An inventory of rugby-related spinal cord injuries in South Africa

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DECLARATION

I, Fiona Joy Hermanus, hereby declare that the work contained in this research is based on my original research and has not, in whole or in part, been submitted towards another degree, at this university or elsewhere. The university is empowered to reproduce either the whole or any portion of the contents for the purposes of research.

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12th November 2008

Date

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DEDICATION

I would like to dedicate my dissertation to my long suffering family. For Curt Warrin, my partner, for being so willing to take our children out to afford me the space and time to sit behind my computer and to Vincent and Georgia who had to be without their mom on many outings and camping trips.

And last but not least, this is for my parents, Leonard and May Hermanus, who have both been a source of inspiration; a special mention goes to my dad who came from so little but gave us all so much of his drive for life.

ABSTRACT

In order to address an apparent increase in the number of rugby-related spinal cord injuries (SCIs) in South Africa, a retrospective case-series study was conducted from 1980-2007. A database was developed to monitor the trends, establish the demographics, distribution and present management of SCIs and to use this knowledge to institute and evaluate preventative measures. Two hundred and forty six SCIs were identified with 119 participants completing a spinal injury questionnaire with information found on a further 64 players (30 were deceased).

The number of SCIs increased from 36 in 1980-9, to 56 in 1990-9 and 65 in 2000-7. The overall trend for the neurological outcome has improved with 25% of players having non-catastrophic outcomes in 1980-89 and 54% in 2000-7. But, previously disadvantaged players had a greater percentage of catastrophic outcomes with almost a quarter of players with catastrophic outcomes dying within two years. The tackle accounted for a greater proportion of SCIs but scrummaging had more catastrophic outcomes. Hookers and players aged 17 had the highest number of SCIs. The majority of players had played rugby for more than five years at the time of injury.

Notably, 75% of players with no pre-season conditioning sustained SCIs with most occurring at the beginning of the season. Over 50% of the players with catastrophic outcomes had no medical personnel present at the time of injury with almost half waiting longer than six hours for acute management. The majority of players received no financial compensation with only four players returning to full participation.

The increasing trend of SCIs needs to urgently be addressed, especially in young players, and the neurological outcome and survival status in the previously disadvantaged players must be improved. A compulsory register for SCIs and an educational preventative injury programme must be initiated with greater emphasis on neck strengthening, conditioning before first contact play and correct techniques for scrummaging and tackling. Adequate financial compensation should be instituted.

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Abbreviations

- **ASIA**: The American Spinal Injury Association scales A to D to classify serious injury claims that involve permanent functional impairment resulting from damage to the spinal cord (http://en.wikipedia.org/wiki/Spinal_injury)
- **BMI**: Body mass index (kg/m^2)
- **CBPF**: Chris Burger / Petro Jackson Players' Fund
- **IRB:** International Rugby Board. The international governing body of rugby union
- **KZN**: KwaZulu-Natal
- **MRC**: Medical Research Council
- **NZ**: New Zealand
- **NZRU**: New Zealand Rugby Union
- **RU**: Rugby Union
- **SA**: South Africa
- **SARU**: South African Rugby Union
- **SASCA**: Southern African Spinal Cord Association
- **SASSU**: South Africa Students Sports Union
- **SCI(s)**: Spinal cord injury (injuries)
- **SSISA**: Sport Science Institute of South Africa
- **SWD**: South Western Districts
- **UCT**: University of Cape Town
- **USSASA**: United Schools Sport Association of South Africa

Terminology

- **Backs**: Player number nine to 15. The main role of the backs in rugby union is to attempt to gain field position and score points. The backs run with the ball or kick for field position after the ball has been won or retained and recycled by the forwards. Backs are involved in tackling and defence.
- **Cape Province**: From 1910 to 1994, South Africa was divided into four provinces. Since 1994, the Cape Province has been broken up into three smaller administrative units: the Western Cape, Eastern Cape and Northern Cape. Parts of the Cape Province were also absorbed into the North West Province. South Africa now has nine provinces (GT = Gauteng) (http://en.wikipedia.org/wiki/Image:South_Africa_Provinces_labeled.svg).

- **Duration of initial care**: The period of time from the date of injury to their date of discharge from the spinal unit to their previous home, or to a new home, nursing home or other accommodation.
- **Engagement**: The moment at which, on the referee's signal, the two forward packs of the opposing teams lock together to form the scrum (Carmody et al 2005).
- **Ethnicity**: The South African government previously used racial classification as a tool in its official state policies to control its population. Prior to elections in SA in 1994, apartheid legislation classified inhabitants into racial groups ('black', 'white', 'coloured' and 'Indian' (or 'Asian'). 'Coloureds' were technically a mixed race and often possess substantial ancestry from Europe, Indonesia, India, Madagascar, Malaysia, Mozambique, Mauritius, St. Helena and Southern Africa (http://en.wikipedia.org/wiki/Apartheid).
- **Forwards**: Player numbers one to eight. The main role of the forwards in rugby union is to win and retain possession of the ball. The forwards contest the ball in set play - scrums and lineouts. Forwards are involved in tackling and defence.
- **Grade of neuropraxia**: (Torg et al 2002)
    - Grade I - Less than 15 minutes
    - Grade II - Greater than 15 minutes but less than 24 hours
    - Grade III - More than twenty four hours
- **Hooker**: Hookers are in the central front-row forward position of the scrum (Carmody et al 2005).
- **Indaba**: Conference (in South African Nguni language)

- **Maul**: In rugby union, a maul is formed when one or more players from each team are on their feet in physical contact closing around a player who is carrying the ball (Scher 1998). The ball is off the ground and is held by a player who is simultaneously held by one or more opponents and a team mate (Quarrie et al 2007).
- **Neurological pattern is defined by anatomical distribution of the neurological symptoms**: (Torg et al 2002)
    - Quad - Involve all four extremities.
    - Upper - Both upper extremities involved.
    - Lower - Both lower extremities involved.
    - Hemi - Involved ipsilateral upper and lower extremity.
- **Outcome**:
    - Catastrophic: Players that permanently require the use of a wheelchair after one year after their injury or are deceased as a result of their spinal cord injury.
    - Non-catastrophic outcome: Players who are able to walk with or without the aid of assistive devices such as crutches.
- **Paraplegia**: Injury at the thoracic, lumbar or sacral levels, with an impairment or loss of motor and/or sensory function in these segments of the spinal cord. Upper limb function is spared, but depending on the level of the injury, the trunk, pelvic organs and lower limbs may be functionally impaired.
- **Paresis**: Episodes with motor weakness (Torg et al 2002).
- **Plegia**: Episodes of complete paralysis (Torg et al 2002).
- **Parathesia**: Episodes that involve only sensory changes without motor involvement (Torg et al 2002).

- **Pre-season conditioning sessions**: Training that occurs before the start of the season with the goal of developing specific fitness characteristics in preparation for the season.
- **Previously disadvantaged**: A player that would have been classified 'black', 'coloured' or 'Indian' under the apartheid government.
- **Prone**: Lying on your stomach.
- **Protective equipment**: Includes mouth guards, padded headgear, padded clothing, fingerless gloves, strapping, support sleeves, shin guards and ankle braces.
- **Ruck**: In rugby union, a ruck is a phase of play (often after a tackle) that occurs when the ball is on the ground. One or more players from each team are on their feet in physical contact, closing around the ball between them and contest possession (Scher 1998, Quarrie et al 2007).
- **Rugby League**: A variant of rugby played between two teams of 13 players and governed by separate administrative body from rugby union. Rugby union and rugby league developed from the same parent game; although they have many similarities; some important differences exist. After a tackle in rugby league, the tackled player is allowed to stand up and restart play by placing the ball on the ground and holding it back to a team member standing behind him. There are no rucks or mauls of the type that occur in rugby union. Scrums in rugby league involve minimal pushing, whereas pushing is a major feature of rugby union scrums (Quarrie et al 2007).
- **RugbySmart**: A joint venture between the New Zealand Rugby Football Union (NZRFU) and Accident Compensation Corporation (ACC) and is based

around ACC SportSmart – the 10-point action plan for sports injury prevention.

- **Rugby Union**: A type of full contact football usually played between two teams of 15 players. Players may carry the ball and pass or kick it. Points are scored by placing the ball over the opposition goal line or by kicking goals. Ten and seven a side versions of the sport are also played. The rules of the game are termed laws and are available at (www.irb.com/EN/Laws=and=Regulations / Quarrie et al 2007).
- **Scrum**: A means of restarting play after minor infringements. The forwards of each team form together in three rows and close up with their opponents so that the heads of the front row players interlock. This creates a tunnel into which the ball is thrown. The front row players contest possession of the ball by hooking the ball back with their feet (Quarrie et al 2007).
- **Scrum**:
  - **contested**: A scrum in which the opposing teams engage in a 'contest', pushing with great force towards each other to try to gain ground and get possession of the ball (Carmody 2005).
  - **loose**: A ruck or maul and often referred to as a loose scrum.
  - **popping**: Front rowers must engage square on. It is an infringement for a loose-head prop to push into the opposition tight-head prop's chest causing his body to pop out of the scrum. Infringement is punished with a penalty (http://en.wikipedia.org/wiki/scrum).
- **Spineline**: An organised rapid response system to assist seriously injured rugby players anywhere in South Africa. Operating 24-hours a day, Spineline has a national toll-free number, 0800–678–678. The aim of the Spineline is to

provide proper spinal stabilization and immediate transportation to an appropriate trauma centre. If the patient is not on medical aid, the costs for transportation will be covered by NETCARE 911. (http://www.playersfund.org.za)

- **Supine**: Lying on your back.
- **Tackle**: When a ball carrier is held by one or more opponents and is brought to the ground. Following a tackle in rugby union, play continues (Quarrie et al 2007).
  - **Double or gang tackle:** The rugby player who is simultaneously tackled by two or more opponents. One tackler targets low on the ball carrier while another targets high. The high tackler increases the force applied to the ball carrier with the addition of gravity, and since the lower body of the ball carrier is fixed, there is little remaining flexibility in the upper body of the ball carrier to dissipate energy (Scher 1991).
  - **High tackle**: When a tackler wraps his arm around his opponent's neck from behind or from the side.
  - **Spear tackle**: It is a dangerous tackle whereby a player is picked up by a tackler on the opponent's side, and turned so that they are upside down. The tackler then drops or drives the player into the ground often head or neck first (http://en.wikipedia.org/wiki/spear_tackle).
- **Tetraplegia / Quadriplegia**: Injury to the spinal cord at the cervical level results in impairment or loss of motor and/or sensory function in the arms as well as in the trunk, legs, and pelvic organs.

Introduction

Literature review

Rugby (union) is a type of full contact football most commonly played between two teams of 15 players (Garraway et al 2000, Quarrie et al 2007). It has an international following - the International Rugby Board (IRB), which is the sport's governing body, lists 95 countries in its online world rankings, although rugby is a major sport in fewer than 20 countries (Quarrie et al 2007). As there is vigorous physical contact, rugby has a very high incidence of injuries (Carmody et al 2005, Garraway et al 2000, Silver 2002) with Rotem et al (1998) making a defining comment that ... "rugby is an inherently dangerous game". Spinal cord injury (SCI) is the most devastating injury a player can sustain in rugby (Shelly et al 2006, Silver 2002, Sinibaldi and Smith 2007). Injury to the spinal cord at the cervical level results in impairment or loss of motor and/or sensory function in the arms as well as in the trunk, legs, and pelvic organs (Cripps 2005).

Despite the relative infrequency of SCIs in terms of player exposure (Browne 2006, Fuller et al 2007, Sinibaldi and Smith 2007), SCIs are a major cause of serious morbidity and mortality in rugby (Quarrie et al 2002, Shelly et al 2006). The most catastrophic outcome of a cervical spine injury is tetraplegia (Silver 2002, Cripps 2005) which has a devastating effect on the life of the person injured and on family members and other close associates (Carmody et al 2005). This outcome increases the negative profile of the sport (Sinibaldi and Smith 2007). In South Africa, rugby is associated with the highest incidence of SCI of all organised sports (Tomasin et al 1989).

Before the 1970s, there was only one serious spinal injury from rugby every four years and these injuries were regarded as being 'the luck of the game' or 'an act of God' as they were rare (Silver 2002). During the 1970s and 1980s, an increase in the reported frequency of catastrophic spinal injuries associated with rugby was documented in medical journals from several countries in which rugby is popular (Haylen 2004, Quarrie et al 2007) with a simultaneous and dramatic rise in the annual numbers of SCIs from 1981-91 in all rugby playing countries including England, Wales, New Zealand, Ireland and Australia and South Africa (Kew et al 1991).

The attention generated by letters to journals (Noakes 1995 and 1999, Silver 1979, Williams 1978), cases reports (Scher 1982, Scher 1983) and case series studies (Kew 1991, Scher 1998, Silver 1984) prompted rugby administrators to act during the 1980s and 1990s in an attempt to decrease the risks of SCIs (Haylen 2004, Quarrie et al 2007). Measures to reduce and prevent SCIs were changes to laws on scrum procedures, stricter application of existing laws and educational initiatives (Haylen 2004, Silver 2002, Quarrie et al 2007). Kew et al (1991) found that SCIs were decreasing in England, Australia and New Zealand in the late 1980s and early 1990s but not in South Africa. They related the continued rise of SCIs in South Africa to the lack of timely adopting specific measures that were found to be effective in other countries. Despite all these measures, when rugby entered the professional era in October 1995, the number of spinal injuries in all countries had again increased dramatically (Bathgate et al 2002, Silver 2002).

Incidence data

Various trends in incidence have been evident in the literature during the last decade. In Australian football codes, the annual incidence has not changed since records were first kept in the 1960s with most SCIs being seen in rugby league and union (Carmody et al 2005, Spinecare Foundation 2003). Statistical analyses of SCIs in Australia had yielded results of 3.5 per 100 000 players per year in 1986-96 and, in 1997-2002, results slightly decreased to 3.2 per 100 000 players per year (Carmody et al 2005, Spinecare Foundation 2003). This contrasts with a review of acute cervical spine injuries by Taylor (2003) who reported a lower incidence of 2.4 per 100 000 players per year from 1986-96 in Australia. In New South Wales, Australia, the rate was 5.1 per 100 000 players per year in 1996-2000 with an increase in 2001-03 to 9.8 per 100 000 players per year (Berry et al 2006). The denominator, in this study, did not include school age players.

In Argentina, four cases of disabling injury to the cervical spine were recorded from 1977–86 with 14 cases occurring from 1987-97, an annual average of 1.4 per annum from 1987-97 (Secin et al 1999). Secin et al (1999) reported that the Argentine Rugby Union (RU) had 48 000 registered players compared to the 400 000 players of Rugby Football Union in England. Silver (1992) observed that the average number of SCIs per year in England was 2.2 from 1956-82 which rose to 3.6 per annum from 1982-87. Shelly et al (2006) reported on 12 cases of acute SCI admitted to the only spinal injury unit in Ireland from 1995-2004. This is a frequency of 1.2 SCIs per annum. Eight of the players were permanently disabled. In 2006, Ireland had 90 000 registered players (Shelly et al 2006).

A recent study conducted by Quarrie et al (2007) found that the number of SCIs in New Zealand had fallen significantly since the implementation of a nationwide preventative programme, RugbySmart in 2001. In total, there were 77 permanently disabling injuries recorded in 1976-2005 (Quarrie et al 2007). They found that the predicted number of SCIs, that occurred in scrummaging, had decreased from 2001-05. The rate of spinal injuries in New Zealand rugby in 1996-2000 was 2.7 per 100 000 players per year which decreased to 1.3 per 100 000 players per year in 2001-05 (Quarrie et al 2007). The average annual number of players registered in New Zealand was 125 900 in 2001-05.

In South Africa, from 1981-87, an average of 5.4 players per year were admitted to the Spinal Injury Unit at Conradie Hospital in Cape Town which, at that time, was the only specialized spinal unit based in the Cape Province (Scher 1998). From 1987-96, an average of 8.7 players per year were admitted (Scher 1998). At present, the incidence in terms of number of players per 100 000 players per year in South Africa is unknown as the actual number of registered rugby players is not available.

In respect to phases of play, a review of papers published up to 2001 reported that 40% of spinal injuries occurring in rugby were the result of the scrum, 36% were from the tackle, 18% from the ruck/maul, and the remainder were either 'other' or from unknown causes (Quarrie et al 2002). Quarrie et al (2002) reviewed results from studies done in Argentina, Australia, Canada, New Zealand, South Africa, United Kingdom, United States and Wales.

Phases of play and impact of law changes

Burry and Calcinai (1988) wrote that "failing to alter the procedures of the game despite the knowledge that existing practices were hazardous and that safe alternative existed could well be held by a court to constitute culpable negligence".

In respect to scrummaging, already in 1981, Scher wrote that "the scrum is an integral part of the game of rugby and it remains part of the defining character of the game". Thus there has been a natural reluctance to tamper with the role of the scrum in RU. Australia recorded a 67% reduction in the number of scrum-engagement spinal injuries since 1985 after the introduction of depowered scrum-engagement laws in RU and, in 1996, with the introduction of non-contested scrummaging in rugby league (Spinecare Foundation 2003). Of note, scrum related catastrophic SCIs in Australian rugby league have been eliminated after the adoption of the non-contested scrum (Carmody et al 2005, Sinibaldi 2007). This motivated a consultant general surgeon, working with SCI patients, to suggest the outlawing of the contested scrum (Bourke 2006). He felt that the consequences of SCIs are too great and the continuing risk of injury remains unacceptable (Bourke 2006). Very few of the responses to the article by Bourke were supportive of his comments. Yet, this debate has been raging for many years with Scher discussing it in 1981 and Bourke, in 2006, merely re-igniting the flame.

SCIs resulting from the tackling situation have also been of concern since the 1980s when Silver (1984) found that the number of injuries sustained in tackles had increased. He related this to inadequate tackling techniques of the tackler. Silver also raised concern about the number of ball carriers injured, especially when

tackled by more than one opponent. Quarrie et al (2002), Fuller et al (2007) and Holtzhausen et al (2006) results show that there was still an upward trend of cervical injuries occurring in the tackle situation, exposing the entire team to increased injury risk (Du Toit et al 2005).

Silver (2002) found that SCIs involving rucks and mauls had "almost ceased" as a result of law changes as compared to his statement in 1984 that the "ruck and maul is inevitably dangerous".

Surveillance registers

Ascertaining the numbers of spinal injuries occurring in rugby and the risks faced by players both in the scrum and in other facets of the game has been hampered by the relative rarity of the events and a lack of standardised procedures for collecting data (Garraway et al 1999, Haylen 2004, Quarrie et al 2002). Despite calls for properly controlled studies and centralised registers for spinal injuries since the 1970s, progress has been limited (Haylen 2004, Quarrie et al 2002). Although the IRB committed to establish an injuries database in November 2002 (Haylen 2004), no information relating to an injury database was found on their website (http://www.irb.com). Also, there are appreciable differences in injury data collection, injury definition, severity definition and methodology in most of the published studies in rugby (Bathgate et al 2002). A further impediment to evaluating the risks of spinal injuries in rugby has been a lack of reliable 'denominator' data – the number and exposure of participants from which the cases result over a specified period (Quarrie et al 2007). Uniformity as to how, when, and why injuries occur, and a standard

injury definition are critical for valid studies and the formulation of management strategies to reduce injury risk (Bathgate et al 2002).

In New Zealand, it is compulsory for the referee and team to report any rugby-related cervical or head injuries that required hospitalisation to the Accident Compensation Corporation (ACC). The ACC, although specifically designed as an insurance recording system, does have a use in injury surveillance. Through the collaboration of the New Zealand Rugby and Football Union and the ACC, the data collected were used to monitor the (positive) effect of RugbySmart which, since from 2001, has been compulsory for all coaches and referees (http://www.rugbysmart.co.nz). It must be added that the ACC does not compensate students nor unemployed persons sustaining a catastrophic injury and also does not provide compensation for loss of future or potential earnings.

The Australian Rugby Union instituted a similar (but less extensive) programme called 'SmartRugby' for its referees and coaches in 2005 but there are no reports on its effectiveness (Orchard et al 2007). In Australia, all SCIs are recorded on a national register, the Australia SCI Register. Berry et al (2006) considered this a useful tool to monitor trends in SCI incidence in rugby but found that its potential value was limited by the lack of accurate estimates of player numbers. Orchard et al (2007) have called for the establishment of a government body in Australia to monitor sports injuries and to co-ordinate sports injury prevention programmes including a compensatory function with adequate financial payouts to motivate prevention strategies.

Similarly, Noakes and Draper (2007) suggested that the decrease in spinal injuries reported in New Zealand was linked to the active support of the New Zealand government in providing a national insurance policy that also covered sports injuries. They felt that advocacy by rugby administrators with strong government support is required to reduce sports injuries but indicated that developing countries, like South Africa and Fiji, with limited resources for quality training, coaching and medical services face great challenges in achieving this objective.

Only through national and international SCI surveillance and properly controlled studies as well as with monitoring of changes to rugby can the numbers of SCIs be significantly reduced (Carmody et al 2005, Quarrie et al 2007). Ultimately, the responsibility of establishing national and international spinal injury registers lies with the RU authorities (Haylen 2004). The New Zealand injury surveillance system with the New Zealand RU prevention programme sets a precedent for all rugby playing countries to follow.

Background

In South Africa, an apparent increase in the number of catastrophic and serious rugby-related injuries over the past few years, and in particular in 2006, was noted by the South African rugby administrators, the South African rugby community and the Chris Burger /Petro Jackson Players' Fund (CBPF). By August 2006, 19 catastrophic injuries were reported with three deaths – one due to cardiac arrest (CBPF 2006) and another declared 'brain dead' after allegedly being kicked and punched by an opponent (Mail & Guardian 2006). This number included 11 schoolboys, six club and two professional players (CBPF 2006).

In response to these alarming statistics, a Rugby Safety Indaba was held in Cape Town in August 2006 to address this situation as a matter of urgency. The Indaba was attended by numerous concerned stakeholders with representatives, notably, from South African Rugby Union (SARU), the CBPF, the QuadPara Association of South Africa, Provincial RUs and the University of Cape Town (UCT) Chair of Exercise and Sports Science, Prof Tim Noakes (SARugby 2006).

One of the main outcomes was to send a delegation to the SARU and to the government to present findings of the Indaba as well as to advocate for enforced legislation of safety and injury prevention measures at all levels and the adoption of a unified positive prevention programme (SARugby 2006). One of the key areas identified to make the game of rugby safer was the necessity of all-encompassing injury reporting structures and the importance of research that is required to make informed decisions (Scrubby 2006).

A rugby injury research project, driven by the UCT / Medical Research Council Research Unit for Exercise Science and Sports Medicine, in collaboration, with the CBPF was launched to establish an accurate database of rugby-related SCIs in South Africa since 1980 (The Spinal Injury Zone 2006). The research would expose the actual state of SCIs in South Africa and, in the future, could be used to monitor the effects of preventative measures. The database would provide up-to-date information on the mechanisms of injury that could be used to support rule changes and plan appropriate awareness programmes. It moves South African rugby closer towards data from different countries being accurately compared in terms of incidence rates rather than frequency of injuries per year allowing better assessment and management of risks.

Aim

The aim of this research was to establish an inventory of rugby-related spinal cord injuries that occurred in South Africa between 1980 and July 2007, and to expand the knowledge of the risk factors. Analysis of this information may lead to improved prevention, treatment and rehabilitation of spinal cord injuries among rugby players at all levels.

Objectives

1. To establish an inventory of rugby-related spinal cord injuries that occurred in South Africa between 1980 and July 2007.

2. To use this inventory to describe the following -
    i. The demographics of individuals that have sustained a spinal cord injury.
    ii. The distribution of rugby-related spinal cord injuries in South Africa.
    iii. The correlates of spinal cord injuries.
    iv. The nature of the treatment received by players and the effect of such treatment on the injury outcome.

Methodology

Study design

In this retrospective case-series study, the data presented are from individuals that sustained rugby-related SCIs in South Africa from 1980 to July 2007.

Research instruments

A SCI questionnaire (Appendix 1) was developed through a consultative process with relevant stakeholders and through reviewing previous studies conducted in South Africa (Kew et al 1991, Noakes et al 1999, Scher 1998) and internationally (Carmody et al 2005, Shelly et al 2006, Silver 1984, Spinecare Foundation 2003, Taylor and Coolican 1987, Quarrie et al 2002). The stakeholders included a neurosurgeon specialising in SCIs, a biokinetist from the High Performance Centre at the Sports Science Institute of South Africa (SSISA), who has extensive experience with rugby, as well as the supervisors of this research. The questionnaire was piloted with a small number of rugby players who had sustained a SCI. As the information requested was highly detailed and retrospective (in numerous cases the SCI occurred many years previously), where possible, medical records were accessed or medical reports reports requested to enhance information supplied by participants. Interviews were to be conducted telephonically, or in person, if this was necessary, as well as by email, post or online. PocketSurvey, a data capturing software package (www.pocketsurvey.co.za) was used to enter and store the information gathered with the injury questionnaire being accessible online.

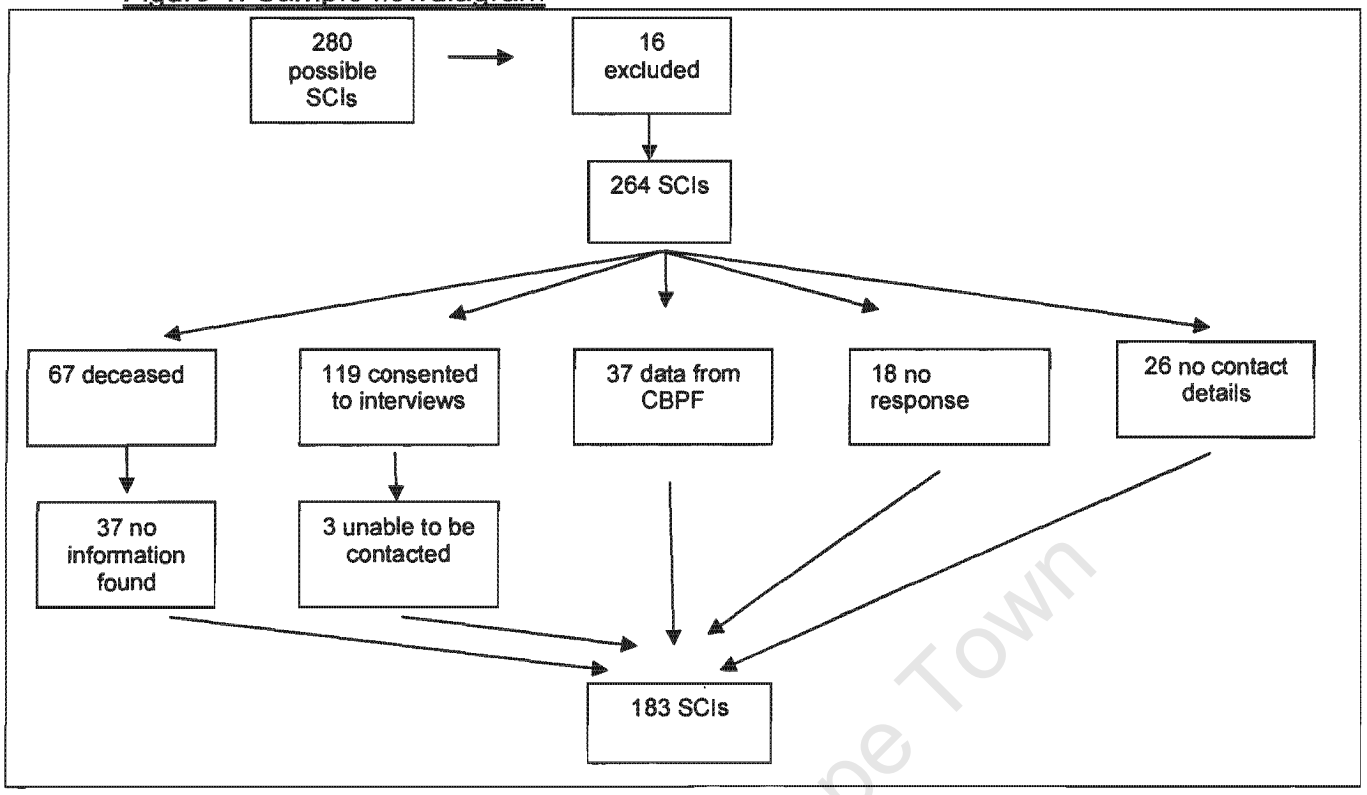
Sample

The total population of players who have sustained SCIs while participating in rugby is unknown. The main sample source was the CBPF that already had on record information of players that had sustained SCIs. Other sources included the SARU, public and private hospitals and rehabilitation sector facilities who manage SCIs (Appendix 2). Players were also notified and identified through public awareness of this study in both print and televised media.

The names of 280 players *(see Figure 1)* who may have sustained a possible SCI were found. Sixteen players were excluded as they had sustained their injury prior to 1980, they sustained their injury outside South Africa or they sustained a catastrophic head injury. Sixty seven players were deceased of which information on 30 players could be found. A further 26 players could not be sent consent forms as no contact details were found. Eighteen players did not respond to requests to be interviewed in the study. A number of these non-responders contact details were found to be outdated. It is acknowledged that the sampling process would not have identified all players who had sustained rugby-related SCIs from 1980 to July 2007.

One hundred and nineteen players consented (Appendix 3) to participate in a structured telephonic interview. The interviewers were unable to contact three of the players as their contact details had changed in the interim and no new contact details were found. In total, information on 183 players was gathered. Thirty of these players were deceased. Information on the 30 deceased players and another 37 players were found through the CBPF with one of the fathers of a deceased player consenting to a telephonic interview.

Figure 1: Sample flowdiagram



Unfortunately, although numerous attempts were made to obtain the number of registered rugby players in South Africa, these data were not forthcoming. Information on the number of matches played per union in 2006 was gained from 11 of the 14 unions.

Procedure

Ethical approval for the study was granted by the UCT's Research Ethics Committee (Appendix 4). All the participants gave written consent for participation in the study and for access to their medical records. If the player was a minor, the parent or guardian gave consent. For a player who was functionally limited by his quadriplegia and unable to sign the consent form, a person of legal age signed on his behalf.

Interviews began in mid January 2007 with the last interview being conducted in July 2007. Telephonic interviews were conducted in the player's first language by interviewers who were fluent in the injured player's mother-tongue of English, Xhosa or Afrikaans. For participants under 18 years, the parents were given the option of completing the questionnaire on behalf of their child or, if they felt the child was able to complete the questionnaire, the injured player was interviewed directly.

Many players could not hold the telephone themselves due to the tetraplegia and the interviewers were, at times, requested to phone back when an assistant was available to help the participant. Some players requested the questions be directed to them via the assistant as they were unable to hear the questions due to poor line connections or inadequate placement of the telephone against their ears. This occurred more often when a cellular phone was used. Interviews were often interrupted by poor cellular phone connections especially when contacting players in rural areas. One player requested to complete the questionnaire online, another player had the questionnaire faxed and four players had personal interviews.

Most of the players with SCIs were known to the CPBF, who were closely involved in the research as well as being the main sample source. However, each telephonic interview was entered directly online onto PocketSurvey that automatically allocated the spinal injury questionnaire a random number, thereby protecting the player's identity. The players' names were known to the interviewers but the random number generated automatically by PocketSurvey prohibited a direct link between the player's identity and the information supplied. The information entered on the database could only be accessed by the interviewers with a unique code.

PocketSurvey also protected against duplication as the interviewer would be notified if the same name or date of birth was entered twice. In the writing up of the research paper, no names of participants were mentioned thereby further protecting the identity of the players.

Medical information was verified through reviewing players' medical records and/or through records kept by the CBPF. These data included site and type of spinal injury, immediate and late management and outcome. Information on 45 players was confirmed through medical files at the Western Cape Rehabilitation Centre (WCRC), previously Conradie Spinal Unit, 27 through the CBPF and eight through medical reports received from specialists. Medical files at WCRC could only be accessed on provision of proof of the player's consent form for participation in this study. There were no responses from health facilities or specialists to 21 requests for medical reports which were all accompanied with a copy of the player's consent form. The medicals records of three players had already been destroyed by the medical facility at which they were managed and three state facilities requested payment before any medical information would be supplied. Information on deceased players was gained through records kept by the CBPF with a father of a deceased player giving verbal consent to be interviewed.

The information gathered was transferred from PocketSurvey to Intercooled Stata Version 8.2 (StataCorp, Texas, USA), a statistical and data analysis programme (http://www.stata.com). Basic statistical analysis was performed on the data to establish normality and range of numerical data. Continuous numerical data such as age, height, weight, length of stay in hospital was transformed into categorical data.

Descriptive information from open-ended questions was grouped into categories based on the content of the data. These were then entered into Stata as categorical data. Statistical analysis for categorical data was conducted using Pearson's Chi square to establish significance of results. Results with a p value of 0.01 or less were considered significant.

Results

GAME INFORMATION

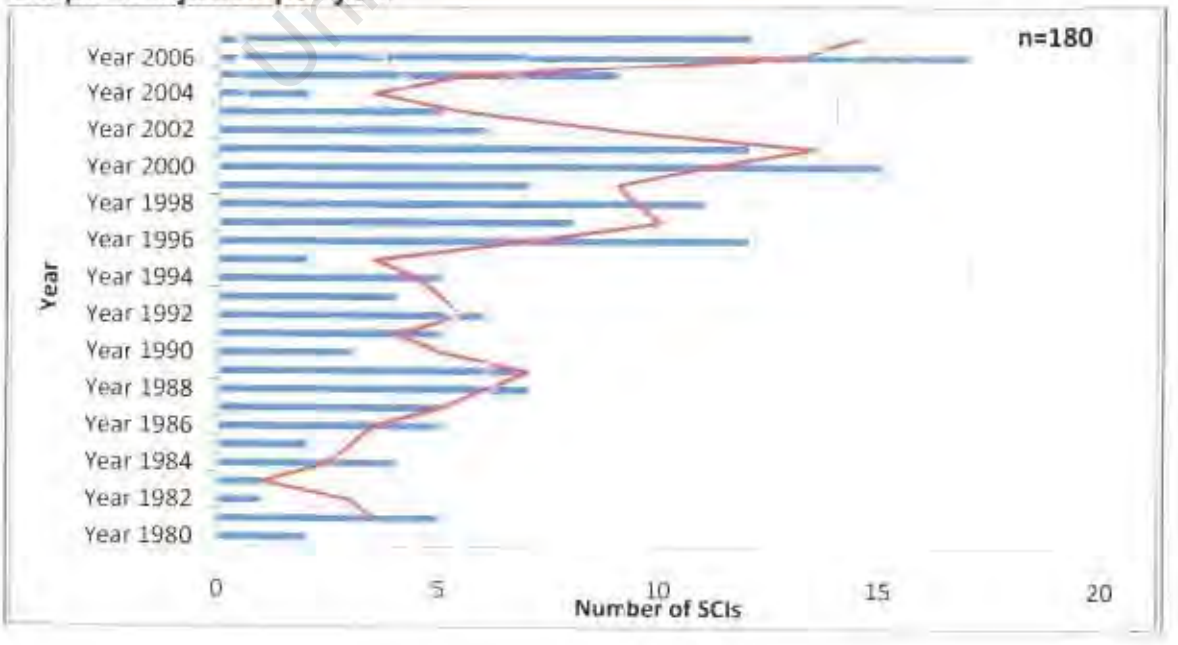
Number of registered players

The number of registered rugby players for 2008 was 464 477 of which 446 821 were male with 147 650 senior, 129 191 teen and 169 980 pre-teen males (http://www.irb.com/unions/union). The number of registered players for preceding years was not available from SARU.

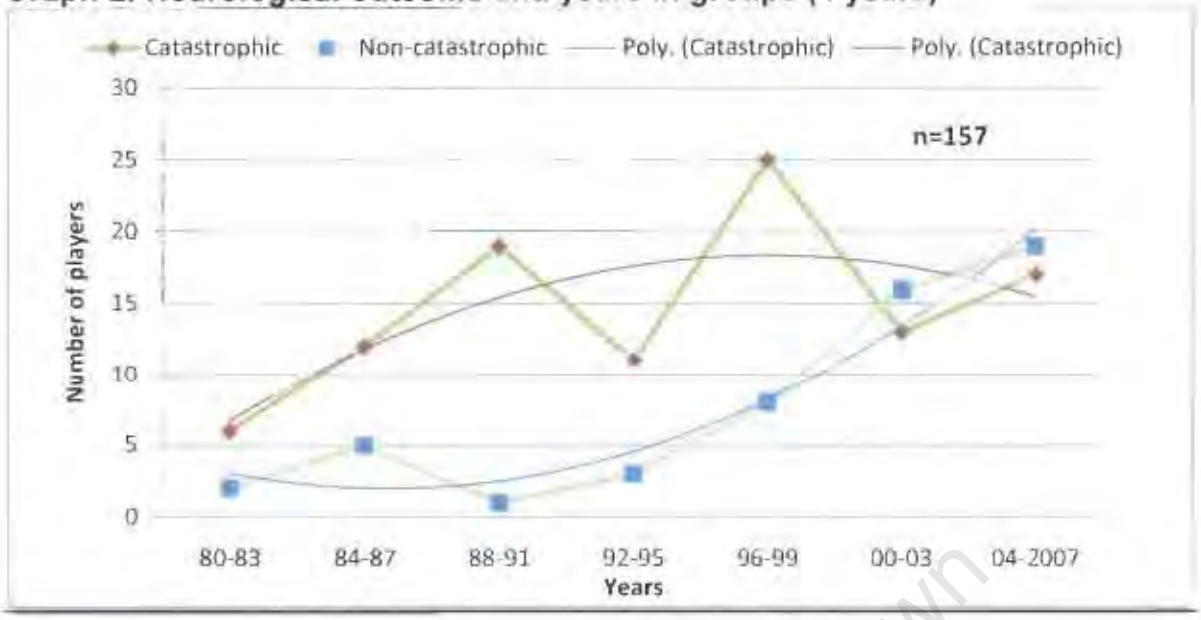
Number of injuries per year

The number of SCIs ranged from two to 17 SCIs per year with a general increase seen in the number of SCIs occurring from 1980 to 2007 (*Graph 1*). The date of injury of three players is unknown. Yet, the trend for the neurological outcome has improved with more players recovering after their initial SCI as demonstrated in *Graph 2*. There was a non-significant association (p=0.047) between neurological outcome and year of injury.

Graph 1: Injuries per year



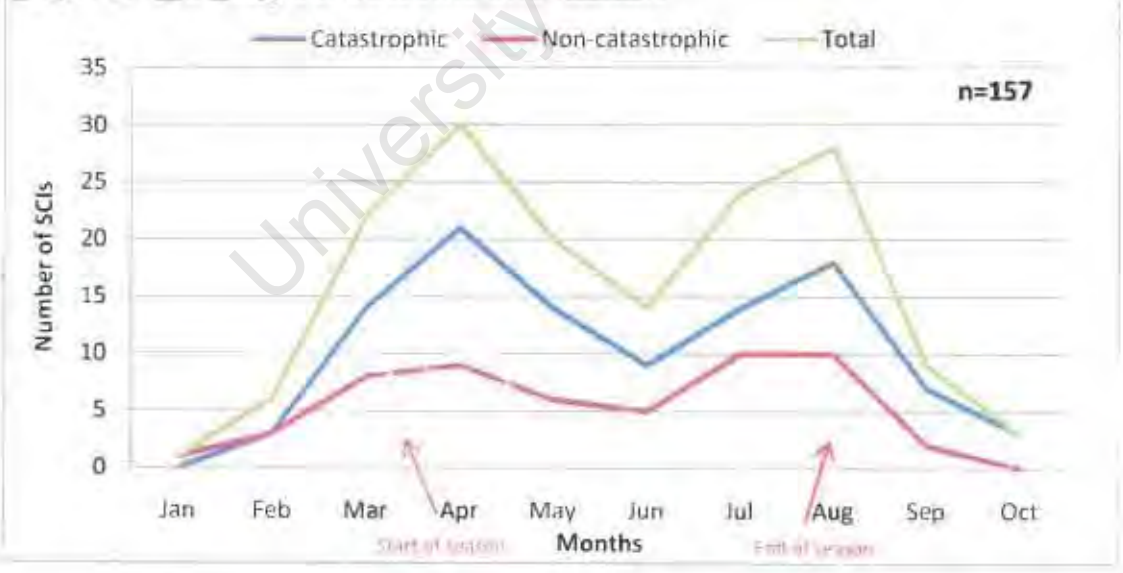
Graph 2: Neurological outcome and years in groups (4 years)



Month of injury

The highest proportion of SCIs (n=180) (*see note below*) occurred in April (21%) followed by August (17%) *(see Graph 3)*. There was no relationship between month of injury and neurological outcome (p =0.824).

Graph 3: Neurological outcome and months



The 'n' of SCIs and the 'n' of outcome (catastrophic / non-catastrophic) may not correspond as outcomes of all the SCIs are not known

Time of injury:

Sixty nine percent of injuries (n = 117) took place in the afternoon *(see Table 1)*. Pearson's chi^2, p=0.045, was not significant for neurological outcome and time of injury.

Table 1: Time of injury

Time of injury	Frequency	Percentage
Morning	25	21
Afternoon	81	69
Nocte	11	9
Total	**117**	**100**

Stage of Season

Fifty seven percent of SCIs (n=133) occurred during the in-season period with 81% of catastrophic SCIs (n=77) occurring in this stage (see *Table 2)*. No association was found between stage of season and neurological outcome (p=0.333).

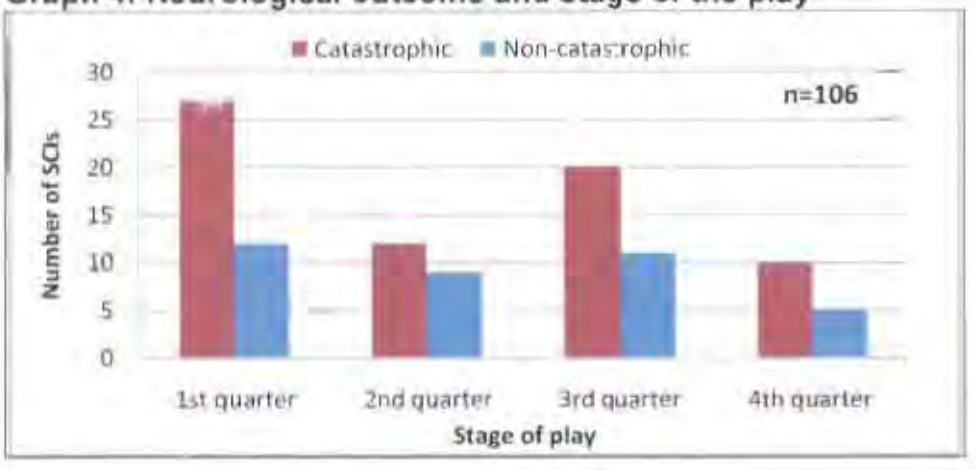
Table 2: Stage of season and neurological outcome

Neurological outcome	Stage of season			Total
	In-season	Pre-season	Transition	
Catastrophic	34	11	3	48
Non-catastrophic	62	12	2	76
Total	96	23	5	124

Stage of play

Thirty nine percent of catastrophic SCIs (n=69) occurred in the first quarter of the match with 29% in the third quarter (*see Graph 4)*. Fifty five percent of players who had two and less pre-season conditioning sessions sustained there SCI in the first quarter (n=38) of the rugby game. There was a non-significant association between stage of the play and preseason conditioning (p=0.045) as well as with neurological outcome (p=0.792).

Graph 4: Neurological outcome and stage of the play



Phase of play

Forty five percent of SCIs (n=126) occurred in the overall tackle phase with 28% of players sustaining a SCI while being tackled. Forty one percent of players sustained their catastrophic SCIs (n=75) during the scrum and 26% while being tackled (*see Graph 5)*. In 2006, seven SCIs (n=16) occurred in the tackling phase with eight in 2007 (n=10 at the end of July). There were no scrum related SCIs in 2007 (end July) but four in 2006. Twenty one percent of players who were injured in the scrum (n=42) and, as well as, 21% in the tackling situation (n=52) said they were not playing in their regular position (*see Table 3)*. There was no association between phase of play and neurological outcome (p=0.139) and normal position (p=0.271).

Graph 5: Neurological outcome and phase of play

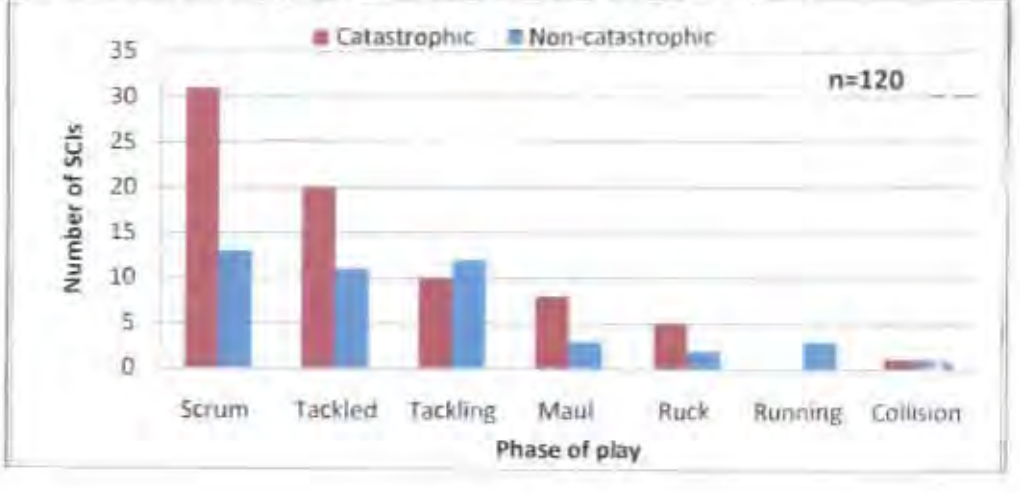


Table 3: Phase of play and normal position

Phase of play	In-season conditioning sessions		Total
	Yes	No	
Being tackled	29	3	32
Collision	2	0	2
Maul	9	2	11
Ruck	6	1	7
Running	3	0	3
Scrum	33	9	42
Tackling	14	8	22
Total	96	23	119

Level of Play

Sixty percent (n=170) SCIs occurred at club level with 33% of SCIs at school level. Six club level players and one at schoolboy player are deceased (n=7). Seventy five percent of club players (n=89) and 54% of school players (n=52) sustained catastrophic SCIs *(see Table 4)*. There was a non-significant association between level of play and neurological outcome (p=0.052).

Table 4: Level of play and neurological outcome

Neurological outcome	Level of play				Total
	Club	School	Informal	Provincial	
Catastrophic	67	28	2	3	100
Non-catastrophic	22	24	3	1	50
Total	89	52	5	4	150

Activity at time of sustaining SCI

Ninety four percent of SCIs (n=171) occurred during match play. Five players said they were injured during trial selection, two in rugby clinics and two in social matches. All the deceased players (n=6) sustained their SCI during match play. Ninety three percent of catastrophic SCIs (n=101) occurred during match play *(see Table 5)*. There was no relationship between activity at time of the incident and neurological outcome (p=0.850).

Table 5: Activity at time of the incident and neurological outcome

Neurological outcome	Activity at time of the incident		Total
	Matches	Training	
Catastrophic	94	7	101
Non-catastrophic	46	4	50
Total	140	11	151

Responsible Organisation

The majority (58%) of SCIs (n=171) occurred in club rugby and 33% under USSASA (United Schools Sport Association of South Africa) with 86% of SCIs in players over 19 (n=100) taking place at club level (*see Table 6)*. Fifty six percent of hookers (n=42) were injured at club level with 36% taking place at school level. Fifty seven percent of SCIs relating to overall tackling phase (n=56) and 48% relating to the scrum (n=46) occurred at club level *(see Table 7)*. Predictably, there was a strong association between responsible organisation and age (p=0.000) but none with neurological outcome (p=0.104), playing position (p=0.839) or phase of play (p=0.541).

Table 6: Responsible organisation and age

Age	Responsible organisation					Total
	Club	USSASA	SASSU	Provincial	Social	
Over 19	86	1	8	5	0	100
Under 19	7	53	0	0	1	61
Total	93	54	8	5	1	161

(SASSU = South Africa Students Sports Union)

Table 7: Responsible organisation and phase of play

Playing position	Responsible organisation					Total
	Club	USSASA	SASSU	Provincial	Social	
Being tackled	23	11	0	0	0	34
Tackling	9	7	5	1	0	22
Scrum	22	17	3	3	1	46
Maul	5	5	0	1	0	11
Ruck	3	4	0	0	0	7
Running	1	2	0	0	0	3
Collision	1	1	0	0	0	2
Total	64	47	8	5	1	125

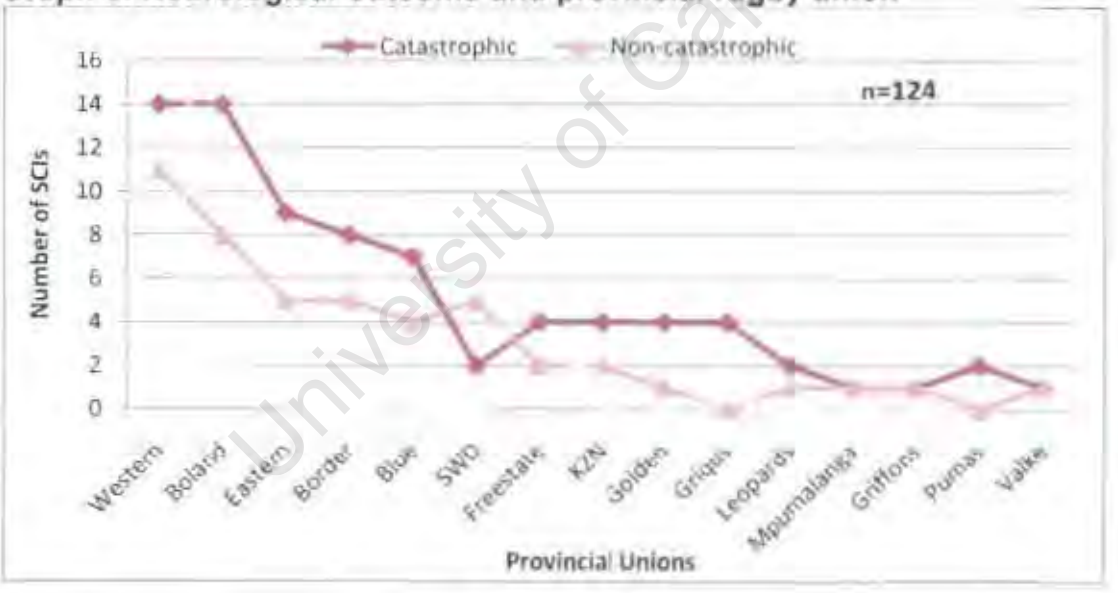
Provincial Rugby Union

Twenty percent (n=133) of injuries occurred in the Boland and Western Provincial Rugby Unions (RUs) respectively followed by the Border and Eastern Provincial RUs with 11% each. The provincial RUs with the lowest number of injuries were Griffons, Mpumalanga, Pumas and Valke with 2% in each union. Border (n=13) had 73% of

the catastrophic outcomes with Boland (n=22), Eastern Province (n=14), Blue Bulls (n=11) having 64% and Western Province (n=25) 56% (*see Graph 6).*

Thirty two percent of hookers (n=37) with SCIs played under the Western Provincial RU with 24% of SCIs in scrummaging (n=46) occurring in this RU. Twenty four percent of SCIs that occurred when the player was tackled (n=34) took place equally in the Boland and Border Provincial RUs with 21% in the Western Province. The Western Provincial RU featured highest in respect to the number of SCIs in hookers and in scrummaging and in the being tackled phases of play. There was no significant association between provincial union and phase of play (p=0.042) as well as with playing position (p=0.153) and neurological outcome (n=0.816).

Graph 6: Neurological outcome and provincial rugby union

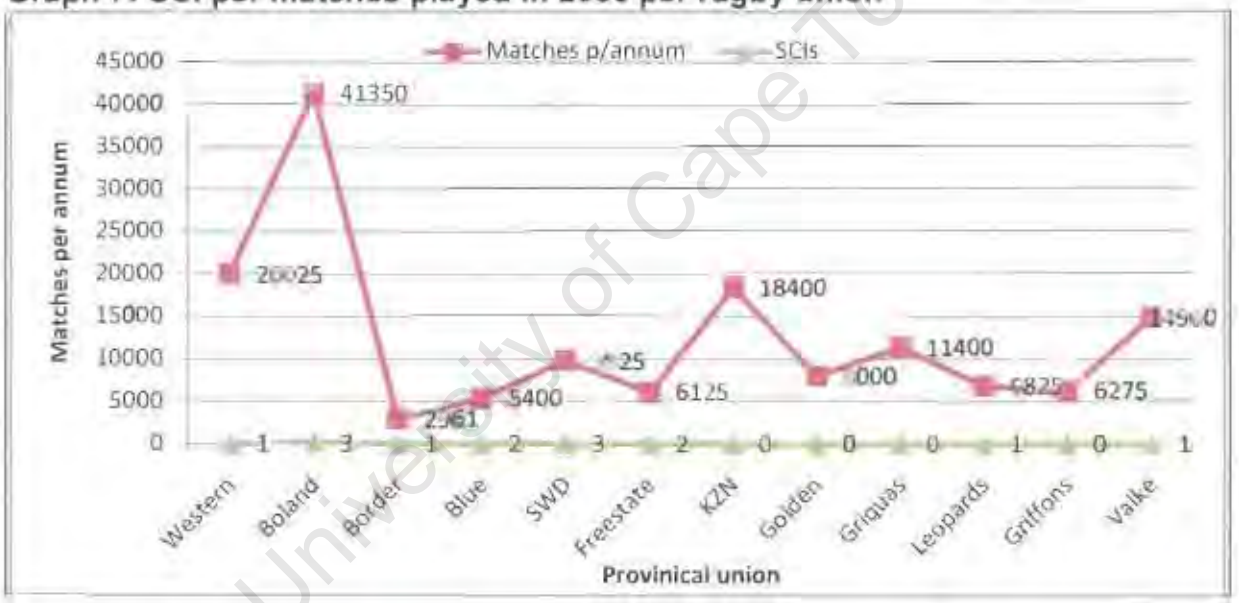


SCIs in 2006 per union per number of matches played

Although the majority of SCIs took place in Boland and Western Provincial RUs, the number of matches played per provincial union needs to be taken into account. Only the number of matches for 2006 is known. No information was received from the Eastern Province, Mpumalanga and the Pumas. Overall, Boland followed by the

Western Province had the highest number of matches in 2006. When the number of SCIs and the number of matches played per annum are compared, Border, Freestate and South West District (SWD) Provincial RUs had more SCIs per number of matches played than Boland and the Western Provincial RUs. There was one SCI per 2961 matches in Border RU, one per 3063 in Freestate, one per 3275 in SWD and, in Boland, one per 13783 with one per 20 025 in the Western Province (*see Graph 7*). Boland and SWD both had three SCIs in 2006. The RU to which two players belonged to is unknown. No known SCIs occurred in 2006 in Kwazulu-Natal, Golden Lions and Griquas RUs.

Graph 7: SCI per matches played in 2006 per rugby union



Description of incident by players

Forty six percent of players (n=118) were injured as a result of a tackle situation with 35% of players sustaining SCIs while being tackled. Twelve of these were high tackles, six players said that the tackle occurred late, three were spear tackled, seven players were tackled by two players and eight players said that they were gang tackled. Two players described being tackled from behind with both involving high tackling and two were tackled when sitting on the ground. Seventy four percent

(n=54) of players injured in the tackle situation felt that rugby rules had been contravened.

Thirty eight percent of SCIs occurred in scrummaging with only one player, a flanker, saying that he was playing out of position replacing an injured hooker. Sixteen SCIs occurred on scrum engagement with three players relating it to foul play and a further two players to aggressive play. Nineteen SCIs occurred when the scrum collapsed and two occurred when the scrum was popped. Eight percent of players describe incidents occurring in a ruck situation with 5% occurring in the maul.

Players input on contributory factors

When players were asked about any contributory factors to their SCI, 32% of responses (n=85) stated that foul play was committed and 22% felt that the incidents were purely accidental (*see Table 8)*. Seven players felt that the referee was not in control of the match with eight players saying that the matches involved aggressive play.

Table 8: Contributory factors for SCIs

Contributory factors	Responses
Foul play	27
Accident	19
Referee not in control	7
Aggressive play	8
Poor ground conditions	11
Mismatch teams	3
Inexperience/Ignorance	10
Total	**85**

Field conditions

Eighty two percent of catastrophic outcomes (n=71) occurred on grass (*see Table 9)*. Other types of field conditions included gravel, sand or mainly sand / gravel with patches of grass cover. There was no asscciation between field conditions and

neurological outcome (p=0.657), month of injury (p=0.919), stage of season (p=0.554) or playing position (p=0.335).

Table 9: Field conditions and neurological outcome

Neurological outcome	Field conditions		Total
	Grass	Other	
Catastrophic	58	13	71
Non-catastrophic	34	6	40
Total	92	19	111

Weather conditions

Seventy four percent of catastrophic SCIs (n=66) occurred in matches played in hot and/or dry weather conditions *(see Table 10)*. Only seven players (n=112) said that they played in wet conditions. There was no association between weather conditions and neurological outcome (p=0.659), month of injury (p=0.121), stage of season (p=0.823) or playing position (p=0.800).

Table 10: Weather conditions

Neurological outcome	Weather conditions		Total
	Hot/dry	Cold/cool	
Catastrophic	49	17	66
Non-catastrophic	29	11	40
Total	78	28	106

Protective equipment

Sixty percent of players (n=109) wore no form of protective equipment with 69% of players with catastrophic SCIs (n=68) not using any form of protective equipment *(see Table 11)*. Types of protective equipment included head gear, shoulder pads, shin pads and mouth guards or a combination of two or more of these pieces of equipment *(see Table 12)*. There were no significant associations between protective equipment and neurological outcome (p=0.015), level of play (p=0.032), playing position (p=0.321), phase of play (p=0.981), anatomical site (p=0.070) or age (p=0.077). Players who suffered catastrophic injury were 2.8 times (p=0.011) more

likely not to have worn protective equipment at the time they were injured, compared to those who were not catastrophically injured.

Table 11: Neurological outcome and protective equipment

Neurological outcome	Protective equipment		Total
	No	Yes	
Catastrophic	47	21	68
Non-catastrophic	18	23	41
Total	65	44	109

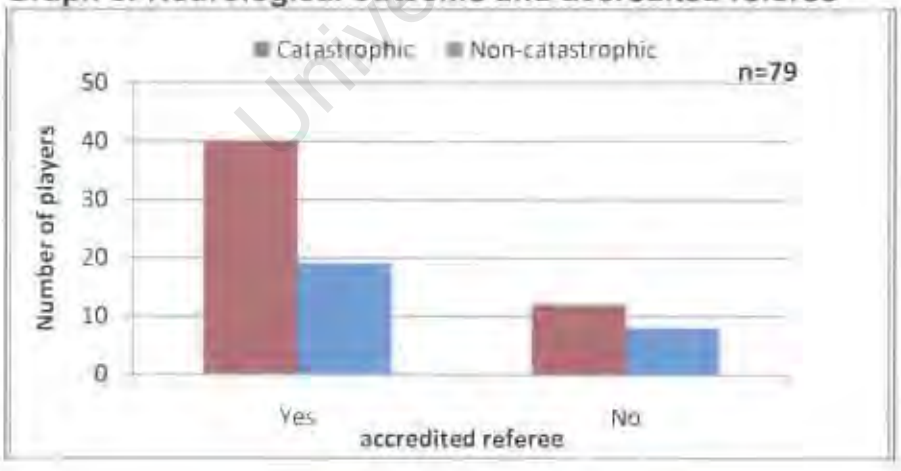
Table 12: Type of protective equipment worn

Type of protective equipment	Frequency	Percentage
Shoulder pads	31	46
Mouth guard	22	32
Headgear	14	21
Shin pads	1	1
Total	68	100

Referee

Seventy five percent of players (n=79) indicated that they considered that the referee was appropriately accredited (*see Graph 8*). Of the non-accredited referees, six were schoolteachers, one a school coach, one a policeman, four were rugby players and the rest were unknown. There was no association between the presence of an accredited referee and the neurological outcome (p=0.622).

Graph 8: Neurological outcome and accredited referee



Violation of rugby rules and dangerous play

Sixteen percent (n=89) of players said that the referee had indicated that the action leading to the incident was in violation of rugby laws with 14% (n=88) of players saying that the referee indicated that the play leading to the incident was dangerous. The referee awarded a penalty for foul play or issued a yellow / red card to the offending player.

PLAYER DEMOGRAPHICS

Ethnicity

Forty percent of the SCI players (n=183) were 'white'. The ethnic group of seven of the players was unknown. In respect to the previously disadvantaged players, 83% of 'black' players (n=30) and 69% of 'coloured' players (n=52) had catastrophic SCIs (see *Table 13).* Seventy two percent of players with medical insurance (n=25) were 'white'. The association between ethnicity and neurological outcome was not significant (p=0.053) as well as between neurological outcome and the player having medical insurance (p=0.06). 'Black' players were more at risk (Odds Ratio=3.59; p=0.020) of sustaining a catastrophic SCI than were 'white' players; 'coloured' players were also more at risk but this was not significant (Odds Ratio=1.478; p=0.311).

Table 13: Neurological outcome and ethnicity

Neurological outcome	Ethnic category			Total
	Black	Coloured	White	
Catastrophic	25	35	39	99
Non-catastrophic	5	17	28	50
Total	**30**	**52**	**67**	**149**

Gender:

All the players were male

Level of Education

Overall 30% of players (n=120) had tertiary education with 24% of players with a catastrophic SCI (n=74) having an educational level of Grade Ten or below (see *Table 14).* Eighty one percent of players who had tertiary education (n=36) were 'white' (see *Table 15).* There was no association between level of education and neurological outcome (p=0.285).

Table 14: Level of education and neurological outcome

Neurological outcome	Level of education					Total
	< Grade 10	Grade 10	Grade 11	Grade 12	Tertiary	
Catastrophic	12	6	18	22	16	74
Non-catastrophic	5	5	6	9	16	41
Total	17	11	24	31	32	115

Table 15: Level of education and ethnicity

Ethnic category	Level of Education					Total
	< Grade 10	Grade 10	Grade 11	Grade 12	Tertiary	
White	0	5	8	22	29	64
Coloured	11	4	9	9	4	37
Black	6	2	7	1	3	19
Total	17	11	24	32	36	120

Survival status

Twenty four percent of players with catastrophic outcome (n=96) were deceased (see *Table 16)* with 63% of deceased players (n=24) being 'black' (see *Table 17)*. Of 67 players known to have died as a direct or indirect result of their SCI, incomplete information was found on 29 players. The length of survival of only 21 players is known with under half of these players surviving for longer than two years. There was a strong association found between survival and ethnicity (p=0.000).

Table 16: Neurological outcome and survival status

Neurological outcome	Survival status		Total
	Deceased	Living	
Catastrophic	23	73	96
Non-catastrophic	0	42	42
Total	23	115	138

Table 17: Survival status and ethnicity

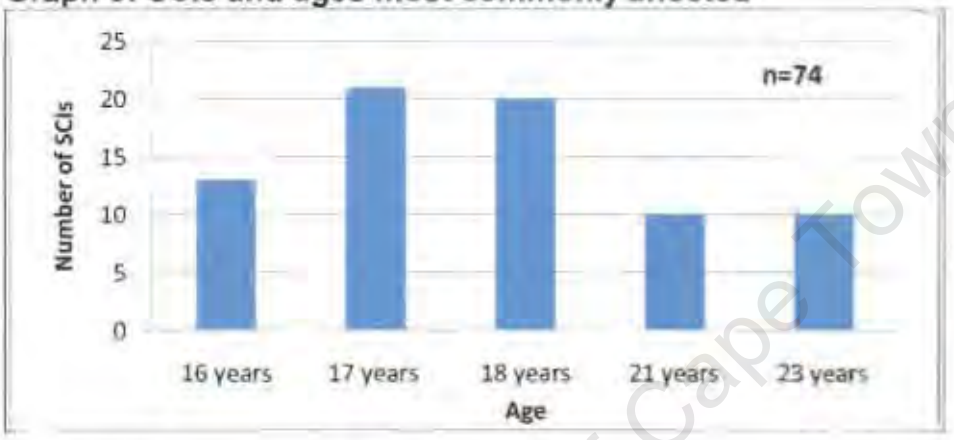
Status	Ethnic category			
	White	Coloured	Black	Total
Living	62	37	18	117
Deceased	3	6	15	24
Total	65	43	33	141

Age

The youngest player was 11 years of age and the oldest was 46 years old with the median age of 21 years. Players aged 17 years had the highest number of SCIs, 21

(13%), followed closely by 18 years old with 20 (*see Graph 9*). Thirty eight percent of players sustaining SCIs (n=165) fall within the under 19 age group with 31% of these SCIs having catastrophic outcomes (n=99) (*see Graph 10*). Sixty percent of players under 19 sustained cervical spine fractures (n=20) (*see Table 18*). Forty three percent of SCIs occuring at C5/C6 level (n=42) and 41% at C4/C5 (n=33) happened in players under 19 (*see Table 19*).

Graph 9: SCIs and ages most commonly affected



Graph 10: Neurological outcome and ages in groups

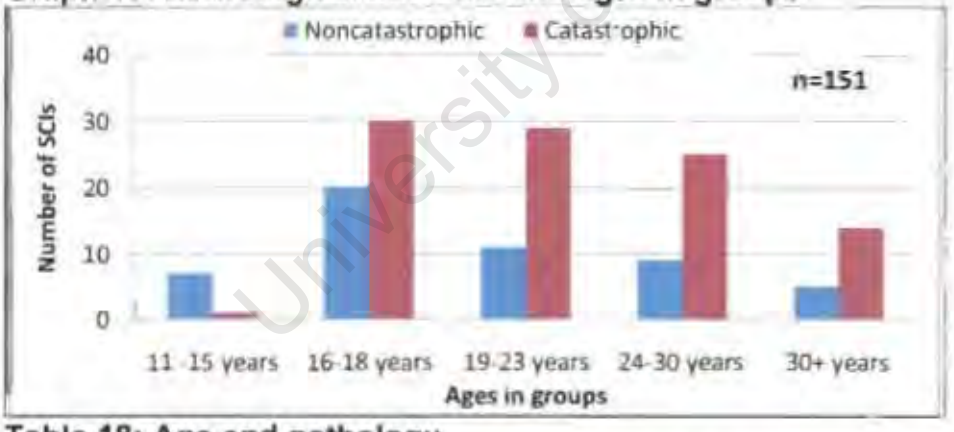


Table 18: Age and pathology

Pathology	Ages in groups					Total
	11 to 15	16 to 18	19 to 23	24 to 30	30+	
Dislocation	1	26	18	14	13	72
Dislocation and fracture	0	10	9	10	2	31
Fracture	4	8	5	3	0	20
Total	5	44	32	27	15	123

Table 19: Age and anatomical level

Anatomical Site	Ages in groups					Total
	11 to 15	16 to 18	19 to 23	24 to 30	30+	
C2/C3	2	2	1	1	1	7
C3/C4	2	3	4	9	2	20
C4/C5	3	19	17	9	6	54

C5/C6	1	17	11	8	5	42
C6/C7	0	8	3	4	2	17
Contusion (C2-C7)	0	0	1	3	0	1
Total	**8**	**49**	**37**	**31**	**16**	**141**

Weight (kg)

The players' weights (n=108) ranged from 38 - 115kg with an average weight of 76.7kg. The most common (30%) weight range was 70 - 79kg with 28% of catastrophic SCIs (n=67) occurring in players falling within this weight range (*see Table 20*). There was no association between weight and neurological outcome (p=0.459), anatomical site (p=0.609), pathology (p=0.261), playing position (p=0.523) or phase of play in which the injury occurred (p=0.040).

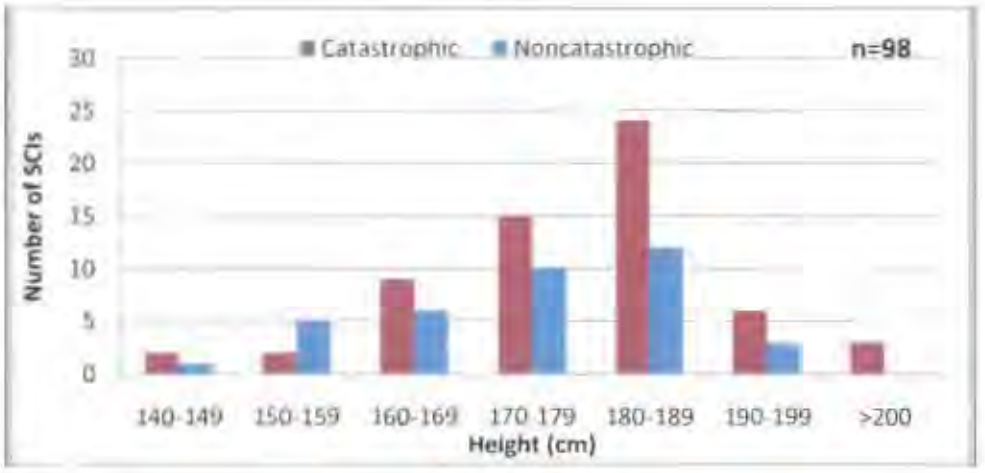
Table 20: Weight and neurological outcome

Neurological outcome	Weights (kg)								Total
	<49	50-59	60-69	70-79	80-89	90-99	100-110	110-119	
Catastrophic	0	4	17	19	15	7	3	2	**67**
Non-catastrophic	1	4	5	11	8	7	1	0	**37**
Total	**1**	**8**	**22**	**30**	**23**	**14**	**4**	**2**	**104**

Height (cm)

The heights of players ranged from 140 - 240cm with the median height of 179cm. The most common height range (30%) was 180 - 189cm with 41% of catastrophic SCIs occurring to players whose heights fell within this range (*see Graph 11*). There was no significant association between height and neurological outcome (p=0.430), anatomical site (p=0.769), pathology (p=0.957), playing position (p=0.957) or phase of play (p=0.510).

Graph 11: Neurological outcome and height (cm)



Body Mass Index (BMI)

BMI (n=100) ranged from 12 - 40 with a mean of 24.7 (sd=4.1). Forty two percent of injuries occurred to players with a BMI of 23 - 25. No significant associations were found between BMI and neurological outcome (p=0.922), phase of play (p=0.661), playing position (p=0.899), anatomical site (p=0.495) or pathological outcome (p=0.737).

Previous injury to cervical spine

Six percent of players said that they had sustained a previous cervical injury (n=116).

Health Insurance or Medical Aid

Twenty nine percent of players had medical aid or health insurance (n=85)

Experience

Forty three percent of injuries occurred to players who had played rugby for longer than 10 years (n=115). Eighty five percent of players who were 19 years and older and had greater than five years experience (this includes players with 5-10 years and 10-30 years experience, n=65) sustained SCIs (*see Table 21).* Forty four

percent of hookers with greater than 10 years experience (n=36) sustained SCIs (*see Table 22)* with 49% of SCIs in tackling with players with greater than 10 years experience (n=53) and 40% in scrummaging occurring in players with greater than 10 years experience (n=40) *(Table 23)*. There was a strong association between experience and age (p=0.00) but none with neurological outcome (p=0.485), playing position (p=0.574) or phase of play (p=0.458).

Table 21: Experience and age

Age-groups	Time playing rugby					Total
	First time	1-2 years	2-5 years	5-10 years	10-30 years	
11-15	0	2	2	3	0	7
16-18	0	1	12	22	8	43
19-23	1	0	4	9	19	33
24-30	0	1	2	3	13	19
30+	0	1	1	2	9	13
Total	1	5	21	40	49	115

Table 22: Experience and playing position

Age-groups	Time playing rugby					Total
	First time	1-2 years	2-5 years	5-10 years	10-30 years	
Centre	1	0	1	2	3	7
Eighth-man	0	0	1	3	1	5
Flank	0	2	5	4	9	20
Fullback	0	0	1	0	1	2
Hooker	0	0	7	13	16	36
Lock	0	0	1	3	1	5
Prop	0	1	1	7	6	15
Scrumhalf	0	0	0	0	1	1
Wing	0	0	2	4	6	12
Total	1	3	19	36	44	103

Table 23: Experience and phase of play

Phase of play	Time playing rugby					Total
	First time	1-2 years	2-5 years	5-10 years	10-30 years	
Being tackled	0	1	8	6	16	31
Collision	0	0	1	1	0	2
Maul	0	1	1	4	5	11
Ruck	0	1	1	3	2	7
Running during play	0	1	0	2	0	3
Scrum	0	1	7	16	16	40
Tackling	0	0	3	8	10	22
Total	1	5	21	40	49	116

Pre-season conditioning sessions

Twenty one percent of players (n=102) did not participate in any pre-season conditioning sessions with 76% of players that did no pre-season conditioning sessions (n=21) sustaining catastrophic SCIs *(see Table 24)*. Sixty one percent of hookers (n=33) (see *Table 25)* and 54% of players injured in scrummaging (n=37) (see *Table 26)* participated in less than 3 sessions per week. There was no significant association between pre-season conditioning sessions and neurological outcome (p=0.462), phase of play (p=0.819) or player position (p=0.002).

Table 24: Pre-season conditioning sessions and neurological outcome

Neurological outcome	Pre-season conditioning sessions					Total
	0	1	2	3	4 and >	
Catastrophic	16	2	17	16	16	67
Non-catastrophic	5	0	10	7	13	35
Total	21	2	27	23	29	102

Table 25: Pre-season conditioning sessions and playing position

Playing position	Pre-season conditioning sessions					Total
	0	1	2	3	4 and >	
Centre	1	0	1	2	2	6
Eight-man	0	1	1	1	2	5
Flank	2	0	4	6	6	18
Fullback	1	0	0	0	1	2
Hooker	7	1	12	7	6	33
Lock	1	0	1	1	1	4
Prop	2	0	5	3	4	14
Wing	4	0	2	2	2	10
Total	18	2	26	22	24	92

Table 26: Pre-season conditioning sessions and phase of play

Phase of play	Pre-season conditioning sessions					Total
	0	1	2	3	4 and >	
Being tackled	6	1	3	6	11	27
Collision	0	0	1	0	0	1
Maul	2	0	1	3	1	7
Ruck	3	0	2	2	0	7
Running	0	0	2	1	0	3
Scrum	6	0	14	7	10	37
Tackling	5	1	4	4	7	21
Total	22	2	27	23	29	103

Conditioning sessions in-season

Sixty five percent (n=112) participated in three and more conditioning sessions per week during in-season with 36% of players with catastrophic SCIs (n=69) having less than three in-season conditioning sessions per week (*see Graph 12).* Seventy one percent of players with complete recovery (n=24) did three and more sessions per week. Sixty six percent of players injured while scrummaging (n= 39) did three and less in-season conditioning sessions (see *Table 27)* with 74% of hookers (n=35) doing three and less in-season conditioning sessions (see *Table 28).* There was no association between in-season conditioning sessions and neurological outcome (p=0.345), player position (p=0.461) and phase of play (p=0.665).

Graph 12: Neurological outcome and in-season conditioning sessions

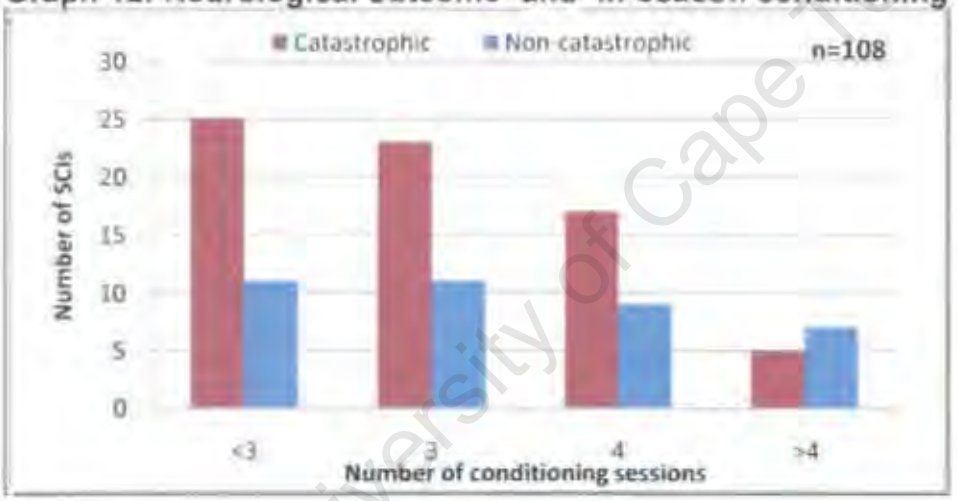


Table 27: In-season conditioning sessions and phase of play

Phase of play	In-season conditioning sessions				Total
	<3	3	4	>4	
Being tackled	11	8	8	2	29
Collision	0	1	0	1	2
Maul	5	3	3	0	11
Ruck	2	4	1	0	7
Running	1	1	0	1	3
Scrum	11	15	9	4	39
Tackling	8	4	5	4	21
Total	38	36	26	12	112

Table 28: In-season conditioning sessions and playing position

Playing position	In-season conditioning sessions	Total

	<3	3	4	>4	
Centre	1	2	3	0	6
Eight-man	0	3	1	1	5
Flank	7	3	5	4	19
Fullback	0	1	0	0	1
Hooker	11	15	9	0	35
Lock	1	1	2	1	5
Prop	6	4	3	2	15
Scrumhalf	0	1	0	0	1
Wing	6	3	1	2	12
Total	32	33	24	10	99

Participated in conditioning sessions

Ninety eight percent of players (n=113) said that they participated in some form of conditioning sessions with 64% of these players (n=109) having catastrophic outcome (*see Table 29*). No relationship was found between conditioning session and neurological outcome (p=0.672).

Table 29: Neurological outcome and conditioning sessions

Neurological outcome	Conditioning sessions (Yes/No)		Total
	Yes	No	
Catastrophic	70	1	71
Non-catastrophic	37	1	38
Total	107	2	109

Playing position:

The forwards sustained 76% of overall SCIs (n=139) with hookers having 36% of catastrophic SCIs (n=81) followed by props (17%) (*see Graph 13*). The front row forwards sustained 38% of the SCIs (n=110) with 26% of hookers injured during scrummaging (*see Table 30*) Forty three percent of hookers (n=40) were under 19 (*see Table 31*) with 81% of hookers (n=36) playing rugby for more than five years (*see Table 32*) There was a strong association between playing position and phase of play (p=0.000) but not with outcome (p=401), age (p=0.384) and experience (p=0.574).

Graph 13: Playing position and neurological outcome

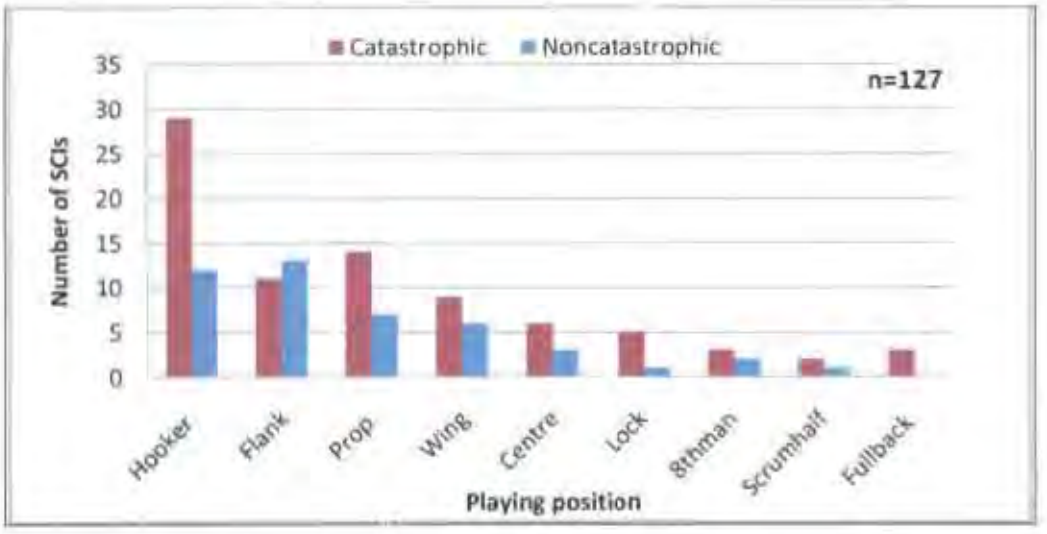


Table 30: Playing position and phase of play

Playing position	Phase of play							Total
	Scrum	Being Tackled	Tackling	Maul	Ruck	Running during play	Collision	
Centre	0	2	3	1	1	0	0	7
Eighth-man	1	2	1	0	0	1	0	5
Flank	3	10	4	3	1	2	0	23
Fullback	0	1	1	0	0	0	0	2
Hooker	29	3	1	3	1	0	0	37
Lock	0	1	1	1	1	0	1	5
Prop	10	4	2	0	1	0	0	17
Scrumhalf	0	0	1	0	0	0	0	1
Wing	0	6	4	1	1	0	1	13
Total	43	29	18	9	6	3	2	110

Table 31: Playing position and age

Playing Position	Age		Total
	Under 19	Over 19	
Centre	2	7	9
Eighth-man	2	3	5
Flank	9	17	26
Fullback	1	2	3
Hooker	17	23	40
Lock	4	3	7
Prop	9	11	20
Scrumhalf	1	3	4
Wing	8	9	17
Total	53	78	131

Table 32: Playing position and time playing rugby

Playing Position	Time playing rugby (years)			Total
	<5	5 to 10	>10	
Centre	2	2	3	7
Eighth-man	1	3	1	5
Flank	7	4	9	20
Fullback	1	0	1	2
Hooker	7	13	16	36
Lock	1	3	1	5
Prop	2	7	6	15
Scrumhalf	0	0	1	1
Wing	2	4	6	12
Total	**23**	**36**	**44**	**103**

Normal position:

Twenty percent of players with SCIs (n=132) said that they were not playing in their normal position with 61% of these players (n=26) sustaining a catastrophic SCI (*see Table 33*). Of SCIs that occurred in players out of normal position (n=27), 63% took place at club level and 22% at school level. Twenty one percent of hookers (n=29) and 21% of players injured in scrummaging (n=42) were not in their normal position. Twenty five percent of players injured in 2006-2007 (n=24) said they were not in their normal position with four of these taking place in 2007 (n=10). There was no association between neurological outcome and normal position (p=0.910).

Table 33: Neurological outcome and normal position

Neurological outcome	Normal position		Total
	Yes	No	
Catastrophic	65	16	81
Non-catastrophic	37	10	47
Total	102	26	128

INJURY INFORMATION

Consciousness level after incident

Seventy seven percent (n=111) of players were fully alert after the incident with no association found with neurological outcome (p=0.378) (*see Table 34*).

Table 34: Consciousness level after incident

Consciousness level	Frequency	Percentage
Alert	85	77
Unresponsive	14	12
Responsive to voice	9	8
Responsive to pain	1	1
Unknown	2	2
Total	111	100

Breathing pattern after incident

Forty six percent (n=100) of players said that their breathing pattern was altered immediately after the incident (*see Table 35*). No detail of immediate breathing pattern was found in the medical record of any SCI player.

Table 35: Breathing pattern immediately after incident

Breathing pattern immediately after incident	Frequency	Percentage
Normal	54	54
Irregular	6	6
Rapid (hyperventilation)	4	4
Difficult	2	2
Shallow	22	23
Shallow; Irregular	3	2
Shallow; Rapid (hyperventilation)	1	1
Shallow; Slow; Irregular; Difficult	1	1
Slow	5	5
Slow; Irregular	1	1
Total	100	100

Neurological deficit immediately after incident

Eighty four percent of players (n=111) said that they were completely paralysed immediately after the incident, while 4% responded that they had no immediate neurological deficit. Ninety percent of players who had catastrophic outcomes (n=70) had initial complete plegia (*see Table 36*). There was no association between

neurological deficit immediately after the incident and neurological outcome (p=0.030).

Table 36: Neurological outcome and immediate neurological deficit

Neurological outcome	Immediate neurological deficit		Total
	Plegia	Incomplete/None	
Catastrophic	63	7	70
Non-catastrophic	28	11	39
Total	91	18	109

Duration of neurological deficits immediately after the incident

Eighty two percent (n=110) of players' neurological deficits lasted more than 24 hours (*see Table 37)* with this occurring in 100% of players with catastrophic SCIs (n=39) *(see Table 38)*. There was a strong association between duration of neurological deficits immediately after the incident and neurological outcome (p=0.000) and non with the attendance of medical personnel (p=0.035).

Table 37: Duration of neurological deficits immediately after the SCI

Neurological deficits duration	Frequency	Percentage
Grade III (more than 24 hours)	90	82
Grade II (more than15 minutes but < 24 hours	15	14
Grade I (less than 15 minutes)	5	4
Total	110	100

Table 38: Neurological outcome and immediate neurological deficit duration

Neurological outcome	Duration of neurological deficit		Total
	>24 hours	<24hours	
Catastrophic	67	0	67
Non-catastrophic	26	13	39
Total	93	13	106

Distribution of neurological deficits immediately after the incident

Eighty three percent of players (n=108) had neurological deficits in all four extremities immediately after the incident (*see Table 39)* with 93% of players with catastrophic SCIs (n=67) presenting in this manner immediately after the incident (*see Table 40)*. There was a strong association between neurological distribution immediately after injury and neurological outcome (p=0.000).

Table 39: Distribution of neurological deficits immediately after the incident

Distribution of deficits	Frequency	Percentage
Quadriplegia	90	83
Paraplegia	10	9
Monoplegia	7	7
Hemiplegia	1	1
Total	108	100

Table 40: Immediate neurological deficit distribution and neurological outcome

Neurological outcome	Immediate neurological deficit distribution		Total
	Quadriplegia	Mono/hemi/paraplegia	
Catastrophic	62	5	67
Non-catastrophic	28	11	39
Total	90	16	106

Position found in immediately after the incident

Immediately after the incident, 49% of players (n=104) recalled that they were found lying on their backs (*see Table 41*) with 51% of players with catastrophic outcome (n=67) saying this (*see Table 42*).

Table 41: Position found immediately after the incident

Position found	Frequency	Percentage
Supine	51	48
Prone	28	27
Lying on side	22	21
Stood up	2	2
Knees	1	1
Twisted	1	1
Total	105	100

Table 42: Position found in immediately after incident and outcome

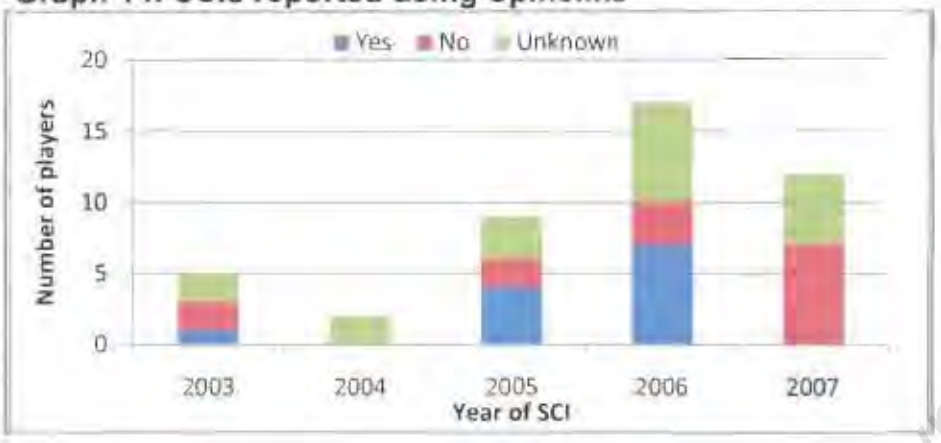
Neurological outcome	Position immediately after incident			Total
	Supine	Prone	Side-lying	
Catastrophic	34	18	15	67
Non-catastrophic	17	10	7	34
Total	51	28	22	101

Reported to Spineline

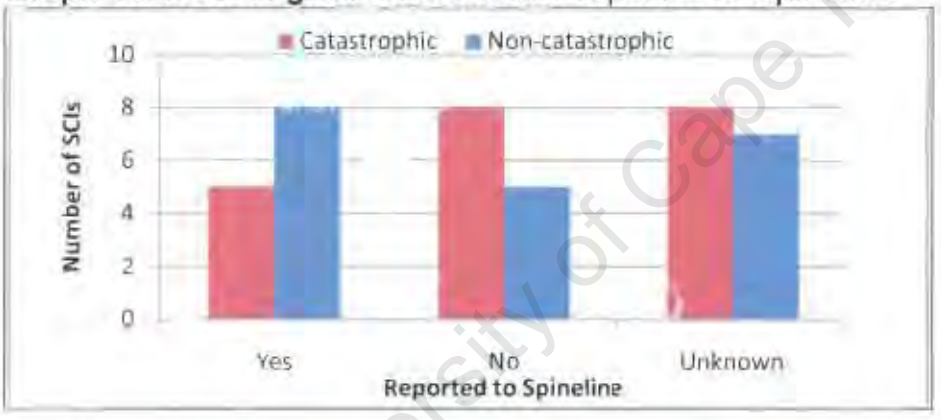
There were 45 SCIs from 2003 to 2007 with 27% of SCIs that occurred from 2003 to 2007 (n=45) being reported via Spineline (*see Graph 14*). Fifty eight percent of players injured in 2007 (n=12) said that their SCI was not reported to Spineline with

the rest being unknown. Of SCIs that were reported to Spineline, 62% had non-catastrophic outcomes (*see Graph 15)*

Graph 14: SCIs reported using Spineline



Graph 15: Neurological outcome and reported to Spineline



Medical personnel

Fifty percent (n=109) of players said that there were some form of medical personnel in attendance at the field on the day of the incident with 57% of players with catastrophic SCIs (n= 69) reporting this (*see Table 43)*. There was no association between neurological outcome and medical personnel in attendance (p=0.071)

Table 43: Neurological outcome and medical personnel in attendance

Neurological outcome	Medical personnel in attendance		Total
	No	Yes	
Catastrophic	39	30	69
Non-catastrophic	15	24	39
Total	54	54	108

On field assistance

Twenty three percent of players (n=92) said they had only first-aiders providing on-field assistance with another 21% having only paramedics *(see Table 44)*. Eight percent of players said that their teammates were the sole on-field treatment providers.

Table 44: On-field treatment providers

Field treatment providers	Frequency	Percentage
Doctor	2	2
Doctor, First aider, Paramedic	1	1
Doctor, Paramedic	6	7
Doctor, Paramedic, Rugby medic, Team official	1	1
Doctor, Rugby medic, Team official	1	1
First aider	21	23
First aider (school)	1	1
First aider (school), Spectators	1	1
First aider, Paramedic	1	1
First aider, Teacher, Paramedic	1	1
First aider, Teacher, Team mates	1	1
Fitness trainer	1	1
Medical student (1st year)	1	1
Paramedic	20	22
Paramedic, Referee, Rugby medic, Team official	1	1
Referee	4	4
Referee, Team official	2	2
Rugby medic	9	10
Spectators	1	1
Sport Science students	1	1
Team mates	7	8
Team official	8	9
Total	**92**	**100**

On-field treatment:

Forty nine percent (n=111) players only had spinal immobilisation/alignment done on the field with 34% of players with SCIs not receiving any form of on-field management but were referred elsewhere *(see Table 45)*.

Table 45: On-field management

Field Treatment	Frequency	Percentage
Spinal immobilisation/alignment	54	49
None given	39	34
First-aid	11	10
First-aid, Spinal immobilisation/alignment	4	4
CPR, Spinal immobilisation/alignment	2	2
CPR	1	1
Total	**111**	**100**

Type of on-field treatment

Twenty one percent of players (n=82) had treatment consisting of cervical and spine board *(see Table 46)* with only 5% describing being managed correctly with a cervical collar, being logrolled and placed onto a spineboard with headblocks in place and body being strapped to avoid any movement. Five percent of players were placed onto a door with one player saying that he was placed onto a sheet of metal with another player being carried and placed directly into a car.

Table 46: Treatment received by players on the field

Treatment on-field	Frequency	Percentage
Cervical collar, Spine board	17	22
Cervical collar, Head blocks, Spine board	9	12
Spine board	9	12
Cervical collar	7	9
Stretcher	6	7
Cervical collar, Head blocks, Spider harness	5	6
Cervical collar, Head blocks, Logroll, Spider harness, Spine board	4	5
Door	4	5
Cervical collar, Stretcher	3	4
Cervical collar, Head blocks, Logroll, Spine board	2	2
Logroll	2	2
Unknown	2	2
Blanket	1	1
Carried to car	1	1
Cervical collar, Head blocks, Logroll	1	1
Cervical collar, Head blocks, Logroll, Scoop	1	1
Cervical collar, Spine board, Intubation	1	1
Head blocks, Logroll	1	1
Head blocks	1	1
Head blocks, Spine board	1	1
None	1	1
Sheet of metal	1	1
Spine board, Logroll	1	1
Stretcher with head taped to stretcher	1	1
Total	82	100

Mode of transport to hospital

Seventy five percent of players (n=118) were transported by ambulance to hospital with 77% of players with catastrophic SCI (n=73) being taken to hospital by ambulance *(see Table 47)*. There was no association between neurological outcome and mode of transport (p=0.748).

Table 47: Mode of transport to hospital and neurological outcome

Neurological outcome	Mode of transport to hospital				Total
	Ambulance	Private	Public	Helicopter	
Catastrophic	56	4	2	1	73
Non-catastrophic	33	7	1	2	43
Total	89	21	3	3	116

Hospital Type

Seventy one percent of players (n=130) were managed at public facilities (*see Table 48)* with the same percentage of these players at public facilities having catastrophic outcomes (n=74). There is no association between neurological outcome and hospital type (p=0.675).

Table 48: Type of hospital

Hospital type	Frequency	Percentage
Public	92	71
Private	38	29
Total	130	100

Hospitals attended for acute management

Sixty four percent of players (n=129) were taken to two or more facilities before acute management of their SCI was done (*see Table 49)* with 71% of players with catastrophic outcomes (n=77) being taken to two or more hospitals. There was with no association being found between number of hospitals attended and neurological outcome (p=0.220) *(see Table 50).*

Table 49: Number of hospitals attended

Number of hospitals	Frequency	Percentage
One facility	47	36
Two facilities	58	45
Three facilities	23	18
Four facilities	1	1
Total	129	100

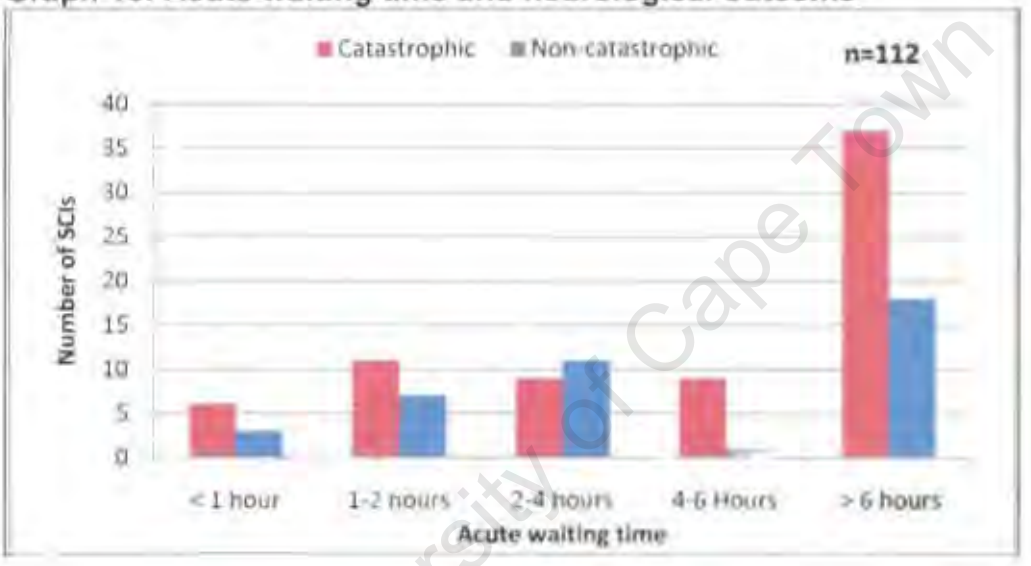
Table 50: Number of hospitals and neurological outcome

Neurological outcome	Number of hospitals				Total
	One	Two	Three	Four	
Catastrophic	22	40	14	1	77
Non-catastrophic	21	16	8	1	46
Total	43	56	22	2	123

Acute waiting time

Forty nine percent of players (n=114) waited longer than six hours before their SCI was managed with 25% being managed in under two hours. The waiting time for access to acute management in 50% and more cases was longer than four hours in 2000-7. Sixty four percent of players with catastrophic SCI (n=72) had to wait longer than two hours for acute management of their SCI (*see Graph 16*). There was no association between acute waiting time and neurological outcome (p=0.092).

Graph 16: Acute waiting time and neurological outcome

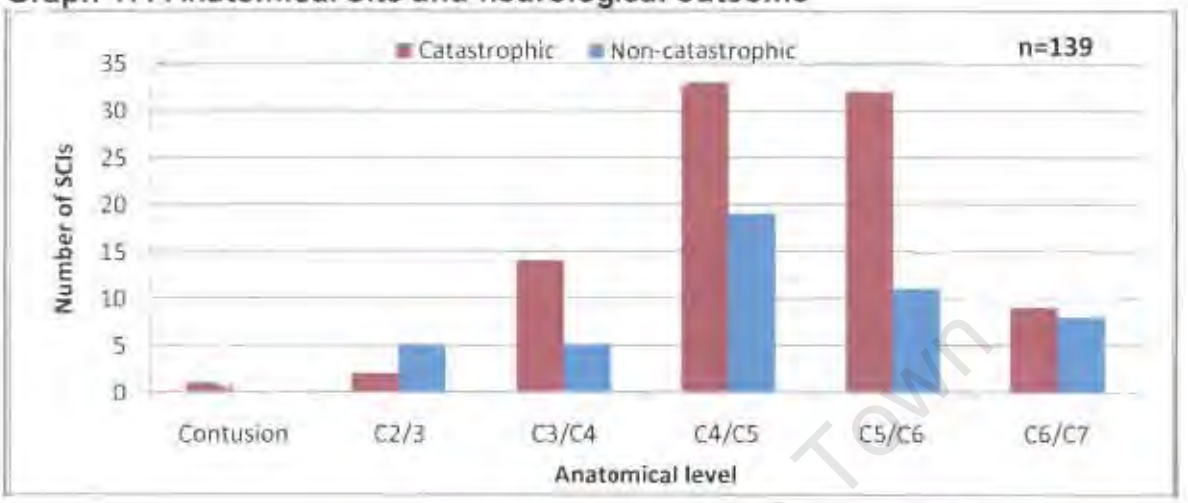


Anatomical site of SCI

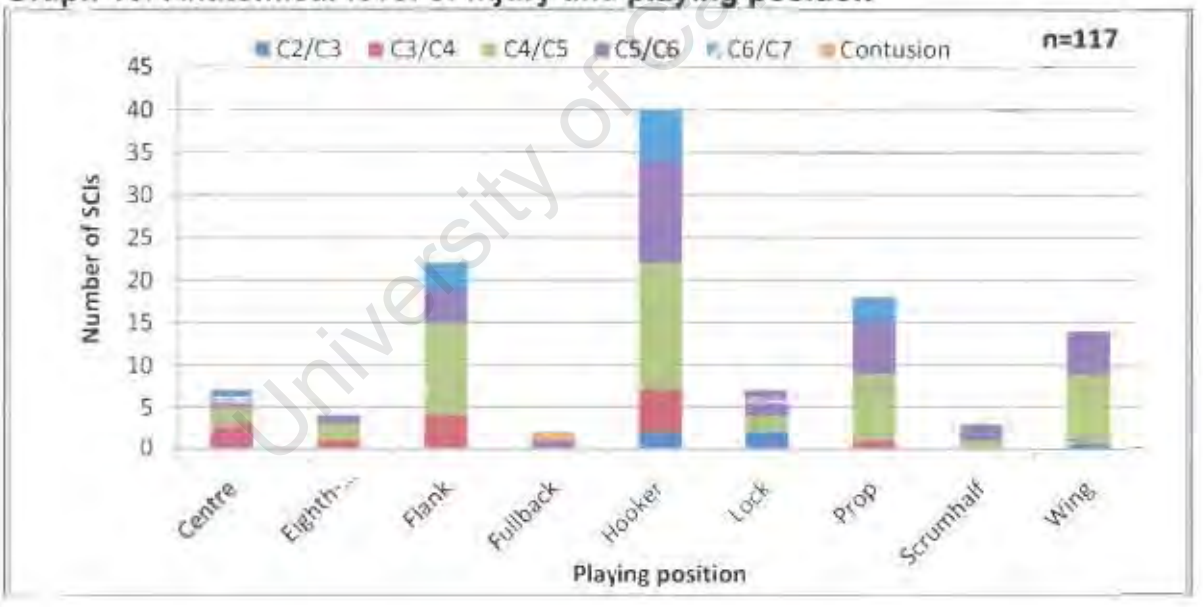
For clarification, if a player sustained a C4 fracture it was assigned to the same level i.e. C4/C5. The most common anatomical sites of SCI (n=150) were C4/C5 with 38% and C5/C6 (31%). Sixty three percent of SCIs at C4/C5 (n=52) and 74% of C5/C6 (n=43) had catastrophic outcomes (*see Graph 17*). Fifteen hookers (n=40) and 11 flanks (n=22) sustained a SCI at C4/C5 level (*see Graph 18*). Forty one percent of scrum related SCIs (n=41) occurred at C5/C6 and 37% at C4/C5 (*see Graph 19*). In the overall tackling phase (n=52), 35% of SCIs occurred at C4/C5 and 27% at C5/C6. There were strong associations between anatomical site and playing position

(p=0.000) as well as preseason conditioning sessions (p=0.000) but none with neurological outcome (p=0.150), phase of play (p=0.145) and age (p=0.295) (*see Table 51)*

Graph 17: Anatomical site and neurological outcome



Graph 18: Anatomical level of injury and playing position



Graph 19: Anatomical site of injury and phase of play

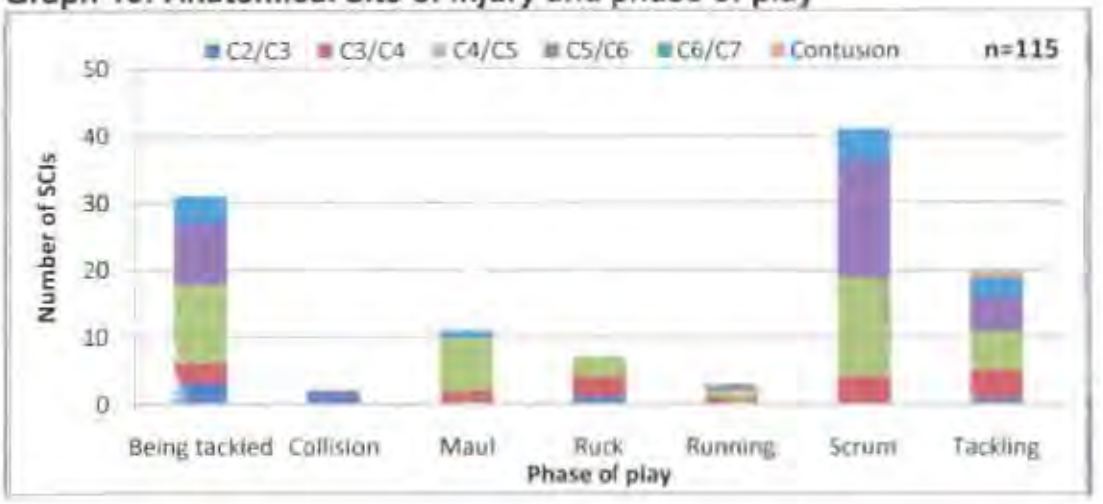


Table 51: Summary of anatomical site associations with possible risk factors

Possible Contributory Factor	Significance (p)
Playing position	0.000
Age	0.295
Time playing rugby	0.096
Phase of play	0.145
Immediate distribution of neurological deficits	0.622
Preseason conditioning sessions	0.000
In-season conditioning sessions	0.464
Waiting time for acute management	0.053
Neurological outcome	0.150

Type of injury

Fifty five percent of players (n=134) sustained a dislocation type injury with 24% having a fracture with dislocation. Seventy two percent of players with dislocations (n=71) and 76% with fractures and dislocations (n=29) had catastrophic neurological outcomes *(see Graph 20)*. Thirty four percent of players with complete recovery (n=29) had a dislocation and the same percentage had fractures. Seventy six percent of dislocations (n=71) and 72% of fractures and dislocations (n=29) occurred at C4/C5 and C5/C6 anatomical levels *(see Table 52)*. Seventy six percent of props (n=17) and 73% of hookers (n=33) had dislocations with 38% (n=72) occurring in players under 19 years of age *(see Table 53)*. Seventy one percent of players were injured in scrummaging (n=41) and 66% in being tackled (n=29) sustained

dislocations of the cervical spine (*see Table 54*). There was a strong association between type of injury and neurological outcome (p=0.000) and anatomical site (p=0.000) but no association with age (n=0.029), with playing position (p=0.075) nor phase of play (p=0.312).

Graph 20: Type of injury and neurological outcome

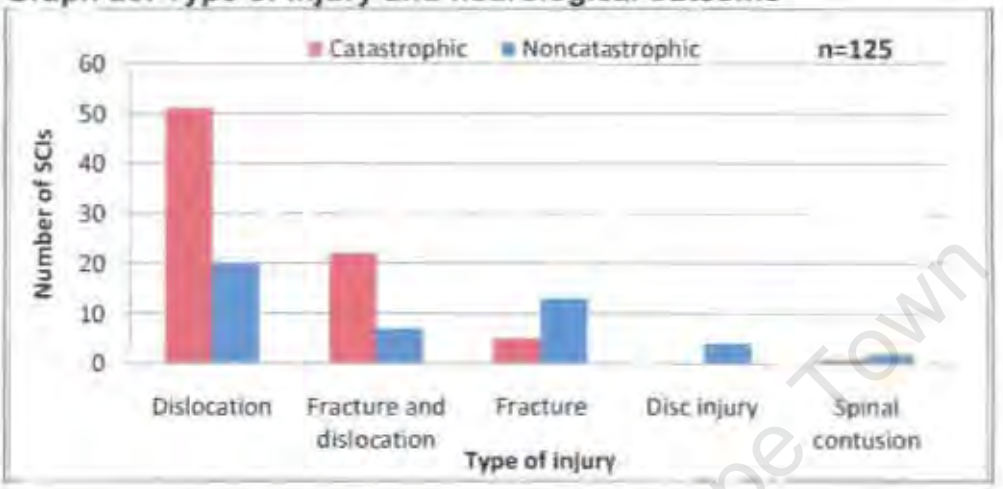


Table 52: Type of injury and anatomical site

Anatomical Site	Type of injury					Total
	Dislocations	Fractures with dislocations	Fractures	Disc injury	Spinal Contusion	
C2/C3	3	0	1	2	0	6
C3/C4	8	4	4	0	0	16
C4/C5	29	11	6	2	2	50
C5/C6	25	10	4	0	0	39
C6/C7	6	4	4	0	0	14
Contusion	0	0	0	0	1	1
Total	**71**	**29**	**19**	**4**	**3**	**126**

Table 53: Type of injury and playing position

Playing Position	Type of injury			Total
	Dislocations	Fractures with dislocations	Fractures	
Centre	2	3	10	6
Eighth-man	3	0	5	4
Flank	10	5	6	21
Fullback	0	1	0	1
Hooker	24	5	4	33
Lock	4	2	0	6
Prop	13	2	2	17
Scrumhalf	0	1	2	3
Wing	5	6	2	13
Total	**61**	**25**	**18**	**104**

Table 54: Type of injury and phase of play

Phase of play	Type of injury					Total
	Dislocations	Fractures with dislocations	Fractures	Disc Injury	Spinal Contusion	
Being tackled	19	5	4	1	0	29
Tackling	8	5	4	3	1	21
Scrummaging	29	7	4	0	1	41
Maul	7	2	2	0	0	11
Ruck	4	2	0	0	0	6
Running	1	0	2	0	0	3
Collision	0	1	1	0	0	2
Total	68	22	17	4	2	113

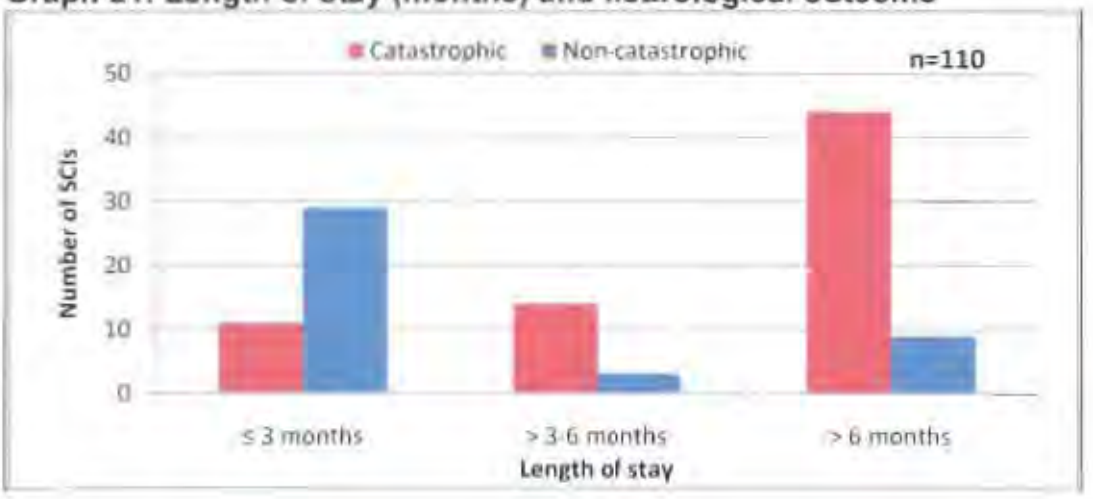
Length of stay in hospital (days)

The length of stay in hospital (LOS) varied from one day to 720 days (n=112) with the median length of stay being 150 days (*see Table 55).* Fifty three percent of players (n=112) spent longer than five months in hospital with 64% of players with catastrophic SCIs (n=69) staying in hospital for longer than 6 months. Ninety percent of players that spent longer than six months in hospital (n=49) had catastrophic outcomes *(see Graph 21).* From 2002-7, at least 50% of players spent less than three months in hospital after the initial incident. There was a strong association between LOS and neurological outcome (p=0.000) as well as type of injury (p=0.000) but not with anatomical site of injury (p=0.316).

Table 55: Length of stay in groups

LOS groups (days)	Frequency	Percentage
0 to 10	13	12
>10 to 50	15	13
>50 to 100	14	13
>100 to 150	11	10
>150 to 200	20	18
>200 to 250	17	15
>250 to 300	10	9
>300 to 400	8	7
>400 to 500	1	1
>500	3	2
Total	112	100

Graph 21: Length of stay (months) and neurological outcome



Effect of SCI

Based on the ASIA Impairment scale, 60% of players (n=150) were classified as being in category A, 1% in B, 2% in C, 13% in D and 23% in E. Seven percent were deceased (n=161). Associations that were found significant ($p \leq 0.01$) with neurological outcome were year of injury, immediate neurological deficit, neurological deficit duration, immediate neurological deficit distribution, pathology, length of stay in hospital and severity after 12 months (*see Table 56*).

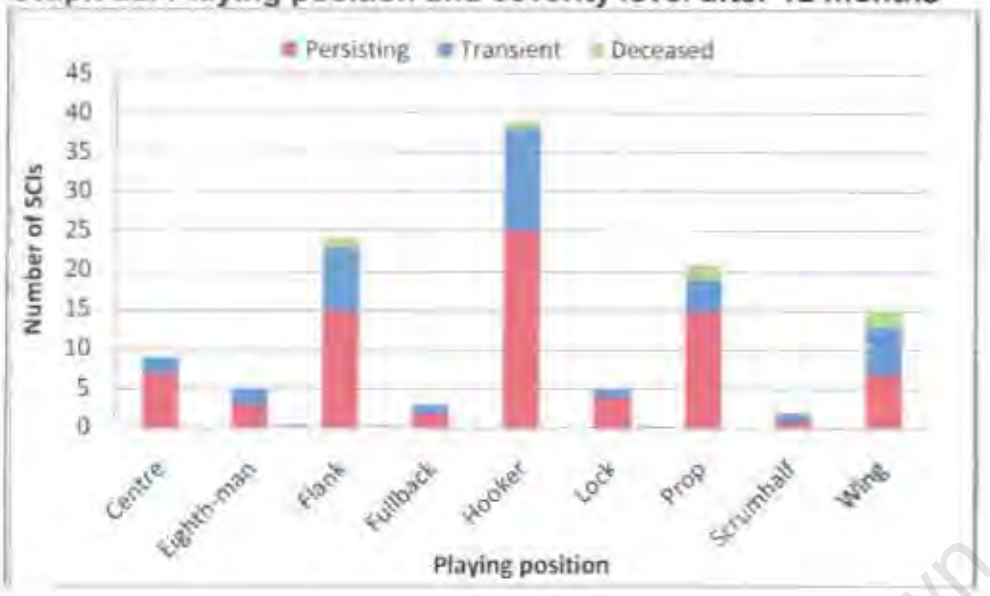
Table 56: Neurological outcome and potential risk factors

Variable	Pearson's Chi2 (p value)
Ethnic category	0.053
Level of education	0.285
Year of injury	0.004
Month of injury	0.824
Playing Position	0.401
Normal playing position	0.910
Level of play	0.052
Activity at time of incident	0.850
Responsible organisation	0.104
Provincial union	0.816
Age	0.096
Weight	0.459
Height	0.430
Time playing rugby	0.485
Pre-season conditioning sessions	0.462
In-season conditioning sessions	0.462
Conditioning sessions (y/n)	0.672
Field conditions	0.657
Weather conditions	0.597
Stage of play	0.792
Stage of season	0.333
Protective equipment (y/n)	0.015
Phase of play	0.198
Immediate neurological deficit	0.004
Neurological deficit duration	0.000
Immediate neurological deficit distribution	0.004
Position found immediately post incident	0.957
Contacting Spineline	0.490
Mode of transport to hospital	0.748
Acute waiting time	0.169
Anatomical injury level	0.063
Pathology/Type of injury	0.000
Length of stay in hospital	0.000
Severity level after 12 months	0.000
Discharge abode	0.026
Insurance	0.389
Accredited referee	0.622
Medical personnel in attendance	0.071

Severity level after 12 months

Catastrophic neurological deficits that had improved within 12 months after the SCI incident were considered transient outcomes. Sixty one percent of players that had a SCI (n=146) had catastrophic outcome after 12 months including the 8% that died within a year after sustaining a SCI. Sixty four percent of hookers (n=39) neurological outcome persisted after 12 months with the same effect in 63% of flanks (n=24) and 71% of props (n=21) (*see Graph 22).* There was a strong association, as expected, between neurological outcome and severity after 12 months and none with playing position (p=0.600).

Graph 22: Playing position and severity level after 12 months



Place of discharge

Seventy five percent of players (n=136) were discharged to their homes with 10% deceased. Seventy one percent of players with catastrophic SCIs (n=90) went home. Other places of discharge included group-living, assisted-living and boarding. There was no association between place of discharge and neurological outcome (p=0.145).

Financial compensation

Sixty six percent of players (n=65) received no form of financial compensation. Of the players willing to expose their 'financial compensation', 3% of players received between R150 000-R200 000, R100 000-R120 000 and R75 000- R80 000 respectively. Nine percent said that they received an amount between R100-R1000. Of 15 'white' players that received 'financial compensation', 13 received greater than R10 000. Of the seven previously disadvantaged received payouts, five received payouts from R110 to 5000 and two, R10 000.

Return date to full participation

Only four players (n = 184) returned to full participation (*see Table 57*).

Table 57: Return to full participation

Date injury	Return date	Time off	Age(years)	Pathology
20 Apr 96	01 Sep 96	100 days	23	C5/6 Fracture Dislocation
28 Aug 97	01 Feb 99	515 days	18	Disc C4 level
12 Aug 06	25 Sep 06	43 days	15	C3 Fracture Hairline
24 Feb 07	31 Jul 07	156 days	19	C2-C5 Contusion

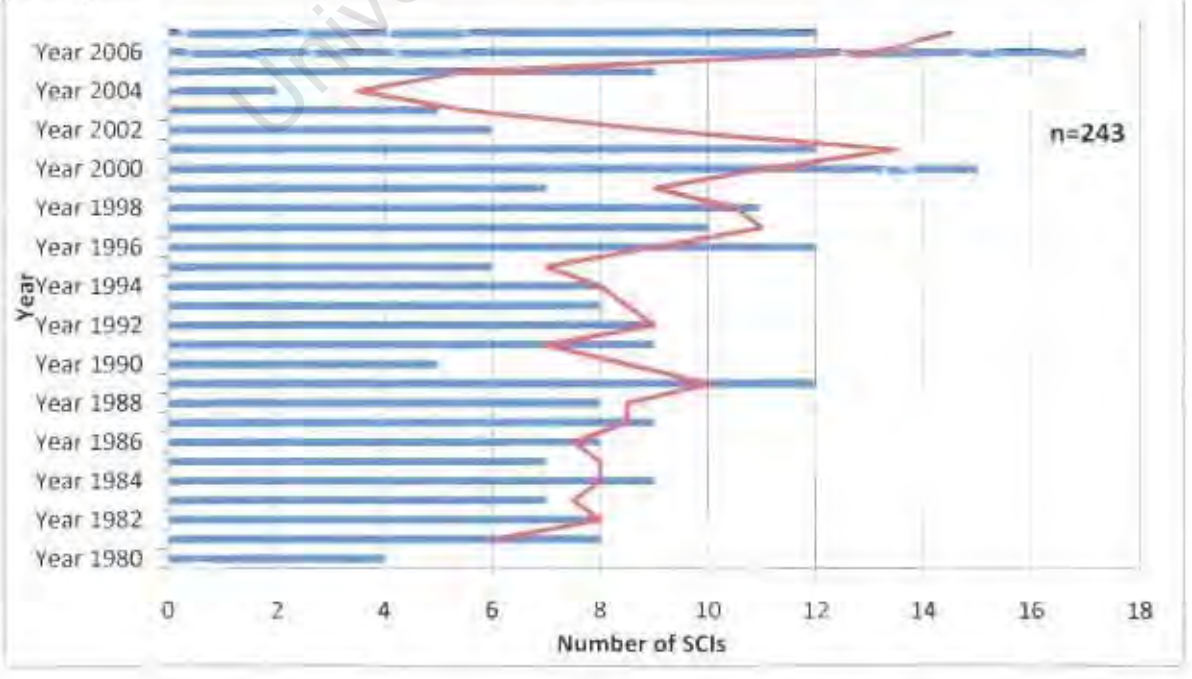
Discussion

GAME INFORMATION

Number of injuries per year

When compared to data collected by Kew et al (1991) for the period 1980-89, we did not find information on a total of 41 SCIs for those years. From data collected by Noakes et al (1999) and Scher (1998), another 22 SCIs were not found from 1990-97. When combining these 63 additional SCIs from Kew et al (1991) and Noakes et al (1999), there was a total of 246 SCIs from 1980 to 2007 with an average of 8.9 SCIs per year for this 27- year period *(Graph 23)*. This reinforces the urgency in the establishment of a compulsory register for SCIs in South Africa as valuable information has been lost. In addition, comparisons to previous studies is not possible and, most importantly, internationally, the validity of SCI research in South Africa will be questioned.

Graph 23: Injuries per year including data from Kew et al (1991) & Noakes et al (1999)



Based on this combined information, the overall trend is that the number of injuries per annum appears to be increasing in South Africa. Kew et al (1991) found 2.5 SCIs per annum for the 10 year period from 1970-9. This rose to eight SCIs per annum from 1980-9 in rugby players admitted to the SCI Centre at Conradie Hospital in Cape Town. Present data, together with data from Noakes et al (1999) and Scher (1998), shows 8.5 SCIs per annum for the period 1990-9. The number of SCIs rose again to 9.8 SCIs per annum from 2000 to July 2007. Note that the present data were collected nationally for South Africa whereas the data for Kew et al (1991), Noakes et al (1999) and Scher (1998) were only for injuries admitted to Conradie Hospital (and Libertas Hospital from 1995).

It is difficult to compare these injury numbers per annum as one set of data are confined to players presenting at one spinal injury unit only compared to the present data for the entire country. Though up until mid 1995, Conradie Spinal Care Centre was the only specialised unit that received all the SCIs from the Cape Province with a population of approximately 10 million people at that stage (Scher 1998, Noakes et al 1999). The Cape Province was broken up into three provinces - Western Cape, Eastern Cape and Northern Cape - after the 1994 South African elections with private health facilities, specialising in acute and rehabilitative care of spinal injuries, emerging from about mid 1995.

Looking at the annual number of SCIs per year the following comparisons can be made. The non-combined data were used when comparing results to other countries as the previous South Africa studies did not assess neurological outcome 12 months after the initial incident. For the total sample (n=157), there were 2.8 catastrophic

SCIs per annum from 1981-90, 4.7 catastrophic SCIs from 1991-2000 and 2.8 for the period 2001-5. Catastrophic outcome include players with permanently disabling SCI as well as deceased players which differs from New Zealand's permanently disabling classification. New Zealand had 2.8 permanently disabling SCIs per annum from 1981-90 and 3.0 permanently disabling SCIs per annum from 1991-2000 (Quarrie et al 2002). This has decreased significantly to 1.6 from 2001-5.

Comparing results to Australia, South Africa had 5.1 acute SCIs per annum for 1984-96 and 3.8 catastrophic SCIs per annum. Australia had 4.6 SCIs per annum from 1984-96 but 2.1 permanently disabling SCIs per annum over the 12 year period (Rotem et al 1998). This differs from results published by the Spinecare Foundation (2003) which has 3.1 ASCIs per annum for the period from 1986-96. There were 3.8 ASCIs per annum from 1997-2002 in Australia (Carmody et al 2005) with 9.8 SCIs in South Africa for the same period.

Ireland had 1.1 cervical SCIs per annum from 1995-2004 with 0.8 permanently disabled SCIs per annum (Shelly et al 2006) compared to 8 ASCIs per annum with 4 catastrophic SCIs in South Africa for the same period.

When comparing the annual number of SCIs in these rugby playing countries, South Africa does not fare favourably. But, the overall number of registered players in South Africa (423 581 wikipedia / 464 477 IRB) far exceeds numbers in Australia (148 750 Carmody et al 2005 / 66 395 IRB), Ireland (90 000 Shelly et al 2006 / 100 974 IRB) and New Zealand (124 900 Quarrie et al 2007 / 141 726 IRB). The

number of registered players was found at http://www.irb.com/unions/union and http://en.wikipedia.org/wiki/Rugby_union.

Although England had the largest number of registered players, 716 505, no articles were found that presented the number of SCIs in England except an article by Silver (1984) that included cases from America.

Incident rates should, therefore, be used to compare results. Unfortunately, the incident rates for South Africa could not be calculated due to lack of information on the number of registered players. Between 1986-96, Australia had 3.5 SCIs per 100 000 players per year (Carmody et al 2005) and in 1997-2002, 3.2 per 100 000 players per year. New Zealand's results were 2.7 per 100 000 players per year for the period of 1996-2000 and 1.3 for 2001-5. Shelly et al (2006) did not report incident rates in her study of SCIs in Ireland for the period 1995 to 2004.

Quarrie et al (2002) found that that internationally over the past 30 years, the frequency of SCIs to rugby players had increased. Many factors were proposed as to the possible reasons including greater public awareness, better record keeping, increased rate of players admitted to specialised spinal units, increased competiveness in play and changes in the number of exposure per player per season (Quarrie et al 2002). New Zealand has recently reported a decline in the number of SCIs that coincided with the introduction of RugbySmart with eight spinal injuries compared to the predicted 18.9 for the period of 2001-5 (Quarrie et al 2007). The decline in the number of SCIs was specifically due to the decrease in SCIs in scrummaging. This study exemplified the benefit of educational initiatives in injury

prevention (Quarrie et al 2007) with Noakes and Draper (2007) commenting that "the beauty of the RugbySmart is that it can do no harm, and according to the results of this study may do great good".

Time of the Season

The highest proportion of SCIs injuries occurred at the beginning of the season. There were similar findings in other studies (Armour et al 1997, Garraway et al 2000, Kew et al 1991, Lee and Garraway 2000, Williams and McKibbin 1987). The same trend of increased number of SCIs in August was seen in a previous South Africa study by Kew et al (1991) who related this to the mid-season break. The Spinecare Foundation (2003) found that in Australia the occurrence of SCIs was spread evenly throughout the season.

Quarrie et al (2002) queried the view that the predominance of injuries early in the season related to the importance of physical conditioning prior to the beginning of the season. They put forward other potential contributors-: that players take up new positions at the beginning of the season; new players generally enter sport at the beginning of the season; players play harder in the trials at the beginning of the season to make it into the team to which they aspire and combined lack of familiarity in the front row players to each other at the start of the season in scrummaging. They concluded that there is a lack of research in respect to what contributes to this pattern.

Weather conditions

As in the study of Kew et al (1991), only 6% of players in South Africa indicated that they played in wet conditions. Lee and Garraway (2000) found that weather may influence the occurrence of overall rugby injuries but that 75% of matches were played in dry weather. They felt that any influence of weather and pitch conditions on the risk of injury may be indirect by changing the way in which the game is played. They concluded that more detailed studies to investigate the influence of environmental factors were required.

Field conditions

Kew et al (1991), as in our present study, found a similar percentage of injured players in South Africa who indicated that they played on grassed fields. Previous studies also found that the ground condition was not a contributing factor in SCIs (Burry 1981, Kew et al 1991) or in all rugby injuries (Lee and Garraway 2000). Lee and Garraway (2000) stated that although hard pitches are more frequent in the early part of the season when the injury rate is at its highest, there are other possible risk factors that may be contributing to the high injury rate. They also found that although the field conditions deteriorated as the rugby season progressed, the number of injuries did not increase. Quarrie et al (2002) proposed that there is a combination of factors relating to the playing fields being harder at the beginning of the season as well as players lacking both practice and physical conditioning for the physical-contact phases of rugby.

Stage of the game

The present study and that of Williams and McKibbin (1987) found that a greater percentage of players sustained there SCI in the first quarter of the game. But in both these studies, these results were not statistically significant. This differs from the Spinecare Foundation (2003) which reported more SCIs in the third quarter of play.

Time of injury

The findings that the majority of SCIs occurred in the afternoon may be reflecting that most rugby games played in South Africa take place in the afternoon. But, as schoolboys play rugby matches on Saturday mornings, it may be reflecting that more adult players are injured. No other studies were found that discussed the impact of time of play during the day on outcome.

Phase of Play

The results show that the tackle situation accounted for the majority of SCIs followed by scrummaging with similar findings in other studies (Kew et al 1991, Noakes et al 1999, Rotem et al 1998, Scher 1998, Shelly et al 2006, Silver 1984). This contrasted with results in Argentina (Secin et al 1999), Australia (Taylor et al 1987, Spinecare Foundation 2003) and America (Wetzler et al 1998) with the set scrum responsible for most of the SCIs. The reduction of SCIs in the scrum In New Zealand after 1984 was thought to be related to the 1984 rules changes (Kew et al 1991). This resulted in a relative increased proportion of injuries in the tackle phase.

The tackle phase is more dynamic than the scrum making the most common mechanism of injury in tackling more difficult to identify (Quarrie et al 2002). High

tackles, spear tackles and double/gang tackles have been identified as dangerous (Carmody et al 2005). Scher (1998) commented that the double tackle is a rare cause of cervical injury and is difficult to avoid owing to the speed at which rugby is played competitively. Sometimes, a formidable player is deliberately marked by two opponent players to neutralise his potential (Scher 1998).

In respect to scrummaging, Carmody et al (2005) and the Spinecare Foundation (2003) reported that 39% of the 21 players with scrum-related SCIs in Australia were not in their regular position compared to 21% of 42 players injured in scrummaging in this study. The Spinecare Foundation (2003) added that this emphasises the specialist role of the front row forwards. Preventative measures should be targeted at tackling techniques and scrummaging as the majority of SCIs occurs in these phases.

Silver (1984) noted that there were no spinal injuries occurring in the ruck or maul before 1970 with the ruck and maul, at present, making up 14% of spinal injuries in South Africa. This has decreased from 17% (Kew et al 1991). Quarrie et al (2002) found that there was insufficient research to identify the risk factors associated with injury in these unstructured phases of play.

Level of Play

The majority of SCIs occurred at club level. These results could not be compared as countries vary in description of level of play. Our questionnaire also did not specify the grade of play i.e. A or B teams. Silver (1992, 1994) found a direct correlation between the standard of play and the number of injuries. He suggested that more injuries occurred in higher levels of play due to the greater speed, size and mass of

the players and the impact of the greater force generated by these players (Silver 2001). This was echoed by Quarrie et al (2001), though it was not reflected in the present results with only 2% of SCIs occurring at provincial level and none at international level. The reason may be due to fewer exposures at top level rugby.

Provincial Rugby Union

The information relating to the denominator data on the number of matches played per union was obtained by the research team with the assistance of SARU. A few of the Provincial RUs required numerous telephonic reminders with three of the RUs not responding to or unable to assist with requests. The reliability of the information obtained is, unfortunately, questionable. For research to provide South Africa rugby authorities, coaches, referees and players with up-to-date information on mechanisms of injuries, for planning appropriate changes and to monitor the effect of measures instituted, accurate data of the number of matches and the number of registered players is required. The lack of availability of this information re-inforces the need for a formal injury registry in South Africa.

Activity at time of sustaining SCI

Ninety four percent of SCIs occurred during match play. A similar percentage was reported in Australia (Carmody et al 2005), Argentina (Secin et al 1999) and Ireland (Shelly et al 2006) as well as in a previous study in South Africa (Kew et al 1991). This finding is significant in that more time is spent in practice than in match play (Kew et al 1991). Kew et al (1991) suggested that the competitiveness and aggression unleashed in match play may be an important factor contributing to these SCIs.

Protective Equipment

Less than 50% of the players in this study wore some form of protective equipment. A variety of protective equipment is permissible under the laws of rugby with little research on their effectiveness in preventing injuries (Garraway 2000, McIntosh and McCrory 2005, Quarrie et al 2005). Players felt that they were more confident and able to tackle harder when wearing headgear (Finch et al 2001) but Marshall et al (2004) found that padded headgear only decreased the risk of scalp injury. Thirty two percent of players in this study wore mouth guards compared to 42% in schoolboy players in the 1991 rugby season (Upton et al 1996). In New Zealand, mouth guard wearing is compulsory since 1998 with Garraway (2000) and Quarrie et al (2005) reporting that the mouth guard is effective in preventing dental injuries. Even though there was a significant association between neurological outcome and protective equipment, no studies were found that evaluated the role of any form of protective equipment and SCI incidence.

Foul Play

A previous study in South Africa found only 3% of players indicated that their spinal injury resulted from foul play (Kew et al 1991). This has greatly increased with 16% of players in the present study considered that foul play as indicated by the refereeing contributed to that injury. Overall almost a third felt that foul play contributed to their injury. Eleven percent of players in the UK (Silver 1984) and 26% across all rugby codes in Australia (Taylor and Coolican 1987) attributed their spinal injury to foul or illegal play. Even though rugby has a high injury rate, injuries that result in permanent loss of function because of foul play are unacceptable (Quarrie et al 2002).

PLAYER DEMOGRAPHICS

Ethnicity

Quarrie et al (2002) commented that although little attention has been focused on whether ethnicity is a risk factor for spinal injury among rugby players, it is worthy of further investigation. In New Zealand, the Maori population had a higher rate of SCI from all causes than the New Zealand Europeans (Dixon et al 1993). In South Africa, there is an assumption that rugby is a 'white' dominated sport but no evidence has been found to corroborate this. Some may feel that the high number of 'white' players sustaining SCI may be related to this assumption. It may also be the result of under-reporting in the other ethnic categories due to previous lack of access to medical facilities and support structures under the apartheid regime. 'White' players had the highest number of players with full recovery which may have been due to access to better medical resources under apartheid or that more 'white' players had medical insurance and therefore access to private healthcare. 'Black' players had almost a 50:50 chance of survival or death. A quarter of the deceased players are 'coloured'. It would be important to monitor and advocate for better neurological outcome and survival status for previously disadvantaged rugby players with greater resources being targeted here.

Education

Almost half of the players with catastrophic outcome did not obtain an education of higher than Grade 11. This may directly be linked to the impact of the catastrophic SCI on access to educational facilities that cater for quadriplegics. Of the players that matriculated and obtained tertiary education, 69% and 81% were 'white' respectively.

It may, therefore, also be tied to issues of lack of access to education for previously disadvantaged players in South Africa.

Age

Our median age for SCI was 21 years (sd = 6.7) with Secin et al (1999) reporting the mean age for disabling cervical spine injuries in Argentine rugby to be 22 years, Australia's average age being 24.4 years (Carmody et al 2005) and Ireland 21.6 years (Shelly et al 2006). In their review article, Quarrie et al (2002) determined from case series studies that the average age of players with SCIs internationally was 22.8 years. Many other articles referred to the older rugby players or the younger rugby players but there was no clear definition as to what exactly these ages were.

Initially, it was suggested that younger players were at greater risk of sustaining SCIs (Horan 1984, Scher 1979, Silver 1979). Other studies have since shown this to be untrue (Brown 2006, Kew et al 1991, Scher 1998). Browne (2006) suggested that catastrophic SCIs are rare in children playing rugby. His reasoning was that young immature teenagers are unlikely to cause collision forces severe enough to result in serious injury to the spine. Other studies made similar deductions in relation to younger players (Armour et al 1997, Kew 1991et al, Silver and Stewart 1994). In Browne's study, there was one catastrophic outcome occurring in the eight aged 15-years-and-under group of SCI players. In South Africa, Kew et al's (1991) youngest player with a SCI was 14 years with the youngest player, in this study, was 11 years (who had complete recovery after his initial SCI).

Kew et al (1991) found that 31% of SCI occurred in schoolboys in South Africa from 1963-89 with an apparent increase to 39% in this study from 1980 to July 2007. This

apparent increase with respect to SCIs in schoolboys may be related to better reporting of SCIs in young players or more schoolboys playing rugby with more players at risk of a SCI. Calculating an incidence rate would reflect whether the increase is real. Once again, the need for a register for SCIs and an up-to-date number of registered players is essential. Scher (1998) found in South Africa that there was more than a twofold greater number of SCIs in adults than schoolboys with the number of schoolboys playing rugby far greater than the adult number. This is similar to the finding in Ireland, where there are approximately 73 000 registered schoolboys playing rugby compared to 17 000 adults with 80% of SCIs occurring in adults (Shelly et al 2006).

Yet, although the present findings are generally similar to Scher (1998), the results reveal that the highest number of SCIs occurred in players aged 17 years followed closely by 18 year old players. The players aged 21 had less than half the number of SCIs than the 17 year old. The concern expressed by Horan 1984 that "..... the growth in the number of serious cervical injuries in schoolboys is particularly disturbing" still rings true with an increasing number of SCIs being seen in young South African players.

In New Zealand, the proportion of younger players confined to wheelchairs was greater (Armour 1997). Of note, in this study, of the SCIs occurring in the 16-18 year olds (n=50), 60% had a catastrophic outcome. But, in respect to overall SCIs, 69% of catastrophic SCIs (n=99) occur in players aged 19 years and older. This is similar to findings of Noakes et al (1999) that only 28% of South African adult players, from 1991-97, had total or near-complete recoveries following their initial SCI

Finally, there may also be a relationship between age and level of injury. The lower cervical level has been found to be more involved in the older players (Williams and McKibbin 1987). In this study, more than half of players aged 19 and older had lower cervical injuries but the results were found not to be significant.

Anthropometric Characteristics

A range of views as to the importance of anthropometric characteristics of players with respect to risk of injury have been expressed in the scientific literature (Quarrie et al 2002). Armour et al (1997) proposed that "all build types are equally at risk in mismanaged scrums". However, Calcinai (1992) felt that it is a recipe for disaster to ask a player who has a long thin neck to play in the front row. Quarrie et al (2001), in looking at risk factors for all types of rugby injuries, found that rugby union players with a body mass greater than 81kg sustained a higher injury rate than players whose body mass was less than 74kg (a non-significant result was found when comparing those less than 74kg to players with weights greater than 74kg-80kg). The present results show that rugby players between 70-79kg had more injuries than those between 80-89kg and 60-69kg.

The findings also reveal that players 180-189cm had more SCIs than those less than 179cm or above 190cm. Quarrie et al (2001) found that rugby players whose heights ranged from 179-181cm missed a greater proportion (16%) of their season due to injuries. Also, New Zealand players with a BMI of greater than 26.5 sustained more injuries than players with a BMI of less than 23. However this relationship was explained by the higher level of rugby achieved by players with higher BMI (Quarrie et al 2001). Players with a BMI of 23-25 had more SCIs in this study.

Survival Status

The length of survival for only 21 of possible 69 deceased players was recorded with just over half of these players dying within one and half years post initial SCI. It is most probable that SCI have a significant impact on life expectancy. No other rugby-related studies have evaluated survival time after initial SCI. From comprehensive surveillance, more reliable results would be gathered on the impact of a SCI and life expectancy and could be included in an educational programme for rugby players at all levels.

Experience

Silver in 1984 and 2002 suggested that greater skill does not protect the player. Is it "the longer one plays rugby, the higher the risk of injury due to greater exposure over time?" In this study many players started playing rugby in primary school and could have had 10 years experience by the time they matriculated. But, the assumption is that the standard of the rugby at school level would differ from club rugby. Therefore, players older than 19 with more than five years of playing rugby were considered experienced players. The majority (85%) of SCIs occurred in this group of players. Also, players playing rugby for more than 10 years have the greater proportion of SCIs irrespective of playing position and phase of play. This can be interpreted as those with more skill having more injuries (Kew et al 1991, Quarrie et al 2002), greater forces generated in higher levels of play (Silver 2001 and Quarrie et al 2001) or it may be related to greater risk of sustaining a SCI the longer the exposure to playing rugby.

The link may be due to the repetitive stress on skeletal and ligamentous systems with premature and advanced degenerative changes of the cervical spine observed in rugby players (Scher 1990) or that the degree of forces generated by skilled or professional players increase the likelihood of injury (Silver 2002). An increase in injuries in both professional and amateur Scottish players occurred coincidentally after the introduction of professionalism in union rugby in 1995 (Garraway 2000). Silver (2002) concluded that the advent of professionalism had placed more emphasis on strength, speed and stamina for all players resulting in more injuries. Players may feel pressurised to returning to contact rugby prior to full recovery from their injury as there may be fears of financial loss and/or being dropped from the team resulting in an increased risk of injury. Unfortunately, the spinal injury questionnaire did not include a question on whether the player was playing professionally or on an amateur level. Therefore, no comparisons could be made.

Conditioning sessions

The present study found that 64% of players (n=109) with catastrophic SCIs partook in some form of conditioning sessions, but a very high proportion (70%) of these players participated in less than three pre-season conditioning sessions per week. Silver (1984) found that 18% of injuries to the spine were due to players being unfit or having insufficient specific positional training. Training to improve strength, fitness, and individual and team skills is an accepted part of sport, but the benefits of these on reducing (head and) neck injuries have not been formally addressed (McIntosh and McCrory 2005). Silver (2001) associated stronger and fitter players with greater number of injuries.

Garraway et al (1999) found that match preparation had no adverse or protective effect on tackle injuries. Upton et al (1996) found in a South African high school rugby survey that fewer than 40% of players (n=2 330) trained adequately in the pre-season with less than 30 minutes allocated to the practice of tackling and falling techniques prior to first full-contact play. This is similar to findings by Silver (1984); in several schoolboy players who were injured there was inadequate tackling technique. Less than 1% of specialist front-row players (n=684) had undertaken an appropriate neck-strengthening programme (Upton et al 1996). They stressed the importance of coaching and pre-season training in schoolboy rugby with too little time spent on practicing techniques that can reduce injuries. Yet, the benefits of neck strengthening, skills, or fitness in reducing (head and) neck injury have not been formally addressed whereas training programmes have been shown to reduce lower limb injury (McIntosh and McCrory 2005).

Playing Position

Consistent with other case series studies, front row players had the highest proportion of SCIs with hookers being most vulnerable (Carmody et al 2005, Scher 1998, Secin et al 1999, Wetzler et al 1998, Quarrie et al 2002). Hookers who make up 6% of all the players by number (Quarrie et al 2002) sustained 36% of catastrophic SCIs (n=81). This over-representation was almost entirely due to the increased risk during the set scrum (Quarrie et al 2002) with hookers being very vulnerable to sustaining a SCI in scrummaging.

As in the previous studies, props (17%) had the second most frequent catastrophic SCI. But for overall SCIs (n=139), flanks sustained more injuries (19%). This is a

drastic change in South Africa rugby in comparison to results of Kew et al (1991) who found that flanks, together with scrumhalves and fullbacks, were at the least risk; sustaining only 5.6% of the SCIs. This may be due to increasing proportion of SCIs occurring during tackling phase especially being tackled.

In contrast to the majority of other studies (Carmody et al 2005, Kew et al 1991, Secin et al 1999, Quarrie et al 2002), Shelly et al (2006) found that the majority of SCIs occurred in the backs in Irish rugby. Kew et al (1991) found that the front row forwards accounted for 85% of the SCIs in scrummaging compared with 91% found in the present study. The forwards had a greater proportion (73%) of SCIs occurring during the ruck and maul phase (n=15) compared to Kew et al (1991) with 65% (n=20). Our results (78%) concur with Kew et al (1991) that the majority of SCIs to backs (n=23) occur during the tackle phase.

Normal Position

In this study, 20% of players said that they sustained their SCI while playing out of their normal position. Kew et al (1991) found that playing out of position was not a major predisposing factor for injury. Yet, it is unacceptable that players are still requested to play out of their normal position with as many as 40% of SCIs in 2007 occurring in such a situation.

INJURY INFORMATION

To improve accuracy of injury information supplied by players, medical records were accessed and medical reports were requested from health facilities and surgeons who managed the players. The player's consent for participation in this study was provided to the health facility and provider. Valuable information was lost as some health care facilities had destroyed the player's medical records as per South Africa regulation for preservation of medico-legal documentation, some requested payment for records as well as requests were ignored by health facilities and providers. Again, the researchers re-iterate the value of a SCI register for the preservation of data and efficient access to information necessary for comparative study.

Classification of SCI Severity

The American Spinal Injury Association (ASIA) classification was used in the spinal injury questionnaire. It became clear that the outcome effect of the SCI supplied by player as well as the medical records was not based on the ASIA classification. The interviewers were not adequately trained in eliciting sufficient information to make the classification reliable. Therefore, the data was combined accordingly. The A, B, C groups of the ASIA scale were players who were quadriplegic and dependent on wheelchairs for mobility. The neurological effect of the SCI was then called a catastrophic event. The deceased outcome was included in the catastrophic group. Players in D had muscle power of three and more and were able to walk with assistive devices such as crutches, walking frames or sticks. Their outcome was considered here as non-catastrophic as they were not wheelchair dependent. The players, who had full recovery, the E group, also formed part of the non-catastrophic category.

In a personal communication with Dr Colin Fuller, the IRB has not agreed on a SCI classification to be used in rugby studies. The ASIA system, developed in the early 1990's, is a based on the Frankel classification of SCIs that was developed during World War II and popularised by Frankel in the 1970's (http://www.sci-info-pages.com/levels.html). Rugby-related SCI research emanating from Ireland (Shelly et al 2006 and Australia (Carmody et al 2005, Spinecare Foundation 2003) use the Frankel grading for SCIs and New Zealand (Quarrie et al 2002) use ASIA. The Southern African Spinal Cord Association (SASCA) promotes the use of ASIA but this, at present, does not appear as a standard classification system used in South Africa. Consensus by the IRB in respect to a SCI classification system would allow comparisons to be made on an international level.

Anatomical Site of Injury

As in previous studies (Carmody et al 2005, Kew et al 1991, Noakes et al 1999, Rotem et al 1998), the majority of SCIs occurred at C4/C5 and C5/C6 spinal levels. Compared to previous South African studies (Kew et al 1991, Noakes et al 1999), the present results showed increasing numbers of SCIs at C3/C4 and C6/C7 spinal levels. Early degeneration of the cervical spine has been documented both by radiographs (Scher 1990) and MRI (Berge et al 1999) in players as young as 20-21 years of age (Scher 1990 and Berge 1999). Quarrie et al (2002) presumed that the increased rate of degeneration was related to the demands of scrummaging which has increased primarily through more time being spent practicing scrummaging and through the greater use of scrum machines. The majority of the changes are located at the lower cervical spine where overload stress predominates (Berge et al 1999) and where older players are more commonly found to be injured (Williams and

McKibbin 1987). Berge et al (1999) referred to players from 21 to 37 years as senior rugby players with 66% of these players having early changes. Although, in this study, almost 60% of players over 19 years had lower cervical injuries, Quarrie et al (2002) stated that there is no evidence to link early degenerative changes to increased risk of SCI.

Type of injury

More than half of the players in this study had dislocation type injuries and a quarter had dislocation with fractures of their cervical spine. In his 10 year review of South African rugby players, Scher (1998) found that most players injured in the scrum had sustained anterior dislocations with bilateral locking of facets and a smaller group had dislocation with unilateral locking of facets. In this study, the type of dislocation was not collected as there was difficulty in locating radiographs and corresponding reports. The interviewers were also not trained in assessing radiographs. The results revealed that the majority of injuries in scrummaging and in being tackled were dislocations of the cervical spine. When complete dislocation and bilateral locking of the articular facets occur, injury to the spinal cord is severe (Scher 1998). This was demonstrated in this study as 72% of players who sustained a dislocation had catastrophic neurological outcomes.

Insurance

Silver (2002) felt that all players should have comprehensive insurance as rugby is a high risk sport. Only 29% of South African rugby players held some form of health insurance with a similar percentage found in Australia (Carmody et al 2005). Internationally, the private health sector grew dramatically in the late 1980s due to

the global trend for privatisation of state-managed structures (Söderlund et al 1998). The first private spinal care unit of Libertas Medical Centre Hospital was established in 1995 in the Western Cape Province. Conradie Spinal Care Unit being the only specialised unit prior to this (Noakes et al 1999) with patients being sent from all areas in South Africa to this unit. Since then, nine private sector hospitals managing spinal injuries have been established throughout South Africa with 6 having acute care facilities. It must be noted that only the minority of South Africa, 20% of the country's population of 47 million are able to afford private health care (Fin24 2008). The public sector still manages the majority (71%) of the players with spinal injuries.

Immediate Management of SCIs

The results revealed that there was inadequate immediate management of injured players with lack of medical personnel on the field, improper immobilisation with lack of equipment on hand for this. Incorrect management of SCIs has the potential to result in spinally injured players who would have otherwise fully recovered, becoming permanently paralysed (Quarrie et al 2002). These authors further commented that environmental concerns, such as having appropriate first-aid equipment on hand and ambulance access, should have high priority in education programmes for club and school rugby administration.

Transport to hospitals, hospital type and number of hospitals

Of great concern was that the majority of players with catastrophic outcomes had been transported to two or more facilities with an unacceptable long waiting period before appropriate acute management was commenced. Many of the players were transported to hospital via a private vehicle. Silver (2002) felt that players should be

rapidly transferred by helicopter directly from the rugby field to a trauma unit where there should be a dedicated spinal surgeon and availability of CT or MRI scans. At present, in South Africa, only five out of the nine provinces have spinal units with only four provinces providing acute care management. Of the 13 acute care facilities, acute public facilities are in three provinces only - Gauteng (four), Western Cape (two with one providing care for military personnel only) and Kwazulu-Natal (one) (http://www.South Africasca.org.za). The time spent waiting for acute management is understandable when the majority of players are being managed in public facilities and being transported by ambulance. But, this has changed with 42% of SCIs (n=130) being managed in the private sector from 1995–2007 compared to 7% of players before 1995. Seventy nine percent of players had catastrophic SCIs from 1980-94 with 57% from 1995-2007. Improved neurological outcome is probably due to earlier acute management with six private hospitals providing acute care since 1995.

Spineline

As mentioned previously, quick access to specialised medical services for players with SCIs in peri-urban and rural areas is a problem in South Africa as both public sector facilities and private hospitals managing spinal injuries are based in or near city centres. The establishment of Spineline by CBPF in 2003 was intended to promptly manage any rugby-related SCI with immediate access to qualified medical personal to provide proper spinal stabilisation for the player as well as immediate transportation to the nearest appropriate medical facility.

Yet, only a small percentage (27%) of the rugby SCIs since 2003 are known to have been reported to Spineline. A high proportion of players whose SCIs were dealt with through Spineline had non-catastrophic outcomes demonstrating a link with quick access to appropriate medical care and minimisation of permanent damage to the spinal column.

Financial Compensation

As in other studies, many injured players were not willing to divulge the amounts received from insurance or other sources. None of the players in this study received adequate financial compensation. In Australia, in 2005, the maximum payout of Aus$300 000 could awarded (Carmody et al 2005) and, in New Zealand, NZ$14 million per case (Orchard et al 2007). The injured player, according to Silver (2002) and Quarrie (2002), should be entitled to compensation, more, especially if foul play was involved. Proceedings could be brought against the referee, the team's coach, player's or opposing team's school or club, the emergencies services and lastly against the owners/controllers of an unsafe pitch (Silver 2002).

Recommendations

While it is clear that the study has many limitations, it has highlighted that a compulsory comprehensive register for rugby-related SCIs in South Africa is essential for monitoring the magnitude of the problem, identifying potential risk factors and for formulating appropriate and timely interventions. As well as, the critical necessity to have available the number of registered players to calculate incident rates for monitoring and comparisons to be made on all levels and, lastly, that including information on deceased players is vital for calculating years of life lost. The register will facilitate the availability of reliable rugby-related SCI statistics especially in monitoring the neurological outcome and survival of previously disadvantaged players.

As further research will be done, a standardised classification system for SCIs should be used to facilitate comparisons with local and international studies. The ASIA classification system for SCIs, as recommended by the SASCA, should be used nationally at all health facilities in South Africa. Only four provinces (Free State, Gauteng, Kwazulu-Natal, and Western Cape) in South Africa have acute care medical facilities for SCIs. As South Africa has limited resources, strengthening collaboration between provinces and between the public and private health sector in the provinces without acute care facilities is likely to reduce the burden on the public sector. Spineline is an example of collaboration between a non-governmental organisation, CBPF, and Netcare 911, a private emergency medical service. Utilisation of Spineline needs to be improved as this important service could alter the neurological outcome of a serious SCI.

Health insurance and appropriate compensation for this life-altering event requires urgent attention. It is mostly the previously disadvantaged players that suffer the consequences of this situation. The spiralling cost of private health care and insurance premiums are unaffordable for most South Africans. Clubs and schools may need to look for sponsors to help cover insurance costs and legislation urgently needs to guide proper financial compensation for players having catastrophic neurological outcomes.

But, ultimately the strongest impact will be a preventative strategy. A recent study by Quarrie et al (2007) has shown that RugbySmart had a positive impact on SCIs. As Noakes and Draper (2007) indicated that, although this observational study may have limitations with possible confounders in changes in the game or players, the data collected was robust and the results were promising. South Africa has not the resources to undertake this form of research at present as, besides the cost, the structures in place do not allow for precise data collection. But, rugby administrators in South Africa have taken the lead by learning from the New Zealand RU and other rugby safety initiatives and have undertaken to implement it own rugby safety programme, BokSmart.

The results of this study have already contributed to the development of BokSmart, with one of its main priorities being to reduce the number of serious and catastrophic injuries. In a personal telephonic communication, the Manager of BokSmart, Dr Wayne Viljoen explained the five legs of BokSmart. The first leg, an educational programme for coaches and referees has been launched with a target of reaching all 55 000 by May 2010. The medical protocol leg will guide management of injuries

with coaches and referees being obliged to report serious and catastrophic injuries within 48 hours. Thirdly, a research leg will monitor effectiveness of BokSmart programme and, from which, further risk factor investigation will be undertaken. Legislation is also targeted but changes cannot be mandated until all coaches and referees are accredited and certified. Lastly, a communication and marketing leg designed to reach the South African public and rugby community with a DVD, booklet and website as tools for communication. Initially, with this raised awareness, an increase in SCIs may be found as the data collected will be more accurate and the public and rugby community more informed to report such incidences.

The dynamics of rugby in South Africa needs to be taken into account with the number of coaches and referees almost four-five times larger than New Zealand and Australia and player numbers three-four times more. The greater numbers, as well as, an added dimension of accessibility of coaches, referees and players especially in rural and peri-urban areas to attend regular training updates may impact on the programme. BokSmart will have its educational programme available on website but, again, it may be limited by infrastructure restraints and affordability for previously disadvantaged areas.

Even with these limitations, BokSmart together with an improved surveillance system will play a vital role in reducing the burden of rugby-related SCIs in South Africa.

Strengths and weaknesses of the study

The strengths would be that this study will serve as a platform for a complete data set for SCIs in South Africa as the data was collected via a data capturing software package, PocketSurvey, which allows further entering and storage of the SCI information. The data were collected for a lengthy period of time (1980 to July 2007). Data collection was not only based on medical records but personal contact was made with players to enhance information that was gathered.

The weaknesses of this study include recall bias with respect to players remembering events that occurred up to 27 years ago, limited access to medical records which were lacking in detail, poor response from health facilities and medical specialists for detailed medical reports, poor cell phone reception in particularly rural areas impacting on the quality of interviews, non-uniform classification of SCIs in South Africa, a limited number of participants who consented to be interviewed, a lack of denominator information, and incomplete data.

Acknowledgments:

The Kwazulu-Natal Rugby Union must be acknowledged for producing a DVD on preventing cervical injuries using the New Zealand RugbySmart guidelines: the DiscoverySharkSmart, Avoiding Neck Injuries

Conclusions

South Africa is a developing country with limited resources. The greatest burden of disease in South Africa is infectious diseases especially HIV/AIDS. Sport injuries in South Africa, therefore, may not be a government priority. Even though, rugby-related SCIs are not common in South Africa, each contributes to burdening an already strained health care system, as well as contributing to early life loss. In order to define the magnitude of rugby-related SCIs, identify its contribution to South Africa's health burden and to identify potential risk factors for sustaining SCIs in rugby, it is essential to have data that are accurate, comprehensive and timely. This study is the first attempt on a national basis to record the number of rugby-related SCIs as well as formulating a database of information relating to the SCIs in South Africa that can be used to identify potential risk factors.

Although the present data collected is incomplete, the results show that the number of rugby-related SCIs are increasing but the neurological outcome has improved with less catastrophic outcome occurring. Despite political transformation in South Africa, it is the previously disadvantaged players that carry the burden of catastrophic outcomes and early life loss following a SCI. It is the public sector that has the burden of managing the majority of rugby-related SCIs and the player that bears the financial fallout from the SCI as compensation is extremely inadequate. The cost to the South Africa community is substantial. Rugby-related SCIs in South Africa can be expected to grow in number unless appropriate preventative interventions are timely implemented. Key elements to reduce rugby-related SCIs would include a compulsory register and implementation of the national rugby safety programme.

References

Armour KS, Clatworthy BJ, Bean AR, Wells JE, Clarke AM. Spinal injuries in New Zealand rugby and rugby league: a twenty-year survey. *NZ Med J* 1997; 110 (1057): 462-5.

Bathgate A, Best JP, Craig G, Jamieson M. A prospective study of injuries to elite Australian rugby union players. *Br J Sports Med* 2002; 36: 265-9.

Berge J, Marque B, Vital J-M, Sénégas J, Caillé J-M. Age-related changes in the cervical spines of front-line rugby players. *Am J Sports Med* 1999. 27: 422-9.

Berry JG, Harrison JE, Yeo JD, Cripps RA, Stephenson SC. Cervical spinal cord injury in rugby union and rugby league: are incidence rates declining in NSW? *Aust NZ J Public Health* 2006; 30(3): 268-74.

Bourke JB. Rugby union should ban contested scrums. *BMJ* 2006; 332: 1281.

Browne GJ. Cervical spinal injury in children's community rugby football. *Br J Sports Med* 2006; 40: 68-71.

Burry HC. Cervical injury in rugby football – A New Zealand survey: discussion. *Br J Sports Med* 1981; 15: 58.

Burry HC, Calcinai CJ. The need to make rugby safer. *BMJ* 1988; 296: 149-50.

Calcinai CJ. Cervical spine injuries. *NZ J Sports Med* 1992; 20 (3): 14-15.

Carmody DJ, Taylor TKF, Parker DA, Coolican MR, Cumming RG. Spinal cord injuries in Australian footballers 1997-2002. *Med J Aust* 2005; 182: 561-4.

Chris Burger / Petro Jackson Players' Fund. Fund News 23rd August 2006. Accessed 5th May 2008. Available at: http://www.playersfund.org.za/news/newsitem.asp?ItemID=130

Cripps RA. Spinal cord injury, Australia 2004-5. Available at: http://www.nisu.flinders.edu.au/pubs/reports/2006/injca86.pdf

Dixon G, Danesh J, Caradoc-Davies T. Epidemiology of spinal cord injury in New Zealand. *Neuroepidemiology* 1993: 12 (2): 88-95.

Du Toit DE, Olivier P, Grenfell, Eksteen B. Isokinetic neck strength norms for schoolboy rugby forwards. *SAJSM* 2005; 17 (1): 19-26.

Edgar M. Tackling rugby injuries. *Lancet* 1995; 345: 1452-3.

Fin24. Private health set to reform 2008. Available at: http:/www.fin24.co.za. Accessed 20th April 2008.

Finch C, Donohue S, Garnham A. Safety attitudes and beliefs of junior Australian football players. *Inj Prev* 2002; 8: 151-4.

Fuller C. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Br J Sports Med* 2007; 41: 328 -331.

Fuller C, Brookes JH, Kemp SP. Spinal injuries in professional rugby union: a prospective cohort study. CJSM 2007; 17: 10-16.

Garraway WM, Lee AJ, Hutton SJ, et al. Impact of professionalism on injuries in rugby union. *Br J Sports Med* 2000; 34: 348-51.

Haylen PT. Spinal injuries in rugby union, 1970-2003: Lessons and responsibilities. *Med J Aust* 2004; 181 (1): 48-50.

Holtzhausen LJ, Schwellnus MP, Jakoet I, Pretorius AL. The incidence and nature of injuries in South African rugby players in the rugby Super 12 competition. *S Afr Med J* 2006; 96: 1260-5.

Horan FT. Injuries to the cervical spine in schoolboys playing rugby football. Editorial. *J Bone Joint Surg* 1984; 66-B (4): 470-71.

Kew T, Noakes TD, Kettle AN, Goedeke RE, Newton DA, Scher AT. A retrospective study of spinal cord injury in Cape Province rugby players, 1963-1989: incidence, mechanisms and prevention. *S Afr Med J* 1991; 80: 123-33.

Lee AJ, Garraway WM. The influence of environmental factors on rugby football injuries. *J Sports Sci* 2000; 18: 91-99.

Mail & Guardian 28th June 2006. Accessed 5th May 2008. Available at: http://www.mg.co.za/articlepage.aspx?area=/breaking_news/breaking_news_nationa

Marshall SW, Loomis DP, Waller AE, Chalmers DJ, Bird YN, Quarrie KL, Feehan M. Evaluation of protective equipment for the prevention of injuries in rugby union. *International J of Epidemiology* 2004; 34 (1): 113-8.

McIntosh AS and McCrory P. Preventing head and neck injury. *Br J Sports Med* 2005; 39: 314-8.

Noakes T, Jakoet I. Spinal cord injuries in rugby union players. *BMJ* 1995; 310: 1345-6.

Noakes T. Spinal cord injuries in rugby players: more of the same. *S Afr Med J* 1999; 89: 531-2.

Noakes TD, Jakoet I, Baalbergen E. An apparent reduction in the incidence and severity of spinal cord injuries in schoolboy rugby players in the Western Cape since 1990. *S Afr Med J* 1999; 89 (5): 540-5.

Noakes TD and Draper CE. Preventing spinal cord injuries. *BMJ 2007*; 334: 1122-3.

Orchard JW and Finch CJ. Australia needs to follow New Zealand's lead on sports injuries. *MJA* 2002; 177 (1): 38-9.

Orchard JW, Leeder SR, Moorhead GE, Coates JJ, Brukner PD. Australia urgently needs federal government body dedicated to monitoring and preventing sports injuries. *MJA* 2007; 187 (9): 505-6.

PocketSurvey. Available at: http://www.pocketsurvey.net

Quarrie KL, Alsop JC, Waller AE, Bird YN, Marshall SW, Chalmers DJ. The New Zealand rugby injury and performance project. VI. A prospective cohort study of risk factors for injury in rugby union football. *Br J Sports Med* 2001; 35: 157-66.

Quarrie KL, Cantu RC, Chalmers DJ. Rugby union injuries to the cervical spine and spinal cord. *Sports Med* 2002; 32: 633-53.

Quarrie KL, Gianotti SM, Chalmers DJ, Hopkins WG. An evaluation of mouthguards requirements and dental injuries in New Zealand rugby union. *Br J Sports Med* 2005; 39: 650-1.

Quarrie KL, Gianotti SM, Hopkins WG, Hume PA. Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study. *BMJ* 2007; 334: 1150-60.

Rotem T, Lawson JS, Wilson SF, Rutkowski SB, Aisbett CW. Severe cervical spinal injuries related to rugby union and league football in New South Wales 1984-1996. *Med J Australia* 1998; 168: 379-81.

Rugby union in South Africa. Accessed 25th June 2008. Available at: http://en.wikipedia.org/wiki/Rugby_union_in_South_Africa

SARugby. Outcomes of the Safety Indaba. Accessed 5th May 2008. Available at: http://www.South Africarugby.com/news/News/article/sid=4967.html

Scher AT. Rugby injuries to the cervical cord [letter]. *SAMJ* 1979; 56 (6): 205.

Scher AT. 'Crashing' the rugby scrum – an avoidable cause of cervical spinal injury: case reports. *S Afri Med J* 1982; 61: 919-20.

Scher AT. The 'double tackle' – another cause of serious cervical spinal injury: case reports. *S Afri Med J* 1983; 64: 595-6.

Scher AT. Premature onset of degenerative disease of the cervical spine in rugby players. *S Afri Med J 1990*; 77: 557-8.

Scher AT. Rugby injuries to the cervical spine and spinal cord: a ten year review. *Clin Sports Med* 1998; 17: 195-206.

Secin FP, Poggi EJ, Luzuriaga F, Laffaye HA. Disabling injuries of the cervical spine in Argentine rugby over the last 20 years. *Br J Sports Med* 1999; 33: 33-6.

Shelly MJ, Butler JS, Timlin M, Walsh MG, Poynton AR, O'Byrne JM. Spinal injuries in Irish rugby. A ten year review. *Br J of Bone Joint Surg* 2006; 88: 771-5.

Silver JR. Rugby injuries to the cervical spine cord [letter]. *BMJ* 1979; 1: 192-3.

Silver JR. Injuries of the spine sustained in rugby. BMJ 1984; 288: 37-43.

Silver JR. Injuries of the spine sustained during rugby. *BMJ* 1992; 26 (4): 252-8.

Silver JR, Stewart D. The prevention of spinal injuries in rugby football. *Paraplegia* 1994; 32 (7): 442-53.

Silver JR. Professionalism and injuries in rugby union. *Br J Sports Med* 2001; 35: 138.

Silver JR. The impact of the 21st century on rugby injuries in rugby union. *Spinal Cord* 2002; 40: 552-9.

Sinibaldi KS, Smith DR. Prevention of spinal injuries in rugby. *National Strength and Conditioning Association* 2007; 29 (4): 18-24.

Söderlund N, Schierhout G, van der Heever A. Private health care in South Africa 1998. Accessed the 13th April 2008. Available at: http://www.healthlink.org.za/SA

Spinecare Foundation and the Australian Spinal Cord Injury Units. Spinal cord injuries in Australian footballers. *ANZ J Surg* 2003; 73 (7): 493-9.

Spineline. Available at: http://www.playersfund.org.za

Stata. Available at: http://www.stata.com

Taylor TKF, Coolican MRJ. Spinal cord injuries in Australian footballers, 1960-1985. *Med J Aust* 1987; 147: 112-8.

The Spinal Injury Zone. Rugby injury research project. Accessed the 5th May 2008. Available at: http://www.thescizone.com/news/articles/899/1/Rugby-injury-research-project/1.html

Tomasin JD, Marin DF, Curl WW. Recognition and prevention of rugby injuries. *Physician Sportmed* 1989; 17 (June): 114-26.

Torg JS, Guille JT, Jaffe S. Injuries to the cervical spine in American Football players. *J. Bone Joint Surg. Am* 2002; 84: 112-22.

Upton PAH, Roux CE, Noakes TD. Inadequate pre-season preparation of schoolboy rugby players – a survey of players at 25 Cape Province high schools. *S Afri Med J* 1996; 86: 531-3.

Williams JP, McKibbin B. Cervical spine injuries in rugby union football. *BMJ* 1978; ii: 1747.

Williams JP, McKibbin B. Unstable cervical spine injuries in rugby: a 20-year review. *Injury* 1987; 32 (7): 329-32.

Wetzler MJ, Akpata T, Laughlin W, Levy AS. Occurrence of cervical spine injuries during the rugby scrum. *Am J Sports Med* 1998; 26: 177-80.

Appendices

Appendix 1

Spinal Injury Questionnaire

Name of person completing this form (if not injured person):

2. Is the injured player completing this form?

- Yes
- No

**
3. Enter the player's full name:

**
4. Enter player's date of birth: (date format yyyy/mm/dd)

5. Enter the following address details for player: Street number, Street name, Suburb, Town, City, Post Code

6. Enter the player's contact details:
Home Phone

Fax Number

Cell Number

Email Address

7. Select appropriate ethnic category for player:

- Black
- Mixed/Coloured
- White
- Asian/Indian
- Other
- Unknown

8. If 'other' was selected above, please define here:

9. Select player's gender:

- Male
- Female
- Unknown

10. Select player's highest qualification:

- Lower than Grade 10/Standard 8
- Grade 10/Standard 8
- Grade 11/Standard 9
- Matric Certificate
- Tertiary Education

- Unknown

11. Enter date of injury: (date format yyyy/mm/dd)

12. Enter time of injury:

13. Playing position at time of injury:

14. Was the injured person playing their normal position?

- Yes
- No

15. Please categorise the level/grade of play at time of injury from the following choices:

- Informal (e.g. social farming)
- School
- Club
- Provincial
- National
- International
- Unknown

16. Type of activity at time of incident:

- Training/practice
- Competition/match
- Other

17. If 'other' was selected above, please define here:

18. Teams involved in the match:
Name of player's team

Name of opposing team

19. Please indicate organisation bearing responsibility for injured person:

- South Africa Rugby Pty (Ltd)
- South Africa Rugby
- SASSU Rugby (Universities)
- SANDF
- Provincial Union
- Club
- School (USSASA)
- Other
- Unknown

20. Select provincial union:

Please select...

21. If 'Other provincial union' was selected for Question 20, name of Provincial Union

22. If 'other' was selected for Question 19, name of the responsible organisation:

23. Enter player's age at time of injury:

24. Enter player's weight at time of injury:

25. Enter player's height at time of injury (cm):

26. Has the injured person had a previous injury of the same type at the same site?

- Yes
- No

27. Was the previous injury caused by:

- Overuse
- Trauma
- Unknown

28. Medical personnel from whom treatment, if any, was sought for previous injury (i.e. treating person):

- None
- Specialist (e.g. neurosurgeon)
- Doctor
- Pharmacist
- Physiotherapist
- Other

29. Was the injured person insured?

- Yes
- No

30. Name of medical aid/insurance:

31. Please enter length of time playing rugby:

- First-time player
- Less than 1 Year
- 1-2 Years
- 2-5 Years
- 5-10 Years
- 10-30 Years
- Unknown

32. Number of conditioning sessions per week (pre-season):

33. Number of conditioning sessions per week (in-season):

34. In which aspects of training was coaching received:

- Strength/resistance training

- [ ] Fitness/cardiovascular training
- [ ] Recovery (cool-down, stretching, injury management-R.I.C.E.D.)
- [ ] Theoretical (laws of game, playing charter, positional requirements)
- [ ] Other
- [ ] Unknown

35. If 'other' was selected above, please define here:

36. Please indicate the type of physical conditioning:

- [ ] Neck strengthening
- [ ] Upper body strengthening
- [ ] Lower body strengthening
- [ ] Core/trunk strengthening
- [ ] Other
- [ ] Unknown

37. If 'other' was selected, please define here:

38. Please indicate the type of warm-up, cool-down & stretch:

- [ ] Aerobic exercises
- [ ] Static stretches
- [ ] Dynamic stretches (position-specific)
- [ ] Recovery (nutrition, hydration, R.I.C.E.D.)
- [ ] Other
- [ ] Unknown

39. If 'other' was selected, please define here:

40. In which phase(s) of play was coaching received on proper/'safe' techniques?

- [ ] Tackling
- [ ] Being tackled
- [ ] Maul
- [ ] Ruck
- [ ] Scrum
- [ ] Lineout

41. Where did the incident occur?
Ground/playing fields

Town/city

Post code

42. Please describe what happened, including playing situation, player & opponent behaviour?

43. What factors may have contributed to the incident? (e.g. playing surface, equipment, foul play, etc.)

44. Please indicate the condition of the field at time of incident:

- [ ] Grass
- [ ] Sand
- [ ] Gravel
- [ ] Muddy
- [ ] Other
- [ ] Unknown

45. If 'other' was selected above, please define here:

46. Please indicate the weather conditions at the time of incident:

- [ ] Hot
- [ ] Cold
- [ ] Dry
- [ ] Windy
- [ ] Wet (drizzle/rain)
- [ ] Other
- [ ] Unknown

47. If 'other' was selected above, please define here:

48. In which stage of match/practice did the incident occur?

- ( ) 1st Quarter (0-20 minutes)
- ( ) 2nd Quarter (21-40+ minutes)
- ( ) 3rd Quarter (41-60 minutes)
- ( ) 4th Quarter (61-80+ minutes)

49. In which stage of season did the incident occur?

- ( ) Off-season (November-January)
- ( ) Pre-season (February-March)
- ( ) In-season (April-August)
- ( ) Transition (September-October)

50. In which phase of play did the incident occur?

- ( ) Tackling
- ( ) Being tackled
- ( ) Maul

- Ruck
- Scrum
- Lineout
- Collision
- Running during play (non-contact with other player)

51. Was protective equipment worn at time of incident?

- Yes
- No

52. If 'yes' was selected, what type: (e.g. brace, taping, padding, headgear, mouthguard, etc.)

53. Name of referee, if any, responsible for enforcement of laws of the game:

54. Was a union-appointed/accredited referee controlling the game?

- Yes
- No
- Unknown

55. If 'no' was selected, who was controlling the game: (e.g. player, school teacher, spectator, etc.)

56. Did the referee indicate the action leading to the incident was a violation of the laws?

- Yes
- No
- Unknown

57. Did the referee indicate the action leading to the incident was dangerous play (Law 10.4)?

- Yes
- No
- Unknown

58. Please describe the immediate action(s) taken following incident:

59. Please indicate the level of consciousness immediately after incident:

- Alert
- Responsive to voice
- Responsive to pain
- Unresponsive
- Unknown

60. Please indicate the breathing rate per minute immediately after incident:

61. Please indicate the breathing pattern immediately after incident:

- Normal
- Shallow
- Slow

- [ ] Irregular
- [ ] Rapid (hyperventilation)
- [ ] Other
- [ ] Unknown

62. If 'other' was selected above, please define here:

63. Please indicate the neurological deficit(s), if any, immediately after incident:

- ( ) Plegia (complete paralysis)
- ( ) Paresis (motor weakness only)
- ( ) Paresthesia (sensory changes only)
- ( ) None
- ( ) Unknown

64. Please indicate the length of time there were neurological deficits:

- ( ) Grade I (less than 15 minutes)
- ( ) Grade II (more than15 minutes but less than 24 hours)
- ( ) Grade III (more than 24 hours)

65. Please indicate the distribution of deficit(s), immediately after incident:

- ( ) Quad (all four extremities)
- ( ) Para (both upper or lower extremities)
- ( ) Mono (one extremity only)
- ( ) Hemi (upper and lower extremity on same side)
- ( ) Unknown

66. In which position was the injured person found immediately after incident?

- ( ) Prone (face down)
- ( ) Supine (face up)
- ( ) Lying on their side
- ( ) Other
- ( ) Unknown

67. If 'other' was selected above, please define here:

68. Is there video footage of the match?

- ( ) Yes
- ( ) No

69. Was the incident reported using Spineline?

- ( ) Yes
- ( ) No

70. Was it arranged that a doctor or medical personnel be at the match?

- ( ) Yes
- ( ) No

71. Please enter on-field treatment provider(s):

- [ ] Doctor
- [ ] Paramedic
- [ ] Red Cross

- [ ] St Johns
- [ ] Rugby medic
- [ ] Team official
- [ ] Referee/match official only
- [ ] Other
- [ ] Unknown

72. If 'other' was selected above, please define here:

73. Please enter on-field treatment provider's highest qualification:

- [ ] Doctor
- [ ] Paramedic
- [ ] BAA (Basic Ambulance Assistant)
- [ ] AEA (Ambulance Emergency Assistant)
- [ ] Certified first-aid officer
- [ ] Rugby medic course (Level 1-3)
- [ ] Other
- [ ] Unknown

74. If 'other' was selected above, please define here:

75. Please enter the number of individuals applying on-field treatment, including unqualified bystanders:

76. Outline the initial treatment, if any, that the injured person received on the field:

- [ ] None given - referred elsewhere
- [ ] First-aid
- [ ] CPR
- [ ] Spinal immobilisation/alignment

77. Sub-category of the initial treatment, if any, that the injured person received on the field:

- [ ] Logroll
- [ ] Spine board
- [ ] Cervical collar
- [ ] Head blocks
- [ ] Spider harness
- [ ] KED (Kendricks extraction device)
- [ ] Scoop
- [ ] Other
- [ ] Unknown

78. If 'other' was selected above, please define here:

79. How was the injured person taken to hospital:

- ( ) By private vehicle
- ( ) By public transport
- ( ) By ambulance

- ○ By helicopter
- ○ Other

80. If 'other' was selected above, please define here:

81. Which hospital was the injured person taken to:
Name

Town/city

Post code

82. Please select from the following choices the type of hospital/ward:
- ○ Private
- ○ Public

83. Select the level of hospital/ward:
- ☐ Medical centre
- ☐ District hospital
- ☐ Regional hospital
- ☐ Tertiary hospital
- ☐ Intensive care unit
- ☐ Spinal injury unit
- ☐ Other
- ☐ Unknown

84. If 'other' was selected above, please define here:

85. Outline the initial treatment, if any, that the injured person received in hospital/emergency department:
- ☐ Open reduction (surgery)
- ☐ Closed reduction (halo-vest/traction)
- ☐ Surgical stabilization (screws/rods/hooks/cages)
- ☐ External stabilization (collar/brace)
- ☐ Intravenous administration of corticosteroids
- ☐ Other
- ☐ Unknown

86. If 'other' was selected above, please define here:

87. Please indicate whether any of the following medical personnel provided acute treatment:
- ☐ Professional nurse
- ☐ Specialist (e.g. neurosurgeon)
- ☐ Doctor
- ☐ Pharmacist
- ☐ Physiotherapist
- ☐ Other

88. Name of medical personnel responsible for implementing/monitoring acute treatment:

89. Contact details for above:

90. Please select total waiting time from time of injury until acute treatment:

- Less than 1 hour
- 1-2 hours
- 2-4 hours
- 4-6 hours
- More than 6 hours
- Unknown

91. Please enter nature of injury, as confirmed by medical personnel/diagnosis:

- Stable spinal injury
- Unstable spinal injury

92. Please enter site of injury, including anatomical location/spinal level:

93. Pathology/type of injury:

- Fracture (wedge, burst, compression)
- Dislocation (unilateral, bilateral)
- Fracture with dislocation
- Disc injury
- Acquired cervical stenosis
- Spinal shock (cord concussion)
- Sprain (soft tissue)
- Strain (soft tissue)
- Other
- Unknown

94. If 'other' was selected above, please define here:

95. Mechanism of injury (i.e. biomechanical description/what went wrong):

- Flexion
- Hyperflexion
- Hyperflexion with compression
- Hyperextension
- Axial compression/loading
- Hyperextension/hyperflexion combination
- Other
- Unknown

96. If 'other' was selected above, please define here:

97. Outline the follow-up treatment/procedure, if any, the injured player received from the following choices:

- Open reduction (surgery)

- [ ] Closed reduction (halo-vest/traction)
- [ ] Surgical stabilization (screws/rods/hooks/cages)
- [ ] External stabilization (collar/brace)
- [ ] Intravenous administration of corticosteroids
- [ ] Other
- [ ] Unknown

98. If 'other' was selected above, please define here:

99. Please enter the total days hospitalised for acute treatment and rehabilitation:

100. What was the effect of the incident on the injured person? (Please select ASIA Impairment Scale Grade):

- ( ) A = Complete paralysis
- ( ) B = Incomplete (motor loss only)
- ( ) C = Incomplete (sensory loss only)
- ( ) D = Incomplete (more than 3 for muscle grading)
- ( ) E = Normal
- ( ) Deceased

101. Outcome measure/level of severity after 12 months:

- ( ) Transient neurological deficit(s)
- ( ) Persisting (more than 12 months) severe functional disability

102. Place of discharge:

- ( ) Private residence
- ( ) Hospital
- ( ) Nursing home
- ( ) Assisted living residence
- ( ) Group living situation
- ( ) Correctional institution
- ( ) Homeless
- ( ) Deceased
- ( ) Other
- ( ) Unknown

103. If 'other' was selected above, please define here:

104. Please enter amount the injured person received in insurance payout(s) and/or financial support via other sources:

105. Date of return to full participation (if applicable): (date format yyyy/mm/dd)

106. In your view, what could be done to prevent serious rugby-related spinal injury?

Appendix 2

Participation Request

Department of Human Biology
UCT/MRC Research Unit for Exercise Science & Sports Medicine
Faculty of Health Sciences, University of Cape Town
Private Bag, Rondebosch 7700, South Africa
Tel: + 27 21 650 4557
Fax: + 27 21 686 7530
Director: Professor T D Noakes

Dear Rugby Enthusiast/Sir/Madam/name or to whom it may concern,

Following an apparent increase in the number of catastrophic / serious injuries sustained over the past few of years, and in particular this year, concern was raised by the Chris Burger / Petro Jackson Players' Fund as well as other rugby stakeholders involved in the prevention of injuries, that this situation must be addressed as a matter of urgency.

An "Injury Prevention Indaba" was held in August 2006, and a number of key areas were looked at with the purpose of making the game of rugby safer. One of the identified needs was the establishment of an accurate ***spinal cord injury (SCI) database*** and in order to achieve this, a grant for a "Scientific Medical Research" position was approved.

Therefore, as the successful candidate for this position, which falls under the direction of Professor Tim Noakes of the UCT/MRC Research Unit for Exercise Science and Sports Medicine, I appeal to all involved in the game of rugby, from provincial unions to clubs, schools, coaches, referees, health facilities and medical personnel to participate in this much needed and valuable research project, by assisting me to collect information, in particular, I require contact details of players with past or pre-existing spinal cord injuries sustained as a result of rugby.

Our experience has been that a large group of "near miss" injuries exist. This refers to players who have sustained a spinal injury which required admission to an emergency unit or hospital for either medical or surgical treatment, but which does not result in paralysis.

All existing catastrophically injured rugby players whom are already associated with and known to the Players' Fund will also be contacted and requested to participate in this study.

My contact details are as follows:
Email: nicawilson@mweb.co.za
Tel: 021 683 0090
Fax: 021 683 0093
Post: Chris Burger / Petro Jackson Fund
5 Murrayfield
Brookside
11 Lansdowne Rd
Claremont 7708
Cape Town

Many thanks in advance for your assistance.
Kind regards

Nicola Wilson
Medical Research Assistant

Appendix 3

Consent Forms

Department of Human Biology
UCT/MRC RESEARCH UNIT FOR EXERCISE SCIENCE & SPORTS MEDICINE
Faculty of Health Sciences, University of Cape Town
Private Bag, Rondebosch 7700, South Africa
Tel: + 27 21 650 4557
Fax: + 27 21 686 7530
Director: Professor T D Noakes

'An inventory of rugby-related spinal cord injuries in South Africa'

Participant consent form

The purpose of this study is to establish a database of rugby related spinal cord injuries that have occurred since 1980 in order to provide information that may lead to improved prevention, treatment and rehabilitation of spinal cord injuries among rugby players at all levels.

In order to establish this database, the research team requires your consent (and the consent of your parent / guardian if you are under the age of 21) to access medical records pertaining to your rugby-related spinal cord injury. Your name will not be included in the data gathered and you will therefore remain anonymous.

Your participation in this study is voluntary, and your cooperation would be greatly appreciated. Should you have any further queries regarding this study, please contact Dr. Cathi Draper: cdraper@sports.uct.ac.za / (021) 650 4567.

Please could you indicate your willingness to participate by signing below.

I _____ hereby give consent for medical records pertaining to my rugby-related spinal cord injury to be made available to the research team involved in the above mentioned study (Prof. Tim Noakes, Dr. Cathi Draper, Ms. Nicola Wilson).

_____ _____
Signature of participant Date

_____
Signature of witness should participant be unable to sign due to injury.

_____ _____
Signature of parent / guardian Date
(if participant is under the age of 21)

Department of Human Biology
UCT/MRC Research Unit for Exercise Science & Sports Medicine
Faculty of Health Sciences, University of Cape Town
Private Bag, Rondebosch 7700, South Africa
Tel: + 27 21 650 4557
Fax: + 27 21 686 7530
Director: Professor T D Noakes

"n Inventaris van rugby geassosieerde rugmurg beserings in Suid-Afrika'

Ingeligde toestemmings vorm

Die doel van die studie is om 'n databasis, van rugby geassosieerde beenmurg beserings wat sedert 1980 plaasgevind het, te skep. Hierdie inligting kan help met die verbetering van voorkoming, behandeling en rehabilitasie met betrekking tot beenmurg beserings, in rugby spellers van alle vlakke.

Om die databasis te skep, benodig die navorser jou toestemming (asook die toestemming van jou ouers/voog indien onder die ouderdom van 21) om toegang te verleen tot mediese afskrifte met betrekking tot jou rugby geassosieerde beenmurg besering. Anoniemitiet word verseker deur die uitsluiting van name tydens data insameling.

Deelname in die studie is vrywillig en samewerking word grootliks waardeer. Vir enige navrae in verband met die studie kontak Dr. Cathi Draper: cdraper@sports.uct.ac.za / (021) 650 4567.

Dui asseblief jou verywillige deelname aan deur onderaan te teken.

Ek, _____, gee hiermee toestemming vir die blootstelling van my mediese afskrifte met betrekking tot ruby geassosieerde beenmurg beserings aan die navorser vir gebruik in bogenoemde studie (Prof. Tim Noakes, Dr. Cathi Draper, Ms. Nicola Wilson).

_____ _____
Handtekening van deelnemer Datum

_____
Handtekening van getuie (indien deelnemer nie kan teken a.g.v besering)

_____ _____
Handtekening van ouer/voog Datum
(indien deelnemer onder die ouderdom van 21)

Appendix 4

Ethics Approval

UNIVERSITY OF CAPE TOWN

Health Sciences Faculty
Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925
Telephone [illegible] • Facsimile [illegible]
[illegible]

16 October 2006

REC REF: 390/2006

Prof TD Noakes
Human Biology
Sports Science Medicine

Dear Prof Noakes

PROJECT TITLE: AN INVENTORY OF RUGBY-RELATED SPINAL CORD INJURIES IN SOUTH AFRICA.

Thank you for submitting your study to the Research Ethics Committee for review

I have pleasure in informing you that the **Ethics** committee has **formally** approved the above mentioned study. However, when making telephonic contact with potential participants (ie injured players), please will [illegible] warn participants that completing the Injury Questionnaire may raise unpleasant and painful memories as they answer questions about the actual incident. It may be well [illegible] a final section to the Questionnaire which provides an opportunity for participants to indicate if they need further assistance (eg counselling) related to their injuries.

A few minor typos:

- **Appendix A**: Q? were (not where) you injured?
- Q.30 should it have a 'Don't know' option rather than [illegible]
- Q[illegible] Please [illegible]
- **Appendix B**. Health (not healthy) [illegible]

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312

Please quote the REC. REF in all your correspondence.

Yours sincerely

PROF. M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS