**ORIGINAL ARTICLE**

**A prospective study of injuries to elite Australian rugby union players**

A Bathgate, J P Best, G Craig, M Jamieson

Objectives: To assess injury patterns and incidence in the Australian Wallabies rugby union players from 1994 to 2000. To compare these patterns and rates with those seen at other levels of play, and to see how they have changed since the beginning of the professional era.

Methods: Prospective data were recorded from 1994 to 2000. All injuries to Australian Wallabies rugby union players were recorded by the team doctor. An injury was defined as one that forced a player to either leave the field or miss a subsequent game.

Results: A total of 143 injuries were recorded from 91 matches. The overall injury rate was 69/1000 player hours of game play. The injury rates in the periods before (1994–1995) and after (1996–2000) the start of the professional era were 47/1000 player hours and 74/1000 player hours respectively. The lock was the most injured forward, and the number 10 the most injured back. Most injuries were soft tissue, closed injuries (55%), with the head being the most commonly injured region (25.1%). The phase of play responsible for most injuries was the tackle (58.7%). Injuries were more likely to occur in the second half of the game, specifically the third quarter (40%). The vast majority of injuries were acute (90%), with the remainder being either chronic or recurrent.

Conclusions: Injury rate increases at higher levels of play in rugby union. Injury rates have increased in the professional era. Most injuries are now seen in the third quarter of the game, a finding that may reflect new substitution laws. There is a need for standardised collection of injury data in rugby union.

**R**ugby Union is an international sport ranking second in participation only to soccer as a football code. The sport’s governing body is the International Rugby Board (IRB), and there are currently 92 member unions. Each member union generally represents one country. In the last 15 years, there has been a considerable increase in participation and interest in the sport in Australia, particularly in schoolboy and junior teams. This is due in part to the success of the Australian national side, the Wallabies. Every four years, the IRB administers an international tournament, the Rugby World Cup. The Wallabies’ successes include two Rugby World Cup victories (1991 and 1999).

Increased participation in the sport may also be linked to the onset of full professionalism in October 1995. There are now considerable financial rewards to be gained from involvement and success at an elite level. In Australia, there are over 100 professional rugby players. These players are drawn from the three provincial teams (NSW, QLD, and ACT), for which squads of 30–40 contracted players exist. Recent contractual changes have led to salary increases, making the average salary the highest of any of the football codes in Australia. Many Australian players who do not receive contracts with the three provincial teams are now playing for wealthy professional club teams in Europe or the United Kingdom. As yet, Australian clubs are not as well financed.

The objective of this study was to assess injury patterns and incidence in the Australian Wallabies rugby union players from 1994 to 2000. These injury patterns and rates were compared with those seen at other levels of play, and also before and after the start of the professional era.

**METHODS**

During 1994–2000, detailed medical records were kept on all Australian Wallabies players. All injuries were recorded. An injury was defined as an event that forced the player to either leave the field or miss a subsequent game. Players were actively managed with professional medical care during the injury period. If the subsequent game was not played the following week, medical staff reviewed the injured player until it was felt that he was able to return to play. This time frame was recorded. The severity of the injury was arbitrarily classified as mild, moderate, or severe. Mild injuries resulted in the player missing up to one game only (up to one week), moderate injuries resulted in the player missing two or three games (one to three weeks), and severe injuries resulted in the player missing more than three games (more than three weeks). Injuries were further subdivided into those that occurred before (1994 and 1995) and after (1996–2000) the start of the professional era.

A standardised Australian rugby union injury data form was used to collate injury data for each match and training session. All training sessions were monitored. A sports doctor recorded details of injuries. Injuries were further classified according to a number of variables: site of injury, position of player, mechanism of injury, type of injury, time and place of injury, whether the injury was acute or chronic, and the severity of injury.

In the collection of injuries per position, the final injury toll was halved for those positions for which two players were represented (such as flankers and props) to allow valid comparison with those positions represented once only.

**RESULTS**

Prospective data were recorded from 1994 to 2000. During this time the Australian rugby union team played 73 Test matches and 13 non-Test matches. In addition, five Australia “A” matches were played. Therefore, 91 matches in total were played by elite Australian rugby players.

The 91 games from 1994 to 2000 were studied. This equated to 1820.3 player hours of game time (this figure includes 20 minutes of extra time played in the 1999 World Cup semifinal). Practice time varied greatly during the study period, and so has not been estimated. Eighty two players participated through the seven seasons of the study. In total, 148...
injury events were recorded over the study time frame. Five of these were medical conditions and were excluded from the final injury total. Therefore, 143 injuries were recorded for analysis; 126 occurred during a game, and 17 during training. This equated to 69 injuries/1000 player hours of game play, or 0.09 injuries per player per game. The injury rate before the start of professionalism in 1995 was 47 injuries/1000 player hours of game play, and after (1996–2000) it was 74 injuries/1000 player hours of game play.

### Position injured

Table 1 shows the year by year breakdown of injuries by position. Positions represented twice, such as wingers, had their total injury toll halved to allow valid comparison with positions represented once. The locks were the most injured players, followed by the number 8. The number 10 was the most injured back. By far the least injured position was the halfback (number 9). Backs, who comprise 46.7% of the players, received 40.8% of the injuries. Forwards comprise 53.3% of the players, but experienced 59.4% of injuries. The tight five (props, hooker, and locks), who comprise 33% of the team, were slightly disproportionately represented, with 39% of the injuries.

### Site of injury

The head was the most commonly injured body site, with 25.1% of total injuries (table 2). Of these, 75% were lacerations requiring suturing, 19.4% concussions, and 5.6% were fractures (one orbital blow-out fracture and one nasal fracture). Concussions were not graded, rather injured players were regularly monitored and decisions on return to play based on symptoms. Using such a system, most players with minor head injuries either did not leave the field or recovered fully before the subsequent game, and so did not meet our injury definition. The next most injured body sites were the knee (14.0%) and the thigh (13.6%), with the ankle comprising 10.5% of injuries. The knee accounted for 25% of the severe injuries, and 40% of injuries to the knee were severe; 50% of these severe knee injuries were medial collateral ligament tears. Of the thigh injuries, 53% were hamstring strains or tears, 37% contusions “corks”, and 10% quadriceps strains/tears.

Both the hand/finger and the shoulder were disproportionately represented by severe injuries, with 62.5% of the hand/finger, and 55.6% of the shoulder injuries being severe. Some 80% of the severe injuries to the hand and fingers were fractures (two Bennett’s fractures, one 3rd metacarpal and one fracture/dislocation of a proximal interphalangeal joint). Eighty percent of severe injuries to the shoulder were dislocations, all requiring open shoulder surgery (stabilisations and rotator cuff repairs); 50% of those requiring stabilisations also required rotator cuff repairs. All players made a full recovery.

There were only two severe injuries to the neck during the study time frame. One was a C5 neurapraxia, which resulted in the player missing four months of play. The other was a brachial plexopathy, which required three months off play. Both players made a full recovery.

When injuries were categorised according to more general body regions, the lower limb was the most commonly injured region, with 51.7% of injuries. The head and neck accounted

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### Table 1 Numer of injuries to elite Australian rugby union players by position

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### Table 2 Numer of injuries to elite Australian rugby union players by anatomical site

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<td>0</td>
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<tr>
<td>Total</td>
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<td>18</td>
<td>32</td>
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<td>11</td>
<td>143</td>
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</table>
for 28.7% and the upper limb 15.4%. Other body parts were rarely represented (fig 1).

Severity of injury
Most injuries were mild (64%), with the player missing one week or less, 14% were moderate with the player missing one to three weeks, and 22% severe, resulting in the player missing more than three weeks (table 3).

In the period before the start of professionalism, 63% of injuries were mild, 26% moderate, and 11% severe. In the period since then, 64% of injuries were mild, 12% moderate, and 24% severe. The vast majority (94%) of the severe injuries occurred in the professional era.

Mechanism of injury
Most injuries occurred in the tackle phase (58.7%), either tackling or being tackled. Open play accounted for 19.6% of injuries, closely followed by the ruck and maul with 14.7%. Open play occurs when the ball is no longer in a set piece, in a ruck or maul, or in the tackle. The set pieces (scrums and lineouts) accounted for very few injuries (2.1%), with no injuries seen in the lineout at all. Foul play resulted in 3.5% of injuries (fig 2). Most of the severe injuries occurred during the tackle phase (66%). Open play resulted in 19%, ruck and maul 9%, and foul play 6% of severe injuries. The two injuries listed as “other” occurred during training in the gym.

Type of injury
Soft tissue, closed injuries accounted for over half of all injuries (55%). These were further subdivided into contusion/haematoma (9.8%), musculotendinous strains/tears (20.3%), and joint/ligament strains/tears (25.2%). Other types of injury included lacerations (23.1%), fractures (8.4%), dislocations/subluxations (6.3%), and concussions (4.9%)(fig 3).

Time and place of injury
Most injuries (88%) occurred during the game, with 12% occurring at training. Approximately 53% of the training injuries were muscle strains or tears. A disproportionately high number of training injuries (76%) were moderate or severe, 54% of these being muscle strains or tears. Training was divided into contact (opposed) and non-contact sessions. Most Australian rugby union teams generally participate in one or two opposed sessions per week. The remaining sessions, generally two or three, are non-opposed.

There were 69% of injuries seen in the second half of the game, with 31% in the first half. When subdivided into quarters, the third quarter was seen to produce most injuries (40%), followed by the fourth (29%), the second (24%), and the first (7%).

Acute or chronic injury
The vast majority (90%) of injuries were acute, with the remainder being either chronic or a recurrence.

DISCUSSION
This study is the most exhaustive yet performed on international rugby players. In 1995, Jakoet et al studied injury patterns during the International World Cup held in South Africa. There are no other published studies on injury patterns in international rugby union players.

In 1997, Targent followed injury rates in a single elite professional New Zealand provincial team for one season during the Super 12 competition. Other studies have compared injury patterns in senior and junior recreational levels as well as schoolboy teams. Data are scarce for female rugby players, although a study by Carson et al attempted to extend our knowledge of injury patterns in women’s rugby.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Severity of injury by year</th>
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<td>'94</td>
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<tr>
<td>Mild</td>
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<tr>
<td>Moderate</td>
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<tr>
<td>Severe</td>
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</tr>
<tr>
<td>Total</td>
<td>13</td>
</tr>
</tbody>
</table>

Mild, player misses up to one week; moderate, player misses one to three weeks; severe, player misses more than three weeks.
In spite of what may appear on the surface to be a reasonably broad volume of injury data on rugby players throughout the world, closer scrutiny shows that the published studies. Uniformity as to how, when, and why injuries occur, and a standard injury definition are critical to allow methodologically sound injury research in the future. This would allow valid comparison of results between studies, and formulation of management strategies to reduce injury risk. An injury data collection form developed and validated by McCamus offers a valuable starting position.

By comparison, injury rates at senior male recreational level have varied from 13.95/1000 player hours to 53/1000 player hours in those studies with injury definitions similar to those of the above studies have confirmed a number of trends in injury patterns. Most, although not all, have shown that injury rate increases with the grade of play. This applies at both senior and junior levels. The expectation in studying an international team, such as the Wallabies, would therefore be that injury rates would be high. This study has confirmed this, with a rate of 69 injuries/1000 playing hours of game play. Although not as high as that seen by Taggett, it is higher than that seen by Jakoet et al (30–43 injuries/1000 player hours).

A number of theories have been postulated as to why there is a higher rate of injury at high levels of play. Firstly, the intangible and obvious reasons are that play is faster, players are bigger and fitter, and tackling is harder. Secondly, it has been shown that, at the elite level and certainly since 1995, the ball is in play for longer periods. Thirdly, with the onset of professionalism, players are now able to devote more time to increasing speed and power and improving skills. Garraway et al showed that injury rates in senior Scottish players doubled in the four years after the onset of professionalism.

This study has further confirmed this trend towards increasing injury rates in the professional era. In the two years of injury data collection before the onset of professionalism, there was an injury rate of 47 injuries/1000 player hours. This has increased to 74 injuries/1000 player hours in the four years since then.

The most commonly injured player was the lock in the forwards, and the number 10 in the backs. The former finding concurs with the findings of Bird et al in a New Zealand club season in 1993. Other studies have most commonly found that the flankers or the number 8 are the most injured positions in senior male rugby. At the international level, locks are no longer the players whose only job is to win lineout ball. They play in many respects like a back row forward in open play; they are important in scrummaging and of course are the dominant lineout players. It is no surprise that they are often injured.

Forwards were disproportionately injured compared with backs. Again, this may simply reflect the fact that the forwards are involved in more phases of the game than the backs. This disproportionality, however, has not been a universal finding.

Most injuries were soft tissue, closed injuries, accounting for 55% of all injuries. This is in accordance with other studies on rugby injuries. The most commonly injured site was the head, with 25.1% of total injuries. Most (75%) of these were lacerations requiring suturing. This high rate of head injury is in accordance with that seen in previous studies.

In total, lower limb injuries accounted for just over half of the injuries. Most of these were knee and thigh injuries. Interestingly, only one anterior cruciate ligament tear was seen, and this injury occurred in open play. It has previously been reported that the rate of anterior cruciate ligament injury in rugby union is two to three times that of rugby league.
The authors are to be commended for their insight into collecting injury data starting in 1994 for the Australian Wal-
labies national rugby union team. The data allow insight into injury rates, mechanisms, and location for international rugby
players, which in turn should stimulate further research. The results are of practical importance for coaches and selectors
who determine the type of player for reserves during games. The data cannot, however, be generalised to all levels of rugby.
Three points in particular are worth commenting on. The high injury rate reported in this study for the time period
just after half time (third quarter) is of practical value to coaches and sport science support staff. There are many
potential strategies to reduce injury in this time frame. Secondly, there appears to be a very low rate of injury to the
clavicle and acromioclavicular joint. With the current controversies about protective padding, one may wonder what role
shoulder padding has in rugby. Finally, the concussion rate was extremely low (seven concussions in seven years or 5% of
all injuries). The authors do point out that some minor concussions may not have been reported. This low rate will
need to be reproduced in other studies to confirm this value.

The take home message is that injury rates increase with higher levels of play in rugby union.

The injury rate has increased considerably since the

Injury prevention and minimise injury risk.

acknowledgements

We thank Drs David Hughes, Greg Smith, and John Lennard for their contributions and comments, Ms Joanna Smit and Dr Megan Best for their administrative support, The Australian Rugby Union for supporting rugby injury surveillance.

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