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Fractures in soccer: The current evidence, and how this can guide practice

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ABSTRACT

This article reviews the current evidence on traumatic fractures in soccer, and assesses how this can guide practice. The incidence of traumatic soccer-related fractures was found to be 0.64 to 0.71/1000 in the general population. Demographics vary between the general population and professional soccer players, with 68% of traumatic soccer fractures occurring in the upper extremity in the general population, and only 23% of traumatic soccer fractures occurring in the upper extremity in professional players. Within the general population, around 80% of traumatic soccer-related fractures are managed non-operatively, with 20% managed operatively. The optimal treatment method is determined by fracture location and configuration. There is an increasing role for primary operative treatment in unstable, non-displaced fracture types, to facilitate an accelerated return to soccer. Around 86% of soccer players return to sport post-fracture. Return times vary by fracture locations and playing level, with elite players having quicker return times than the general population. Regarding injury prevention, shin guards appear to confer substantial benefit against tibial diaphyseal fractures. However, further research is required to determine the optimal preventative measures against fractures in soccer.

1. Introduction

Soccer is the most popular sport in the world, with around 270 million active players globally.[1,2] For the 2018 World Cup, there were 3.6 billion television viewers overall, with 1.1 billion watching the live Final alone.[3]

The financial implications of such popularity are significant.[4] Pre-COVID revenues from the 2018/2019 Premier League season were calculated at €5.85 billion, with the 2018/2019 European Football Markey Revenue valued at €28.9 billion.[4]

With such a significant role in modern society, the management of soccer players and their associated injuries is of key importance.[5]

Among professional soccer players, fractures comprise 4% of all injuries.[6] Despite their relatively low representation, fractures represent one of the most serious injuries incurred by soccer players, accounting for the most time to recover post-injury.[5–7]

Despite the importance of such injuries, research into fractures in soccer remains limited.[5] There is however an increasing focus on this area, with such research guiding evidence-based management of these injuries.[8]

This article reviews the current evidence on traumatic fractures in soccer, providing a summary of how this research can guide evidence-based practice for the future.

2. Methodology

This article is a narrative review, providing a contemporary overview of the topic 'Fractures in soccer'. Relevant articles on the topic were found through systematic searches of Pubmed and Google Scholar, using the terms 'Soccer' 'Football' 'Fracture'. The reference lists from previous related projects were also reviewed, to provide relevant references. The information available was then collated as a narrative review to present the current evidence on the topic.

3. Epidemiology

Research from FIFA,[9–13] UEFA,[6,7,14,15] the English Football Association,[16] the Olympic Games,[13,17] the Royal Belgian Football Association[18] and the US Injury Surveillance System (NEISS)[19] has found that fractures represent 1%–20% of all injuries sustained during soccer. Within the United Kingdom and South-East Asia, soccer results in 45–63% of sporting fractures, and is the most common cause of

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sport-related fracture.[20,21] In the USA however, soccer has been found to be second to American Football, comprising 13% of all fractures sustained during sport.[22]

4. General population

4.1. Site-specific descriptive epidemiology studies

Data from site-specific descriptive epidemiology studies have found that a quarter of tibial diaphyseal fractures are sustained during soccer,[23] with soccer accounting for 80% of sport-related tibial fractures.[24] For other fracture types, the percentage of soccer as a causative sport is: 75% for the ankle[25]; 50% for the distal radius,[26] 44% for the carpus[27]; 33% for the clavicle[28]; 36% for the finger phalanges[27] and 33% for the metacarpus.[27]

4.2. Descriptive epidemiology data

Court Brown et al. published an initial systematic overview of the epidemiology of traumatic soccer fractures in the general population.[20] Within the adult Lothian population, the authors found the incidence of traumatic soccer fractures to be 0.64/1000 population.[20] 6% of all adult traumatic fractures were soccer-related, and 45% of all adult sporting fractures were soccer-related.[20] 66% of fractures occurred in the upper limb, with 34% occurring in the lower limb.[20] Fractures of the distal radius (19%), fracture of the finger phalanges (18%) and fractures of the ankle (11%) were the three commonest locations.[20]

Seven years later, from the same population, Robertson et al. found the incidence of traumatic soccer-related fractures to be 0.71/1000 population.[5] 5% of all traumatic fractures were soccer-related, and 37% of sporting fractures occurred during soccer.[5]

The mean age at fracture was 26.9 years: there were 349 males and 8 females.[5] The recorded level of play was: 5 professional players; 11 semi-professional players; 113 amateur players; 25 school-boy players; and 158 recreational players.[5] There were 2 open fractures (0.5%).[5] Upper limb fractures comprised 68% of the total cohort, and lower limb fractures 32% of the total cohort.[5]

For the upper limb fractures, finger phalanx (21%), distal radius (20%), metacarpal (7%), carpus (7%), and clavicle (5%) were the five most common fracture locations.[5] For the upper limb cohort, fall and goals were the commonest mechanisms of injury.[5]

For the lower limb fractures, ankle (13%), metatarsal (6%), tibial diaphysis (5%), toe phalanx (2%), and distal tibia (1%) were the five most common fracture locations.[5] For the lower limb cohort, tackle and inversion injury were the commonest mechanisms of injury.[5]

These studies demonstrated an increase in incidence of adult soccer-related fractures within the general population (0.64–0.71 per 1000 population).[5,20] This is probably secondary to a region-based increase in soccer participation, likely a reflection of the ever-growing global interest in this sport.[1,2]

Similar findings were reported from US Emergency Department data, with 60% of soccer fractures occurring in the upper limb within the general population.[19] The commonest fracture locations were those of the wrist (18%), lower arm (16%) and fingers (10%).[19] In line with the Lothian data, between 2010 and 2016, the incidences of soccer wrist and shoulder fractures were found to significantly increase.[19]

Data from the Royal Belgian Football Association, covering all registered Belgian soccer players (pre-dominantly amateur), for 1999–2000 and 2009–2010, found that, from 56,364 soccer injuries, 12% (6484) were fractures.[18] There were 1600 (3%) lower leg (LL) fractures, with a mean of '0.03 LL fractures/100 soccer players' for each season.[18] Ankle fractures were the commonest LL fracture (36%), followed by foot fractures (33%), tibial fractures (22%) and fibula fractures (9%).[18] Three-quarters of the LL fractures were sustained during match-play.[18] The key demographic factors for increased risk of sustaining LL fractures were amateur status, older age and male gender.[18]

5. Elite soccer players

5.1. Descriptive epidemiology data

Larsson et al. provided the first overview of fractures in the professional soccer player, through the UEFA Champions League Elite Club Injury Study.[6] This prospectively recorded all fractures from 41 elite male soccer teams in 10 top-tier European Leagues from 2001 to 2013.[6] From 2439 players, 10,255 injuries were recorded, of which 364 were fractures: this included both acute and stress fractures.[6] Fifty-one fractures occurred in the upper extremity, with 163 in the lower extremity and 13 in the spine.[6] The mean age at fracture was 25.2 years.[6]

Traumatic fractures had an incidence eight times ($p < 0.001$) that of stress fractures.[6] Just under half (45%) of all traumatic fractures and seven-eights (86%) of stress fractures were located in the lower limb.[6] By contrast, one-quarter (23%) of all traumatic fractures and no stress fractures were located in the upper limb occurred in the upper limb.[6]

The commonest traumatic upper limb fractures were: metacarpal (7%); finger (3%); clavicle (2%) and forearm (2%).[6] The commonest traumatic lower limb fractures were: metatarsal (16%); ankle (6%); fibula (6%); toes (5%); tibia and fibula (3%).[6] Traumatic spinal fractures comprised 3% of all fractures.[6]

'Match-play' fracture incidence was 12-times higher ($p < 0.001$) than 'training' fracture incidence.[6] The incidence of traumatic fractures did not significantly vary with time of season, playing position or player age.[6]

The discrepancy in fracture location (upper limb vs lower limb) between professional players and the general population (Table 1) is likely multifactorial, reflecting variations in intensity of training and matches, as well as player physiology, health and baseline function.[5,6]

Interestingly, despite the increased rate of lower extremity fractures in professional players, upper extremity fractures constitute a considerable percentage of upper extremity injuries in professional soccer: fractures comprise 59% of all hand, wrist and forearm injuries, with goalkeepers suffering around 30% of such fractures.[29]

6. Management

6.1. General population

Robertson et al. recorded that 80% of traumatic soccer fractures were treated non-operatively, with 20% treated operatively.[5] Tibial diaphyseal fractures (67% treated operatively), ankle fractures (51% treated operatively) and scaphoid fractures (25% treated operatively) had the highest rates of operative intervention.[5] For the upper limb fractures, 89% were managed non-operatively, and 11% were managed operatively.[5] For the lower limb fractures, 62% were managed non-operatively, and 38% were managed operatively.[5]

6.2. Optimising choice of management

There is limited evidence to guide the optimal management of soccer-related fractures.[5,6] For most fracture types, the standard AO principles of anatomic reduction, robust stabilisation and expedient rehabilitation apply. However, there is emerging evidence to guide the

Table 1
Most common soccer-related traumatic fracture locations.

General Population[5]	Elite Players[6]
Finger Phalanx (21%)	Metatarsal (16%)
Distal Radius (20%)	Metacarpal (7%)
Ankle (13%)	Ankle (6%)
Metacarpal (7%)	Fibula (6%)
Carpus (7%)	Toes (5%)
Metatarsal (6%)	Tibia & Fibula (3%)

optimal treatment of sporting fractures[8]: this is in the form of meta--analyses,[30–33] systematic reviews[34] and cohort studies[35] (Table 2). This is particularly relevant for unstable, undisplaced fracture types, in which primary operative intervention may facilitate an accelerated return to sport.[8] Translating this evidence to the field of soccer fractures, the recommended treatment choices are as follows:

6.3. Tibial diaphyseal fractures

For undisplaced tibial diaphsyeal fractures, primary operative management might offer an improved rate of return and time to return to soccer compared to non-operative management.[30]

6.4. Fifth metatarsal base (Jones) fractures

For undisplaced fifth metatarsal base (Jones) fractures, primary operative management might offer an improved rate of return and time to return to soccer compared to non-operative management.[31]

6.5. Scaphoid waist fractures

For undisplaced scaphoid waist fractures, primary operative management might offer an improved rate of return and time to return to soccer compared to non-operative management.[32]

6.6. Middle-third clavicle fractures

For displaced middle-third clavicle fractures, primary operative management might offer an improved rate of return and time to return to soccer compared to non-operative management.[33]

6.7. Metacarpal fractures

Non-operative treatment is the recommended option for non-displaced and minimally-displaced metacarpal fractures.[34] Operative treatment can be the preferred option for displaced fractures of the metacarpus.[34]

6.8. Ankle fractures

Non-operative treatment is the recommended option for undisplaced ankle fractures.[35] Operative treatment is the gold standard choice for displaced ankle fractures.[35]

7. Outcome

7.1. Descriptive epidemiology studies

7.1.1. General population

Robertson et al. found that 86% of traumatic soccer fractures returned to soccer (85% for upper limb fractures, 86% for lower limb fractures).[5] 81% of the operatively-managed fractures and 87% of non-operatively-managed fractures returned to soccer ($p = 0.305$).[5] Clavicle (24%), distal radius (21%), and tibial diaphysis (20%) fractures showed the highest non-return rates.[5]

Of the patients who did not return to soccer (14%), 13 cited symptom-related reasons, and 32 cited personal-related reasons.[5] A high proportion of upper-limb fracture patients cited personal reasons for quitting (84%) as compared to the lower-limb fracture patients (57%).[5] The no-return rate for players aged over 30 years was 26%, while that for players aged under 30 years was 9% ($p < 0.001$).[5]

The soccer mean time of return was 15.0 weeks: that for the upper extremity cohort being 9.2 weeks, and that for the lower extremity cohort being 26.5 weeks ($p < 0.001$).[5] Tibial diaphysis (38.2 weeks), ankle (31.2 weeks) and clavicle (18.2 weeks) fractures demonstrated the highest duration to return to soccer.[5] The operative cohort had a mean soccer return time of 33.9 weeks, while the non-operative cohort had a mean soccer return time of 10.8 weeks ($p < 0.001$).[5]

7.1.2. Elite soccer players

Larsson et al. reported return to soccer data for elite soccer players from the UEFA Champions League Elite Club Injury Study.[6]

For the upper extremity traumatic fractures, the soccer mean times to return were: clavicle fractures - 6.0 weeks; forearm fractures - 5.3 weeks; finger fractures - 3.6 weeks; and metacarpal fractures - 2.7 weeks.[6]

For the lower extremity traumatic fractures, the mean return times were: tibia/fibula fractures - 20.0 weeks; patella fractures - 17.1 weeks; ankle fractures - 12.6 weeks; metatarsal fractures - 11.1 weeks; fibula fractures - 11.0 weeks; knee fractures - 9.4 weeks; tarsal fractures - 10.3 weeks; and toe fractures - 3.7 weeks.[6]

For the traumatic spinal fractures, the mean return time was 3.7 weeks.[6]

Reviewing the two studies, the elite players demonstrated shorter times to return to soccer for a number of locations of fracture compared to the general population (Table 3).[5,6] The reasons are multifactorial, with key factors which likely influence the elite times being: more intensive levels of rehabilitation; more specialised and individualised medical care; higher quality rehabilitation resources; and higher levels of patient motivation, especially due to the financial consequences of time from play.[5,6,8]

8. Site-specific outcome data

The main site-specific outcome studies for soccer-related fractures

Table 3
Mean duration to soccer return by traumatic fracture location.

	General Population[5]	Elite Players[6]
Upper Limb		
Metacarpal	6.7 weeks	2.7 weeks
Finger	6.6 weeks	3.6 weeks
Clavicle	18.1 weeks	6.0 weeks
Lower Limb		
Tibia & fibula	38.2 weeks	20.0 weeks
Ankle	31.2 weeks	12.6 weeks
Metatarsal (acute)	11.5 weeks	11.1 weeks
Fibula	11.0 weeks	11.0 weeks
Toe	7.0 weeks	3.7 weeks

Table 2
Optimal treatment choices: Meta-analyses, systematic reviews and studies.

Fracture Type	Return Rate		p value	Mean Return Time (wks)		p value
	Non-Operative	Operative		Non-Operative	Operative	
Tibial Diaphysis[30]	67%	92%	$p < 0.001$	107.7	38.2	$p < 0.001$
5th Metatarsal Base (Jones)[31]	72%	99%	$p < 0.001$	13.1	9.6	$p < 0.001$
Scaphoid Waist[32]	90%	98%	$p < 0.045$	9.6	7.3	$p < 0.002$
Displaced Middle-Third Clavicle[33]	93%	99%	$p < 0.027$	21.5	9.4	$p < 0.001$
Metacarpal[34]	100%	100%	n/a	3.1	4.1	n/a
Ankle[35]	100%	87%	$p < 0.016$	20	35	$p < 0.001$

are listed in Table 4[24, 26, 36-41]. Data on other fracture types remains limited: a recent study reporting on soccer-related scapula fractures recorded two patients, with sporting outcome data only available for one (return to play: 25.6 weeks).[42] Recent outcome studies have grouped together fracture types from common locations (e.g. lower limb fractures).[2,43] While one such study found that lower limb fractures did not result in the deterioration of elite soccer player performance, such data can be challenging to apply to individual cases.[2]

9. Fracture prevention

Fracture prevention is a pivotal step for the future reduction of the incidence and morbidity of these injuries.[8] The three key areas of fracture prevention are: protective body-wear, adjustment of the playing environment and adjustment of the playing technique.[8] The evidence-base to guide fracture prevention in soccer is limited.[8]

The protective body-wear that has been recommended by FIFA are: shin guards (to protect against tibial diaphyseal fractures) and goal keeper gloves (to protect against hand fractures).[44]

The role of shin guards in protecting against tibial diaphyseal fractures, has been promoted by both laboratory-based[45,46] and clinical-based studies.[8,47] Laboratory-based studies have found that shinguards can absorp up to 95% of the force of impact,[46] and reduce the strain of impact by up to 51%.[45] Epidemiological studies have also found a decreasing proportion of soccer-related tibial diaphyseal fractures: soccer-related tibial diaphyseal fractures comprised a quarter of all tibial diaphyseal cases from 1988 to 1990,[24] a sixth of all cases from 1990 to 1994,[48] and a tenth of all cases from 1997 to 2001.[37] Such findings are believed to coincide with FIFA legalisation on the mandatory use of shin guards in 1990.[47,49]

With regards to shin guards, FIFA recommends that they are of sufficient size to protect the entire surface of the tibia, both length and width.[44] Each players should be individually assessed to ensure their shin guards are of correct dimensions.[44] While most shin guards only provide anterior protection, specially-fitted guards can be custom-made to provide posterior protection as well.[44] Regarding FIFA regulations on shin guards, these are essential for all players in formal competitive matches.[44] While not mandatory during training and unofficial matches, FIFA recommends that coaches and players enforce shin guard use during these events to protect players.[44] FIFA also provides regulations on the quality of shin guard design and composition.[44]

By contrast to shin guards, despite the relatively high proportion of hand fractures among goalkeepers, there is very limited evidence which assesses the value of goalkeeper gloves in preventing fractures.[29]

The influence of environmental adjustments has been preliminary studied, with two papers assessing the role of playing surface on the incidence of soccer-related fractures.[26,50]

For fall-related distal radius fractures, sustained during soccer, Lawson et al. noted that over half (54%) occurred playing on artificial grass pitches, while only a quarter (28%) occurred playing on grass pitches.[26] Eighteen percent occurred playing on cinder, wood or asphalt.[26] Injury data from Major League Soccer found that players had a significantly higher risk of sustaining an ankle fracture on synthetic turf pitches compared to grass pitches.[50] It would appear that synthetic grass pitches may pose an increased risk of soccer-related fracture, when compared to natural grass pitches: potential mediators include an increased rate of falls and an increased impact of injury.[26,50]

Further research should assess the role of boot type and stud configuration in the precipitation of soccer fractures, given the high rates of preceding falls, twisting injuries and inversion injuries prior to fracture.[8] At present, there is no significant evidence to guide adjustment of playing technique, as a mode to avoid soccer-related fractures.[8]

Table 4
Site specific outcome studies.

Study	n	Treatment	Return Rate	Mean Return Times
Distal Radius Fractures				
Lawson et al.[26]	65	–	82%	–
Tibial Diaphyseal Fractures				
Boden et al.[36]	26	Non-op (n = 16) Op (n = 10)	96%	38.0 weeks
Chang et al.[37]	24	Non-op (n = 11) Op (n = 13)	–	25.3 weeks (Non-op 27.6 wks; Op 23.3 wks)
Fankhauser et al.[38]	20	Op (n = 20)	70%	40.9 weeks
Shaw et al.[24]	74	Non-Op (n = 29) Op (n = 32)	93%	40.0 weeks
Fifth Metatarsal Base Fractures				
Baumfeld et al.[39]	34	Op (n = 34)	100%	10.4 weeks
Ekstrand et al.[40]	37	Non-Op (n = 9) Op (n = 28)	84% (Non-Op 33%; Op 100%)	9.5 weeks (Non-op 10.6 wks; Op 11.3 wks)
Stone et al.[41]	21	Op (n = 21)	95%	11.1 weeks

Table 5
Highlights of positive points and negative points.

	Positive Points	Negative Points
Epidemiology	The current literature provides a comprehensive description of the epidemiology of soccer-related fractures in the general population.	Further studies are required to provide a more comprehensive description of the epidemiology of soccer-related fractures in elite soccer players.
Management	The treatment methods of soccer-related fractures in the general population have been well described.	Further research is required to determine the role of treatment adjustment, particularly in the elite soccer player, in order to improve return rates and times to soccer.
Outcome	The current literature provides a comprehensive overview of outcome data for soccer-related fractures in general and elite populations	There is scope to provide more outcome data on rarer fracture types in the soccer player e.g. intra-articular distal tibia (pilon) fractures and tibial plateau fractures.
Preventative Measures	The role of shin guards, in preventing tibial diaphyseal fractures, has been well-described in the current literature, both through laboratory and clinical studies.	There is limited evidence for other fracture protective equipment, particularly the role of goalkeeper gloves in preventing hand fractures.
Future Research	There is a growing body of evidence to support the adjustment of fracture management principles in the athlete, to optimise return rates and times to sport post-fracture. Further soccer-specific research in this area should be encouraged.	Despite the significant morbidity that soccer-related fracture incur, the proportion of soccer injury research, which is based around fractures, remains limited. Future research should be directed towards this topic, given its importance to the soccer player.

10. Areas for future research

Expansion and development of current Injury Surveillance Systems will allow a better establishment of the epidemiology of soccer-related fractures, and will also enable clinicians to assess the influence of injury prevention measures on these injuries.[8]

Future research should focus on defining the optimal treatment modalities for soccer-related fractures: this is particularly relevant for

undisplaced, unstable fracture types, where there may be a role for primary operative intervention, to facilitate an accelerated rehabilitation.[8] With this, further outcome studies can better determine the predicted recovery of soccer-related fractures, facilitating optimisation of treatment and rehabilitation.[8]

Lastly, future research should focus on injury prevention measures for soccer-related fractures, both developing better protective equipment, and establishing the optimal playing environment to reduce the risk of such injuries.[8] Such research should better establish the value of FIFA-recommended protection modalities (e.g. shin guards for tibial fractures and goal keeper gloves for hand fractures) and should explore the role of other potential protective equipment (e.g. ankle braces as protection against ankle fractures and shoulder pads as protection against clavicle fractures).[44]

11. Conclusion (Table 5)

Soccer-related fractures remain a common injury, accounting for up 20% of all soccer-related injuries. They cause significant morbidity, with some lower limb fractures taking over 38 weeks to return to play. Elite players have been shown to return to soccer sooner than amateur players, and this is likely attributed to better rehabilitation and higher motivation. There is a growing body of evidence to support the adaptation of standard fracture management principles (e.g. consideration of primary surgical management for unstable, non-displaced fractures) in soccer players to facilitate a quicker return to sport. Future research should focus on establishing the optimal treatment modalities for these injuries, and defining the optimal methods of fracture prevention.

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Authors contribution

GAJR – Conceptualization; Data curation; Investigation; Methodology; Project administration; Resources; Software; Validation; Visualization; Writing – original draft; Writing – review & editing, KKA – Data curation; Investigation; Methodology; Software; Writing – original draft; Writing – review & editing, BJ - Conceptualization; Methodology; Project administration; Supervision; Writing – review & editing.

Declaration of competing interest

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