EDITOR'S CHOICE

Interim evaluation of the effect of a new scrum law on neck and back injuries in rugby union

S Gianotti,[1,2] P A Hume,[2] W G Hopkins,[2] J Harawira,[1] R Truman[1]

[1] Accident Compensation Corporation, Wellington, New Zealand; [2] Institute of Sport and Recreation Research New Zealand, Faculty of Health and Environmental Science, AUT University, Auckland, New Zealand

Correspondence to:
Mr S Gianotti, Accident Compensation Corporation, PO Box 242, Wellington, New Zealand;
simon.gianotti@acc.co.nz

Accepted 17 March 2008
Published Online First 7 April 2008

ABSTRACT

Background: In January 2007 the International Rugby Board implemented a new law for scrum engagement aimed at improving player welfare by reducing impact force and scrum collapses. In New Zealand the new law was included in RugbySmart, an annual compulsory workshop for coaches and referees.

Objective: To determine the effect of the new law on scrum-related moderate to serious neck and back injury claims in 2007.

Methods: Claims filed with the Accident Compensation Corporation (the provider of no-fault injury compensation and rehabilitation in New Zealand) were combined with numbers of registered players to estimate moderate to serious scrum-related claims for players who take part in scrums (forwards). Poisson linear regression was used to compare the observed claims per 100 000 forwards for 2007 with the rate predicted from data for 2002–6.

Results: The observed and predicted claims per 100 000 forwards were 52 and 76, respectively (rate ratio 0.69; 90% CI 0.42 to 1.12). The likelihoods of substantial benefit (rate ratio <0.90) and harm (rate ratio >1.1) attributable to the scrum law were 82% and 5%, respectively.

Conclusion: The decline in scrum-related injury claims is consistent with a beneficial effect of the new scrum law in the first year of its implementation. Another year of monitoring should provide more evidence for the efficacy of the new law.

Rugby union (rugby) scrummaging is considered to epitomise the physical nature of the game.[1] In the scrum, which is a means of restarting play after minor infringements,[2] the front rows of each team's scrum pack (eight players in each pack in front, second and back row combination) engage through their heads and shoulders in a forceful driving motion.[3 4] As a result of the scrum, a tunnel is created into which a scrum-half player throws in the ball so that front row players can compete for possession by hooking the ball with their feet.[5]

The scrum has received substantial attention over the years with regard to neck and back injury, especially the spinal cord.[3 6 7] With scrum engagement occurring through the head and shoulders, spinal cord damage on engagement can result from hyperflexion with or without rotation,[8] or high axial compressive neck forces combined with a bending moment and/or shear forces.[3] Scrum collapse as a result of improper engagement is another area that has been identified as a leading cause of scrum injury.[8] While spinal cord damage is rare, there is a higher risk on scrum engagement than with collapse.[3 4 9]

Measures to prevent neck and back injury have included changes to laws on the scrum procedures, stricter application of the existing laws and educational initiatives.[2 4 9–11] On 1 January 2007, in all rugby-playing countries a new International Rugby Board (IRB) law governing the scrum came into effect. The scrum engagement law changed to a four-stage "crouch, touch, pause, engage" sequence for the initial scrum engagement at all levels[12] based on the result of a review of the scrum by the IRB.[13] This new sequence was designed to standardise the distance between the two sets of forwards and reduce the collision forces at engagement.[12 13]

Although the IRB provided no injury epidemiology evidence for the potential benefits of the law change, there was some biomechanical evidence in the literature to support the new sequence, particularly addressing engagement and collapse. The forces on engagement have the potential to exceed axial neck load and bending movement tolerance limits.[3] Milburn[14 15] identified forces during scrums against an instrumented scrum machine and found controlled engagement would reduce forces on the neck compared with usual scrum engagement technique. After initial engagement, the sustained force decreased by about 20%.[14 15] In another study measuring engagement force, Du Toit *et al*[16] reported a 19% decrease in the force between a full scrum engagement and a staggered scrum engagement technique for schoolboy rugby union players under 19 years of age. However, the analysis by Du Toit *et al* was for sustained forces acting on the shoulder of the players rather than the neck, as determined by Milburn. Both Milburn and Du Toit *et al* showed that a reduced amount of force occurred by varying the technique (controlled or staggered) of scrum engagement.

In addition to controlling the forces at engagement, the new law was designed to reduce scrum collapse by standardising the distance between the two sets of forwards. Standardising the distance is achieved by the front rows touching the opposition on the shoulder when the "touch" command in the four-stage engagement sequence is given by the referee.[13] While having front rows too far apart will lead to scrum collapse at engagement, Milburn[15] reported that front rows who tend to stand too close to each other, and second row and back row forwards who apply the push before the front row is properly formed, contribute to the risk of scrum collapse at engagement.

Improving player welfare or reducing injuries through changing the laws is not new. Adherence to the laws of the game may reduce the rate of injuries.[17] Although rules are one of the most common methods used to prevent injury, there

have been few interventions that have identified the benefits associated with specific rules.[4] Typically, laws to prevent injuries centre around fair or foul play (including performance enhancing drugs)[18–22] or protective equipment such as mouthguards.[23 24] With respect to preventing head and neck injuries, McIntosh and McCrory cited the usefulness of laws around preparticipation screening, rugby scrums, tackling (legal and illegal) as well as protective equipment.[4]

We were interested in whether the new scrum law would reduce scrum neck and back injury rates for community rugby players in New Zealand. The unique nature of the New Zealand system for collecting nationwide injury data and the existence of an established system to communicate the new law via RugbySmart made the interim evaluation of the effect of the new law possible.

METHODS

Implementation of the new scrum law

To ensure consistency across New Zealand for the implementation of the new IRB scrum law, education on the law was incorporated into the RugbySmart DVD and was a focus for the RugbySmart workshops in 2007. RugbySmart is a joint injury prevention programme between the Accident Compensation Corporation (ACC) and the New Zealand Rugby Union (NZRU)[2] designed to deliver injury prevention messages. Attendance at a RugbySmart workshop is an annual compulsory requirement and teams are withdrawn from competition for non-compliance by coaches, and referees are not assigned matches for non-compliance. Coaches are given a copy of the RugbySmart DVD at the completion of the 1 h workshop and are encouraged to show it to their players. While the IRB had released footage of the new scrum law, ACC and NZRU re-videoed it to be consistent with its RugbySmart format. The new RugbySmart scrum law footage was approved by the IRB.

Moderate to serious neck and back ACC claims

To determine if the new scrum law had reduced injuries in New Zealand, we used the ACC claims database.[2] In New Zealand the ACC provides a no-fault accident compensation and rehabilitation scheme covering costs of injury. People make claims against the scheme and, as a result, medical information such as the type and diagnosis of the injury is collected. The diagnosis of an injury is undertaken by a registered medical professional such as a doctor or physiotherapist when the person seeks treatment for the injury. The registered medical professional (30 000 throughout New Zealand) submits the injury claim to the ACC and a standardised set of injury codes is used to describe specific injury types. There is no disincentive for making a claim; people are not discriminated against or risk-rated for the number of claims made. People can elect not to claim by not seeking medical treatment. Minor injuries would fall into this category.

We assessed moderate to serious neck and back (including spine) claims to the ACC that occurred in the scrum. These injuries were selected because they occur predominantly in the scrum, particularly on engagement and collapse.[4 5 7] Since the RugbySmart programme, the last serious spinal injury arising from the scrum was in 2004.[2] A moderate to serious neck and back injury would include contusions, fractures, disc protrusions and prolapsed disc. As an indication of severity or incapacity, an employed person would be unable to work for a minimum of 7 days.

We reviewed all rugby claims for moderate to serious neck and back injuries in rugby from 2002, determining the phase of play (eg, scrum, tackle, ruck). When people making a claim to the ACC were asked how the injury occurred (as a standard injury collection field), the information was used to determine the phase of play. If it was still unclear, then contact was made with the person to clarify. Six claimants injured in 2002 were unable to be contacted. Analysis from claims made in 2003–6 showed that approximately 20% of neck and back claims were scrum-related. One additional claim was therefore added to the 2002 total. We assumed that all scrum injuries were from players in the forward line as these are the only people who participate in the physical aspect of the scrum.

Final claims were extracted from the ACC database on 10 January 2008 and included all injuries up to and including 31 December 2007. The rugby season runs from February to August for community and amateur players. Representative rugby (a small number of games) occurred after the amateur season and took place in September and October 2007. We considered sufficient time had passed from the end of the rugby season to the date of final data extraction on the basis of an assessment of moderate to serious claims in the scrum between 2003 and 2006 which showed that a mean of 9 days (geometric mean 6 days; range 0–81 days) between the occurrence of the injury and seeking ACC treatment. Analysis of the moderate to serious claims for this paper showed that in 2002–6 only three injuries occurred after the amateur season and two injuries resulted from people taking more than 2 months to seek ACC treatment.

Player numbers

We used the number of players registered to the NZRU to determine a rate per 100 000 forwards.[2] The age of the players was collected by the NZRU. In New Zealand players older than 12 years of age are allowed to engage fully in scrums and push with force, so 12 years of age was the lower age limit for data analyses. We assumed that 8/15 registered players were forwards.

The IRB has laws regarding scrum safety for different age groups. Players at the under 19 level (U19) have additional safety restrictions on the scrum (eg, a scrum can only be pushed 1.5 m before the referee intervenes). In New Zealand almost all scrums are governed by the U19 safety restrictions (T Howard, personal communication, 2008). The few grades in New Zealand to have scrums governed by international laws are Senior representative rugby (players aged >19 years) and Senior 'A' competitions (the top grade in local/amateur competitions in a region).

Table 1 Claims arising from scrum-related moderate to serious neck and back injuries sustained by forwards in New Zealand in 2002–7

Year	No. of claims	No. of forwards
2002	24	39593
2003	29	39942
2004	22	40821
2005	25	41372
2006	33	39821
2007	20	38247

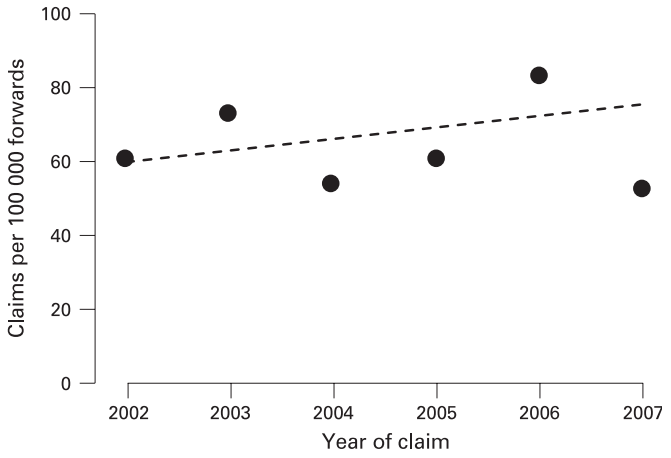

Figure 1 Claims per 100 000 forwards for scrum-related moderate to serious neck and back injuries. The dashed line shows injury rates predicted from a linear model fitted to the 2002–6 data.

Statistical analyses

The injury rate was analysed using the generalised linear modelling procedure (Proc Genmod) in the Statistical Analysis System Version 9.1.3 by assuming a simple linear trend in the logarithm of the injury rate.[2] The ratio of the observed to the predicted rate and its 90% confidence intervals (CI) were estimated from the model by including an effect for the law change (with values of 0 for 2002–6 and 1 for 2007). A simpler comparison of the mean claim rate for 2002–6 with the observed rate in 2007 was also performed. The likelihood that the true change in injury rate was beneficial and harmful was calculated using a spreadsheet,[25] assuming least clinically important ratios for benefit and harm of 0.90 and 1/0.9.

RESULTS

Table 1 shows the injury claims and numbers of forwards for the years 2002–7, and fig 1 shows the claims per 100 000 forwards. The observed and predicted claims per 100 000 forwards for 2007 were 52 and 76, respectively, giving a rate ratio of 0.69 (90% CI 0.42 to 1.12). The likelihood of beneficial and harmful changes in the true rate of claims was 82% and 5%, respectively. The mean rate of claims for 2002–6 was 66 per 100 000 forwards, the observed rate relative to this mean rate was a ratio of 0.79 (90% CI 0.53 to 1.18) and the likelihood of beneficial and harmful changes was 70% and 8%, respectively.

Most of the injuries from 2002–7 occurred on a Saturday, which is the main game day. The numbers of injury claims on Saturday through Sunday were 111, 9, 3, 7, 6, 11 and 6, respectively.

DISCUSSION

The new IRB scrum law came into effect with the aim of improving player welfare. At the end of the first year our analysis showed that the new law change is likely to have reduced scrum-related neck and back injury claims in New Zealand. The fact that most head and neck injuries occurred on the main game day underscores the importance of the law change for this type of injury.

There are several data analysis issues to consider when interpreting this interim evaluation. First, the moderate to serious claims we analysed were for acute injuries. Chronic injuries such as spine degeneration could not be analysed because these injuries cannot be claimed through the ACC under current legislation. Second, the upward trend in claim rate apparent in fig 1 is due partly to the fact that the highest claim rate occurred in 2006. The simpler comparison of claim rate for 2007 with the mean claim rate for 2002–6 still showed the possibility of benefit from the new law, but the likelihood of harm was too high for the outcome to be considered clear. Third, changes in the number of scrums in games could affect the rate of injury, but there are no available data to adjust for the number of scrums in games at the community level in New Zealand. We can think of no reason why the new law would result in fewer scrums per game or why the number of scrums would fall for any other reason. Fourth, scrum safety has been part of the RugbySmart programme since 2001. In countries with no mandatory safety programme the impact of the new law could be greater. Finally, the results are encouraging but not conclusive. The ACC system can be used to track the effect of the law in 2008, as the only law changes will affect professional players who represent approximately 0.2% of players in New Zealand.

What is already known on this topic

- The scrum is an area that can produce serious injuries to the neck and back including spinal damage.
- Laws may be used to help prevent injuries.

What this study adds

- Laws can be used to prevent injuries without interfering with how the game is played.
- The first year results validate the International Rugby Board's new law initiative to help prevent injuries.

CONCLUSION

At the end of the first year our analysis shows that the new law change appears to have had the intended effect on scrum-related head and neck injuries. Another year of monitoring should provide more evidence for the efficacy of the new law. This study exemplifies how a nationwide injury database controlled by legislation can provide rapid follow-up for assessing efficacy of interventions.

Competing interests: None.

REFERENCES

1. **Habka D,** Laporte S, Piscione J, *et al*. Biomechanical study of impact engagement in rugby union scrummaging of front row player. *Comput Methods Biomech Biomed Engin* 2007;**10**(Suppl 1):43–4.
2. **Quarrie KL,** Gianotti SM, Hopkins WG, *et al*. Effect of a nationwide injury prevention programme on serious spinal injuries in New Zealand rugby. *BMJ* 2007;**334**:1150–3.
3. **McIntosh AS.** Rugby injuries. In: Maffulli N, Caine DJ, eds. *Epidemiology of pediatric sports injuries: team sports*. Basel: Karger Med Sport Science, 2005:120–39.
4. **McIntosh AS,** McCrory P. Preventing head and neck injury. *Br J Sports Med* 2005;**39**:314–8.
5. **International Rugby Board**. *IRB laws of the game - rugby union*. Ireland: International Rugby Board, 2007.
6. **Armour KS,** Clatworthy BJ, Bean AR, *et al*. Spinal injuries in New Zealand rugby and rugby league: a twenty year survey. *N Z Med J* 1997;**110**:462–5.
7. **Fuller CW,** Brooks JHM, Kemp SPT. Spinal injuries in professional rugby union: a prospective cohort study. *Clin J Sports Med* 2007;**17**:10–6.
8. **Quarrie KL,** Cantu RC, Chalmers DJ. Rugby union injuries to the cervical spine and spinal cord. *Sports Med* 2002;**32**:633–53.

9. **Wetzler MJ,** Akpata T, Laughlin W, *et al*. Occurrence of cervical spine injuries during the rugby scrum. 2nd World Congress on Sports Trauma/22nd Annual meeting of the AOSSM. Lake Buena Vista, Florida, 1996.
10. **Haylen PT.** Spinal injuries in rugby union, 1970–2003: lessons and responsibilities. *Med J Aust* 2004;**181**:48–50.
11. **Berry JG,** Harrison JE, Yeo JD, *et al*. Cervical spinal cord injury in rugby union and rugby league: are incidence rates declining in NSW? *Aust N Z J Public Health* 2006;**30**:268–74.
12. **International Rugby Board**. Scrum law changes. http://www.irb.com/newsmedia/mediazone/pressrelease/newsid = 278652.html#scrum+law+change (Accessed 6 December 2006).
13. **International Rugby Board**. IRB announces scrum initiative. http://www.irb.com/newsmedia/mediazone/pressrelease/newsid = 278652.html#irb+announces+scrum+initiative (Accessed 17 November 2006).
14. **Milburn PD.** *The biomechanics of rugby scrummaging*. Wollongong: University of Wollongong, 1990.
15. **Milburn PD.** Biomechanics of rugby union scrummaging. *Sports Med* 1993;**16**:168–79.
16. **Du Toit DE,** Olivier PE, Buys FJ. Kinetics of full scrum and staggered scrum engagement in under 19 schoolboy rugby union players. *S Afr J Res Sport Phys Educ Recreation* 2005;**27**:15–28.
17. **Anderson TE,** Engebretsen L, Bahr R. Rule violations as a cause of injuries in male Norwegian professional football. *Sports Med* 2004;**32**:62.
18. **Yesalis CE,** Cowart VS. *The steroids game*. Auckland: Human Kinetics, 1998.
19. **Stannard JP,** Bucknell AL. Rupture of the triceps tendon associated with steroid injections. *Am J Sports Med* 1993;**21**:482–5.
20. **Clark SC,** Jones MW, Choudhury RR, *et al*. Bilateral patellar tendon rupture secondary to repeated local steroid injections. *J Accid Emerg Med* 1995;**12**:300–1.
21. **Jorgensen U.** Regulations and officiating in injury prevention. In: Renstrom PAFH, ed. *Sports injuries. Basic principles of prevention and care*. Oxford: Blackwell Scientific Publications, 1993:213–9.
22. **Cross MJ.** General prevention of injuries in sport. In: Renstrom PAFH, ed. *Sports injuries. Basic principles of prevention and care*. Oxford: Blackwell Scientific Publications, 1993:334–42.
23. **Quarrie KL,** Gianotti SM, Chalmers DJ, *et al*. An evaluation of mouthguard requirements and dental injuries in New Zealand rugby union. *Br J Sports Med* 2005;**39**:650–1.
24. **Chalmers DJ.** Mouthguards: protection for the mouth in rugby union. *Sports Med* 1998;**25**:339–49.
25. **Hopkins WG.** A spreadsheet for deriving a confidence interval, mechanistic inference and clinical inference from a p value. *Sportscience* 2007;**11**:23–36.