Knee Surg, Sports Traumatol, Arthrosc
(1999) 7:262–266

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Tibia and fibula fractures in soccer players

Received: 1 March 1998
Accepted: 10 August 1998

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Abstract We performed a retrospective review of 31 athletes who sustained a fracture of the lower leg from a direct blow while playing soccer. Fifteen fractures involved both the tibia and fibula, 11 only the tibia, and 5 only the fibula. Information was collected using a standardized questionnaire. The mean follow-up from the time of injury was 30 months. Injuries typically occurred in young, competitive athletes during game situations. The mechanisms were broadly classified into several categories: contact during a slide tackle (13, 42%), a collision with the goalkeeper (8, 26%), two opposing players colliding while swinging for a loose ball (7, 23%), or a player being kicked by a standing opponent (3, 10%). The majority of fractures (26, 90%) occurred while the athletes were wearing shin guards. The point of impact was with the shin guard prior to the fracture in 16 cases (62%). Return to competitive soccer averaged 40 weeks for combined tibia and fibula fractures, 35 weeks for isolated tibia fractures, and 18 weeks for isolated fibula fractures. Injuries were associated with a high incidence of major complications (12 out of 31, 39%), especially in concurrent tibia and fibula fractures (8 out of 15, 50%). These findings suggest that lower leg fractures in soccer players are serious injuries, often necessitating a prolonged recovery time. In addition, this study questions the ability of shin guards to protect against fractures.

Key words Shin guard · Tibia fracture · Fibula fracture · Soccer injury

Introduction

Soccer is the most popular sport outside the USA and is rapidly becoming one of the most popular sports in the USA. There are an estimated 120 million soccer players worldwide [8]. In the USA, soccer has become the third most popular team sport among children under the age of 18 years old [13]. As the participation in soccer expands, an increase in the number of injuries is inevitable. Contusions, ligament sprains, and muscle strains to the lower extremities are responsible for 50%–88% of all soccer injuries [8]. Fortunately, catastrophic events are rare in soccer. Nonetheless, the sport is associated with a significant number of serious injuries such as fractures [10].

The mechanism of kicking in soccer may be associated with the generation of high kinetic energy which is usually dissipated by the soccer ball and the extremity during follow-through [5]. Since soccer is a contact sport, the kicking leg can produce severe injuries. During miskicks or slide tackles, the energy may be transmitted to an opponent's lower leg, resulting in a fracture. In an attempt to reduce the number of abrasions, contusions, and fractures of the lower extremity, shin guards have become the only protective devices required by collegiate and international soccer associations. Although shin guards may protect the lower extremity from minor injuries, we were alarmed by the number of tibia, fibula, or combined tibia and fibula fractures seen in our clinic over the past 6 years in soccer players wearing shin guards.

The incidence of fractures in soccer has been reported to range from 1% to 9.7% of all injuries [4, 6, 9, 11, 12]. McCarroll and colleagues reviewed the incidence and location of injuries in 4018 youth soccer players; they documented 17 (9.7%) fractures [9]. Only 4 of the 17 fractures occurred in the lower extremity. In a review of youth soccer injuries, Hoff and Martin documented 6 (8%) fractures in indoor soccer players, and only 1 (2%) in outdoor soccer athletes [6]. Putukian et al performed a prospective study of soccer injuries during a 3-day indoor soccer tournament [12]. They reported 3 (7.9%) fractures out of a total of 38 injuries. None of the fractures involved the lower extremity.

Nielsen and Yde reported 6 fractures (3 in the foot, 1 in the ankle, and 2 in unspecified location) out of a total of 109 injuries during one outdoor season [11]. Engstrom et al. reviewed soccer injuries in two female elite soccer teams and noted only one fracture of unspecified location out of a total of 78 injuries [4]. During the 1995–1996 soccer season, the National Collegiate Athletic Association (NCAA) injury surveillance system recorded 42 fractures of unspecified site for an injury rate of 0.37 per 1000 athletic exposures [10]. Each athletic exposure is equivalent to one practice session or game.

There is an abundance of data on the epidemiology and location of soccer injuries. However, little attention has been focused on the mechanisms, treatment, prognosis, and prevention of lower extremity fractures. The purpose of this study was to gain a better understanding of the characteristics of lower leg fractures in soccer players. To our knowledge, this is the first comprehensive study of diaphyseal fractures of the tibia, fibula, or combined tibia and fibula reported in soccer players.

Patients and methods

Thirty-one tibia, fibula, or concurrent tibia and fibula fractures were identified in 31 soccer players. All injuries were the result of contact with an opposing athlete. Data on 27 patients were collected through a telephone interview. Information on the remaining 4 athletes was obtained from a chart review, as well as an interview with an athletic trainer who was present at the scene of the injury in 3 of these patients. Eight of the athletes were managed at the Duke University Medical Center from 1990 through 1996. The remaining patients were located by contacting trainers or physicians responsible for providing the medical care of various soccer teams. Radiographs were obtained and reviewed for 16 fractures. A description of the location and fracture characteristics was provided by the injured athlete or trainer for 15 fractures.

Clinical information was obtained on all patients by one author (B.P.B.) using a standardized form. In addition to demographic data, patients were questioned in detail concerning the playing conditions, mechanisms of injury, and whether contact occurred with the shin guard prior to the fracture. The treatment, time to recovery, recurrences, and complications were recorded.

Results

The mean follow-up from the time of injury was 30 months (range 3 months to 8.5 years). There were 24 men and 7 women with a mean age of 19 years (range 7–27 years) at the time of the injury. Fifteen fractures affected both the tibia and fibula (Fig. 1), 11 only the tibia (Fig. 2), and 5 only the fibula (Fig. 3). There were no open fractures. The right leg was injured in 24 patients and the left leg in 7. The 27 patients who were interviewed were able to recall the position of the affected leg at the time of the injury. The injured leg was not planted on the ground (shooting, dribbling, or sliding) for 77% (17 out of 22) of the right leg fractures and 60% (3 out of 5) of the left leg fractures.

The majority of athletes were competing at the varsity or elite level at the time of the injury: 12 (39%) college players, 5 (16%) varsity high school athletes, 4 (13%) professionals, 4 (13%) select team participants, and 3 (10%) Olympians. Three (10%) athletes were injured while participating in an intramural league.

The injuries predominantly occurred during game situations (27, 87%) on a grass field (26, 83%). The remaining injuries were reported during practice sessions or while playing on an artificial surface. Forwards or strikers were the most frequently injured (13, 42%), followed by defenders (6, 19%), midfielders (5, 19%), and goalies (2, 6%). Five (16%) players were not assigned to a position at the time of the injury. The team formations (i.e., 4-4-2) at the time of injury were not recorded. Therefore, the exact incidence of injuries per position could not be calculated. Of the 26 fractures sustained during a game, 11 (42%) fouls were called for intentionally dangerous plays. The definition of a foul play (direct or indirect kick, yellow or red card) was not elicited during this study. Two (8%) injured athletes considered their fracture to be the result of a malicious foul after the play was completed. The majority of fractures occurred in players who were the recipient of foul play.

Several common injury mechanisms were identified. The most typical scenario (13, 42%) involved a slide tackle, often from behind, to an offensive player's planted leg. In three of these cases, the player performing the slide tackle sustained the fracture. The next most common situation (8, 26%) occurred when the goalkeeper collided with a striker. Four of these injuries occurred during fastbreaks. In one of these cases, the goalie sustained a fracture instead of the forward. In 7 (23%) fractures, two opposing players were swinging for a loose ball and contacted each other instead of the ball. The remaining three (10%) fractures occurred when an offensive player with the ball was kicked by a standing opponent. The point of impact was with the opposing player's instep in 10 (32%), cleats in 8 (26%), tibia in 6 (19%), knee in 3 (10%), and thigh, ankle, body of goalie, and unknown in 1 (3%) each. An opposing player was injured in

Fig. 1 Radiograph demonstrating displaced tibia and fibula fractures

Fig. 2 Radiograph of nondisplaced tibia fracture

Fig. 3 Lateral radiograph of fibula fracture

two of the collisions: one ankle fracture and one quadriceps contusion.

Twenty-six fractures (90%) occurred despite the use of shin guards. None of the athletes felt that the shin guard was out of position at the time of injury. The point of impact occurred on the shin guard prior to the fracture in 16 (62%) cases. In the remaining 10 players, who were wearing shin guards and were able to recall the point of impact, the contact took place at variable locations in relation to the shin guard: lateral (5, 16%), medial (2, 6%), inferior (1, 3%), and inferomedial (1, 3%). Of the 5 fractures sustained from contact lateral to the shin guard, 3 resulted in a fibula fracture and 2 in a tibia and fibula fracture. Only 16 (52%) athletes were able to recall the shin guard's material: 13 were plastic, 2 were Kevlar, and 1 was cushioned by an air device.

Review of 16 radiographs demonstrated that the location of the fracture was at the junction of the middle and distal thirds of the lower leg in 12 patients, in the middle third of the bone in 3 fractures, and at the junction of the proximal and middle thirds in 1 patient. A description of the other 15 fractures by the patient or trainer revealed that 6 fractures were located at the junction of the middle and distal thirds of the bone, 5 in the distal third, and 4 in the middle third.

Due to the variety of injuries and treating orthopaedic surgeons, the treatment protocols differed greatly. Athletes who sustained combined tibia and fibula fractures were treated by an intramedullary (IM) nail in 9, cast immobilization in 5, and an external fixator followed by an IM nail in 1. All 11 of the isolated tibia fractures were initially treated by cast immobilization. Management of fibula fractures was individualized depending on the location and displacement of the injury as well as the ligamentous damage. Three cases were treated by cast immobilization, 2 by operative intervention, and 1 with crutches only.

The return to activity correlated with the energy of the initial trauma (Table 1). Athletes with combined tibia and fibula fractures reached full recovery at a mean of 40 weeks (range 18–130 weeks). Soccer players with fractures just of the tibia or fibula required 35 weeks (range 8–78 weeks) and 18 weeks (range 6–35 weeks), respectively, before returning to competitive soccer.

Complications were divided into major and minor (Table 1). Major complications were defined as a refracture, a repeat surgical procedure, or a long-term disability. Minor complications included soft-tissue injuries sustained during the rehabilitation period. The highest incidence of complications occurred in the 15 athletes with combined tibia and fibula fractures: 8 (53%) major complications and 1 (7%) minor. Three fractures became displaced after an initial attempt at cast immobilization. Two were successfully treated with IM fixation of the tibia, and the third developed a malunion which was treated

Table 1 Follow-up results after leg fracture

	Tibia/fibula	Tibia	Fibula
Number of fractures	15	11	5
Mean time to walking without crutches (weeks)	7.2	8.8	3.2
Mean time to jogging (weeks)	20.5	23.9	9.4
Mean time to playing soccer (weeks)	40.2	35	18
Major complications	8	4	0
Minor complications	1	1	1

with a corticotomy and Ilizarov fixator. Two patients developed a lower leg compartment syndrome requiring fasciotomies. Both patients were treated with IM nailing of the tibia within 24 h of the injury. An additional two patients developed a delayed union. One patient, who was initially treated with an IM rod, required dynamization and bone grafting for healing. The other patient, who was initially treated with Enders rods, underwent multiple procedures including bone grafting, osteotomy, and replacement of the Enders rod with an IM nail to achieve union. Finally, one patient sustained a refracture 8 weeks after the injury when she was converted from a long leg cast to a walking boot. The fracture subsequently healed after a prolonged period of immobilization in plaster. The minor complication in this group consisted of a patient who suffered a muscle strain during rehabilitation. The injury healed after 4 weeks of restricted activity.

Isolated tibia fractures were also associated with a high rate of major (4 out of 11, 36%) and minor (1 out of 11, 7%) complications. Major complications included three refractures at an average of 10 months after the original injury. All three patients were initially treated with cast immobilization. The recurrent fracture healed in all three patients after treatment with an IM nail and partial fibulectomy, an extended period of cast immobilization, or immobilization in a short leg boot. The fourth major complication involved a loss of reduction in plaster after three separate closed reductions. The patient was subsequently treated with IM fixation to stabilize the fracture. The minor complication involved a severe contusion over the fracture site in one player who became “psychologically scarred” from the injury and decided to retire from the sport of soccer.

The fibula fractures healed without any major complications. The rehabilitation period was prolonged in one patient who developed a lower leg tendinosis after prematurely resuming soccer activities.

Discussion

The objective of this study was to identify and characterize lower leg fractures in soccer players. Since the population and time periods were not defined, we were unable to calculate the incidence of this injury. Nonetheless, the number of fractures reported indicates that the problem may be more common than anticipated.

The fractures in this study occurred mostly in high level athletes during game situations. It is not surprising that the forward position is most at risk for leg fractures due to slide tackles from behind or collisions with the goalkeeper. Since 42% of the fractures occurred after a slide tackle from behind, enforcement of the red card rule should discourage this type of tackle. Nearly half of all injuries resulted from a foul play. Suspensions for longer than one game may deter malicious fouls. No correlation was found between injuries caused by violation of the rules and the different levels of play.

The lower extremity fractures reported in this study were associated with prolonged recovery times. In addition, the complication rate was high, especially given the short follow-up period. The combined tibia and fibula fractures were associated with the highest incidence of major complications. Closed treatment of combined tibia and fibula fractures mandates close observation for the loss of reduction. All three patients who were unsuccessfully treated with a cast suffered fracture displacement at the time of injury. Initial treatment with a tibial IM nail is recommended when displacement is greater than 50% in skeletally mature athletes [1]. In a prospective randomized trial of patients with displaced tibial shaft fractures, Hooper et al. compared conservative treatment with closed IM nailing [7]. Treatment with IM nailing resulted in a more rapid union with fewer malunions and less shortening. Proper technique and timing are critical to avoid surgical complications. Patients with combined tibia and fibula fractures should also be monitored closely for compartment syndrome. In order to prevent the onset of a compartment syndrome, delaying surgery for at least 24–48 h after the injury may allow for partial resolution of swelling, thereby decreasing the risk of compartment syndrome.

The majority of isolated tibia fractures were nondisplaced or minimally displaced. Nonetheless, the complication rate was high. Refracture at the initial site of injury may occur when the athlete is allowed to return to competition prior to complete healing or rehabilitation. Although callus formation may be present on follow-up radiographs, complete consolidation of the fracture may be delayed due to the distracting force of the intact fibula. Teitz et al. reported a 26% rate of delayed union or nonunion in tibial fractures with an intact fibula [14]. Therefore, any residual clinical symptoms at the fracture site should be a warning sign of a delayed union or a nonunion. Various treatment protocols, such as a partial fibulectomy with weightbearing, fixation with an IM nail or tension-band plate, and/or noninvasive ultrasound, may be employed to stimulate healing [3]. Initial treatment to avoid this complication may involve a long leg cast in 10 deg of flexion with early weight-bearing or a partial fibulectomy to allow compression at the fracture site.

All of the fibula fractures healed without any major complications. The one minor complication, tendinosis, might have been avoided by a monitored, gradual return to activity.

In the early 1990s shin guards became the only mandatory protective equipment in soccer. Shin guards reduce the impact forces to the leg, thereby preventing or reducing the severity of soft-tissue injuries and fractures. However, it is clear that shin guards are inadequate at preventing lower extremity fractures once an unknown force has been exceeded.

The protective ability of shin guards has only been studied to a limited extent [2, 15] (Francesco and Garrett, manuscript in preparation). Experimental studies by van Laack have shown that shin guards decrease the magnitude of forces by prolonging the amount of contact time [15]. The best effect was seen when forces were less than 3000 N. Gainor et al calculated the maximum kinetic energy for a soccer-style kick to be close to 680 Nm [5]. The collision force may be up to twice this value if two opposing players contact each other while swinging for the ball.

Bir et al. tested the mechanical properties of 21 commercially available shin guards [2]. Using a Hybrid III crash dummy to simulate the tibia, they found that load forces were reduced 41.2%–77.1% at the ankle and knee with shin guards. Extremes of temperature had no effect on the ability of the shin guard to attenuate the forces. This study only indirectly measured the protective effect of shin guards since the authors failed to account for the forces at the point of impact.

In another biomechanical study of shin guards, Francesco used a drop track model to measure forces at the point of impact on cadaver and synthetic specimens (Francesco and Garrett, manuscript in preparation). The authors analyzed the mechanical properties of 21 shin guards which were grouped into four categories: thermoplastic/fiberglass, plastic/foam, compressed air, and kevlar. No significant differences were found between the groups with regard to principal strain, impulse, and contact time. However, a trend was identified which revealed that the compressed air shin guards were most effective at dissipating forces.

The weaknesses of this study include the retrospective collection of data and the inability to examine all of the radiographs. In addition, the accuracy of the information collected on the playing conditions relied on the athletes' memory of an event that occurred on average 30 months prior to the interview. Despite these flaws, the study illustrates a serious injury in soccer players. Future studies should be performed prospectively to determine the incidence of this injury. In addition, foul plays should be further analyzed in order to reduce injuries through rule changes. The results also imply that shin guards need to be improved if they are to prevent lower extremity fractures. Recommendations include a stronger material which is still lightweight and comfortable enough for players to wear. The material must also have a soft outer layer to avoid the risk of shin guard-induced injuries. Enlarging the shin guard to cover the tibia and fibula more fully may help reduce the number of fractures. Lastly, the shin guard should function to maximally attenuate forces at the junction of the middle and distal thirds of the tibia and fibula where the majority of fractures occur.

Acknowledgements We thank Dr. Bert Mandelbaum and Patti Marchak for contributing patients to this study.

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