Video Analysis of Shoulder Dislocations in Rugby

Insights Into the Dislocating Mechanisms

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Background: Mechanisms previously described for traumatic shoulder injuries in rugby may not adequately describe all the mechanisms that result in shoulder dislocations.

Purpose: To investigate the mechanism of shoulder dislocation events in professional rugby players through use of systematic video analysis.

Study Design: Case series; Level of evidence, 4.

Methods: In our series, 39 cases of shoulder dislocations from games played in top professional leagues and international matches across a 2-year period were available for video analysis. All cases were independently assessed by 2 analysts to identify the sequence of events occurring during shoulder dislocation. This included injury circumstance such as contact with another player or the ground, game scenario, injury timing, and the movements and force vectors involved in the dislocation mechanism.

Results: We identified 4 distinct injury mechanisms. The previously described mechanisms ''try scorer,'' ''tackler,'' and ''direct impact'' were identified in 67% of cases. We describe a new injury mechanism occurring in the ''poach position,'' accounting for 18% of all shoulder dislocations studied. The remaining 15% could not be categorized. Shoulder dislocations occurred to a ball carrier in 15% of cases (n = 6) and a non–ball carrier in 85% of cases (n = 33). The injury most commonly occurred during a tackle (49%; n = 19) followed by ruck/maul (26%; n = 10). Time of injury showed that 36% (n = 14) of cases occurred in the last quarter of the game.

Conclusion: Shoulder dislocations have now been shown to occur predominantly as a result of 1 of 4 distinct mechanisms, most frequently in the second half of the game. A new mechanism for shoulder dislocation has been described in this series, termed the poach position.

Keywords: shoulder instability; injury mechanism; rugby; video analysis

Shoulder injuries are the third most common injury in rugby union behind head and neck and lower limb injuries,[2,6,7,12] and the shoulder is the second most commonly injured joint.[14] The shoulder injury group can be further subdivided into hematomas, fractures, acromioclavicular joint injuries, instability-dislocation, and rotator cuff tears.[6,7,14,25] The shoulder has the highest risk of dislocation among all joints during sports.[19] After anterior cruciate ligament injuries, shoulder instability-dislocation is responsible for the most days absent from training and matches in professional rugby union.[6] Thus, shoulder instabilities can have a significant effect on a player's health and career. This highlights the need for a better understanding of injury mechanisms as a first step to possibly reduce the incidence of shoulder instabilities.

Despite this, few studies have systematically investigated shoulder instability and dislocation mechanisms.

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We are aware of only 3 video analysis studies that investigated mechanisms of shoulder injuries in rugby, which included instability and dislocation injuries.[8,20,25] These studies were bolstered by the availability of broadcast quality video recordings of the injuries. One study investigated only 4 cases of first-time primary anterior dislocations, noting that anterior dislocation appears to result from abduction and external rotation. Hyperflexion and internal rotation also appear to put players at risk of anterior dislocations.[20] Another study examined mechanisms of all traumatic shoulder injuries, including shoulder instability, in 24 elite rugby union and rugby league players, of whom 16 experienced a dislocation.[8] The investigators identified 3 distinct mechanisms for traumatic shoulder injuries: the "try scorer," the "tackler," and "direct impact." The third study analyzed 47 cases of shoulder injuries of varying severity, only 8 of which were shoulder dislocations. The main mechanisms of injury were similar to the tackler and direct impact mechanisms.[25]

The current study aimed to use video analysis to describe shoulder dislocation injury mechanisms in elite rugby union players. Our focus was to describe mechanisms of injury and compare them with the previously described mechanisms for all shoulder injuries, while investigating play-specific factors, such as time in the match, pitch location, and player positions.

METHODS

Research Design

A semi-quantitative observational cohort study design was used to identify phase-of-play specific variables relating to shoulder dislocations in professional rugby union using video analysis. All information accessed was already freely available through team websites or previously televised match events, and therefore ethical approval was not required.

Data Collection

A database of shoulder dislocations in rugby games from January 1, 2014, to December 31, 2015, was compiled by use of Google News and Internet searches. Searches covered major club and international competitions and the elite clubs in male rugby union. General searches (eg, "shoulder dislocation injury rugby union"), tournament-specific searches (eg, "shoulder dislocation injury Six Nations"), and club-specific searches (eg, "shoulder dislocation injury Ulster rugby") were applied (see Appendix Table A1, available in the online version of this article). This search method has been used previously for video analysis of anterior cruciate ligament injuries in rugby union.[21] A total of 51 shoulder dislocations were identified in training, preseason games, and competitive matches. Video footage of the 39 cases from competitive matches were obtained for analysis through Optapro Rugby (Figure 1). In total, 9 cases were available with 3 camera views, 6 cases with 2 camera views, and 24 cases with 1 camera view. Where possible, composite videos were created by manual synchronization.

Video Processing

Sportscode Elite version 9.8.3 software was used to cut and process the injury sequences, with all files converted to QuickTime (.mov). QuickTime player (version 7.7.9; Apple) then allowed for a frame-by-frame analysis of the injury. The progressive scan feature of Elgato Turbo .264 was used to de-interlace all videos. As in previous video analysis studies, cases were cut as a sequence containing approximately 10 seconds before the injury event and 2 to 3 seconds after the injury to assess the specific match situation.[21,27]

Video Analysis

To identify the sequence of events leading to the shoulder dislocation, 2 analysts (sports medicine specialists; C.M., D.E.O.) independently assessed all videos in real time and frame by frame. Thereafter, all videos were categorized independently by the analysts using a questionnaire adapted from previous research (Appendix Table A2, available online).[8] This included categorical variables on injury circumstance and the movements involved in the dislocation mechanism.

In addition to assessing the categorical variables, analysts recorded whether the injury occurred through contact with the ground, an opposing player, or a team member. Where there was disagreement, the categorical variables were confirmed by a senior author (C.J.M.) arbitrating the disagreement; this was required in 4 cases.

Each analyst wrote an overall description of each injury mechanism; these were then compared with previously reported mechanisms of injury.

Statistical Analysis

All statistics were calculated through use of IBM SPSS Statistics for Windows, version 22.0 (IBM Corp). Analysis of variance was performed on the distribution of players' age, height, weight, and body mass index across the different injury mechanisms. Chi-square analysis was used to assess affected shoulder and player position (forward vs back) across the different injury mechanisms. Statistical significance was set at the .05 level.

RESULTS

A total of 39 cases were identified in 38 professional rugby players. Video sequences were available for analysis of all identified match injuries. A total of 3 cases could not be fully assessed due to limited camera angles of the injury. Player characteristics are provided in Table 1. The left shoulder was injured in 23 cases (59%) and the right

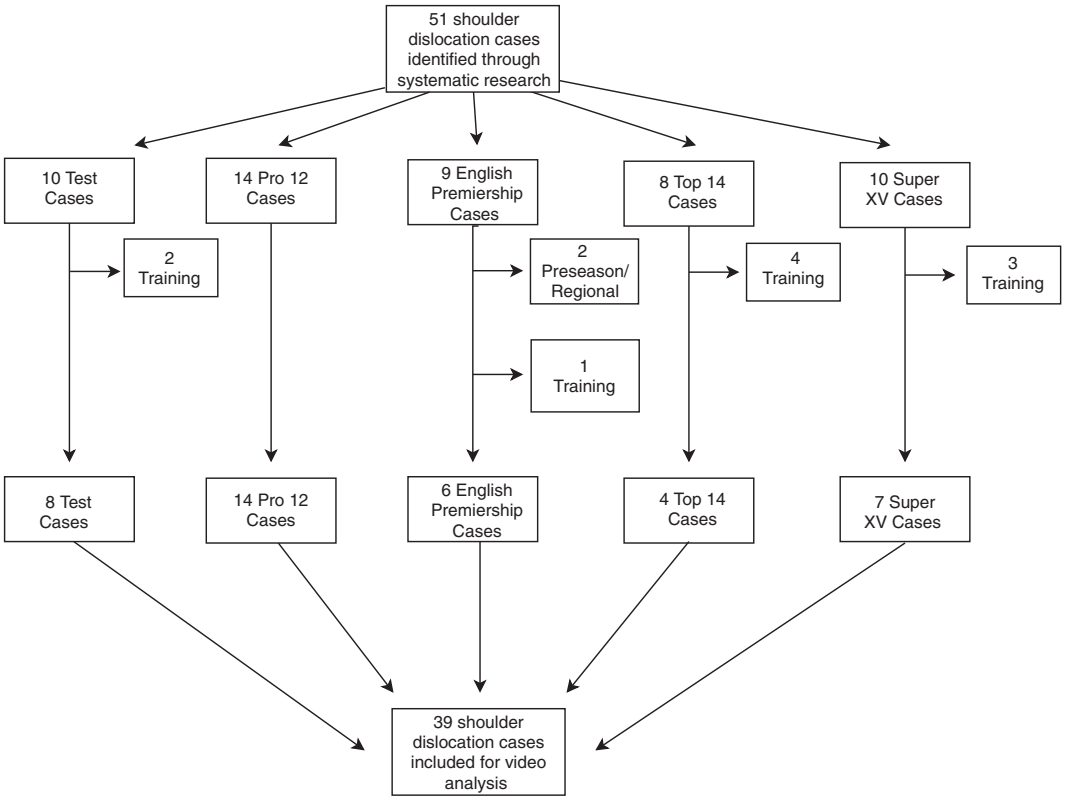

Figure 1. Flowchart outlining the 51 shoulder dislocation cases identified and the screening process used to select the 39 cases of competitive match injuries used for video analysis.

TABLE 1
Player Characteristics

	Mean	Range
Age, y	25.5	20-34
Height, m	1.86	1.75-2.01
Weight, kg	101.2	85-120
Body mass index	29	24.6-34.3

shoulder in 16 (41%). The injury occurred during a tackle in 19 cases (49%), ruck/maul in 10 cases (26%), open play in 6 cases (15%), a scrum in 3 cases (8%), and foul play in 1 case (3%). Of the players injured in the tackle, 14 (74%) were tacklers and 5 (26%) were tackled. The 1 incidence of foul play resulted in an injury to the tackler who committed the infringement.

Players were traveling toward the opposition try line in 29 cases (74%), toward their own try line in 6 cases (15%), and across the field in 4 cases (10%). The injury occurred to a ball carrier in 6 cases (15%) and a non–ball carrier in 33 cases (85%). Forwards were injured in 21 cases (54%) and backs in 18 cases (46%). When injuries were calculated as a ratio of the number of injuries per individual position, hookers and fullbacks had the highest number of injuries with 4 cases (10%) each (Figure 2). The mean time of injury was 46 minutes, with 36% (n = 14) of injuries occurring in the final quarter of the game. However, for 4 of 6 ball

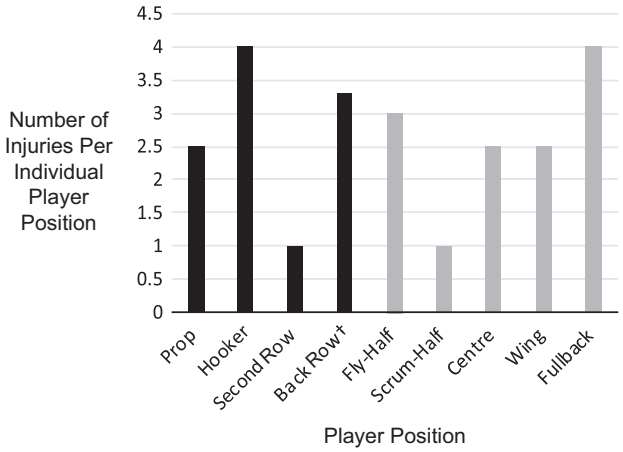

Figure 2. Breakdown of shoulder dislocation cases by position (all positions of multiple players calculated as a ratio for comparative purposes). †*Back row* denotes No. 8 and 2 flankers.

carriers (67%), injuries occurred in the first half. In 20 of 33 non–ball carriers (61%), injuries occurred in the second half with a mean time of 50 minutes. Impact with other players was responsible for 27 cases (69%), and impact with the ground was responsible for 12 cases (31%).

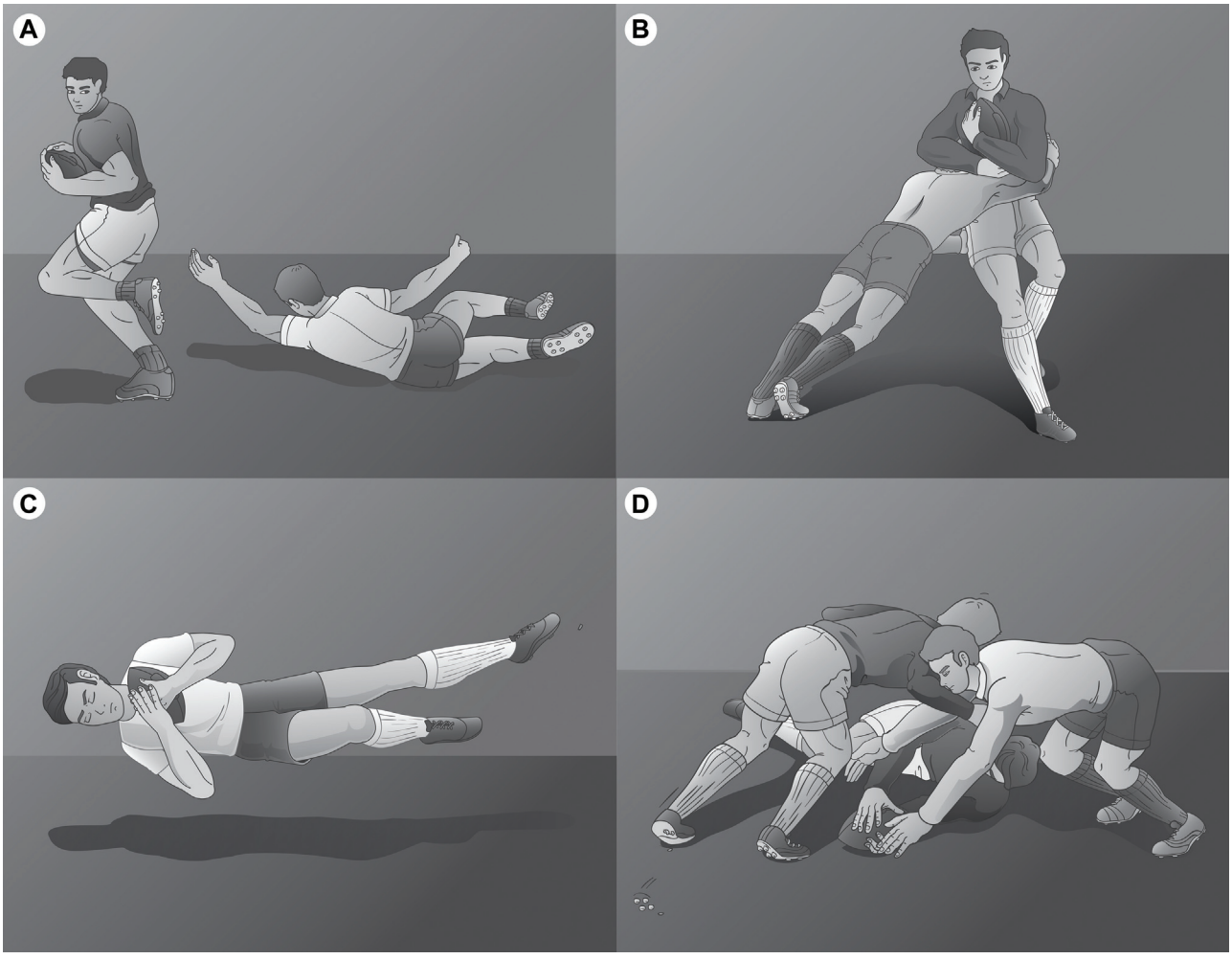

Figure 3. Shoulder dislocation cases in rugby. (A) Diving tackler / Try scorer: the injured arm is flexed more than 90°, and a posterior force moves the arm backward, exerting leverage on the glenohumeral joint, with the arm remaining fixed in flexion or pushed into further flexion. (B) Tackler: the player tackles an opponent traveling toward him. The arm is abducted at 90°. A posteriorly directed force from the opposing player extends the arm behind the injured player in the plane of abduction. (C) Direct impact: the arm is flexed less than 90° or is in a neutral position with internal rotation. A compressive force due to direct impact to the shoulder causes injury. (D) Poach position: characterized by a player in a crouched rucking position with the arm flexed more than 90° at the shoulder, sustaining a direct posteroinferior force from an opposing player.

Of the 39 cases studied, 26 (67%) could be classified into the previously described injury mechanisms of try scorer, tackler, and direct impact (Appendix Table A3, available online). The try scorer mechanism occurred in 9 cases (23%) (Figure 3A). The try scorer mechanism was previously so named due to the player's becoming injured after diving with the ball-carrying hand while reaching forward to score a try. This "try scoring" scenario occurred only twice in our study; the injuries more commonly occurred as players attempted to make a diving tackle before landing on the ground with their arms outstretched (4 cases). The tackler mechanism resulted in 9 injuries (23%) (Figure 3B), and the direct impact mechanism resulted in 8 injuries (21%) (Figure 3C). This was seen in ball-carrying players receiving direct impact to the shoulder from a tackler or in tackled players falling to the ground.

A new mechanism of injury, called the "poach position," was described for 7 cases (18%) (Figure 3D); this mechanism was named after the term commonly used for players crouched over a ruck attempting to secure possession for their team. In all cases, this mechanism occurred to a player in a rucking situation who was attempting to secure the ball with outstretched arms (Appendix Table A3). The poach position differs from the direct impact mechanism in that the arm was flexed more than 90°, most commonly in neutral rotation (Table 2). A further 6 cases could not be categorized into the above 4 mechanisms, 3 cases did not match any of the described mechanisms, and 3 cases were a result of scrums, where poor visualization of the incident was available; all are outlined in Appendix Table A3. Player characteristics for each mechanism are provided in Table 3. No player-specific

TABLE 2
Characteristics of Players Injured by the Poach Position Mechanism (n = 7)[a]

At Initiation of Injury			Further Movement		
Flexion/Extension	Rotation	Abduction/Adduction	Flexed/Extended	Rotated	Abducted/Adducted
Flexion: 7	Internal rotation: 2 Neutral: 5	Abduction: 2 Adduction: 1 Neutral: 4	Extended: 6 No further: 1	Internally: 1 No further: 6	Adducted: 4 No Further: 3

[a]Values are numbers of players.

TABLE 3
Player Characteristics According to Injury Mechanism

Mechanism	Age at Injury, y	Weight, kg	Height, m	Body Mass Index	Shoulder, n	Position, n
Try scorer	24.7	100.2	1.90	27.8	5 Right 4 Left	5 Forwards 4 Backs
Tackler	26.0	98.2	1.86	28.4	1 Right 8 Left	3 Forwards 6 Backs
Direct impact	25.5	95.9	1.84	28.5	4 Right 4 Left	2 Forwards 6 Backs
Poach position	25.7	102.0	1.87	29.4	3 Right 4 Left	5 Forwards 2 Backs

characteristic reached statistical significance in terms of variation across mechanisms (age, $P = .871$; height, $P = .229$; weight, $P = .625$; body mass index, $P = .626$; side of injury, $P = .220$; position, $P = .245$).

DISCUSSION

The most important finding of the present study was the identification of a fourth mechanism of shoulder dislocation, the poach position, which occurred in 18% of the cases analyzed. The identification of this mechanism is important due to the prevalence of rucking in rugby union. This allows for a better understanding of the mechanisms associated with shoulder dislocations in professional rugby union. The poach position mechanism has been described for the first time due to its increase in prevalence after rule changes requiring players to release the ball and/or ball carrier after a tackle and return to their feet before competing for the ball.[16] Previous video analysis studies took place either before or during the rule change.[8,20,25] Identifying a new mechanism gives coaching staff and players the ability to adequately prepare rehabilitation and prevention programs aimed at reducing the potential risks associated with such a mechanism. This is important, as previous attempts at investigating equipment as preventive measures for glenohumeral dislocations have been unsuccessful.[4,13,24] The poach position mechanism has been clearly identified as an increased risk of shoulder dislocation. However, more concerning could be its role in generating progressive instability, often subluxation without reaching a real dislocation through repeated attritional episodes throughout a player's career. Such a situation would be of particular importance, because it would appear difficult to avoid this mechanism in match situations at a professional level without decreasing a player's competitiveness during a ruck or without changing the rules of the game. However, players should be advised to avoid coming into a rucking situation with their arms flexed greater than 90° while attempting to protect the ball from the opposing team. Where possible, players should position themselves so that contact occurs at the shoulder, rather than along the humerus, as arms flexed greater than 90° and contact along the humerus appear to be the main risk factors for this injury mechanism.

Crichton et al[8] initially described the 3 distinct mechanisms for serious shoulder injuries in 24 elite rugby league and rugby union players. However, Longo et al[20] first studied shoulder dislocation in elite rugby players, describing what would become the try scorer and tackler mechanisms. It was suggested that players be advised to avoid tackling their opponents with outstretched abducted arms and instead concentrate on tackling opponent players with internal rotation and antepulsion, thereby taking the main impact at their shoulder, which would reduce the risk of shoulder injury by reducing the lever arm of the applied force.[8,25] Likewise, it was suggested that players should avoid diving for the try line with the ball in hand with an outstretched flexed arm.[8] The results of the current study corroborated these findings, with 67% of our cases occurring as a result of 1 of the 3 mechanisms

previously described.[8] We also identified that a diving tackle with the outstretched flexed arm should be avoided whenever possible.

A player's risk of shoulder instability per tackle or ruck is very low, given that on average more than 200 tackles and 100 rucks occur per game in rugby.[11] However, the cumulative risk in these athletes is high, as demonstrated by the high rate of shoulder instability in rugby.[2,6,14] This indicates that preventive strategies have a role in the reduction of risk to the athlete, despite the low risk at an individual basis. Prevention is particularly important given the high severity of the injury as measured by days absent from training and matches.[6] Although 4 distinct mechanisms were identified in this study, no statistically significant player-specific characteristic was associated with the different injury mechanisms. This suggests that injury prevention programs should target all players. Prospective studies investigating exact numbers of instability cases and the breakdown per mechanism would guide future preventive strategies.

The results of this study show that the tackle is responsible for a substantial proportion (51.3%) of shoulder dislocation events in rugby union, with the tackler sustaining 74% of these injuries. This finding is in keeping with previous research that showed the tackle to be the most common cause of shoulder dislocations in rugby.[14,15,18] Tackling has been reported to contribute to 49% to 77% of shoulder injuries in rugby union, followed by rucking scenarios.[1,6,14,15,18,22,23,25] These studies did not individually report the percentages for shoulder dislocations in the tackle, which may explain why the results of the current study are at the lower end of the range. It is likely that the incidence of other shoulder injuries, such as injury to the acromioclavicular joint, is higher in the tackle scenario. Other studies combining the 2 sports of rugby union and rugby league demonstrated inflated percentages of tackle scenarios, due to the considerably higher number of tackles per player per game in rugby league.[5,10] In addition, rucking is not a feature of rugby league, and therefore studies looking at both sports would have a reduced percentage of rucking injuries.[8,15] Two epidemiological studies reported that the tackle contributed to 66% to 68% of shoulder dislocations, which is higher than the rate seen in our study.[2,23] In the present study, if a player was tackled when in a rucking setting or around a ruck without the ball, it was classified as a rucking scenario. Because video analysis studies eliminate the effect of recall bias, they have a significant advantage over other mechanism of injury studies. In questionnaire studies, players may record rucking or mauling scenarios as having occurred due to a tackle. In fact, it has been reported that up to 37% of athletes are unable to recall the mechanism of injury.[15,26]

In rugby union, forwards are mainly involved in highly physically demanding activities, such as tackles, rucks, and mauls, and have a higher tackle count per game compared with backs.[9,23] However, reports differ as to whether forwards are at an increased risk of shoulder injuries. Headey et al[14] reported an increased risk in tackle-derived shoulder injuries for backs. In other studies, an increased injury rate was seen in forwards compared with backs.[6,17,25] Bohu et al found a closer correlation of injury rates with that seen in the present study, with 55% of injuries occurring to forwards.[2] In our study, playing positions, when calculated as a ratio, showed the positions of fullback and hooker to have the highest number of injuries, 4 times that of scrum-half and second row. This is in keeping with findings by Sundaram et al,[23] who reported fullbacks to be at higher risk and second row to have a lower risk.

The average game time of shoulder dislocation was 46 minutes, with 36% of cases occurring in the final quarter of the game. This finding indicates that fatigue may play a role in shoulder dislocations in rugby union. It also indicates that shoulder dislocations are similar to other shoulder injuries, in that previous studies showed the number of injuries to be significantly higher in the second half compared with the first.[1,3] If we analyze shoulder dislocation cases in players without the ball, the average time increases to 50 minutes. This may be a sign that players fail to prepare themselves for contact situations as successfully in the later stages of the game. Preventive rehabilitation programs aimed at addressing fatigue-related issues may reduce the overall rate of shoulder dislocations in professional rugby, with the greatest effects expected to be seen in the tackler and rucking mechanisms.

Strengths and Limitations

This study is based on 39 cases, identified in the major rugby tournaments over a 2-year period for which analysis was possible. This is a larger sample size than previous studies.[8,20] The cases were evenly distributed among leagues and test matches, with at least 4 cases in each competition. The database was collected by a structured search of worldwide media, but it was not possible to confirm independently that true shoulder dislocations occurred; whether the dislocation was anterior, posterior, or inferior; the extent of associated injuries; or the history of previous injuries. However, we do not suspect any selection bias in the reported results. It is assumed that media reports of shoulder dislocation are reliable due to the long injury absences involved. Only cases that resulted in players' being substituted after the injury were identified. Incidences where dislocations or subluxations occurred but players continued to play may have been missed.

All cases were recorded with at least 1 camera angle. However, the quality was of a varying degree and at times made analysis difficult. The nature of shoulder dislocations and their occurrence in a contact situation also made the analysis more difficult at times. More widespread use of Hawk-Eye multifeed video analysis has occurred since the study period; this technology may provide better visualization of injury mechanisms in future video analysis studies. This technology would have been beneficial in identifying the unclassified cases in our study. The current study considered only injuries occurring in the top professional rugby tournaments and therefore does not address training injuries, injuries in female athletes, or community-level injuries, which may result from different mechanisms than those described. However, although the intensity of the game differs across these different

subgroups, the overarching gameplay is the same, and we suspect that the mechanisms of injury are similar.

CONCLUSION

Shoulder dislocations have now been shown to occur predominantly as a result of 1 of 4 distinct mechanisms, most frequently in the second half of the game. A new mechanism for shoulder dislocation has been described in this series, termed the poach position.

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