (12 of 16) rate of concussions associated with isolated mandible fractures was identified. Patients with isolated mandible fractures may benefit from being screened for concussion and referred to a concussion clinic.

**LEVEL OF EVIDENCE** 4.
The mandible is one of the most commonly fractured bones in the craniomaxillofacial skeleton, second only to the nasal bone. In the United States, motor vehicle crashes and interpersonal violence are the most frequent causes of mandible fractures. In urban trauma centers, these altercations often involve men between the ages of 20 to 30 years under the influence of illicit substances. Significant force is required to fracture the mandible. More than 100 years ago, investigators found that 2000 N applied to the subcondylar region resulted in fractures in cadavers. In 1965, it was reported that a force of 44.6 to 74.4 N is required to obtain such a fracture. The horseshoe shape of the mandible and its relationship with the skull base allows it to absorb rather than transmit forces to the middle cranial vault, which often leads to fractures in 2 locations, providing a degree of protection to the brain.

Despite the fact that the mandible is equipped to absorb forces, high-velocity impact will overcome this evolutionary advantage. With increasing force, the likelihood of intracranial and cervical spine injury grows. In terms of intracranial injury, most of the literature focuses on structural damage, as evidenced on head computed tomography. In high-speed motor vehicle crashes, mandible fractures are associated with closed head injuries and skull fractures 50% of the time and with life-threatening injury 64% of the time. In another study, mandibular trauma was the most common fracture associated with severe closed head injury. The locations of mandible fractures associated with traumatic brain injury are condylar, angle, and symphyseal fractures, in descending order of occurrence. In a retrospective review, Zandi and Seyed Hoseini examined mild and severe traumatic injury are condylar, angle, and symphyseal fractures. Mulligan and Mahabir found that isolated mandible fractures had a 5.1% rate of concomitant cervical spine injuries, which increases to 9.1% with additional facial fractures.

Concussions sustained in sports and active-duty combat have received significant media attention. Increased consideration of the long-term complications of mild traumatic brain injury (mTBI) has led to public outcry for improved regulations and protective gear. Concussions comprised almost 11% of injuries sustained during the Iraq war from combat explosions. Little is known about concussions incurred during craniofacial trauma. Although the terminology is varied, it is generally agreed that a concussion is defined as a “functional disturbance rather than a structural injury... with an impulse force transmitted to the head.” The diagnosis of concussion represents a subset of mTBI.

We hypothesized that concussion after a mandible fracture is more common than previously understood. Concussions often are underdiagnosed or undiagnosed in the emergency department. In our study, we aimed to better clarify the rates of concussion seen with mandible fractures. This prospective study was approved by the institutional review board at State University of New York Upstate Medical University. Written informed consent was obtained from all participants. Patients were seen in the emergency department at a level I trauma center between June 20, 2013, and June 20, 2014. Mandible fractures were identified using computed tomography and an additional form of imaging such as orthopantomography or a 4-view mandibular radiograph. Patients with medical comorbidities, concomitant facial fractures, or additional injuries were excluded from the study. Computed tomography of the head was conducted in the emergency department to rule out structural intracranial injury. Our institution is unique in that all facial fractures are managed by the Department of Otolaryngology.

The Military Acute Concussion Evaluation (MACE) was administered to those diagnosed as having isolated mandible fractures within 24 hours of their injury. Included in the study were patients between 18 and 89 years old who were able to participate in the questionnaire.

The MACE is a standardized tool, originally designed to identify mild traumatic brain injury or concussion in the military theater. The examination section is derived from a standardized assessment of concussion that is a validated tool. The MACE does not diagnose concussion but is a screening tool to identify high-risk patients. It is a cognitive evaluation measuring orientation, memory, concentration, and recall after head trauma. The raw scores were aggregated, with 30 possible points. A score of less than 25 is predictive of mild traumatic brain injury or concussion. The benefit of the MACE is that no pretest is necessary. The MACE was selected based on recommendations from the concussion clinic at our institution. An example of an immediate memory exercise on the MACE is to repeat a series of 5 nouns (elbow, apple, carpet, saddle, bubble) after the examiner reads them. One resident physician (L.S.) or nurse practitioner (R.W.) administered the examination. Patients with a diagnosis of concussion were followed up in the concussion clinic at State University of New York Upstate Medical University. Mandible fractures were managed as appropriate by the Department of Otolaryngology.

Demographic information was recorded. Included were age, sex, mechanism of injury, fracture location, loss of consciousness, subjective pain, elapsed time since injury to MACE, and use of alcohol or illicit drugs.

Statistical analyses were performed with chi-squared test or Fisher exact test. These tests were used to evaluate any associations among fracture location, laterality of fracture, and alcohol or illicit drug use at the time of injury.

In addition, discharge data from the Nationwide Inpatient Sample (NIS) database (Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality) were analyzed to compare current documented rates of concussion and mandible fractures. This database represents approximately a 20% sample of US hospitals. Detailed information on the design of the NIS database is available elsewhere (http://www.hcup-us.ahrq.gov).
Incidence of Concussion in Patients With Isolated Mandible Fractures

Results

Sixteen patients met the inclusion criteria. Fourteen were male, and their mean age was 27.5 years. Overall, 28 fractures were sustained. Twelve patients had 2 fractures, and the remaining 4 patients had one fracture. Parasymphyseal fractures (29%) and angle fractures (29%) were the most common, followed by subcondylar fractures (25%), body fractures (11%), ramus fractures (4%), and symphyseal fractures (4%). There was no association between fracture location and concussion ($P = .54$) or between laterality of fracture and concussion ($P = .78$).

The mean time since injury to administration of the MACE was 11.25 hours (range, 3-21 hours). Assault was the most common mechanism of injury, accounting for 12 cases (75%). Additional mechanisms included all-terrain vehicle crash, biking, and sports injuries. Alcohol consumption was acknowledged by 8 patients (50%), while none reported the use of illicit drugs. Eleven patients (69%) reported loss of consciousness.

The mean score on the MACE was 20.8. The mean scores were 4.6, 11.0, 2.0, and 3.1 for orientation, memory, concentration, and recall, respectively. Twelve patients (75%) met criteria for possible concussion according to the MACE, with a score of less than 25. Seven of 12 patients (58%) with concussion admitted to the use of alcohol before injury, and 1 of 4 patients (25%) without suspicion of concussion admitted to having consumed alcohol at the time of injury. There was no correlation between the use of alcohol and a diagnosis of concussion ($P = .12$, Fisher exact test) (Table). Data from the NIS database were used to evaluate current rates of a diagnosis of concussion with mandible fractures. In total, 9994 mandible fractures were identified with the aforementioned ICD-9 codes between January 1, 2008, and December 31, 2010. Among those with fractures, only 562 patients (6%) were diagnosed as having a concurrent concussion.

Discussion

The literature is scarce regarding the rates of concussion associated with craniofacial fractures. In this study, a 75% (12 of 16) rate of suspected concussion was associated with isolated mandible fracture. The NIS database revealed a much lower 6% (562 of 9994) rate of diagnosis of both a mandible fracture and a concussion. It would follow that many of our patients sustained concussions without adequate evaluation or follow-up. It is our belief that concussion is often overlooked in the setting of life-threatening injuries often seen in the emergency department.

Concussions have been in the spotlight recently. Athletes at all levels, from school-age children to professionals, are affected by this silent epidemic. Traumatic brain injury is also considered the hallmark of military personnel returning from the wars in Iraq and Afghanistan.

Most patients who sustain concussions will have no long-term sequelae and can expect a return to baseline in 1 to 2 weeks. However, a subset of patients will have persistent cognitive symptoms at 1 year and beyond. At this point, there is little evidence to predict a given patient’s clinical course. Long-term effects can be devastating for the patient and his or her family, with mTBI being associated with chronic pain syndromes, migraine headaches, and posttraumatic stress.

Table. Characteristics of the Study Patients

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Alcohol Use</th>
<th>Loss of Consciousness</th>
<th>Mechanism of Injury</th>
<th>Fracture Location</th>
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<th>Concussion</th>
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<td>1/M/30</td>
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<td>Assault</td>
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</table>

Abbreviations: ATV, all-terrain vehicle; MACE, Military Acute Concussion Evaluation; PS, parasymphyseal; SC, subcondylar.

Data from January 1, 2008, to December 31, 2010, were included in the present study.

Patients with a diagnosis of both mandible fractures and concussions were identified using International Classification of Diseases, Ninth Revision (ICD-9) codes. The codes used for mandible fractures were 80220 to 80239. The codes used for concussion were 8500, 85011, 85012, 8502 to 8505, and 8509.
Conclusions

As otolaryngologists, we are often asked to assess patients with facial fractures in the emergency department. Given the high rates of potential concussion seen in our study and the low rates previously reported, we recommend an awareness of concussive symptoms and a high index of suspicion for mTBI. Physicians in the emergency department should also be cognizant of this association because they are often performing the initial evaluations.

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Author Contributions: Dr Sobin had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: All authors. Acquisition, analysis, or interpretation of data: Sobin, Kopp, Walsh. Drafting of the manuscript: Sobin, Kopp. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Sobin, Kopp. Administrative, technical, or material support: Sobin, Kopp, Walsh, Harris. Study supervision: Kopp, Kellman, Harris.

Conflict of Interest Disclosures: None reported.

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REFERENCES