Oral and Maxillofacial Surgery (2021) 25:389–393
https://doi.org/10.1007/s10006-020-00925-9

ORIGINAL ARTICLE

# Rugby-related adult maxillofacial trauma injuries: a NEISS database study

David Lafferty[1] · Tyler Pion[2] · Jason E. Cohn[1] · Tom Shokri[3] · Yadranko Ducic[4] · Mofiyinfolu Sokoya[5]

Received: 16 June 2020 / Accepted: 17 November 2020 / Published online: 7 January 2021


## Abstract

**Purpose** The primary objective of this study is to delineate the data on maxillofacial trauma in rugby utilizing the National Electronic Injury Surveillance System (NEISS) database. Specifically, we want to establish the prevalence of facial rugby injuries in terms of age, mechanism of injury, and degree of injury in order to develop ways to limit facial trauma in the future.

**Methods** The NEISS database was accessed in February 2020 in order to identify adult patients (> 19 years of age) presenting to the emergence department (ED) for rugby-related head and facial injuries from the previous 10 years (2009–2018). Descriptive statistics were organized and presented. Chi-squared testing ($\chi^2$) was performed to compare categorical variables, and ANOVA was performed to compare continuous variables.

**Results** A total of 507 patients (national estimate = 18,952) from 2009 to 2018 were identified as appropriate for study inclusion. The most common injuries were those to the facial region including the eyelid, eye area, and nose (59.4%). The most frequently encountered facial fracture while playing rugby was the nasal bone (58.6%). Overall, 98.4% of patients who presented to the ED with rugby injuries were treated and released, 1.2% were admitted or observed, and 0.4% left against medical advice.

**Conclusions** When evaluating a patient with a rugby-related injury, one should expect injuries to the eyelid, eye area, or nose. The most common fracture pattern will most likely be nasal bone. Despite these injuries, the vast majority of patients will be treated and released.

**Keywords** Facial trauma · Rugby · Sports medicine · Facial plastics and reconstruction · Facial fractures

## Introduction

Rugby is being played more than ever before, with 9.6 million players in 123 countries partaking in the sport [1]. With upwards of 475 million fans, rugby is ranked as the ninth most popular sport in the world [2]. In a sport characterized by a fast pace and frequent tackling, players are susceptible to a wide array of injuries [3], with the majority of injuries occurring in tackling situations in both men and women [3–7]. Increasing age and the first half of the playing season have also been

✉ David Lafferty
dl157414@pcom.edu

Tyler Pion
tp7265@pcom.edu

Jason E. Cohn
jasoncoh@pcom.edu

Tom Shokri
tshokri@pennstatehealth.psu.edu

Yadranko Ducic
yducic@sbcglobal.net

Mofiyinfolu Sokoya
fiyinsokoya@gmai.com

[1] Department of Otolaryngology-Head and Neck Surgery, Philadelphia College of Osteopathic Medicine, 4190 City Line Avenue, Philadelphia, PA 19131, USA

[2] Philadelphia College of Osteopathic Medicine, 4190 City Line Avenue, Philadelphia, PA, USA

[3] Department of Otolaryngology-Head and Neck Surgery, Penn State Hershey Medical Center, 500 University Drive, Hershey, PA 17033, USA

[4] Otolaryngology and Facial Plastic Surgery Associates, 923 Pennsylvania Ave., Fort Worth, TX 76104, USA

[5] Department of Otolaryngology-Head and Neck Surgery, University of Arizona College of Medicine, 1501 N. Campbell Avenue, Tucson, AZ 85724, USA

reported as risk factors for injury in rugby [3]. A study in 2017 reported a total of 426 injuries in only 825 adolescent rugby players across just one playing season [4].

While common injuries in rugby have been studied [3–6], there is limited research targeting maxillofacial trauma [7–9]. Ma et al. analyzed a breakdown of the frequency of head and neck injuries in women compared with men and noted that head and neck injuries were more common in women (16%) than men (5%), although a breakdown of the types of injuries to the head and neck was not performed. Hada et al. retrospectively reviewed 10 professional rugby players with facial fractures. They noted medial orbital wall fractures to be the most common ($n = 5$), followed by zygomatic arch ($n = 2$), orbital floor ($n = 2$), and zygomatic arch ($n = 1$).

With rugby gaining momentum nationally, facial trauma should be further investigated and categorized, as has been done with many other sports including baseball, soccer, combat sports, ice hockey, golf, and basketball [10–15]. The primary objective of this study is to delineate the data on maxillofacial trauma in rugby. Specifically, we want to establish the prevalence of facial rugby injuries in terms of age, mechanism of injury, and degree of injury in order to develop ways to limit facial trauma in the future.

## Methods

An analysis of rugby-related facial trauma was conducted using the National Electronic Injury Surveillance System (NEISS). The NEISS is a public database maintained by the US Consumer Product Safety Commission that collects information from approximately 100 emergency departments (EDs). The database presents pertinent demographics (age, gender, and ethnicity), injury information (diagnosis, injury location, and disposition), and a short narrative describing the details surrounding the event. The data are extrapolated to give a national representative sample.

The NEISS database was accessed in February 2020 in order to identify adult patients (> 19 years of age: ages were reported in 10-year increments 0–9 years, 10–19 years, 20–29 years, etc.) presenting to the ED for rugby-related head and facial injuries from the previous 10 years (2009–2018). Patients were excluded if they sustained an injury outside the head and neck and if they sustained the following nonmaxillofacial injuries—aspiration/ingestion, burns, amputation, anoxia, avulsion, crushing, dermatologic/conjunctival, dislocation, electric shock, foreign body, hematoma, hemorrhage, internal organ injury, nerve damage, poisoning, puncture, strain/sprain, submersion, and not stated/unknown. Data surrounding each event were collected including age (further stratified into age groups: young adults 20–35 years, middle-aged adults 36–64 years, and the elderly > 64), gender, race, injury type (concussion, contusion/abrasion, fracture, laceration, and dental injury), injury location (head, eyeball/globe, face [eyelid, eye area and nose], neck, mouth [lips, tongue, and teeth], and ear), and disposition of the patient (treated and released, treated and transferred, treated and admitted, held for observation, signed out against medical advice [AMA], and death). Due to the lower numbers of fractures seen in the study, subtypes were divided into nasal, mandibular, midface, cervical spine, and skull fractures for analysis.

Descriptive statistics were organized and presented. Chi-squared testing ($\chi^2$) was performed to compare categorical variables, and ANOVA was performed to compare continuous variables, using IBM SPSS 25th version statistical software (Armonk, NY). Statistical significance was set for $p$ value less than 0.05 ($p < .05$). The ANOVA test was performed on data in which the observations were independent, that was normally distributed, and the homogeneity assumption was met. The homogeneity assumption was tested by Levene's test.

NEISS is a public anonymized database, the nature of which qualifies as nonhuman subject research. Per Drexel University's (Philadelphia, PA) institutional review board (IRB) policy, this research is exempt from IRB review.

## Results

After screening for inclusions and exclusion criteria, a total of 507 patients (national estimate = 18,952) from 2009 to 2018 were identified as appropriate for study. This amounts to 50.7 injuries/year (national estimate = 1895.2 injuries/year). The average age was 24.47 years (SD = 5.35 years). Young adults were the most common age group to present with injuries ($n = 486$, 95.9%), while middle-aged adults made up the remaining 4.1% ($n = 21$) of patients. There were no elderly patients identified in the study. Males composed the majority of patients who experienced maxillofacial trauma due to rugby ($n = 415$, 81.9%). Of the patients that race data were provided for, Caucasians were the most represented race ($n = 264$, 91.7%) (Table 1).

The most common injuries were those to the facial region including the eyelid, eye area, and nose ($n = 302$, 59.4%), while injuries to the head were also common ($n = 154$, 30.4%). The most common diagnosis overall was laceration ($n = 256$, 50.5%) followed by concussion ($n = 123$, 24.3%), fracture ($n = 87$, 17.2%), contusion/abrasion ($n = 37$, 7.3%), and dental injury ($n = 4$, 0.8%) (Table 2). Overall, 98.4% ($n = 499$) of patients who presented to the ED with rugby injuries were treated and released, 1.2% ($n = 6$) were admitted or observed, and 0.4% ($n = 2$) left AMA.

The most frequently encountered facial fracture while playing rugby was the nasal bone ($n = 51$, 58.6%), followed closely by the midface ($n = 28$, 32.2%) (Table 3). Of the patients evaluated for fractures, 97.7% were discharged. The

**Table 1** Demographic data

| | *N* (%) |
|---|---|
| Age group | |
| Young adults (20–35 years old) | 486 (95.8) |
| Middle aged (36–64 years old) | 21 (4.1) |
| Elderly (> 64 years old) | 0 (0.0) |
| Sex | |
| Male | 415 (81.9) |
| Female | 92 (18.1) |
| Race | |
| Not stated | 219 (43.2) |
| Caucasian | 264 (52.1) |
| African-American | 9 (1.8) |
| Hispanic | 8 (1.6) |
| Asian | 6 (1.2) |
| Pacific Islander | 1 (0.2) |

patients admitted consisted of one midface fracture and one cervical spine fracture. There were no statistically significant differences among the types of fractures suffered by sex ($p = .429$), age groups, or race ($p = .265$) as determined by the chi-squared test. There were no statistically significant differences among the types of fractures suffered by age ($p = .718$) as determined by the ANOVA with Levene's statistic to test the homogeneity of variances ($p = .167$).

Finally, injury type (head, eyeball/globe, face [eyelid, eye area and nose], neck, mouth [lips, tongue, and teeth], and ear) was compared by injury location (head, eyeball/globe, face [eyelid, eye area and nose], neck, mouth [lips, tongue, and teeth], and ear) to determine which types of injuries were reported in specific locations most commonly. The most common injury to the head were concussions ($n = 123$, 79.9%, $p < .001$), while lacerations mostly occurred to the face ($n = 191$, 63.2%, $p < .001$), mouth ($n = 32$, 88.9%, $p < .001$), and ear ($n = 8$, 88.9%, $p = .021$). All injuries to the eyeball/globe were contusions/abrasions ($n = 5$, 100%, $p < .001$), while injury to the neck was exclusively a fracture ($n = 1$, 100%, $p = .027$) (Table 4).

**Table 2** Injury location and type of data

| | *N* (%) |
|---|---|
| Injury location | |
| Face | 302 (59.6) |
| Head | 154 (30.4) |
| Mouth | 36 (7.1) |
| Ear | 9 (1.8) |
| Eyeball/globe | 5 (1.0) |
| Neck | 1 (0.2) |
| Injury type | |
| Laceration | 256 (50.5) |
| Concussion | 123 (24.3) |
| Fracture | 87 (17.2) |
| Contusion/abrasion | 37 (7.3) |
| Dental injury | 4 (0.8) |

**Table 3** Fracture distribution

| Fracture | *N* (%) |
|---|---|
| Nasal | 51 (58.6) |
| Midface | 28 (32.2) |
| Mandible | 6 (6.9) |
| Cervical spine | 1 (1.1) |
| Skull | 1 (1.1) |

## Discussion

The head and face are among the most prevalent areas for injury in rugby [3, 5]. In fact, three studies found the head and neck to be the most common area of injury, which ranged from 16 to 23.9% of total rugby injuries [4, 6, 7]. While general injury rates are lower in women than men, Ma et al. found head/neck injuries to happen at a higher rate in US female rugby players than in international male rugby players. Additionally, the 20–29-year-old age group has the highest prevalence for maxillofacial trauma during rugby [9, 16] and the risk for injury rises as the level of competition rises [3, 17]. This was consistent with our findings, with younger adults (aged 20–35 years) comprising 95.8% of patients in our cohort. Although race was studied, it did not predict any particular injury patterns. When race was reported, the vast majority of rugby-related injuries were incurred by Caucasians.

The most common type of injury in rugby overall, on many accounts, was found to be due to sprain/strain [4–7]; however, in maxillofacial injuries specifically, the research is not quite well defined. In our cohort, the most common type of injury was a laceration, accounting for 50.5% of rugby injuries evaluated in the ED. Lacerations were mostly likely to involve the

**Table 4** Anatomic location versus injury type

| Body part | Most common injury | *p* value |
|---|---|---|
| Head | Concussion (79.9%) | $p < .001$ |
| Face | Laceration (63.2%) | $p < .001$ |
| Eyeball/globe | Contusion/abrasion (100%) | $p < .001$ |
| Mouth | Laceration (88.9%) | $p < .001$ |
| Neck | Fracture (100%) | $p = .027$ |
| Ear | Laceration (88.9%) | $p = .021$ |

face (nose, eye, and eyelid region), mouth, and ear. Contusions/abrasions were also common injuries, mostly affecting the eyeball/globe. According to Kim et al., the mechanism of injury is most commonly due to another opponent's head (31.5%), followed by knee (14.7%), elbow (14.7%), and forearm/fist (14.7%) [9]. Facial injury is most prevalent in the tackling/contact situation [18, 19]. While we were not able to determine the mechanism of injury based on the NEISS database results, our data did support that facial injuries are the prevalent in contact sports with 59.6% of patients in our study presenting with some sort of facial injury involving the nasal, eye, and eyelid regions.

The anatomic location of facial fractures among rugby players has been relatively well studied. Of the 20 fractures reported by Murphy et al., there were eight zygomatic complex, five orbital, three nasal, three mandibular, and one maxillary sinus fracture [18]. In another study involving nine patients, there were five zygoma, two mandibular, two nasal bone, and two frontal sinus fractures [16]. Of note, mandibular fractures were more commonly seen in rugby than other sports [16]. Likewise, another study found that the mandible and zygomatic complexes were particularly common sites for fractures in rugby [19]. Hada and colleagues looked at 10 professional rugby players with maxillofacial fractures in which two were at the zygomatic complex, five at the medial orbital wall, two at the orbital floor, and one at the nasal bone [8]. Kim et al. studied 134 patients with facial fractures sustained during rugby, for which the majority involved the mandible (54%), followed by the zygoma (33%), orbit (16%), and maxilla (8%), although when broken down by overall region upper/midface fractures composed 60% of fractures while the mandible made up 40% of the fractures [9]. A large number of mandible fractures were localized to the angle, followed by symphysis, condyle, and body [9]. It is unclear why Kim et al. reports substantially more mandible fractures than our review of the NEISS database. It is important to point out that their study population is composed of a single institution in Australia while the NEISS database collects data from multiple hospitals throughout the USA. In summary, mandibular fractures were most common followed by zygomatic complex, then closely by orbital fracture, and a lower number of nasal and maxillary fractures.

Our review of the NEISS database revealed a much higher rate of nasal bone fractures than the abovementioned studies examining rugby-related injuries. While the nasal bones are the most commonly fractured bone of the facial skeleton overall [20], the vast majority do not require a surgical consultation in the ED [21]. Three of the four abovementioned studies noted fractures of the zygoma and orbit to the be the most frequently encountered fractures [8, 16, 18]. Fractures of the midface were the second most common fracture encountered in our cohort at 32.2%. Due to the low number of fractures in the database, orbital, zygomatic, and maxillary fractures were combined to encompass total midface fractures for the purposes of analysis. This complicates comparing our results with the established literature on fractures sustained while playing rugby. While Kim et al. noted that 45% of fractures were mandible fractures [9], our review of NEISS only noted 6.9% of fractures to be of the mandible, which is much more consistent with the other three authors' findings [8, 16, 18]. Although neck injuries were very uncommon, one could expect to sustain a fracture while playing rugby.

There are several limitations of this study that require acknowledgement. The data provided by the NEISS represents information collected from various health systems, which may create possible inconsistencies and inclusion bias due to institutional differences in reporting. Due to the fact that the data is collected from ED visits, it does not characterize the incidence and prevalence of all injuries incurred while participating in rugby. Less severe injuries may be missed, and injuries managed in an outpatient setting are not captured. We must also acknowledge that the reporting of injuries may not always be consistent. Additionally, the database does not provide details regarding patient treatment. The database reports injuries as involving the face, mouth, eyeball, head, neck, and ear which are further defined above. We must recognize that there is significant crossover among these regions which may also skew the results. Finally, demographic information was able to be obtained from the database; however, as we do not know the male/female ratio of people playing rugby, it cannot be interpreted fully. Despite the limitations mentioned, researchers from the Centers for Disease Control and Prevention (CDC) and the US Consumer Product Safety Commission have determined that the NEISS could provide nationally representative data on all nonfatal injuries treated in US EDs [22].

## Conclusions

Research on rugby-related maxillofacial trauma injuries is limited. Better knowledge of these patterns can assist providers in understanding these types of injuries. In addition, it can spark interest in providing grounds for implementing better rules and safety equipment for the sport. When evaluating a patient with a rugby-related injury, one should expect injuries to the eyelid, eye area, or nose. The most common fracture pattern will most likely be nasal bone. Despite these injuries, the vast majority of patients will be treated and released.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s10006-020-00925-9.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This article does not contain any studies with human participants or animals performed by any of the authors.

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