8 Rugby

Rugby Injuries

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8.1 Introduction

Rugby is a full contact team sport which has worldwide participation ranging from school games to elite professional tournaments. It is a sport in which individual player fitness including anthropometric and physiological characteristics are vital to the success of the team [1, 2]. It is one of the only contact-collision sports where the rules for women and men are the same [3].

A detailed description of the history and evolution of rugby is a vast topic and beyond the scope of this chapter. However, knowledge of some of the key historical events in this sport should help the reader develop a better understanding of the different formats of the current game and the associated injuries.

8.2 History

The origins of this sport date back to 1823 in Rugby, a town in the midlands area of England. The legendary story of William Webb Ellis, a schoolboy who picked up the ball in a soccer game and ran with it thereby creating an entirely new sport is widely reported [4, 5].

The sport of Rugby Football League originated in the north of England in the mid-1890s, when players of rugby football union demanded expenses in compensation for wages lost when playing [6]. In 1895, following the refusal of their demand by Rugby Football Union, 21 northern clubs broke away to establish their own version of the game. The rules of the new sport were changed radically from that of rugby union, including the abolition of the lineout, a reduction from 15 to 13 players, and the introduction of the immediate 'play-the-ball' after a tackle. These early modifications still form the basis of the modern-day sport of Rugby Football League. In the early 1900s, the sport was introduced to New Zealand, followed shortly by Australia. A dispute similar to the one in England over professionalism gave rise to Rugby League in France and, more recently, the sport has developed in numerous countries worldwide, including Russia, the islands of the South Pacific and South Africa [7].

8.3 Popular Formats

The sport of rugby is played in two major formats (codes), namely Rugby Union (RU) with 15 players per team and Rugby League (RL) with 13 players per team. World Rugby (WR) and International Rugby League (IRL) are the highest governing bodies of RU and RL, respectively. In their 2018 report, WR noted participation of 9.6

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million players in 123 countries [8] whereas IRL noted that the league version is played in over 50 nations, thereby making rugby a global mega sport with growing popularity [9]. A 'sevens' version of rugby with seven team members is also played widely [10, 11].

8.4 Team Composition

8.4.1 Rugby Union (RU): Fifteen Players per Team

Forward positions consist of the following: (1) Hooker (number 2), (2) Loose and tight head props (number 1 and 3), (3) Locks (number 4 and 5), (4) Flankers (number 6 and 7), (5) Eightman (number 8).

The hooker along with the props (loose head and tight head) constitute the front-row forwards. The locks are also referred to as the second-row forwards, and they help lock the scrum together. The number 8 and the two flankers form the back-row forwards.

Back positions consist of the following: (1) Scrumhalf (number 9), (2) Flyhalf (number 10), (3) Wings (number 11 and 14), (4) Inside and outside centres (number 12 and 13), (5) Fullback (number 15).

Players in scrumhalf and flyhalf positions are also known as half-backs. Players in the inside and outside centres and the two players on the wing are collectively referred to as three-quarter backs.

8.4.2 Rugby League (RL): Thirteen Players per Team

Forward positions consist of the following: (1) Prop (number 8), (2) Hooker (number 9), (3) Front-row forwards (number 10), (4) Second-row forwards (number 11 and 12), (5) Loose forwards (number 13).

Back positions consist of the following: (1) Fullback (number 1), (2) Right wing (number 2), (3) Right centre (number 3), (4) Left centre (number 4), (5) Left wing (number 5), (6) Stand-off (number 6), (7) Scrumhalf (number 7).

8.5 Similarities and Differences Between Rugby Union and League

RU and RL have similarities in game duration, field size, and goal posts. However, they also have distinct differences in rules and scoring methodology [5, 12–15]. Information regarding the current rules and regulations including the prescribed dimensions of the playing field, the ball, number, and position of players in the different formats of rugby can be obtained from the aforementioned official and regulatory organisations [5, 12–15]. In general, the match consists of two halves lasting 40 min each and a halftime of 10 min. The ball is advanced down the field by kicking or running with it or can be passed between teammates only by way of backward or lateral tosses. Points are scored by each team for advancing the ball over the opponent team's goal line with differential points awarded for a try, conversion, or goal based on the format of the rugby game. Each player in the team is assigned a particular number. Player positions can be broadly grouped into forwards and backs. The forward players are involved in gaining and maintain the possession of the ball during the course of the match.

As highlighted above, an RU team consists of 15 players, whereas RL has 2 less forward positions with 13 players. The two formats of rugby differ significantly in terms of what happens when players are involved in a tackle situation. When a player is tackled in RU game, the ball is recycled by a ruck or by a maul, with no limit to the number of phases whereas a tackled player in RL game stops play and the team in possession is able to recycle the ball up to six times before the ball is handed over to the opposition [5, 12–15]. Another significant difference between the two formats of rugby is observed when the ball goes out or 'into touch'. In RU game, the play is restarted with a lineout, whereas in RL game, the play is restarted with a scrum, retention, or changeover in possession [5, 12–15].

As the popularity of RU and RL has evolved, there has been an extensive list of players who have participated in both codes of rugby [16, 17]. These skilled players have been collectively referred to as ‘dual-code rugby internationals’ or ‘code converts’ by some authors and include players of both forward and back positions [16–18].

It must be noted that whilst some overlap and similarities exist between RU and RL, the differences between these two formats of rugby also play a role in the injuries sustained by the players. Hence, these factors are discussed in the subsequent sections of this chapter, and whilst we use the term ‘rugby’ to cover both codes, differences relevant to injuries in RU and RL are highlighted as appropriate.

8.6 Unique Mechanics and Risk Factors for Injury

A combination of gameplay manoeuvres and full contact/collision which is inherent to rugby makes the players prone to distinct pattern of injuries. Furthermore, player factors such as the age group, physique, physiology, field position, gender, and the competitive level of the game amongst others influence the characteristic contact situations and subsequent injuries unique to rugby [19–22]. In general, player movements during rugby have been described to be intermittent in nature, with periods of high-intensity activity (contact, sprinting, low- and high-speed running) and low-intensity recovery (standing, walking, and jogging) over two halves of the game [23]. Some of the distinct features and factors relevant to the aetiopathology of injuries in rugby players is discussed below.

8.6.1 Phase of Play

During a rugby game, contact situations can emerge depending on the phase of play [24, 25]. Tackle, ruck, and scrum are the major contact events in RU games and are associated with 50%, 9%, and 4% of all injuries, respectively [26]. Similarly, tackle has been attributed to be the cause of 38–77% of injuries in players during RL matches [27]. These factors are discussed below.

8.6.2 Tackle

Tackle is an important component of the competitive rugby game. However, it has been associated with injury irrespective of the level of competition [28–39]. The unique collision demands of rugby matches make strength a requisite quality for competitors to effectively tolerate the blunt force trauma that occurs in tackles and the physical stress associated with wrestling activities [40]. Tackles occur in open play, often involve relatively high-velocity impacts, and in many cases the tackler and ball carrier have limited time to prepare for the contact situation compared with other events [26, 41]. Current evidence suggests that player speed, mass, type of body contact, momentum, and energy transfer involved during contact are crucial factors associated with injury [21, 28, 42].

The most frequent activity immediately before tackling is striding, followed by sprinting [43]. In an extensive study, Quarrie et al. analysed 140,249 tackles in 434 professional RU matches [42]. They observed that injuries were most frequently the result of high or middle tackles from the front or side, but rate of injury per tackle was higher for tackles from behind than from the front or side. Furthermore, ball carriers were at highest risk from tackles to the head-neck region, whereas tacklers were most at risk when making low tackles. The impact of the tackle was the most common cause of injury, and the head was the most common site, but an important mechanism of lower limb injuries was loading with the weight of another player [42].

Roberts et al. reported that tackles resulted both in the greatest propensity for injury [2.3 (2.2–2.4) injuries/1000 events] and the greatest severity of rugby injuries [16 (15–17) weeks missed/1000 events] [41]. Furthermore, collision tackles (illegal tackles involving a shoulder charge) had a propensity for injury of 15.0 (12.4–18.3) injuries per 1000 events and severity was 92 weeks missed per 1000 events, which were both higher than any other event [41]. Injury risk was higher when being tackled compared with tackling. It has been demonstrated that most tackle injuries to the ball carrier are sustained when the tackler approaches from the ball carrier's peripheral vision [44] or from behind [42, 44].

Garraway et al. noted that 85% of tackling players who were injured were three quarters, and 52% of injuries occurred when the tackle came in behind the tackled player or within his peripheral vision [44]. Either the tackling or tackled player was sprinting or running in all these injury episodes. One third of injuries occurred in differential speed tackles that is, when one player was travelling much faster than the other at impact. The player with the lower momentum was injured in 80% of these cases [44].

In 2010, McIntosh et al. evaluated tackle characteristics in RU and described shoulder tackle as a tackle in which the tackler's shoulder is the first point of contact [28]. Recently, Tanabe et al. studied the role of shoulder position during tackle and the effect on resultant shoulder kinematics and injuries [45]. They reported that with the shoulder tackle as a reference, shoulder abduction on the side of impact was higher in both the arm and head-in-front tackles, whilst shoulder external rotation was lower in the head-in-front tackles. They concluded that kinematics in both the arm tackle and the head-in-front tackle were significantly different from that in the shoulder tackle. They were of the opinion that this may represent a distinct risk factor for shoulder dislocation.

Seminati and colleagues investigated the biomechanics of the shoulder during tackles based on whether it was the dominant or non-dominant side of the RU player [46]. They noted that the peak impact force was substantially higher in the stationary dominant (2.84 ± 0.74 kN) than in the stationary non-dominant condition (2.44 ± 0.64 kN), but lower than in the moving condition (3.40 ± 0.86 kN). Furthermore, muscle activation started on average 300 ms before impact, with higher activation for impact-side trapezius and non-impact side erector spinae and gluteus maximus muscles. They reported that players' technique for non-dominant side tackles was less compliant thereby posing a potential injury risk. Younger players (below 15 years) are engaged in more passive tackles and tend to stay on their feet more than experienced players. Consequently, this cohort players have been reported to have a significantly lower risk of tackle game injury (13%) compared with elite players (31%) [28].

8.6.2.1 Ruck and Maul

Rucks and mauls are phases of play peculiar to RU, and do not occur in RL. A ruck is the phase of play in which one or more players from each team contest the ball on the ground whereas maul is when the ball carrier is in contact with at least two other players on their feet [5]. Together ruck and maul represent intense non-running exertion during a game [47]. When a ruck or maul is executed, the action begins when the participant comes in purposeful contact with another player and ends with their detachment [5]. The number of rucks per match has increased almost fourfold since the introduction of professionalism [48, 49]. The number of mauls per match has decreased during the same period. Both of these changes are likely to be related to the introduction of the use-it-or-lose-it law in 1994. This law increased the risk of losing possession in mauls and made the option of a ruck preferable to that of a maul for the team in possession of the ball. It has been reported that rugby has changed from a maul-dominated to a ruck-dominated game in the post-professional era, as ball in playtime has increased [49]. Furthermore, McLean et al. noted in their study that rucks and mauls outnumbered scrums by 56% and lineouts by 44% [50].

A ruck involves twisting and straining of the upper body and unusual stress on the knees, especially when the ruck becomes unstable and collapses [51]. More than one third of the injuries to forwards and half of the injuries to loose forwards occur in rucks and mauls [52]. Seventy percent of these injuries result from kicking and trampling [51]. Fifty-five percent of the injuries are to the head, neck, and hands, which together constitute only 15% of the body area [51]. Ruck represents 1.6 injuries/1000 player hours and 0.5 injuries/1000 events [41]. It must be noted that rucks contributed the second largest proportion of concussions [41]. Roberts et al. observed that players involved in fulfilling a defensive role in the ruck are more susceptible to concussive impacts [41].

Spinal injuries have been associated with rucks and maul. Scher et al. outlined three different mechanisms in which spinal injuries were sustained during rucks and mauls [52]. These include: (1) forced flexion of the ball carrier's neck, (2) forced flexion of the neck of the player at the bottom of the ruck, (3) head and neck injury caused by charging into a mass of struggling players.

8.6.2.2 Scrum

During an RU game, scrum is the phase of play in which eight players from each team push against each other in a crouched position and contest the ball that is fed in by one team to re-start play [5] (Fig. 8.1). It is a relatively 'controlled' contact event and a highly dynamic activity with the risk of acute injury being moderate but the risk per event is high [53]. Approximately 40% of all rugby-related spinal cord injuries can be attributed to the scrum [53]. Scrums also take place in RL, but are non-competitive and involve minimal force, and therefore are not usually a source of significant injury in RL.

Clayton et al. reported that scrummaging places significant biomechanical demand on players with axial compression forces of approximately 1.8 kN during impact and 1.1 kN during the sustained push phase [54]. They observed that quads fatigue contributed towards increased cervical spine flexion and decreased muscle activation in the trunk during scrum. They hypothesised that a combination of cervical spine flexion, decreased trunk activation and the high axial compressive forces may pose a risk of cervical spinal injuries including disc herniation [54].

Milburn et al. studied the kinetics of scrummaging in university first-grade rugby union players using an instrumented scrum machine

Fig. 8.1 Formation of scrum during rugby match. (Reproduced from Hendricks et al. [55])

[19]. They observed that the primary role of the second row appeared to be application of forward force whereas the back-row ('number 8') forwards did not substantially contribute any additional forward force. However, the side-row contributed an additional 20–27% to the forward force, but at the expense of increased vertical forces on all front-row forwards. Significant amount of force (5761 N) was generated during sustained scrummaging. Interestingly, the sum of the individual player's maximum forward force was noted to be 17,725 N (approximately 1.75 tonnes) or in excess of three times the force recorded for the full scrum [19]. Using electromyography (EMG), Yaghoubi et al. analysed lower extremity muscle function of front-row rugby union players [56]. They noted that the professional props produced more synchronised muscle activation than amateur players. Furthermore, all players produced more synchronised muscle activation against the instrumented scrum machine compared to live scrummage.

In their study, Roberts et al. observed that only a small proportion (5%) of scrums collapse [41]. The propensity for injury during collapsed scrums was four times higher [2.9 (1.5–5.4) injuries/1000 events] and the severity was six times greater [22 (12–42) weeks missed/1000 events] than for non-collapsed scrums. On the other hand, Taylor et al. reported that 31% of scrums in competitive matches resulted in collapse [57]. However, similar to the previous study they noted that injury incidence associated with collapsed scrum-events (incidence: 8.6 injuries/1000 scrum-events) was significantly higher than those scrums that did not collapse (incidence: 4.1/1000 scrum-events).

Scrum is a relatively controllable event. Hence, investigators have suggested that further attempts should be made to reduce the frequency of scrum collapse and injuries associated with it [41, 57]. In January 2007, the IRB implemented a new law for scrum engagement aimed at minimising scrum collapses and the resultant injuries [58]. Fuller et al. attributed the significant reduction in cervical spine injures during scrummage to the positive implementation of this law which is aimed at overall player welfare [59].

8.6.2.3 Running

Running has been reported to be a common mechanism of non-contact injury in rugby [60]. Rugby forwards typically perform 10–15 short distance (10–20 m) sprints during a game, therefore, the initial acceleration over the first 10 m of a sprint may be a critical factor in their performance [61]. Thus, for rugby forwards, the ability to attain maximum speed quickly following a break from the opposition is an important performance requirement for this group.

Gabbett et al. demonstrated that greater amounts of very high-velocity running (i.e., sprinting) are associated with an increased risk of lower body soft tissue injury, whereas distances covered at low and moderate speeds offer a protective effect against soft tissue injury [62]. Sprint activities such as bouts of repeated high-intensity activities completed by players for up to and sometimes longer than 120 s in duration and which are separated by as little as 25 s recovery have a high physiological cost. Prolonged high-intensity intermittent running ability is a significant predictor for the risk of contact injury [63]. Higher physical demands placed on elite players during the first half could result in the earlier onset of physical fatigue towards the end of a match [64]. Body mass and body height of athletes influence sprint running performance [65]. Fatigue and muscle damage accumulate over an intensified competition, which is likely to contribute to reductions in high-intensity activities and work rates during competition [66]. Overall running activities account for 68–93% of hamstring injuries [67, 68].

8.6.2.4 Kicking

The place kick is an important skill in an RU game as it can contribute between 45% and 77% of the total points scored by the team through a penalty kick at goal or through converting a try [69–72]. A player who can produce a longer kick distance is able to attempt a penalty kick or try conversion from a greater fraction of the field of play and hence has a greater opportunity to score [72]. Kicking has been observed to be a common stretch-shortening cycle (SSC) activity [68, 73]. This movement has been associated with injuries notably to hamstrings amongst other structures [68]. Furthermore, hamstrings injuries resulting from kicking are regarded as severe leading to a significant time-loss (36 days) of player activity [68].

It must be noted that the energy demands of scrums/rucks/mauls and tackling are different from those of sprinting and high-intensity running. Nonetheless, they have a high physiological cost as suggested by Austin and colleagues [74]. This fact coupled with a complex interplay of the factors discussed above contributes to the unique injury patterns seen in rugby players.

8.6.3 Physiological Demands on Player

Rugby matches generally consist of two halves, each of 40 min, separated by a 5–10-min recovery period. The players are involved in low-intensity, aerobic exercise, combined with periods of intermittent, intensive anaerobic exercise [75]. Individual players have been shown to cover distances of approximately 5000–8000 m during a game and be involved in 20–40 tackles per match. Maximum oxygen uptake values of around 56 ml/kg/min have been reported for RL players, with no differences between the values of forwards and backs [76]. Forwards have higher body mass, subcutaneous fat and fat-free mass levels than backs [77, 78]. Backs have been found to be quicker than forwards and produce greater leg power output when related to fat-free mass [76].

Data suggests that RU players spend 47% of total time walking and jogging, 38% of their time standing, and 15% of their time in various forms of high-intensity activity [75, 79]. Similar findings have been noted in studies on RL players [75]. The mean distance covered by the backs (7336 m) has been shown to be greater than that covered by the forwards (6647 m) [80]. RL players cover between 5000 and 7000 m during an 80-min match [75]. Whilst the amount of time spent by individual players on low-intensity exercise exceeds the duration of high-intensity exercise, the nature of the high-intensity efforts (involving sprinting, lower and upper-body impacts, and high force generation) is such that the overall intensity of the game is greatly increased. Thus, the various physiological demands on players during rugby games and training period can impact their fatigability and susceptibility to injuries [62, 81–86].

8.6.4 Player Position

Positional roles play an important part in determining the amount of physical and game-specific skill involvement during match play [87–89].

RU forwards are involved in more rucks, mauls, lineouts, and scrums, which require greater body mass, body height, strength, and power in order to be successful [90]. In contrast, the backs' primary role in beating the opposition in open play requires a combination of speed, acceleration, and agility [90]. In their study, Sirotic et al. reported on the performance of professional RL team players based on five positional groups [22]. These groups consisted of backs ($n = 8$), forwards ($n = 8$), fullback ($n = 7$), hooker ($n = 8$), and service players ($n = 8$). They noted that the fullback players completed a significantly higher proportion of the very high-intensity running (VHIR) compared to all other positional groups ($p = 0.017$). Additionally, the VHIR ($p = 0.004$) and sprinting indices ($p < 0.002$) were also significantly greater in the second half of a match for the fullback players. The hooker spent more time jogging than the backs and forwards. The backs spent more time walking than the forwards, hooker, and service players. The forwards, hooker, and service players completed more tackles per minute during a match than the backs and fullback [22]. For forwards, acceleration may be less important, given their higher involvement in the physical contact aspects of the game. Sprinting performance over the shorter distances (10–15 m) is a crucial aspect for the forwards and back players. Hence, player position plays a role in their performance during match and their differential susceptibility to injuries [91, 92].

Several investigators have studied player characteristics in RU [61, 89, 90]. Some of the characteristics of players in certain positions during the game are described below.

8.6.4.1 Forwards

(1) Forwards are generally taller, heavier, and have higher body fat content than the backs with differences of ~5%, ~15%, and ~25%, respectively. (2) Typically, forwards have an endomorphic-mesomorphic physique compared to the backs [93]. (3) Forwards tend to have higher endomorphy and lower ectomorphy than backs, which is probably due to the strength demands placed upon them at the contact situation. (4) Forwards are generally stronger than backs in both upper and lower body due to requirements of strength in scrums and the higher frequency in which the forwards are involved in tackles and ruck situations [89]. (5) Forwards were involved in the ruck/maul/tackle category for a greater duration of time and at a higher frequency than backs [47]. (6) Forwards engaged in 33% more static exertion activities than backs [47].

8.6.4.2 Backs

(1) These players play crucial role in beating the opposition in open play and require speed, acceleration, and agility. (2) RU players in back positions need explosive leg power to be able to accelerate to create opportunities for the wings [94]. (3) Backs cover a greater distance than forwards during a game [94].

8.7 Top Five Rugby-Related Injuries

Several investigators have studied the common types of injuries sustained by rugby players [37, 39, 92, 95–99]. Williams et al. performed a meta-analysis of the published studies and reported the incidence rate from the pooled analysis for the following common types of injuries amongst rugby players [99].

8.7.1 Muscle and Tendon Injuries (40 per 1000 Player Hours, 95% CI 21–76)

This group of injuries is seen most commonly and includes:

8.7.1.1 Muscle Injuries

Injuries to the hip, groin, thigh and calf musculature associated with contusion/haematoma have been reported by several investigators [24, 27, 32, 95, 98, 100–104]. Muscular injuries are the predominant form of injury in rugby players accounting for 20–32% of the overall injury burden irrespective of amateur or professional nature of the game [27, 98, 100, 101, 105–108]. Calf muscle injuries have been reported to be the most common type of scrummaging injury [53].

Hamstring injury is a common problem faced by rugby players with reported incidence rate of 5.6 injuries/1000 player hours [68]. Whilst the majority (93%) of hamstring injuries are new [67], it is estimated that this injury is associated with a high recurrence rate of 25–34% [68, 104]. Hamstring strains are more likely to affect the biceps femoris and commonly occur at the distal myofascial junction [67, 68]. Hamstring strains most commonly occur during running and nearly 60% of recurrent injuries are reported within the first month of the index injury [68]. Furthermore, players in the backline positions who cover greater distance at speed compared to forwards have higher incidence (8.6 injuries per 1000 player hours) of these injuries. Additionally, fatigue, poor flexibility, inadequate warm-up, quadriceps to hamstring strength imbalance, and poor posture have been suggested as aetiological factors [109].

8.7.1.2 Tendon Injuries

High-loading conditions during scrums, mauls, sprinting, tackling, and landing following jumps have been attributed to partial or complete tendon ruptures during rugby [110]. Achilles tendon injuries accounted for 9% of all match injuries and 19% of all training injuries in one study [111]. Furthermore, 35% of these injuries can be recurrent thereby adding to the injury burden. It has been suggested that front-row forwards are susceptible to Achilles tendon injuries given the explosive and eccentric muscle loading patterns experienced during scrummaging [111]. Recently, Brazier et al. have proposed that there is a genetic component to these injuries with inter-individual variability of tendon properties amongst different rugby players thereby resulting in vastly different outcomes [110]. Achilles tendon ruptures are particularly severe injuries and may have a big impact on players as the mean time of return to full fitness has been reported to be 176 days [111].

In general, the knee joint is the most common site of injury in junior RL players [112]. Disruption of knee extensor mechanism has been described in the literature [95, 113]. The reported incidence is 183 injuries/1000 players amongst male professional RL players [113]. Unlike other knee injuries, in a recent review, Awwad et al. noted that majority of the extensor mechanism injuries (73%) in professional RL players occurred during training and were due to insidious causes [113]. However, the players who injured their knee extensor mechanism were the youngest and comparatively had the highest body mass index (BMI) [113].

Tendon and soft tissue injuries of the hand in the form of mallet finger and flexor digitorum profundus (FDP) rupture also referred to as jersey finger have also been described in rugby players [29, 114–116].

8.7.2 Ligament and Joint (Non-bone) Injuries (34 per 1000 Player Hours, 95% CI 18–65)

This group is the second most common type of injuries amongst rugby players and includes:

8.7.2.1 Ligament Injuries

Ankle and knee ligament injuries have been extensively reported in the literature [26, 98, 111, 113, 117, 118].

Injury to the lateral ankle ligament complex is a common injury and accounted for 11% of all match injuries [98] and 15% of all training injuries [111]. The reported incidence is 10 injuries per 1000 player hours [111]. This injury occurs following an inversion/plantar flexion mechanism [98]. Subsequently, the anterior talo-fibular and/or calcaneo-fibular ligaments undergo spectrum of injury ranging from sprain to complete tear [98]. Sankey et al. reported that majority (25%) of lateral ligament complex injuries in their cohort (male professional rugby union players) were grade I sprains whereas grade III sprains were relatively low at 2.4% [111]. In the same cohort, it was noted that ankle injuries were highest in second-row forwards and lowest in back-row forwards.

Roberts et al. reported an injury incidence of 2.4 per 1000 player match hours with the knee joint being the most common site of injury amongst community level rugby players [26]. Both professional male rugby league and rugby union players sustain similar pattern of knee injuries including time to return to play [113]. Common knee ligament injuries involve: (1) medial collateral ligament (MCL) (2) anterior cruciate ligament (ACL).

MCL injuries are well described comprising about 8% of overall injuries [106] with a reported injury incidence of 3.1 injuries per 1000 player hours [95]. Direct blow to the lateral aspect of the knee is a common contact mechanism in MCL injury [98]. The resultant MCL injury can vary in severity from a sprain to a complete tear from its femoral attachment [98]. A significant valgus stress during contact can result in both MCL and ACL injuries [98].

ACL injuries have been reported to constitute about 3% of overall injuries [98]. ACL injuries are relatively less frequent with an incidence of 50 injuries per 1000 players. Nonetheless, ACL injuries account for the longest time to return to play with a median of 236 days [113]. In their study, Dallalana et al. noted that with ACL injury in rugby union players the predominant mechanism of injury was contact based (being tackled, tackling, or general collision) in 86% of injuries [117]. In the remainder 14% of ACL injuries, non-contact mechanisms such as twisting and turning played a role [117]. Twisting of the player's body with a foot fixed in the ground is a common non-contact mechanism for this injury [98]. However, players sustaining a fall subsequent to an ACL injury can land in a valgus position and tear their MCL [98]. Using video analysis technique, Montgomery et al. [118] noted that 57% of ACL injuries occurred in a contact manner. They identified offensive running and being tackled as the two main scenarios of ACL injury with a higher risk to the ball carrier [118]. During non-contact injuries, lower knee flexion angles and heel-first ground contact in a side-stepping manoeuvre were associated with ACL injury [118].

8.7.2.2 Joint (Non-bone Injuries)

Shoulder joint injuries account for between 9% and 17% of all injuries [24, 119, 120]. The reported injury incidence rate is 13 per 1000 player hours [121]. The spectrum of shoulder injuries in rugby players includes haematomas, acromioclavicular joint (ACJ) injuries, instability-dislocation of glenohumeral joint, and rotator cuff tears amongst others [24, 122–124]. Common mechanisms of injury include (1) contact with the ground with the shoulder/arm in horizontal adduction, flexion, and internal rotation (2) impact to the lateral aspect of the shoulder with flexed elbow and the arm at the side [121]. Additionally, Crichton et al. [125] performed video analysis of elite rugby players and described 'try-scorer' (hyperflexion of the outstretched arm such as when scoring a try) and 'tackler' (extension of the abducted arm behind the player whilst tackling) mechanisms of shoulder injury. In a recent study, Montgomery et al. have described a new mechanism of injury (poach position) observed in 18% of all shoulder dislocations [126]. In this position, a player in the crouched rucking position with arm flexed more than 90° at the shoulder sustains a direct postero-inferior force from the opposing player [126].

Usman et al. evaluated shoulder injuries in elite RU matches using the RugbyMed injury database from New Zealand [121]. In addition to injury incidence rate (per 1000 hours), they estimated injury burden (incidence multiplied by severity) of different shoulder injuries and reported it as the number of days unavailable per 1000 hours of play. Injuries to the acromioclavicular joint (ACJ) were noted to have an injury incidence rate of 3.7 per 1000 hours. Dislocation of the glenohumeral joint was relatively less frequent (injury incidence rate of 1.8 per 1000 hours). However, the impact on the players from this injury appeared to be more (373 days unavailable per 1000 hours of play) [121].

Dislocation of interphalangeal joints in the hand amongst rugby players has been described by several investigators [115, 127, 128]. These injuries occur during contact situations like tackle, ruck, maul, and direct impact from the ball [114, 115]. It has been suggested that the vast majority of these are closed injuries treated on the field with a small proportion being open dislocations that seek medical attention [114]. Knee joint chondral and meniscal injuries have also been described in the literature [113].

8.7.3 Injuries of Central and Peripheral Nervous System (Eight per 1000 Player Hours, 95% CI 4–15)

Injuries to the central and peripheral nervous system are relatively less common. However, they may be associated with significant morbidity to the players. The common types of injuries in this group include:

8.7.3.1 Central Nervous System

Concussion is a common injury experienced by rugby players. The rugby tackle has been reported as the most common cause for concussion [21, 107, 108, 129–131], with the tackled player relatively more at risk of injury than the player making the tackle [132]. Using wireless head impact sensor, King et al. reported linear acceleration range of 10–123 g with a rotational acceleration range of 89–22,928 rad/s^2 during head impacts amongst junior rugby league players under 11 years of age [133]. They reported an average of 13 impacts per player per match with the aforementioned forces at play during such impacts.

Following a systematic review of the topic, Gardner et al. have reported incidence rates of concussion in both RU [134] and RL [135]. In men's rugby-15 s they reported an incidence rate of 4.73 and 0.07 per 1000 hours for match play and training, respectively. However, the incidence rate was relatively lower at 3.01 and 0.55 for the sevens and the women's 15 version of the game, respectively. Furthermore, they observed that the incidence of concussion varied considerably between levels of play with the sub-elite level having highest incidence of injury (2.08 per 1000 player match hours). They noted a similar rate of concussion between forwards and backs in men's rugby-15 s at 4.02 and 4.85 concussions per 1000 player match hours, respectively. During RL matches, the incidence rate for concussion has been reported to vary widely from 0 to 40 per 1000 playing hours.

The incidence rate for concussion in children and adolescent players in RU games is 0.2–6.9 per 1000 hours whereas in RL games it varies between 4.6 and 14.7 per 1000 hours [136]. Similarly, the probability of a player sustaining a concussion in the same cohort over a season is 0.3–11.4% and 7.7–22.7% for RU and RL, respectively [136]. Semi-professional RL players have concussion injury risk which is threefold and 600-fold greater compared to their amateur and professional counterparts, respectively [137].

The wide variation in the reported incidence rate of concussion is due to a combination of factors including the inconsistencies in definition of injury (time-loss vs. no time-loss), sampling and methodology of the included studies [135]. Hence, following the IRB pilot study [138], World Rugby has subsequently introduced a guideline with three-stage diagnostic process and assessment criteria to identify or rule out concussion within 48 hours of injury [139].

8.7.3.2 Peripheral Nervous System

Common peripheral spine injuries include facet fractures, disc injuries, and nerve root compressions. Additionally, acute spinal cord injuries (ASCI) have been reported by several investigators [140–143].

In general, injuries to the cervical spine are rare [59, 144] compared to other injuries. Carmody et al. reported average annual incidence of ASCI at 3.2 and 1.5 per 100,000 players for RU and RL, respectively [140]. However, they are among the most serious form of injuries noted in rugby players and are associated with poor outcomes [144]. The most common mechanism of injury is hyperflexion of the cervical spine with subsequent fracture dislocation of C4–C5 or C5–C6 [144]. Investigators have reviewed several external (phase of play, time of season, coach input, referee control of game, pitch, and environmental conditions) and player-related (age, gender, ethnicity, position, skill, anthropometric parameters, visual acuity, physiological and psychological characteristics) risk factors to evaluate spinal injuries [59, 143–146]. The majority of these injuries have been noted to occur early in the season which is due to a combination of the grounds being harder and the players lacking adequate conditioning for physical contact phases of the game [144]. Earlier studies suggested that these injuries were sustained by the forward players (predominantly the hooker) during scrum [19, 143–145]. Additionally, the scrum has been the cause of other spinal injuries (56% of thoracic, 71% of lumbar) in rugby players [53]. However, following the rule changes to 'de-power' the scrum by controlling the engagement, the risk of cervical spine injury is now relatively higher during tackle than scrum [147, 148].

8.7.4 Injuries from Bone Stresses and Fractures (Four per 1000 Player Hours, 95% CI 2–8)

Whilst relatively less frequent, this group constitutes more severe degrees of injury in terms of time-loss (42 days, 95% CI 32–51) [99]. This group of injuries includes fractures involving: (1) Axial spine, (2) upper limb, and (3) lower limb.

Cervical spine fractures associated with spinal cord injury in rugby have significant morbidity [59, 144, 148–155] and in rare cases mortality [156] associated with them. Using a porcine biomechanical model, Holsgrove and colleagues demonstrated that lordosis of the cervical spine was a key factor for anterior fractures of the vertebral body and bilateral dislocation with facet fractures [157]. They observed that the anterior fractures resulted from tension in the cervical vertebral bodies following the buckling of the cervical spine in extension [157]. Furthermore, they suggested that a large axial load transfer from the head to torso with severe movement constraints as noticed during improper engagement during scrummaging could potential cause these injuries [157]. Thoracic and lumbosacral spine injuries including stress fractures in rugby players have been described by several investigators [158–163].

Fractures involving the forearm, wrist and hand/finger account for 90% of all upper limb fractures [128]. Similar findings have been reported in a prospective cohort study of rugby players across various competition levels as part of the Rugby Union Injury Surveillance Study (RUISS) [164]. Furthermore, fractures were one of the most common form of injury to the upper limb, occurring in 17% of the cases [164]. Sixty percent of upper limb fractures occur during tackle and are seen in wing- or prop-forward positions [128]. However, the prognosis with these injuries is relatively better, with Robertson et al. reporting that 94% of players with upper limb fractures were able to return to sport by 6 months following the index injury [165].

Lower limb fractures are relatively less common, accounting for 0.8–1.8% [111, 166] of overall injuries. Nonetheless, they are associated with significant morbidity and time-loss ranging between 118 and 471 days [111, 167].

8.7.5 Laceration and Skin Injuries (One per 1000 Player Hours, 95% CI 1–3)

Lacerations to the head and face are common injuries amongst rugby players [98]. Several factors including studs have been suggested in the aetiology of skin lacerations [168]. Following their meta-analysis, Oudshoorn et al. defined the mean skin injury prevalence of 2.4 and 0.06 injuries per 1000 exposure hours during match and training sessions, respectively [169]. They noted that amateur players were more likely to sustain skin injuries during training sessions compared to professional rugby union players.

8.8 Epidemiology (Prevalence and Incidence of Injury)

Amongst the various team sports, rugby has been reported to register one of the higher overall rates of injury (69 per 1000 playing hours) compared to soccer (28 per 1000 playing hours) and ice hockey (53 per 1000 playing hours) [170]. This has been attributed to greater player size, speed with multidirectional nature of play, increased competitiveness, more aggression, and also foul play [171]. Additionally, rugby as a sport has well-established injury surveillance systems enabling documentation of training and match-related injuries to players on a regular basis [110, 120, 166, 172–179].

One of the limitations in the available literature is that the definition of injury used by different investigators has varied considerably [31, 51, 95, 101, 180–183]. Definitions ranging from the need for on-field assessment and/or treatment, to attendance at medical stations after the game, to missed games and/or training sessions have been highlighted by authors who have reviewed the epidemiological data on rugby injuries [39, 95, 184]. It has been suggested that each definition changes the 'injury' characteristics. Hence, inclusion of match injuries will increase the rate and include more minor soft tissue injuries and concussion. Contrarily, exclusion of match injuries and focusing on injuries resulting in loss of playing or training time will bias the injury patterns towards the more serious spectrum of musculoskeletal and neurological injuries [39, 135].

The International Rugby Board (IRB) established a Rugby Injury Consensus Group (RICG) to reach an agreement on the appropriate definitions and methodologies to standardise the recording of injuries and reporting of studies in RU. Subsequently, a consensus statement was published by Fuller and colleagues [185]. This document provides definition of injury, recurrent injury, and non-fatal catastrophic injury together with criteria for classifying injuries in terms of severity, location, type, diagnosis, and causation [185]. The following definition of injury was accepted:

> Any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as a 'medical-attention' injury and an injury that results in a player being unable to take a full part in future rugby training or match play as a 'time-loss' injury.

Irrespective of the methodological variabilities in the epidemiological studies of rugby injuries, certain general points can be inferred as below:

1. Overall there is a higher incidence of injuries reported in RU and RL compared to other team sports [30, 166, 176, 186–190].
2. Amateur players and professional players have been reported to have different injury risk (Tables 8.2, 8.3, 8.5, and 8.6) [191, 192].
3. The incidence of RL injuries typically increases as the playing level is increased [192]. In a recent meta-analysis examining RU, Yeomans et al. reported match injury incidence rate of 46.8 and 81 per 1000 player hours for amateur and professional cohorts, respectively [29].
4. The sevens version of the game has higher incidence of injuries compared to 15 member team format in women [189, 193] and men [34, 194, 195].
5. Injuries are most commonly sustained during tackles [28, 189, 196].
6. Player fatigue and overexertion are amongst the most common cause of injuries sustained during training [192, 197, 198].

It is apparent from the above that the dynamics of the game and consequently the risk of injury to players in the two popular formats of rugby such as RU and RL is considerably different. Therefore, a brief summary of studies describing the injury incidence in RU (Tables 8.1, 8.2, and 8.3) and RL (Tables 8.4, 8.5, and 8.6) players at different competitive levels has been presented separately below.

Table 8.1 Rugby union—summary of injury incidence amongst school/junior players (<19 years)

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Sparks [199]	England	1950–1979	13–18	19.8
Davidson [200]	Australia	1969–1986	11–19	17.6
Nathan et al. [201]	South Africa	1982	10–19	8.2
Garraway [186]	Scotland	1993–1994	Under 16 18–19	3.4 8.67
Garraway et al. [202]	Scotland	1993–1994 1997–1998	Under 16 16–19 Under 16 16–19	4.6 10.4 10.8 16.8
McManus et al. [203]	Australia	1997	Under 16	13.26
Durie [204]	New Zealand	1998	Under 19	27.5
McIntosh et al. [39]	Australia	2002	Under 15 Under 18	40.4 52.6
Palmer-Green et al. [205]	England	2006–2008	16–18 (academy) 16–18 (school)	47 35
Nicol et al. [206]	Scotland	2008–2009	11–18	10.8
Leung et al. [207]	Australia	2016	Overall 17–18 14–16 10–13	23.7 14.8 34.9–49.2 9.1–15.5
Pringle [208]	New Zealand	NR	6–15	15.5

NR not reported

Table 8.2 Rugby union—summary of injury incidence amongst amateur/semi-professional players

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Bird et al. [166]	New Zealand	1993	Amateur	
			Senior A	14
			Senior B	10.7
Garraway et al. [186]	Scotland	1993–1994	Amateur	13.95
Schneiders et al. [119]	New Zealand	2002	Amateur	52
Chalmers et al. [209]	New Zealand	2004	Amateur	
			Senior A	15.4
			Senior B	10.5
Roberts et al. [210]	England	2009–2012	Amateur	16.6
Lopez et al. [211]	USA	2010	Sevens	55.4
Swain et al. [212]	Australia	2012	Amateur	52.3
Falkenmire et al. [213]	Australia	2016	Amateur	164

Table 8.3 Rugby union—summary of injury incidence amongst professional players

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Bathgate et al. [181]	Australia	1994–2000	Elite–15	74
Jakoet et al. [214]	International	1995	Elite–15	32
Targett et al. [215]	New Zealand	1997	Elite–15	120
Garraway et al. [202]	Scotland	1997–1998	Elite–15	68
Holtzhausen et al. [216]	South Africa	1999	Elite–15	
			Match	55.4
			Training	4.3
Best et al. [120]	International	2003	Elite–15	97.9
Brooks et al. [217]	England	2003	Elite–15	
			Match	218
			Training	6
Brooks et al. [24]	England	2003	Elite–15	
			Match	91
Brooks et al. [122]	England	2003	Elite–15	
			Training	2
Fuller et al. [173]	International	2007	Elite–15	
			Match	84
			Training	4
Cruz-Ferreira et al. [34]	International	2010–2013	Sevens	101.5–119.8
Fuller et al. [174]	International	2011	Elite–15	
			Match	89
			Training	2
Fuller et al. [175]	International	2015	Elite–15	
			Match	90.1
			Training	1

Table 8.4 Rugby league—summary of injury incidence amongst school/junior players (<19 years)

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Gabbett et al. [218]	Australia	NR	17–19	56.8
King et al. [219]	New Zealand	2005	Under 16	217.9
King et al. [219]	New Zealand	2005	Under 18	216
Estell et al. [183]	Australia	NR	Under 19	405.6
Estell et al. [183]	Australia	NR	Under 17	343.2
Estell et al. [183]	Australia	NR	Under 15	197.8

Table 8.5 Rugby league—summary of injury incidence amongst amateur/semi-professional players

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Gabbett et al. [105]	Australia	2000–2001	Semi-professional	
			Training	105.9
			Match	917.3
Gabbett et al. [100]	Australia	1995–1997	Amateur	160.6
Gabbett et al. [101]	Australia	2000–2001	Semi-professional	824.7
King et al. [220]	New Zealand	NR	Amateur Training	22.4
Gabbett et al. [108]	Australia	2000–2003	Semi-professional	55.4
Babic et al. [180]	Croatia	NR	Amateur	18.22

Table 8.6 Rugby league—summary of injury incidence amongst professional players

Author	Location	Study period	Age group/game type	Injury incidence (rate of injury per 1000 playing hours)
Gibbs et al. [106]	Australia	1989–1991	Professional	44.9
Stephenson et al. [221]	England	1990–1994	Professional	114.3
Seward et al. [104]	Australia	1992	Professional	139
Hodgson Phillips et al. [222]	UK	1993–1996	Professional	462.7
Gissane et al. [223]	Europe	1996	Professional	50.3
Gissane et al. [224]	International	1990–2000	Professional	
			First	40.8
			Reserve	38.9
			Overall	40.3
Estell et al. [183]	Australia	NR	Professional	210.7

8.9 Anatomic Locations of Common Rugby Injuries

The majority of the injuries (30–55% of injuries) in rugby players affect the lower limb [24, 34, 98, 167, 176, 181, 182, 210]. Head and spine (14–30%), upper limbs (15–20%), and trunk (10–14%) are the other common location of injuries [225] (Fig. 8.2).

Amongst professional players, the head (including concussions) is the most affected part of the body (25%), followed by the knee (14–20%), thighs (13–19%), and ankle (11%) [24, 111, 117, 225]. Roberts et al. noted that in professional rugby league players, the lower limb was the most common injury site for rucks, mauls, lineouts, scrums, and tackles [41]. However, the upper limb was the most common site for tackling injuries. Furthermore, they reported a higher incidence of upper limb injuries to the tackler compared with the tackled player ($p < 0.001$) and a higher incidence of lower limb and trunk injuries to the tackled player (both $p < 0.001$).

Lower limb injuries represent a high proportion of injuries because the fundamental elements of the game involve running and lower limb tasks such as acceleration, deceleration, tackling, and impact [109].

8.10 Unique Prevention Plans to Avoid the Most Common Injuries

Injury prevention in the different formats of rugby has been the focus of authorities and investigators alike [63, 209, 226–231]. Some of the salient aspects of injury prevention in rugby are presented below:

8.10.1 Contribution of International/National Governing Bodies

Injury prevention in rugby has been recognised as priority area for research and the major governing bodies including World Rugby and Rugby League International Federation have reviewed the regulations of the game and promoted systematic research in this area [173, 175, 230, 232, 233].

At a national level, the following initiatives have been undertaken with systematic research into prevention of catastrophic injuries and subsequent programmes:

1. South Africa—BokSmart was launched in 2009 [226, 234]. This programme consists of mandatory biennial courses aimed at coaches

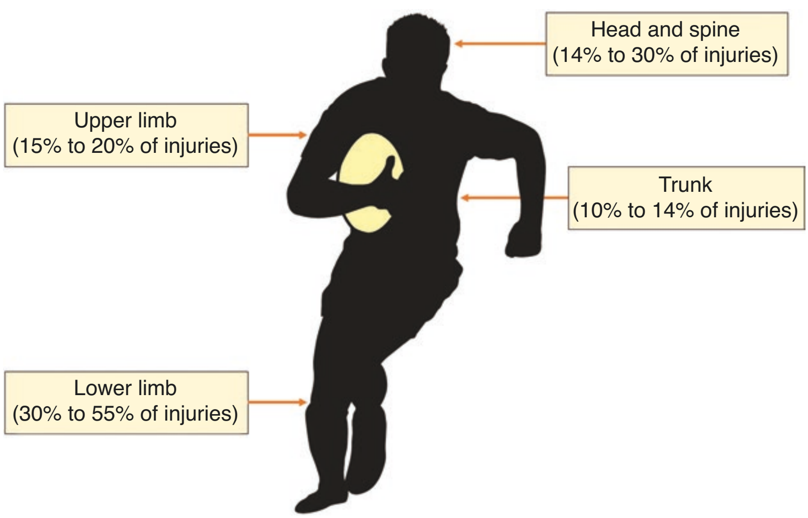

Fig. 8.2 Anatomic locations of rugby injuries

and referees [235]. It has been associated with injury prevention behaviour amongst players and an overall decrease in catastrophic injuries in junior rugby players in South Africa [236, 237].

2. New Zealand—RugbySmart was launched in 2001 as a joint project between New Zealand Rugby Union and Accident Compensation Corporation [238]. Annual completion of the RugbySmart requirements was compulsory for all coaches and referees in order to continue with the job. This programme has been associated with reduction in number of spinal injuries [239] and injuries to the neck and back following safe scrum engagement that was implemented as part of it [58].
3. England—FMC:RUGBY project, a collaboration between Rugby Football Union and University of Bath is involved in the development of warm-up and training programmes to minimise injury risk [184].
4. Australia—SmartRugby is an occupational health and safety programme operated by Australian Rugby Union [184].

Van Mechelen and colleagues proposed a sports injury prevention model in 1992 [240]. It consists of four steps: establish the extent of the problem, establish the aetiology, and mechanism of the sports injury, introduce preventive measures, and evaluate the effectiveness of prevention strategies by repeating step one [240]. It must be noted that amongst the aforementioned programmes, only BokSmart and RugbySmart have completed all the four steps [184]. Hence, this will continue to be an area for further research and development.

8.10.2 Protective Equipment-Based Studies and Their Evidence

Several investigators have evaluated the feasibility and effectiveness of protective equipment as part of injury prevention strategy in rugby [241–247]. However, current evidence suggests that protective equipment (headgear) does not significantly reduce the risk of injuries including concussion [134, 245, 246] or spinal injuries [59]. Some studies have found mouthguards to be beneficial [248–250] whereas others [245] have found no significant difference in the reduction of orofacial injuries. Given the variability in literature, some authors have suggested that this equipment may play a 'protective' role and not necessarily a 'preventive' role in injuries and that their use needs to be encouraged [250–252]. As a part of player welfare, WR have enlisted performance specifications and general requirements for body padding, headgear, and goggles amongst other equipment [253].

8.10.3 Injury-Specific Programmes and Plans

8.10.3.1 Concussion

Over the course of a season, the probability of concussion to a child or adolescent rugby player is between 0.3% and 11.4% in rugby union and 7.7% or 22.7% in rugby league [136]. There is evidence to support educational programmes of coaches and referees to prevent concussion on rugby union [254]. It must be noted that the majority of the current evidence has been generated from just four rugby playing countries (Australia, New Zealand, South Africa, and UK) [136]. Furthermore, given the differential popularity between the two rugby codes, most of the current literature is based on rugby union [136]. Nonetheless, the scope for targeted injury prevention programmes and the beneficial impact of such programmes in limiting concussion injury is obvious [255].

Following the IRB pilot study [138], World Rugby has subsequently introduced a guideline with three-stage diagnostic process and assessment criteria to identify or rule out concussion within 48 hours of injury [139]. Currently, the fifth edition of the Sport Concussion Assessment Tool (SCAT5) is recommended for players who are 13 years of age or older whereas the child SCAT5 is intended for use in players aged 5–12 years [255]. In a recent systematic review, Patricios et al. reported that the overall strength of evidence examining sideline screening tools was very low [256]. Hence, given the lack of definitive evidence confirming the diagnostic accuracy of sideline screening tests, the authors recommended the use of consensus-derived multimodal assessment tools such as SCAT [256].

8.10.3.2 Cervical Spine Injury

Scrum has been phase of play associated with cervical spine injuries during RU games in the past [257]. In January 2007, the IRB implemented a new law for scrum engagement aimed at minimising scrum collapses and the resultant injuries [58]. Fuller et al. attributed the significant reduction in cervical spine injures during scrummage to the positive implementation of this law which is aimed at overall player welfare [59]. It has since been included in the mandatory RugbySmart programme for coaches and referees in New Zealand [58, 238]. Isometric neck strengthening programmes have been demonstrated to improve neck strength in RU players with a potential to minimise the risk of cervical spine injuries [258–260].

In comparison to RU, majority of the cervical injuries in RL players are a result of being tackled during a game [192, 261]. Following rule changes, scrum has been 'de-powered' in RL games. This has been attributed to have significantly reduced the incidence of severe cervical spine injuries in RL [261].

8.10.3.3 Shoulder Injury

Shoulder muscle strengthening has been a focus area given the predisposition of rugby players to shoulder injuries [51]. The use of shoulder pads has been explored by investigators [262, 263]. Currently, there is no demonstrable evidence to support their use to minimise injury risk [264].

8.10.3.4 Ankle Injury

Sankey et al. noted that 35% of ankle injuries were sustained during non-contact activities. There is ample evidence to suggest that proprioception-based training regimen is beneficial in reducing risk of ankle injuries [265–267]. Hence, incorporation of such regimen may play a role in minimising ankle injury risk in rugby players.

8.10.4 Training-Based Programmes

Given that tackle or being tackled is the predominant reason for injury during matches, investigators have focussed on the identification of tackler characteristics associated with positive tackle outcome thereby minimising injury risk. Hendricks et al. demonstrated that appropriate tackle training of players was associated with behaviours that reduced risk of serious injuries during matches [268]. Head positioned up, forward and facing the ball carrier, counter-acting the ball carrier, shoulder tackles targeted at the mid-torso of the ball carrier, using the arms to wrap or pull the ball carrier and leg driving after contact have been associated with positive tackle outcomes [269].

Training frequencies of two to four resistance training sessions per muscle group/week has been recommended to develop upper and lower body strength and power [270]. Tackle-related mechanisms have been reported to be amongst the leading causes of injury in rugby players with both formats of the game [39, 42, 97, 98, 112]. Hence, this has been an area of continued research and training programmes have been developed to teach players the safe tackle methods to minimise risk of injury [51, 271].

Simulation model-based studies have been performed by some investigators to enhance our understanding of the complex injury patterns in rugby and help develop better injury prevention strategies and training programmes [271–273].

8.10.5 Other Injury Prevention Strategies

It has been reported that normal variations in development observed in children of the same age can result in significant differences in physical characteristics leading to a mismatch in size [274]. Some authors have suggested that grouping of child rugby players merely on chronological age may pose a potential injury risk due to the disparity in physical size [39, 184, 275]. Hence, in New Zealand child rugby players are matched by size rather than chronological age and skills has been adopted as strategy to help reduce the frequency of severe injuries [276]. Other mechanisms such as 'weigh down' rule have been proposed and used in some competitions wherein players of higher chronological age are permitted to participate in a younger age group category if their weight is below the competition agreed threshold for a particular age group [39].

8.11 Paralympic Rugby Athletes

Wheelchair rugby as a team sport for paralympic athletes has grown in popularity since its origin back in 1976 and was included as a medal event in the 2000 Summer Paralympics in Sydney, Australia. Athletes competing in wheelchair rugby can have loss of function in the limbs or impairment from spinal cord injuries at the level of cervical vertebrae, multiple amputations, neurological conditions such as cerebral palsy, muscular dystrophy, and polio amongst other conditions. A detailed description of the laws of this sport are beyond the scope of this chapter and can be found at the International Wheelchair Rugby Federation website (www.iwrf.com) [277]. However, it is useful to note that it is a competitive team sport performed by male and female athletes with some of the aforementioned conditions [277–279]. Some of the unique features of this sport include (1) team consists of 12 players of which only 4 may be on the court at any time (2) physical contact between wheelchairs is permitted but direct physical contact between players is not permitted (3) wheelchair rugby is played indoors on a hardwood court similar in dimensions to a basketball court.

The paralympic athletes participating in wheelchair rugby are classified based on impairments that cause activity limitations in the sport into one of seven groups (from 0.5 to 3.5 points) [277]. To ensure fairness and team balance of functional levels, the total value of all players on each team cannot exceed 8 points [277]. This is vital as it has been noted that different propulsion approaches [280], asymmetries [281], speed and activity [278] exist across classification groups with arm impairment in players having a greater impact on performance compared to trunk impairment [282]. Furthermore, these players are under greater thermal strain due to their reduced heat loss capacity [279]. However, wheelchair rugby training enables players to improve cardiorespiratory function [283, 284].

The type of wheelchair prescription including design features such as seat depth, seat angle, wheel camber angle, and wheel diameter amongst others can contribute significantly to performance in these players [285–287].

Sports injuries in paralympic athletes participating in wheelchair rugby may have serious consequences and impact their ability to function independently for daily activities [288]. Nonetheless, information available in the current literature regarding injury patterns in paralympic athletes playing wheelchair rugby is limited. In a pilot study, Bauerfeind et al. [289] studied 14 male players from national team over a 9-month period and reported incidence rate 0.3 per athlete per training day. However, majority of the injuries were minor in nature and did not require medical intervention. Furthermore, injuries occurred more frequently in offensive players than in defensive players [289].

8.12 Summary

Rugby is a contact sport and the two popular formats of rugby union and rugby league are associated with a relatively high risk of injury to players compared to other team sports. The unique mechanics of this sport involve different contact situations and player characteristics, which can result in distinct pattern of injuries. The majority of these injuries are soft tissue injuries of the lower limb, including muscle, tendon, or ligament injuries, whilst head and neck injuries are less common, but frequent enough to be a significant ongoing concern. Epidemiological data and injury-related research have helped develop and implement laws and programmes aimed at minimising injury risk to players, with evidence that effective training programmes and law changes can reduce the risk of injury. In the future, incorporation of evolving technologies has the potential to enhance our understanding of the complex injury patterns, and enable development of more robust injury prevention strategies and programmes.

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