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Original article

Etiology of orbital fractures at a level I trauma center in a large metropolitan city[☆]Elizabeth Chiang^{a, *}, Lily V. Saadat^b, Jared A. Spitz^b, Paul J. Bryar^b, Christopher B. Chambers^c^a Department of Ophthalmology, Medical College of Wisconsin, Milwaukee, WI, USA^b Department of Ophthalmology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA^c Department of Ophthalmology, University of Washington School of Medicine, Seattle, WA, USA

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ABSTRACT

Background/Purpose: Orbital fractures are a common facial fracture managed by multiple surgical specialties. **Methods:** A retrospective review of the electronic medical records of patients (age, 18–85 years) presenting to Northwestern Memorial Hospital and Northwestern Medical Faculty Foundation in Chicago, IL, USA with International Classification of Diseases, Ninth Revision codes for facial fractures or CPT (Current Procedural Terminology) codes for orbital fracture repair.

Results: A review of the electronic medical records identified 504 individual incidents of orbital fractures with available imaging for review. The most common location for an orbital fracture was a floor fracture (48.0%) followed by a medial wall fracture (25.2%). Left-sided orbital fractures were statistically significantly more common than right-sided orbital fractures (99% confidence interval). Orbital fractures were more prevalent in younger age groups. The mean patient age was 39.3 years. The most common cause of all orbital fractures was assault followed by falls. However, falls were the most common cause of orbital fractures in women and in patients aged 50 years and older. Evaluation by an ophthalmologist occurred in 62.8% of orbital fracture patients, and evaluation by a team comprising the facial trauma service (Otolaryngology, Plastic Surgery, and Oral and Maxillofacial Surgery) occurred in 81.9% of orbital fracture patients. **Conclusion:** Assault was the largest cause of all orbital fractures, and occurred most commonly in young males. Assaulted patients were more likely to have left-sided fractures compared to nonassaulted patients. In patients aged 50 years and older, falls were the most common cause of orbital fractures.

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1. Introduction

In the United States, trauma to the eye and surrounding region accounts for approximately 3% of emergency department visits.¹ These facial injuries have been most commonly associated with assault, motor vehicle accidents, sports, and falls.^{2–4}

Understanding the cause, severity, and type of facial fracture can help guide effective prevention of these injuries.⁵ The epidemiology of orbital fractures is constantly evolving, and a periodic review of these fractures and their causes can provide valuable clinical information.⁶ The goal of this study is to evaluate the most common type of orbital fracture, associated facial trauma, etiology, sequelae, and management in patients presenting with orbital fractures at Northwestern Memorial Hospital (NMH), Chicago, IL, USA.

Conflicts of interest: The authors have no financial or conflicts of interest to disclose.

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2. Methods

The Enterprise Database Warehouse was used to abstract patient records from NMH and Northwestern Medical Faculty Foundation electronic medical records (EMRs) using the International Classification of Diseases, Ninth Revision (ICD-9) codes for facial fractures and CPT (Current Procedural Terminology) codes for

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orbital fracture repair for patients 18–85 years of age between January 1, 2001 and October 15, 2012.

The first section of the study reviewed the imaging reports for all 1025 patients with available imaging. Information collected from imaging reports included type of imaging studies performed, location of orbital fracture, and whether the orbital fracture was chronic or acute. Determination of an acute fracture or a chronic fracture was made by the radiologist.

Of the group with radiographic evidence of orbital fractures, 412 patients were identified as having computed tomography (CT) imaging identifying an acute fracture as well as medical records that included documentation of examination available for review. Two patients had two independent incidents with acute orbital fractures resulting in 414 individual incidents of orbital fractures. The medical records of these patients were reviewed for their age, race, mechanism of injury, time between injury and presentation to medical care, symptoms, and examination findings. Information regarding the location where the patient sought medical care, the specialties of physicians that evaluated the patient, the number of evaluations by each specialty, and whether surgery was performed were recorded. Different departments incorporated use of the EMR system for outpatient documentation at different periods in the study. Because each department had a variation in the availability of outpatient notes, analysis was scaled for each department accordingly. Data were analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) with Binomial Distribution testing.

3. Results

3.1. Location of fractures

Imaging for 1025 patients with ICD-9 codes for facial fractures was reviewed to determine the presence and location of facial

fractures, of which almost half (504) were found to have orbital fractures. Of patients with imaging, 49% of patients had orbital fractures, 32% had other facial fractures without an orbital fracture, and 19% had no facial fracture found on the imaging obtained.

Of patients with a verified orbital fracture on radiologic imaging, both acute and chronic, 72% were male and 28% were female. Orbital fractures occurred in conjunction with other facial fractures in 65.9% (332) of patients. In these patients with combined facial/orbital fracture(s), 59% (195) had multiple orbital walls fractured compared to 41% (137) who had a single orbital wall fractured. Of the 172 patients with a radiologically verified orbital fracture with no additional facial fractures, 67% (116) had a fracture isolated to a single orbital wall and 33% (56) had fractures of multiple walls (Figure 1).

In patients with acute orbital fractures, left-sided orbital fractures were statistically significantly more common than right-sided orbital fractures [99% confidence interval (CI)]. Orbital floor fractures were the most common type of fracture, and accounted for 47.9% (371) of all orbital fractures. The incidence of medial wall fractures was 25.2% (195), lateral wall fractures 18.6% (144), and roof fractures 8.2% (63). When reviewing the location of isolated orbital fractures, 70.0% (77) were floor fractures, 21.8% (24) were medial wall fractures, 3.6% (4) were lateral wall fractures, and 4.5% (5) were roof fractures.

Orbital fractures may be associated not only with muscle entrapment but also globe injury. The incidence of an extraocular muscle located inside or below the fracture site was 13%. There were two patients with globe ruptures noted on imaging, both of whom had multiple facial fractures.

3.2. Demographics

Orbital fractures were most common in young adults, and the prevalence of orbital fractures decreased with each decade of age.

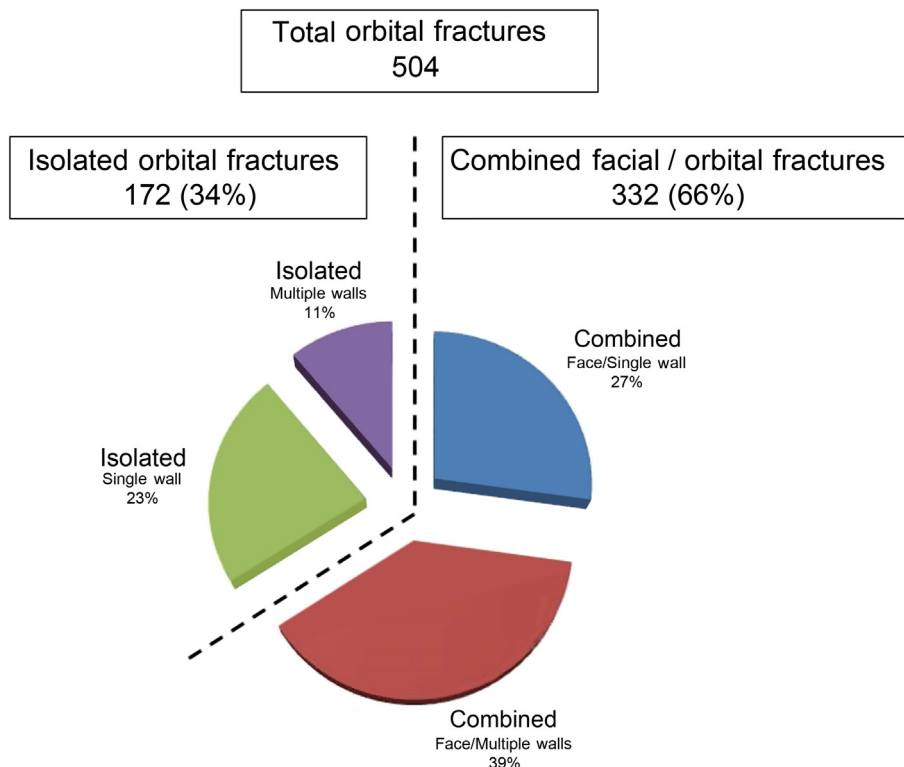


Figure 1. Pie chart showing the distribution of orbital fractures. The chart delineates isolated orbital fractures from orbital fractures occurring with facial fractures and shows the division between fractures involving a single wall to those involving multiple walls.

Of the 412 patients, 31.6% were 20–29 years of age; 23.3% were 30–39 years of age, 14.3% were 40–49 years of age, 10.2% were 50–59 years of age, 9.5% were 60–69 years of age, and 5.1% were 70–79 years of age. The mean patient age was 39.3 years.

Our study showed that the most common racial group for orbital fractures was Caucasian (56.0%), followed by African-American (23.0%), Hispanic (7.7%), and Asian (4.6%). A minority of patients was identified as Native American (0.5%) or indicated some other race (0.5%). No race was indicated in 7.7% of cases.

In all racial groups, the most common location for an orbital fracture was a left-side floor fracture. In Caucasians, there were 87 incidents of right-sided floor fractures compared to 111 left-sided floor fractures, which is statistically significantly different than an equal incidence of right- and left-sided floor fractures (95% CI). In African-Americans, there were 30 right and 52 left orbital floor fractures, which was statistically significant for more left-sided fractures compared to an equal distribution (99% CI). This trend was also seen in Hispanic and Asian populations, but likely because of the small sample size, it was not statistically significant.

3.3. Etiology

The most common cause of all orbital fractures was assault, which was responsible for 38.6% (160) of all fractures. Falls were the second most common cause of fractures, accounting for 25.6% of fractures with 106 incidents. Of the falls, 32% were from a height higher than standing and 68% were falls from standing height. Sports injury was the third most common cause of orbital fracture (69, 16.7%).

The fourth most common cause of orbital fractures involved motor vehicle collisions, which included passengers within the vehicle as well as pedestrians and bicyclists hit by a motor vehicle. Overall, motor vehicle collisions accounted for 13.3% (55) of orbital fractures. Motor vehicle collisions where the patient was a passenger in the motor vehicle caused 6% (25) of fractures, whereas motorcycle or motorized bike collisions accounted for 1.4% (6) of fractures. There were 18 incidents where a pedestrian was hit by a motor vehicle, six incidents where a bicyclist was hit by a motor vehicle, and two incidents where the pedestrians were hit by a bicycle.

The cause of orbital fractures varied by the age of the patient. Table 1 outlines the most common causes of orbital fractures by age cohorts by decade. Assault was the most common cause of orbital fractures in patients younger than 50 years, with sports injury being the second most common cause in this age group. By contrast, falls were the most common cause of orbital fractures in older patients (patients aged 50 years and older), whereas the second most common cause was either sports injury or assault. Additionally, of the 28 orbital fractures caused by falls in patients aged 70–85 years, 24 (85.7%) were from a fall from standing height and only four (14.3%) were from a fall from higher than standing height.

Table 1
Etiology of orbital fractures by age group.

Age range (y)	Most common cause	Second most common cause
20–29	Assault, 61 (46.9)	Sports injury, 22 (16.9)
30–39	Assault, 35 (36.5)	Sports injury, 24 (25.0)
40–49	Assault, 30 (50.6)	Sports injury, 10 (16.9)
50–59	Falls, 19 (45.2)	Assault, 12 (28.6)
60–69	Falls, 24 (61.5)	Sports injury, 6 (15.4)
70–79	Falls, 16 (76.2)	Assault, 3 (14.3)
80–85	Falls, 12 (100)	

Data are presented as n (%).

The cause of orbital fracture differed substantially by sex, where assault was the most common cause in men and falls were the most common cause in women. Assault accounted for 47.7% (144) of orbital fractures in men, followed by falls (56, 18.5%) and sports injuries (55, 18.2%). Falls were the most common cause for orbital fracture in women (49, 45.8%) followed by motor vehicle collision (23, 20.5%) and assault (19, 17.0%). Falls causing an orbital fracture in men were much more likely to be from higher than standing height (46.4%) compared to women (14.3%).

A variety of sports injuries caused 69 orbital fractures in this study. The most common cause of orbital fractures was bicycling (24, 34.8%), followed by softball (9, 13.0%) and baseball (7, 10.1%). See Table 2 for a full list of sports injuries.

In patients who were assaulted, 61.9% had left-sided fractures, 32.5% had right-sided fractures, and 5.6% had bilateral fractures. The larger number of left-sided fractures compared to right-sided fractures is statistically significant (95% CI). In patients where assault was not the cause of the fracture, 42.6% had right-sided fractures, 46.5% had left-sided fractures, and 11.0% had bilateral fractures. This suggests that individuals who are assaulted are much more likely to have left-sided fractures compared to those who had an orbital fracture by a different mechanism of injury.

3.4. Entrapment and diplopia

Entrapment is a clinical diagnosis that is made by examination of eye movements, the clinical presence of diplopia, and/or a positive forced duction test. Imaging can be helpful for the clinician to evaluate for entrapment. Radiographic suggestion of entrapment occurred in 20% of patients, which was more common than diplopia or restriction of eye movements on examination. Of 414 individual incidents analyzed, 13% (52) of orbital fractures showed radiographic suggestion of entrapment, and an additional 7% (30) had possible entrapment indicated by fat but not muscle herniating in the defect or deviation of muscle toward but not through the fracture. Suggestion of entrapment or possible entrapment was noted in 18.2% (26) of the 18–29 years age group, 18.8% (18) of the 30–39 years age group, 28.8% (17) of the 40–49 years age group, 14.3% (6) of the 50–59 years age group, 15.4% (6) of the 60–69 years age group, and 6.1% (2) in the 70–85 years age group.

Restriction of eye movements was documented in 17% of patients, and diplopia was reported in 13% of patients. Seventy percent of patients (288) reported no diplopia, 13% (56) of patients

Table 2
Orbital fractures caused by sports injuries.

Sport	No. of fractures associated	%
Biking	24	34.8
Softball	9	13.0
Baseball	7	10.1
Basketball	4	5.8
Hockey	4	5.8
American football	3	4.3
Soccer	3	4.3
Martial arts	2	2.9
Rugby	2	2.9
Skiing	2	2.9
Boomerang	1	1.4
Boxing	1	1.4
Cage fighting	1	1.4
Dancing	1	1.4
Dodgeball	1	1.4
Frisbee	1	1.4
Racketball	1	1.4
Tubing	1	1.4
Ultimate fighting	1	1.4

reported diplopia, and 17% (69) of patient charts did not document the presence or absence of diplopia.

Few patients had all three findings of diplopia, restriction of eye movements, and radiographic suggestion of entrapment. Many patients had either one or two of these findings. Of 56 patients with subjective diplopia, 30% (17) had suggestion of entrapment on CT scan and 9% (5) of patients had possible entrapment. Of 72 patients with restriction of extraocular movements on examination, 33% (24) had evidence of entrapment on CT scan, and 6% (4) had possible entrapment. Fourteen patients had all three findings of diplopia, restriction of eye movements, and radiographic evidence of entrapment.

3.5. Association of alcohol and illicit drugs

Alcohol and illicit drug use may predispose patients to being involved in assault or a motor vehicle collision that could cause an orbital fracture. Some falls could also be caused by alcohol intoxication. Although most patients did not undergo testing for blood alcohol levels, many charts documented confirmed or suspected alcohol use. Likely intoxication with alcohol was noted in 25.4% (105) of events causing the fracture. Of those patients where alcohol was involved, assault was the cause of 60% of fractures, falls were the cause of 21.0% of fractures, and motor vehicle collisions were the cause of 10.5% of fractures. Illicit drug use was noted in 3.1% (14) of incidents, and both alcohol and illicit drug use were noted in 0.7% (3) of incidents. Intoxication with drugs and/or alcohol at the time of fracture was most common in the 18–29 years age group and occurred in 39.2% of these patients.

3.6. Evaluation

Most patients with orbital fractures initially sought medical attention in the emergency room, although a small number of patients saw their primary care physician, ophthalmologist, or otolaryngologist. The location where the patient initially sought medical attention was indicated in 401 cases. Most patients sought medical attention at Northwestern's Emergency Department (364, 90.8%), and an additional 17 patients underwent evaluation at an outside hospital emergency department. A few patients initially presented to their primary care doctor (13, 3.2%). There were five patients who presented directly to the Ophthalmology clinic, and one patient who presented to the Otolaryngology clinic. In 13 cases, the primary location of where the patient first presented was outside of Northwestern and could not be determined.

Most patients sought medical evaluation within 2 days after the initial injury, although some patients delayed medical attention. The time from injury to when the patient first sought medical evaluation was indicated in 387 incidents of facial injury. The vast majority of patients (319, 82.4%) presented within 1 day of facial injury. Patients who waited until the day after the injury occurred to seek medical attention accounted for 11.9% (46). Within 1 week of injury, 98.7% (382) of patients had been evaluated. The longest period a patient waited after injury prior to finally seeking medical attention was 3 weeks.

Trauma that causes orbital fractures can affect the eye itself. Thus, many patients with orbital fractures are evaluated by an ophthalmologist in the emergency department, after admission to the hospital, or in an outpatient clinic. Ophthalmology evaluated 57.0% (236) of the 414 incidents of orbital fractures in this study, as evidenced by at least one note from the Ophthalmology service. Of the 236 incidents, Ophthalmology was the only specialty to evaluate the patient in 18.6% (44) of cases. The facial trauma service evaluated 81.4% of patients that Ophthalmology evaluated. There were 7.5% (31) of patients who were not evaluated by

Ophthalmology or the specialties that comprise the facial trauma service. The facial trauma call is covered by Otolaryngology (ENT), Plastic Surgery, and Oral and Maxillofacial Surgery (OMFS) departments.

There were 333 incidents of orbital fractures from the time the Ophthalmology outpatient clinic started using EMR in 2008. Of the 333 instances of orbital fracture, the Ophthalmology service evaluated 62.8% (209) of patients. The location of where the patient was first evaluated by Ophthalmology appears in Table 3. The average number of ophthalmology examinations for all patients who saw an ophthalmologist was 2.4 visits, with 58.4% of patients evaluated only once by an ophthalmologist at Northwestern. Ophthalmology performed surgical repair on eight patients, six of whom had EMR records with an average of 10.2 evaluations by Ophthalmology.

The services that take facial trauma calls are consulted to evaluate and repair orbital fractures that present to the emergency department. One of the services that take facial trauma call evaluated 81.9% of incidents of orbital fractures in this study. In some incidents, patients were evaluated by both Plastic Surgery and ENT, ENT, and OMFS, or Plastic Surgery and OMFS. No patients were evaluated by all three of the services comprising the facial trauma service.

Of the services taking facial trauma call, ENT evaluated the most number of orbital fractures. Of the 414 incidents of orbital fracture, ENT evaluated 42.0% (174). Patients had an average of 2.9 evaluations by ENT, with 42.0% of patients having only one evaluation by ENT. The ENT service performed surgical repair on 41 incidents of orbital fractures, accounting for 23.6% of patients they evaluated with an orbital fracture. Patients who underwent surgical repair had an average of 5.5 visits.

Although the Plastic Surgery service saw fewer orbital fractures than the ENT service, they performed a larger number of orbital fracture repairs. Plastic Surgery evaluated 27.3% (79) of the 289 incidents of orbital fractures occurring after the use of EMR. Overall, patients averaged 3.3 visits to Plastic Surgery with 25.3% of patients having only one evaluation by the Plastic Surgery Service. Plastic Surgery performed surgical repair on 53 orbital fractures, or 67.1% of the fracture patients they evaluated. Of the 25 patients who underwent surgical repair after Plastic Surgery joined the EMR system, there was an average of 5.7 visits to Plastic Surgery.

The OMFS service evaluated 12.5% (52) of the 414 incidents of orbital fractures. OMFS Outpatient clinic notes were not available for review. OMFS saw 78.8% of patients in the emergency department and 21.2% of patients in the hospital with a range of 1–5 evaluations during the patient's hospital admission. OMFS repaired 11 orbital fractures, or 21.1% of the fracture patients they evaluated.

For all services, the average number of evaluations was lowest in patients first evaluated in outpatient clinics. Patients who were first evaluated in the hospital had the most number of follow-up evaluations on average. Many patients seen in the emergency department did not return for follow-up at Northwestern.

4. Discussion

Orbital fractures are relatively common injuries and may occur in isolation or combined with other facial fractures. Epidemiological surveys can help determine prevention strategies and patient management.⁶ This study provides a current demographic and management assessment of a large series of orbital fracture patients evaluated at a Level 1 trauma center in an urban setting. In comparing the results presented here with other studies, it is important to consider that differences in study population, geographic location, local demographics, and social behaviors can impact the epidemiology of a particular illness or injury.^{2,4}

Table 3
Location of evaluation of patients and average number of examinations by service.

	Ophthalmology	ENT	Plastic surgery	OMFS
Evaluated by service	62.8	42.0	23.7	12.5
ED	59.3	52.3	70.9	78.8
Inpatient	15.3	8.6	16.5	21.2
Outpatient	25.4	39.1	12.7	No data
Average no. of examinations	2.4	2.9	3.3	
ED	2.5 (1–17)	3.1 (1–11)	2.9 (1–13)	
Inpatient	3.0 (1–20)	4.7 (1–10)	5.0 (1–22)	
Outpatient	1.7 (1–7)	2.2 (1–15)	2.9 (1–10)	
% of evaluated fractures repaired	3.8	23.6	67.1	21.2

Data are presented as % or *n* (range), unless otherwise indicated.

ED = Emergency Department; ENT = Otolaryngology; OMFS = Oral and Maxillofacial Surgery.

The male/female ratio in our patient population was 2.5:1. This differs from a 4:1 male/female ratio reported by some studies in Europe, but a similar ratio to studies in the United States.^{3,7–11} As in previous literature, the young male population makes up the highest orbital fracture risk group.^{2,3,12,13}

Previously published studies on the epidemiology of facial fractures have reported the main causes of facial fractures as motor vehicle accidents, followed by assaults, falls, and sports injuries.^{7,13} However, more recent studies have suggested that assaults now surpassed motor vehicle accidents as the top cause of facial fractures.^{2–6,8,12} Our study supports assault as the most frequent cause of orbital fractures, followed by falls and sports injuries. This suggests that violence prevention programs may help decrease the frequency and the morbidity associated with facial trauma.

Men were much more likely to have an orbital fracture due to assault compared to women. Whereas assault was the most common cause of an orbital fracture in men, falls were the most common cause in women. Falls were still a significant cause of orbital fracture in men, accounting for the second most common cause of orbital fracture. Falls were a large cause of orbital fractures in the elderly. Preventing falls in older populations may decrease the incidence of facial fractures, as well as potentially other fractures such as hip fractures, which are associated with high morbidity in this population group.¹⁴

Our study showed that the most common racial group for orbital fractures were Caucasians (56.0%), followed by African-Americans (23.0%), Hispanics (7.7%), and Asians (4.6%). This distribution differs from the 2010 census of racial makeup of Chicago, which reported 31.7% white, 32.4% Black or African American, 28.9% Hispanic or Latino, and 5.4% Asian.¹⁵ The distribution of the area code 60611 where Northwestern Memorial Hospital is located is 74.6% white, 4.2% Black or African American, 4.9% Hispanic or Latino, and 14.2% Asian.

Overall, our study found that left orbital fractures were more common than right orbital fractures. This corresponds with studies by Chi et al,¹² but the side of fracture was not analyzed in the other studies reviewed. Individuals who are assaulted are much more likely to have left-sided fractures compared to those who had an orbital fracture by a different mechanism of injury. Assaulted patients had 61.9% left-sided fractures compared to 32.5% right-sided fractures. Patients where assault was not the cause of fracture had 46.5% left-sided fractures compared to 42.6% right-sided fractures. We hypothesize that the increased probability of left-sided fractures with assaults may be attributable to the higher prevalence of right-handedness in the human population.¹⁶ A right-handed assailant is more likely to strike the victim's left orbit.

The most common location for every service to evaluate the patient was in the emergency room. Of the services taking facial trauma call, ENT evaluated the highest number of orbital fractures, but Plastic Surgery performed the most number of orbital fracture

repairs. The Plastic Surgery service operated on 67.1% of orbital fractures evaluated, ENT operated on 23.6% of fractures evaluated, and OMFS operated on 21.2% of fractures evaluated. Ophthalmology operated on 1.8% of fractures evaluated, but many patients who were evaluated by Ophthalmology had their fracture repaired by the service taking facial trauma call at the time of patient presentation. As the Ophthalmology service does not take facial trauma calls at Northwestern, the service is much less likely to operate on orbital fractures.

The analysis of evaluation by the different services was limited to the availability of notes in the EMR. Despite these limitations, this is the first report of the management of orbital fractures by number of evaluations in different clinical settings and by different services.

In conclusion, two-thirds of all orbital fractures are associated with a nonorbit facial fracture; one-third involves only the orbit. The orbital floor is the most common site for orbital fractures. Orbital fractures were most likely caused by assault for patients younger than 50 years and most likely caused by falls in patients aged 50 years or older. Orbital fractures caused by assault were more likely to be left-sided than fractures caused by another etiology. An understanding of the current trends in etiology, demographics, and clinical findings of orbital fractures will help guide clinicians in efforts of prevention, assessment, and treatment.

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References

- Bord SP, Linden J. Trauma to the globe and orbit. *Emerg Med Clin North Am.* 2008;26:97–123.
- Kontio R, Suuronen R, Ponkkinen H, Lindqvist C, Laine P. Have the causes of maxillofacial fractures changed over the last 16 years in Finland? An epidemiological study of 725 fractures. *Dent Traumatol.* 2005;21:14–19.
- Tong L, Bauer RJ, Buchman SR. A current 10-year retrospective survey of 199 surgically treated orbital floor fractures in a nonurban tertiary care center. *Plast Reconstr Surg.* 2001;108:612–621.
- Shere JL, Boole JR, Holtel MR, Amoroso PJ. An analysis of 3599 midfacial and 1141 orbital blowout fractures among 4426 United States Army Soldiers, 1980–2000. *Otolaryngol Head Neck Surg.* 2004;130:164–170.
- Eski M, Sahin I, Deveci M, et al. A retrospective analysis of 101 zygomatico-orbital fractures. *J Craniofac Surg.* 2006;17:1059–1064.
- Hwang K, You SH, Sohn IA. Analysis of orbital bone fractures: a 12-year study of 391 patients. *J Craniofac Surg.* 2009;20:1218–1223.
- Ellis 3rd E, El-Attar A, Moos KF. An analysis of 2,067 cases of zygomatico-orbital fracture. *J Oral Maxillofac Surg.* 1985;43:417–428.
- Gosau M, Schöneich M, Draenert FG, et al. Retrospective analysis of orbital floor fractures—complications, outcome, and review of literature. *Clin Oral Investig.* 2011;15:305–313.
- Rosado P, de Vicente JC. Retrospective analysis of 314 orbital fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012;113:168–171.
- Hartzell KN, Botek AA, Goldberg SH. Orbital fractures in women due to sexual assault and domestic violence. *Ophthalmology.* 1996;103:953–957.

11. Ko MJ, Morris CK, Kim JW, Lad SP, Arrigo RT, Lad EM. Orbital fractures: national inpatient trends and complications. *Ophthal Plast Reconstr Surg*. 2013;29:298–303.
12. Chi MJ, Ku M, Shin KH, et al. An analysis of 733 surgically treated blowout fractures. *Ophthalmologica*. 2010;224:167–175.
13. Read RW, Sires BS. Association between orbital fracture location and ocular injury: a retrospective study. *J Craniomaxillofac Trauma*. 1998;4:10–15.
14. Nazrun AS, Tzar MN, Mokhtar SA, Mohamed IN. A systematic review of the outcomes of osteoporotic fracture patients after hospital discharge: morbidity, subsequent fractures, and mortality. *Ther Clin Risk Manag*. 2014;10:937–948.
15. U.S. Bureau of Census 2010. Available at: http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml. [Accessed June 10, 2014].
16. Raymond M, Pontier D. Is there geographical variation in human handedness? *Laterality*. 2004;9:35–951.