A Prospective Video-Based Analysis of Injury Situations in Elite Male Football

Football Incident Analysis

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Background: The mechanisms for football injuries are largely unknown.

Aim: To describe the characteristics of injury situations in elite male football using a video-based method called football incident analysis.

Study Design: Prospective cohort study.

Methods: During the 1999 season, videotapes from 52 matches in the Icelandic elite football league were reviewed. Incidents (N = 95) were recorded when the match was interrupted by the referee because of a suspected injury. Team physical therapists recorded injuries prospectively (N = 28 time-loss injuries).

Results: Duels caused 84 of the incidents, mostly tackling duels (n = 54). The exposed player's attention appeared to be focused away from the opponent in 93% of the cases. The 3 main mechanisms observed were (1) breakdown attacks, tackling from the side or the front, attention focused on the ball (24%); (2) defensive tackling duels, attention focused on the ball or low ball control (20%); and (3) heading duels, attention focused on the ball in the air (13%).

Conclusion: Most incidents and injuries occurred during breakdown attacks and when a player was involved in tackling duels. Player attention appeared to be focused mainly on the ball, not on the opponent challenging him to gain ball possession.

Keywords: football; injuries; match analysis; video analysis; football incident analysis

European football is one of the most popular sports in the world,[27,36] but injuries are common in football as compared with many other types of sports (13-34.8 injuries/1000 match hours and 1.5-7.6 injuries/1000 training hours).[3,14,17,19,23,29,34] Many studies have been carried out to investigate the type, location, and severity of injuries in football,[‖] but information on injury mechanisms in football is limited.[¶] However, a precise understanding of the injury mechanisms and situations leading up to injuries in football is important to be able to develop effective preventive measures. In the previous studies available, players have reported the injury mechanisms mainly through their team physicians, physical therapists, or athletic trainers,[#] although questionnaires completed by the football players themselves have also been used.[11] In elite male players, contact injuries are said to represent 33% to 44% of all acute injuries, and tackling is the most common injury mechanism, leading to 25% to 39% of all acute injuries.[3,23,25,29] Body contact other than tackling is rarely seen as a cause of injury.[3,29] Noncontact injury mechanisms account for 56% to 67% of acute injuries in elite male football, with sprinting, shooting, and kicking as the most frequent causes reported.[3,23,25]

Because acute injuries occur in a split second, it is difficult for players or medical staff to provide exact information on injury mechanisms and playing situations leading up to injuries. A different approach is needed to more accurately describe the circumstances leading to injuries. Video

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¶References 3, 11-13, 16, 23, 25, 26, 29, 30, 33, 39.

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analysis has been used to study the distance covered during matches and the running intensity of football players,[9,31,38] the playing effectiveness of individual players,[21] the effect of foul play on injury risk,[22,24] and, recently, the exposure of players to injury risk.[35] A new method—football incident analysis (FIA)—based on video analysis of injury incidents has been developed at the Oslo Sports Trauma Research Center.[1] The FIA method combines football-specific and medical information to describe injury-risk incidents in football and the events leading up to them. Thus, to provide information that potentially can be used to develop preventive strategies, the aim of this study was to describe the characteristics of injury-risk incidents and injury situations in elite Icelandic football.

MATERIALS AND METHODS

Nine of 10 teams in the Icelandic elite football league during the 1999 football season participated in the present study. One team declined the invitation to take part. Because of weather and field conditions, the Icelandic football season is relatively short, lasting from the middle of May until the middle of September. During the season, the elite league teams played a total of 90 matches in the league (double round-robin format, home and away) and participated in 23 official cup (single-elimination) matches. Of these 113 matches, 52 (46%, 46 from the league and 6 from the cup) were taped in full by the Sports Department of the Icelandic National Broadcasting Service–Television. The team that did not participate in the study played in 4 of these matches, and incidents and exposure related to this team were not included. This means that the total player exposure covered on videotape was 1650 player hours. These videotapes were reviewed by one of the authors (AA, an experienced physical therapist), and injury-risk incidents were transferred to a master videotape for further analyses. An *injury-risk incident* was defined as a situation in which the match was interrupted by the referee, a player lay on the pitch for more than 15 seconds, and the player appeared to be in pain or received medical treatment.[1]

Football Incident Analysis

A football expert (AT, an experienced match analyst) analyzed the master videotape using FIA.[1] Each incident was classified according to predetermined criteria, using 19 variables that have been developed to describe the playing situation in the following categories: (1) the exposed player (eg, playing position, action with the ball, movement direction, and intensity), (2) the injured team (eg, the type of relational skill, including all types of passes), (3) the opposing team (eg, degree of defensive team balance), (4) match (eg, match type, match time, playing phase), (5) attack characteristics (eg, attack type, attacking effectiveness), (6) defensive characteristics (eg, duel type, tackling type, ball winning), (7) playing field (eg, localization and positioning in one-on-one situations), and (8) foul play (eg, foul type, referee's decision).[1]

Injury Registration

The team physical therapists prospectively recorded all injuries that occurred during the season on a special form, which included information about the date of injury, whether it occurred during match or training, player position, injury type, injury location, former similar injuries, the injury mechanism, the duration of absence, and the exact diagnosis. An *injury* was defined as incident causing the player to miss participation for at least the subsequent training session or match. Only injuries that occurred in a football match or during organized training were recorded. The player was classified as injured until he was able to comply fully with all instructions given by the coach.[3-5,28] Detailed information on the injury incidence, injury types, and risk factors for injury has been reported separately.[5] The data from the injury registration were compared with the data from the video analysis to identify which of the incidents could be classified as injuries.

A χ^2 test was used to compare the number of injury-risk incidents and injuries between the 6 quarters of the matches and to compare differences between the attacking phase and defending phase of play in number of incidents and injuries.

RESULTS

A total of 95 incidents occurred during the 52 matches available for this study (ie, on average, 1.0 incidents/team/match or 57.6 incidents/1000 player hours). The team physical therapists recorded 52 acute injuries during these matches (ie, 0.5 injuries/team/match or 31.5 injuries/1000 player hours). Of these, 28 (54%) were identified on video (Table 1). The most common injury locations were the thigh (23%), groin (12%), ankle (12%), and knee (10%) (Table 1). Of the 12 thigh injuries, 7 were anterior or lateral contusions and 5 were hamstring strains. The 6 groin injuries were all adductor muscle strains. All ankle and knee injuries were ligament sprains, except 1 knee contusion. All of the knee and ankle injuries were identified on video, whereas only 4 (33%) of the thigh injuries (3 contusions and 1 strain) and 2 (33%) groin strains were found on video.

Football Incident Analysis

The 95 incidents, including 28 injuries, found on video were distributed evenly through the six 15-minute periods of the matches ($\chi^2 = 2.5$, $P = .18$; overtime injuries were attributed to the final period). A total of 54 incidents (15 injuries) occurred when the team was in the attacking phase, whereas 41 incidents (13 injuries) occurred during the defending phase ($\chi^2 = 1.8$, $P = .18$). In the attacking phase, most incidents (21, 39%) and injuries (7, 47%) occurred in midfield 2, nearest to the attacking zone (Figure 1). In the defending phase, most incidents (20, 49%) and injuries (8, 62%) occurred in the defensive zone (mainly in the middle corridor).

The most common playing formation among the elite league teams in Iceland was 1-4-4-2, that is, 1 goalkeeper,

TABLE 1
Body Location of Acute Injuries During
52 Matches in the Icelandic Elite Football League
Analyzed With Football Incident Analysis[a]

Location of Injury	Identified on Video	Not Identified on Video	Total
Head	1	1	2
Cervical spine	0	1	1
Shoulder	2	1	3
Elbow	1	0	1
Wrist/hand/fingers	1	1	2
Torso	1	1	2
Spine	1	0	1
Groin	2	4	6
Hip	1	3	4
Thigh	4	8	12
Knee	5	0	5
Lower leg	2	1	3
Ankle	6	0	6
Foot/toe	1	3	4
Total	28	24	52

[a]The injuries from 9 of 10 teams were prospectively registered by team physical therapists, and out of these teams, 28 injuries were identified on video and 24 injuries were not identified on video.

4 defensive players (2 fullbacks and 2 central defenders), 4 midfield players (2 wing midfielders and 2 central midfielders), and 2 strikers. If injury risk were the same among the different positions, the expected distribution of incidents and injuries would be 9% for goalkeepers, 36% for defensive players, 36% for midfielders, and 18% for strikers. The observed distribution of incidents was 3% for goalkeepers (n = 3), 36% for defensive players (n = 34), 52% for midfielders (n = 49), and 9% for strikers (n = 9) (Figure 2). The corresponding figures for injuries were 4% for goalkeepers (n = 1), 36% for defenders (n = 10), 57% for midfielders (n = 16), and 4% for strikers (n = 1). This means that the relative proportion of incidents and injuries appeared to be higher than expected among midfielders and lower than expected among goalkeepers and strikers.

Breakdown attack is when one team loses the ball and the opponent team immediately tries to exploit their numerical and positional advantage by attacking as quickly as possible. During breakdown attacks, 52 (55%) incidents and 13 (46%) injuries occurred (Figure 3). This was even more pronounced among fullbacks and wing midfielders (60% of the incidents and 77% of the injuries, respectively). A short pass was the most common team action before incidents (50, 53%) and injuries (10, 36%) (Figure 4). This trend was seen among wing midfielders (14, 64%), central midfielders (16, 59%), and fullbacks (10, 50%), in particular.

A total of 84 of the 95 incidents (88%) and 20 of the 28 injuries (71%) resulted from duels. Of these, 54 incidents (64%) and 13 injuries (65%) occurred during tackling duels (Figure 5A). A tackling duel was the most common mechanism for all playing positions, except for goalkeepers. Of the 54 tackling duels, being tackled from the side (25, 46%)

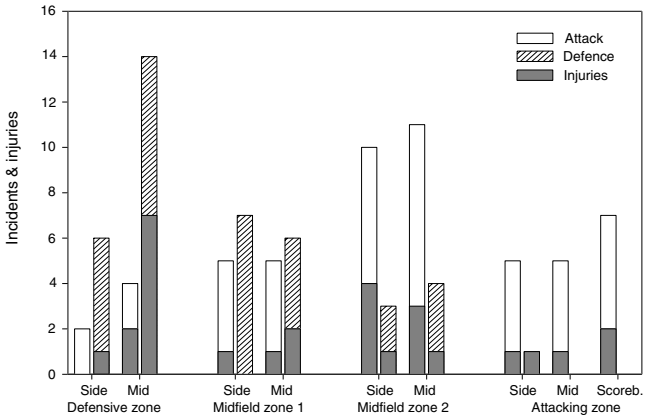

Figure 1. Number of incidents (N = 95) and injuries (N = 28) that occurred during the attacking or defending playing phase in the different zones of the playing field. The defensive zone is defined as the defending third of the field. The midfield zone is the middle third, divided into midfield 1 (nearest to the defensive zone) and midfield 2 (nearest to the attacking zone). The attacking zone is the attacking third of the field. The score box (Scoreb) is a part of the attacking zone, located in the penalty area, and reaches to a line halfway between the 16-m line and the line dividing the attacking and midfield zones. Side corridors (Side) are defined as one third of the width of the field on each side, and the remaining third is defined as the middle corridor (Mid).[1]

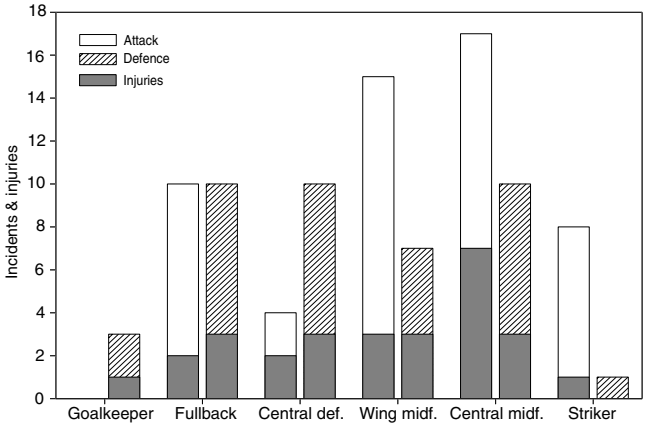

Figure 2. Number of incidents (N = 95) and injuries (N = 28) that occurred during the attacking or defending playing phase for the different player positions. Def, defender; Midf, midfield.

was the most common tackling type causing incidents (Figure 5B).

Most of the incidents (67, 71%) and injuries (21, 75%) occurred during high-intensity (sprinting) or moderate-intensity running. The same trend was seen for all playing positions.

Of the 84 incidents and 20 injuries occurring in duels, the attention of the exposed player appeared to be focused

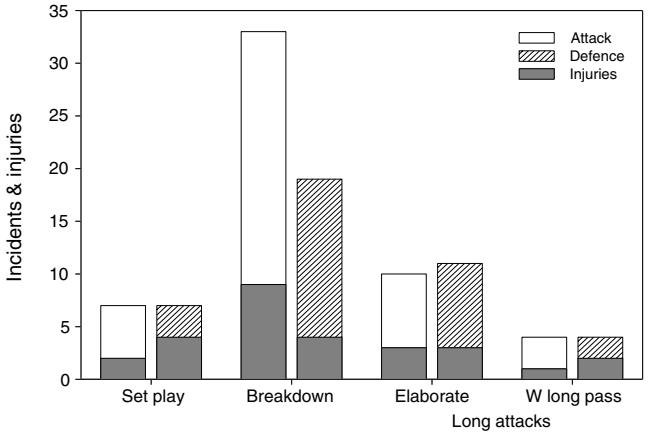

Figure 3. Number of incidents (N = 95) and injuries (N = 28) occurring in different types of attacks (ie, after set plays, breakdown attacks, long attacks without long passes [elaborate], and long attacks including long passes [W long pass]).

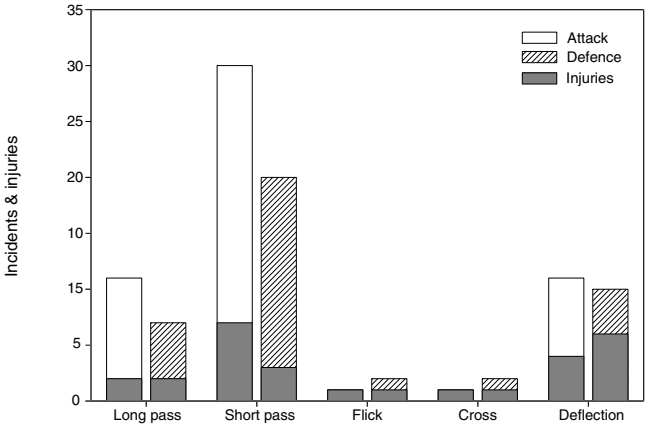

Figure 4. Number of incidents (N = 95) and injuries (N = 28) classified after the last team action (ie, type of passing action by the attacking team) before the incident.

on the opponent challenging him for ball possession in only 6 (7%) of the incidents and 1 (5%) of the injuries (Figure 6). In 76 (90%) of the incidents, including 19 (95%) injuries, player attention was on the ball, which was located on the ground in 53 (63%) incidents and 12 (60%) injuries, and located above the head in 15 (18%) incidents and 3 (15%) injuries. In all of the incidents resulting from heading duels (n = 12), player attention was on the ball above the head. Of the 54 tackling duels, 47 (87%) of the incidents and 11 (85%) injuries occurred when the exposed player's attention was on the ball in front of him.

The degree of ball control for the exposed player was low in 63 (66%) incidents and 19 (68%) injuries. During the attacking phase, 28 (52%) of the incidents and 7 (47%) of the injuries occurred when the exposed player had low ball control. The corresponding numbers for the defensive playing phase were 35 (85%) incidents and 12 (92%) injuries.

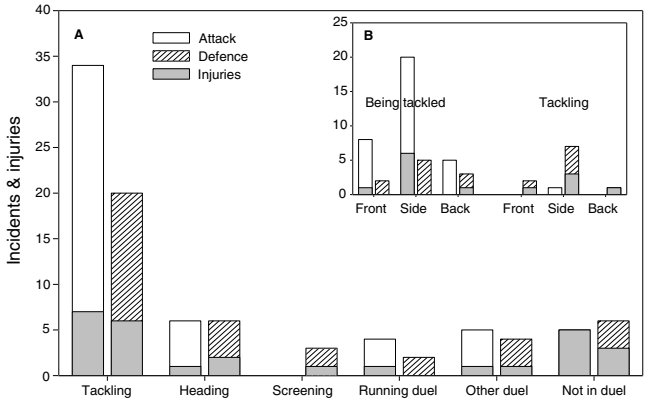

Figure 5. A, number of incidents (N = 95) and injuries (N = 28) in different types of duels that occurred during the attacking or defending playing phase. B, number of incidents (n = 54) and injuries (n = 13) that occurred during tackling duels, which were classified according to the exposed player either receiving a tackle or tackling another player, and the tackling direction.

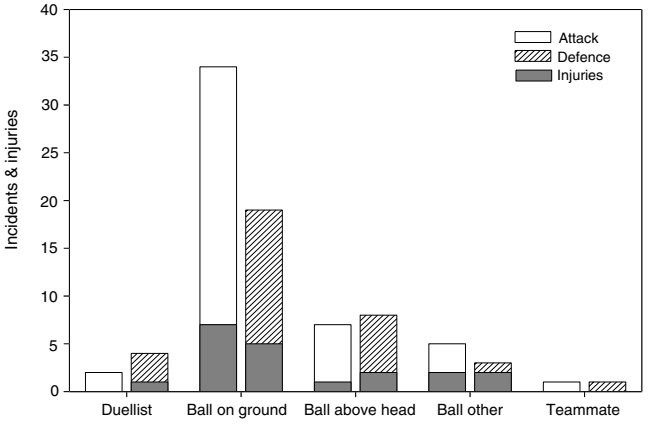

Figure 6. Number of incidents (n = 84) and injuries (n = 20) during duels, classified according to where the attention of the affected player appeared to be directed (on the primary duelist, on the ball on the field, on the ball at head height or higher, on the ball between head height and the field, or on a teammate).

The trend was the same for all of the player positions, except goalkeeper.

Most incidents (83, 87%) and injuries (22, 79%) occurred in situations in which the attack was classified as ineffective with respect to scoring, and more than half of the incidents (57, 60%) and injuries (16, 57%) occurred when the opponent's team defense was in good numerical and positional balance. This was the case for all outfield player positions except strikers, in which the majority of the incidents occurred when the opposing defense was in poor balance (5, 56%), but the attacks were still not effective (8, 89%).

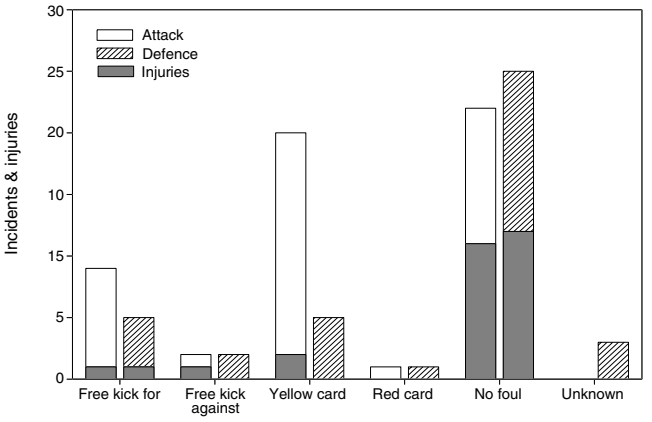

Figure 7. Number of incidents (N = 95) and injuries (N = 28) classified according to the referee's decision during the attacking or defending playing phase.

A free kick was awarded by the referee in 45 (47%) of the incidents and 5 (18%) of the injuries, and of these, 25 resulted in yellow cards and 2 in red cards. As seen in Figure 7, it is interesting to note that nearly half of the incidents that occurred in no-foul situations as judged by the referees resulted in injuries (23, 49%).

From these 95 incidents, 3 compound injury mechanisms were found to be responsible for 57% of all incidents: (1) breakdown attacks with tackling from the side or the front with the attention focused on the ball (24%), (2) defensive player in a tackling duel with his attention focused on the ball or with low ball control (20%), and (3) heading duels with the attention focused on the ball in the air (13%).

DISCUSSION

The main findings of the present study were that most incidents and injuries occurred during breakdown attacks and when a player was involved in tackling duels. The most common event before an incident was a short pass, and a notable finding was that player attention appeared to be focused mainly on the ball on the field or in the air above him, not on the opponent challenging him for ball possession.

Match Analysis

Video-based match analysis has previously been used to assess the effect of foul play on injury[22,24] and to study players' exposure to injury risk.[35] Football is a contact sport characterized by short sprints, rapid acceleration and deceleration, turning, jumping, kicking, and tackling.[8,37] During a 90-minute football match, many situations can predispose a player to injury. Rahnama et al[35] found 17 877 playing actions with the ball during 10 English Premier League matches. Of these, 7667 actions were found to have some injury potential, 600 playing actions were defined as situations with severe injury potential, and 20 injuries were identified. However, they did not describe the injury situations in detail and did not have access to simultaneous medical information.

The FIA method combines football-specific and medical information to provide a more complete description of the injury mechanisms and events leading to incidents in football. In the present study, 0.5 injuries were registered per team per match or 31.5 injuries per 1000 player hours. These findings are in accordance with results from a previous study from the Icelandic league,[3] the Norwegian U-21 national team (0.5 injuries/team/match and 29 injuries/1000 player hours),[1] and the English professional league,[23] but they are slightly higher than the Norwegian elite league teams (0.3 injuries/team/match or 21.5 injuries/1000 player hours)[2] and some other studies from similar playing levels.[18,19,30,34] Some studies have observed higher injury rates during the final 15 minutes of each half,[23,25] which could be due to player fatigue or intense tackles in the decisive periods of a match. We did not observe any difference in the number of incidents or injuries during the 6 quarters of the matches, a finding in accordance with some other studies.[13,35]

The analysis of the incidents using the FIA method did not reveal one particular injury mechanism that could account for a large number of incidents, such as that seen for anterior cruciate ligament injuries in alpine skiing[20] or team handball[32] or the ankle sprains in volleyball.[6] However, 3 characteristic playing situations were observed when analyzing the injury situations: breakdown attacks, defensive tackling duels, and heading duels. A common trend with all of these is that the attention of the exposed player appeared to be focused on the ball in the air or in front of him—away from the opponent challenging him for ball possession.

One fourth of the incidents occurred during the first category of injury situations. Most breakdown attacks started with a short pass, and the striker was tackled from the side or from the front while he was running down the field with his attention focused on the ball. In almost half of these situations, the exposed player had low control of the ball (eg, through passing the ball too far in front of him and inviting a tackle by an opponent in an attempt to win the ball). That many injuries result from duels, especially tackling duels, is in accordance with the findings from other studies.[2,3,23,29]

The second category of incidents was defensive tackling duels in which the defender was injured, accounting for about one fifth of the incidents. These cases were also characterized by a low degree of ball control, and the attention of the injured player seemed to be focused on the ball, not on the opponent challenging for ball possession. The third category was heading duels, in which the player focused his attention on the ball. Although we acknowledge that player attention is difficult to evaluate from the videos, in almost all of these cases, it clearly seemed as if the player was unaware of and unprepared for the subsequent duel by the opponent (or, in the case of several heading incidents, the teammate).

Previous studies have shown that 12% to 29% of injuries in football result from foul play.[22-24] This is in accordance with the findings from the present study, in which foul play

was called by the referee in only 18% of the incidents that led to injuries. However, it is noteworthy that 49% of the incidents in which the referee did not call a foul did cause an injury, compared to only 11% of the incidents in which fouls were called. In other words, the proportion of injuries was considerably higher in nonfoul than in foul situations. This finding calls into question whether rule interpretation by the match referee is adequate protection against injury for players. It also seems relevant to question whether the rules of the game can be improved to safeguard players from potentially dangerous playing situations. More research is needed to answer these questions, both to assess referee performance in injury situations and to understand the direct causes of specific injury types, such as head injuries, ankle injuries, and knee injuries.

When interpreting the results from the present study, there are some methodological issues that need to be addressed. First, although the intrarater and interrater reproducibility of the FIA method is good,[1] it is important to keep in mind that the method only describes the playing events leading to injury—it does not assess the direct causes for specific injury types in classic biomechanical terms. In our opinion, video analysis is a promising tool to analyze the mechanisms of specific injury types, as shown by a recent study on the mechanisms of anterior cruciate ligament injuries in team handball.[32] In the present study, the number of videos of each particular injury type was too small to do this, but FIA is a research tool that should be vigorously pursued to provide more information on injury mechanisms. Second, in the present study, we included not just injuries (defined as time-loss injuries) but also incidents that were believed to carry a high risk of injury (defined as situations in which a player went down on the pitch). As shown by the figures, for most variables the distributions of incidents and injuries were comparable, which serves to support the use of incidents to describe the characteristics of injury situations. Finally, it should be noted that only one half of the acute injuries that were recorded by the team physical therapists during the matches in question were identified on the videotapes. This is important to keep in mind because it means that a video analysis like the one performed in the present study will provide clues to how certain injury types, mainly ankle and knee injuries, occur (all of these were identified on the tapes). Other injury types and their causes will be underestimated (eg, thigh injuries). Minor contusions will not stop the player from continuing the game, although he may be forced to miss the next training sessions if a hematoma has set in. Hamstring strains may also be overlooked on videotapes because they are mainly noncontact injuries—resulting from sprinting, turning, or rapid increases in speed, which do not always take place near the ball.

Perspectives

The findings of the present study may be potentially important in developing preventive strategies. The 3 categories of incidents observed accounted for more than half of all the incidents reviewed on tape. Two factors seem to be of particular relevance in preventing injuries—player attention and ball control (especially the first touch on the ball). Therefore, it may be hypothesized that increasing player awareness of the typical injury mechanisms and teaching them to develop avoidance strategies based on increased player attention and better ball control could reduce the risk of injury. Based on actual game tapes, this could be done on a one-on-one basis with the player, analyzing how he behaves in high-risk situations such as tackling and heading duels. It could be done in the same way that coaches have increasingly used video sessions as a tool to teach playing skills to improve match performance. Such an approach could potentially also be used in groups to improve awareness and to develop avoidance strategies. Such programs have been successful in preventing anterior cruciate ligament injuries in skiing and ankle sprains in volleyball.[7,20]

CONCLUSION

Football incident analysis is a new method that can increase our knowledge of injury mechanisms in football and the events leading up to injury situations. In this study, 57% of incidents found on video could be classified according to 3 compound mechanisms. In these mechanisms, player attention and ball control appeared to be factors that could potentially be important in preventing injuries in football.

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