ORIGINAL ARTICLE

Cervical spinal injury in children's community rugby football

G J Browne

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Objective: To examine the characteristics of cervical spinal injury (CSI) in school aged children injured in community based rugby football who presented to the emergency department for assessment.

Methods: This is a retrospective descriptive case series study reviewing the medical records of all children younger than 15 years of age who presented to the emergency department at the Children's Hospital at Westmead, Sydney, Australia for assessment of injury to the cervical spine between 2000 and 2003.

Results: There were 125 children with CSI; most (97%) were boys of mean age 12.7 years. Injuries occurred throughout the season, with an unexpected peak in June. Neck pain was the main presenting complaint (98%). Neurological symptoms were reported in 43%, half having concussion. Hyperextension of the neck accounted for a third of all cases and was usually the result of a spear tackle. Appropriate treatment of the cervical spine on the field of play before transport to hospital was inconsistently performed. Half of the players with CSI suffered secondary injuries, consisting of concussive head injury, faciomaxillary injury, eye injury, or limb fracture. Admission to hospital was common, with all children admitted undergoing further radiological assessment. Two minor fractures were reported and no permanent neurological disability. Overall, no adverse events were reported and the clinical outcome was good.

Conclusion: CSI in children playing rugby football is rarely catastrophic although often associated with other injuries. Continued efforts are needed to educate players and referees to prevent injury.

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Correspondence to:
G J Browne, The Children's
Hospital Institute of Sports
Medicine, Westmead,
Sydney, NSW, Australia;
garyb@chw.edu.au

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Cervical spine injury (CSI) in children is a relatively rare event, with motor vehicle accidents and falls as the prevailing mechanisms in young children less than 10 years old.[1] In children older than 10, more sustain a CSI while involved in sports than in motor vehicle accidents. Spinal cord injury can have catastrophic consequences if the diagnosis is delayed and/or the initial treatment is inadequate. A missed injury in a child can result in permanent paralysis or even, in rare cases, death.[1 2]

In the 1980s in Australia and New Zealand, there was major concern about player safety, with a reported increase in acute CSI in schoolboy rugby players.[3–5] These injuries were identified as occurring in the scrum in union players and during a tackle in league players.[3 6] A review of acute CSI injuries between 1986 and 1996 in Australia reported an incidence of 2.4/100 000 players-year.[7] This high incidence of CSI resulted in the introduction of prevention strategies such as changes to the rules to allow more controlled engagement in the scrum in union and an education programme for players and referees focused on injury prevention.[7 8] Injuries during the tackle in league were not addressed.

Reports on elite rugby have suggested that interventions to improve player safety have possibly reduced the incidence of CSI in recent years.[7] No data are available, however, on the current nature of CSI in non-elite (community based), school aged rugby football players. The purpose of this study was to examine the characteristics of CSI in school aged children who were injured in non-elite (community based) rugby football and presented to the emergency department for assessment. Of particular interest is the association between these characteristics and the outcome of assessment, namely admission to hospital.

METHODS

This is a retrospective descriptive case series study reviewing medical records of all children younger than 15 years of age who presented to the emergency department of the Children's Hospital at Westmead for assessment of a potential injury to the cervical spine between 2000 and 2003. This hospital is the designated paediatric spinal unit for the state of New South Wales in Australia. Included in the study were children involved in community based rugby football and who were identified on the field of play as having a potential injury to their cervical spine needing assessment at the specialised spinal unit. The study was approved by the hospital's ethics committee.

During the study period, there were 21 248 trauma episodes, with 1745 episodes of CSI in children younger than 15 years. Of these, 1610 were due to motor vehicle and pedestrian accidents. There were 139 sports related CSIs, of which 125 were related to rugby. The remaining 14 were sustained in other activities such as trampoline, soccer, gymnastics, netball, baseball, and softball.

Injured children were assessed as to whether they needed urgent medical attention on the field of play by the coach/teacher. As a standard requirement in Australia, all coaches and teachers in charge of physical education receive full training in first aid provided by the St Johns ambulance. They are also educated to assess the significance of an injury, particularly to the neck. Once there is any suspicion of significant injury or any potential injury to the neck, the NSW Ambulance Services is contacted to transport the injured child to a hospital for further assessment and treatment. While attending the injured child at the scene, the ambulance officer follows the standardised assessment and treatment protocol stipulated by the NSW Ambulance Services. At the same time, the emergency department of the receiving hospital is alerted that a patient with potential cervical spinal injury will be arriving. Once the patient arrives in the emergency department, treatment follows a predetermined clinical pathway.

In this study, comprehensive clinical information was collected using the emergency department clinical information system (Health-e-Care) in addition to the trauma information system. The patient characteristics collected included age, sex, nature and type of injury, and treatment

Table 1 Characteristics of patients with cervical spine injury (n = 125)

Characteristic	Number (%)
Age*	
⩽10	27 (22)
⩾11	98 (78)
Sex	
M	121 (97)
F	4 (3)
Rugby rules	
Union	99 (79)
League	26 (21)
Mechanism of injury	
Flexion	37 (30)
Extension	9 (7)
Flexion/extension	16 (13)
Distraction	7 (6)
Rotation	3 (2)
Hyperextension	44 (35)
Unknown	9 (7)
Triage category	
1	5 (4)
2	44 (35)
3	52 (42)
4	21 (17)
5	3 (2)
Neck pain	
Yes	115 (98)
No	2 (2)
Concussion	
Yes	29 (23)
No	95 (77)
Neurological symptoms	
Yes	53 (43)
No	69 (57)
Other injuries	
Yes	68 (54)
No	57 (46)
Treatment at scene	
Yes	96 (82)
No	21 (18)
Clinical evaluation at ED	
Assessment & observation only	20 (16)
Imaging	105 (84)
Surgery required	
Yes	0
No	125 (100)
Admission	
Yes†	39 (31)
No	86 (69)

*Mean (SD) age 12.7 (2.1) years.
†Mean (SD) length of stay 43.4 (14.2) hours (median 48.0).
ED, Emergency department.

on the field and in the emergency department. The following clinical outcomes were reported: admission to hospital, length of stay in the emergency department, morbidity (spinal cord or bony injury), co-morbidity (injuries other than CSI), and mortality from CSI.

Data were analysed descriptively using frequencies and percentages. As all variables of interest in this study were categorical variables, the Pearson χ^2 test for the association between patients' characteristics and admission was used. If the expected values in any one of the cells were less than 5, Fisher's exact test was used.

RESULTS

There were 125 children who injured their cervical spine while playing rugby football during the study period. Of these 125 cases, 99 were the result of playing rugby league and 26 were from playing rugby union. Table 1 summarises the results. Most (n = 121, 97%) rugby football CSIs occurred in boys who were over 11 years of age (n = 98, 78%) (mean (SD) age 12.7 (2.1) years) . Injury incidence was consistent throughout the season, although a third were reported as

occurring in June (p<0.001) (fig 1). There were no trends in player position and injury, as permanent positions were rarely allocated, although players tended to be in either the forward pack or back row.

Neck pain was reported in 98% of presentations and was the main complaint of CSI reported at the scene or on the field of play by attending ambulance officers. Associated neurological symptoms were reported in 53 cases (43%), and concussion was reported in 39 (23%). Of those patients suffering a concussion, 27 (69%) had a brief alteration in mental state or confusion, and 12 (31%) were reported to have an associated loss of consciousness. Transient sensory, motor, or general paralysis was also reported in 14 cases; 10 had transient sensory or motor deficit, and four had transient quadriparesis.

Further review of the ambulance reports indicated that treatment at the scene, which consisted of immobilisation of the cervical spine, occurred in 96 cases (82%).

Resuscitation on the field, consisting of oxygen and fluid administration, was reported in one rugby league player who had a seizure on the field of play.

The mechanisms of injury were extension of the neck (53; 37%), flexion of the neck (37; 30%), flexion/extension (16; 13%), distraction of the neck (seven; 6%), and a rotation type injury (three; 2%). In nine (7%) cases, the mechanism of injury was unreported. Further examination of the nature of injury indicated that, of the 46 cases of extension injury, 27% were hyperextension injuries that occurred as a result of a spear tackle. This type of injury was reported exclusively in players of rugby league. Of the 37 cases of flexion injury to the neck, 23% occurred during a scrum while playing rugby union. Thirty five of these players reported that they were either filling in for an absent player or trying out a new position at the time of injury.

There was a significant association between rugby codes and the nature of injury. A rugby union player was more likely to have sustained a flexion/extension injury (81%) than a rugby league player (41%; χ^2_1 = 12.76, p<0.001). Alternatively rotation/hyperextension injury was more commonly reported in rugby league players with a hyperextension injury, many the result of a spear tackle. A significant association was also found between rugby codes and the incidence of concussion: 27% of rugby league players v 8% of rugby union players (χ^2_1 = 4.14, p = 0.042). No other variables were found to be associated with rugby rules. Because of the lack of difference in all of the other variables, the two rugby codes were combined for the analysis of outcomes.

The occurrence of co-morbidity in players of rugby football was significant. A concussive head injury was reported to occur in 29 (23%) of all rugby players with a CSI. Additional co-morbid injuries with a CSI included fractures to the maxilla, orbit, arm, or leg in six (5%), laceration to the face/scalp in 24 (19%), epistaxis in six (5%), and hyphaema in two (2%) cases.

Of the 125 children with rugby football related CSI, 20 (16%) were observed in the emergency department without any further investigation. The remaining 105 (84%) required imaging, which include cervical spine radiology in all, computed tomography scan in 22 (18%), and magnetic resonance imaging in 10 (8%). Although 39 (31%) patients were admitted to hospital, none required surgical intervention.

Of the 39 patients admitted to hospital, admission was for CSI injury alone in 17 (14%). In 22 (18%) patients, admission was for treatment of co-morbid conditions, with laceration repair accounting for 15 (68%). The mean length of stay for all admitted patients was 43.4 hours with a median of 48 hours. Morbidity was low, with two cases of isolated
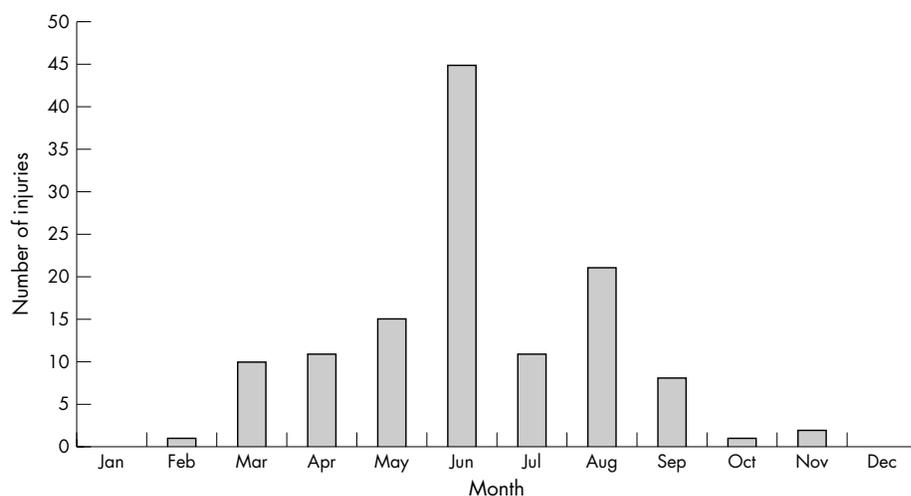
fracture to the spinous process (C5 and C6 respectively) treated in hospital conservatively. Both players were from the rugby league code and suffering a hyperextension injury to the neck (spear tackle). No deaths were reported.

Some patient characteristics were identified to be associated with admission to hospital (table 2). These included neurological symptoms, other injuries, treatment at the scene, and imaging in the emergency department.

DISCUSSION

Many studies have reported on acute CSI in football, but this is the first to report on acute CSI in non-elite (community based) rugby football players of school age. Most of these injuries were found to be potential CSI in which a strain or sprain occurs without damage to the spinal cord or surrounding vertebral column. The most common mechanism of injury was hyperextension. It resulted in two stable fractures to the lower cervical spine. These were uncomplicated fractures which

responded well to conservative treatment. No long term adverse events were reported in relation to the primary CSI. A quarter of cases required admission to hospital for treatment of secondary injury, which included concussion, maxillofacial injury, eye injury, and limb fracture.

In this study, rugby union was more likely to be associated with a flexion/extension mechanism of injury. This is consistent with other studies which found that rugby union players were more likely to suffer CSI in a collapsed scrum.[2] [3] Conversely rugby league was found to have a significant association with rotation/hyperextension injury, which in most cases resulted from a spear tackle. However, no significant differences in clinical outcomes were found between the two rugby codes. A possible explanation is that young immature teenagers are unlikely to cause a collision severe enough to result in serious injury to the spine. This, however, remains to be confirmed. The spear tackle was a common cause of injury in the rugby league players. This

Table 2 Characteristics of patients related to admission status

	Admitted (n = 39)	Not admitted (n = 86)	Significance
Age			
⩽10	11 (28)	16 (19)	$\chi^2_1 = 1.46$, p = 0.23
⩾11	28 (72)	70 (81)	
Mechanism of injury			
Flexion/extension or both	16 (41)	46 (53)	$\chi^2_1 = 1.67$, p = 0.20
Others	23 (59)	40 (46)	
Neck pain			
Yes	35 (97)	80 (99)	Fisher exact p = 0.52
No	1 (3)	1 (1)	
Concussion			
Yes	9 (23)	20 (23)	$\chi^2_1 = 0.003$, p = 0.96
No	30 (77)	65 (76)	
Neurological symptoms			
Yes	24 (61)	29 (35)	$\chi^2_1 = 7.64$, p = 0.01
No	15 (38)	54 (65)	
Other injuries			
Yes	27 (69)	41 (43)	$\chi^2_1 = 5.03$, p = 0.03
No	12 (31)	45 (52)	
Treatment at scene			
Yes	34 (92)	62 (77)	$\chi^2_1 = 3.56$, p = 0.06
No	3 (8)	18 (22)	
Clinical evaluation at ED			
Assessment & observation	0 (0)	20 (23)	$\chi^2_1 = 10.80$, p = 0.001
Imaging	39 (100)	66 (77)	

Values in parentheses are percentages.
ED, Emergency department.

What is already known on this topic

- Cervical spine injury in children is relatively rare
- In elite rugby, interventions to improve player safety have possibly reduced the incidence of cervical spine injury but no data are available for school aged rugby football players

What this study adds

- Cervical spine injury in children playing rugby football is rarely catastrophic although often associated with other injuries
- Continued efforts are needed to educate players and referees to prevent injury

suggests that better adherence to the rules of rugby league may prevent most of these injuries.

Studies on adult players have reported an increase in frequency of CSI early in the season,[7] but this trend was not shown in the present study. CSIs were spread throughout the season except for an unexpected peak in June, which is probably due to heavy exposure to rugby in that month.

Although the position of the player when injured is not well reported in this study, most CSIs occurred in the scrum for rugby union and during a tackle in rugby league. Tackle injuries in league were of particular concern as many were the result of the illegal spear tackle.[9] [10] Here education and leadership from elite players may be important in preventing these injuries.[11]

Precautions must be taken in every case of a potential CSI. In this study, treatment on the field of play was not effectively applied in over a quarter of cases, with no spinal immobilisation before transport to hospital in these players. Recent reports highlight the need to review policies and practices in New South Wales in relation to sporting injuries.[12] One study in particular reported a lack of policies for the effective treatment of head and neck injuries on the field of play in children.[13] The results from the present study support the need for policies for on-field injury management to be put in place so that more effective treatment is delivered to players with potential CSI before they are transported to hospital for assessment.

Spinal cord injuries are at one end of a spectrum of injury in football. An association of CSI with secondary injury is well reported in the literature, particularly concussive head injury.[7] [8] In this study, over half of the players had suffered an injury in addition to the primary CSI. These associated injuries were concussive head injury, limb fractures, or facial, maxillary, and/or eye injuries. A quarter of children with secondary injury were admitted to hospital for further treatment of that injury. Associated secondary injury adds to the considerable overall burden of CSI (even if the spine is cleared of trauma) to the healthcare system.

Given the current nature of the paediatric trauma system in Sydney, most suspected cases of CSI in children are eventually assessed in hospital. This has provided a convenient sample which includes nearly all paediatric CSI patients in the western region of Sydney, where most of the city's children reside. One limitation of this study is report bias, as in most cases the mechanism of injury was obtained from the patient or parent. In the few cases where this information could not be obtained directly, it was obtained by proxy. This may result in some report bias in the data collection. A second limitation of this study is that only players who presented to the emergency department were included. As these are the most seriously injured players, care must be taken in extrapolating these results to the general rugby playing population. This may have introduced bias, which could subsequently affect recommendations for any injury prevention.

CSI in children playing rugby football is rarely catastrophic. Some of these injuries are uncomplicated fractures which respond well to conservative treatment. In this study, secondary injury accounted for the greatest morbidity. Continued efforts should focus on education and more effective use of safety equipment.

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