Soccer-Related Ocular Injuries

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Objective: To outline the severity and long-term sequelae of eye injuries in soccer.

Design: Prospective observational study of 163 patients who sustained soccer-related ocular injuries between April 1, 1992, and March 31, 2000 (8 years).

Methods: Patients were observed at a sports ophthalmology unit located in the largest university hospital of the northern region of the country and central to all major soccer fields in town. The data were recorded using the United States Eye Injury Registry report forms for initial and follow-up observation.

Main Outcome Measures: (1) Self-reported history surrounding the ocular trauma, initial visual acuity, diagnosis, and operations and (2) final visual acuity, late diagnosis, and additional operations.

Results: Injuries occurred predominantly in young men (mean±SD age, 23.2±8.8 years) practicing indoor soccer (50.9%) or outdoor soccer (47.2%), and most resulted from a kicked ball (79.1%) near the goalpost (60.1%). Angle recession and peripheral vitreoretinal lesions were more likely to occur in the superotemporal quadrant (54.7%; 95% confidence interval, 44.2%-65.0%; and 57.6%; 95% confidence interval, 48.4%-66.4%; respectively). Vitreoretinal lesions were present in 42.2% (95% confidence interval, 33.1%-51.8%) of patients with “normal” visual acuity (≥20/40) and in 50.0% (95% confidence interval, 38.1%-61.8%) of patients without hyphema. No significant association was found between severity of injury and age, sex, type of soccer, level of athletic expertise, or player position.

Conclusions: Severe ocular lesions can occur in soccer players without symptoms and at all skill levels. The development of laboratory models will be essential to explain the tendency for lesions to be in the superotemporal quadrant. The data support the need for protective eyewear designed specifically for soccer.

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The effect of ocular trauma on the health care system and the community is potentially enormous.1-5 Sports are recognized as a leading cause of serious eye injuries.6-11 The first wave of effort by ophthalmologists to alter the incidence of eye injuries in sports was directed toward hockey, baseball, and racquet sports.12-14 The successful work done with these sports has involved the efforts of ophthalmologists to identify the sports that are inherently more dangerous, analyze injury mechanisms, and develop standards for protective eyewear specific to the sport.

Soccer is the most common cause of sports-related eye injuries in Europe and Israel.15-22 Although little is written in the American literature concerning soccer injuries, the injury potential appears to be disproportionately severe compared with other sports.23 The incidence of soccer-related eye injuries increased by more than 260% from 1973 to 1978 in the United States.24,25 This corresponds to soccer’s rapid rise in popularity among school-aged children. It is possible that soccer may become worldwide the most common cause of sports eye injury.

Regular patient observation and follow-up were performed in a sports ophthalmology unit, using the United States Eye Injury Registry report forms.18 The objective of this study was to outline the severity and long-term sequelae of eye injuries in soccer.

METHODS

One hundred sixty-three soccer players (163 injured eyes) who sustained sports-related ocular injuries and were seen at the Eye Emergency Department of S João Hospital between
Table 1. Mechanism of Injury by Sport (N = 163)*

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Total</th>
<th>Indoor</th>
<th>Outdoor</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball††</td>
<td>129 (79.1)</td>
<td>72</td>
<td>55</td>
<td>2‡</td>
</tr>
<tr>
<td>Fist§</td>
<td>10 (6.1)</td>
<td>3</td>
<td>7</td>
<td>...</td>
</tr>
<tr>
<td>Foot§</td>
<td>10 (6.1)</td>
<td>1</td>
<td>8</td>
<td>1†</td>
</tr>
<tr>
<td>Head§</td>
<td>3 (1.8)</td>
<td>2</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Elbow§</td>
<td>2 (1.2)</td>
<td>2</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Knee§</td>
<td>2 (1.2)</td>
<td>1</td>
<td>1¶</td>
<td>...</td>
</tr>
<tr>
<td>Goalpost</td>
<td>2 (1.2)</td>
<td>1</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Glasses frame</td>
<td>1 (0.6)</td>
<td>...</td>
<td>1</td>
<td>...</td>
</tr>
<tr>
<td>Other/ unknown</td>
<td>4 (2.4)</td>
<td>1</td>
<td>3</td>
<td>...</td>
</tr>
</tbody>
</table>

*Values are expressed as number of injuries (percentage of total).
†Kicked directly from an opposing player or rebounds of the ball kicked by the player himself or herself.
‡Beach (n = 1) and intramural (n = 1).
§From an opposing player.
¶Volleyball.
¶¶By the player himself or herself.

April 1, 1992, and March 31, 2000, (8 years) were studied. Patients were observed at a sports ophthalmology unit located in the largest university hospital of the northern region of Portugal and central to all major soccer fields in town. Patients underwent periodic ophthalmologic examinations by one of us (J.A.C.F.), including best-corrected visual acuity, intraocular pressures, and dilation. A slitlamp was used to examine the anterior segment; Goldmann 3-mirror lens and direct and indirect ophthalmoscopy were used to examine the posterior segment. Angle recession was diagnosed by gonioscopy during follow-up. Examination findings were recorded using the initial and follow-up United States Eye Injury Registry report forms adapted to sports-related injuries.1–3,12,13,21,22 The initial standardized registration included details related to the circumstances of the eye injuries (the source, place, whether the subject was wearing eye protection at the time of injury, and level of athletic expertise), initial tissues involved, best-corrected visual acuity, diagnosis, and operations. The follow-up form included final best-corrected visual acuity, late diagnosis, and additional operations. A severe injury was defined as one requiring hospitalization or outpatient follow-up for hyphema or vitreoretinal (VR) lesion. Patients were followed up for at least 1 year.

Results are presented as mean ± SD or proportions and respective 95% confidence intervals (CIs). Proportions were compared using χ², Fisher exact, or McNemar test when paired samples were evaluated, as was the case for impaired vision at first and final observations. A statistical power of 80% and a significance level of P < .05 were considered for the analysis.

INJURIES BY TYPE OF SOCCER

An analysis of all soccer injuries (N = 163) showed indoor soccer (50.9%) injuries to be the most common, followed by outdoor soccer (47.2%), with 1 case each of beach soccer, volleyball soccer, and intramural soccer. The latter is indoor soccer played inside a closed field.

Most players were practicing recreational sports (n = 83, 50.9%), followed by professional (n = 45, 27.6%) and school (n = 35, 21.5%) sports. Six patients were not athletes (5 soccer spectators and 1 soccer linesman), and all were hit by a ball.

BACKGROUND DATA AND DEMOGRAPHICS

One hundred fifty-two patients (93.3%) were male and 11 (6.7%) were female, with a 14:1 male-female ratio. The mean ± SD age was 23.2 ± 8.8 years (range, 9–48 years). For male and female patients, the mean ± SD ages were 23.6 ± 8.8 years and 16.9 ± 5.8 years, respectively. This difference was statistically significant (P = .007). One hundred fifteen patients (70.6%) were adults, and 48 (29.4%) were classified as pediatric (aged < 8 years). Patients younger than 35 years (145 subjects) accounted for 89.0% of all injuries.

The seasonal distribution showed a peak incidence in March and May, with a decrease in April, July, August, and December (corresponding to holiday months). The injuries occurred during the weekend in 77 cases (47.2%).

Thirty-five patients (21.5%) played with some visual acuity handicap. Thirty subjects (18.4%) wore glasses with corrective lenses on a regular basis but did not use them during sports practice. Two patients (1.2%) wore contact lenses during the game. Four patients (2.5%) were functionally 1-eyed (visual acuity, < 20/300), one of whom sustained 2 injuries during the study.

MECHANISM OF INJURY

Most injuries resulted from impact by the ball kicked from an opposing player or by rebounds of the ball (n = 129, 79.1%), followed by fist (n = 10, 6.1%) and foot traumas (n = 10, 6.1%) (Table 1). The most serious eye injury was caused by a fingernail scratch from an opponent soccer player. Injury was considered unintentional in 155 patients (95.1%). Of the 8 athletes (4.9%) who considered the injury an assault, 6 were professional.

No patient had any experience of ocular protection or knowledge about where to obtain it. The only patient wearing glasses was an outdoor soccer spectator, who was wearing street wear spectacles for high myopia. When hit with a ball, he had a retinal dialysis after the eyeglass frame collapsed.

PLACE OF INJURY AND PLAYER POSITION

Inside the arenas, injuries occurred more frequently near the goalpost (60.1%) than in the midfield (34.4%). The ball hit 7 subjects who were not on the playing field: 5 soccer spectators on the bench, 1 reserve player, and 1 soccer linesman. The injuries were spread across all of the player positions, with forwards (38.7%) and defenders (30.7%) being most prone to injury.

VISUAL ACUITY

At initial examination, visual acuity was 20/40 or better in 116 patients (71.2%), and ranged between 20/20 in 79 patients (48.5%) and light perception in 7 patients (4.3%) (Figure 1). The visual acuity of 8 patients (4.9%) remained less than 20/300 at the final follow-up examination; 3 (1.8%) of these patients were functionally 1-eyed with poor visual acuity previous to the sports injury. The causes of permanent visual loss of the remaining 5 patients (3.1%) were 3 cases of contusion maculopathy.
or orbit, and VR lesion (14.9%; 95% CI, 7.7%-25.0%) without hyphema and in 11 patients (40.8%-62.4%) with hyphema and in 11 patients (14.8%-35.2%) (Table 3). The left eye was significantly more frequently injured (n=91, 55.8%; vs n=72, 44.2%) (P=.04). All injuries were unilateral. The most common ocular tissue involvement was the anterior chamber, followed by the eyelids or orbit, and VR lesion (Table 2). The most common initial diagnosis was eyelid or orbital contusion and hypHEMA, followed by retinal hemorrhage, vitreous hemorrhage, and uveitis. The most frequent diagnosis during follow-up was angle recession and retinal tears. Four patients (2.5%) had orbital fractures caused by the impact of a foot (2 cases), elbow (1 case), or hand (1 case).

CLINICAL DIAGNOSIS

The left eye was significantly more frequently injured (n=91, 55.8%; vs n=72, 44.2%) (P=.04). All injuries were unilateral. The most common ocular tissue involvement was the anterior chamber, followed by the eyelids or orbit, and VR lesion (Table 2). The most common initial diagnosis was eyelid or orbital contusion and hyphema, followed by retinal hemorrhage, vitreous hemorrhage, and uveitis. The most frequent diagnosis during follow-up was angle recession and retinal tears. Four patients (2.5%) had orbital fractures caused by the impact of a foot (2 cases), elbow (1 case), or hand (1 case).

GLAUCOMA AND ANGLE RECESSION

Forty-three patients (26.4%) had intraocular pressures greater than 21 mm Hg, and 2 patients (1.2%) required medication for persistently elevated pressures. Acute glaucoma was present in 41 (46.1%; 95% CI, 35.4%-56.9%) of 89 patients with hyphema and in 2 (2.7%; 95% CI, 0.3%-9.4%) of 74 patients without hyphema (P<.001). Angle recession was present in 146 patients (51.7%; 95% CI, 40.8%-62.4%) with hyphema and in 11 patients (14.9%; 95% CI, 7.7%-25.0%) without hyphema (P<.001). Angle recession was more frequent in the superotemporal quadrant (54.7%; 95% CI, 44.2%-65.0%), followed by the superonasal quadrant (25.3%; 95% CI, 16.9%-35.2%) (Table 3).

VR LESIONS

Peripheral VR lesions were more frequently in the superotemporal quadrant (57.6%; 95% CI, 48.4%-66.4%), followed by the superonasal quadrant (24.0%; 95% CI, 16.8%-32.4%) (Table 3). Fifteen patients had blunt injuries causing peripheral retinal breaks, which proceeded to retinal detachment in 7 instances. Most breaks were holes, occurring in 10 patients, with 6 cases of multiple holes (3 cases of 2 holes, 2 cases of 3 holes, and 1 case of 4 holes). The holes showed particular predilection for the superotemporal quadrant, followed by the superonasal quadrant. Retinal dialysis, the second most common type of break (4 patients), showed also a predilection for the superotemporal quadrant. The only horseshoe tear was located superotemporally and superonasally. Retinal detachment was also present more frequently in the superotemporal quadrant, followed by the superonasal quadrant. The circumferential extension of retinal detachment was more than 90° in 3 cases. No severe myopia was present in any of these patients with retinal breaks or retinal detachment.
Patients with anterior segment lesions were not more likely to experience a VR lesion (Table 4). No significant trend to VR lesions was observed in patients with or without eyelid or orbital contusion (52.2% vs 49.3%), subconjunctival hemorrhage (34.8% vs 53.6%), corneal abrasions (47.1% vs 51.9%), uveitis (58.0% vs 47.8%), hyphema (51.7% vs 50.0%), or glaucoma (55.8% vs 49.2%) (P > .05 for all).

The only exception was patients with angle recession, who had significantly more VR lesions than patients without angle recession (64.9%; 95% CI, 51.1%-77.1%; vs 43.4%; 95% CI, 33.8%-53.4%) (P = .01).

HYPHEMA AND VR LESIONS

There was no association between the extension of hyphema and the presence of VR lesions (Table 5). A similar number of peripheral retinal breaks was present in patients with or without hyphema (9.0%; 95% CI, 3.7%-16.9%; vs 9.6%; 95% CI, 3.9%-18.5%). Among patients without hyphema, there were 5 cases of multiple holes and 1 case of macular hole.

VISUAL ACUITY AND VR LESIONS

As expected, a higher level of visual acuity at initial examination was associated with a lower proportion of VR lesions (P = .002). Also, visual acuity recovery was more common in patients without VR lesions. However, 49 (42.2%; 95% CI, 33.1%-51.8%) of 116 patients with “normal” visual acuity (defined as ≥ 20/40) had VR lesions (Figure 2). If we exclude 3 patients who were functionally 1-eyed with poor visual acuity previous to the sports injury, all of the patients with final visual acuity worse than 20/40 had an initial visual acuity worse than 20/40 and a VR lesion.

SEVERE INJURIES

Among all severe injuries (n = 123, 75.5%), 65 lesions (52.8%) occurred during indoor soccer games, and 56 lesions (45.5%) occurred during outdoor soccer games (Table 6). The remaining injuries were associated with other types of soccer games. No significant association was found between severe injuries and patients’ age, sex, type of soccer, level of athletic expertise, or player position.

TREATMENT AND ECONOMIC EFFECT

Twenty-two patients (13.5%) required 42 surgical procedures (Table 7). The retina was successfully reattached in all cases. After retinal surgery, 5 patients had...
visual acuities of 20/40 or better. Visual acuity remained worse than 20/200 in 3 cases; these patients had severe traumatic maculopathy. Most patients required topical medication (mydriatics, corticosteroids, antibiotics, β-adrenergic blocking agents, or patching) and systemic medication (antibiotics, nonsteroidal anti-inflammatory agents, corticosteroids, anticoagulants, or acetazolamide). This sample of patients required 31 diagnostic x-ray films and 7 computed tomographic scans for suspected orbital fracture. Twelve retinal fluorescein angiographies, 24 ocular echographies, and 20 Humphrey automated perimetries were performed.

**ABSENCE TIME**

Twenty patients (12.3%) required hospitalization. The in-hospital stay averaged 5 days. The mean absence time for all 45 injured professional players was 15 days, which increased to 80 days for operatively treated patients. Forty-five injuries (100.0%) resulted in at least 2 missed games, and 29 players (64.4%) were absent from soccer training or games for more than 1 month. One professional player, a female outdoor soccer player, was unable to practice sports indefinitely.

**COMMENT**

Soccer enjoys a large and active participation in Europe. Each season in the Portugal Football Association, approximately 12 300 men and 2000 women participate in organized indoor soccer, and 95 800 men and 900 women participate in outdoor soccer. Although our results partly reflect the fact that soccer is by far the most popular sport in Portugal, they also highlight the serious nature of indoor and outdoor soccer injuries. Despite the small number of players in new soccer modalities, we already have seen injuries in beach soccer, volleyball soccer, and intramural soccer. Analysis of ocular lesions allows us to answer some questions about these sports.11

**SOCCER BALL INJURY**

Most patients were young men, amateurs, playing recreational sports, and hit by a soccer ball during weekends or at school, as found in previously published studies.16,18,20,28 The finding that 75.5% of eye injuries in the soccer players we treated were severe corroborates the findings of previous studies23,29,30 showing that soccer injuries were disproportionately severe compared with those of other sports. One of the most surprising results of our data was that the age, sex, type of soccer, level of athletic expertise, and player position did not relate to the severity of ocular injury, despite the inherent differences. Beyond an unknown ball velocity limit, which needs to be determined, injury can occur independent of all these differences.

It is a common misconception that experience in itself protects from injury. In our series, 27.6% of the sample

![Table 5. Size of Hyphema and Vitreoretinal (VR) Lesions*](image)
were professional sports players of proven competence. The illusion that injuries occur only among beginners must be quashed. The injuries occurred predominantly among forwards and defenders near the goalpost. This area of the field may be where the ball is kicked more often, because the forwards kick the ball to the goal, while the defenders kick off the goal. Furthermore, the goal area has the greatest number of players nearby during the match. In fact, most of the injuries resulted from the ball kicked directly from an opposing player who was nearby or from rebounds of the ball kicked by the player himself or herself. These rebounds of the ball are a mechanism similar to injuries experienced in squash, in which players may not know from which side the ball is coming and cannot protect their eyes.

We are unable to provide an explanation why the left eye was more frequently injured, because no such hypothesis was specifically tested. However, we speculate that this could result from the fact that most players are right-footed kickers.

### PATHOGENESIS OF EYE CONTUSION

Despite the differences between the opening of the bony orbit and the diameter of a standard indoor or outdoor soccer ball, direct trauma to the globe is possible. The reason is that the soccer ball frequently comes toward the eye from below. The flatter inferior orbital rim affords less protection to the globe from a projectile coming at this angle. Therefore, whether the ball is or is not underinflated, the force of the impact is strong enough to deform the intraocular structures without exceeding the tensile strength of the eyeball. As a result, hyphemas and peripheral VR lesions were the most frequently encountered injuries. As expected, the ball caused none of our cases of blowout fracture.

The flat orbital rims in children and young teenagers give the globe more prominence, theoretically making these persons more susceptible to soccer ball injury. Our data did not support this; adults were just as susceptible to soccer eye injuries. Among patients who were younger than 30 years, a previous study found that the most common cause of traumatic retinal detachment was a soccer ball striking the eye. The data from these series showed that the patients had myopic globes. This sharply contrasts with the findings of the present study, in which none of the retinal detachment cases were associated with severe myopia. Therefore, the impact of the soccer ball is strong enough to cause a lesion in persons without previous ocular fragility.

### SUPEROTEMPORAL QUADRANT LESIONS

Our study confirms that in soccer VR lesions tend to occur in the superotemporal quadrant. The literature describes that traumatic breaks are commonly found in the inferotemporal and superonasal quadrants. Blunt trauma can cause retinal damage by direct contusive injury to the globe through 2 mechanisms: coup (adjacent to the point of trauma) and countercoup (opposite to the point of trauma). The classic experiments of Schepens have elucidated the pathogenesis of retinal detachments caused by ocular contusion. How can we explain in soccer why peripheral angle recession and VR lesions tend to occur in the superotemporal quadrant? The answer may be that the soccer ball frequently comes toward the eye from below. On the other hand, we found that retinal holes rather than tears are likely to develop from soccer-associated blunt trauma. This confirms that small holes at the posterior border of the vitreous base and equatorial holes, without apparent VR attachment and secondary to retinal necrosis, constitute the major types of retinal breaks seen following contusion. The development of more sophisticated laboratory experiments will doubtless reveal additional alterations as a consequence of soccer ball blunt injury.
CLINICAL MANAGEMENT

It may be appropriate in soccer to encourage visits to the emergency department or physician's office regardless of the immediate assessment of injury severity. Although an athlete may not report symptoms suggestive of peripher al VR lesions, a thorough examination should be performed immediately after the game injury. The considerable number of patients with superficial injuries in whom we found unsuspected VR damage emphasizes this. We postulate that 38.1% to 61.8% of patients without hyphema (no blurred vision) and 33.1% to 51.8% of patients with normal visual acuity (defined as ≥ 20/40) may have VR lesions. Among patients with hyphema, 40.8% to 62.4% may have angle recession. Any athlete with hyphema is at a lifelong heightened risk of glaucoma and should have pressures checked regularly.

EYE INJURY PREVENTION

Our study alerts us to the need to protect soccer spectators, including the assistant referees. How can we protect them, especially when stadiums are removing lateral protections because of the danger of unruly spectators smashing them against people and things? It will probably be necessary to maintain a set distance between the stadium arena and the spectators.

Inside the arenas, the area in and around the goalpost is the area most often associated with injury. The proportion of goalkeepers with injuries in our sample (approximately 10%) indicates that, although they are the only players using their hands and thus are more able to protect their eyes, they also are at risk. The use of padded goalposts in soccer has been documented to reduce injuries in the laboratory phase and in pilot testing.36

SOCCER EYE PROTECTION

The number of monocular patients injured in our study corroborates that functionally 1-eyed athletes should not participate in sports associated with an eye injury risk for which adequate eye protection is not available and underscores the need for a standard specification specific to the risks and requirements of soccer.37-39 Soccer is one of the few sports that, with the exception of the goalkeeper, is a hands-off sport, with the purposeful use of the head to control, pass, or shoot the ball. An eye protector for soccer must have a close-fitting frame that does not affect the projection of the ball. Until such a standard is developed, a minimal soccer eye protector requirement should be one that has been developed for squash (F803) by the American Society for Testing and Materials.40 Endorsement by the Protective Eyewear Certification Council indicates that a protector has been tested according to the American Society for Testing and Materials standards and that the manufacturer has had quality control certified by an independent testing laboratory. The eyewear should be clearly labeled (eg, a Protective Eyewear Certification Council seal indicating that the standards of the American Society for Testing and Materials have been met). We recommend that soccer protective eyewear be worn, particularly by players who require prescription lenses, functionally 1-eyed athletes, and those who have had refractive surgical procedures that weaken the eye.41 Dresswear glasses are never recommended for use during soccer.

CONCLUSIONS

Indoor and outdoor soccer trauma is an important eye health problem in Europe, and likely in the United States, affecting young athletes independent of age, sex, type of soccer, level of athletic expertise, or player position. An explanation for the predilection of eye injury lesions in soccer to the superotemporal quadrant needs to be sought by development of laboratory models. Soccer player education is warranted to raise awareness about the risk of ocular trauma and about the appropriate ocular protection conforming to the moderate impact standard requirements to prevent eye injuries.

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