Pediatric Golf-Related Ophthalmic Injuries

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Objectives: To document ophthalmic morbidity of golf-related injuries in children and to report specific injury patterns.

Design: A noncomparative, interventional, retrospective case series of 11 pediatric patients treated at 2 institutions for ophthalmic trauma resulting from golf-related injuries during 15 years.

Results: Eleven eyes of 11 patients were injured. There were 6 boys and 5 girls, with a mean age of 10.2 years (age range, 7-14 years). Ten patients were injured by golf clubs and 1 patient by a golf ball. One injury occurred on a golf course. At the initial ophthalmic examination, visual acuity was 20/20 in 4 eyes (36%), 20/25 to 20/80 in 3 eyes (27%), no light perception in 3 eyes (27%), and undeterminable in 1 eye (9%). Nine of 11 patients required surgery. Follow-up ranged from 0 to 66 months (mean follow-up, 12 months). Three of 11 subjects had permanent deficits, including blindness, decreased vision, and anophthalmia. Final visual acuity was no light perception in 2 eyes (18%), 20/70 in 1 eye (9%), and 20/20 or better in 8 eyes (73%).

Conclusions: The findings from this series reveal that pediatric ophthalmic golf injuries, although rare, may be devastating to the eye, periocular adnexa, and visual system. Among our cases, most injuries occurred off the golf course, many required surgery, and some resulted in permanent loss of vision.

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A report by the US National Research Council describes injury as the "most underrecognized health problem facing the nation." The National Society to Prevent Blindness estimates that 900,000 patients in the United States are visually impaired secondary to trauma, with 79% of these patients having monocular blindness. Although sports-related injuries account for only a small percentage of ophthalmic trauma, they are often more severe and visually devastating than other eye injuries. In fact, among all traumatic injuries resulting in enucleation, sports-specific cases account for 16%, surpassing motor vehicle crashes, occupational accidents, violent attacks, and gunshot wounds. Forty-two thousand patients per year in the United States are treated for eye injuries from sports-related trauma, and recent data indicate that this number is increasing.

Golf is rarely reported as a cause of ophthalmic trauma. Golf has been estimated to be responsible for 1.5% to 5.6% of ocular injuries from sports. Although previous reports have described various ophthalmic injuries occurring from golf-related trauma, we found no series describing pediatric-specific golf-associated ophthalmic injuries in the MEDLINE-indexed literature. In this series, our objectives are to document ophthalmic morbidity of golf-related injuries in children and to report specific injury patterns. Identification of injury patterns may facilitate determination of effective preventive measures and elevation of public awareness of the issue.

METHODS

The medical records of all patients with ophthalmic trauma caused by golf-related injuries during 15 years (January 1992 to March 2007) in our practices at 2 institutions were reviewed. Inclusion criteria required ophthalmic injury resulting from golf clubs or golf balls and patient age younger than 18 years. Patient demographics were analyzed, including age, sex, location of trauma, periocular injuries, mechanism of injury, initial and final visual acuities, surgical interventions (if any), and final outcomes. Diagnostic studies were reviewed when available, including computed tomography, magnetic resonance imaging, orbital ultrasonography, and automated perimetry. The study was performed under institutional review board approval (Colorado Multiple Institutional Review Board protocol 04-047).

RESULTS

As summarized in the Table, 11 eyes of 11 pediatric patients were injured by golf-associated trauma. None of the patients had preexisting ophthalmic pathologic conditions or a history of trauma. There were 6
boys and 5 girls, with a mean age of 10.2 years (age range, 7-14 years). Ten patients (91%) were injured by golf clubs and 1 patient (9%) by a golf ball. One injury (9%) occurred on a golf course. At the initial examination, visual acuity was 20/20 in 4 eyes (36%), 20/25 to 20/80 in 3 eyes (27%), no light perception (NLP) in 3 eyes (27%), and undeterminable in 1 eye (9%) because of altered mental status. Injuries included orbital fracture (11 eyes [100%]), hyphema (4 eyes [36%]), traumatic optic neuropathy (3 eyes [27%]), and iridodialysis, ruptured open globe, optic nerve avulsion, retrobulbar hemorrhage, macular chorioretinal scar, and zygomaticomaxillary complex fracture in 1 eye (9%) each. Final visual acuity was NLP in 2 eyes (18%), 20/70 in 1 eye (9%), and 20/20 or better in 8 eyes (73%). Nine of 11 patients (82%) required surgery. Follow-up ranged from 0 to 66 months (mean follow-up, 12 months). Two of 11 cases are described in further detail for illustrative purposes.

### REPORT OF CASES

#### PATIENT 1

An 11-year-old girl was struck on the right side of her face by a golf club at school (patient 1 in the Table). She had immediate loss of vision, ocular pain, and facial bleeding. The findings at the initial ophthalmic examination revealed visual acuity of NLP OD and 20/30 OS. The right eye demonstrated traumatic mydriasis and a relative afferent pupillary defect. Motility of the right eye was severely limited. Penlight examination results revealed right

### Table. Cases of Pediatric Golf-Related Ophthalmic Injuries

<table>
<thead>
<tr>
<th>Patient, No./ Sex/Age, y</th>
<th>Mechanism of Injury</th>
<th>Eye</th>
<th>Site of Injury</th>
<th>Visual Acuity</th>
<th>Injuries</th>
<th>Interventions</th>
<th>Follow-up, mo</th>
</tr>
</thead>
</table>
| 1/F/11 Golf club | Right | School | NLP | 20/70 | Retrobulbar hemorrhage with compartment syndrome, traumatic optic neuropathy, medial orbital fracture, hyphema, nasal fracture, iridodialysis, and chorioretinal scar
| | | | | | Anterior orbitotomy and orbital decompression, optic nerve sheath fenestration, medial canthoplasty, and spinal dose of methylprednisolone acetate | 27 |
| 2/F/8 | Golf club | Left | Unknown | 20/20 | 20/20 | Superior orbital fracture, ptosis, and eyelid laceration | Eyelid laceration repair | 1 |
| 3/M/14 | Golf club | Left | Home | 20/20 | 20/15 | Orbital floor, medial wall, and rim fracture; and canalicular laceration
| | | | | | Orbital floor repair, and nasolacrimal system intubation | 1 |
| 4/M/12 | Golf ball | Right | Golf course | NLP | NLP | Ruptured open globe, orbital floor and ZMC fractures, epiphthalmos, pterygium, transient infraorbital nerve paresis, and pain, painful eye
| | | | | | Open-globe repair, enucleation, and ZMC and orbital floor repair | 12 |
| 5/F/11 | Golf club | Left | Home | 20/80 | 20/20 | Eyelid laceration, orbital floor and medial wall fracture, inferior rectus entrapment, transient infraorbital nerve paresis, hyphema, commotio retinae, and transiently elevated intraocular pressure
| | | | | | Eyelid laceration repair, orbital floor repair, and temporary glaucoma drops | 66 |
| 6/M/7 | Golf club | Left | Home | 20/40 | 20/15 | Eyelid laceration, canalicular laceration, orbital floor fracture, and hyphema
| | | | | | Eyelid laceration repair and orbital floor repair | 7 |
| 7/F/12 | Golf club | Right | School | NLP | NLP | Facial fractures; nasal-orbitoethmoid, orbital floor, and orbital rim fracture; optic nerve avulsion; traumatic optic neuropathy; eyebrow laceration; traumatic cataract; right hypertropia; hyphema; and iris sphincter tear
| | | | | | Orbital floor and rim repair, epiphthalmos repair, superior rectus recession, and scleral shell | 15 |
| 8/M/11 | Golf club | Left | Home | 20/20 | 20/20 | Orbital floor fracture
| | | | | | None | 0 |
| 9/M/7 | Golf club | Left | Unknown | 20/20 | 20/20 | Superior orbital fracture
| | | | | | Lost to follow-up | 0 |
| 10/M/10M | Golf club | Left | Home | Undeterminable | 20/20 | Superior orbital fracture and traumatic brain injury
| | | | | | Superior orbital fracture repair | 1 |
| 11/F/10 | Golf club | Left | Home | 20/25 | 20/20 | Orbital floor fracture with inferior rectus entrapment and eyelid laceration
| | | | | | Orbital floor repair and eyelid laceration repair | 2 |

Abbreviations: NLP, no light perception; ZMC, zygomaticomaxillary complex.
eyebrow edema and ecchymosis, right medial canthal lacerations, and a small hyphema. Orbital computed tomography revealed a right sphenoid, right nasal, and right medial wall fracture with an abnormal optic nerve and retrobulbar hematoma. She underwent emergent orbital decompression via medial orbitotomy with optic nerve sheath fenestration and repair of her lacerations. For suspected traumatic optic neuropathy, the patient was given intravenous methylprednisolone acetate (30 mg/kg once and then 15 mg/kg every 6 hours for 48 hours). On postoperative day 1, magnetic resonance imaging of the orbits demonstrated an intact optic nerve. On postoperative day 2, she underwent repair of her nasal fracture, and dilated funduscopic examination under anesthesia revealed a normal nerve and fundus. Visual acuity improved to 20/70 OD, and automated perimetry results obtained 5 months after the accident revealed inferonasal field loss.

**PATIENT 7**

A 12-year-old girl was struck by a golf club swung by another child at school, hitting her on the right side of her face (patient 7 in the Table). Findings from an ophthalmic examination demonstrated visual acuity of NLP OD and 20/30 OS. The right pupil was fixed at 8 mm with a severe relative afferent pupillary defect. Intraocular pressure (TonoPen; Mentor, Norwell, Massachusetts) was 29 mm Hg in the right eye. Motility of the right eye was significantly decreased. External examination was significant for a right eyebrow laceration, small hyphema, traumatic cataract, small iris sphincter tear, and moderate right eyelid edema with complete ptosis. Results of a dilated funduscopic examination demonstrated a normal posterior pole with a cup-disc ratio of 0.1. Computed tomography showed a right naso-orbitoethmoid fracture and right orbital floor fracture (Figure). Methylprednisolone acetate (30 mg/kg intravenously for 6 hours) was administered for suspected traumatic optic neuropathy. Magnetic resonance imaging showed an intact optic nerve; however, orbital ultrasonography revealed diffuse choroidal thickening and avulsion of the optic nerve. The patient underwent open reduction and internal fixation of her orbital and facial fractures via a midface degloving approach. The patient had residual ptosis, NLP vision, enophthalmos, and hyperdeviation of the right eye. Nine months later, the patient underwent repair of her enophthalmos and placement of a porous polyethylene wedge, with good cosmesis. She underwent maximum superior rectus recession for hyperdeviation without significant benefit and now wears a scleral shell.

**COMMENT**

Most sports-related ophthalmic injuries occur in younger populations, with 72% occurring in patients younger than 25 years, 43% occurring in subjects younger than 15 years, and 8% occurring in children younger than 5 years. The potential severity of sports-related ophthalmic injuries in younger populations led the American Academy of Pediatrics and the American Academy of Ophthalmology to issue a joint policy statement recommending appropriate eye protection for certain youth sports. The joint policy statement categorizes sports as high risk, moderate risk, low risk, or safe with respect to eye injury. Golf is listed as a moderate-risk sport along with tennis, badminton, soccer, volleyball, water polo, football, and fishing.

There are 3 specific at-risk groups for injuries related to golf, including adult players who acquire overuse injuries, employees and spectators who are injured as bystanders, and children and adolescents who are injured...
during unsupervised play with golf equipment. Of these groups, the pediatric population is at greatest risk for severe, devastating, yet preventable injuries.

Although there are few reports of pediatric ophthalmic injuries resulting from golf-related trauma, pediatric head injuries are well documented in the neurosurgical and emergency medicine literature. In many regions in which golf is popular, it is often the most common cause of sports-related head injuries in children requiring hospital admission. This literature supports our opinion that golf is a more dangerous sport than may be commonly believed. Based on our review of the MEDLINE-indexed English-language literature, the injury pattern and severity of pediatric golf-related head trauma are similar to those of pediatric golf-related ophthalmic injuries.

Eight additional studies regarding golf-related injuries initially treated at an emergency department were reviewed. All report that patients are often injured playing golf and that these injuries are usually caused by being struck in the head by a golf club while playing golf at home. In addition, most accidents occur among children without adult supervision. This recurrent pattern of head injuries inspired Parkinson to convince the United States Golf Association to add a warning to its rule book recommending that players look before swinging a golf club.

The pattern of golf-related ophthalmic injuries seems to have changed over time. In 1967, Millar described 7 patients (including 3 pediatric patients) who sustained ocular trauma from golf balls and golf clubs. Three patients sustained open-globe injuries, with 2 of them requiring primary enucleation. All other reported golf-related ocular injuries in the 1960s and 1970s occurred from accidents caused by golf ball dissection. In these cases, the high-pressure liquid center of a golf ball would explode, often as it was being disected by a curious child. Changes in golf ball design have eliminated these injuries.

Six more recent case reports and case series review golf-related ophthalmic injuries in patients of all ages. Cumulatively, these reports describe 27 adult patients and 10 pediatric patients injured by golf balls, golf clubs, golf tees, and golf carts. Of these 37 patients, 22 (59%) had final visual acuities worse than 20/150, with 15 (41%) having NLP. The eyes of 14 patients (38%) were enucleated. These findings are similar to our case series regarding the severity of golf-related ocular injuries. Furthermore, these reports illustrate the different injury patterns in children vs adults. In these reported cases, most adults are injured by a golf ball (24 of 27 [89%]) rather than by a golf club (3 of 27 [11%]). In the pediatric population, most patients are injured by a golf club (7 of 10 [70%]) rather than by a golf ball (2 of 10 [22%]). In addition, a 16-year-old boy sustained a penetrating limbal wound from a golf tee. In our series, 10 of 11 injuries (91%) were caused by a golf club.

In previous series, the enucleation rate has ranged from 25% to 67%. In our series, 1 patient (9%) required enucleation. Previous authors have theorized that high enucleation rates result from hard, dense, small objects traveling at high velocities (range, 145-193 km/h) that easily fit into the orbit. In a review of ocular injuries by Fountain and Albert, golf (71%) was associated with the third highest incidence of enucleation per injury after hockey (80%) and BB guns (75%). The high rate of hyphemas (36%) in our series is consistent with previous series by Macewen and Schein et al demonstrating sports injuries as a common cause of hyphemmas. The high rate of orbital fractures in our series supports neurosurgical literature demonstrating that golf clubs are a frequent cause of skull fractures. All of the patients in our series sustained an orbital fracture. Only 1 patient (9%) sustained an open-globe injury.

Golf is a popular sport, with an estimated 2 million junior (age range, 12-17 years) golfers in the United States. The neurosurgical literature demonstrates recent increases in the number of pediatric golf-related head injuries as the popularity of golf has increased. Authors suggest that the popularity of younger golf professionals, especially Tiger Woods, may have sparked an interest in golf among the pediatric population and a higher rate of associated injuries. We would expect a similar increase in pediatric golf-related ophthalmic injuries.

Negrel and Thylefors state that the evaluation of eye injuries has been hampered by a general attitude of inevitability regarding the occurrence of accidents. They argue that eye injuries do not occur as random events, that some populations are at increased risk, and that 90% of injuries could be avoided if appropriate eye safety practices are made available and are effectively used. Although the American Academy of Pediatrics and the American Academy of Ophthalmology have issued a joint policy statement regarding the use of ocular protection for children who play sports, there are no specific recommendations for golf. Furthermore, there are no product performance specifications by the American Society for Testing and Materials or the Protective Eyewear Certification Council regarding protective eyewear for golf participants.

In reviewing the available literature and our experience, it is apparent that most pediatric golf-related injuries do not happen in the setting of a golf course or under supervised play. Most children are injured by other children wielding a golf club while at play away from the golf course. The frequency of potentially devastating ocular and head trauma has been demonstrated in our series and in our review of the literature. Moreover, the analysis by Ridenour identified golf clubs as possibly being responsible for 19 pediatric deaths. Increased public awareness may help to decrease morbidity from golf-related ocular injuries to children. We recommend close adult supervision, adequate separation between children, and protective eyewear for children learning to play golf. Furthermore and most critically, golf equipment should be stored in a secure area away from children. Children should be taught that golf equipment should never be used without supervision. The efforts of ophthalmologists to prevent eye injuries in other sports, notably hockey and baseball, have been successful and should serve as models to prevent golf-related ocular injuries in the pediatric population.

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REFERENCES


