

# Impact of the national prevention policy and scrum law changes on the incidence of rugby-related catastrophic cervical spine injuries in French Rugby Union

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## ABSTRACT

**Background and aims** Catastrophic cervical spine injuries are rare in rugby union but require close monitoring. The aim of this study was to analyse the incidence of severe cervical spine injuries and determine the impact of a national prevention programme and new scrum rules implemented by the French Rugby Union.

**Methods** A prospective study was performed between 2006 and 2013 including all players affiliated to the French Rugby Union. All cervical spine injuries resulting in death, tetraplegia or a permanent neurological deficit were included. Prevention programmes were implemented from 2007 to 2013 and a change in scrum rules in 2010. To measure the impact of rule changes, results between 2006–2010 and 2010–2013 were compared using a Poisson regression.

**Results** Altogether, 31 injuries were observed and the mean annual incidence was 1.6 per 100 000 players. There were significantly more injuries in senior players compared to junior players (3.5 vs 0.6 per 100 000 players; CI 95% (2.1 to 4.9) vs (0.1 to 1.0)). Incidence decreased from 1.8 in 2006 to 1.0 per 100 000 players in 2013 ( $p < 0.0001$ ). After 2010, there were significantly fewer injuries during scrums ( $p = 0.02$ ). In contrast, there were significantly more injuries in backs during 2010–2013 compared to 2006–2010 ( $p = 0.003$ ).

**Conclusions** The incidence of catastrophic cervical spine injuries has declined in French Rugby Union. The implementation of specific prevention programmes and scrum law changes has notably resulted in a decrease in scrum injuries in forwards. This prospective study should be continued to monitor the future progression of injuries and adapt prevention programmes accordingly.

## INTRODUCTION

Rugby union is a contact sport with a high overall risk of injury and a small specific risk of fatal and catastrophic spinal injury. The estimated incidence of catastrophic injuries observed in England was between 0.48 and 1.5 catastrophic injuries per 100 000 players per year between 1956 and 2002.<sup>1</sup> In other countries, the incidence of catastrophic injuries varies between 0.89 and 7.4 per 100 000 players per year.<sup>2–9</sup> The risk of their occurrence has been classified as ‘acceptable’.<sup>1</sup> Between 1996 and 2006, cervical spine injuries in French rugby declined from 2.1 per 100 000 players per year during the 1996–1997 season to 1.4 during the 2005–2006 season following scrum rule

modifications and the creation of an obligatory medical certificate for front-row players.<sup>10</sup> A national register of catastrophic injuries was created in France in 2006 to monitor the progression of these injuries.

In France, the French Rugby Union has also developed a nationwide prevention policy entitled ‘Play safely’ implemented by the national performance director, national refereeing direction and national medical committee. This policy was initiated in 2007 with the creation of a ‘front-row academy’ (whose goal was to train players, coaches, educators and referees on the specificities of the front-row position) and ‘safety days’ (a day of mandatory training for coaches and club officials providing medical information and prevention). These activities mainly concerned players at non-professional standards. Coaches and educators all over the country now participate in prevention programmes. In 2010, this policy was bolstered by the creation of new scrum laws with new scrum engagement sequences. In rugby union, the forces generated between the two front rows during the scrumming engagement phase are considerable and multi-directional.<sup>11</sup> In 2010, French Rugby Union decided to adopt a new scrum engagement sequence without any impact between front-row players for non-professional standards, the ‘crouch-placing-pause-play’ sequence. When the referee gives the ‘placing’ order, the two front rows are placed without any impact and the scrum must be stable during the ‘pause’ order. At ‘play’ order (ie, when the scrum half introduces the ball immediately), both packs are then allowed to exert an intense sustained shove limited to a 1.5 m distance. Scrum engagement sequence is controlled by the referee in order to suppress any impact during front-row placement. This scrum engagement sequence is still running in non-professional standards. For professional standards, Institutional Review Board laws were following using the ‘crouch-touch-pause-engage’ sequence until the 2012–2013 season, then the ‘crouch-touch-set’ sequence since the 2012–2013 season and finally replaced by the ‘crouch-bind-set’ sequence in 2013. The goal of this study was to evaluate the incidence of catastrophic cervical spine injuries between 2006 and 2013 and measure the impact of the aforementioned nationwide prevention policy and scrum law changes by comparing the two periods (2006–2010 and 2010–2013) prior to and following implementation.

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## MATERIALS AND METHODS

A prospective cohort study was performed based on the national register of catastrophic injuries from the only insurance company affiliated to the French Rugby Union (CGA Colonna).

### Study period and population

Epidemiological data were collected from September 2006 to August 2013 (7 competitive seasons). For inclusion in the study, players had to be permitted to play (eg, medical certification) and affiliated to the French Rugby Union. Since 2004, any player permitted to play is registered in the French rugby union database (Oval-e). Every affiliated player across each of the different categories (gender, age and level) of competition and over the seven seasons is included (1 918 806 players).

### Definition

All catastrophic cervical spine injuries in rugby players that resulted in death, permanent quadriplegia or permanent neurological deficits were included in the study. Medical or traumatic brain injuries, cardiac events and catastrophic dorsal or lumbar spine injuries were excluded. Catastrophic cervical spine injuries were included following an expert medical evaluation by the insurance company that had confirmed the neurological consequences of the accident within a 2-year period following the accident. The risk of missing data was limited due to the severity of the injuries, the significant medical and financial consequences of the accident, and because only one insurance company is affiliated with the French Rugby Union.

### Statistical analysis

The incidence was calculated using the number of reported catastrophic cervical spine injuries as the numerator and the total population of rugby players for the period studied as the denominator. The average annual incidence was presented as the number of catastrophic cervical spinal injuries per 100 000 players. The progression of the annual incidence by season was analysed to evaluate the impact of the prevention programme. The average annual incidence of catastrophic cervical spine injuries from 2006 to 2010 and from 2010 to 2013 was also

calculated. Using a Poisson regression, injury numbers were compared between 2006–2010 and 2010–2013 to evaluate specifically the impact of the new scrum laws implemented in 2010. The incidence was also calculated according to age (junior level: between 6 and 18 years and senior level: over 19 years old, respectively). The incidence with 95% CIs was calculated using the standard formula suggested for rugby injury studies.<sup>12</sup> Incidences were considered significantly different if the 95% CIs did not overlap.<sup>13</sup> Any negative lower 95% confidence limits were presented as 0. Incidence across playing position could not be calculated. While information on the injured player's playing position was available, this was not the case for the global population.

Comparisons between groups for other variables (playing position, playing activities) were assessed by Fisher's exact test.  $p < 0.05$  was considered to be significant.

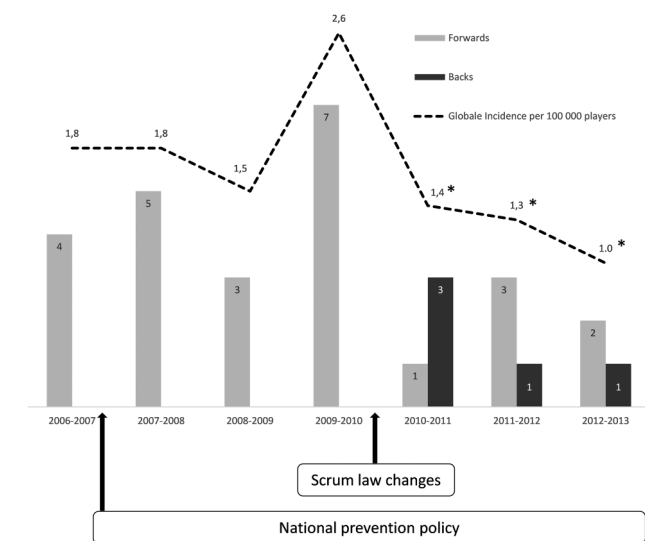
## RESULTS

### Incidence of catastrophic cervical spine injuries

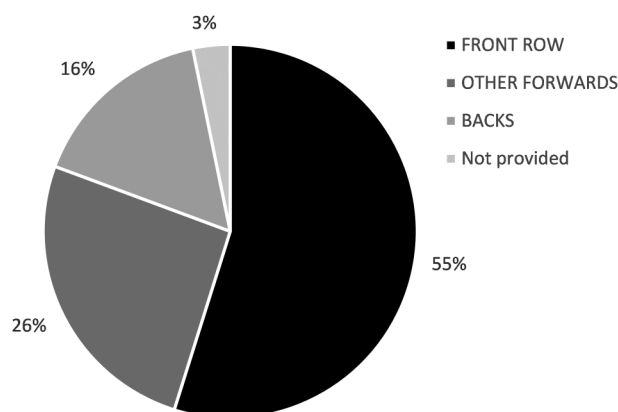
From 2006 to 2013, a total of 1 918 806 affiliated players were included (1 229 468 (64%) under 19 or juniors and 689 339 over 19 or seniors (36%)). From 2006 onwards, 31 catastrophic cervical spine injuries were observed in French Rugby. The distribution of catastrophic cervical spine injuries and the incidence among seasons is reported in [figure 1](#). All injured players were male and their mean age was 24.2 (SD 6.8). No catastrophic cervical spine injuries were reported at professional standards. The average annual incidence of catastrophic cervical spine injuries from 2006 to 2013 was 1.6 per 100 000 players (95% CI 1.0 to 2.2). Two of the 31 (6.5%) were fatal catastrophic cervical spine injuries (6.5%) and occurred in 2006 and 2007. Both players were hookers and the accident occurred during collapsed scrums. The remaining injuries had quadriplegic or neurological deficit outcomes.

### Age, playing position and playing activities

Altogether, 81% of catastrophic cervical spine injuries (3.5 per 100 000 players per year 95% CI 2.1 to 4.9) occurred in senior players. The incidence in junior level players was significantly lower (0.6 per 100 000 players per year 95% CI 0.1 to 1.0). Of the catastrophic cervical spine injuries, 81% occurred in forwards. The majority of these injuries (55%) were sustained by front-row players ([figure 2](#)). Before the 2010–2011 season, no catastrophic cervical spine injuries were reported in backs ([figure 1](#)). The scrum phase accounted for 39% of the



**Figure 1** Progression of the number of catastrophic cervical spine injuries among forwards and backs and global incidence of catastrophic cervical spine injuries per 100 000 players from 2006 to 2013. \*Significant difference.



**Figure 2** Repartition of number of catastrophic cervical spine injuries according to playing position.

total catastrophic cervical spine injuries. The incidence of catastrophic cervical spine injuries was significantly higher during matches than during training sessions (1.4 per 100 000 players per year (95% CI 0.9 to 1.9) and 0.2 (95% CI 0 to 0.4), respectively).

### Progression by season-impact of prevention programmes

The annual incidence of catastrophic cervical spine injuries decreased ( $p < 0.0001$ ) from 1.8 per 100 000 players (95% CI 0 to 3.5) during the 2006–2007 season to 1.0 per 100 000 players during the 2012–2013 season (95% CI 0 to 2.2). The highest annual incidence of catastrophic cervical injuries (2.6 per 100 000 players 95% CI 0.7 to 4.6) occurred during the 2009–2010 season. The Poisson regression shows that the number of injuries in the final three seasons significantly differs ( $p < 0.0001$ ) from the first seasons (figure 1).

### Comparison between 2006–2010 and 2010–2013—impact of the modification of scrums laws

The average incidence of catastrophic cervical spine injuries decreased from 1.9 (95% CI 1.1 to 2.8) to 1.3 (95% CI 0.5 to 2) per 100 000 players between these two periods. In the regressionline over the entire period, the three seasons between the 2010–2013 period significantly differed from those in the 2006–2010 period ( $p < 0.0001$ ). Although the average annual incidence among seniors decreased between these two periods, the average annual incidence among juniors increased (0.4 (95% CI 0 to 1) versus 0.7 per 100 000 players (95% CI 0 to 1.4)). Table 1 summarises these results.

In the period 2006–2010, all injuries involved forwards, while between 2010 and 2013 catastrophic cervical spine injuries involved 55% of forwards and 45% of backs (table 2). Backs were affected significantly more in the period from 2010 to 2013 compared to 2006 to 2010 ( $p = 0.003$ ). In addition, 55% of catastrophic cervical spine injuries occurred during scrums from 2006 to 2010 compared to 9% from 2010 to 2013. There were significantly fewer catastrophic cervical spine injuries during scrums from 2010 to 2013 ( $p = 0.02$ ). In addition, the average incidence of catastrophic cervical spine injuries during scrums significantly decreased between these two periods (1.1 per 100 000 players 95% CI 0.4 to 1.7 from 2006 to 2010 vs 0.1 per 100 000 players 95% CI 0 to 0.3).

## DISCUSSION

### Incidence of catastrophic cervical spine injuries

In the period between 2006 and 2013, a total of 31 catastrophic cervical spine injuries were sustained in French Rugby. The mean annual incidence of catastrophic cervical spine

injuries over seven seasons was 1.6 per 100 000 players. The incidence is decreasing and is lower than that observed between 1996 and 2006 (1.7 per 100 000 players).<sup>10</sup> One major problem concerns the definition of catastrophic spinal cord injuries in studies investigating catastrophic cervical spine injuries.<sup>9</sup> In the literature, non-permanent spinal injuries were frequently reported alongside spinal injuries resulting in a permanent disability. Furthermore, the number rather than the incidence of catastrophic injuries was commonly reported. In 2008, a study showed that the estimated incidence of catastrophic injuries in rugby varied from 0.84 per 100 000 players in England to 13.0 per 100 000 players in Fiji.<sup>1</sup> However, these figures were based on the number of injuries reported in various publications and using estimations of the average annual number of club and school rugby union players during this period; hence, a reliable comparison with the present investigation is difficult. In the only recent paper reporting rugby-related catastrophic injuries that employed a methodology similar to that in the present study, a lower incidence of acute spinal cord injuries (1.0 per 100 000 players vs 1.6 per 100 000 players in our study), including back and lumbar injuries, was observed in South African rugby between 2008 and 2011.<sup>14</sup>

In this study, senior players were found to have a significantly higher incidence of catastrophic cervical spine injury (3.5 per 100 000 players) than junior peers (0.6 per 100 000 players). In South Africa between 2008 and 2011, the population mainly included juniors (81%) and the incidence of acute spinal cord injury with a permanent deficit (neurological, quadriplegic and fatal) in seniors was higher (4.52 per 100 000 players) and the incidence of acute spinal cord injury with a permanent deficit in juniors was lower (0.24 per 100 000 players) than observed here.<sup>14</sup> Some studies excluded players under 15 years of age, potentially resulting in a higher incidence of catastrophic injury in their population (3.5 per 100 000 players).<sup>5 15</sup> A high number ( $n = 36$ ) of catastrophic cervical spine injuries in U19 rugby union players were reported in Great Britain and Ireland between 1996 and 2010.<sup>16</sup> Even if the incidence is low in junior players, the consequences are significant and junior and senior level players should be separated when calculating the incidence for two reasons: first, to follow the progression of incidents in this population, and second, to avoid influencing the denominator when calculating incidence if juniors are over-represented. To prevent catastrophic injuries in this population, a technical ‘passport’ for front-row players aged over 15 years has been created by the French Rugby Union. This passport, which contains several essential specifications, must be validated each year for front-row players. In our opinion, this scheme must

**Table 1** Average annual incidence of catastrophic cervical spine injuries according to period, age and type of play

	2006–2010			2010–2013			2006–2013 (Total)		
	N	I	95% CI	N	I	95% CI	N	I	95% CI
Total	20	1.9	(1.1 to 2.8)	11	1.3	(0.5 to 2.0)	31	1.6	(1.0 to 2.2)
Age									
Juniors	3	0.4	(0.0 to 1.0)	4	0.7	(0.0 to 1.4)	7	0.6	(0.1 to 1.0)
Seniors	17	4.5	(2.4 to 6.6)	7	2.2	(0.6 to 3.9)	24	3.5	(2.1 to 4.9)
Type of play									
Match	19	1.8	(1.0 to 2.6)	8	0.9	(0.3 to 1.6)	27	1.4	(0.9 to 1.9)
Training	1	0.1	(0.0 to 0.3)	3	0.3	(0.0 to 0.7)	4	0.2	(0.0 to 0.4)

N, number of injuries; I, incidence.

**Table 2** Comparison of number of catastrophic cervical spine injuries from 2006 to 2010 and from 2010 to 2013 according to playing position, playing activities and age

	2006–2010	2010–2013	Total	p Value*
Backs	0 (0%)	5 (100%)	5†	<b>0.003</b>
Forwards	19 (76%)	6 (24%)	25†	
Scrum	11 (92%)	1 (8%)	12	<b>0.020</b>
Other playing activities	9 (47%)	10 (53%)	19	
Seniors	17 (71%)	7 (29%)	24	0.210
Juniors	3 (43%)	4 (57%)	7	

\*Fisher's exact test on the interaction effect.

†One missing injury for playing position.

be continued to decrease the incidence of junior level catastrophic cervical spine injuries.

Here, no catastrophic cervical spine injuries were reported in professional standard players owing to a lower exposure due to fewer player numbers. Two other reasonable explanations can be suggested to explain the absence of injuries at professional standards. First, improved cervical strength commonly developed during training sessions potentially decreases the risk of incurring cervical spine injuries in elite standard players.<sup>17</sup> Second, in 2010, the national medical committee established a new classification for cervical injuries when determining aptitude in the professional rugby union. This new decision-making tool provides precise evaluation of the neurological risk based on data collected by clinical examination and cervical MRI and, if necessary, cervical X-rays.<sup>18</sup>

### Impact of the national prevention policy and scrum law changes

In this study, we chose to include only cervical injuries because we wanted to evaluate the impact of a nationwide prevention policy to reduce catastrophic cervical spine injuries. Prevention programmes have been implemented in several national rugby unions to reduce the incidence of catastrophic spinal injuries. For example, Rugbysmart in New Zealand is a nationwide catastrophic injury prevention programme that has been associated with a significant decrease in scrum-related spinal injuries.<sup>7, 19</sup> Recently, the BokSmart rugby injury prevention programme, implemented by the South African Rugby Union, has been shown to be effective in junior players.<sup>20</sup> A vast programme was begun in 2007 by the French Rugby Union including players, coaches, referees and the national medical committee. It began with the creation of a 'front-row academy' (whose goal is to train players, coaches, educators and referees on the specificities of the front-row position) and 'safety days' (mandatory training days for coaches and club officials and dissemination of medical information and prevention programmes). As a result of these activities, numerous coaches and educators all over the country are now aware of prevention programmes. In addition, new scrum laws were created at the beginning of the 2010–2011 season. The engagement sequence is now performed without any physical impact between opposition front-row players in non-professional standards. The number of scrum-related catastrophic cervical spine injuries significantly decreased between 2006–2010 and 2010–2013. France was one of the first rugby nations to use these engagement sequences and this result confirms the positive effect of new scrum laws on serious spine injuries.<sup>21, 22</sup> In addition to

the change in scrum laws, the nationwide prevention programme was potentially linked to the reduction in catastrophic cervical spinal injuries after 2010. However, it is difficult to confirm the effectiveness of this prevention programme because the present reduction may have occurred without the national prevention programme. It is noteworthy that, since 2010, significantly more catastrophic cervical spine injuries have occurred in backs notably during tackling or tackled activities. The aim of French Rugby Union is to continue and guide these preventive actions to further decrease the incidence of catastrophic spine injuries.

### Limitations

A potential limitation in this study might be the non-inclusion of some catastrophic cervical spine injuries. However, the consequences of these catastrophic injuries are so important that it reduces the risk of non-inclusion. Furthermore, having a unique insurance company affiliated to the French Rugby Union also contributes to reducing this risk of non-inclusion.

Finally, comparisons of incidence across playing positions would have been pertinent. However, the exact number of backs or forwards in the present population was unavailable.

### CONCLUSION

The incidence of catastrophic cervical spine injuries is decreasing in French rugby union. The nationwide prevention policy entitled 'Play safely' implemented by the national performance director, the national refereeing chief and the national medical committee has probably contributed to this decline. The scrum law changes in 2010 also had a large influence in this decline by decreasing significantly injuries in the scrum phase and in forward players. The national register of catastrophic injuries must continue to longitudinally monitor the evolution of catastrophic injuries and to assess the effectiveness of prevention programmes.

#### What are the findings?

- ▶ The incidence of catastrophic cervical spine injuries is decreasing in French rugby union.
- ▶ The implementation of specific prevention programmes since 2007 and scrum law changes in 2010 has resulted in a decrease in scrum injuries in forwards.
- ▶ Since 2010, significantly more catastrophic cervical spine injuries have occurred in backs, notably during tackling or tackled activities.

#### How might it impact on clinical practice in the future?

- ▶ The national register of catastrophic injuries must continue to longitudinally monitor the evolution of catastrophic injuries and assess the effectiveness of prevention programmes.
- ▶ Injury prevention programmes must be supported and developed to reduce the incidence of injuries.
- ▶ The modification of rugby rules can be considered an important part of prevention policies to reduce incidence of injuries.



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**Collaborators** Chris Carling.

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