

Fore! A 10-year Analysis of Golf-related Facial Fractures

Sandra R. Oska, BS*
Kongkrit Chaiyasate, MD†
Stephen M. Lu, MD, MDiv†

Background: Over 30 million people in the United States play golf, which, while considered a low-impact sport, involves balls and clubs moving >100 miles/h (>160.93 km/h), creating potential for a significant facial trauma. The objective of this study was to characterize the epidemiology of golf-related facial fractures in the United States.

Methods: The National Electronic Injury Surveillance System, which records injuries from approximately 100 US emergency departments, was queried for golf-related facial fractures from 2009 to 2018. Entries were tabulated for mechanism of injury and fracture location. Age, gender, seasonality of injury, type of fracture, and injury mechanism were analyzed using SPSS. Because of the different nature and management of pediatric fractures, we looked at pediatric patients as a distinct subgroup.

Results: There were 114 reported cases of golf-related craniofacial fractures in patients 2–91 years of age with male predominance (73.7%). This rate extrapolates to an estimated 3,850 ED presentations. Although accounting for about 10% of total players, patients under 18, commonly referred to as “junior golfers,” comprised 55.3% of the cohort. Nasal fractures (25.4%), skull fractures (23.7%), unspecified facial fractures (17.5%), and mandible fractures (10.5%) predominated, which most commonly result from clubs (63.2%), balls (23.7%), and falls (11.4%).

Conclusions: Facial fractures resulting from golf clubs and balls may not be as common as in other traditionally identified “high-impact sports,” but they affect pediatric patients disproportionately and with a greater morbidity. Parents and children engaging the sport should be aware of the risk of head trauma, especially with any form of off-course participation. (*Plast Reconstr Surg Glob Open* 2020;8:e3128; doi: 10.1097/GOX.0000000000003128; Published online 22 October 2020.)

INTRODUCTION

Golf continues to be a widespread and popular sport throughout the United States. The National Golf Foundation reported that in 2018 there were 24.2 million people in the United States who played a total of 434 million rounds of golf on a golf course.¹ Approximately 5.7 million (23.6%) of course players were female, 2.5 million (10.3%) were junior golfers (under 17), and 2.6 million were new players.¹ Golf is also becoming a more accessible sport, as 75% of facilities were open to the public as of the end of 2018. Nontraditional off-course formats, such as indoor entertainment driving ranges, are also becoming more popular and attract a more casual golfing population.¹

Although golf is typically considered a low-impact sport, there are a wide range of injuries that players of any skill level may experience as a result of overuse, poor technique, or a direct blow. The sport involves hard-shelled balls and titanium or stainless-steel club heads moving over 100 miles/h (>160.93 km/h), which can incur a significant facial trauma. Although injuries have been well-studied in sports that are considered to be a higher risk, such as baseball, basketball, and hockey, craniofacial injuries related to golf have been less commonly studied.^{2–6} Given the popularity of the sport and the risk for a serious injury, we characterized the nature of golf-related facial fractures in the United States over the last 10 years.

METHODS

The National Electronic Injury Surveillance System (NEISS), which uses data from the US Consumer Product Safety Commission, was queried for craniofacial fractures related to golf equipment. The NEISS collects data on consumer-product-related injuries from approximately 100 US hospital emergency departments as a probability

From the *Oakland University William Beaumont School of Medicine, Rochester, Mich.; and †William Beaumont Hospital, Royal Oak, Mich.

Received for publication June 15, 2020; accepted July 23, 2020.

Copyright © 2020 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \(CCBY-NC-ND\)](https://creativecommons.org/licenses/by-nc-nd/4.0/), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000003128

Disclosure: The authors have no financial interest to declare in relation to the content of this article.

sample of all hospital emergency departments located in the United States.

We examined the most recent 10 years of treatment dates (2009–2018) for golf-related fractures of the face and head. We included any injuries related to golf equipment, activity, or apparel, and excluded golf-cart-related injuries, as carts are a separate type of injury and not always associated with golf as a sport. We used the following golf product code in our search: golf (activity, apparel, or equipment; code 1212). Although hand and extremity fractures comprise the most common golf-related fractures, we focused on injuries to the head and face because of the significant energy required to cause, and consequent morbidity from, facial fractures. For the body part codes, we utilized the head (code 75) and face (code 76) codes. The diagnosis codes selected in the query included the fracture code (code 57).

Entries were tabulated for demographic information, mechanism of injury, and fracture location. Age, gender, seasonality of injury, type of fracture, and mechanism of injury were analyzed using SPSS. Because of the different nature and management of pediatric fractures overall, we looked at pediatric patients (age 17 and younger) as a distinct subgroup. SPSS Version 24 (IBM SPSS Statistics, Armonk, N.Y.) was used to analyze each variable.

RESULTS

Ten years of data (2009–2018) were analyzed, with an average of 11 golf-related fractures a year (range: 7–17; Fig. 1). The 114 entries evaluated extrapolated to 3,850 fractures treated over this time frame in the US emergency departments.⁷

The mean age at the time of injury was 27 years (range 2–91; Table 1). Patients aged 12 and under comprised

42.2% of cases (Fig. 2). An estimated 73.7% were male, and 26.3% were female. In total, 55.3% of the cohort was composed of patients 17 and younger, while adults made up 44.7% of injured patients.

In all patients, the most common mechanism of injury was a result of golf clubs (63.2% of cases), followed by golf balls (23.7%), falls (11.4%), and unspecified etiology (0.9%). An estimated 18.4% of patients sustaining fractures were specifically reported to have been hit by a family member or friend’s golf club. Pediatric injuries were predominantly caused by golf clubs (82.5% of cases), and less frequently caused by golf balls (15.9%). This finding was less pronounced in the adult population, with 39.2% of adults sustaining injuries from clubs and 33.3% injured by golf balls (Fig. 3). In adults, other etiologies included falls (syncope or mechanical falls) on the golf course (27.5%) and golf-bag-related injuries (2%).

There was a seasonal pattern to injuries, with June (18.4%) and May (16.7%) as the most common months for injuries and October–December accounting for less than 10% of injuries (Fig. 4).

According to the database, the most common fracture was nasal fracture (25.4%), followed by nonspecific “skull fractures” (23.7%) and “facial fractures” (17.5%). Where specified, jaw fractures and orbital fractures accounted for 10.5% and 12.3% of injuries, respectively (Fig. 5). For pediatric patients, 41.3% were treated and transferred or treated and admitted for hospitalization (within the same facility) as a result of their injuries, in contrast to 31.4% of adults. Skull fractures frequently resulted in hospital admission, with 23 of 27 cases necessitating in-patient treatment. Although nasal bone fractures were fairly common, only 14.3% of patients with nasal fractures were admitted (4 of 29 patients). Similarly, jaw fractures infrequently resulted in admission. Of the 12 patients with jaw

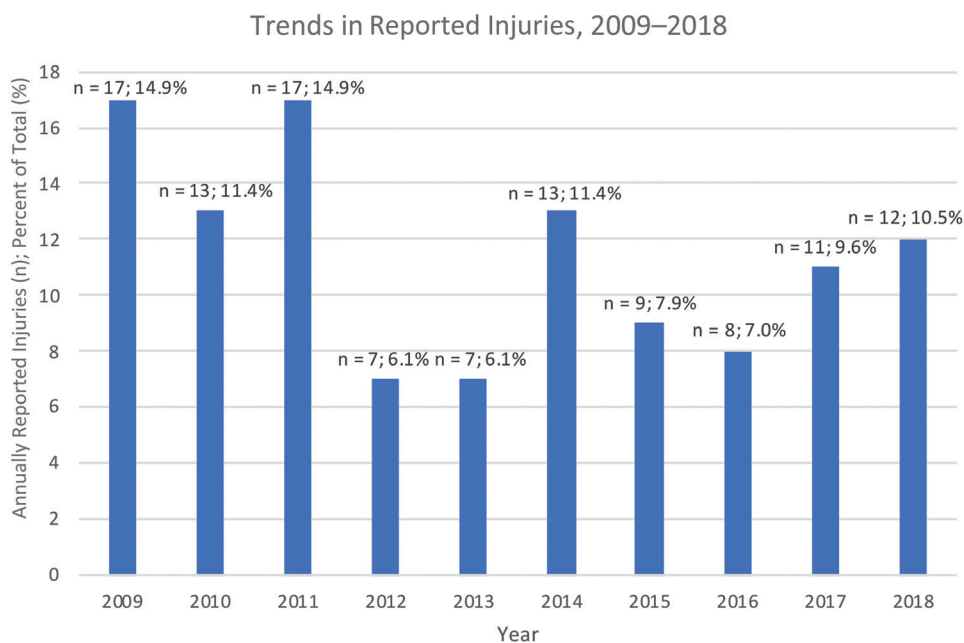


Fig. 1. Trends in the number of golf-related craniofacial injuries over 10 years.

Table 1. Demographic Characteristics of Golf Injuries

	Overall	Adult	Pediatric	Projected Total
N (%)	114	51 (44.7%)	63 (55.3%)	3,850
Average age, y (SD)	27 (SD = 24.5)	49.02 (SD = 21.71)	9.68 (SD = 3.67)	
Male (% vs. female)	73.7%	70.6%	76.2%	2,837
Female (%)	26.3%	29.4%	23.8%	1,013
Mechanism of injury				
Clubs (%)	63.2%	39.2%	82.5%	2,433
Balls (%)	23.7%	33.3%	15.9%	912
Falls (%)	12.3%	27.5%	0.0%	474
Fracture type				
Jaw	10.5%	11.8%	9.5%	404
Orbital	12.3%	13.7%	11.1%	474
Nasal	25.4%	27.5%	23.8%	978
Nonspecific skull	23.7%	11.8%	33.3%	912
Nonspecific facial	17.5%	19.6%	15.9%	674
Disposition				
Treated and released, or examined and released without treatment	61.4%	66.7%	57.1%	2,364
Treated and transferred to another hospital	9.6%	3.9%	14.3%	370
Treated and admitted for hospitalization (within the same facility)	27.2%	27.5%	27.0%	1,047
Held for observation (includes admitted for observation)	1.8%	2%	1.6%	69

fractures, only 4 were admitted to the hospital. None of the patients noted to have ethmoid bone, mastoid bone, frontal bone, or zygomatic fractures were admitted. In this NEISS-derived sample, none of the injuries were fatal.

Although reporting was inconsistent, several types of intracranial injury were specifically mentioned in 5.3% of patients. In total, 2.6% of patients experienced subarachnoid hemorrhage that accompanied their fracture. Pneumocephalus, traumatic brain injury, concussion, and frontal lobe contusion were each reported in 0.9% of patients.

In the pediatric population, the location at the time of injury was not reported for 47.6% of cases. When location was listed, 42.4% of patients sustained fracture in the home, suggesting that the home setting accounts for a substantial portion of injuries (22% of all injuries with

or without location noted). However, in adults, location was reported 76.5% of the time, with only 7.7% of patients injured in the home setting, representing 5.8% of the total injuries reported.

DISCUSSION

Although golf is usually thought of as a low-impact sport, there is potential for severe injury, due to the use of hard-shelled balls and titanium or stainless-steel club heads. In comparison with other sports, golf may be considered more benign, thereby misleading healthcare professionals and players alike.

Many studies report on the commonality of golf-related overuse injuries.^{8,9} As the number of beginner golfers rises and off-course golf activity becomes a more popular activity, it is important to understand the potential injuries that

Age composition of patients sustaining golf-related fractures

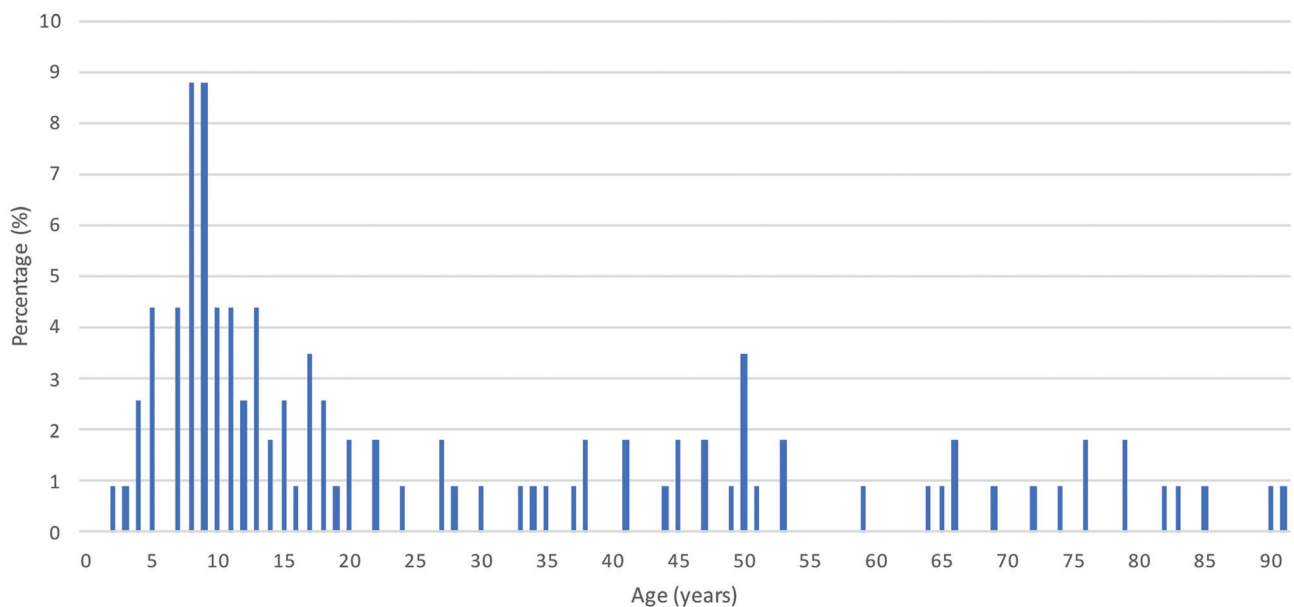


Fig. 2. Age distribution of patients injured from golf.

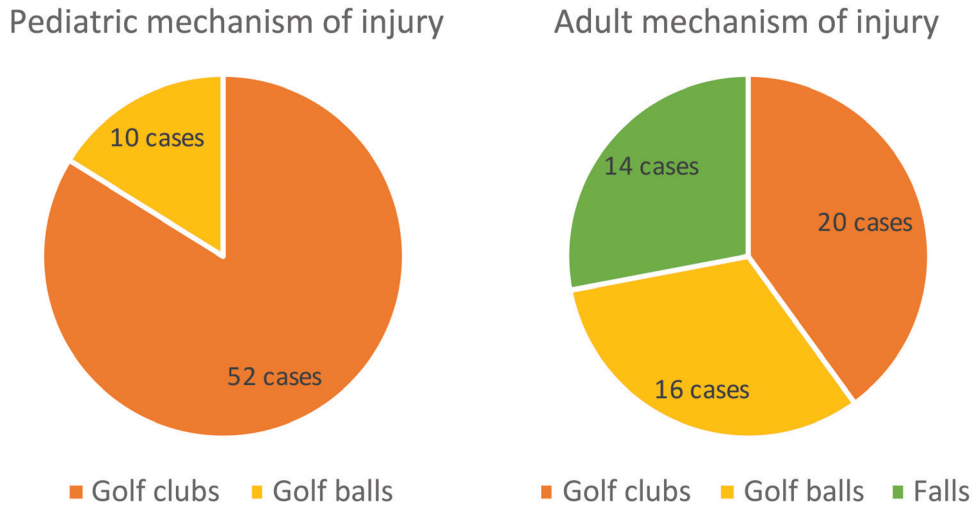


Fig. 3. Mechanism of injury distribution in pediatric and adult cohorts; two cases were unspecified.

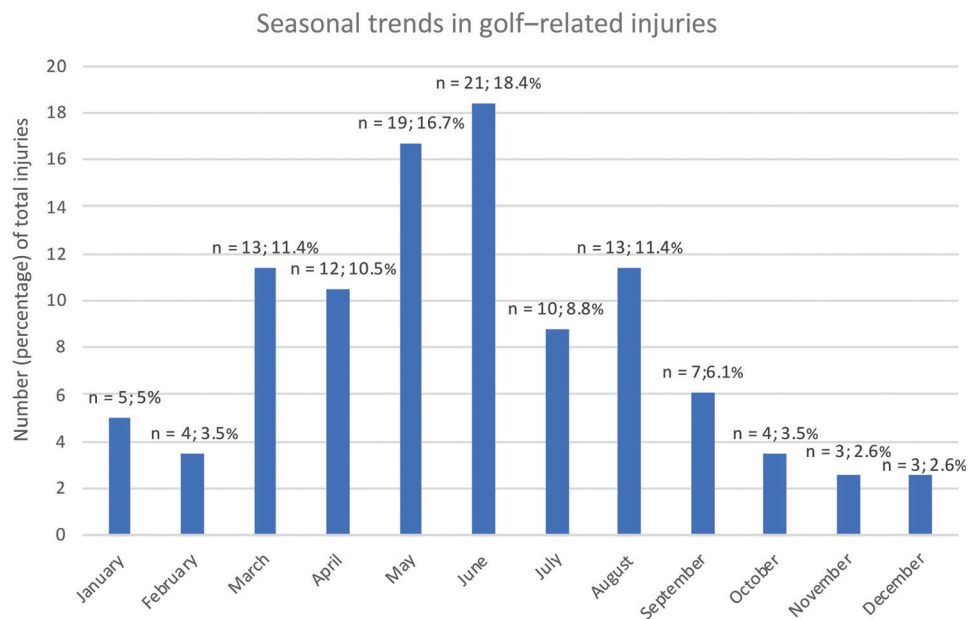


Fig. 4. Incidence of golf-related skull and facial fractures, by month.

can occur on and off the golf course. Improper use of equipment poses a significant risk for injury.

Our study found that children under 18 represented the majority of facial fractures, 55.3%, with the highest number between age 7 and 12. This is in contrast to pediatric players only representing 10.3% of all golfers. Overall, NEISS generated an extrapolated estimate of 2,129 pediatric patients age 17 and younger sustaining golf-related head and face fractures over the 10-year period.⁷ The disproportionate pediatric representation in the sample was particularly surprising because such patients are generally much less likely to sustain facial fractures than adults, with previous studies showing pediatric facial fractures accounting for less than 10% of all facial fracture cases.^{10,11} Reasons for this reduced incidence include flexibility of

the facial bone, lack of paranasal sinus pneumatization, and incomplete dentition that stabilizes the jaws.^{12,13} Also, the cranium comprises a higher proportion of the craniofacial skeleton and helps protect the facial skeleton from injury.¹⁴ These anatomic differences explain why a more significant force is required to cause pediatric facial fractures.¹⁵ When these injuries do occur, though, they tend to be associated with significant morbidity and disability.¹⁶ Prior research found that the most commonly associated injury in children with craniofacial fractures is neurologic injury.¹⁵ Commonly, a conservative management approach is usually favored to minimize the risk of causing more harm to facial development, and fractures need to be followed through the healing progress until skeletal maturity is achieved,^{17,18} though these features were not reported in

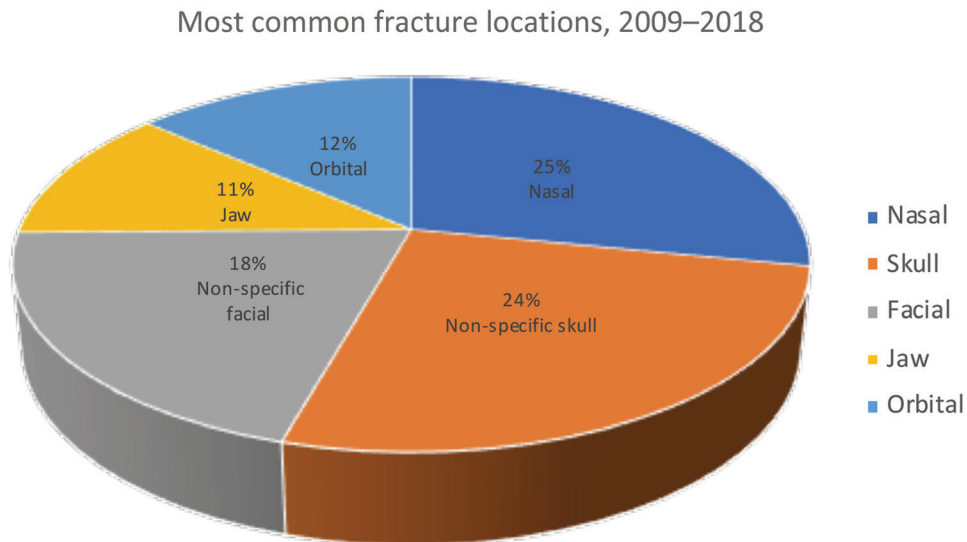


Fig. 5. Five most common types of golf-related facial fractures, comprising 90% of injuries reported.

NEISS. Facial skeletal injuries can result in altered function and growth disturbance, making a prompt diagnosis particularly important.¹⁹

Other studies have utilized the NEISS database to describe the incidence and characteristics of patients with injuries to the head and neck from other sports and recreational activities. NEISS samples have been used to describe the risk of pediatric facial trauma associated with cheerleading, swimming, diving, skiing, snowboarding, and baseball, among other recreational activities.^{19–23} These studies similarly emphasize injury prevention strategies, including closer supervision of children who are particularly vulnerable to fracture risk.²⁰

In our study, pediatric patients were 4 times more likely than adults to experience an intracranial injury (7.9% pediatric vs. 1.9% adult). Golf clubs and balls, the major mechanisms of injury in the pediatric population, may result in facial fractures because of the speed and particular dimensions of the equipment—high velocity, but neither small or sharp enough for deep penetrating injury, nor large or broad enough for blunt trauma (eg, vehicular accidents and baseballs). Further investigation into the physics of trauma on the pediatric facial skeleton may be warranted but difficult to conduct.

Another reason for the higher incidence of pediatric facial fractures is that young golfers have not been taught proper safety techniques, may not be as aware of their surroundings, or are less reactive to fast-moving objects. Children may be observing another golfer and unexpectedly walk into the swing-plane of another player. For example, our findings demonstrate that 31.7% of pediatric patients were injured as a bystander. The higher prevalence of injuries sustained at or in the home likely reflects access to and use of golf equipment in smaller spaces, for non-golf recreational purposes, or with less direct supervision. An increase in incidence in the teen years (Fig. 2) may reflect more teenagers trying out the sport, with associated physical strength as well as higher risk behaviors.

To avoid such injuries in the pediatric age group, kids should be instructed in proper use and technique, and parental supervision of young, inexperienced golfers may help reduce the number of injuries they sustain. Correctly selecting golf equipment and maintaining an awareness of the environmental conditions can contribute to making golf safe and fun.

Compared with adults, children, particularly younger ones, may be more likely to present to an emergency room after an injury because of parental concern, but this alone would not explain the disproportionate representation of the pediatric population in this sample. Moreover, the ratio of male-to-female patients (73.7% male) closely matches the overall demographics of golf players (76.4% male) for both adult and pediatric populations.

Although previous research has characterized head and neck injuries due to golf cart trauma, our study identifies head and facial fractures unrelated to golf carts. Prior research has reported that golf cart injuries have severe consequences, including traumatic brain injury (TBI) or head injury. Miller et al²⁴ demonstrated that children were more vulnerable to face, head, and neck fractures from golf cart injuries, when compared with adults. In a separate NEISS query we conducted on head and face fractures from golf carts, we found that there were 110 cases of craniofacial fractures from golf carts reported to NEISS from 2009 to 2018.

These findings suggest that education, supervision, and use of protective gear may be necessary to reduce golf-related morbidity and hospitalization, especially in the pediatric population. Given the risks associated with trauma to the head and face, pediatric patients and their parents should be adequately counseled on the risk for severe injury. These findings provide valuable insight and identify pediatric patients as the most vulnerable population for head and facial fractures. Providers should be aware that pediatric patients injured playing golf may be more likely to have a facial fracture and require admission.

Face shields and protective head gear may minimize these risks, and may be helpful to mention when counseling junior golfers who are beginner players.

Limitations of this study relate to the NEISS database—only patients who presented to the representative Emergency Departments in the United States are included. Therefore, the NEISS may underestimate the number of golf-related injuries. Patients who seek care in the outpatient setting are not included in the sample. Additionally, there may be injured patients who do not seek care at all. The results may not generalize to other countries, as the NEISS only collects information in the United States. The database is not as comprehensive as actual patient charts, limiting understanding of management (eg, operative vs. nonoperative) and postpresentation course (eg, long-term sequelae). Additionally, other head injuries related to golf (eg, concussions) but not resulting in a facial fracture were not captured.

CONCLUSIONS

Facial fractures resulting from golf clubs and balls may not be as common as in other traditionally identified “high-impact sports,” but they affect pediatric patients disproportionately and with a greater morbidity. Parents and children engaging the sport should be aware of the risk of fracture, especially with any form of off-course participation. To minimize this risk, children should be adequately supervised and instructed in technique and safety when using golf equipment, especially golf clubs.

Stephen M. Lu, MD, MDiv

Division of Plastic and Reconstructive Surgery
Oakland University William Beaumont School of
Medicine/Beaumont Health
3555 W. 13 Mile Rd, Suite N120
Royal Oak, MI 48073
E-mail: Stephen.lu@beaumont.org

REFERENCES

- Matuszewski, E. NGF Issues 2018 Golf Industry Report. The National Golf Foundation. 2018. <https://www.thengfq.com/2018/05/ngf-issues-2018-golf-industry-report>. Accessed December 5, 2019.
- Chorney SR, Sobin L, Goyal P, et al. Maxillofacial injuries among national collegiate athletic association athletes: 2004–2014. *Laryngoscope*. 2017;127:1296–1301.
- Carniol ET, Shaigany K, Svider PF, et al. “Beaned”: a 5-year analysis of baseball-related injuries of the face. *Otolaryngol Head Neck Surg (United States)*. 2015;153:957–961.
- Lawrence LA, Svider PF, Raza SN, et al. Hockey-related facial injuries: a population-based analysis. *Laryngoscope*. 2015;125:589–593.
- Kim SY, Chan CL, Hyam DM. Facial fractures in football: incidence, site, and mechanism of injury. *Br J Oral Maxillofac Surg*. 2016;54:936–940.
- Bak MJ, Doerr TD. Craniomaxillofacial fractures during recreational baseball and softball. *J Oral Maxillofac Surg*. 2004;62:1209–1212.
- U.S. Consumer Product Safety Commission. *NEISS Data Highlights: National Electronic Injury Surveillance System*. 2018. <https://www.cpsc.gov/Research-Statistics/NEISS-Injury-Data>. Accessed September 7, 2020.
- Zouzias IC, Hendra J, Stodelle J, et al. Golf injuries: epidemiology, pathophysiology, and treatment. *J Am Acad Orthop Surg*. 2018;26:116–123.
- Gosheger G, Liem D, Ludwig K, et al. Injuries and overuse syndromes in golf. *Am J Sports Med*. 2003;31:438–443.
- Imahara SD, Hopper RA, Wang J, et al. Patterns and outcomes of pediatric facial fractures in the United States: a survey of the national trauma data bank. *J Am Coll Surg*. 2008;207:710–716.
- Wheeler J, Phillips J. Pediatric facial fractures and potential long-term growth disturbances. *Craniomaxillofac Trauma Reconstr*. 2011;4:43–52.
- Eggensperger Wymann NM, Hölzle A, Zachariou Z, et al. Pediatric craniofacial trauma. *J Oral Maxillofac Surg*. 2008;66:58–64.
- Koch BL. Pediatric considerations in craniofacial trauma. *Neuroimaging Clin N Am*. 2014;24:513–529, viii.
- Owusu JA, Bellile E, Moyer JS, et al. Patterns of pediatric mandible fractures in the United States. *JAMA Facial Plast Surg*. 2016;18:37–41.
- Merikli AF, DeCesare GE, Zuckerbraun NS, et al. Pediatric craniofacial fractures due to violence: comparing violent and nonviolent mechanisms of injury. *J Craniofac Surg*. 2011;22:1342–1347.
- Maqusi S, Morris DE, Patel PK, et al. Complications of pediatric facial fractures. *J Craniofac Surg*. 2012;23:1023–1027.
- Chandra SR, Zemplenyi KS. Issues in pediatric craniofacial trauma. *Facial Plast Surg Clin North Am*. 2017;25:581–591.
- Boyette JR. Facial fractures in children. *Otolaryngol Clin North Am*. 2014;47:747–761.
- Svider PF, Bobian M, Hojjat H, et al. A chilling reminder: pediatric facial trauma from recreational winter activities. *Int J Pediatr Otorhinolaryngol*. 2016;87:78–82.
- Guys NP, Mir A, Svider PF, et al. Wet and wounded: pediatric facial trauma from swimming and diving. *Int J Pediatr Otorhinolaryngol*. 2018;111:153–157.
- Lawson BR, Comstock RD, Smith GA. Baseball-related injuries to children treated in hospital emergency departments in the United States, 1994–2006. *Pediatrics*. 2009;123:e1028–e1034.
- Shields BJ, Smith GA. Cheerleading-related injuries to children 5 to 18 years of age: United States, 1990–2002. *Pediatrics*. 2006;117:122–129.
- Singh S, Smith GA, Fields SK, et al. Gymnastics-related injuries to children treated in emergency departments in the United States, 1990–2005. *Pediatrics*. 2008;121:e954–e960.
- Miller B, Yelverton E, Monico J, et al. Pediatric head and neck injuries due to golf cart trauma. *Int J Pediatr Otorhinolaryngol*. 2016;88:38–41.