

EPIDEMIOLOGY AND PREVENTION OF RUGBY INJURIES
AMONGST SCHOOLBOY, SENIOR CLUB AND PROVINCIAL RUGBY
PLAYERS IN THE WESTERN CAPE

Thesis submitted for the degree of Master of Science (Medical)

by

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DEDICATION

For my parents

still married and madly in love

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DECLARATION

I, Patrick Anthony Howard Upton, do hereby declare that the above thesis is my own unaided work, both in concept and execution, and that apart from the normal guidance from my supervisor, I have received no assistance.

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ABSTRACT

This thesis comprises a series of independent investigations examining rugby injuries occurring to players from under 14 to senior provincial level in the Cape Province now the Western Cape). The first two studies report data aimed at gaining a more detailed understanding of rugby injuries in specific populations or under specific conditions, whilst the remainder of the thesis reports injury data from both a retrospective and a prospective epidemiological survey involving the same 3990 boys from 25 high schools.

Following publication of data showing a progressive rise in the number of spinal cord injuries in the Western Cape, coupled with a sustained media attack on the attitudes of the (then) South African Rugby Board, certain experimental law changes were introduced to South African schoolboy rugby in 1990 and 1991. The purpose of the law changes was either to make the game safer or to make it more open and flowing, or both. Accordingly, the studies described in chapters 4 -8 set out to analyse the effects of these law changes on the incidence and nature of rugby injuries. This was accomplished by comparing data with a similar study conducted in 1983 and 1984 in the same 25 schools (Roux, 1992).

The study reported in chapter 2 determined whether the use of neoprene (thermal) pants might reduce the risk of hamstring injury amongst 60 senior club rugby players, all of whom had previously sustained a hamstring muscle tear. The rationale was that the few seasons prior to this 1992 study had been characterised by an increasing use by rugby players of thermal or neoprene pants; a practice which seemed to have evolved spontaneously and without any scientific assessment of its value. We concluded that the wearing of thermal pants can reduce the risk of hamstring injury during rugby. However, other risk factors for injury are probably more important. These include levels of pre-season physical fitness, correct warm up and stretching procedures before activity and adequate rehabilitation before returning to activity following injury.

The objective of the study reported in chapter 3 was to determine the influence of pre-season strength and endurance training on risk of injury in rugby players from two South African provincial teams during the 1992 rugby season. Players from one province followed a supervised scientifically-designed physical training programme, while those from the other did not follow a structured programme. The findings of the study, the first study to prove the relationship between pre-season preparation and early season injury, showed that inadequate pre-season endurance training is a major contributor to the high injury rate at the beginning of the season amongst provincial rugby players. Further, strength and endurance training are interrelated as risk factors. Thus, compared to players with adequate strength and endurance training, those with adequate strength training and insufficient endurance training are at greatest risk of injury, followed by players with insufficient strength and endurance training. It was also shown that contact practices 2 days after inter-provincial match contributed more to an increased number of injuries than to success; that “niggling” injuries may develop into more serious injury if players attempt to “play through” them; and that the lack of structured treatment and rehabilitation of an injury places players at risk of being re-injured.

Chapter 5 reports retrospective data from 3330 players from the 25 Cape Province high schools. Prior to the first full contact match of the 1991 rugby season, players completed a detailed questionnaire which sought to establish their previous rugby injury experiences as well as their knowledge and use of injury prevention techniques. The principal conclusions of this study were that the players' knowledge of techniques known to prevent rugby injuries was inadequate; that at the start of the rugby season insufficient attention was paid to neck strengthening exercises, to the teaching of correct tackling and falling techniques, to the wearing of gumguards, and to physical and skill training. The result was that coaching errors may have predisposed some of these players to injury. We also found that not all parents, and particularly not all mothers, encouraged their sons to play rugby; and that the incidence and nature of the injuries reported retrospectively were similar to those reported in prospective studies at the same schools.

The objective of the data reported in chapter 6 was to evaluate the effects of the law changes on the overall injury incidence and the incidence at each playing position, while the more general aims were to describe the incidence of injury during match play and practices, at different age-groups and levels of play, and during the different periods of the season. Also investigated was the availability of first-aid in the advent of match injuries. The overall impression was that the law changes did not produce any significant decrease in the incidences of injury amongst schoolboy rugby players, but that they possibly did contribute to a change in injury patterns.

Accordingly, the specific aim of the study reported in chapter 7 was to investigate the effect on injury patterns during particularly the loose scrum, scrum, the tackling phases and due to foul play. The more general aims were to describe, for each phase of play during which injuries occurred, the nature and specific diagnosis of injuries, the distribution at each age-group, level of play, position and the anatomical site. The principle finding was that, apart from loose scrum injuries, the law changes did not produce any significant decrease in the incidence of injury during the various phases of play, but they did in fact contribute to a change in injury patterns. These changes were characterised by an increase in the proportion of tackle injuries to all players, in the number of loose scrums per match, and in the number of injuries to flyhalves whilst being tackled, a decrease in the overall risk of injury to eighthmen and in the number of tackling injuries to scrumhalves. Further findings were that the law which penalised a player for playing the ball immediately after being grounded in a tackle, had the advantage of promoting open and flowing rugby, but the disadvantage of predisposing the tackled player to injury. The sequential scrum engagement law did not decrease the overall incidence of injury to forwards during scrums, but did contribute to an increased risk of scrum injuries to hookers in general, and amongst less experienced front-row forwards in specific. Finally, the slightly different questionnaires used in the two studies precluded true evaluation of the effect on injury of the amendment to the foul play law.

Chapter 8 is epidemiological in nature and did not consider the law changes evaluated in chapters 3 and 4. The aims of this chapter were to analyse for schoolboy rugby injuries, the specific diagnosis, the anatomical site, the distribution at each age-group, level of play, playing position, and phase of play, as well as the rate of recurrence, the number of days off rugby as a direct result of the injury and the administration of medical treatment. This chapter presents possibly the most comprehensive epidemiological portrait of schoolboy rugby injuries yet published. Principle findings were that the danger of rugby players sustaining residual (potentially serious) brain damage from concussion injuries is exacerbated by the recurrent nature of concussion injuries, the assumption that several of these injuries may pass undiagnosed, and the fact that the majority of players do not follow recommendations by medical and rugby authorities that 3 weeks rest from participation should follow a concussion injury. One of the major factors predisposing a player to particularly concussion, muscle and ligament injuries, is having previously sustained a similar injury. Younger (under-14 to under-16) players are at greater risk of sustaining a fracture injury than older (under-19) players. Finally, non-standardisation of research methods and procedures in the various rugby injury studies severely hampers comparative analysis of the effect on injury of variables such as age, level of play, weather and ground conditions.

The objective of chapter 9 was to assess the potential financial costs of injuries to schoolboys, and to extrapolate this for all registered rugby players in South Africa. Although these data may be inaccurate as a result of averaging and extrapolation, it was shown that the cost of rugby injury to the 303 551 registered South African rugby players in 1999 is estimated at R126 633 344. Furthermore, several schoolboys from the schools surveyed in the present study had inadequate medical insurance, and that often placed parents/ guardians at risk of severe financial burden in the advent of rugby injury.

In conclusion, chapters 2, 3 and 5 identified, in 3 different rugby playing populations, certain specific factors which contributed to an increased risk of rugby injury. These included, a lack of knowledge of rugby injury prevention techniques, inadequate pre-season preparation, coaching errors and inadequate treatment and rehabilitation following an initial injury.

The findings described in chapters 6, 7 and 8 of this thesis suggested that the law changes introduced to schoolboy rugby in 1990 and 1991 did not succeed in the objective to decrease the risk of injury during specific phases of play. This illustrates that any future amendments to rugby laws, whatever their purpose, should be preceded by scientific evaluation of their effectiveness. The study reported in these chapters was not commissioned by the (then) South African Rugby Board, nor are we aware of any that have been commissioned by similar rugby authorities around the world.

In summary, the global aim of the studies presented in this thesis was to gain a more detailed understanding of rugby injuries in specific populations or under specific conditions. The objective of this understanding was to identify both the areas where the risk of injury may be reduced, and possible measures that may be employed to this means. Short-term measures included the education of players (and coaches) regarding techniques known to prevent injuries, the employment of safe coaching principles, correct pre-season physical preparation of players for each specific position, and following an injury, adequate rest, rehabilitation and preventative strapping/ protection. Long-term measures included standardising rugby injury research world-wide, a constant analysis of existing laws and patterns of play to identify possible solutions for high risk situations, and assessing the merits of protective clothing.

PUBLICATIONS

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CHAPTER ONE

INTRODUCTION

1.1 Rugby injury studies. A brief overview

In the early 1980's concerns that the incidence of rugby injuries, particularly serious spinal cord injuries, had been on the increase in most rugby playing countries over a period of 20 years, allied to the perception that first-aid management for injured rugby players was inadequate, precipitated the initiation of extensive research into the nature and incidence of South African schoolboy rugby injuries (Nathan *et al.*, 1983; Roux, 1992). Prior to these studies, 2 sparsely detailed reports, conducted at Loftus Versveld rugby ground in Pretoria, had been published on South African schoolboy rugby injuries (Wessels, 1980; Northern Transvaal Rugby Union, 1982). This was despite the fact that the Human Sciences Research Council (1982) identified rugby as the sport in which the second highest number of white South African schoolboys participated.

Roux (1992) also highlighted various problems associated with rugby injury surveys in any of the 104 rugby-playing countries world wide; that the majority were retrospective (Williams and McKibbin, 1978; Hoskins, 1979; Butty and Gowland, 1981; Sovio *et al.*, 1984; Kew *et al.*, 1991), they considered only specific injuries (Roy, 1975; Durkin, 1981; O'Carrol *et al.*, 1981; McCoy *et al.*, 1984; Silver, 1984; Taylor and Coolican, 1987; Scher, 1977-91), they reported only those injuries seen at one location such as a medical practice or a rugby field (Walden, 1975; Lingard *et al.*, 1976; Van Heerden, 1976; Durkin, 1977; Davidson *et al.*, 1978; Davies and Gibson, 1978; Ingles and Stewart, 1981; Briscoe, 1985), most did not distinguish minor injuries such as abrasions and bruises from major injuries (O'Connel, 1954; Weightman and Brown, 1974; Roy, 1974; Wessels, 1980; Addley and Farren, 1988), and finally that some of the survey methods may have been inaccurate or erroneous (Adams, 1977; Sparks, 1981; Dinkelman, 1983; Akpata, 1990). Thus, the understanding of the nature and cause of rugby injuries is hampered by a lack of adequately controlled prospective epidemiological surveys.

Cervical spinal injury studies in rugby players

Noakes and du Plessis (1996) identified that all the major rugby-playing countries in the world, including England (Hoskins, 1979, Silver, 1984, 1988), Wales (Williams and McKibbin, 1978, 1987), Ireland (O'Carroll *et al.*, 1981, Horan, 1984, McCoy *et al.*, 1984), Australia (Wiggelsworth, 1987, Taylor and Coolican, 1987), New Zealand (Burry and Calcinai, 1988), South Africa (Scher, 1978, 1981, 1982a, 1982b, 1983a, 1983b, 1987, 1990) Canada (Sovio *et al.*, 1984) and the United States (Akpata, 1990) reported, without exception, there had been an increase in the number of cervical spinal injuries to rugby players in all rugby-playing countries after 1976.

New Zealand introduced law changes involving the maul in 1980. The changes reduced the annual number of cervical spinal injuries from 3 per season to 1 per season between 1980 and 1986 (Burry and Calcinai, 1988). Alterations to the scrum laws in 1984 reduced cervical injuries caused by the scrum from an average of 3 per annum between 1973 and 1984, to 1 per annum from 1984 (Burry and Calcinai, 1988; Calcinai, 1992).

Various law changes at under-19 level were implemented in Australia in 1985 specifically to address the incidence of cervical spinal injuries during scrummages. For the first 8 years (1985-1992) after their introduction there was not one report of a serious spinal cord injury at that level in games played under the revised laws (Noakes and du Plessis, 1996).

As a result of these successful law changes in New Zealand and Australia, and to a lesser extent, the United Kingdom, the International Rugby Board (IRB) issued a circular in March 1988 which inter-alia emphasised the following:

1.1a The set scrum

- Only appropriately built players should be chosen in the front-row,
- front-row forwards should undergo specific upper body, neck and shoulder strength training,
- players should be made aware of the dangers of uncontrolled or violent scrum engagements, of scrum collapsing, of popping or continuing to push an unstable scrum, especially after it had collapsed,
- that the shoulders of the front-row players should not dip below their hips,
- that popping of the scrum should be outlawed as an illegal procedure,
- that the scrum should not be allowed to wheel beyond 90 degrees before the emergence of the ball,
- that the duration of the scrum be limited, and
- that in the case of a front-row forward being replaced, only a specialist front-row forward should be used as a substitute.

To reduce the impact forces of scrum engagement, it was recommended that:

- the front-rows first engage by adopting the crouch-touch-pause-engage (CTPE) technique, and
- only when the front-rows were stable should the back 5 players join the scrum.

1.1b The tackle

- Players should be coached to tackle fairly and correctly and taught how to “ride” a tackle and fall correctly,
- the dangers of the crash tackle to both tackler and player being tackled should be stressed to players, and
- in the event of a high ball, the ball should be contested by the attacking player(s), as opposed to attacking player(s) executing high speed tackles on the ball catcher.

1.1c The ruck and maul

- The danger of the player in possession of the ball posting the ball between his legs during a ruck, potentially causing his head to be caught in a flexed position between the attacking and defending players, should be stressed,
- players should be taught not to dive blindly into the loose-scrum either to collect the ball or post it, or to add weight to the scrum, and
- players should keep their heads up and thus their necks extended when entering the loose-scrum.

1.2 **Law changes in South African Schoolboy rugby**

The recommendations of the IRB were, however, not immediately adopted in South African schools rugby in the 1989 season. Perhaps as a result, the highest number of spinal cord injuries to rugby players admitted at the Spinal Cord Injuries Unit to the Conradie Hospital in any year after 1963 occurred in 1989, with the admission of 12 injured players. (Noakes and du Plessis, 1996). Following publication of data on spinal cord injuries in Western Cape schoolboys which showed a progressively rising annual trend (Kew *et al.*, 1991), coupled with a sustained media attack on the attitudes of the (then) South African Rugby Board, certain experimental law changes were finally introduced to South African schoolboy rugby from the middle of the 1990 season. Further experimental law changes were introduced into schoolboy rugby at the beginning of the 1991 season. The combined changes, enforced during the 1991 year were as follows:

1.2a Law 20 - scrummage

Law 20 (2)

The following amendments were applied to the existing law;

The scrum must to go down in 3 phases at the command of the referee,

- phase one; the 3 players in the front-row bind and go down,
- phase 2; 2 players go down to form the second row,

- phase 3: the other players taking part in the scrum go down last.

The scrum must be stationary until the ball was put in, and a minimum of 5 players of each team must take part in the scrum.

Purpose: To lessen the force in the scrum and to build up pressure gradually.

Penalty : A free kick at the place of infringement.

Law 20 (4)

Except for the eighthmen, all the players in the scrum had to remain bound until the scrum was over. The eighthman could break away from the scrum before the ball emerged.

Penalty : i) A free kick against any player, except the eighthman, who breaks up and retreats before the scrum is completed.

ii) A penalty against any player except both eighthmen, who remains stationary or moves forward after breaking up from the scrum.

Purpose : To stop players interfering with the passage of the ball.

Law 20 (6)

In 1990 the experimental law was that no player in the second row of the scrummage may bind with his hands between the legs of a player in the front-row. In 1991, the law placed no restriction on the manner in which the locks were allowed to bind on the props, whether around the hips or through the legs.

Law 20 (7)

The ball was to be put in at a scrum by the team that did not have possession of the ball, or the ball at their feet, prior to the stoppage. In case of doubt, the referee should award the scrum to the attacking team. It was noted that the team not in possession may also have been responsible for not making the ball available. Thus the team that did not make the ball available, was punished. The opponents of the team in possession would put the ball into the scrum, except if they were responsible for the non-availability of the ball.

Purpose: To encourage players to make the ball available.

Law 20 (8)

This law required amendment, as it was no longer possible to put the ball in as soon as the front-rows had engaged. The ball was to be put in as soon as the whole scrum had gone down.

Law 20 (19)

No player was allowed to deliberately prevent the ball from emerging from a scrummage.

Purpose: To get the game going again after the re-start and to shorten the duration of the scrum.

Penalty: A free kick at the place of infringement.

1.2b Law 23 - Touch and line out

Law 23 B (10)

The ball could be brought into play by a quick throw in or at a formed line-out. In either event, the player had to throw the ball

- at the place indicated,
- so that it first touched the ground or was touched by a player at least 5m from touch along the line-of-touch or over the formation formed by the inner shoulders of the players in the line-out, and
- while throwing in the ball, he was not to put either foot in the field-of-play.

It was also stipulated that players would be allowed to bind as soon as the line-out started, that is, as soon as the ball left the thrower's hands.

Purpose : To reduce the number of resulting scrums.

1.2c Law 24 - off-side

Law 24 A (2) (c)

This law states that there is no penalty for being in an off-side position unless the player on all other occasions, moves towards the opponents waiting to play the ball or towards the

place where the ball pitches, before he is put on-side. The addition to this section defined the player as off-side if he “moves towards his opponents’ dead-ball line while he is in an off-side position”.

A player was deemed to have been placed on-side if;

- the kicker passed him,
- he fell back behind the kicker,
- an opponent carrying the ball ran 5m,
- an opponent passed or kicked the ball, or
- an opponent deliberately touched the ball but did not catch it or gain control of it.

Law 24 B (2)

The player putting the ball into the scrum as well as his opponent, were not permitted to put a foot beyond the middle line of the scrum.

Purpose: To eliminate negative play by the scrumhalves.

Penalty: Penalty kick at the place of infringement.

1.2d Law 26 - foul play

Addition: For a serious offence of such nature that the referee would send the offender off the field or to the cooler, the referee would award the non-offending team a penalty kick at any place along the 22m line of their opponents (the offenders). The non-offending team had the choice of place along the 22m line. If the offence took place within the offenders’ 22m area, the non-offenders would have a choice of a penalty kick at the place of infringement or at any place along the offenders’ 22m line.

1.2e First-aid

Schools had to acquaint themselves with the minimum first aid requirements at matches, as drawn up by the South African Rugby Board’s Medical Society. If there was no first aid or first aid equipment at a match, the referee was instructed to cancel that match.

1.3 Scope of this thesis

The brief overview highlights the continuing need for prospective epidemiological rugby injury research especially in South Africa. There was also the need to determine the effects on injury of the law changes introduced into South African schoolboy rugby in 1990 and 1991. Hence, this thesis was planned to address some of these concerns. Subsequently, additional investigations were initiated with the aim of gaining a more detailed understanding of rugby injuries in specific populations or under specific conditions.

Thus this thesis consists of 3 individual studies, the first 2 (Chapters 2 and 3) are aimed at gaining a more detailed understanding of rugby injuries in specific populations or under specific conditions. These include i) the effect of thermal pants on reducing the risk of recurrent hamstring injuries in rugby players; and ii) the influence of pre-season strength and endurance training on risk of injury in rugby players from 2 South African provincial rugby teams. The third study (Chapters 4 – 9) reports injury data from both a retrospective and prospective epidemiological survey involving the same 25 high schools in the Cape Province.

1.4 Chapter Two

This study titled; “Thermal pants may reduce the risk of recurrent hamstring injuries in rugby players”, was published in the British Journal of Sports Medicine, Volume 30 in 1996.

Research has shown that hamstring muscles are the most commonly injured muscles in athletes (Safran *et al.*, 1989; Stanton and Purdam, 1989) and they can be devastating because they frequently heal slowly and often become recurrent as a result of inadequate treatment and rehabilitation (Muckle, 1982; Agre, 1985; Stanton and Purdam, 1989). The few seasons leading up to the 1991 study year were characterised by an increasing use by rugby players of thermal or neoprene pants. As this practice seemed to have evolved

spontaneously and without any scientific assessment of its value, the objective of this study was to determine whether the use of these pants might reduce the risk of hamstring injury.

1.5 Chapter three

This study entitled; “The influence of pre-season strength and endurance training on risk of injury in rugby players from two South African provincial teams”, is in the process of being submitted for publication.

Several rugby injury surveys have shown that injuries occur predominantly at the beginning of the season and again after the mid-season break (Sparks, 1981; Nathan *et al.*, 1983; Williams, 1984; Roux *et al.*, 1987; Clark *et al.*, 1990; Alsop *et al.*, in press). The most common explanation for the increased risk at these times of the season is that players are either not match-fit, not physically-fit or both (Burry, 1981; Sparks, 1981; Dalley *et al.*, 1982, 1992; Nathan *et al.*, 1983; McCoy *et al.*, 1984; Roux, 1992; Williams, 1984; Clark *et al.*, 1990; Hughes and Fricker, 1994; Garraway and Macleod, 1995).

In 1989, one South African Provincial rugby team (Natal) became the first in South Africa to employ a full-time exercise specialist (Biokineticist) to assist with the physical preparation of the team for the 1990 rugby season in South Africa. In October 1990 Natal won the Currie Cup for the first time in 100 years. After a years absence, the Biokineticist was re-appointed for the 1992 rugby season.

Thus, the adoption of a specific rugby fitness training programme by only one Currie Cup team for the 1992 South African rugby season invited the comparison of the injury risk of that team compared to the risk in another provincial team, who received no formal pre-season training and which assembled as a squad for the first time five days prior to the first provincial fixture of the season. This province had dominated South African rugby during the 1980's prior to the introduction of specific training programmes into international rugby.

The aim of that study was to investigate the influence of pre-season endurance and strength training on injury patterns amongst senior provincial rugby players from two provinces, only one of which followed a modern pre-season physical training programme.

Thus, the data presented in Chapters 2, 3 and 5 contribute to gaining a more detailed understanding of rugby injuries in specific populations or under specific conditions. The goal of this understanding of rugby injuries is ultimately to identify various methods or means of either preventing or minimising their occurrence.

1.6 **Chapter four**

This Chapter reports the methods used in the retrospective study reported in Chapter 5 and the prospective study reported in Chapters 6 – 9, both involving the same 25 high schools in the Western Cape, and both conducted in 1991.

1.7 **Chapter five**

This study entitled; “Inadequate pre-season preparation of schoolboy rugby players - a survey of players at 25 Cape Province high schools”, was published in the South African Medical Journal, Volume 86, No. 5 in May 1996. The information appearing under the heading “Anthropometric measurements” did not appear in the published version, but has been included in this Chapter.

The objective of this study was to establish high school rugby players’ previous rugby experience, their rugby injury history, the extent of their participation in pre-season strength and endurance training, gumguard possession and use, the extent of front-row substitution by non-specialist players and any subsequent injuries, knowledge of and participation in neck strengthening exercises, the amount of pre-season tackling practice, parental attitudes to schoolboy rugby, and attitudes to two specific playing situations -

falling on an outstretched arm when tackled and falling on the point of the shoulder when tackled - both of which may be associated with injury risk.

1.8 Chapters six – nine : Epidemiology and prevention of schoolboy rugby injuries

The broader aim of this study was to investigate the effect of law changes described above on the incidence and nature of the specific rugby injuries. This was accomplished by determining the difference in injury patterns between the study conducted by Roux (1992) and the present study. For this reason, the same rugby playing population was surveyed using similar research techniques. The same 26 schools were chosen, although as 1 school no longer offered rugby as a school sport in 1991, it was removed from the study. The remaining 25 schools were all monitored via correspondence. The same definition of injury was used, with the addition of the requirement that all laceration injuries that required sutures were included. This did often not keep a player out of rugby for 7 days or more and would therefore have failed to be defined as an injury according to the criteria adopted by Roux (1992) and other researchers from this unit.

1.8.1 Specific aims

The specific aims of this study were to compare the effect of the law changes on;

- (a) the overall number and incidence of injured players,
- (b) the number and incidence of scrum injuries to front-row forwards, with particular reference to neck injuries sustained by these players during scrums,
- (c) the number and incidence of injuries occurring during loose scrums, and
- (d) the incidence of foul play injuries.

1.8.2 General aims

The general aims of Chapter 6 were to determine the;

- (a) match and practice incidence of injury,
- (b) incidence of injury at the different age-groups and levels of play,

- (c) incidence of injury at the different playing positions,
- (d) incidence of injuries sustained by players who were substituting in an unfamiliar position at the time of injury,
- (e) incidence of injury during the different 4-week periods of the season,
- (f) effect on injury of the venue, match point difference between the winning and losing teams and time in the match in event of a match injury,
- (g) player's subjective assessment of whether their injury could or could not have been avoided.

The general aims of Chapter 7 were to determine for each of the phases of play, the;

- (a) age-group and playing level of the injured players,
- (b) playing position of the injured players,
- (c) whether players were in possession of the ball at the time of injury or not,
- (d) designation of injuries as a match or practice event,
- (e) player's subjective assessment of whether their injury could or could not have been avoided,
- (f) nature and anatomical site of injuries,
- (g) specific diagnosis of injuries.

Additional information was sought, the aim of which was to determine the;

- (h) speed of impact in the tackling or being tackled phases, during which an injury was sustained,
- (i) direction from which the tackler impacted with the player being tackled for injuries occurring during both tackling and being tackled,
- (j) anatomical point of impact on the player being tackled for injuries occurring during both tackling and being tackled,

The general aims of Chapter 8 were to determine for each of the types of injuries (concussions, fractures etc.), the;

- (a) specific site and diagnosis,
- (b) designation as a match or practice event,

- (c) whether or not players were in possession of the ball at the time of injury,
- (d) age-group and playing level of the injured players,
- (e) playing position of the injured players,
- (f) phase of play,
- (g) days off rugby,
- (h) administration of first-aid, and by whom,
- (i) medical professional who was consulted, where the consultation took place, if hospitalisation was required and for how many days.

1.9 Shortcomings of the study

1.9.1 Chapter two

Players who had previously sustained hamstring injuries, were able to decide for themselves whether or not they would wear thermal pants during the season.

Accordingly the study was not randomised controlled, and with the result that study groups were unequal in number. However that players were allowed to choose for themselves, meant that a far greater population were able to be monitored for the full duration of the season, sufficient to facilitate statistic analysis.

1.9.2 Chapter three

This study took advantage of a naturally occurring situation to investigate the influence of pre-season strength and endurance training on the risk of injury amongst players from 2 senior provincial teams. Players in team B were not prescribed standardised pre-season training, and were not tested for physical fitness. Whilst it is very likely that training and fitness are correlated, this relationship could however not be examined. Accordingly, pre-season strength and endurance training was assessed according to the number of those training sessions undertaken during a specified pre-season period.

Although the scatter plot of strength versus endurance training variables for the injured and uninjured players shows distinct cutpoints at 20 sessions, which accordingly was used to differentiate between adequate versus inadequate strength and endurance training, this method lacks rigorous definition.

1.9.3 Chapters 4 - 9

- (a) A shortcoming identified by Roux (1992) in his study was that the method of surveying via correspondence resulted in under-reporting of injury by as much as 40-50% of injuries. As in Roux's study, none of the coaches nor co-ordinators in the present study were paid to participate in the study. Despite telephonic contact with the master-in-charge of rugby at each of the 25 schools, initially to seek their active support and co-operation, and later to clarify any areas of uncertainty, it was postulated that under-reporting of injuries would most likely continue to be a significant problem in this study.

However, although this possible under-reporting might have resulted in a lower than actual incidence of injury being reported amongst players in the study population, the extent of the study ensured sufficient injury data were obtained to determine the nature of injuries occurring to schoolboy rugby players.

- (b) Another shortcoming identified by Roux (1992) was the possible antagonism of some rugby authorities towards academics involved in rugby injury research who were perceived to be publicity seeking (Noble, 1984) or attempting to discredit the game (Noakes, 1980). Although the present study was sanctioned and conducted in conjunction with the Cape Education Department, a body responsible for the well-being of its pupils, and the researcher played first-division rugby at a local club and coached rugby at one of the selected schools, there were certain schools and coaches who still showed a reluctance to co-operate fully with the aims and objectives of the study. Analysis of the results established that the number of injuries reported at those schools were very low and could not have reflected the

true number of injuries experienced during the season.

- (c) In order to compare results with those of Roux (1992), incidence rates of injury were reported as 1 injury per boy-hours of rugby. However, the assumptions that, i) each match lasted for a period of 1 hour, and that ii) all players practised as a team for a period of 3 hours per week during the season, were erroneous. Firstly, matches varied from 50 to 70 minutes in duration from the under-14 to under-19 age-groups, and secondly, practice hours per week would most likely have varied according to level of play (A-teams would have practised for longer periods than C- and lower teams) and the regularity of weekly matches (lower level teams, particularly in the schools which had a large number of teams per age-group, would have had fewer fixtures and accordingly would have probably practised less).

Where possible, and in alignment with more recent research, match injury rates are also reported as the number of injuries per 100 player-games, or injuries per player-seasons. However, as the number of practices per week per team was not recorded, the practice incidences reported in this study remain inexact.

- (d) The term “loose scrum” was used to combine the analysis of “ruck” and “maul” injuries. This is an error repeated from Roux’s study. The ruck and maul are two distinctly different phases of play subject to different laws.
- (e) The questionnaire sought a specific diagnosis of the injury. However, that players or players’ parents were required to complete the questionnaire, resulted in the diagnosis being reported in lay rather than in clinical terms. Accordingly, under the section “Diagnosis of injuries” (Chapter 8), more general and lay terms are presented.

- (f) Data was collected in 1992, yet was only submitted in 1999. During this lapse in time, and as a result of the nature of the game of rugby and the rule changes that are continually being made, injuries to players in the various positions, as well as the nature of the injuries may have changed. Thus, many of the findings that were reported the time of data collection may have had very little relevance in 1999.

- (g) It was not possible to measure whether every coach and/or referee implemented all the law changes, at all times.

CHAPTER TWO

THERMAL PANTS MAY REDUCE THE RISK OF RECURRENT HAMSTRING INJURIES IN RUGBY PLAYERS

2.1 INTRODUCTION

The hamstring muscles, which are biarticular muscles with a predominance of fast twitch fibres (Agre, 1989) are the most commonly injured muscles in athletes (Safran *et al.*, 1989; Stanton and Purdam, 1989). These injuries can be devastating because they frequently heal slowly and often become recurrent as a result of inadequate treatment and rehabilitation (Muckle, 1982; Agre, 1989; Stanton and Purdam, 1989). Many of these injuries are believed to be avoidable (Muckle, 1982; Safran *et al.*, 1989). Aetiological risk factors that have been identified for these injuries include inadequate warm up, incorrect stretching, inflexibility, muscle strength imbalance, fatigue, previous injury, intra-muscular corticosteroid injections, and return to activity before complete rehabilitation following injury (Muckle, 1982; Agre, 1989; Safran *et al.*, 1989; Stanton and Purdam, 1989). In addition, recent research on rabbit muscle has shown that muscle warming increases the amount of force and length of stretch necessary to tear the muscle (Safran *et al.*, 1988; Strickler *et al.*, 1990). This suggests that warming of muscles might reduce the probability that it will be injured during exercise (Shellock and Prentice, 1985).

Interestingly, recent rugby seasons have been characterised by an increasing use by rugby players of thermal or neoprene pants. The practice seems to have evolved spontaneously and without any scientific assessment of its value. Accordingly this study set out to determine whether the use of these pants might reduce the risk of hamstring injury.

2.2 METHODS

Sixty rugby players from 10 Western Cape clubs who had reported that they had missed seven days of rugby or more due to a hamstring injury during either of the previous two playing seasons, were identified as subjects. Subjects gave their informed consent to be monitored for the duration of the 1992 rugby-playing season.

Each player completed a hamstring injury questionnaire (Appendix IV) which included the following details:

- (1) Personal details; name, height, weight, date of birth; club, team playing position.
- (2) injury history; details of initial hamstring injury including when it occurred, how it occurred, to which leg, what strapping or protection was used at the time of injury, days off as a result of hamstring injury, which part of the muscle was injured, style of boots worn, similar details regarding any recurrent injuries, what protective aids are presently being used and how often during training and matches they are used,
- (3) details of warm up and stretching routines and how frequently the routine is followed.

Players were given the choice of wearing or not wearing thermal warmers during the season. The pants were made from closed cell neoprene material (1.5mm thick) with nylon laminated on both sides and had an inside leg length of 25cm. They were manufactured and supplied by Medac (Pty) Ltd. Cape Town, South Africa.

During the course of the season the following information was obtained on a weekly basis by postal questionnaires which were returned at the end of each three week cycle: (1) Did the player participate fully in all team training sessions? (2) Reasons for not participating; (3) Were thermal pants worn at training? (4) Number of matches played; (5) Reasons for not playing matches; (6) Were pants worn during matches? (7) Any comments the player felt might be relevant to the study.

At approximately six weekly intervals personal contact was made with each player to confirm the return of relevant forms and to clarify ambiguous data.

If at any stage during the season a player sustained a hamstring injury, defined as muscle strain that caused the player to be unable to run unhindered and at full speed at any time during a match or training, he was required to complete a questionnaire (Appendix V). The questionnaire obtained information on the following:

(1) Injury details; date, site of injury in muscle, which leg, whether injury occurred during a match, training or any other situation, when during practice, in which quarter during the match, how injury occurred, severity of injury which was measured in days off rugby (mild <14 days, moderate 14 - 28 days, severe strain >28 days), protective device used at time of injury, whether the player was in possession of the ball or not, condition of the playing field, weather conditions.

(2) Warming up and stretching routine followed within 2 hours before injury occurred.

(3) What medical or other treatment was given.

Three subject groups were studied: Group I, wore thermal pants on the previously injured leg during training and matches for the entire duration of the season ($n = 5$); Group II, who never wore these pants ($n = 17$); and Group III, who wore the thermal pants some of the time and other times not ($n = 22$). Time spent wearing, and time spent not wearing the pants during training or competition was determined for players in Group III.

2.2.1 Analysis of data

Comparison of survival time (playing minutes) until injury was calculated for Groups I and II. If a player sustained a hamstring injury severe enough to keep him out of rugby for 14 days or more and then suffered a second injury at exactly the same site in the same hamstring muscle within 12 days of returning to rugby, the second injury was considered an extension of the original injury and thus excluded from the initial calculations.

Data were analysed using a Quattro Pro spreadsheet (Borland International). The survival time to injury was calculated as the number of minutes played before an injury occurred in a player. The mean survival time to injury for Groups I and II was compared using BMDPIL (Dixon, *et al.*, 1985). The Kaplan-Meier survivor functions (Kaplan and Meier, 1958) were calculated using BMDPIL. The generalised Wilcoxon test (Gross and Clark, 1975) was used to compare the difference between the survival curves for the two Groups. Statistical significance was established at $P < 0.05$.

Analysis of the injury rate per 1000 hours played was calculated for Groups I and II as well as for the time spent wearing or not wearing thermal pants for the subjects in Group III. To test the hypothesis that the two rates are the same, a different test was used for each of these Groups; Poisson Rates formula on the STATSGRAPHICS package (Statistical Graphics Co.) was used for Groups I and II, and a non-parametric test, the Wilcoxon Signed rank test, was used to compare the injury rate for subjects in Group III when wearing and not wearing pants.

2.3 RESULTS

2.3.1 Subject characteristics

Forty-four of the sixty subjects completed the study (73%). Of the 16 players who did not complete the study, six stopped playing rugby early in the season for various reasons and 10 repeatedly did not return questionnaires. The mean (SD) age of was 23 (3) years. There were four tight forwards, eight loose forwards and 32 backline players. Thirty-two percent of the players had previously worn thermal pants.

2.3.2 Injuries before the 1992 season

The initial hamstring injury suffered before the 1992 season kept the players off rugby for an average of 23 (30) days. All these injuries resulted from playing or training for rugby. Eighteen of the 44 players who completed the study suffered recurrent injuries: two players were injured a further five times, six players twice and ten players once.

2.3.3 Wearing of thermal pants over the season

Table 2.1 shows the total playing time (hours) completed by 44 subjects, the hours played while wearing thermal pants, the total hours missed as the result of any injury, and the hours missed specifically due to hamstring injury. Thermal pants were worn for nearly half the time spent in practice (48%) or in match play (49%). Injuries caused players to miss 39% of the scheduled match hours; 85% of this lost time was due to hamstring injuries. Similarly players missed 42% of the scheduled practice hours, 83% as a result of hamstring injuries.

Table 2.1 Total playing time (hours) completed by the 44 subjects, hours played while wearing warmers, total hours missed, and hours missed due to hamstring injury.

	TOTAL HOURS COMPLETED	COMPLETED WEARING THERMAL WARMERS	HOURS MISSED	MISSED DUE TO HAMSTRING INJURY
Matches	504	246	328	275
Practices	1391	670	1008	832

2.3.4 Injury rates

Table 2.2 shows the overall time played, number of injuries, and injury rates for players in the Groups I, II and III. Five players wore thermal pants for the entire season (Group I) and 17 never wore pants (Group II). The respective injury rates were 24 and 32 injuries per 1000 playing hours which were not significantly different ($P = 0.63$).

Table 2.2 Overall time playing, number of injuries and early recurrent injuries, and injury rates per thousand hours of play for players in Groups I, II and III

	GROUP I	GROUP II	GROUP III	
			wearing	not wearing
TOTAL PLAYERS	5	17	22	22
TOTAL PLAYING TIME (hours)	246	680	654	315
TOTAL INJURIES SUSTAINED	8	24	10	18
EARLY RECURRENT INJURIES*	2	2	8	0
INJURY RATE/ 1000 hours PLAY	24#	32	3**	57

* Not considered in calculation of injury rate

Not significant ($p=0.63$)

** Significant ($p<0.05$)

In Group III, thermal pants were worn for 60% of the playing hours, while no protection was worn for the remainder. The injury rate of 3 injuries per 1000 hours for the Group wearing thermal pants was significantly less ($P < 0.05$) than the 57 injuries per 1000 playing hours for the non-users. If the eight early recurrent injuries (within 12 days of return) are included in the wearer Group, the rate rises to 16 injuries per 1000 hours which

is still significantly less ($P < 0.05$) than the incidence in the Group who wore no protection.

2.3.5 Survival times to injury - Groups I and II

The survival curves for Groups I and II are shown in Figure 2.1. The mean (SE) survival time without injury for players in Group I was 35.2 (7.8) hours, and for players in Group II was 24.8 (3) hours; these values were not significantly different ($P = 0.23$). But at the end of the study, 2 of the five players in Group I were still not injured after 58.5 hours, whereas all 17 players in Group II had been injured after 62.0 hours.

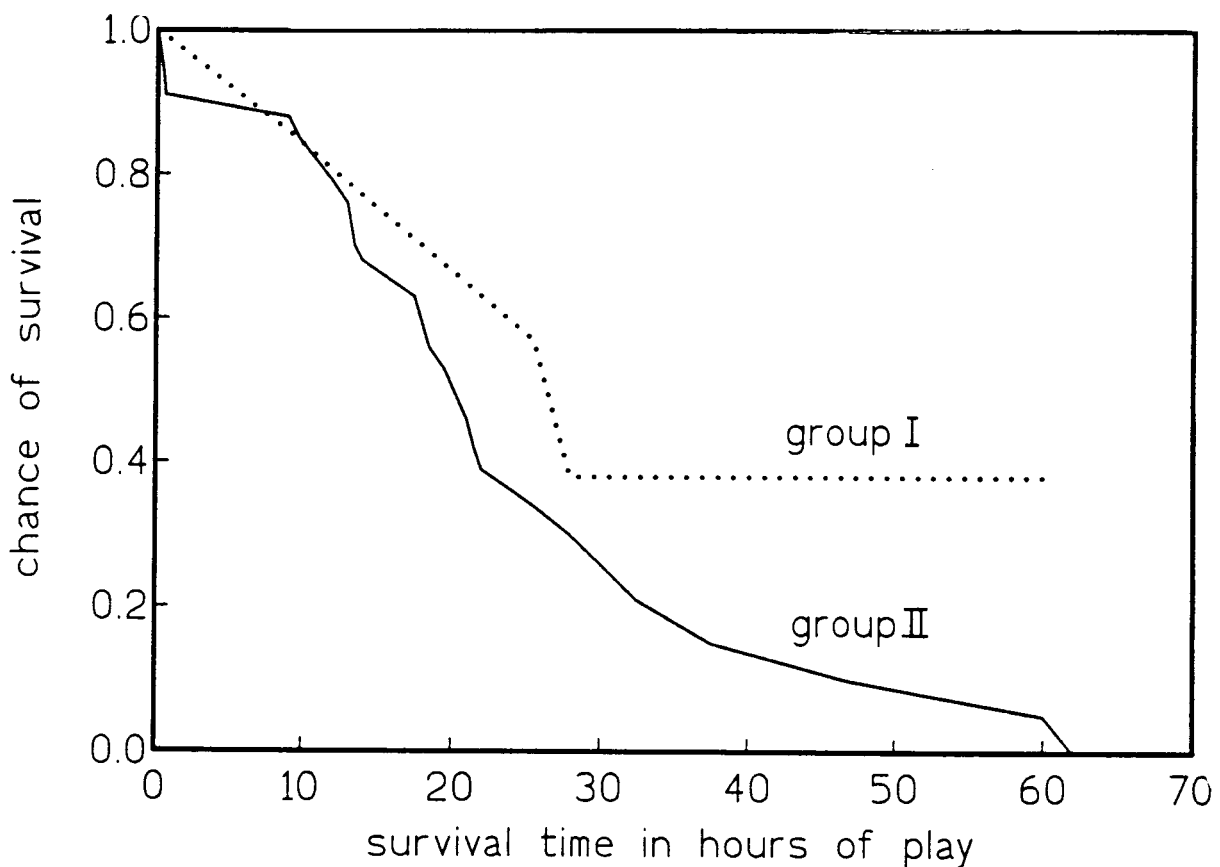


Figure 2.1 Cumulative proportion survival curves of Group I compared with Group II. Note that the chance of survival remains greater for Group I although there is no significant difference between the medians.

2.3.6 Details on injuries sustained during the season

Of the 60 hamstring injuries suffered by these players, 40% occurred during two three week periods, at the start of the season and after the mid-season break; 42% recurred at exactly the same site as the previous injury; 90% were moderate or major tears; 55% occurred during practices and 45% during matches. Seventy-eight percent of hamstring injuries suffered during match play occurred in the second half of the game.

2.4 DISCUSSION

The main finding of this study was that the hamstring injury rate among players in Group III was significantly lower when they wore the thermal pants than when they did not. This is especially interesting because of the possibility that players who believe that the use of these pants reduces the risk of injury would be more likely to wear them when they believed injury to be more likely.

Although no significant difference between injury rates was found between players who wore thermal pants at all times and those who never wore them, the former Group consisted of only five players. The small sample size may have prevented a statistically significant finding. Furthermore the survival curves suggest that the Group who wore thermal pants all the time had a longer injury-free period. Hence this study provides preliminary evidence which suggests that thermal pants might have a role in preventing recurrent hamstring injuries.

Other relevant findings were that 18% of the hamstring injuries in this study recurred at exactly the same site in the muscle and within 12 days of the player returning to rugby after the initial injury. This confirms the finding that many acute hamstring injuries become recurrent as a result of inadequate treatment or rehabilitation, with the athlete returning to active participation before full recovery has occurred (Agre, 1985; Safran *et al.*, 1989)

The high incidence of hamstring injury in the first three weeks of the season and the first three weeks after the mid-season break supports the findings of Roux *et al.* (1987) who proposed that the reason was lack of “match fitness”. Stanton and Purdam (1989) have suggested that many injuries occur because of “poor conditioning” at the beginning of a competitive season.

The importance of preventing hamstring injuries is shown by the findings that over 80% of match and practice time lost by the injured players in this study was a direct result of their hamstring injuries. Muckle (1982) also found that the amount of playing time lost as a result of hamstring injuries was disproportionately high when compared to the overall incidence of this injury.

In summary, this study showed that the wearing of thermal pants can reduce the risk of hamstring injury during rugby. However, other risk factors for injury are probably more important. These include levels of pre-season physical fitness, correct warm up and stretching procedures before activity and adequate rehabilitation before returning to activity following injury.

CHAPTER THREE

THE INFLUENCE OF PRE-SEASON STRENGTH AND ENDURANCE TRAINING ON RISK OF INJURY IN RUGBY PLAYERS FROM TWO SOUTH AFRICAN PROVINCIAL TEAMS.

3.1 ABSTRACT

Objective - To determine the influence of pre-season strength and endurance training on risk of injury in rugby players from two South African provincial teams during the 1992 rugby season. Methods - Players from team A followed a supervised scientifically-designed physical training programme, while those from team B did not follow a structured programme. Individual player's pre-season training programmes were collected retrospectively for strength and endurance training components. Injuries that kept players from playing rugby for seven days or more, with the inclusion of all fracture and laceration injuries regardless of whether or not the injury kept players out of rugby, were prospectively analysed via questionnaire and in liaison with the team medical doctor. Data were statistically analysed to determine the effect of pre-season strength and endurance training on risk of first, second and multiple injuries. Results - Twenty-four of the combined total of 89 players sustained a total of 38 injuries. Match play accounted for 58% of injuries and full-contact practice for 29%. Five injuries were sustained by four of the 37 players in the better prepared team A which played 21 matches. Thirty-three injuries were sustained by 20 of the 52 players in team B that played 20 matches. Team A had a match injury rate of 1.3 injuries per 100 player-games, compared to 4.7 per 100 player-games in team B. The scatter plot of strength versus endurance training for injured and uninjured players demonstrated cut-points at 20 sessions. The multiple injury analysis shows that players with adequate pre-season strength training and inadequate endurance training were 14.4 times more likely to be injured than those with both adequate strength and endurance training. Players with both inadequate strength and endurance training were 6.3 times, and players with adequate endurance and inadequate strength training, 6.1 times more likely to be injured than players with both adequate strength and endurance training.

Full-contact match practice two days after a match contributed to increased number of injuries, which had a negative influence on performance. Inadequate management and rehabilitation of injuries further contributed to the high number of injuries in team B. Of the 38 injuries, 58% occurred in the first quarter of the season, 61% were sustained by forwards, 16% occurred during both open play and when being tackled and 13% each during tackling, loose scrums, punching and physical fitness training. 44% occurred to the upper limb. Muscles and ligaments were most commonly injured (24% each) followed by other injuries (21%) and fractures (18%). Players missed an average of 28.5 (SD=22) days of rugby due to their injuries; one player would never return to participation. Conclusions - The type of pre-season training predicted injury risk, with endurance and strength training being interrelated as risk factors. Compared to those with adequate strength and endurance training, players with adequate strength training and insufficient endurance training are at greatest risk of injury, followed by players with insufficient strength and endurance training. In conclusion, this is the first study to provide strong evidence of a relationship between pre-season preparation and early season injury. It establishes that inadequate pre-season endurance training is a major contributor to the high injury rate at the beginning of the season amongst provincial rugby players.

Key terms : Rugby football injuries; provincial players; strength training; endurance training

3.2 INTRODUCTION

Several rugby injury surveys have shown that injuries occur predominantly at the beginning of the season and again after the mid-season break (Sparks, 1981; Nathan *et al.*, 1983; Williams, 1984; Roux *et al.*, 1987; Clark *et al.*, 1990; Alsop *et al.*, in press). A few studies have however shown a steady rate of injury throughout the season with no notable increase at the beginning of the season (Roy, 1974; Williams, 1984). The most common explanation for the increased injury risk at the start of the season is that players are either not match-fit, nor physically-fit or a combination of both (Burry, 1981; Sparks, 1981; Dalley *et al.*, 1982, 1992; Nathan *et al.*, 1983; Williams, 1984; McCoy *et al.*, 1984; Clark *et al.*, 1990; Roux, 1992; Hughes and Fricker, 1994; Garraway and Macleod, 1995).

Further, anecdotal evidence suggests that the winning teams in both the 1987 and 1991 Rugby World Cups owed at least some of their success to the superior fitness resulting from the adoption of superior fitness training programmes (Noakes and du Plessis, 1996; Dwyer, 1992). Indeed it is not usually recognised how recently fitness training has become a feature of modern rugby. It appears that the New Zealand All Blacks were the first to institute specific training for rugby players in the months leading up to the 1987 Rugby World Cup (Noakes and du Plessis, 1996). This innovation was further refined by the winning 1991 Australian Rugby World Cup team under the coaching of Bob Dwyer (Dwyer, 1992).

As a result of international sporting isolation, these international trends were adopted by South African rugby teams at different times and to different extents after 1987. In 1989, one South African Provincial rugby team (Natal) became the first in South Africa to employ a full-time exercise specialist (Biokineticist) to assist with the physical preparation of the team for the 1990 rugby season in South Africa. In October 1990 Natal won the Currie Cup for the first time in 100 years.

The adoption of a specific rugby fitness training programme by only one Currie Cup team for the 1992 South African rugby season invited the comparison of the injury risk of that

team compared to the risk in another provincial team (Western Province), who received no formal pre-season training and which assembled as a squad for the first time five days prior to the first provincial fixture of the season. This province had dominated South African rugby during the 1980's prior to the introduction of specific training programmes into international rugby.

It was hypothesised that players who underwent the least rigorous pre-season training would be at greatest risk of injury.

Thus the aim of this study was to investigate the influence of pre-season endurance and strength training on injury patterns amongst senior provincial rugby players from two provinces, only one of which followed a modern pre-season physical training programme.

3.3 MATERIALS AND METHODS

Permission to conduct the study was obtained from the respective coaches and administrators of both Provincial teams. In team A, training data were supplied by the Biokineticist. In team B, training data were collected via a pre-season training questionnaire and by personal communication with the players by the investigator. The questionnaire sought answers to the following questions:

- (i) personal data; name, club, position, age, height, mass in January, mass in mid-March,
- (ii) general; date of commencement of pre-season training, details on fitness testing, training advice, programme prescription and advice sought, and
- (iii) specific training details regarding strength, power, speed, flexibility and endurance.

Injury data were collected by means of a questionnaire and by direct personal communication with the player and the respective teams' medical practitioners. The questionnaire sought answers to the following questions;

- (i) personal data; age, height, mass, position, team,
- (ii) injury data; site of injury, diagnosis, days off rugby, mechanism of injury, details if a tackle injury, a kick off injury or a foul play injury, possession of ball, match or practice,

type of practice, date of injury, account of how injury occurred, whether the player felt the injury was avoidable, score in game, wearing of mouth-guard, quarter in game in which injury occurred, condition of playing field, recurrence of previous injury, (iii) specific injury data; type of injury and exact location of injury, and (iv) medical treatment; first aid administration, medical practitioner consulted, where they were consulted, and whether or not the player was hospitalised.

3.3.1 Provincial variations

Distinct patterns emerged when the two teams were analysed separately. Team A had a structured approach to their pre-season physical training, beginning in November of 1991 with pre-season evaluation of physical fitness specific to rugby, prescription of a periodised training programme and follow-up testing every six weeks. Conversely, team B were issued with access cards to various local gymnasias and received, through the mail, a general training programme drawn up by their provincial rugby Union. The onus was on the players to seek and pay for any specialised advice they may have required. Players in team B assembled for the first time in the 1992 season just five days prior to the start of the first provincial match of the season.

In team A, Mondays involved a "flushing" session of 75 minutes which included warm-up and stretching, skill drills at $\pm 70\%$ of maximal intensity and an assessment of the previous game and of any existing injuries. Tuesday was a one-and-a half hour "hard training session" with the coach. Wednesday was own training as specified by the Biokineticist, or a squad practice. Thursday was an easier practice, which was the Captain's responsibility. During practices, no full-body contact ever took place so that all contact drills were executed using tackling bags. Further, the Biokineticist was present at all practices to oversee warm-up, stretching and fitness drills.

Provincial team A aimed to maintain their fitness level at approximately 80% of maximum fitness and to "peak" three times in the season. This was achieved by increasing the intensity of training 5 weeks prior to each peak with a 1 week "taper" involving a decrease in the intensity and volume of training before each event.

In contrast, in team B, individual players took responsibility in rotation to conduct the warm-up and stretching routines. Few players had adequate knowledge of these procedures; thus the routine was often inadequate (personal observation of P.A.H.U.). Monday night practices took the form of a full-contact match-practice or full-contact situational-practice, where forwards engaged in scrumming, driving and mauling against each other, referred to as "koppestamp" ("head-bashing" in English). Opposition used in match practices constituted future potential Provincial players ("possibles"). Tuesday, Wednesday and Thursday practices varied, often taking the form of heavy running and drill sessions and often on soft and muddy fields. No fitness trainer was present at any practice nor was one consulted regarding aspects of fitness training.

All injured players in team A attended squad practices where their injury was assessed by the Doctor or Physiotherapist, or both, and their training programme was modified according to the nature of the injury. Injured players in team B were left to seek their own treatment. They were not required by team management to follow any form of compulsory rehabilitation, nor was there a designated medical professional or support team to perform this task. They did not attend squad practices, but returned to play for their club when they, or their chosen medical professional, felt their injury had healed. Players in team B who experienced "niggling" injuries were compelled to continue practising as the coach deemed these injuries unworthy of rest. Some players were often too hesitant to report these "injuries" for fear of receiving prejudicial treatment.

3.3.2 Definitions

Terms frequently used in this study are defined as follows;

Endurance training session: A minimum of 20 minutes of continuous running, fartlek running or interval running or a minimum of 30 minutes of cycling on a cycle ergometer at a heart rate above 60% of the maximum heart rate calculated using the formula, 220 beats per minute minus age.

Strength training session: A training session lasting for a minimum of 20 minutes in which the player performed exercises using free-weights, weight machines or own-body weight as resistance. Sessions included both the initial strength-conditioning sessions that involved 3-4 sets of 15 or more repetitions per exercise, and strength-building, which involved 3-4 sets of 4-12 maximal repetitions per exercise.

Rugby injury: A player was deemed injured if he sustained an injury which was severe enough to prevent him from returning to rugby for at least 7 days after the injury. All concussion had to be reported regardless of whether or not the player left the field of play, or played again within 7 days. Concussion was defined as a blow to the head, causing the player to become disoriented or confused, or to lose consciousness, no matter how short the interval might have been; even one second was considered sufficiently long for the diagnosis. All laceration injuries which required sutures and all diagnosed fracture injuries were also required to be reported, whether or not these injuries kept the player out of rugby for seven days or more.

Niggling injury: An injury was defined as niggling if it caused physical discomfort, required medical treatment, but did not preclude a player from participation.

Provincial players : Players who played for their club teams when there were no provincial fixtures scheduled, or when provincial and club fixtures fell on different dates, were still deemed to be a provincial player if they had played in the previous provincial match. During the season, when the newly selected provincial teams were announced, the newly selected players were all deemed to be provincial players, and players who were dropped from the team were discarded from the study population. Reserve players were only regarded as part of the study population when they substituted during a match, and remained part of the study population until they were replaced. In this manner, only the 15 players per team actually playing in any match formed part of the study population at any given time.

Provincial matches : Provincial matches were divided into two categories; competitive, which included the Currie Cup and Lion Cup competitions, and “friendlies”, which included all non-competition games (warm-up games, cross-section or tour games). The reason for making the differentiation is that in the latter games, some key players were often rested, earning less regular players a provincial cap.

3.3.3 Statistical analysis

The study setting was one of convenience with a unique opportunity. Thus it was an observational study as neither players nor intervention was randomised to the two venues. To analyse the risk for the first injury, the Cox proportional hazards regression models were used and the survival distributions of different sub-Groups were calculated using Kaplan-Meier estimation (Kaplan and Meier, 1958). Second injuries were analysed using the same model as for first injuries, using the population of players with first injuries who had returned to provincial rugby, plus the players who had not yet sustained an injury. The modelling of multiple injuries within players was done using the Anderson-Gill proportional hazards model which models the process of injuries as a counting process (Collett, 1994). Every player is treated as an observation of a slow Poisson process in which events (injuries) can occur. If a player is injury-free at the end of the season, he is used as a censored observation in the survival analysis.

The parameters of the Cox models can be evaluated as the ratio of the hazard function for the category under consideration compared to the reference category. The hazard function is the probability that a player is injured at time t , conditional on him having survived to that time.

3.3.4 Assumptions

In analysing the data, the following assumptions were made;

- That the risk of injury during matches and practices were equal for players in the different playing positions.
- That each match lasted for a period of 80 minutes.
- That each player practised for a total of four-and-a-half hours per week for the duration of the 26-week playing season.

These assumptions were made as exposure time to injury for each player was taken as the sum of match and practice time.

3.4 RESULTS

3.4.1 Overall injury patterns in teams A and B

A combined total of 89 players from both teams played in 41 provincial matches during the 1992 season. A total of 38 different injury incidents were reported by 24 players. Thus 14 players were injured on one occasion, 7 were injured on 2 different occasions, 2 on 3 different occasions and 1 on 4 occasions.

Table 3.1 shows the number of players who represented teams A and B in competitive or friendly matches, and the total number of injuries sustained by these players. In team A, 2 (8%) of the 25 players who played in the 14 competitive matches were injured, one during

a match and one during a club contact-practice. Three (9%) of the 32 players who played in the 7 friendlies sustained injuries, all of which occurred during matches. Overall, 5 injuries were sustained by 4 (11%) of the 37 players who played in 21 matches; one player sustained a second injury. The 4 injuries in the 21 provincial matches translate to a rate of 1.3 injuries per 100 player-games.

Table 3.1 Number of players who represented teams A and B in either competitive or friendly matches, and the number of injuries sustained by these players during matches and practices.

	NUMBER GAMES	PLAYERS USED	MATCH INJURY	PRACTICE INJURIES		CLUB INJURIES	
				CONTACT PRACTICE	PHYSICAL TRAINING	CONTACT PRACTICE	MATCH INJURY
TEAM A							
Currie Cup/ Lion Cup	14	25	1	-	-	1	-
Friendlies	7	32	3	-	-	-	-
TOTAL	21	37	4	-	-	1	-
TEAM B							
Currie Cup/ Lion Cup	12	43	6	5	4	5	3
Friendlies	8	38	8	1	-	-	1
TOTAL	20	52#	14	6	4	5	4

Includes one player who was selected to play in his debut match but was injured at practice in preparation for that game.

In team B, 43 players played in the 12 competitive matches, 14 (33%) of whom sustained injuries on 23 different occasions. Of the 38 players who played in the friendlies, nine (24%) were injured on ten different occasions. Overall, 33 injuries were sustained by 20 (38%) of the 52 players who played in 21 matches. Eleven players each sustained 1 injury, 6 were injured twice, 2 players were injured thrice and 1 player 4 times. The 14 injuries in the 20 provincial matches translate to a rate of 4.7 injuries per 100 player-games. Six of

3.4.3 Analysis of first injuries

Using the Cox model, the hazard ratio for first injury for ≤ 20 sessions of pre-season endurance training is 7.2 (95% CI: 2.3-22.1; $p= 0.0006$). This means that the probability of first injury at exposure time t for a player with less or equal to 20 sessions of pre-season endurance training is 7.2 times the probability of first injury in a player who underwent more than 20 sessions of pre-season endurance training at time t . For strength training as a single risk factor, the risk is not influenced; in other words strength training or the lack of it, did not either increase nor decrease risk of first injury.

With both pre-season strength and endurance training, the results show that they are interrelated as risk factors since both are significant when modelled together (endurance $p= 0.0001$, strength $p= 0.024$). Using the same model but adding an interaction model, there is a significant interaction between pre-season endurance and strength training ($p= 0.0211$). Thus, for evaluating the effect of pre-season strength training on first injuries consideration should be given to the level of pre-season endurance training. Accordingly, the risk for a player who completed at least 20 sessions of pre-season strength training but less than 20 sessions of endurance training is 14.5 (95% CI: 4.2-50.3) times that of a player with adequate endurance training irrespective of strength training. For a player with little pre-season endurance and strength training the risk is 4.2 (95% CI: 1.2-15.0) times that of a player with adequate pre-season endurance training irrespective of strength training (Table 3.2). Thus comprehensive pre-season strength training without the corresponding level of endurance training increases the risk of first injury by 14.5 times.

Table 3.2 Population and number of first injuries sustained in each of the four risk categories, and the risk ratios in categories (D), endurance ≤ 20 and strength ≥ 20 sessions and (C), endurance ≤ 20 and strength < 20 sessions compared to the reference category (A+B), endurance > 20 irrespective of strength training.

STRENGTH TRAINING	20	(D) n= 18 13 injuries (72%) Risk ratio = 14.5	(B) n= 27 3 injuries (11%) REFERENCE CATEGORY
	0	(C) n= 25 7 injuries (28%) Risk Ratio = 4.2	(A) n= 5 1 injury (20%) REFERENCE CATEGORY
number of sessions	0	20	
	ENDURANCE TRAINING		

3.4.4 Analysis of second injuries

The sample used for analysis of second injuries was made up of 71 players, 20 of whom returned to Provincial rugby after sustaining a first injury plus 51 players with no injury during the season. (Four players who sustained a first injury did not return to represent their Province that season). Of the 11 second injuries, 10 were sustained by players with ≤ 20 sessions of pre-season endurance training. Of these 10 injuries, 7 (70%) were sustained by players with ≥ 20 sessions of pre-season strength training, a ratio nearly identical to the ratio for first injuries (65%). Therefore, although there are less second injuries (11) than first (24), the ratio of the injuries in the two strength categories for players with low pre-season endurance training remains fairly constant.

3.4.5 Analysis of multiple injuries

That 24 players reported a total of 38 different injury incidents indicates that some players suffered more than one injury during the season. For endurance training alone, the estimated risk ratio of the two endurance training categories is 6.6 for the multiple injuries model compared to the first injury model estimate of 7.2. As was the case for first injuries, strength training or the lack of it neither increased nor decreased the risk of injury.

The interaction model shows a significant interaction between risk factors $p=0.0071$ (Table 3.3). This model is refitted with a different reference category (endurance > 20 and strength ≥ 20) to that used for first injuries. The estimated risk ratios for injury in the different categories is shown in Table 3.4.

Table 3.3 Interaction model of pre-season strength and endurance training for multiple injuries sustained by Provincial rugby players in the 1992 season.

Survival function = endurance (≤ 20) + strength (< 20) + endurance (≤ 20) x strength (< 20) + player effect						
	estimated coefficients	e^{coef}	standard error (unadjusted)	standard error (adjusted)	standardised test statistic	p-value
endurance ≤ 20	0.0343	1.035	0.770	0.818	0.0419	0.9700
strength ≤ 20	-1.7984	0.166	0.923	0.877	-2.0510	0.0400
end ≤ 20 *str ≤ 20	2.6312	13.89	10.992	0.977	2.6941	0.0071

Likelihood ratio test = 30.8 on 3 df, $p = 9.13e-007$ $n = 106$

The category endurance > 20 and strength < 20 (category A) shows that this combination is just significantly different from the reference category (category B), a finding different from the first injury analysis where no difference could be shown. This is due to the fact that, in the case of the multiple analysis, more information is available to assess the significance. The results mean that players with adequate pre-season endurance training but less than adequate strength training are 6.1 times more likely to be injured than a player with adequate pre-season strength and endurance training (Table 3.4).

3.4.6 Survival functions - first injuries

Figure 3.2 shows the Kaplan-Meier estimates of survival functions in the four different risk categories that are presented in Table 3.2. From the graph it is clear that the minority of first injuries occur after 50 hours of playing time. Seventy-five percent of injuries occur before 22 hours of playing time. For first injuries 20/24 (83%) occur in players with ≤ 20 sessions of pre-season endurance training (Table 3.2). Of these 20 injuries 13 (65%) were sustained by players with ≥ 20 sessions of pre-season strength training. This further illustrates the inter-relationship between strength and endurance training as risk factors for injury.

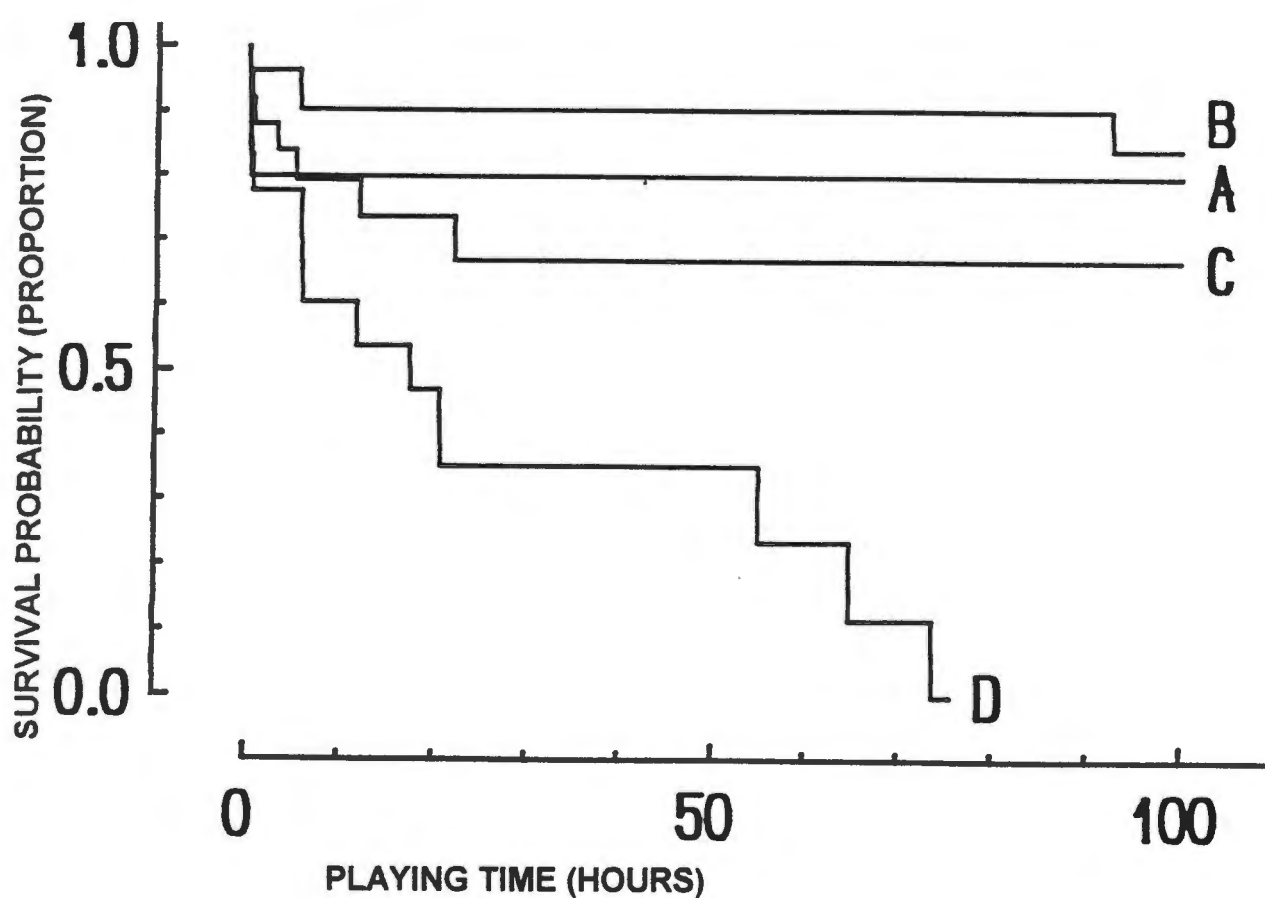


Figure 3.2 Kaplan-Meier survival functions for Groups (A) endurance > 20 and strength < 20 sessions, (B) endurance > 20 and strength ≥ 20 sessions, (C) endurance ≤ 20 and strength < 20 sessions, (D) endurance ≤ 20 and strength ≥ 20 sessions.

Table 3.4 The risk ratio and 95% confidence intervals for the three different risk categories A, C and D compared to the reference category B.

STRENGTH TRAINING	20	(D) Risk ratio = 14.4 95% CI: 4.3 - 48.9	(B) REFERENCE CATEGORY
	0	(C) Risk ratio = 6.3 95% CI: 1.8 - 22.1	(A) Risk ratio = 6.1 95% CI: 1.1 - 33.7
number of sessions	0		20
		ENDURANCE TRAINING	

3.4.7 Related injury data

(a) Time in season

Of the 33 injuries sustained by players in Team B, thirty (90%) occurred in the first half of the season, with 21 (64%) in the first quarter of the season. Two (40%) of the five team A injuries occurred in the first half of the season, only one of which occurred in the first quarter. Overall, 84% of injuries occurred during the first half of the season. The remaining six injuries all occurred in the third quarter of the season. No injuries were reported in the fourth quarter of the season.

(b) Position and phase of play

Twenty-three (61%) of the 38 injuries occurred to forwards and 15 to backline players. Injuries occurred most frequently to props and centres (7 each), flanks (6) and locks (4), and least frequently to scrumhalves and flyhalves (1 each). The phases of play in which injuries occurred most commonly were during open play and while being tackled (6 each) and while tackling, during loose scrums and as a result of physical fitness (interval sprint) training during practices (5 each). Foul play injuries, all of which resulted from punching, were restricted to forwards, while physical training injuries occurred most predominantly

(80%) amongst backline players. Forwards sustained 80% of injuries occurring during the tackling phase.

(c) Diagnosis of injuries

Of the 38 injuries sustained, muscles and ligaments were the most common (each 24%), followed by other injuries (21%) and fractures (18%). Seventeen (45%) were to the lower limbs, 12 (32%) to the upper limbs, seven to the head and neck and two to the trunk.

When the type and site of injuries were compared, it was found that all (nine) muscle injuries were to the lower limbs, six (67%) of which were to the hamstrings, and one each to the groin, thigh and calf. Of the nine ligament injuries, four (44%) were to each of the shoulders and knees and one to the ankle. Five (71%) of the seven fractures were to the fingers and one each to the nose and fibula. Other injuries included two cases each of cervical disc damage and finger nerve injuries, and one case each of a rib cartilage tear, ankle capsule damage, patella tendon rupture and sciatic nerve irritation. Only one dislocation (shoulder) injury was reported.

(d) Days off rugby

As a result of 37 of the 38 injuries, players missed 1054 days of rugby, an average of 28.5 (SD=22.4) days per injury. One prop forward who sustained cervical disc damage which required surgery, and who was forced to retire from rugby is not included in this analysis. Little difference in average days off existed between team A and team B players. Only two injuries reported in this study were of such a nature that players were able to return to participation within seven days (one head laceration and one finger fracture).

3.5 DISCUSSION

This study took advantage of a unique opportunity to investigate the influence of pre-season strength and endurance training on the risk of rugby injury in two senior provincial teams, one which undertook comprehensive pre-season preparation and the other which did not.

The scatter plots of strength versus endurance training for the injured and uninjured players, provided discrete cutpoints at >20 sessions, which accordingly were used to define “adequate” or “inadequate” strength and endurance training.

The first finding was that the type of pre-season training predicted injury risk. Endurance and strength training were found to be interrelated as risk factors. From the first, second and multiple injury analyses, this study clearly demonstrates the severe risk associated with adequate pre-season strength training and inadequate endurance training in this group of players. Players with adequate strength training and insufficient endurance training were at more than 14 times greater risk of injury than players with both adequate strength and endurance training. Players with insufficient strength and endurance training and those with adequate endurance training and insufficient strength training were at more than six times greater risk of injury than players with adequate strength and endurance training. Multiple injury analysis established that players with adequate pre-season endurance and strength training had the lowest risk of injury whether for first, second or third injury.

Several rugby injury surveys have shown that injuries occur predominantly at the beginning of the season and again after a mid-season break (Sparks, 1981; Nathan *et al.*, 1983; Roux *et al.*, 1987; Williams, 1984; Clark *et al.* 1990). Alsop *et al.* (in press) showed that the injury rate amongst male rugby players peaked near the start of the season followed by a significant decrease in match and practice injury rates as the season progressed. Of the 38 injuries sustained by players in the present study, 84% occurred in the first half of the season with 58% occurring in the first and 26% in the second quarter. The most common explanation for this increased risk of injury at the beginning of the

season is that players are either not match-fit, nor physically-fit or both (Burry, 1981; Sparks, 1981; Dalley *et al.*, 1982, 1992; Nathan *et al.*, 1983; McCoy *et al.*; 1984, Williams, 1984; Clark *et al.*, 1990; Roux, 1992; Hughes and Fricker, 1994; Garraway and Macloed, 1995). The present study shows that a lack of adequate strength and endurance training amongst provincial rugby players is a significant factor contributing to the high injury risk at the beginning of the season.

The second finding was that full body-contact practices, either in the form of match practice or “koppestamp” sessions, that took place in a competitive environment and within 48 hours after a match, probably before the body had fully recovered, contributed to the increased number (6) of injuries in team B, while they had no apparent performance benefits. This latter assumption is based on the fact that the injured players would have been replaced by second choice players, thus weakening the original team. Evidence supporting this is that team B won only 60% of all matches compared to team A winning 81%. Clark *et al.* (1990) found that only 15% of injuries to senior club players occurred outside of match play, compared to between 29% to 32% occurring outside of match play in various schoolboy studies (Nathan *et al.* 1983, Roux *et al.* 1987, Roux 1992). Noakes and du Plessis (1996) proposed that the high ratio of match injuries compared to practice injuries was a result of the very high levels of competitiveness during matches. Another possibility is that this high ratio may be due to the number of incidents of physical contact during match play and the unpredictability of these incidents.

The third finding was that inappropriate management of injured players may have further contributed to the high number of injuries in team B. That players were compelled to continue practising despite suffering “niggling” injuries, resulted in these injuries developing into more serious injury on four occasions. Further, the lack of any formal treatment, rehabilitation or re-conditioning of injured players in team B may have contributed to the high number of players who were injured on more than one occasion.

That this study was observational and not randomised, suggests the possibility of certain confounding factors that may have influenced the observations. Chapter 6 of this thesis demonstrated the extent of underreporting of injuries where a pyramid system of data collection was employed. This source of error was largely eliminated in the present study as the author, who monitored team B, remained in close contact with the Biokineticist in team A, who was responsible for data collection in that team. However, that Team A was based in Durban (Natal), where the mid-winter temperature range is 11-20° Celsius and rainfall is 43 millimetres per month, and Team B in Cape Town (Western Cape), where the mid-winter temperature range is 7-17° Celsius and rainfall is 84 millimetres (South African Weather Bureau, 1994), may have influenced injury patterns. Interestingly, few similarities regarding the influence of weather conditions on injury exist amongst different rugby injury studies (Davies and Gibson, 1978; Inglis and Stewart, 1981; Williams, 1984; Sparks, 1984; Davidson, 1987). However, the author suggests the possibility that muddy underfoot conditions in Cape Town may have placed a greater demand on the legs of players in team B, and thus contributed to the intrinsic lower limb muscle injuries sustained during training. Thus, the overall impression is that the observations made in this study were minimally, if at all influenced by confounding factors.

3.5.1 Discussion of related injury data

The match injury rate of one injury for every 5.3 and 1.4 provincial matches played in team A and team B respectively, translate to a combined match injury rate of one injury for every 2.3 provincial matches. Myers (1980) showed one injury for every 0.45 provincial matches, while Wessels (1980) showed one injury for every 1.1 provincial matches. These variations are primarily due to the different definitions of injury used in each of these studies. Nonetheless, the difference between team A and B is still striking.

The tackling phase accounted for 29% of injuries, 80% of which were sustained by forwards. Open play, loose scrums, foul play and physical training during practices were the next most commonly occurring mechanism of injury. Clark *et al.* (1990) showed similar percentages of injuries occurring during these phases of play among senior club

players. At International level, Jakoet and Noakes (1998) found 56% of injuries occurring during the tackling phases and 23% occurring during rucks and mauls. The five (13%) foul play injuries reported in the present study were all from punches and were restricted to forwards. Other researchers (Roy, 1974; Davies and Gibson, 1978; Wessels, 1980; Inglis and Stewart, 1981; Lewis, 1994; Bird *et al.*, 1998) found that 13% to 40% of all injuries were a result of foul play. Noakes and Jakoet (1998) found foul play accounting for only 9.0% of injuries occurring at International level. The present usage of retrospective television citing of foul play incidents in senior Provincial and International rugby may well prove effective in reducing the incidence of foul play injuries. However, players should accept personal responsibility for their actions, as should coaches for the message they provide to players. New Zealand recently established judicial committees to deal with foul play in rugby and initiated the awarding of fair play prizes (Bird *et al.*, 1998).

Individual players most commonly injured were props, centres, flanks and locks and the least commonly injured were scrumhalves and flyhalves. However, the low number of injuries (38) in this study may not truly reflect the risk of injury at the different playing positions. Jakoet and Noakes (1998) found that at International level, loose forwards, halfbacks and to a lesser extent locks were most frequently injured, while backline players and fullbacks especially, were the least injured players. Clark *et al.* (1990) found that among senior club players, hookers and wings were at greatest risk of injury and props, locks and scrumhalves were at least risk. In contrast, Bird *et al.* (1998) found locks to have the highest injury rate while wings and fullbacks did not stand out as a high-risk group. Two other studies amongst senior rugby players (Durkin 1977, Northern Transvaal Rugby Union, 1982) found hookers, fullbacks, eighthmen and flyhalves at most risk of injury. Thus, there seems to be very little commonality for positional risk of injury amongst the various rugby studies.

A little over half of the players (52%) in this study were able to return to rugby within 21 days of sustaining the injury, 32% took more than 35 days to recover, while one player would never return to rugby. No similar data seems available for Provincial players, but at senior club level, Clark *et al.* (1990) found that 48% were able to return to rugby within 21

days of sustaining the injury and 35% took more than 35 days to recover. Williams (1984) found that 48% of senior players were not able to play for three to six weeks and 29% were off for more than seven weeks.

3.6 CONCLUSION

In conclusion, this is the first study to demonstrate a relationship between pre-season preparation and early season injury. The study showed that,

1. inadequate pre-season endurance training is a risk factor for injury, and one which contributes to the high injury rate at the beginning of the season amongst provincial rugby players.
2. strength and endurance training are interrelated as risk factors.
3. compared to those with adequate strength and endurance training, players with adequate strength training and insufficient endurance training are at greatest risk of injury, followed by players with insufficient strength and endurance training.
4. contact practices 2 days after inter-provincial matches contributed more to an increased number of injuries than to success.
5. “niggling” injuries may develop into more serious injury if players attempt to “play through” them.
6. lack of structured treatment and rehabilitation of an injury places players at risk of being re-injured.

CHAPTER FOUR

This Chapter describes the materials and methods used in the retrospective study reported in Chapter 5 and the prospective study reported in Chapters 6-9, both involving the same high schools in the Western Cape, and both conducted in the same year.

MATERIALS AND METHODS

4.1 Selection of schools

The same 26 Cape Province high schools that were selected in the 1983 and 1984 studies (Roux, 1992) were used in this study. These particular schools were originally selected for investigation as they generally had a tradition of excellence in schoolboy rugby. While this selection was not random and therefore may have influenced the data obtained, it was deemed more important to select schools that had large rugby playing populations and who also normally fielded teams in all age-groups. The schools were monitored through correspondence in conjunction with the Cape Education Department.

4.2 Data collection

Instruction, weekly report and injury questionnaire forms (appendices I and II) were sent to all 26 schools. The teacher/ coach of each team was instructed by the Cape Education Department to complete a weekly injury report form on the Monday following any rugby-playing week. Two telephone calls were made to the masters-in-charge of rugby at each of the schools. The first was made prior to sending the correspondence and served to inform him of the proposed rugby injury study and seek his active support and co-operation. The second was made subsequent to the correspondence arriving at the school and served to clarify any areas of uncertainty.

The weekly report form sought;

- (a) the date of the preceding Saturday,

- (b) a summary of players injured during the week (including age-group and team-level of injured players as well as the number of players injured in the team),
- (c) signatures of the school principal and the master-in-charge of rugby.

The weekly report forms had to be completed for all teams each week, even by those teams that either did not play rugby or did not have any injuries during that week. Once completed, these forms were to be signed by the master-in-charge of rugby at the school and by the headmaster.

A separate injury questionnaire was to be completed in the event of an injury. In an attempt to more comprehensively analyse the nature and cause of these injuries, additional information was sought in the current questionnaire that was not included in the previous study (Roux, 1992). The questionnaire contained the following data - additions included in the 1991 questionnaire are denoted in italics:

- a) personal particulars (name, date of birth, age, height, mass, name of school, team and playing position, *usual playing position, playing position at time of injury*)
- b) injury data which included the site and type of injury, specific diagnosis, number of days out of rugby, *number of days out of school*, the phase of play during which the player was injured, *if the injury occurred during the tackling phase, whether it was deemed a fair tackle, at high speed or not, from which direction (head on, side on, behind) and to which part of the players body (neck, shoulders, hip/waist, legs), if the injury occurred during the kick off/in, whether the player was in the receiving or attacking team and if the player was in the receiving team, if he was the ball catcher or not, possession of the ball at the time of injury*, designation of the injury as an inter-schools match, practice or social match event, *designation of a practice injury as a match practice, physical exercises or skills training event*, date of injury, an account of how the player was injured, *whether the player felt the injury could have been avoided*, final score of match (for injuries sustained during matches), *venue of the match (home vs. away)*, number of years the injured player has played rugby, *number of seasons played in the position in which the injury occurred, level*

of play at the time of injury (whether participating at usual, higher, or lower level), wearing of mouth-guard at the time of injury, in the event of a match injury, the quarter in which the injury occurred, the condition of the playing field (firm, soft, wet/ slippery), the condition of the grass cover.

c) As players and coaches may have limited anatomical knowledge, an additional listing was supplied from which the player had to denote the specific anatomical site of injury.

For concussion injuries, details were sought concerning the duration of the loss of consciousness as well as the object which was struck to cause the injury. Muscle and tendon injuries were classed as a strain, tear or bruising, and specific muscles were listed. Under each of the following headings, comprehensive options were given, in each case eliminating problem areas that arose in the previous study; ligament injuries, fracture injuries, dislocations, lacerations, internal injuries, other injuries not mentioned. In the 1983 study (Roux, 1992), no classification allowed for lacerations under the heading of specific injuries, but this was included in the 1984 study. However those injuries were only reported if the player missed 7 days or more of rugby due to the injury. In this study, players were required to fill in the injury report if they suffered a laceration injury that required sutures, regardless of the time out of rugby.

d) medical treatment included specific diagnosis, *whether it was the recurrence of an old injury, administration of first aid, by whom, if not administered reasons were sought, which specific medical professional was consulted and where the consultation took place, if hospitalisation was required and for how many days.*

e) the medical costs form sought *the costs arising from consultations, medication, bracing, hospitalisation and any other medical procedures resulting from the injury.*

The completed injury questionnaires were attached to the weekly report and returned to the Cape Education Department. Schools that failed to return forms, or that returned

inadequately completed forms after any week during the season were immediately telephonically contacted by the Cape Education Department. This contact was maintained until correctly completed forms were returned.

4.3 Definitions

Most of the terminology used in the thesis is self-explanatory. Some of the terms that may require clarification are the following;

(a) i) Injury

A player was deemed injured if he sustained an injury that was severe enough to prevent him from returning to rugby for at least 7 days after the injury. All concussion injuries had to be reported regardless of whether or not the player left the field of play, or played again within 7 days. Concussion was defined as a blow to the head, causing the player to be disoriented or confused, or to lose consciousness, no matter how short the interval might have been; even 1 second was considered sufficiently long for the diagnosis. All laceration injuries which required sutures were also required to be reported, whether or not they kept the player out of rugby for 7 days or more.

ii) Recurrent Injury

An injury, as defined above, occurring to the same site and of the same type as one previously sustained.

(b) Match play incidence of injury

This was determined using two methods. The first, in order to make comparison with the study of Roux, was determined by multiplying the number of matches played during the season by 15 (number of players per team) and dividing this

product by the number of players injured during match play during the season. An average match was assumed to last for 1 hour in duration and the incidence was expressed as 1 injured player per boy-hours of match play. Using this method, to express the match incidence of injury as 1 injured player per number of matches, simply divide the number of boy-hours of match play by 15. For example, a match incidence of 1 injury per 150 boy-hours of rugby translates to an incidence of 1 injury for every $(150/15)$ 10 matches played.

The second, and more accepted method in modern research, was calculated by dividing the total number of injuries by the total number of player-games (1 game = 15 player-games), multiplied by 100. The incidence is then expressed as the number of injuries per 100 player-games.

(c) Practice incidence of injury

This was determined by taking the product of the number of teams, weeks per season, hours of practice per week and players per team and dividing this product (total hours of practice) by the number of players injured during practices during the season. The incidence was expressed as 1 injured player per boy-hours of practice play.

(d) Overall incidence of injury

Again this was determined using two methods. Following the study of Roux, the first was determined by adding the total number of match hours, (a) above, to the total number of practice hours, (b) above, and then dividing this sum by the total number of players injured during the season. The incidence was expressed as 1 injured player per boy-hours of rugby.

The second method, again in accordance with modern research, was calculated by

dividing the total number of injuries by the total number of player, multiplied by 100. The incidence is then expressed as the number of injuries per 100 player-seasons.

(e) Anatomical site of injury

Distinction was made between 4 anatomical sites; the head and neck, trunk (chest, abdomen and back), upper limb (shoulder, arm, forearm, wrist and hand), and lower limb (hip, buttock, thigh, knee, lower leg, ankle and foot).

(f) Nature of injuries

The nature was classified as i) type of injury e.g. muscle, ligament, fracture, laceration etc. and ii) specific injuries, for example, hamstring muscle injury, lateral ankle ligament injury, clavicle fracture etc.

(g) Loose scrum

The term loose scrum is used as a collective term for a ruck and a maul. A “ruck” is formed when the ball is on the ground and one or more players from each team are on their feet and in physical contact, closing around the ball between them. A “maul” is formed when one or more players from each team are on their feet and in physical contact, closing around a player who is in possession of the ball.

4.4 Analysis of survey forms

All results were entered into a Quattro-Pro spreadsheet (Borland International, Inc. Scotts Valley, California) at the end of the rugby season. These data were later transferred to a Microsoft Excel package (Microsoft corp., Washington D.C.). The following data were analysed for comparison with the previous study;

- (a) the overall number and incidence of injured players,
- (b) the age-group and playing level (team) of the injured players,
- (c) the incidence of injured players during different 4-week periods of the rugby season,
- (d) the injured player's position and the phase of play at the time when the player was injured,
- (e) the incidence of players injured during match play and practices,
- (f) the nature and anatomical site of injuries,
- (g) specific diagnosis of injuries,
- (h) the medical treatment that injured players received,
- (i) the number of days out of rugby and absent from school as a direct result of the rugby injury.

4.5 Statistical analysis

Where comparative analyses were made between data from the two studies (Roux, 1992 and this study), similar statistical testing methods were applied. The purpose was to detect any evidence in the data of non-random association between factors such as age-group, level of play, time of season, playing position and frequency of injured players.

The chi-square test, which was chosen in the previous study, tests for evidence of association between factors effecting the frequency of injury events. A statistically significant difference in the relative incidence rates or frequencies is indicated by a large chi-square value.

4.6 Assumptions

The following assumptions were made:

- all players were male high school rugby players aged between twelve and nineteen,

- all inter-high school matches were played according to the International Rugby Board laws and that the law changes introduced in 1990 and 1991 were applied by the match referee,
- each match lasted for a period of 1 hour and was controlled by a referee,
- all players practised as a team for a period of 3 hours per week during the season,
- the exposure time to injury risk during matches and practices was equal for players in different playing positions.

These assumptions were made as exposure time to injury for each player was taken as the sum of match and practice time.

CHAPTER FIVE

INADEQUATE PRE-SEASON PREPARATION OF SCHOOLBOY RUGBY PLAYERS: A SURVEY OF PLAYERS AT 25 CAPE PROVINCE HIGH SCHOOLS

5.1 SUMMARY

Prior to the first full contact match of the 1991 rugby season, 3330 players from 25 Cape Province high schools completed a detailed questionnaire which sought to establish their previous rugby injury experiences as well as their knowledge and use of injury prevention techniques. The principal conclusions of this study were that the players' knowledge of techniques known to prevent rugby injuries was inadequate; that at the start of the rugby season too little attention was paid to neck strengthening exercises, to the teaching of correct tackling and falling techniques, to the wearing of gumguards, and to physical and skill training. The result was that coaching errors may have predisposed some of these players to injury. This study also found that not all parents, and particularly not all mothers, encourage their sons to play rugby; and that the incidence and nature of the injuries reported retrospectively were similar to those reported in prospective studies at the same schools.

5.2 INTRODUCTION

Previous studies from the Department of Sport Science at the University of Cape Town (Nathan *et al.*, 1983; Roux *et al.*, 1987; Clarke *et al.*, 1990) have determined the incidence and aetiology of schoolboy rugby injuries. As a result of concerns that the incidence especially of cervical spinal injuries (Kew *et al.*, 1991; Noakes, 1992) was unacceptably high, a series of specific rule changes were introduced to South African schoolboy rugby in 1990. The effects of these rule changes on the incidence and nature of schoolboy rugby injuries is currently being evaluated in 25 of the 26 schools surveyed in the original study (Roux *et al.*, 1987).

An issue that has yet to be addressed is the attitude of schoolboy rugby players and their coaches to rugby injuries, in particular their knowledge of factors that might either predispose to, or reduce their injury risk.

Accordingly, for this study a questionnaire was sent to all rugby players at the 25 high schools involved in the larger study. The questionnaire was designed to evaluate the pre-season training of these players as well as their knowledge of training and other techniques that are known to reduce the risk of rugby injury.

5.3 SUBJECTS AND METHODS

In the week before the first full-contact match of the season, all schoolboys in 25 high schools in the Cape Province who intended playing rugby during the 1991 season were required to complete a pre-season questionnaire (Appendix III). As was the case in previous studies (Nathan *et al.*, 1983; Roux *et al.*, 1987) the project was sanctioned by the Cape Education Department and participation was compulsory.

The questionnaire sought answers to the following questions:

- (i) personal data - age, height, mass, position, number of years playing rugby, average level (e.g. A-team) played during career;
- (ii) previous injuries; and
- (iii) general questions relating to techniques known to prevent injury.

The latter included gumguard possession and use, front-row substitution by non-specialist players, the amount of pre-season strength and endurance training, knowledge of and participation in neck strengthening exercises, the amount of pre-season tackling practice, parental attitudes to schoolboy rugby, and attitudes to two specific playing situations - falling on an outstretched arm when tackled and falling on the point of the shoulder when tackled - both of which may be associated with injury risk.

Of the 4100 players scheduled to play during the season, 3300 (81%) returned questionnaires and all were used. All data from the questionnaire were entered into a Dbase III system (Ashton-Tate product by Borland International, Inc. Berkshire, England). Totals and averages for relevant data were acquired using the adding and averaging features of the Dbase III package.

5.4 RESULTS

5.4.1 Previous injuries

Figure 5.1 compares the frequency of the different types of injuries reported retrospectively in this study with those reported in the prospective study undertaken at the same schools (Roux *et al.*, 1987). With the exception of ligament injuries, which were reported less frequently in this study, the incidence of the different injuries in the two studies was very similar.

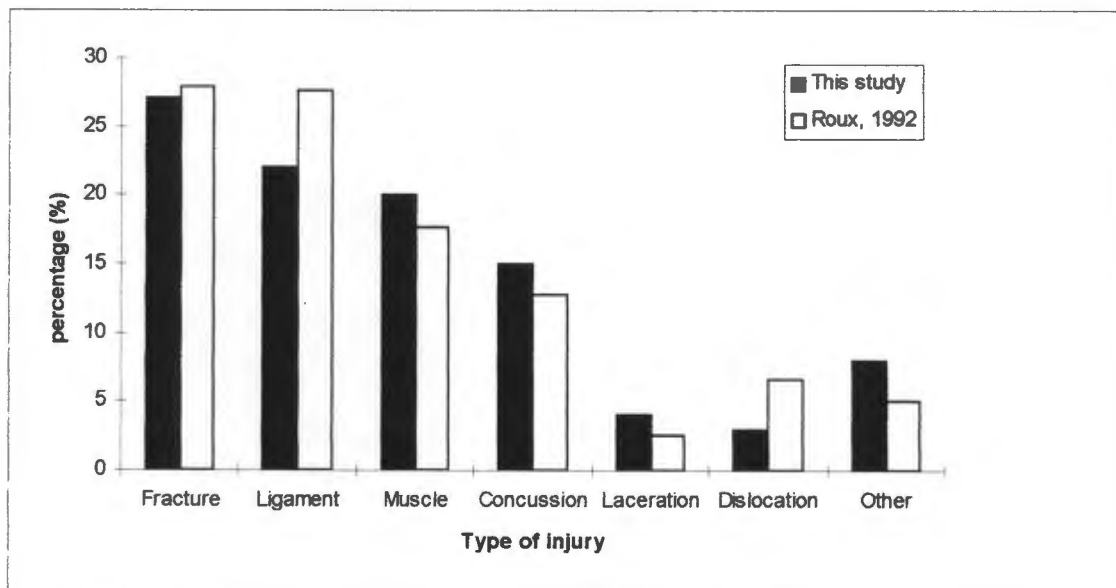


Figure 5.1 The frequency of different types of injuries reported retrospectively in this study, compared to those reported in a prospective study at the same schools (Roux, 1992).

Fractures were the most common injuries (27%), followed by ligament injuries (22%), muscle injuries (20%), concussions (15%), lacerations (4%) and dislocations (3%). Eight hundred and eighty-eight concussion injuries were reported by 471 players, an average of 1.9 concussions per concussed player during their playing careers. Thirty-six percent of injuries were to the lower limbs, 28% to the head and neck, 26% to the upper limbs and 10% to the trunk and abdomen.

5.4.2 Pre-season training

Figure 5.2 shows the percentage of players classified as A-team players or lower-team players in each age-group who completed pre-season training programmes for endurance and general strengthening.

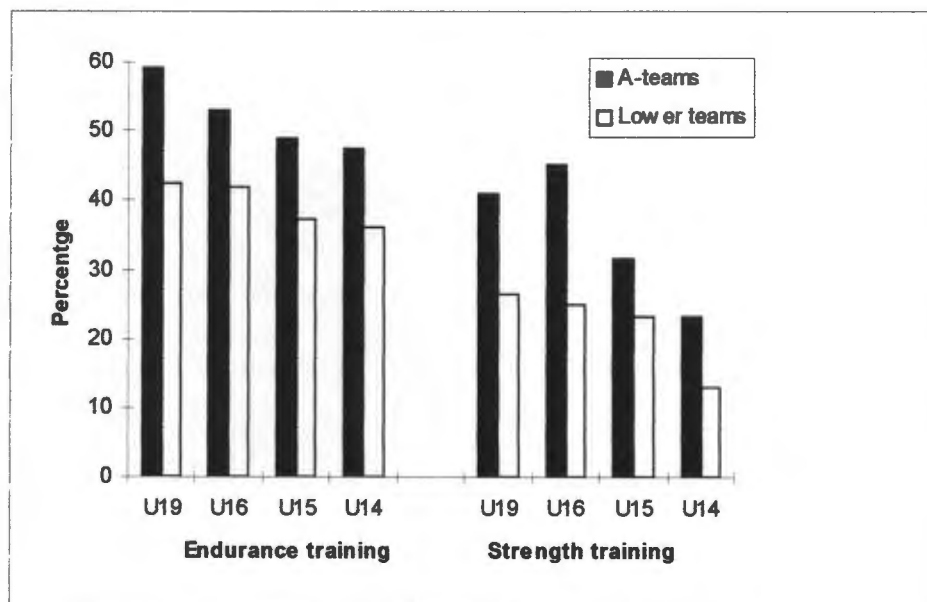


Figure 5.2 Percentage of players in the A and Lower teams in each age-group who completed pre-season training for endurance and general strength.

A greater percentage of A-team players of all ages undertook pre-season endurance or strength training. At all ages and at all levels of play, more players reported that they participated in endurance training than strength training. Similarly, a greater percentage of players in older age-groups reported that they had completed such programmes.

Far fewer players reported that they undertook specific strength training, especially neck strengthening programmes. Of the 684 specialist front-row forwards in the study, only 6 (0.9%) had followed an appropriate neck strengthening programme and a further 6 had undertaken isometric strengthening using their hands. Eighteen percent of players had a knowledge of correct methods for neck strengthening (bridging exercises, resistance exercises using a partner and/or weights attached to a head piece); 16% believed that resistance training using their own hands was adequate for isometric strengthening.

5.4.3 Gumguards

Forty-six percent (1543) of the 3300 players possessed gumguards. Of these 24% wore them all the time and 58% never used them.

Of the 1781 players who did not possess gumguards, 48% thought they were unnecessary and 35% said that they did not know enough to warrant their use. The remaining 17% provided other reasons for not possessing gumguards. These included: expense (11%), will be obtaining one soon (2%), and could not be bothered, they are a nuisance, wear braces, or they make one feel sick (each 0.5%).

5.4.4 Front-row substitutions

Of a total of 2646 non-specialist front-row forwards in the study, 973 (37%) had previously substituted in this position at some stage of their career; 160 (16%) indicated they were injured while doing so.

5.4.5 Reasons for playing rugby

Sixty-nine percent of players gave leisure as one of the reasons for playing rugby, 48% gave health and fitness, 20% played for social reasons, 16% as a result of external pressure, 15% for the image of masculinity, 11% for psychological reasons (religion, glory, sportsmanship) and 11% for mastery of the game. Ten percent of players gave only one reason for playing rugby.

5.4.6 Tackling practice

The average (\pm SD) total time spent in practising falling techniques prior to the first full-contact match of the season was 16 ± 22 minutes. The average total time spent on tackling practice was 15 ± 24 minutes; the average time spent listening to verbal coaching or lecturing on tackling techniques was 11 ± 21 minutes. These averages did not differ at the different ages.

5.4.7 Anthropometric measurements

1575 players classified themselves as playing or having played in A-teams; the remaining 1725 players played in B- or lower teams. In order to evaluate any relationship between anthropometric measurements and team level (A-team or lower), data were grouped according to each player's highest level of achievement.

Table 5.1 lists the heights of "A" and lower team players in the different age-groups in the different playing positions. Under-16 and under-19 A-team players were significantly taller than their counterparts in lower teams ($P < 0.01$); this difference was not significant in younger players.

A-team players in all age-groups were significantly heavier than their counterparts in lower teams ($p < 0.01$; table 5.2)

Table 5.1 Mean weight (kg) of "A" and lower team schoolboy rugby players in the different playing positions at different ages.

TEAM	PROP	HOKKER	LOCK	LOOSE FORWARD	SCRUM HALF	FLY-HALF	CENTRE	WING	FULL-BACK	TOTAL GROUP
19A	89	73	83	75	64	69	72	72	73	75.7*
LOWER	81	66	77	71	63	68	66	69	67	70.8
16A	87	71	77	72	62	67	67	68	69	71.5*
LOWER	77	60	71	63	56	60	60	65	59	63.5
15A	75	63	69	65	50	59	58	61	57	63.0*
LOWER	71	55	64	57	48	52	53	56	54	58.2
14A	67	53	62	56	46	48	51	50	52	54.2*
LOWER	63	44	58	49	42	44	43	47	48	49.6

* $P < 0.01$ for A-team players vs. players of the same age in B- or lower teams.

Table 5.2 Mean height (cm) of "A" and lower team schoolboy rugby players in the different playing positions at different ages.

TEAM	PROP	HOKKER	LOCK	LOOSE FORWARD	SCRUM HALF	FLY-HALF	CENTRE	WING	FULL-BACK	TOTAL GROUP
19A	181	174	188	181	174	180	178	178	180	180.1*
LOWER	178	172	186	180	172	178	176	178	179	178.5
16A	179	174	187	180	173	175	176	177	174	178.0*
LOWER	173	174	180	175	166	174	172	174	173	173.6
15A	175	170	182	176	160	171	169	174	169	173.1
LOWER	174	164	175	168	159	170	166	169	166	168.2
14A	168	162	173	167	156	162	162	162	164	164.6
LOWER	167	153	170	159	150	159	155	159	161	160.4

* $P < 0.01$ for A-team players vs. players of the same age in B- or lower teams.

5.4.8 Knowledge of risk factors

Forty-four percent of the players felt that falling on an outstretched arm when tackled was an injury risk; and 72% felt that falling on the point of the shoulder when tackled was an injury risk.

5.4.9 Parental attitudes

Eighty-four percent of fathers and 63% of mothers encouraged their sons to play rugby, while 10% of fathers and 31% of mothers actively discouraged their sons from playing; the remainder were indifferent. Sixty-four percent of the 305 fathers who discouraged their sons from playing rugby had played rugby while at school.

5.5 DISCUSSION

The impression gained from this study is that the schoolboy rugby players who were surveyed had insufficient knowledge of techniques known to prevent rugby injuries; they were inadequately prepared at the start of the rugby season; and coaching errors may have predisposed some of these players to injury. These findings may be even more pronounced amongst players in other schools in which rugby is a less important activity.

That the players were ignorant of even the most basic techniques known to prevent rugby injuries, is shown by the finding that the majority of players did not possess let alone wear gumguards despite conclusive evidence that the gumguards not only prevent injuries to the oro-facial region almost completely, but they also reduce the probability of concussion and even neck injuries (De Wet *et al.*, 1980; De wet and De Muelenaere; 1984; Sparks, 1985; Tomasin, *et al.*, 1989). Wearing of a gumguard should be made compulsory at all levels of play and parents should be advised accordingly.

Furthermore, the majority of players in this study did not know of one correct method for strengthening their neck muscles, and they were not aware of the risk of injury to the wrist, elbow, shoulder and clavicle when falling, or of how to prevent these injuries.

Evidence that the players in this study were inadequately prepared at the start of the rugby season is shown by the small percentage who reported that they had undergone pre-season endurance and strength training programmes. Disturbingly few players, and in particular

specialist front row forwards (<1%), had followed a pre-season neck strengthening programme.

It is recommended that all players be strongly encouraged to follow comprehensive and position-specific pre-season training programmes (Hazeldine and McNab, 1991; Walsh, 1991). These should be closely monitored and revised during the season. Coaches need to ensure in particular that their forwards participate in a supervised programme of neck strengthening (Walsh, 1991); front-row forwards should not be allowed to scrum in that position unless the programme has been completed.

While the large standard deviations in the time allocated to pre-season tackling practise indicates that some coaches might spend a large amount of time on this practise, and others not, the overall impression is that insufficient time for and emphasis on tackling practice may have predisposed some of the players to injury. This is particularly important, as more than 50% of schoolboy rugby injuries occur during the tackling phase of the game (Sparks, 1985; Roux, *et al.*, 1987). Little emphasis was also placed on the practice of falling techniques. Williams (1984) reported that 93% of all acromio-clavicular injuries resulted from falling.

As a result of the high injury risk during the tackling phase of the game, players should be taught relentlessly how to tackle correctly and how to "ride" a tackle. Emphasis should be placed on the technique of tackling and falling, rather than on the speed and impact of the collision.

Even more serious was the high incidence of injury to non-specialist front-row forwards substituting in that position. Such players are a danger not only to themselves but also to competent players scrumming against them (MOSA, 1979).

Greater body mass, and at under-16 and 19 age-groups, greater standing height, seemed to promote selection of players at higher levels of play. Scales (1999) also showed that greater body mass influenced the likelihood of players being selected for teams

participating at the highest level of play, and Quarrie *et al.* (1995) found that body mass, particularly fat-free body mass, was an important variable determining on the field performance - with higher level players being heavier.

Finally it was found that not all parents, and particularly not all mothers, supported their sons playing rugby.

An area that was not investigated was pre-exercise warm-up and stretching procedures. The benefits and the necessity of correct warm-up and stretching procedures is well documented (Williams, 1984; Siff, 1986; Watson, 1981; Tomasin *et al.*, 1989; Hazeldine and McNab, 1991; Walsh, 1991). Coaches should ensure that all players follow correct procedures before all matches and practices. This is essential for preventing injuries, while incomplete or incorrect warm-up and stretching procedures may predispose to injury.

In summary, the principle findings of this study suggest that the prevention of injury is not a high priority amongst players and rugby coaches at high school. Findings that indicate this include a lack of pre-season physical training, lack of time spent on learning tackling and falling skills, and an inadequate knowledge and use of techniques known to prevent injuries.

It is recommend that more attention be paid to pre-season physical and skill training and to injury prevention amongst schoolboys. Perhaps the desire to win rugby matches has become so pervasive that other considerations are neglected.

CHAPTER SIX

RISK AND INCIDENCE OF INJURY

6.1 INTRODUCTION

The two phases of experimental law changes to South African schoolboy rugby in 1990 and 1991 were introduced to make certain phases of the game safer and improve the flow of the game. These changes are discussed in detail in Chapter 1. The present Chapter evaluates the effects of these law changes on injury, both the overall incidence and the incidence at each playing position. This is accomplished by comparing results with the study of Roux (1992), that was conducted in the same population and prior to the introduction of the law changes.

The two law changes which were introduced specifically to address the increasing incidence of (catastrophic) cervical injuries to front-row forwards during scrums were; law 20 (2) which prescribed the three phase scrum-engagement technique, and law 20 (19) which was designed to decrease the duration of the scrum. The hypothesis under evaluation was that the de-powering of the scrum during engagement and the decreased duration of the scrum would result in a decreased exposure to, and thus incidence of injuries to front-row forwards.

Changes to laws 20 (4), (19) and 24B (2), which were introduced to decrease the duration of the scrum and to law 20 (7), which was introduced to decrease the duration of the loose scrum, were introduced with the objective of increasing the flow of the game. Accordingly, these changes might have required both coaches and players to make certain adjustments to their patterns of play. It is postulated that, if players' roles within the game were adjusted as a direct result of the law changes, then injury profiles at the different positions would likely change accordingly.

In addition, the more general aims of this Chapter were to describe the incidence of injury during match play and practices, at different age-groups and levels of play, at the different playing positions and during the different periods of the season. Also investigated was whether or not players were in possession of the ball during injury. In addition, for match injuries, the effects on injury of the venue, match score difference for the teams with the injured player and time in the match, the availability of first-aid, and whether players believed that their injury could have been avoided or not were investigated.

Finally, as was evident by the 1991 World Cup rugby tournament, a new style of play was being introduced to the game of rugby around that time, one which amongst others, was characterised by a runner taking a crash-ball to set up 2nd, 3rd and 4th etc. phases of play. That certain schools coaches might have adopted this new pattern of play in their coaching methods, coupled with the law changes, made analysis of exactly which factor(s) were affecting injury incidences, more problematic.

6.2 RESULTS

6.2.1 Overall incidence of injury

The 25 high schools fielded 266 teams, an average of 1 team per school less than reported in the 1983 and 1984 studies (Roux, 1992). The 266 teams played 2906 matches, which represents the same number of matches per team reported in 1983 and 1984. There were 415 injured players who sustained a total of 498 injuries. Of these players, 309 (74.5%) were injured during match play and 106 (25.5%) during practices or training for rugby.

The overall incidence of injury was 1 injured player for every 624 boy-hours of rugby (Figure 6.1), or 10.4 injuries per 100 player-seasons. This former Figure was almost identical (617 boy-hours) during the more tightly controlled 1983 study and slightly higher than the incidence of 1 injury per 741 boy-hours reported in the 1984 study (Roux, 1992). The incidence of injury during matches was 1 injured player per 141 boy-hours (or 0.71 injuries per 100 player-games), compared to 142- and 193 boy-hours in the 1983 and 1984

studies respectively. The practice incidence was 1 injury per 2032 boy-hours, compared to 1810 and 1742 boy-hours in the 1983 and 1984 studies (Figure 6.1).

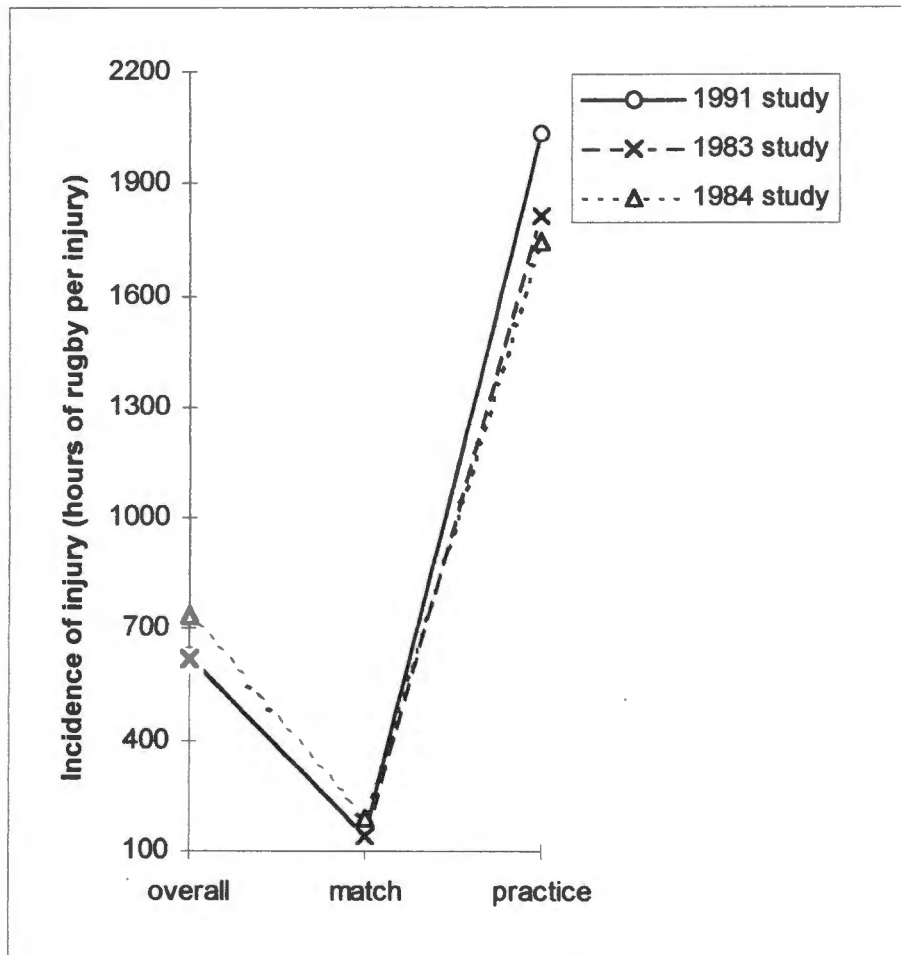


Figure 6.1 The overall, match and practice incidence of injury in the 1991 study, compared to the 1983 and 1984 studies (Roux, 1992).

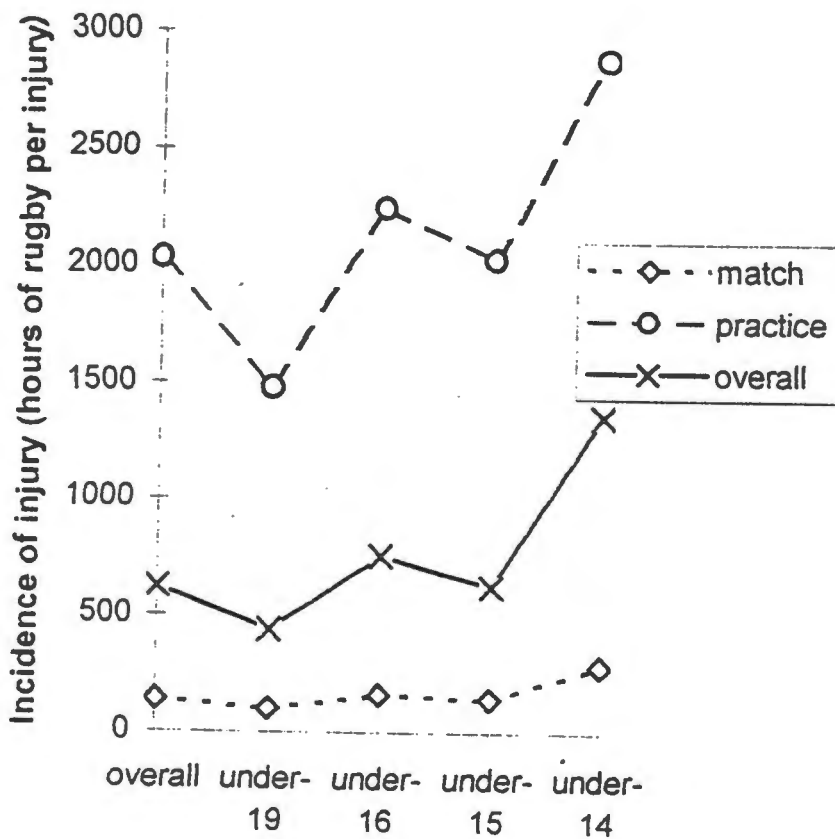


Figure 6.2 The incidence of injury during matches, matches and practices (overall), and practices only for the different age-groups in the 1991 study.

6.2.2 Risk and incidence of injury at different ages and levels of play

Similar to the results in both the 1983 and 1984 studies, the overall incidence of injury was lowest in the under-14 age-group, but increased in the under-15 and under-19 age-groups (Table 6.1, Figure 6.3). The present study showed a (insignificant) linear increase in injuries with increasing age from under 14 to under 19 ($p=0.1106$), with a significant increase in incidence of injury with increasing age ($p<0.0001$). Under-19 players (14.9 injuries per 100 player-seasons) were at a 3.2 greater risk of injury than under-14 players (4.7 injuries per 100 player-seasons).

Table 6.1 The match and overall incidence of injury for players in the different age-groups in the 1991 study.

AGE	NUMBER OF PLAYERS	NUMBER OF MATCHES	NO. INJURED PLAYERS		INCIDENCE OF INJURY	
			MATCH	OVERALL	MATCH *	OVERALL#
UNDER-19	1560	1219	176	233	0.96	14.94
UNDER-16	540	378	34	46	0.60	8.52
UNDER-15	825	64	634	86	0.67	10.42
UNDER-14	1065	35	675	50	0.35	4.69
OVERALL	3990	2906	309	415	0.71	10.4

* Injuries per 100 player-games

Injuries per 100 player-seasons

In comparison with the 1983 and 1984 studies of Roux, Figure 6.2 shows the frequency of injury expressed as a percentage of all players in each age-group.

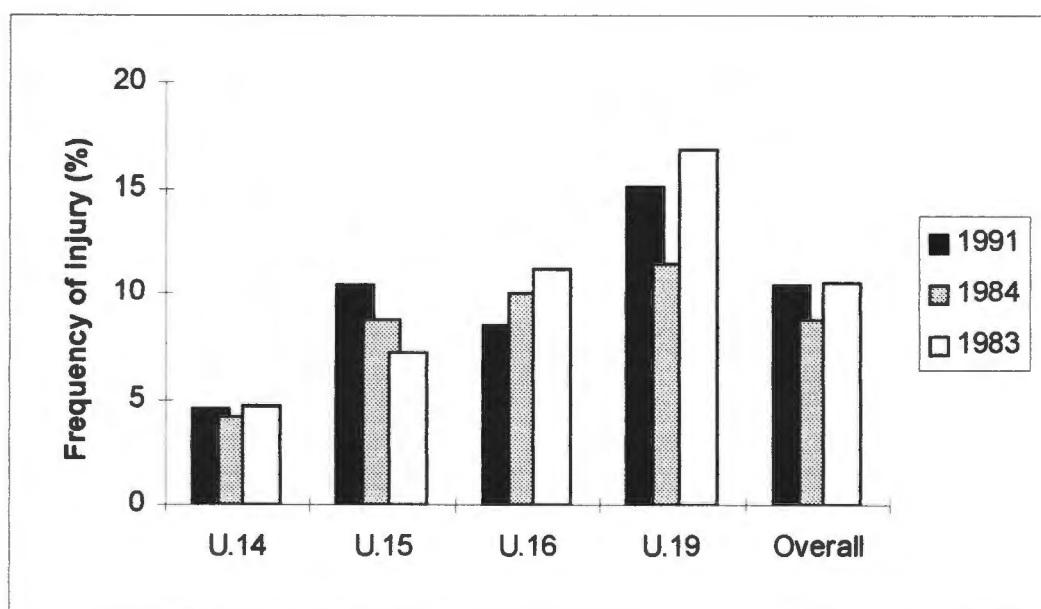


Figure 6.3 The frequency of rugby injury in schoolboy rugby players in 1991 compared to data from the 1983 and 1984 studies (Roux, 1992), expressed as a percentage of all players in each of the age-groups.

Figure 6.4 compares the frequency of injury in A- and lower teams in the different age-groups. It is clear that A-team players at all ages are at greater risk than lower team players. Using the Cochran-Mantel-Haenszel test, A-team players had significantly more injuries than lower team players ($p < 0.001$) (Mantel, 1963). This is true for all of the age-groups. Testing for increased risk amongst A-team players with increasing age, the Breslow-Day test for homogeneity of the odds ratios is not significant ($p < 0.533$) (Breslow and Day, 1980). Thus A-team players at all age-groups are at 1.52 times greater risk of injury than players in lower age-groups (95%CI: 1.26 - 1.85). A-team players, who represented 32.0% of the total number of players, accounted for 46.0% of all injured players.

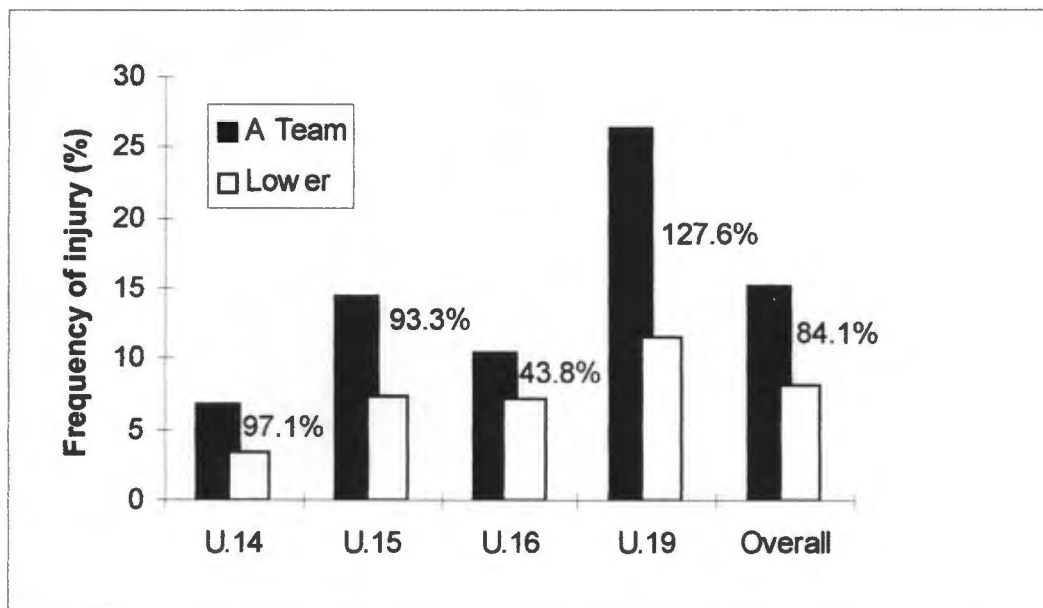


Figure 6.4 The frequency of rugby injury in schoolboy rugby players in A or lower teams in the 4 different age-groups, expressed as the percentage of injured players in either the A or lower teams in the 4 different age-groups. Numerical values represent the percentage differences between A and lower teams.

6.2.3 Pre-season fitness training and injury

Approximately 50% of the 3990 high school rugby players in the present study indicated that they participated in pre-season endurance training, while about 35% indicated that they participated in pre-season strength training (Chapter 5 of this thesis). When injury risk was calculated for those players who participated in strength training, those who participated in endurance training, and those who did no pre-season training, no significant differences were found. These findings were contrary to those in chapter three where it was demonstrated that amongst senior provincial players, type of pre-season training predicted injury risk, whilst endurance and strength training were interrelated as risk factors.

Chapter 5 of this thesis also shows that fewer than 1 percent of the 684 specialist front-row forwards at schoolboy level completed a programme of neck strengthening exercises prior to the first match of the season. The reason for this outdated “play-to-get-fit” approach (as opposed to “get-fit-to-play”), was a lack of knowledge of methods used to strengthen neck muscles, and not a reluctance to train. It was also suggested that this lack of knowledge amongst players in these schools with a tradition of excellence in rugby might even be more prevalent in other schools and even club rugby playing populations, in which high levels of excellence have not been achieved.

6.2.4 Injury risk for players in different playing positions

Table 6.2 lists the number and the incidence of injury per 100 player-seasons for players in the different positions, compared to the 1983 and 1984 studies. In 1991, players who played at the wing (16.5 injuries per 100 players-seasons), hooker (14.3 injuries per 100 players-seasons) and fullback (12.4 injuries per 100 players-seasons) were at significantly greater risk of injury ($p < 0.02$), whilst players in the lock (5.6 injuries per 100 players-seasons) and eighthman (6.0 injuries per 100 players-seasons) positions were at significantly lower risk of injury ($p < 0.0003$).

With the exception of flyhalves, who had a notably lower injury risk in the 1984 study when compared to 1983, little difference in risk existed between players in the same playing positions in the 1983 and 1984 studies (Table 6.2). When the 1991 study was compared to the 1983 and 1984 studies, the notable differences are observed at hooker (increased injury risk in 1991) and eighthman (decreased injury risk in 1991).

Table 6.2 The total number of injured players and the incidence of injury for players in the different positions in the 1991 study, compared to the 1983 and 1984 studies.

POSITION	NUMBER OF INJURED PLAYERS			INCIDENCE (injuries per 100 player-seasons)			RANK		
	'91	'83	'84	'91	'83	'84	'91	'83	'84
WING	88	81	67	16.5	12.9	10.7	1	2	2
HOKKER	38	28	18	14.3	8.9	5.8	2	7	9
FULLBACK	33	39	28	12.4	12.4	9.0	3	3	4
SCRUMHALF	31	32	27	11.7	10.2	8.7	4	6	5
FLANKER	58	65	53	10.9	10.3	8.5	5	5	6
CENTRE	54	70	62	10.2	11.1	9.9	6	4	3
FLYHALF	27	41	22	10.2	13.0	7.1	6	2	8
PROP	40	54	53	7.5	8.6	8.5	8	8	6
EIGHTHMAN	16	44	35	6.0	14.0	11.2	9	1	1
LOCK	30	41	45	5.6	6.5	7.2	10	9	7
TOTAL	415	495	410	10.4	10.5	8.8			

6.2.4a Injury risk at each specific position

(i) Props

Forty players were injured while playing at prop, at an incidence of 7.5 injuries per 100 player-seasons (Table 6.2). Five (12.5%) of these players were not specialist props, but were injured whilst substituting in this position (3 were specialist locks and 2 were loose-forwards) (Table 6.3). Of all players injured at prop, 29 (72.5%) were injured during match play, a further 11 were injured during match practice, 21 (52.5%) were under-19 players,

and 27 (67.5%) were A and B-team players from all age-groups. Fourteen (35.0%) of the injured props sustained head and neck, 32.5% upper limb and 27.5% lower limb injuries.

The phases of play during which props were most often injured were during scrums (30.0%), loose scrums (22.5%) and being tackled and tackling (25.0%). Props sustained 40.0% of all scrum injuries, compared to 40.0% in the 1983 study and 66.7% in 1984.

Table 6.3 Positions of players who sustained an injury whilst substituting in a position different to that in which they normally specialise.

USUAL POSITION	UNFAMILIAR POSITION IN WHICH PLAYER WAS INJURED								
	PROP	HOOKER	LOCK	FLANK	NO. 8	FLYHALF	CENTRE	WING	FULLBACK
PROP	-	1	-	-	-	-	-	-	-
HOOKER	-	-	-	1	-	-	-	-	-
LOCK	3	1	-	-	1	-	-	-	-
FLANK	1	2	-	-	-	-	1	1	-
EIGHTHMAN	1	-	-	-	-	-	3	-	-
SCRUMHALF	-	-	-	-	-	-	-	-	1
FLYHALF	-	-	-	1	-	-	-	2	1
CENTRE	-	-	-	-	-	2	-	5	1
WING	-	-	1	-	-	-	1	-	1
FULLBACK	-	-	-	1	-	-	-	-	-
TOTAL	5	4	1	3	1	2	5	8	4

The 40 injured props sustained 54 specific injuries. Of these injuries, 15 (27.8%) were fractures, 13 were ligament injuries, and 11 were muscle injuries. Props were at 1.6 times greater risk of sustaining a dislocation injury when compared to players in other positions. One prop suffered a “slipped” cervical disc injury. One specialist flanker, substituting at prop, suffered a cervical spinal dislocation that prevented him from ever playing rugby again. Only 1 neck fracture was sustained by props in this study, compared to 2 neck and 2 trunk vertebral fractures in the 1984 study. No players in this study reported being paralysed during the 1991 season.

Clavicle (4), wrist (4) and finger (2) were the common fractures sustained. The neck and knee (4 each) were the commonly injured ligaments, and the neck (6) and thigh (2) the commonly injured muscles. The percentage occurrence of both neck ligament and neck muscle injuries were similar to those reported in the 1984 study.

That 22.2% of all injuries sustained by props were neck injuries, although less than the corresponding 30.0% reported in the 1984 study, is an indication that props are still at high risk of sustaining a neck injury, despite the 1990 and 1991 rule changes.

(ii) Hookers

Hookers were at the second highest risk of injury (14.3 per 100 player-seasons) (Table 6.2). Four (10.5%) of the 38 injured hookers were not specialists in that position, but were injured whilst substituting at hooker (Table 6.3). Two indicated that they were specialist flanks and 1 each a specialist lock and prop. Of all players injured at hooker, 32 (84.2%) were injured during match play, a further 4 were injured during match practice, 21 (55.3%) were under-19 players, and 28 (73.7%) were A and B-team players from all age-groups. Twelve sustained head and neck, and 10 each sustained upper limb and lower limb injuries.

The phases of play during which hookers were most often injured were during scrums (36.8%), loose scrums (26.3%) and being tackled and tackling (23.7%). Hookers sustained 46.7% of all scrum injuries, compared to 32.0% in 1983 and 15.2% in 1984 and compared to 40.0% sustained by both props in the 1991 study.

The 38 injured hookers sustained 44 specific injuries. Of these injuries, 13 (29.5%) were ligament, 12 were muscle, and 8 were fracture injuries. Two hookers reported “slipped” lumbar disc injuries, while there were no reports of neck or trunk vertebral fractures to hookers. Injuries to the knee ligaments (5), back muscle (5) and neck muscle (4) were the most common injuries suffered by hookers.

Of the total of 6 neck injuries (4 muscle and 2 ligament), 3 (2 muscle and 1 ligament) were sustained by non-specialists substituting in this position.

(iii) Locks

Locks had the lowest risk of injury (5.6 per 100 player-seasons) (Table 6.2). Of the thirty injured locks, one was a specialist wing playing out of position (Table 6.3). Of all injuries, 21 (70.0%) occurred during match play and 7 (23.3%) during match practice, 20 (66.7%) were to under-19 players, and 22 (73.3%) were to A and B-team players from all age-groups.

Twelve (40.0%) of the injured locks sustained upper limb, and 9 (30.0%) head and neck injuries. The phases of play during which locks were most often injured were during loose scrums (56.7%) and the combined tackling phases (20.0%). In the 1984 study, loose scrums accounted for only 23.1% of injuries to locks. Three of the 5 line-out injuries were sustained by locks.

The 30 injured locks sustained 37 specific injuries. Of these injuries, 11 (29.7%) each were ligament and muscle injuries. One lock reported a cervical spinal dislocation during a loose scrum which kept him out of rugby for 6 weeks. Although reported as such, it is questionable whether a player might return to rugby so soon after sustaining a true cervical dislocation.

(iv) Flanks

Fifty-eight players were injured while playing flank, at an incidence of 10.9 injuries per 100 player-seasons (Table 6.2). Three non-specialist flanks, a hooker, flyhalf and fullback were each injured while substituting in this position (Table 6.3). Of all flanks, 38 (65.5%) were injured during match play, a further 18 (31.0%) were injured during match practice, 31 (53.4%) were under-19 players, and 43 (74.1%) were A and B-team players from all

age-groups. Twenty-one (36.2%) of the injured flanks sustained upper limb, 18 (31.0%) lower limb and 16 (27.6%) head and neck injuries.

The phases of play during which flanks were most often injured were during tackling (20.7%), being tackled (24.1%) and during the loose-scrum (32.8%). Of all scrum injuries, 3.3% were sustained by flanks, compared to 10.0% in 1983 and 9.1% in 1984.

The 58 injured flanks sustained 61 specific injuries. Of these injuries, 19 (31.1%) were ligament, 16 (26.2%) were fracture, and 12 (19.7%) were muscle injuries. Five of the 9 reported concussion injuries to flanks resulted in a loss of consciousness for more than 60 seconds. Twelve (63.2%) of the ligament injuries were to the knees and ankles, 12 (75.0%) of the fractures were to the shoulders and arms and 8 (66.7%) of muscle injuries were to the neck and shoulder region.

(v) Eighthmen

The eighthman went from the player at greatest risk of injury in 1983 (14.0 injuries per 100 player-seasons) and 1984 (11.2 per 100 player-seasons), to the player with the second from least risk in 1991 (6.0 per 100 player-seasons) (Table 6.2). One of the 16 injured players was a specialist lock who was substituting at eighthman at the time of injury (Table 6.3). Of all injuries, 12 (75.0%) occurred during match play, the remaining 4 occurred during match practice, 10 (62.5%) were to under-19 players, and 11 (68.8%) were to A and B-team players from all age-groups. Six (37.5%) of the injured eighthmen sustained head and neck, 5 sustained upper limb and 4 sustained lower limb injuries.

The phases of play during which eighthmen were most often injured were while being tackled (37.5%), during tackling (25.0%) and during the loose-scrum 25.0%. The latter value was compared to 40.0% in the 1984 study. As was the case in the 1984 study, eighthmen reported no scrum or line-out injuries.

The 16 injured eighthmen sustained 22 specific injuries. Of these injuries, 7 (31.8%) were ligament, 5 were concussion and 4 were muscle injuries.

(vi) Scrumhalves

All thirty-one of the players injured while playing scrumhalf (11.7 injuries per 100 player-seasons) were specialists in that position (Table 6.2). Of all scrumhalves, 23 (74.2%) were injured during match play, a further 6 were injured during match practice, 15 (48.4%) were under-19 players, and 27 (87.1%) were A and B-team players from all age-groups. Ten (32.3%) of the injured scrumhalves sustained head and neck, 9 (29.0%) upper limb, and 8 (25.8%) lower limb injuries.

The phases of play during which scrumhalves were most often injured were being tackled (38.7%), the loose-scrum (25.8%) and tackling and open play (each 12.9%). In the 1991 study, 12.9% of the injuries to scrumhalves were sustained during tackling compared to 33.3% in the 1984 study.

The 31 injured scrumhalves sustained 36 specific injuries. Of these injuries, 9 (25.0%) were fractures, 7 each were concussion and ligament and 6 were muscle injuries.

(vii) Flyhalves

Twenty-seven players were injured at flyhalf at an incidence of 10.2 per 100 player-seasons (Table 6.2). Two of these indicated that they were specialist centres substituting at flyhalf at the time of injury (Table 6.3). Of all flyhalves, 24 (88.9%) were injured during match play, the remaining 3 were injured during match practice, 17 (63.0%) were under-19 players, and 22 (81.5%) were A and B-team players from all age-groups. Twelve (44.4%) of the injured flyhalves sustained lower limb, and 7 each sustained either an upper limb, a head or a neck injury.

The phases of play during which flyhalves were most often injured were being tackled (63.0%) and during open play and loose scrums (14.8% and 11.1% respectively). In the 1984 study, being tackled accounted for only 36.4% of all injuries to flyhalves.

The 27 injured flyhalves sustained 30 specific injuries. Of these injuries, 8 each (26.7%) were ligament and fracture injuries. All fracture injuries were to the shoulders, arms and hands, while all ligament injuries were to the knees and ankles. One flyhalf reported suffering a cervical spinal dislocation while being tackled which kept him from playing rugby for 6 weeks.

(viii) Centres

Fifty-four of the injured players were centres, translating to a rate of 10.2 injuries per 100 player-seasons (Table 6.2). Five of these players were not specialist centres, but were injured whilst substituting in this position (3 were specialist eighthmen, and 1 each a flank and a wing) (Table 6.3). Of all centres, 42 (77.8%) were injured during match play, while 9 (16.7%) were injured during match practice, 29 (53.7%) were under-19 players, and 43 (79.6%) were A and B-team players from all age-groups. Nineteen (35.2%) of the injured centres sustained upper limb, 18 (33.3%) lower limb, and 12 (22.2%) head and neck injuries.

The phases of play during which centres were most often injured were while being tackled (42.6%), tackling (35.2%) and during open play (9.3%).

The 54 injured centres sustained 68 specific injuries. Of these injuries, 18 (26.5%) were fracture, 17 (25.0%) were ligament and 16 (23.5%) were muscle injuries. Five of the ten concussion injuries reported by centres resulted in the player losing consciousness for more than 60 seconds. Three potentially catastrophic fracture injuries were sustained by centres, 2 to the skull and 1 to the trunk vertebra. One of the skull fractures was sustained by a specialist flank during tackling and whilst substituting at centre. The severity of this injury was such that the player would never play rugby again.

(ix) Wings

Wings were at the greatest risk of injury, sustaining injuries at a rate of 16.5 per 100 player-seasons (Table 6.2). Of the 88 injured wings, 8 were not specialists and were injured whilst substituting in this position (5 were centres, 2 were flyhalves and 1 a flank) (Table 6.3). Of players injured while playing wing, 65 (73.9%) were injured during match play, while 18 (20.5%) were injured during match practice, 53 (60.2%) were under-19 players, and 66 (75.0%) were A and B-team players from all age-groups. Thirty-three (37.5%) of the injured wings sustained lower limb, 34.1% upper limb, and 23.9% head and neck injuries.

The phases of play during which wings were most often injured were while being tackled (55.7%) and tackling (28.4%). In the 1984 study, being tackled accounted for only 44.8% of injured wings and open play for 19.4% compared to 3.4% in 1991.

The 88 injured wings sustained 106 specific injuries. Of these injuries, 30 (28.3%) were fractures and 23 (21.7%) each were muscle and ligament, and 18 (17.0%) were concussion injuries. Wings suffered the greatest number of concussion injuries compared to the other positions, with 8 (29.6%) of the more serious concussions (loss of consciousness > 60 seconds) being suffered by players in this position.

(x) Fullbacks

The incidence for the 33 injured fullbacks was 12.4 per 100 player-seasons (Table 6.2). Four of these players were not specialist fullbacks, but were injured whilst substituting that this position (1 each was a specialist scrumhalf, flyhalf, centre and wing) (Table 6.3). Of all players injured at fullback, 27 (81.8%) were injured during match play, while 4 (12.1%) were injured during match practice, 19 (57.6%) were under-19 players, and 19 (57.6%) were A and B-team players from all age-groups. Twelve (36.4%) of the injured fullbacks sustained upper limb, 30.3% lower limb, and 24.2% head and neck injuries.

The phases of play during which fullbacks were most often injured was being tackled, accounting for 63.6% of all injuries to fullbacks, open play (18.2%) and tackling (9.1%). In the 1984 study, being tackled accounted for 39.3% and tackling for 28.6% of injured fullbacks (Chapter 7).

The 33 injured fullbacks sustained 40 specific injuries. Of these injuries, 15 (37.5%) were fractures, and 9 (22.5%) were ligament injuries. No dislocation injuries were reported by fullbacks. Of the 5 concussions reported by fullbacks, 3 resulted in a loss of consciousness of more than 60 seconds.

6.2.4b Injuries to players substituting in unfamiliar playing positions

Thirty-three players (8.0% of all injured players) were injured whilst substituting in a position different to that in which they normally played (Table 6.3). Nine non-specialist front-row players, all of whom were locks or loose forwards, were injured while substituting in this position; 8 players were injured while substituting at wing, 5 players, 4 of whom were loose forwards, were injured while substituting at centre and 4 other players were injured while substituting at fullback.

6.2.4c Playing position versus anatomical site and type of injury

Table 6.4 lists the incidence of injury at each anatomical site and for each type of injury for backline versus forward players in 1991, compared to the 1984 study (Roux, 1992). Backline players were at 1.5 times greater risk of injuries than forward players in 1991, compared to only a 1.1 times greater risk in 1984. In 1991, the risk of lower limb injuries to backline players was 1.9 times, and upper limb injuries 1.7 times greater than forwards. This higher risk of upper and lower limbs were similar to those reported in the 1984 study (Roux, 1992)

However, the risk of head and neck injuries to backline players increased in 1991 when compared to 1984, as did the risk of trunk injuries. The former increase in risk is accounted for in the increased rate of concussion injuries reported amongst backline players (2.8 injuries per 100 player-seasons in 1984 increased to 3.9 in 1991) and the decrease in the incidence reported by forwards, with little difference in the overall number of concussions reported. In both this study and Roux (1992), concussion injuries were shown to be under-reported by more than 40.0% in schools monitored by correspondence.

Backline players were at twice the risk of fracture and concussion injuries, whilst forwards were at 1.5 times greater risk of sustaining a dislocation. Further, backline players were at 4 times greater risk of lower limb muscle injuries, whilst forwards were at twice the risk of sustaining a neck injury.

Table 6.4 The incidence of injury at each anatomical site, and for each type of injury sustained by backline and forward players in 1991, compared to the 1984 study.

ANATOMICAL SITE TYPE OF INJURY	NUMBER OF INJURIES		INJURY INCIDENCE* (per 100 player-seasons)			
	1991	1984	Backline		Forwards	
			1991	1984	1991	1984
Head and neck	143	159	3.9	2.8	3.3	3.9
Upper limb	159	165	5.4	4.5	3.1	2.3
Lower limb	151	124	5.0	3.4	2.7	1.9
Trunk	45	58	1.2	1.0	1.1	1.4
Overall	498	506	12.5	9.4	8.6	8.2
Concussion	72	67	2.7	1.8	1.3	1.6
Dislocation	20	18	0.4	0.3	0.6	0.4
Lacerations	20	25	0.6	0.5	0.4	0.5
Muscles	107	94	3.1	2.2	2.6	1.8
Ligaments	127	152	3.5	3.4	2.9	3.0
Fractures	124	147	4.1	3.7	2.2	2.6

* Based on the 415 injured players

6.2.4d Playing position versus age of injured players

In order to determine injury patterns between players in the younger age-groups, who were still undergoing physical growth changes, and under-19 players who should have achieved a greater degree of physical maturity, injured players were divided into these two groups accordingly.

In the 1991 study, under-19 players were at twice the risk of injury (14.9 injuries per 100 player-seasons) when compared to players in junior teams (7.5 injuries per 100 player-seasons) (Table 6.5). When divided into backline and forwards, backline players in the under-19 age-group were at 1.8 times greater risk of injury than their counterparts in the junior teams, while under-19 forwards were at 2.2 times greater risk than junior players.

Overall, backline players (12.5 injuries per 100 player-seasons) were at 1.4 times greater risk of injury than forwards (8.6 injuries per 100 player-seasons). In the under-19 age-group, backline players were only at 1.2 times greater risk of injury when compared to forward players, while at the junior ages, the risk was 1.5 times greater for backline players.

When risk at the specific positions were investigated, it was found that under-19 locks were at 3.1 times, and props and wings at 2.7 times greater risk of injury than their junior counterparts (Table 6.5). At junior level, no playing positions held greater risk of injury than corresponding positions at under-19 level. However, junior scrumhalves (1.4 times) and centres (1.5 times) held a proportionately higher risk than players in other positions in this age-group.

Combined data from the 1983 and 1984 studies (Roux, 1992) highlighted 3 specific age versus playing position differences; firstly, that under-19 fullbacks were injured considerably less than at the younger ages; secondly, that junior level props were more commonly injured; and thirdly, that under-19 hookers were more commonly injured. Roux's explanations for these findings were that, at younger ages the fullback participates

only occasionally in the game, whereas at the under-19 level he is more involved in collisions that usually occur at high speed. He suggests at a young age, props were not sufficiently developed physically, or adequately conditioned and coached in scrumming techniques. No explanations were offered regarding the higher percentage of injuries sustained by under-19 hookers. This study found no evidence of any of these 3 specific differences mentioned in Roux's study (1992).

Table 6.5 The incidence and risk of injury for under-19 and junior age-group (under-14 to under-16) players in the different playing positions in the 1991 study.

POSITION	INCIDENCE (per 100 player-seasons)		
	UNDER-19	JUNIOR AGES	RISK RATIO
BACKLINE	16.5	9.1	1.8
FORWARDS	13.5	6.1	2.2
WING	25.5	10.8	2.7
HOOKER	20.3	10.5	1.9
FULLBACK	18.6	8.6	2.2
SCRUMHALF	14.4	9.9	1.4
FLANK	14.9	8.3	1.8
FLYHALF	12.5	8.6	1.5
CENTRE	16.3	6.2	2.6
PROP	10.1	5.9	2.7
EIGHTHMAN	9.6	3.7	2.6
LOCK	9.6	3.1	3.1
OVERALL	14.9	7.5	2.0

6.2.5 Incidence of injury during different periods of the season

The overall chi-square test shows that significantly more injuries occurred at the beginning of the season than later in the season ($p < 0.0003$). Compared to the first 4-week period at the beginning of the season, the overall risk of injury decreased by 2.0, 4.2, 2.7 and 6.5 times in the second to fifth 4-week periods (Figure 6.5).

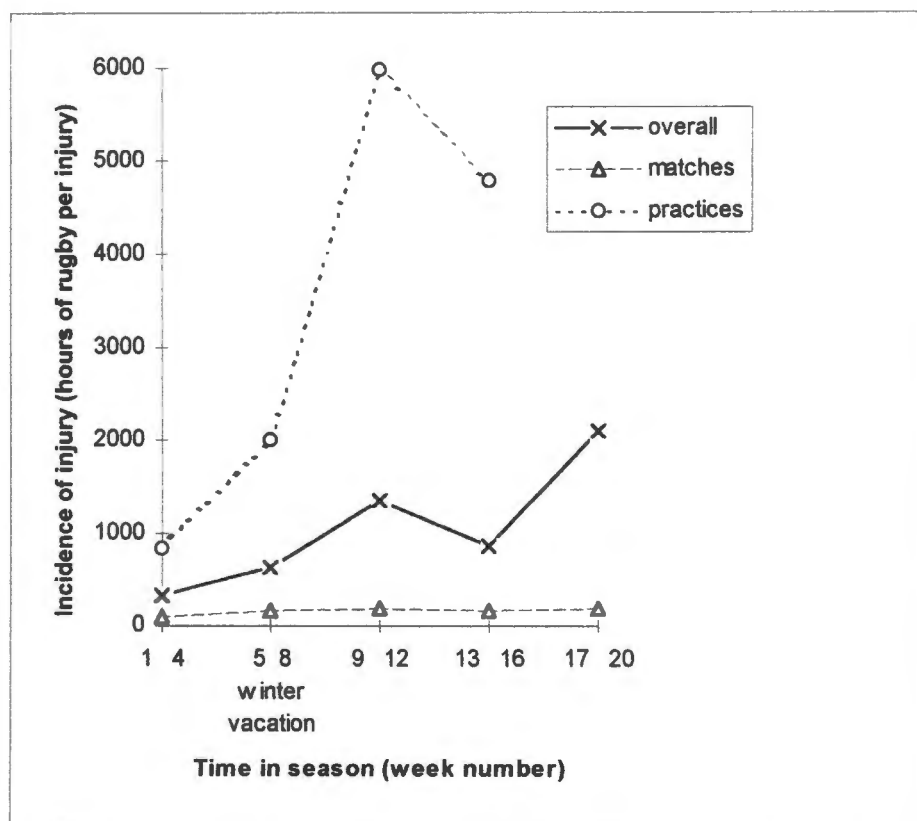


Figure 6.5 The match, practice and overall incidence of injury during different 4-week periods of the 1991 season.

[Note that no practice injuries were reported in the 5th 4-week period of the season.]

When match and practice incidences were studied separately, it was risk of injury during matches decreased over the five 4-week periods from 14.7 injuries per 100 player-games in the first, to 9.7 in the second, 8.0 in the third, 9.2 in the fourth, and 8.3 in the fifth.

Practices injury occurrence decreased considerably during the course of the season, with the number of practice hours per injury decreasing from 825.5 in the first 4-week period to 1995 in the second, 5985 in the third and 4788 in the fourth. No injuries occurred during practices in the fifth 4-week period.

6.2.6 Possession of ball at the time of injury

Forty-four percent (183) of all 415 injured players were in possession of the ball at the time of injury. Interestingly, 32 (20.5%) out of the 156 players who were injured when being tackled were not in possession of the ball at the time of injury (Table 6.6). Eighteen (56.3%) of these 32 players indicated that the tackle was late and reported it as dangerous play. The remainder may have released or passed the ball at the moment of impact with the tackler and then sustained the injury when impacting with the ground. Fifty-six percent of players injured during open play were not in possession of the ball at the time of injury, while 66.0% were not in possession during a loose scrum injury. Only 1 of the thirty players injured during a scrum reported he was in possession of the ball at the time of the injury. Foul play injuries were largely restricted to off the ball incidents, with only 1 of the 42 players injured in this manner being in possession of the ball at the time of the incident.

Table 6.6 Possession of the ball during injury in the different phases of play.

	BEING TACKLED	TACKLING	LOOSE- SCRUMS	OPEN PLAY	SCRUM	PHYSICAL EXERCISE	FOUL PLAY	LINE-OUT	TOTAL
YES	124	4	28	18	0	2	13	3	192
NO	32	76	55	20	30	6	29	2	250

Note : Nine injuries sustained during 'other' phases and 2 during kick off/ in are not reported here. Of the 42 player who reported foul play injuries, 4 reported foul play as the only mechanism of injury, and 38 reported foul play injuries occurring during the various phases of play.

6.2.7 Venue and final score of match injuries

Match venue seemed to have little influence on injuries, with 54.0% being sustained by players playing away from their home venue and 46.0% occurring at the home venue. Similarly, whether players were on the losing or winning team seemed to have little influence on the risk of injury. Players in the winning team sustained 49.5% of the total match injuries, players in the losing team sustained 45.6% and 5.0% were sustained during a match in which the result was a draw. When margins of victory/ loss were investigated it

was found that 63.4% of injuries occurred in more closely contested matches in which the winning/losing margin was less than 15 points and 34.6% of injuries occurred in matches in which the margin was greater than 15 points. When these margins were considered, there was still no statistical difference between injuries to players in the losing or winning team ($p=0.466$).

6.2.8 Match injury vs. time in match

Fifty-nine percent of all match injuries occurred during the first (28.3%) and fourth (30.7%) quarters of the match, while 41.0% occurred during the second (19.8%) and third (21.2%) quarters (Table 6.7). Fracture injuries occurred more frequently in the first (32.2%) and fourth (28.9%) quarters and least in the second quarter (14.4%). Ligament injuries occurred most frequently in the first quarter (31.4%) and least frequently in the third (19.6%) quarter with similar percentages (25.0%) in the second and fourth quarters. Of the seventy-eight muscle strains or tears that occurred during match play, 32.1% occurred in the fourth quarter when the players were most often physically fatigued. Forty-four percent of concussion injuries occurred in the first half and 56.0% in the second half of the match. There was no significant association with the quarter in the game in which either fracture ($p=0.35$), ligament ($p=0.49$), muscle ($p=0.91$) or concussion ($p=0.27$) injuries occurred. Dislocation and laceration injury patterns were identical, the majority (66.7%) occurred in the first and fourth quarters combined, while they seldom (6.7%) occurred in the third quarter. Significance tests for these latter two types of injuries were rendered suspect due to there being too few data points.

Table 6.7 The percentage of the different types of injuries that occurred during each of the 4 quarters of a match.

TYPE OF INJURY	QUARTER OF THE MATCH			
	1 ST (%)	2 ND (%)	3 RD (%)	4 TH (%)
FRACTURE	32.2	14.4	24.4	28.9
LIGAMENT	31.4	24.4	19.6	25.6
MUSCLE	25.6	20.5	21.8	32.1
CONCUSSION	21.9	21.9	29.7	26.6
DISLOCATION	33.3	26.7	6.7	33.3
LACERATION	33.3	26.7	6.7	33.3
INTERNAL/ OTHER	26.1	26.1	17.4	30.4
TOTAL PER QUARTER	28.3	19.8	21.2	30.7
TOTAL PER HALF	48.1		51.9	

6.2.9 Injuries that players believed could have been avoided

Players were asked to state whether they believed that their injury could have been avoided, but were not asked to elaborate on how this might have been achieved. Answers were thus subjective. Forty-three percent of all injured players believed that their injury could have been avoided, while the rest were of the opinion that their injury could not have been avoided. When the phase of play was considered, players believed that 75.0% of injuries occurring during physical exercise, 60.0% during scrums, 43.0% while being tackled, 41.0% each while tackling and during loose scrums and 32.0% during open play could have been avoided. Interestingly, 7 (17.0%) of the 42 players who reported a foul play injury believed that the injury could not have been avoided.

When type of injury was considered, players believed that 40.0% of dislocations and lacerations, 44.0% of concussions, muscle injuries and ligament injuries and 48.0% of fracture injuries could have been avoided.

6.2.10 First-aid and medical treatment

For match injuries, first-aid was administered at the field of play to 230 (74.4%) of the 309 injured players. In each of these injury events, personnel responsible for administration of first-aid treatment was an official first-aider in 77.3% of cases, a medical doctor 9.7%, a referee 8.2%, a coach 3.3%, a parent and another player, each 1.0%. Of those 79 players who did not receive first-aid treatment, 31 indicated that first-aid was not available at the playing venue, and 48 said that their injury did not require first-aid attention at the time of the injury. For the 106 practice injuries, players indicated that they received first-aid treatment in 39 (36.7%) events, that they did not require it in 26 (24.5%) events and that it was not available in 41 (38.7%) events.

Of the 415 injured players, 396 sought further medical attention, 279 consulted a general practitioner, 28 a physiotherapist and 89 a medical specialist as a direct result of their injury; the remaining 19 indicated that their injury did not require medical consultation. Of all consultations, 286 (72.2%) took place at a private medical practice, 80 (20.0%) at hospitals, 17 at the playing field and 13 at other venues. Sixty-one players were hospitalised for one or more nights, totalling 136 nights of hospital care.

6.3 DISCUSSION

6.3.1 The effects of each law change on the incidence of injury

(a) Law 20 (2)

The purpose of the experimental law change involving the scrum going down in three phases was to reduce the forces in the scrum and to build pressure gradually, in so doing to decrease scrum and especially spinal cord injuries to the front-row players. The incidence of injury (in 100 player-seasons) to props remained relatively unchanged during the 1983 (8.6), 1984 (8.5) and 1991 (7.5) studies, while the risk of injury to hookers in 1991 was 1.6 times greater than in 1983 and 2.5 times greater than in 1984 (Table 6.2). In the 1984 study

(Roux, 1992), 18 hookers were injured, 5 of whom were injured during scrums, compared to the 38 injured during the 1991 season, 14 of whom were injured during scrums. Thus, the percentage of all scrum injuries sustained by front-row players increased from 72.0% in 1983 and 81.9% in 1984 to 86.7% in 1991. Although the low numbers preclude a significant finding, it was encouraging that in the 1991 study, only 13.6% of all injuries to hookers were neck injuries, compared to 31.6% in the 1984 study (Roux, 1992), and that front-row players sustained only 1 cervical dislocation and 1 cervical fracture during scrums in 1991, compared to 2 of each injury in 1984.

Milburn and O'Shea (1994) analysed the biomechanical effects of the three phase scrum engagement (as was used during the 1991 study) and compared the effects of this technique with the Crouch-Touch-Pause-Engage (CTPE) technique. They showed that, although the three phase technique resulted in reduced forces on engagement, these forces would still be more than sufficient to cause vertebral fracture and paralysis if they were applied to a neck that was slightly mis-aligned to the side. Furthermore, they pointed out that this technique contributed to a prolonged duration and added a risk of instability during front-row contact, and again when the props moved away from the hooker to accommodate the locks joining the scrum. The combination of these factors contributed to a greater variation in the vertical and sideways forces which in turn increased the risk of scrum collapse. They concluded that all techniques of scrum engagement exposed front-row forwards to potentially dangerous forces. Milburn and O'Shea's final conclusion was that their study failed to support the value of the three phase scrum engagement.

Supporting the findings of Milburn and O'Shea, this study rejects the hypothesis that the introduction of the sequential scrum engagement technique (law 20 (2)), would result in a decreased incidence of scrum injuries to front-row forwards. On the contrary, this law was most likely responsible for the increase in the risk of scrum injuries to hookers.

(b) Law 20 (4), 20 (19) and 24B (2)

These law changes, the purposes of which were to decrease the duration of the scrum, or to stop players interfering with the passage of the ball from the scrum, and thus make the game more flowing, may have caused the eighthman to go from player most at risk of injury in 1983 and 1984 to the player with the second lowest risk in 1991. The probability was that, under these laws, the tactic of the eighthman attacking around the fringes from the base of the set scrum was rendered less effective than under the previous laws. Further, a more popular option that was gaining popularity in Provincial and International rugby circles around that period, was for a runner (usually the flyhalf) to take a crash-ball, committing the backline defence to the tackle and the subsequent loose-scrum, and then attacking with second phase from this base. The eighthman in the attacking team was more often used as a ball-fetcher, and the eighthman of the defending team would be the second line of defence behind his flyhalf or centre- both of which were low injury-risk situations for eighthmen. Although there was no change in the proportion of injuries to flyhalves from 1984 (Roux, 1992), it is postulated that the change in the role of the flyhalf may result in a different distribution of flyhalf injuries amongst the various phases of play.

Thus this Chapter suggests that the above-mentioned 4 law changes, introduced with the purpose of promoting open play by means of minimising the duration of set scrums and loose scrums, combined with the possible introduction of more modern playing patterns, may have influenced injury patterns at the different positions and during the different phases of play. These are characterised by a decreased risk of injury to eighthmen and a possible change in the distribution of injuries to flyhalves amongst the various phases of play. In Chapter 7, the specific changes in injury patterns at the different phases of play will be more closely analysed.

In concluding this section on the effects of the law changes, reference is made to an article written in 1992 by L.D. Smith, the New Zealand Rugby Football Union Director of coaching who said; "No matter how much law is put into the Law Book we cannot guarantee a safe game. The wider issue is an ethical one..... In a contact, or collision sport,

the opportunity exists for the coach to coach and the player to play in such a way that opposing players are badly injured unless both are made aware of the ethical standards expected in the game. No amount of legislation will solve this problem..... When common sense does not prevail we need the support of the law but it must be the business of our coaching movement to establish and maintain a safe rugby environment, and to make sure the game is played positively and constructively.”

6.3.2 Incidence of injury

(a) Under-reporting of injuries

Incidences of injury per boy-hours of rugby is discussed under this section in order to make direct comparisons with the study of Roux (1992). In the 1983 study, 495 players were reportedly injured whereas 410 were injured in 1984 (Roux, 1992). This 17.2% decrease may have indicated a decrease in the incidence of injury. However it was noted that during the second (1984) year, personal contact with the 6 personally monitored schools was relaxed, resulting in 79 (42.7%) fewer players reported injured in those 6 schools (185 injuries in 1983 and 106 in 1984). In the 20 correspondence monitored schools, there was a decrease of only 1.9% over the 2 years (310 injuries in 1983 and 304 in 1984), suggesting that the research methods may have been responsible for the decreased number of reported injuries.

When schools in the present study were divided into those which were personally and correspondence monitored in the study of Roux (1992), the overall incidence of injury in the “personally monitored” group was 1 injured player for every 417, 723 and 836 boy-hours of rugby in 1983, 1984 and 1991 respectively, while in the 20 “correspondence monitored” group, the overall incidence was 1 injured player for every 736, 748 and 563 boy-hours of rugby in 1983, 1984 and 1991 respectively. (Figure 6.6). Thus, in 1983, the incidence of injury in the correspondence monitored schools was 43.3% lower than in the personally monitored schools, in 1984 was only 3.3% lower in the correspondence

monitored schools, but surprisingly, in 1991 was 32.7% higher in the “correspondence monitored” group than in the “personally monitored” group.

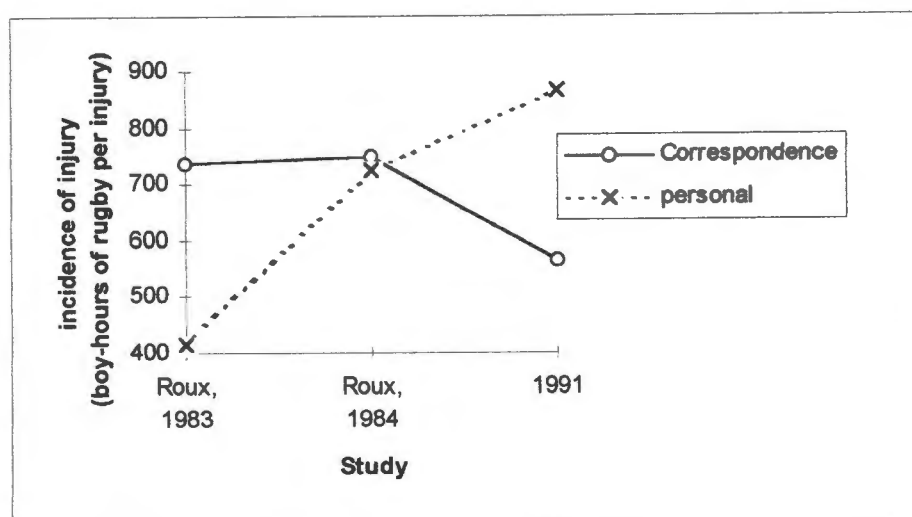


Figure 6.6 The incidence of injury in the personally monitored and the correspondence monitored schools in 1983, 1984 (Roux, 1992) compared to the same two groups of schools in 1991 (this study).

The increased incidence in the “correspondence monitored” group in 1991 may have been a result of telephonic contact with the master-in-charge of rugby at each school at the beginning of the 1991 season, the purpose of which was to seek active support for and cooperation in the study and on a second occasion, to clarify areas of uncertainty. In the study of Roux (1992), no contact was made with this group of schools. Further, the decreased incidence in the “personally monitored” group was most likely a result of 2 schools in particular who displayed a reluctance to participate in the survey (personal observation). The overall injury rate at each of these 2 schools in 1991 was 1 injury per 1067 and 1248 boy-hours of rugby respectively, compared to the combined injury rate of 1 injury per 417 and 723 boy-hours of rugby respectively reported for the 6 personally monitored schools in 1983 and 1984. Individual injury rates from Roux’s study (1992) for these 2 schools are unfortunately not available.

These findings clearly show that, when monitoring of injuries via correspondence, the incidence of injury may be inaccurate by up to 50.0%, and that the extent of the inaccuracies is highly dependent on the nature of the correspondence and the attitudes of the participants in the study. Thus the injury incidences reported in the present study reflect substantial underreporting in the “personally monitored” schools, the opposite of the finding in the earlier studies of Roux (1992).

(b) Overall incidence of injury

The risk of injury was 10.4 per 100 player-seasons in 1983, 8.8 in 1984 and 10.4 in 1991. Bird *et al.* (1998) who monitored 356 under-19, under-21 and senior club rugby players via weekly telephonic contact showed a risk of 164.9 injuries per 100 player-seasons. This high incidence when compared to the present study is a result of the researchers using a more inclusive definition for injury, the fact that subjects included club players (who are more often injured than schoolboy players, Clarke *et al.*, 1990) and that their method of data collection largely eliminated under-reporting of injuries.

It is concluded that contrasting incidences reported in the various rugby injury studies are primarily a result of the different definitions and the different research methods employed in each study, and less as a result of differences in the actual incidences. Underreporting of injury remains as a significant deterrent to determining exact injury incidences. Hence all the reported data in this thesis reflect estimates rather than precise numbers.

(c) Match and practice incidence of injury

Researchers who included a differentiation between match and practice injuries concur that approximately two-thirds or more of rugby injuries occur during match play. Nathan (1983) reported that 63.3%, Sparks (1985) 60.1%, Bird *et al.* (1998) 81.2%, Roux 71.5% in 1983 and 64.6% in 1984 and the present study 74.5% of all injuries occurred during match play. The competitive levels of match play, the high level of physical contact during matches, increased vigour, the unpredictability of match play situations, “psyching up” and

a strong desire to win are probably the main contributors to the higher incidence of match injuries.

When practice injuries are considered, Clark (1990) reported that 58.0% of those occurring in senior first-division clubs, and Chapter 3 of this study reports 68.8% of those occurring at Senior Provincial level were as a result of contact match-practice. There is also evidence (Chapter 3) that different coaching philosophies and techniques may influence the incidence of practice injuries. Roy (1974) made the observation that injuries occurring during practice sessions suggest inadequate supervision and flawed coaching methods, and that they simply should not occur. This is an unrealistic observation, if practices are to mimic matches then more unavoidable injuries would occur during practices. In order to reduce contact injuries occurring during practices and to condition players to sustain physical contact during matches, it is suggested that physical contact during practices should occur in a controlled and predictable environment.

6.3.3 Age-group and level of play

The present study showed that relative risk of injury with increasing age is significant ($p < 0.0001$), and that A-team players from all age-groups are at 1.52 times greater risk of injury than players in lower age-groups ($p < 0.533$). Davidson (1987), Nathan *et al.* (1987) and Roux (1992) showed that over 20.0% of all schoolboy rugby injuries occurred in players in the under 19-A teams. In the present study, the players most at risk were under-19 A players, followed by under-19 B, under-15 A and under-16 A players.

Various researchers have proposed that reasons for the greater incidence of injury occurring in higher teams and older age-groups include physical maturation, and that stronger, faster and heavier players are selected in the A-teams where the game is played with increased vigour, determination and speed (Walkden 1975; Myers 1980; Silver 1984; Silver and Gill 1988; Taylor and Coolican, 1987). The present study suggests that the emphasis on winning may also be greater at A-team level, particularly in the under-19 age-group where the success of the first rugby team (under-19 A) is often seen as a reflection

of the school's overall rugby prowess, and is sometimes perceived as a reflection of the schools public standing. Hence, players in higher teams and older age-groups are subject to far greater collision forces than their physically less mature and less competitive counterparts in lower teams and younger age-groups.

(a) Morphology

From the fact that A-team players at all levels of play are heavier than their counterparts in lower teams (Chapter 5 of this thesis), and that they are also at greater risk of injury than players in lower teams, it follows that the heavier players in each age-group would sustain a higher percentage of injuries. Indeed, 3 separate studies have shown that heavier players tend to be injured more frequently (Van Heerden, 1976; Van Heerden, 1997a; Davies and Gibson, 1978). It is concluded that heavier players are more frequently injured at schoolboy level primarily as a result of being selected in higher levels of play where injury is more frequent.

(b) Pre-season training

Chapter 5 of this thesis shows that a greater percentage of players at higher levels (A-team) and older (under-19) age-groups undertook pre-season endurance and strength training. As risk of injury is greatest at these higher levels of play and older age-groups, it may be deduced that musculo-skeletally fitter players would sustain a greater percentage of injuries when compared to less fit players. This was the case in Van Heerden *et. al's* study (1997b), in which it was concluded that superior musculo-skeletal fitness among high school rugby players appeared to predispose to, rather than preclude from injury. This conclusion is potentially dangerous as it may discourage players to train their physical fitness. At Provincial senior level, the evidence is that the incidence of injury may be decreased via participation in comprehensive pre-season strength and endurance training (Chapter 3 of this thesis).

That Chapter Five showed no relationship between pre-season strength or endurance training and injury risk amongst schoolboy players, and Chapter Three demonstrated that pre-season training did predict injury risk amongst senior provincial players, may have been a result of a number of factors. These include; the diversity in levels of play and physical maturity amongst schoolboy players compared to very similar competency levels amongst the physically mature senior players; the more subjective nature of the data collection in the schoolboy study compared to more controlled methods in the provincial study; and that it was not possible to calculate the inter-relationship between strength and endurance training amongst schoolboy players.

It is concluded that, as schoolboy players mature in age and skill level, the risk of injury increases. Accordingly, correct coaching techniques, improved knowledge of injury prevention and increased physical conditioning become increasingly important factors in preventing injuries.

6.3.4 Playing positions

Clarke et al (1990) found that amongst first-division rugby players, hookers (19.0%) sustained the most injuries. Roy (1974) also reported a high percentage of injuries to hookers, although he showed eighthmen to be the most commonly injured player. Other studies reported that fullbacks were at most risk of sustaining an injury (Durkin, 1977; Myers, 1980; Williams, 1984). Bird *et al.* (1998) reported no significant difference between positional groups for males during matches, but that for females, inside backs had the highest incidences in matches and practices. Hughes and Fricker (1994) and Garraway and MacLeod (1995) reported no significant differences in the proportion of injury episodes according to position. Thus, except for a commonly high percentage of injury to wings (Roy, 1974; Durkin, 1977; Myers, 1980; Williams, 1984; Clarke *et al.*, 1990; Roux, 1992), few similarities regarding positional risk of injury exist amongst different rugby injury studies.

In the present study, wings (16.5 injuries per 100 player-seasons) and hookers (14.3 injuries per 100 player-seasons) were individual players most often injured ($p < 0.02$), while locks (5.6 per 100 player-seasons), eighthmen (6.0) and props (7.5) the players least often injured ($p < 0.0003$). In contrast, in the 1983 and 1984 studies (Roux, 1992), the eighthman was the player most at risk of injury and the hooker one of the players at least risk. It has been postulated that contrasting risks at hooker (increased in 1991) and eighthmen (decreased in 1991) was a result of the law changes introduced in 1990 and 1991 (see earlier in discussion).

(a) Forwards vs. backline players

Backline players were at 1.5 times greater risk of injury than forwards. Furthermore, the risk of injury to tight-forwards (front-row and lock) was 8.1 injuries per 100 player-seasons, to loose forwards was 9.3, to halfbacks (scrumhalf and flyhalf) 10.9 and to outside-backs (centre, wing, fullback) 13.2.

It is concluded that, at schoolboy level, outside-backs are the players most often involved in the high speed phases of play, and in particular the tackling phases, and are thus at greatest risk of sustaining an injury that will keep them out of rugby for 7 days or more.

(b) Substitutes in unfamiliar positions

The number of boy-hours of rugby that players spent substituting in unfamiliar positions is not known, but that 33 players (8.0% of all injured players) were injured whilst doing so, indicates that this unacceptable practice still occurs. Of particular concern is that 9 non-specialist front-row players were injured whilst substituting in this position, 5 of whom were injured during scrums. Further emphasising the danger of this practice is that the only cervical spinal dislocation sustained by a player in this study during a scrum, was sustained by a flank whilst substituting at prop. The other scrum injuries sustained by these 'substitute' front-row substitutes were, a neck ligament injury, a neck muscle injury, a

combined neck muscle and neck ligament injury and combined back muscle and back ligament injury.

Several other researchers have also demonstrated and highlighted the dangers of inexperienced, unfit or un-skilled players playing in the front-row of the scrum (Calcinai, 1985; Burry and Calcinai, 1988; Silver, 1988; Silver and Gill, 1988; Silver, 1992). In a study of the same population as the present study (Chapter 8 of this thesis), 937 (37.0%) of a total of 2646 players who were not specialist front-row forwards indicated that they had substituted in this position at some stage of their career; 160 (16.0%) indicated that they were injured whilst doing so. Milburn (1990) went on to identify the powerful downward forces that develop on all front-rows and suggested that only the very best scrummagers could prevent the natural tendency of the scrum to collapse on engagement. This further confirms why it is totally unacceptable for non-specialist front-row players to substitute in this position.

Lee *et al.* (1997) reported one fifth of all injuries occurring to players who were playing out of position, with flanks (33.0%), centres (25.0%) and eighthmen (24.0%) incurring the highest proportion of injuries while playing out of position. Williams (1984) showed 6.3% of injuries that kept players from rugby participation for 2 weeks or more were sustained by players substituting in unfamiliar positions.

Concurring with other researchers, it is concluded that the practice of playing an inexperienced player out of position in high-risk positions (such as hooker and prop) is dangerous and inexcusable (Silver, 1984; Burry and Calcinai, 1988), contrary to the guidelines of the International Rugby Football Union (Noakes and du Plessis, 1996) and thus should simply not occur.

(c) Effect of age

There seemed to be no difference in the injury patterns at any of the playing positions between players in younger age-groups (under-14 to under-16) who were still undergoing

physical growth changes, and under-19 players who should have achieved physical maturity.

Further, no evidence of the high injury risk at under-19 fullback, under-19 hookers and junior level props that were highlighted in Roux's study (1992), was found in the present study.

6.3.5 Different periods of the season

(a) Match injuries

Several rugby injury surveys have shown a higher incidence of schoolboy (Nathan *et al.*, 1983; Roux, 1992) and adult (Sparks, 1981; Williams, 1984) rugby injuries during the first 4- to 8-week period at the beginning of the season and again after the mid-season break. Amongst male rugby players, Alsop *et al.* (in press) showed an early-season peak followed by a significant decrease in match and practice injury rates as the season progressed, while female match and practice injury rates were highly variable with no significant trend over time. Van Heerden (1976) found that injuries were most likely to occur in the first half of the season; Roy (1974) found that injuries were likely to occur at any stage of the season, whereas Williams (1984) found that injuries occurred more frequently in mid-season. Explaining the mid-season injury trend, Williams suggested that pre-season training is taken very seriously at club level (which constituted the majority of players in his study) in Wales but not at school level.

Further, studies of cervical spinal injuries conducted amongst adult (Williams and McKibbin, 1978; Scher, 1979; McKibbin, 1987; Kew *et al.*, 1991) and schoolboy (McCoy *et al.*, 1984, Kew *et al.*, 1991) rugby players showed that more of these injuries occurred at the start of the rugby season. Thus, it is of particular concern that only 18.0% of 684 specialist front-row forwards in the present study had knowledge of correct strengthening exercises and that less than 1.0% followed such a programme (Chapter 5 of this thesis).

The most popular explanations for the increased number of injuries at the beginning of the season is a lack of match fitness or physical conditioning, or both. Similarly the greater number after the mid-season break is ascribed to a loss of some match fitness or physical fitness during the mid-season break (Burry, 1981; Sparks, 1981; Dalley *et al.*, 1982, 1992; Nathan *et al.*, 1983; McCoy *et al.*, 1984, Williams, 1984; Clark *et al.*, 1990; Roux, 1992; Hughes and Fricker, 1994; Garraway and Macleod, 1995).

That there was no significant difference in injury risk for players who either participated in pre-season fitness training and pre-season strength training but without playing any pre-season contact matches, or who did no physical training or match practice whatsoever, suggests that lack of match (contact) fitness is the major factor responsible for the high injury incidence amongst schoolboy rugby players at the beginning of the season.

(b) Practice injuries

The sharp decrease in the number of injuries reported during practices in the third 4-week period was most likely due to the advent of mid-year academic examinations which would have resulted in less time being allocated to practices. Some of the lower teams in each age-group might not have had scheduled fixtures and thus would not have practised. Similarly, by the fifth 4-week period, some of the lower league teams may have completed their league programmes, and thus would not have practised, which would have contributed to the apparent decreased risk of injury at the end of the season.

Alsop *et al.* (in press) showed that the pattern for practices follows closely that for matches, that is that the fewer the number of matches, the less the time spent practising. For the above reasons, the assumption used in the present study that all teams practice for 3 hours per week throughout the playing season may be incorrect and would most likely have contributed to erroneously deflated (practice and overall) injury rates, particularly during the third and fifth 4-week periods of the season, due to an overestimation of the real number of hours of rugby practice.

Alsop *et al.* (in press) also argue that part of the decrease in injury rates/ incidence over the season observed in studies using the so called “pyramid” approach to data collection (where information is collected by a person appointed to a team, who passes it on to a co-ordinator, who passes it on to the researchers), may be attributable to a decrease in interest both among players and those responsible for co-ordinating the collection of information. Dalley *et al.* (1992) who used such a pyramid system, reported that 46.0% of injuries occurred in the first month and only 1.0% in the final month. Garraway and MacLeod (1995) suggest that the pyramid system can work successfully providing that intensive monitoring is performed by paid staff. Both Roux’s study (1992) and this study, which relied on a pyramid system with no reimbursement to participants, showed a high rate of under-reporting.

It is concluded that the high incidence of match injuries at the beginning of the season was a result of lack of match (or contact) fitness and not a lack of physical conditioning, and that it may have been accentuated by possible under-reporting of injuries as the season progressed. It is further concluded that the dramatic decrease in practice injuries as the season progressed is exaggerated due to the incorrect assumption that all teams practised for 3 hours per week during the season.

6.3.6 Venue and score in match

This study suggested that neither the match venue (home 46.0%, away 54.0%) nor end result of a match (winning team 49.5%, losing team 46.5%) had any influence on injury risk. Further, although the distribution of winning margins for all matches over the course of the season is not known, it is reported that 63.4% of injuries occurred in more closely contested matches where the winning/losing margin was less than 15 points, a differential which was arbitrarily chosen.

6.3.7 Time in match

Physiological fatigue over the course of a match has been suggested as a contributing factor for rugby injury (Reilly and Hardiker, 1981; Dalley *et al.*, 1982; Wekesa *et al.*, 1996) and Wekesa *et al.* argued that more injuries should occur in the second half of the match when players are fatigued. Most researchers who investigated the time in the match in which injury occurred agree that the majority occurred in the fourth quarter, while there was little commonality for the incidence of injuries occurring in the first three quarters (Davies and Gibson, 1978; Williams, 1984; Sparks, 1985; Addley and Farren, 1988) (Table 6.8). In the present study, 32.1% of all muscle strains or tears occurred in the fourth quarter when the players were more likely to be physically fatigued. In contrast, Bird *et al.* (1998) reported that, when examined in ten minute intervals, injuries occurred evenly throughout the match.

Table 6.8 The percentage distribution of injuries in each of the 4 quarters of match play for the different studies.

STUDIES	QUARTER IN MATCH			
	1st	2nd	3rd	4th
Addley & Farren 1988	15	31	22	33
Davies & Gibson 1978	----- 39 -----		15	46
Sparks 1985	26.4	20.8	20.7	32.1
Williams 1984	15	27	30	28
This study 1991	28.3	19.8	21.2	30.7
Average :	21.2	24.7	21.2	34.0

Williams (1984) and Williams and McKibbin (1987) showed that 50.0% and 56.0% of serious cervical spinal injuries occurred during the first quarter of the match. Williams (1984) also showed that 75.0% of all scrum injuries occurred during the first 2-3 scrums of the match and suggested that this phenomenon may be due to players scrumming more vigorously and testing each other during the first few scrums, due to players being unsure of their relative strength of the front-row compared to the opposition and due to players

being unsure of their binding early on in the match. Although the present study showed 36.0% of the 22 scrum injuries during matches occurring in the third quarter and only 23.0% in the first, and thus does not concur with Williams (1984), it is none-the-less recommended that referees maintain particularly close control of the initial scrums of a match.

6.3.8 Avoidance of injury

Of all injuries in William's study (1984), players believed that 28.0% and referees that 34.0% could have been avoided. This compares to 43.0% of players in the present study who believed that their injury could have been avoided. That no allocation was made for players to explain how they believed their injury could have been avoided was an unfortunate omission in the present study. Interestingly, only 83.0% of the 42 players who reported a foul play injury believed that their injury could have been avoided. It is possible that the remainder of these players accepted foul play as a part of the game! It is suggested that future rugby injury studies should make an allocation for injured players to discuss, if so, how they felt their injury could have been avoided.

6.3.9 First-aid treatment

That in 72 (17.3%) of the 415 injury events the injured player reported that first-aid was not available at the playing venue, demonstrated that referees disregarded instructions by the (then) South African Rugby Board that if no first-aid or first-aid equipment was available at a match, the referee was instructed to cancel the match.

6.4 SUMMARY

1. The introduction of the sequential scrum engagement law 20 (2) did not decrease the overall incidence of injury to forwards during scrum, but did contribute to an increase in the risk of scrum injuries to hookers.

player most at risk of injury in 1983 and 1984, to the player second from the least at risk in 1991, while also contributing to a change in the distribution of injuries to flyhalves amongst the various phases of play.

3. Under-reporting of injuries by as much as 50% is a product of the method of monitoring of injuries via correspondence, and also of the attitudes of participants responsible for co-ordinating data gathering toward rugby injury research.
4. The contrasting incidences of injury reported in the various rugby injury studies are primarily a result of the different definitions of injury and the different research methods employed in each study, and less as a result of differences in the actual incidences.
5. There is a significant increase in injury risk with increasing age from under-14 to under-19, while players in A-teams at each age-group have a 1.52 times greater risk of injury than their counterparts in the lower levels of play.
6. Heavier players are more frequently injured at schoolboy level primarily as a result of being selected in higher levels of play where injury is more frequent.
7. Playing inexperienced players out of position, particularly in high-risk positions, such as hooker and prop, is a practice which still prevails amongst the schoolboy players in this study, and one which places the player at high risk of injury.
8. Lack of match (contact) fitness, rather than a lack of pre-season physical fitness, is the major factor responsible for the high injury incidence amongst schoolboy rugby players at the beginning of the season.
9. The incorrect assumption that all teams practised for 3 hours per week during the season was the primary cause of the dramatic decrease in the incidence of practice injuries as the season progressed.
10. Instructions by the (then) South African Rugby Board that if there was no first-aid or first-aid equipment available at the match site, the referee was to cancel the match, were not followed at 10.0% of matches venues where injuries occurred.

CHAPTER SEVEN

MECHANISM OF INJURY

7.1 INTRODUCTION

The previous Chapter failed to demonstrate any significant decrease in the overall incidence of injury amongst schoolboy rugby players as a result of the law changes introduced in 1990 and 1991. It did however, suggest that certain of the law changes may have contributed to the increase in the number of scrum injuries to front-row forwards, and others to a decreased risk of injury to eighthmen and a possible change in the distribution of injuries to flyhalves amongst the various phases of play. This Chapter further evaluates possible changes in injury patterns at each position and during the different phases of play as a result of the law changes, and possibly also as a result of modern playing patterns.

Although the off-side law 24A (2)(c) was amended in 1991 to protect the ball catcher during a kick (see Chapter 1), no other law changes were made that directly addressed the tackling phase of the game. This, despite most rugby injury studies showing tackling to be the most dangerous phase of play causing the majority of injuries, and also being identified as a contributor to serious cervical spinal injuries. The hypothesis under evaluation was that the laws which were introduced with the purpose of promoting more flowing play by decreasing the duration and interference of the ball from set scrums (Laws 20 (4), (19) and 24B(2)) and loose scrums (law 20 (7)), would cause an increase in the number of tackle incidents and thus a great number and proportion of injuries resulting from the tackling phase of the game.

Research has shown the loose scrum to be the phase of play responsible for the next highest occurrence of rugby injury (Inglis and Stewart, 1981; Sparks, 1985; Roux, 1992). In 1991, law 20 (7) was amended to encourage players to make the ball available at loose-scrums and in so doing to decrease the duration of this phase of play. The hypothesis under

evaluation was that lessening the duration of loose scrums would reduce the risk of injury during this phase.

The scrum, which accounted for 7-12% of injuries in studies of schoolboy (Nathan *et al.*, 1982; Sparks, 1985; Roux, 1992), is also a phase responsible for potentially catastrophic cervical injuries. Front-row players are the players at greatest risk of injury during scrums (Ingles and Stewart, 1981; Northern Transvaal Rugby Union study, 1982; Williams, 1984; Roux, 1992), with the majority of scrum injuries occurring to the head, neck and trunk region (Northern Transvaal Rugby Union study, 1982; Roux, 1992).

The previous Chapter showed that the amendments to law 20 (2), which prescribed the sequential scrum engagement, and which was introduced to reduce the forces in the scrum and to build pressure gradually, in fact caused a destabilising of the scrum which resulted in an increased risk of injury to hookers. Thus, the aim of this Chapter is to further investigate the exact nature and incidence of scrum injuries, particularly to front-row forwards.

Research has shown that 13% to 40% of all rugby injuries were a result of foul play (Roy, 1974; Davies and Gibson, 1978; Wessels, 1980; Inglis and Stewart, 1981; Lewis, 1994; Bird *et al.*, 1998). Addressing this undesirable and dangerous facet of the game, law 26 was amended to accentuate the penalty against offenders. Although not a direct result of the law changes, it was noted that various schools involved in the study administered corporal punishment to players who were sent off the field for foul play (personal communication). The hypothesis under evaluation was that the implementation of one or both of these deterrents would contribute to a decrease in the number of incidents of foul play, and thus in the number of resulting injuries.

In summary, the specific aims of this Chapter were to investigate the effect on injury patterns of the changes to laws involving the loose scrum, the set scrum and foul play by comparing results to those obtained in Roux's study (1992). It was postulated that as a result of the introduction of, or changes to laws 20 (4), (7), (19) and 24 B (2), there would

be an increase in the number and proportion of injuries resulting from the tackling phase of the game; law 20 (7), there would be a decrease in the number of injuries occurring during loose scrums; and law 26, there would be a decrease in the number of foul play injuries.

In addition, the more general aims of this Chapter were to describe for each phase of play during which injuries occurred; the distribution at each age-group and level of play, the distribution at each position, whether the player was in possession of the ball at the time of injury or not, the designation as a match or practice injury, whether the player felt his injury could have been avoided or not, the anatomical site and nature of injuries, and the specific diagnosis.

7.2 RESULTS INCLUDING COMPARISON WITH PREVIOUS STUDIES

The percentage occurrence of injury for different phases of play is shown in Figure 7.1, which also includes data from the 1983 and 1984 studies (Roux, 1992). The phase of play during which players were most commonly injured was while being tackled (37.6%). When added to the 19.3% of players injured while tackling, it confirms the finding in the 1983 and 1984 studies that more than 50% of injuries occurred during these two phases of play. All studies that differentiated between the tackler and the player being tackled found that the player being tackled was more frequently injured than the player executing the tackle (Roy, 1974; Nathan *et al.*, 1983; Addley and Farren, 1988; Clark, 1990; Roux, 1992; Bird *et al.*, 1998) (Table 7.1). Further, the loose-scrum was responsible for 20.0% of all injuries, and when this number is added to the injuries that occurred during the two tackling phases, the three phases accounted for 76.9% of all injuries. The safest phases of play were the line-out, kick-off/in and physical fitness training during practice (Figure 7.1).

Table 7.1 The proportion (%) of injuries occurring during the two tackling phases of play amongst schoolboy rugby players

LEVEL OF PLAY	STUDY		COMBINED TACKLING PHASES (%)	BEING TACKLED (%)	TACKLING (%)
School	Nathan	(1983)	47	25	22
	Roux	(1992)	53.1	29.4	23.7
	This study		56.9	37.6	19.3
	NTRU*	(1982)	39.5		
University	Roy	(1974)	49	40	9
Senior Club	Addley & Farren	(1988)	33.3	17.9	15.5
	Bird <i>et al.</i>	(1998)	40	20	19
	Clarke	(1990)	40	26	14
	NTRU*	(1982)	28.4	-	-
International	NTRU*	(1982)	25	-	-

* Northern Transvaal Rugby Union

When phase of play is reflected as a percentage of the players injured within an age-group, the findings of interest are that under-19 players, who sustained 56.1% of all injuries, sustained only 40.0% of scrum injuries and that under-14 players, who sustained 12.1% of all injuries, sustained 23.3% of scrum injuries and only 5.3% of open play injuries. (Figure 7.2; Table 7.2). Further, when phase of play is reflected as a percentage of the players injured at the different levels of play, A and B team players, who sustained 74.2% of all injuries, sustained only 53.3% of scrum injuries, and lower team players who sustained 25.8% of all injuries, sustained 46.7% of all scrum injuries. These findings indicate that players in the lower age-groups and lower levels of play sustained a disproportionately high percentage of scrum injuries when compared to other levels.

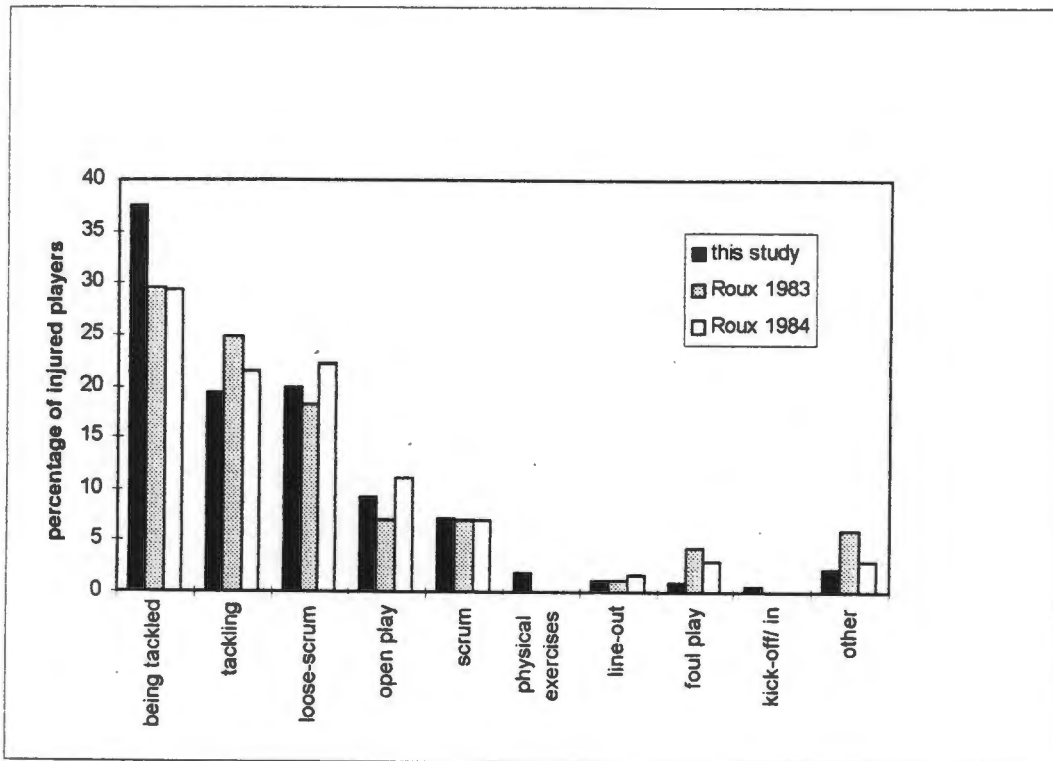


Figure 7.1 The percentage occurrence of injury for players in the different phases of play in the 1991 study, compared to the 1983 and 1984 studies (Roux, 1992).

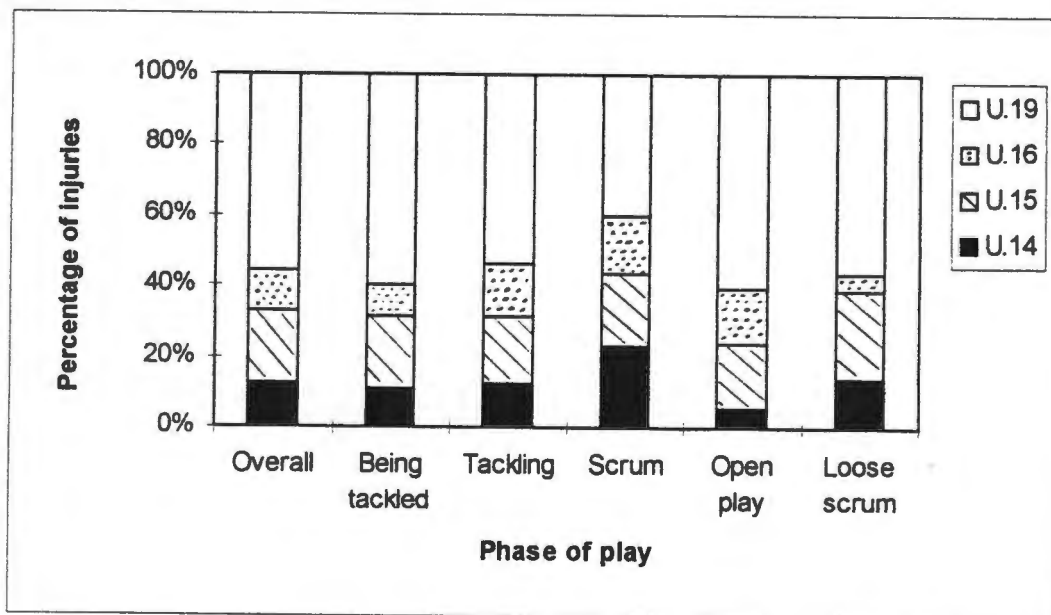


Figure 7.2 The percentage distribution at the different age-groups of injuries occurring during the different phases of play.

Table 7.2 The percentage distribution at the different age-groups and team levels of injuries occurring during the different phases of play.

	Overall players (%)	Overall injuries (%)	Being Tackled (%)	Tackling (%)	Scrum (%)	Open play (%)	Loose scrum (%)
AGE							
U.14	27.1	12.1	10.9	12.5	23.3	5.3	13.3
U.15	20.7	20.7	20.5	18.8	20.0	18.4	25.3
U.16	13.5	11.1	8.9	15.0	16.7	15.8	4.8
U.19	38.7	56.1	59.6	53.8	40.0	60.5	56.6
TEAM							
A and B	60.9	74.2	75.0	80.0	53.3	71.1	75.9
Lower	39.1	25.8	25.0	20.0	46.7	28.9	24.1

7.2.1 Being tackled

One hundred and fifty-six (37.6%) of the 415 injured players were injured while being tackled (Figure 7.1), compared to 29.4% in Roux's study (1992). Of these 156 injured players, 59.6% were under-19, 20.5 % were under-15, 10.9% under-14 and 8.9% under-16 (Table 7.2). In contrast, Roux (1992) showed 41.2% occurring to under-14 players and only 21.4% to under-19 players and suggested that the higher incidence amongst younger players was a result of poor tackling techniques.

In the present study, 75.0% of players injured whilst being tackled were A and B-team players from all age-groups (Table 7.2) and 78.2% were backline players. Players most at risk of injury were wings, fullbacks, flyhalves and scrumhalves (Table 7.3). Ten players who were injured while being tackled indicated that they were substituting in an unfamiliar position at the time of sustaining the injury.

Thirty-two (20.5%) of the players injured while being tackled indicated that they were not in possession of the ball at the time of sustaining the injury. Eighteen (56.0%) of these were a result of a late tackle, while the rest were due to the player having released the ball on being tackled and then being injured on contact with the ground.

Table 7.3 The incidence of injury in 1000 player-seasons at the different playing positions during the different phases of play.

	OVERALL	BEING TACKLED	TACKLING	LOOSE SCRUM	SCRUM	FOUL LAY
OVERALL	104.0	39.1	20.1	20.8	7.5	10.5
PROP	75.2	9.4	9.4	16.9	28.2	15.0
HOOKER	142.9	18.8	11.3	37.6	52.6	22.6
LOCK	56.4	5.6	5.6	32.0	5.6	7.5
FLANK	109.0	26.3	22.6	35.7	1.9	5.6
EIGHTHMAN	60.1	22.6	15.0	15.0	-	3.8
SCRUMHALF	116.5	45.1	15.0	30.1	-	11.3
FLYHALF	101.5	63.9	7.5	11.3	-	11.3
CENTRE	101.5	43.2	35.7	7.5	-	7.5
WING	165.4	92.1	47.0	13.2	-	15.0
FULLBACK	124.1	78.9	11.3	7.5	-	7.5

Of all players injured while being tackled, 77.6% were injured during match play. Thirty-two of the 35 players injured during practice were injured during a match practice, with the remaining 3 being injured whilst practising tackling skills. Eighty-nine (57.0%) of all players injured while being tackled felt that the injury could have been avoided. However, the questionnaire neglected to ask players to elaborate on how they felt their injury could have been avoided; hence these conclusions remain subjective.

The 156 players injured while being tackled reported 188 specific injuries. Of these injuries, 60 (31.9%) were fractures, which represents 48.4% of all fracture injuries sustained during all phases, and 35 (18.6%) were concussion injuries, which represents 48.6% of all concussion injuries sustained during all phases of play. Roux (1992) found 28.3% and Williams (1984) only 8.0% of concussion injuries occurring during this phase. One of the 2 neck fractures and 1 of the 3 neck dislocations reported in this study occurred

whilst the player was being tackled. In both of these being-tackled injuries to the neck, the collision occurred at high speed as the player was tackled high and directly from the front, an illegal procedure. In Roux's study (1992), 3 of the 7 cervical dislocations were sustained by a player whilst being tackled.

Sixty-four (41.0%) of the 156 players injured while being tackled sustained upper-limb injuries, the majority of which were muscle and fracture injuries. Thus 66.7% of muscle injuries during this phase occurred to the neck, shoulders and back and 80.0% of all fracture injuries during this phase occurred to the shoulders, arms and hands. These upper limb injuries were probably as a result of striking the ground after being tackled, either on an outstretched arm or on the point of the shoulder - as may occur when the ball carrier is tackled on the upper half of his body with his arms held in the tackle. Williams (1984) showed that 56.0% of all clavicle fractures occurred as a result of falling on an outstretched arm.

Of the 26.9% of lower limb injuries, ligament injuries were most common, 58.7% of which were to the knees and ankles. Contrary to these findings, Wilson *et al.* (1999) in their study of players ranging from International to schoolboy/girl level, found a higher proportion of injuries sustained by ball carriers were to the lower limb (51% vs. 27%), while a higher proportion sustained by tacklers were to the upperlimb (35% vs. 15%) and head/ face/ neck (28% vs. 17%). This suggests the possibility that at the different levels of play, the different skill levels involved in tackling, riding a tackle and falling may result in different injury patterns.

It is postulated that at lower levels of play, more upperbody injuries occur to the ball carrier as a result of impacting with the ground and as a result of poor falling techniques or possibly when being (judo) thrown to the ground in a lower speed tackle, while at higher levels of play, more lower limb injuries occur to the ball carrier as a result of high impact tackles around the legs. Wilson *et al.* (1999) concluded that the tackle injury was most often caused by impact with another player rather than impact with the ground. However, that 67% of the injuries reported by Wilson *et al.* were sprains/ strains (41%) and

haematomas/ bruises (26%) makes comparison difficult as the majority of these two injury types would have not been reported in the present study.

The player being tackled was most commonly injured when being tackled around the shoulders and hip/ waist (each 32.7%), while being tackled from a side-on direction (49.4%) and in a tackle executed at high speed (77.6%) (Table 7.4). The player being tackled deemed the tackle as unfair in 41 (26.3%) cases, and was injured in a head/ neck-height tackle in 12 (7.7%) cases.

Table 7.4 The anatomical site of impact, direction from which impact occurred, speed of impact and fairness of the tackle in cases in which injury was sustained by the player being tackled.

DETAILS OF IMPACT n = 156							
<u>SITE</u>		<u>DIRECTION</u>		<u>SPEED</u>		<u>FAIR</u>	
head/ neck	12	front-on	45	high speed	121	fair	115
shoulders	51	side-on	77	low speed	35	unfair	41
hip/ waist	51	behind	34				
legs	42						

7.2.2 Tackling

Eighty (19.3%) of the 415 injured players were injured while tackling (Figure 7.1), compared to 23.4% in Roux's study (1992). Of these 80 injured players, 53.8% were under-19, 80.0% were A and B-team players from all age-groups (who represented 74.2% of all injured players) and 66.3% were backline players. Backline players most often injured were wings and centres, and forward players most often injured were flanks (Table 7.3). Eight players who were injured while tackling indicated that they were substituting in an unfamiliar position at the time of the injury.

Of all players injured while tackling, 83.8% were injured during match play. Ten of the 13 players injured during practice were injured during a match practice, while the remaining 3

were injured whilst practising tackling skills. Thirty-three (41.3%) of the injured players felt that the injury could have been avoided.

Thirty (37.5%) of the 80 players injured while tackling sustained head and neck, 35.0% upper limb and 23.8% lower limb injuries.

The 80 players injured while tackling reported 94 specific injuries. Of these injuries, 24.5% were muscle, 22.3% were fractures and 21.3% were concussion injuries. Eight (40.0%) of the 20 laceration injuries occurred during the tackling phase. No cervical fractures or dislocations were reported.

Muscle and ligament injuries occurring during tackling were fairly evenly distributed between the upper and lower body, while 90.5% of fractures injuries occurred in the upper part of the body. The most commonly occurring were clavicle (6) and finger (6) fractures.

The tackler was most commonly injured when impacting the ball carrier around the hip/waist (47.5%) and legs (38.8%), while executing a tackle from a front-on direction (47.5%), and while executing the tackle at high speed (85.0%) (Table 7.5). The tackler deemed his tackle as unfair in only 2 (2.5%) cases, and was never injured while executing a head/ neck-height tackle.

Table 7.5 The anatomical site of impact on the player being tackled, direction from which impact occurred, speed of impact and fairness of the tackle in cases in which the injury was sustained by the player executing the tackle.

DETAILS OF IMPACT n = 80							
<u>SITE</u>		<u>DIRECTION</u>		<u>SPEED</u>		<u>FAIR</u>	
head/ neck	0	front-on	38	high speed	68	fair	78
shoulders	11	side-on	29	low speed	12	unfair	2
hip/ waist	38	behind	13				
legs	31						

7.2.3 Being tackled and tackling

Two hundred and thirty-six (56.9%) of the 415 injured players were injured during the two phases of being tackled and tackling. Of these 236 injury incidents, only 81.8% were reported to have been fair tackles, 80.1% were deemed as high speed collisions, 35.2% were from the front, 44.9% from the side and 19.9% from behind. The anatomical point of impact to the person being tackled was, around the neck 5.1%, shoulders 26.3%, hips and waist 37.7 and legs 30.9%.

A greater percentage of players sustained head and neck injuries while tackling (37.5%) than while being tackled (25.0%). Of all concussion injuries, the tackler sustained 27.8% and the ball carrier 48.6% in the present study compared to 22.4% and 28.4% reported by Roux (1992). In contrast, Williams (1984) showed that 5 times more concussion injuries were sustained by the tackler (39%) than by the ball carrier (8%) ($p=0.01$).

From evidence of 30 Provincial and International tackling injury incidents, Wilson *et al.* (1999) showed that tackles to the trunk (57%) were more frequently associated with injuries than low (43%) tackles, and that front-on tackles were responsible for nearly 3 times more injuries than either side-on tackles or tackles made from behind. This high incidence of front-on tackle injuries may have been a result of Wilson *et al.* including sprains and haematomas in their definition of injury. Further, they showed that no particular action in the tackle (e.g. crouch, arms out, leg drive, wrap arms, etc.), appeared to be associated with a greater number of observed injuries. However, when falling in the tackle, the landing was most associated with injury.

In the present study, 74.2% of injuries occurring during the tackling phases were to backline players compared to 66.8% in the 1984 study (Roux, 1992) and 64% in both Ingles and Stewart (1981) and Williams' (1984) studies. Common to all these studies was that the backline players most often injured were wings, centres and fullbacks, whereas flankers were the forwards at greatest risk. Thus players in these high risk positions should spend considerable time learning correct tackling and falling techniques. Research

amongst schoolboy rugby players (Chapter 8 of this thesis) gave the overall impression that insufficient time and emphasis was placed on the coaching of these techniques in pre-season training.

7.2.4 Loose-scrum

Eighty-three (20.0%) of the 415 injured players were injured during the loose-scrum (Figure 7.1). Of these players, 56.6% were under-19 players, 75.9% were A and B-team players from all age-groups and 72.3% were forward players. Forward players most often injured were hookers, flankers and locks, and backline players most often injured were scrumhalves (Table 7.3). Interestingly, flanks (35.7 injuries per 1000 player-seasons) were at 2.4 times greater risk of loose scrum injuries than eighthmen (15.0 injuries per 1000 player-seasons). Three players who were injured during a loose scrum indicated that they were substituting in an unfamiliar position at the time of sustaining the injury.

Twenty-six (31.3%) of the 83 players injured during the loose-scrum sustained head and neck injuries, the same number sustained lower limb injuries, and 25.0% sustained upper limb injuries.

Of all players injured during the loose-scrum, 77.1% were injured during match play. Eighteen of the 19 players injured during practice were injured during a match practice. Thirty-four (41.0%) of the injured players felt that the injury could have been avoided.

The 83 players injured during the loose-scrum reported 102 specific injuries. Of these injuries, 29.4% were ligament, 24.5% were fracture and 16.7% were muscle injuries. One neck dislocation was reported during a loose-scrum in this study compared to 2 neck dislocations and 1 hip dislocation in the 1984 study (Roux, 1992). None of the neck injuries sustained in either study caused permanent disability.

The neck muscles accounted for nearly half (47.1%) of all muscle injuries that occurred during the loose-scrum. The knees and ankles (70.0%) were the most common sites for ligament injuries, while the arms and hands (56.0%) were the most common fracture sites.

7.2.5 Open play

Thirty-eight (9.2%) of the 415 injured players were injured during open play (Figure 7.1). Of these players, 60.5% were under-19 players (who sustained 56.1% of all injuries), 5.3% were under-14 players (who sustained 12.1% of all injuries), 71.1% were A and B-team players from all age-groups and 57.9% were backline players. Amongst backline players, the occurrence of injury during open play was evenly distributed across the different playing positions.

Twenty-six (68.4%) of the 38 players injured during open play sustained lower limb injuries. Of all players injured during open play, 65.8% were injured during match play. Twelve of the 13 players injured during practice were injured during a match practice. Twelve (31.6%) of the injured players felt that the injury could have been avoided.

The 38 players injured during open play reported 43 specific injuries. Of these injuries, 41.9% were ligament and 23.3% were fracture injuries. Of the ligament injuries sustained, 94.4% were to the legs, which occur when the ankle or knee joints were forced beyond their normal range of movement. The fracture injuries were evenly distributed over the body. Of the six muscle injuries that occurred during open play, all were lower limb muscle strains.

7.2.6 Scrum

Thirty (7.2%) of the 415 injured players were injured during scrums (Figure 7.1). Of these players, 40.0% were under-19 players (who sustained 56.1% of all injuries), 23.3% were under-14 players (who sustained 12.1% of all injuries), and 46.7% were C and lower-team players from all age-groups (who represented 25.8% of all injured players). Players playing

in the front-row sustained 26 (86.7%) of all scrum injuries, with hookers (14 injuries at a risk of 52.6 per 1000 player-seasons) at 1.9 times greater risk of injuries than props (12 injuries at a risk of 28.2 per 1000 player-seasons) (Table 7.6). In Roux's study (1992), front-row players sustained 27 (81.8%) of all scrum injuries, with the hookers sustaining 5 and the props 22 injuries. A total of seven (23.3%) of the 30 players who were injured during scrums indicated that they were substituting in an unfamiliar position at the time of sustaining the injury. A flank and a lock were injured whilst substituting at prop, a lock and 2 flanks were injured at hooker, a wing was injured at lock and a fullback injured at flank. No eighthmen were injured during scrums.

In the present study, 66.7% of the 30 players injured during scrums sustained injuries to the head and neck (33.3%) and trunk (33.3%), compared to 81.8% to the head and neck (42.4%) and to the trunk (39.4%) in the 1984 study (Roux, 1992) and 64.6% to the head, neck and trunk in the Northern Transvaal Rugby Union study (1982). Of all players injured during scrums, 73.3% were injured during match play. Seven of the eight players injured during practice were injured during match practice. Eighteen (60.0%) of the injured players felt that the injury could have been avoided. No player was in possession of the ball at the time of injury.

The 30 players injured during scrums reported 42 specific injuries. Of these injuries, 45.2% were muscle and 26.2% were ligament injuries. One neck dislocation and 1 neck fracture occurred during scrums, compared to 2 of each of these injuries occurring during scrums in Roux's study (1992). Of the muscle injuries sustained during scrums, all were to the neck, shoulder, back and chest, while 72.7% of the ligament injuries were to the same anatomical sites. The 18 neck injuries (10 muscle, 6 ligament, 1 fracture, 1 dislocation) accounted for 42.9% of all injuries sustained during scrums, compared to the 19 neck injuries (15 muscle and ligament, 2 fractures, 2 dislocations) which accounted for 46.0% of all scrum injuries in Roux's study (1992). No concussions nor lacerations were reported.

Table 7.6 The percentage distribution of scrum injuries amongst the forward players.

POSITION	PERCENTAGE OF INJURED PLAYERS		
	1983 (%)	1984 (%)	1991 (%)
	n = 38	n = 33	n = 30
PROP	40	66.7	40
HOOKER	32	15.2	46.7
LOCK	10	9.1	10
FLANK	10	9.1	3.3
EIGHTHMAN	4	-	-
SCRUMHALF	4	-	-

7.2.7 Line-out

Five (1.2%) of the 415 injured players were injured during the line-out. Of these players, 4 were from the under-19 and 1 from the under-15 age-group. Two players were A and B-team players from all age-groups. Three locks, 1 flank and 1 scrumhalf were injured during line-outs

All injuries occurred during match play, 2 players felt that their injury could have been avoided and 3 were in possession of the ball at the time of injury. The 5 players injured during line-outs each reported only 1 specific injury. They included 1 concussion injury, 1 knee ligament injury and 1 abdominal, shoulder and arm muscle injury.

7.2.8 Kick-off/ in

Two players reported that their injuries occurred during a kick-off/ in. Both occurred during matches; an under-19 D flank injured a groin muscle and an under-15A lock dislocated a finger. Both players were in the team receiving the ball.

A further 2 players reported that they were injured while being tackled at the kick-off/ in, and 1 reported being injured during the ensuing loose-scrum. These injuries were reported

in this Chapter under “being tackled” and “loose-scrum” injuries. All 3 were in the team receiving the ball at the kick-off/ in.

7.2.9 Foul play

Foul play injuries, which accounted for 10.1% of all injuries, included injuries occurring as a result of illegal tackles, illegal scrummaging techniques, punches and kicks. Four of the 42 players injured as a result of foul play reported foul play as the only mechanism of injury (Figure 7.1). The remaining 38 players indicated that they were injured as a result of foul play during other phases which included; the loose-scrum (44.7%), while being tackled (34.2%), during scrums (10.5%), open play and whilst tackling (5.3% each). Roux (1992) found 2.9% and Nathan found 8.0% of injuries occurring at schoolboy level were as a result of foul play. Other researchers (Roy, 1974; Davies and Gibson, 1978; Wessels, 1980; Inglis and Stewart, 1981; Lewis, 1994; Bird *et al.*, 1998) found that 13% to 40% of all injuries were a result of foul play. Williams (1984) demonstrated that foul play injuries occur more frequently at club level than school level.

Of the 42 foul play injuries, 47.6% occurred at under-19 level, 42.9% in A-teams at all levels of play and 90.5% during match play, where aggressive and competitive play was the likely cause. Hookers followed by props had the highest risk of foul play injuries, the majority occurring during loose scrums, whilst wings had the next highest risk, the majority occurring while being tackled. Twenty-nine (69.0%) of the players were not in possession of the ball when injured, a situation known as an “off-the-ball” incident in rugby.

Fifty-four specific injuries were sustained by the 42 players, with fractures (27.8%), ligament (24.1%) and muscle injuries (22.2%) the most commonly occurring.

7.2.10 Physical exercises during practice

Eight (1.9%) of the 415 injured players were injured during the physical exercises that constitute physical fitness training. Of these players, 4 were from the under-19 and 3 from the under-16 age-group. Five players were from A and B-teams.

Six (75.0%) players were in possession of the ball at the time of injury and 6 players felt that their injury could have been avoided. Three ligament injuries (neck, knee and ankle), 2 fractures (both clavicle), 2 muscle injuries (both hamstring) and 1 severe concussion, in which the player lost consciousness for more than 5 minutes, were sustained during physical exercises at practice.

7.2.11 Other phases of play

Nine (2.2%) of the 415 injured players reported that their injury occurred during other phases of play. Of these players, 3 (33.3%) were under-19 and 3 were under-14, and 6 were A and B-team players from all age-groups.

The 9 players injured during other phases of play reported 10 specific injuries. Five of these injuries were muscle injuries (3 back and 2 thigh), and 1 each was a spinal ligament, a toe fracture, a ruptured tibial artery, a slipped intervertebral “disc” and a knee effusion. Three of the players felt that the injury could have been avoided during these other phases.

7.3 DISCUSSION

7.3.1 Tackling and being tackled

The hypothesis under evaluation was that changes to the laws 20 (4), (7), (19) and 24B (2) (see Chapter 1), which were introduced with the purpose of promoting open play by means of minimising the duration of set scrums and loose scrums, would cause an increase in the number of tackle incidents and thus a great number and proportion of injuries resulting from the tackling phase of the game. This hypothesis is rejected as the 56.9% of injuries occurring in the combined tackling phases in 1991 is only slightly higher than the 54.3% and 50.8% reported in the 1983 and 1984 studies respectively (Roux, 1992).

However, the previous Chapter suggested that the above-mentioned law changes, combined with possible introduction of modern playing methods, may have influenced injury patterns at the different positions and during the different phases of play. It was postulated that the tactic of the eighthman attacking around the fringes from the base of the scrum was rendered less effective than under the previous laws, in conjunction with the introduction of modern playing patterns, may have resulted in a decrease in the risk of injury to eighthmen and a change in the role, and thus injury patterns, of the flyhalves.

Supporting the explanation of the flyhalf taking a crash ball to set up phases of play, is the finding that there was a 73.1% increase (from 36.4% in 1984 to 63.0% in 1991) in the proportion of injuries sustained by flyhalves while being tackled. A further indicator that the flyhalves in this study assumed a tighter and more contact game is that the proportion of open play injuries to flyhalves decreased by 84.5% (from 27.3% in 1984 to 14.8% in 1991) and that the proportion of match injuries increased by 50.4% (from 59.1% in 1984 to 88.9% in 1991). That injuries to scrumhalves whilst tackling decreased from 9 in 1984 to 4 in 1991, also supports the suggestion that the above-mentioned laws rendered attacking movements around the fringes from the base of the scrum less effective than under the previous laws, and that these attacking movements took place further out from the scrum (at flyhalf). It was not possible to present data for inside- and outside-centres in

this study as several teams still used the system where players played at either left- and right-centre (personal observation).

It is concluded that changes to laws 20 (4), (7), (19) and 24B (2), and the introduction of new playing patterns, caused only a slight increase in the proportion of tackle injuries, but did contribute to a decrease in overall risk of injury to eighthmen, a slight decrease in tackling injuries to scrumhalves and marked increase in the number of injuries to flyhalves whilst being tackled.

In the 1984 study, Roux (1992) suggested that the greater percentage (41.2%) of under-14 than under-19 (21.4%) players who were injured while being tackled, was a result of poor tackling and falling techniques in the younger age-groups. In the present study, under-14 players (who sustained 12.0% of all injuries) sustained 10.9% and under-19 players (who sustained 56.1% of all injuries) sustained 59.6% of injuries while being tackled. Thus there was no evidence for an increased risk of being tackled injuries at under-14 level. Further, if poor tackling and falling techniques do predispose players to injury, one might expect that not only younger, but also less skilled players in possibly C- and lower teams would be at an increased risk of injury during the tackling phase. In the present study, C- and lower team players in all the age-groups (who sustained 25.8% of all injuries) sustained 25.0% of all being tackled injuries. Further, under-19 C- and lower players (who sustained 33.5% of all injuries) sustained 34.4% and under-14 C- and lower players (who sustained 16.0% of all injuries) sustained 17.7% of injuries while being tackled.

Hence the present study does not support the findings of Roux (1992) that younger players are at greater risk of injury when being tackled, nor does it support his explanation that these injuries occur at these younger age-groups as a result of poor tackling and falling techniques.

7.3.2 Nature of being tackled injuries

Williams (1984) suggested that knee and ankle ligament injuries occurred to the ball carrier as a result of rotatory movement whilst being tackled. Under the 1991 laws, in order to minimise stoppages and to promote more flowing play, the ball carrier was penalised for playing the ball immediately after being grounded in a tackle. The tackled player was thus compelled to concentrate on transferring the ball, rather than breaking his fall, while in the process of being tackled. The action of attempting to sight and then pass to support players while being held or falling in a tackle would predispose the tackled player firstly, to rotatory injuries of the lower limb and, secondly to upperbody injuries resulting from impact with the ground. Evidence of the latter situation is that 9.0% of players injured whilst being tackled were not in possession of the ball at the time of sustaining the injury and indicated that they had released the ball in the tackle and were injured on landing. Until recently (1998), the laws allowed a player to play the ball immediately after being grounded in a tackle. This law facilitated concentrating first on falling safely in the tackle and then on making the ball available.

It is concluded that the law penalising a player for playing the ball immediately after being grounded possesses the advantage of promoting open and flowing rugby, but the disadvantage of predisposing the tackled player to injury.

7.3.3 Loose scrum

The change to loose scrum law 20 (7), which was introduced to decrease the duration of this phase, had little effect on the overall percentage of players injured during loose-scrums (22.2% in 1984 and 20.0% in 1991). The only notable change in loose-scrum injury patterns was that in 1991, eighthmen sustained 4.8% of all loose scrum injuries compared to 15.9% in 1984. That there was no significant change in the percentage of loose scrum injuries may however, (falsely) lead to the rejection of the hypothesis that the amendments to law 20 (7) would reduce the risk of injury during loose scrums. It is postulated that changes to laws 20 (4), (7), (19) and 24B (2), the purpose of which was to decrease the

duration of the scrum and loose scrum and thus to make the game more flowing, and the adoption of more modern patterns might have caused an increase in the number of loose scrums per match. If this is true, then the finding that there was little change in the number of loose scrum injuries between 1984 (Roux, 1992) and 1991, suggests that the amendments to the loose scrum law may have indeed decreased the risk of injury during loose scrums.

7.3.4 Scrum

Front-row players sustained 86.7% of all scrum injuries in this study, 72.0% and 81.8% respectively in the 1983 and 1984 studies (Roux, 1992), 71.4% in the Northern Transvaal Rugby Union study (1982) and 75% in Ingles and Stewarts' study (1981). Compared to the 1983 and 1984 studies (Roux, 1992), the increased percentage of injuries to front-row forwards in 1991 was accounted for by an increased percentage of injuries to hookers. Scrum injuries sustained by locks were largely unchanged over the study period, while injuries to the loose forwards decreased in the 1991 study. Further, scrums accounted for 7.7%, 8.0% and 7.2% of all injured players in the 1983, 1984 (Roux, 1992) and 1991 studies respectively, representing little variation in the incidence of scrum injuries.

These findings suggest that the law changes introduced in 1991 caused an increase in the proportion of scrum injuries sustained by front-row forwards, and in particular hookers, but had no effect on the overall incidence of injury to players in the scrum. If this latter finding is correct then the disproportionately high percentage of scrum injuries that occurred to under-14 players, who sustained 23.3% of scrum injuries compared to 12.1% of all injuries, and to players in C- and lower teams, who sustained 46.7% of scrum injuries compared to 25.8% of all injuries (Table 7.2), suggest that the scrum law changes might have placed less skilled players at greater risk of injury than more skilled players.

Supporting this finding, Silver and Gill (1988) suggest that law changes might take more time to take effect at junior levels where players are, unfortunately, often unskilled and

sometimes lack understanding of correct and safe techniques. These authors also highlighted that it was not always possible to provide a properly trained referee at these levels of play. Nathan *et al.* (1983) suggested that, particularly at younger ages, hookers are more prone to neck injuries than are prop forwards because they are usually less muscular than the more physically endowed props. Further, in the present study and particularly at the lower levels of play, coaching duties were performed by school teachers who were often not qualified, nor paid as coaches.

However, overshadowing all of the above explanations are the findings of Milburn and O'Shea (1994), who showed that the sequential scrum mechanism (law 20 (2)) contributed to prolonged duration and added a risk of instability during front-row contact, and again when the props moved away from the hooker to accommodate the locks joining the scrum. These findings were made using players from a first grade team and from a National squad. Milburn and O'Shea (1994) suggested that it was possible that less experienced scrummagers might experience even greater instability during these phases. Thus, it is concluded that the sequential scrum engagement law 20 (2) was ineffective in reducing the overall incidence of injury during scrums, but did contribute to an increased risk of scrum injuries to hookers, and also to less experienced front-row forwards.

Further, that 23.3% players who were injured during scrums were substituting in an unfamiliar position at the time of sustaining the injury, and that 71.4% of these were substituting in the front-row, clearly illustrates the danger of this practice. Further, the cervical spinal dislocation sustained during a scrum was sustained by a flank whilst substituting at prop. In a study of the same population (Chapter 8 of this thesis), 937 (37.0%) of a total of 2646 non-specialist front-row forwards indicated that they had substituted in this position at some stage of their career; 160 (16.0%) indicated that they were injured whilst doing so. Silver (1992) suggests that the importance of being trained for a particular position, especially the front-row, is not appreciated in the lower echelons of rugby. Of all the phases of play, players felt that scrum injuries were the most avoidable, with 60.0% of players injured in the scrum indicating that they felt that their injury could have been avoided. It is concluded that, as is evident by the number of injuries sustained

under these circumstances, the “unacceptable” practice of substituting non-specialists in the front-row position still prevails. This practice should be entirely eradicated from the game of rugby.

7.3.5 Foul play

The present usage of retrospective television citing of foul play incidents in senior Provincial and International rugby may well prove effective in reducing the incidence of foul play injuries at these levels. However, at club and schoolboy level, players should accept personal responsibility for their actions, as should coaches for the message they provide to players. In an attempt to reduce incidents of foul play, New Zealand recently established judicial committees to deal with this issue and initiated the awarding of fair play prizes (Bird *et al.*, 1998).

That Nathan *et al.* (1983) found 8.0% of injuries occurring as a result of foul play in a study of 10 to 19 year-old players, and Roux (1992) found only 2.9% occurring amongst 14 to 19 year-old players, and that both used the same injury definition and similar study populations, suggests an error in study methods. Roux demonstrated that the extent of under-reporting in his study could have been as much as 40-50% when compared to methods used in Nathan *et al.*'s study. Further, that the present study, which showed 10.1% of all injuries occurring as a result of foul play, was conducted after an amendment to the law 26 (which should have had the effect of decreasing foul play injuries) and that the same population, definition of injury and methods of data collection was used as in Roux's study (1992), is more suggestive of erroneous study methods than an actual increase in foul play injuries.

It is postulated that the questionnaire used in 1991 was more inclusive and thus resulted in a higher percentage of foul play injuries being identified. The 1984 questionnaire did not adequately provide for example, for a foul play injury occurring during a scrum. Players had a choice of indicating only one mechanism of injury, either scrum or foul play. In the 1991 questionnaire, for a similar injury incident, the player would have filled in that the

injury occurred during a scrum, and then was prompted in a separate question to indicate if the injury was a result of foul play or not.

Thus the greater incidence of foul play injuries reported in 1991 compared to the 1984 study (10.1% vs. 2.9%) is most probably the result of a more inclusive injury questionnaire and not an increase in the number of foul play injuries. Thus it is not possible to either accept or reject the hypothesis as the slightly different questionnaires used in the two studies precluded true evaluation of the effect of the change to foul play law 26 on related injuries.

7.4 SUMMARY

1. Amendments to laws 20 (4), (7), (19) and 24B (2), combined with the possible introduction of new playing patterns, are likely to have contributed to;
 - the slight increase in the overall proportion of tackle injuries to all players,
 - the decrease in overall risk of injury to eighthmen,
 - the slight decrease in tackling injury incidents to scrumhalves,
 - the marked increase in the number of injuries to flyhalves whilst being tackled,
 - a possible the increase in the number of loose scrums per match.
2. Hence, the possibility that there was an increase in the number of loose scrums per match, but that there was minimal change in the percentage of loose scrum injuries from 1983 and 1984 (Roux, 1992), suggests that the amendments to the loose scrum law 20 (7) may have indeed decreased the risk of injury during this phase.
3. The present study does not support the findings of Roux (1992) that younger players are at greater risk of injury during being tackled, nor does it support his explanation that these injuries occur at these younger age-groups as a result of poor tackling and falling techniques.
4. The law which penalises a player for playing the ball immediately after being grounded in a tackle has the advantage of promoting open and flowing rugby, but as it encourages the tackled player to concentrate more on transferring the ball rather than on falling safely whilst being held in the tackle, it has the disadvantage of predisposing the tackled player to injury.
5. The sequential scrum engagement law 20 (2) did not decrease the overall incidence of injury to forwards during scrums, but did contribute to an increased risk of scrum injuries to hookers in general, and amongst less experienced front-row forwards in specific.
6. The slightly different questionnaires used in the two studies precluded true evaluation of the effect on injury of the amendment to foul play law 26.

CHAPTER EIGHT

DIAGNOSIS OF INJURIES

8.1 INTRODUCTION

While the specific aims of Chapters 6 and 7 of this study were to evaluate the effects on rugby injury of the law changes introduced in 1990 and 1991, this Chapter is epidemiological in nature and does not consider these law changes. Thus the primary aims of this Chapter are to analyse for schoolboy rugby injuries; the diagnosis, the anatomical site, whether the injury occurred during a match or practice, the distribution at each age-group, level of play, playing position, and phase of play, the rate of recurrence, and the number of days off rugby as a direct result of the injury and medical treatment administered.

Although previous rugby injury researchers have collectively evaluated the above factors, this study attempts to provide the most comprehensive epidemiological portrait of schoolboy rugby injuries to date.

Chapter 1 of this study describes the factors that complicate comparative analysis amongst various rugby injury studies. Briefly these include, a lack of adequately controlled prospective epidemiological surveys, and that most surveys used different definitions of injury, different methods of data collection, considered only specific injuries and/ or reported injuries seen only at one location. Further, weather conditions, condition of the playing field, different levels of play, variations in rugby laws and/ or coaching methods and presence or absence of protective devices may also cause variations in injury patterns in the different studies. Where possible these factors are further evaluated in this Chapter.

8.2 RESULTS

A total of 498 specific injuries were reported by the 415 injured players, indicating that certain players suffered more than 1 specific injury per injury incident. The most commonly occurring types of injury were ligament (31.8 injuries per 1000 player-seasons), fracture (31.1 injuries per 1000 player-seasons) and muscle injuries (26.8 injuries per 1000 player-seasons) (Table 8.1). These 3 accounted for 71.9% of all injuries, compared to 68.5% and 77.7% respectively in the 1983 and 1984 studies (Roux, 1992). Concussion accounted for 14.5% of all injuries in this study compared to 12.3% and 13.2% respectively in the 1983 and 1984 studies (Roux, 1992).

Ninety-two (18.5%) of the 498 injuries were reported as a recurrent rugby injury, where the initial injury was sustained either earlier in, or prior to the 1991 season. Concussions (33.3%) were reported with the highest incidence of recurrence, followed by specific muscle (26.2%) and ligament injuries (25.2%). The least commonly recurring injuries were fractures (3.1%) and dislocations (5%).

Table 8.1 shows the average number of days that players spent out of rugby due to the different types of injury. As was the case in Roux's study (1992), Figures were only calculated for cases where a player sustained only 1 specific injury during 1 injury incident. In cases where more than 1 injury was sustained in the same incident, it was not possible to determine the number of days out of rugby for each specific injury sustained. An exception was made in the case of a dislocation injury, in which a ligament injury would almost always be suffered. The number of days out of rugby during this particular injury incident were reported under the heading of dislocation injuries.

Table 8.1 The incidence for the different types of injury per 1000 player-seasons, for each age-group, level of play and playing position, as well as the average days off rugby as a result of these injuries.

		LIGAMENT	FRACTURE	MUSCLE	CONCUSSION	DISLOCATION	LACERATION
Total injuries		127	124	107	72	20	20
Incidence		31.8	31.1	26.8	18.0	5.0	5.0
AGE	U-19	49.2	38.2	38.2	25.2	6.5	9.7
	U-16	14.8	31.5	29.6	14.8	7.4	-
	U-15	34.0	31.5	24.2	24.2	3.6	4.8
	U-14	13.9	20.4	11.1	4.6	2.8	0.9
TEAM	A	34.5	42.4	34.5	36.9	7.8	11.0
	B	32.9	32.9	30.3	12.1	5.2	1.7
	Lower	28.8	20.5	17.9	7.1	2.6	2.6
Backline		34.4	43.0	30.6	23.6	3.8	5.9
Forwards		29.6	20.7	23.5	13.2	6.1	4.2
Prop		24.4	28.2	20.7	5.6	11.3	5.6
Hooker		48.9	30.1	45.1	22.6	7.5	-
Lock		20.7	7.5	20.7	9.4	3.8	1.9
Flank		35.7	30.0	22.6	16.9	1.9	5.6
No 8		26.3	3.8	15.0	18.8	7.5	7.5
Scrumhalf		26.3	33.8	22.6	26.3	3.6	11.3
Flyhalf		30.1	30.1	18.8	15.0	7.5	-
Centre		32.0	33.8	30.0	18.8	1.9	5.6
Wing		43.2	56.4	43.2	33.8	5.6	5.6
Fullback		33.8	54.4	26.3	18.8	-	7.5
DAYS OFF (average)		27.7	40.1	17.1	14.2	44.9	7.6

Of the 415 injured players, a total of 352 (84.8%) reported only 1 specific injury.

Twelve players were never to return to rugby as a result of the following injuries; a neck, a knee and an ankle dislocation; 2 neck and 1 knee ligament injuries; 2 neck, 2 humerus, 1 skull and 1 trunk vertebral fractures. Twenty-five players did not return to rugby for the

remainder of the season as a result of their injuries. Players who reported only 1 specific injury and for who the exact number of days out of rugby could be determined, were out of rugby for a total of 9248 days (average 27.7 days). Thirteen percent of players were out of rugby for less than 7 days of rugby, 30% for 8-14 days, 13% for 15-21 days, 25% for 22-42 days and 19% for 43 or more days.

Dislocation injuries kept players out of rugby for an average of 44.9 days, compared to the average of 40.1 days out of rugby as a result of fracture injuries, 27.7 days as a result of ligament injuries, and 17.1 days as a result of muscle injuries (Table 8.1).

Sixty-three players reported more than 1 specific injury. Eighty percent of the players who reported dislocation injuries sustained more than just the dislocation, as was the case with 37.4% of players who reported muscle injuries, 33% who reported ligament injuries and 25% who reported concussion injuries. Injuries were most commonly treated by General Practitioners (63.5%) and at private practices (67.5%) (Table 8.2)

Table 8.2 Percentage of each of the different types of injuries treated by General Practitioners, Medical Specialists or Physiotherapists and the percentages treated at private practices, hospitals, playing fields or other venues, including those not receiving medical treatment.

A. MEDICAL CONSULTATION	LIGAMENT (%)	FRACTURE (%)	MUSCLE (%)	CONCUSSION (%)	LACERATION (%)	DISLOCATION (%)	OTHER/INTERNAL	TOTAL (%)
GENERAL PRACTITIONER	58.3	67.6	58.9	83.3	95.0	45.0	57.1	63.5
SPECIALIST	30.6	29.0	15.9	11.1	--	55.0	32.1	21.7
PHYSIOTHERAPIST	8.7	2.4	15.9	1.4	--	--	7.1	6.8
NO CONSULTATION	3.1	0.8	9.3	4.2	5.0	--	3.6	4.0
B. CONSULTATION VENUE								
PRIVATE PRACTICE	78.7	70.2	68.2	52.8	40.0	55.0	67.8	67.5
HOSPITAL	15.0	28.2	15.9	16.7	40.0	45.0	21.4	21.3
FIELD	0.8	0.8	2.8	15.3	15.0	--	--	3.8
OTHER	2.4	--	3.7	11.1	--	--	7.1	3.4
NO CONSULTATION	3.1	0.8	9.3	4.2	5.0	--	3.6	4.0

8.2.1 Incidence of injury at the different anatomical sites

The incidence of injury per 1000 player-seasons at the different anatomical sites was; upper limb 33.6, lower limb 32.8, head and neck 28.8 and trunk 8.8. The percentage occurrence of injury to the upper limb and trunk were nearly identical in Roux's study (1992), while a decreased occurrence of injury (by 3.3%) to the head and neck in this study corresponded to an increased occurrence (by 4.7%) to the lower limbs.

(a) Head and neck injuries

One hundred and fifteen (27.7%) of the 415 injured players sustained head and neck injuries, an injury risk of 28.8 per 1000 player-seasons (Figure 8.1). The phase of play in which head and neck injuries most commonly occurred was, while being tackled (33.9%), tackling (26.1%) and in loose-scrums (22.6%).

The 115 players who sustained head and neck injuries reported 143 specific injuries. Most common were concussions (49.7%), neck muscle injuries (19.6%) and lacerations (13.3%). Nine (7.8%) players sustained neck ligament injuries, 2 sustained neck fractures and 3 sustained neck dislocations. In the 1984 study, Roux (1992) reported 5 cervical fractures and 7 cervical dislocations.

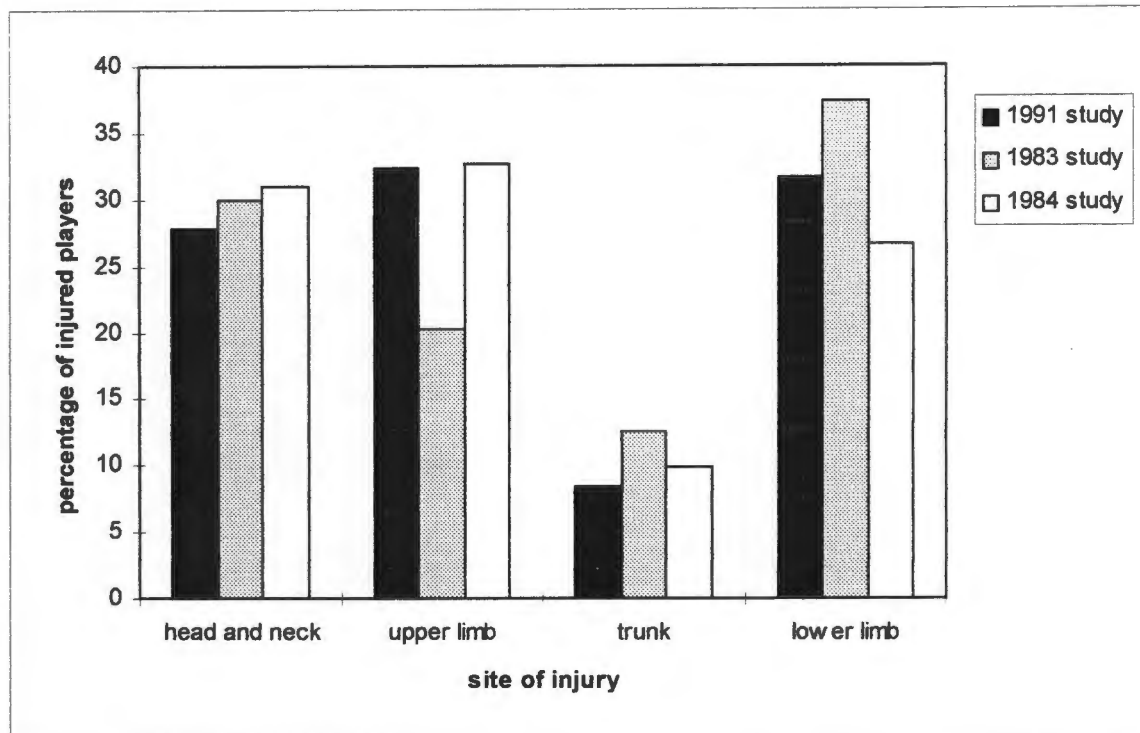


Figure 8.1. The percentage occurrence for injuries at the different anatomical sites in the 1991 study, compared to the 1983 and 1984 studies (Roux, 1992).

(b) Upper limb injuries

One hundred and thirty-four (32.3%) of the 415 injured players sustained upper limb injuries, an incidence of 33.6 injuries per 1000 player-seasons (Figure 8.1). The phase of play during which upper limb injuries most commonly occurred was being tackled (47.8%), tackling (20.9%) and in loose-scrums (18.7%).

The 134 players who sustained upper limb injuries reported 159 specific injuries. Most common were clavicle fractures (18.2%), forearm fractures (17.6%), shoulder muscle (13.2%) injuries and shoulder ligament (9.4%) injuries.

(c) Trunk injuries

Thirty-five (8.4%) of the 415 injured players sustained trunk injuries, an incidence of 8.8 injuries per 1000 player-seasons (Figure 8.1). Players who sustained trunk injuries were

most commonly injured while being tackled (31.4%), during scrums (28.6%) and in loose-scrums (17.1%).

The 35 players who sustained upper limb injuries reported 45 specific injuries. Most common were back muscle (28.9%) injuries, rib fractures (15.6%) and back ligament (13.3%) injuries.

(d) Lower limb injuries

One hundred and thirty-one (31.6%) of the 415 injured players sustained lower limb injuries, an incidence of 32.8 injuries per 1000 player-seasons (Figure 8.1). The phase of play during which lower limb injuries most commonly occurred was being tackled (32.1%), during loose-scrums (19.8%) and during open play (19.8%).

The 131 players who sustained lower limb injuries reported 151 specific injuries. Most common were knee (28.5%) and ankle ligament (22.5%) injuries.

8.2.2 Dislocation injuries

Twenty dislocation injuries were reported (4% of all injuries), occurring at an incidence of 5.0 injuries per 1000 player-seasons (Table 8.1). Three players suffered cervical vertebral dislocations, none of which resulted in paralysis. Whether these were “true” cervical dislocations is questionable, as 2 of the players reported that they returned to rugby only 6 weeks after sustaining the injury. In the 1984 study (Roux, 1992) 7 players reported cervical dislocations, 6 of which were able to return to rugby in the same 1984 season - again it is questionable whether these were “true” dislocations. Five knee, 4 shoulder, 3 ankle, 2 finger and 1 elbow, wrist and rib dislocations were also reported. It was not defined whether the knee dislocations were patellar dislocations or tibio-femoral problems. Sixteen of the players sustained a secondary injury to the dislocation. One player sustained a recurrent (shoulder) dislocation injury.

Risk of dislocation during match play was 3.8 injuries per 1000 player-seasons and for combined A and B-team players, was 4 per 1000 player-seasons.

Of the 20 dislocation injuries, thirteen (65%) were sustained by forward players, 8 occurred during the two tackling phases, 5 occurred during loose-scrums and 4 occurred during scrums. Three cervical dislocations were sustained, 1 each by a flyhalf while being tackled, a lock during a loose scrum and a flank (who was substituting at prop) during a scrum. Three of the 4 shoulder dislocations were sustained by a player who was tackled and the fourth by the player executing the tackle. Four of the 5 knee dislocations were sustained by front-row forwards, 3 during a scrum and 1 during open play.

Of the sixteen players who reported dislocations with other injuries, eleven sustained associated ligament injuries, 2 sustained muscle injuries, 2 sustained fracture injuries, 1 sustained a meniscus injury and 1 a concussion injury.

Three dislocations (neck, knee and ankle) prevented players from ever returning to rugby, while another (ankle) kept the player from rugby for the remainder of the season. The remaining sixteen dislocations kept players were out of rugby for a total of 719 days (average 44.9 days) (Table 8.1).

Eleven (55%) dislocations were treated by a medical specialist and 9 by a general practitioner (Table 8.2). Eleven of these consultations took place at a hospital and 6 at a private practice.

8.2.3 Concussion injuries

Seventy-two concussion injuries were reported (14.5% of all injuries), occurring at a rate of 18.0 per 1000 player-seasons (Table 8.1). Of these injuries, 54 (75%) were reported as concussion injuries only. The remaining 18 concussion injuries were reported in association with 6 neck muscle injuries, 5 lacerations, 4 fractures and 4 other injuries. One

in 3 (33.3%) players who reported a concussion injury indicated that they had previously been concussed while playing rugby.

Of the 72 players who were concussed, 45 (62.5%) reported a loss of consciousness for less than 1 minute, 14 (19.4%) reported losing consciousness for between 1-5 minutes and 9 (18.1%) for in excess of 5 minutes. However, the finding that nearly 1-in-5 of concussed players reported losing consciousness for in excess of 5 minutes may be inflated as some (less severe) concussion injuries, which require a high degree of clinical suspicion, may have been under-reported.

Sixty-four (88.9%) of the 72 concussion injuries occurred during match play, the remainder occurred during match practice. A-team players were at 4 times greater risk of concussion injuries than players in lower teams (Table 8.1)

The phase of play during which concussion injuries most commonly occurred were while being tackled (48.6%), while tackling (27.8%) and during loose-scrums (13.9%). Together these 3 phases accounted for 90.3% of all concussion injuries. One concussion was sustained during a line-out and none during scrums.

Objects with which the players' head/ neck impacted at the time of sustaining the concussion injury was a knee (40.3%), the ground (33.3%), a head (6.9%) and a boot/ foot (6.9%). The other objects included another player's hip (5.5%), elbow (2.8%), fist (1.4%) and the ball (1.4%).

Of the 54 players who reported concussion injuries only, 2 did not return to rugby that season. The remaining 52 players were out of rugby for a total of 740 days (average 14.2 days) (Table 8.1). Seven players returned to rugby within 1 week, 7 within 2 weeks and 29 within 3 weeks of injury. Thus of these 52 players, only 11 (20.4%) players followed recommendations by medical and rugby authorities that a 3 week rest period from participation in rugby should follow a concussion injury.

Sixty (83.3%) concussions were treated by a General Practitioner, 8 by a medical Specialist and 1 by a physiotherapist (Table 8.2). Thirty-eight (52.8%) of the consultations occurred at a private practice, 12 (16.7%) at a hospital and 11 (15.3%) at the playing field.

8.2.4 Laceration injuries

Twenty laceration injuries were reported (4% of all injuries), occurring at a rate of 5.0 per 1000 player-seasons (Table 8.1). Fifteen were reported as laceration injuries only and the remaining 5 were reported with concussion injuries. Fourteen of the 20 laceration injuries occurred during match play, 4 during match practice and 1 during physical exercises. Eight laceration injuries occurred during tackling, 3 during being tackled and 7 in the loose-scrum. Together these 3 phases accounted for 90% of all laceration injuries.

A-team players were at 5 times greater risk of laceration injuries than players in lower teams, while under-19 players were at 4.8 times greater risk than lower team players (Table 8.1). The fifteen players who reported laceration injuries only were out of rugby for a total of 114 days (average 7.6 days). Six of these 15 players returned to rugby within 1 week of sustaining the injury. The remaining 5 players who reported concussion injuries together with the laceration injury were out of rugby for a total of 25 days (average 5 days), further indicating the lack of adherence to recommendations by medical and rugby authorities that 3 weeks rest from participation should follow a concussion injury. Nineteen (95%) of the lacerations were treated by a General Practitioner, 8 each at a hospitals and private practices and 3 at the playing field (Table 8.2)

8.2.5 Muscle injuries

One hundred and seven muscle injuries were reported (21.5% of all injuries), occurring at a rate of 26.8 per 1000 player-seasons (Table 8.1). Seventy-eight (72.9%) were reported as muscle strains or tears and 29 (27.1%) as muscle bruising. Forty muscle injuries were reported in association with 42 other injuries, 20 (47.6%) of which were ligament injuries, 7 (16.7%) were fractures and 6 were concussions. Muscle injuries that occurred most

commonly with associated injuries were those to the neck (50%) and shoulder (47.6%). Twenty-eight (26.2%) players reported that their muscle injury was a recurrence the same muscle injury sustained previously whilst playing rugby (Table 8.3). The hamstring (60%), groin (50%), back (40%) and neck (32%) were the most frequently recurring muscle injuries.

Muscle injuries were fairly evenly distributed at the different anatomical sites, with the head and neck and upper limbs accounting each for 26.2%, the lower limbs for 27.1% and the trunk for 20.6%. Most commonly injured were the neck (26.2%), shoulder (19.6%), thigh (15.9%) and back (14.0%) muscles (Table 8.3).

Eighty (74.5%) of the 107 muscle injuries occurred during match play, 19 during match practice, 4 during physical exercises and 3 during skills training. Hookers (45.1 per 1000 player-seasons), wings (43.2 per 1000 player-seasons) and centres (30.0 per 1000 player-seasons) were at greatest risk of muscle injuries (Table 8.1). Thirteen (12.1%) of all muscle injuries were sustained by players who, at the time of injury, were substituting in an unfamiliar position.

Table 8.3 The number, rate of recurrence, percentage distribution and average number of days out of rugby due to muscle injuries.

MUSCLE INJURED	NUMBER OF INJURIES	RECURRENT INJURIES	DISTRIBUTION (%)	AVERAGE DAYS OUT #
NECK	28	(9)	26.2	22.7 (1s)
SHOULDER	21	(3)	19.6	12.0
THIGH	17	(4)	15.9	18.1
BACK	15	(6)	14.0	19.0 (1s)
HAMSTRING	5	(3)	4.7	15.4
CALF	5		4.7	21.0
CHEST	4	(1)	3.7	21.0
ARM	4		3.7	7.0
GROIN	4	(2)	3.7	9.3
BUTTOCK	2		1.9	7.0
ABDOMINAL	1		0.9	21.0
HAND	1		0.9	--
TOTAL	107	(28)	99.9	17.1

Calculated only for cases where a player sustained only 1 specific injury during 1 injury incident.

(1s)= One player did not return to rugby during the 1991 season.

Three of the 67 players who reported muscle injuries only were out of rugby for the remainder of the season, while the remaining 64 were out of rugby for a total of 1097 days (average 17.1 days). On average, the neck (22.7 days), calf and chest (21 days) and back (19 days) kept players out of rugby for the longest period, while the groin (9.3 days) and the shoulder (12 days) kept players out for the shortest period of time (Table 8.4).

Sixty-three (58.9%) of the muscle injuries were treated by General Practitioners and 17 (15.9%) each by medical Specialists and Physiotherapists. Seventy-three (68.2%) of the consultations took place at private practices and 17 (15.4%) at hospitals (Table 8.2). Ten (9.3%) players did not receive any medical treatment for their muscle injuries.

(a) Neck muscle injuries

Twenty-three (82.1%) of the 28 neck muscle injuries were reported as neck muscle strains/tears and 5 (17.9%) as muscle bruises. Fourteen (50%) of the neck muscle injuries were reported as neck muscle injuries only, while the other 14 were reported in association with 6 concussions, 6 neck ligament, 2 fractures, 1 dislocation and 1 displaced cervical disc injury. On 9 (32.1%) occasions the injury was a recurrence of a previous rugby injury.

The phases of play during which neck muscle injuries most commonly occurred was while being tackled (9 injuries) and during scrums and loose-scrums (8 each). Of the 9 injuries that occurred while being tackled, 4 were reported to have been unfair tackles, 6 were executed at high speed, 4 were executed from the front and 5 from the side. The anatomical site at which the injured player was tackled was evenly distributed between the head and neck, the trunk and the legs (3 each). Neck muscle injuries only, kept players from rugby participation for an average of 22.7 days (Table 8.3).

(b) Shoulder muscle injuries

Eleven (52.4%) of the 21 shoulder muscle injuries were reported as a shoulder muscle injury only, with the remainder being reported in association with 7 ligament injuries, 2 fractures (clavicle and humerus) and 1 (elbow) dislocation. On 3 (14.3%) occasions the injury was a recurrence of previous rugby injury. Nine of the 21 shoulder muscle injuries were reported as muscle bruises and 12 as strains/tears.

The phases of play during which shoulder muscle injuries most commonly occurred were while tackling (8 injuries) and being tackled (7). Scrums (3), loose-scrums (2) and the line-out (1) accounted for the remaining shoulder muscle injuries. Shoulder muscle injuries only, kept players from rugby participation for an average of 12 days (Table 8.3).

(c) Back muscle injuries

Nine (60%) of the 15 back muscle injuries were reported as back muscle injuries only, while the remainder were reported in association with 5 ligament injuries and a displaced thoracic disc. On 6 (40%) occasions the injury was a recurrence of a previous rugby injury.

The phases of play during which back muscle injuries most commonly occurred were the scrum (6 injuries) and while being tackled (4). No player reported having sustained a back muscle injury while tackling. Back muscle injuries only, kept players from rugby participation for an average of 19 days (Table 8.3).

(d) Anterior thigh muscle injuries

Twelve (70.6%) of the 17 anterior thigh muscle injuries were reported as thigh muscle injuries only, while the remainder were reported in association with 3 knee effusions and 1 each with a hip and knee ligament injury. Thirteen (76.5%) of these muscle injuries were reported as muscle bruises and 4 as muscle strains/ tears. On 4 (23.5%) occasions the injury was a recurrence of a previous rugby injury.

The phases of play during which anterior thigh muscle injuries most commonly occurred were while tackling (6 injuries), being tackled (4) and loose-scrums (3). Anterior thigh muscle injuries only, kept players from rugby participation for an average of 18.1 days (Table 8.3).

(e) Hamstring, calf, buttock and groin muscle injuries

Five hamstring, 5 calf, 4 groin and 2 buttock muscle injuries were reported. The hamstring (60%) was the most frequently re-injured muscle, followed by the groin (50%). One of the groin muscle injuries was reported in association with a testicular injury, while the rest of the hamstring, calf, buttock and groin injuries were reported as only 1 specific muscle

injury. Except for 1 buttock muscle bruising, all injuries were reported as muscle tears/strains.

(f) Arm, chest, abdominal wall and hand muscle injuries

Four arm, 4 chest, 1 abdominal wall and 1 hand muscle injury was reported. One arm muscle (wrist fracture), 2 chest muscle (rib fracture, lung injury) and 1 hand (wrist fracture) were reported in association with other injuries (other injuries are reported in brackets). Only 1 chest muscle injury was reported as a recurrent injury.

8.2.6 Ligament injuries

As in the 1984 study (Roux, 1992), ligament injuries had the highest incidence (31.8 per 1000 player-seasons), accounting for 25.5% of all injuries (Table 8.1). Of the 127 ligament injuries reported in this study, 85 were reported as ligament injuries only. Of those reported in association with other injuries, muscle (47.6%), dislocation (26.2%) and fracture injuries (19%) were the most common. The most frequently injured ligaments were the knee (33.9%), ankle (27.6%), shoulder (11.8%), wrist (7.9%) and neck ligaments (7.1%) (Table 8.4). When anatomical site is considered, the lower limb accounted for 62.2% and the upper limbs for 26% of all ligament injuries.

Thirty-two (25.2%) players reported their ligament injury as a recurrent rugby injury. The most commonly recurring ligament injuries were those to the back (57.1%), ankle (34.3%), neck (33.3%), shoulder (26.7%) and knee (20.9%) (Table 8.4).

Hookers (48.9 per 1000 player-seasons), wings (43.2 per 1000 player-seasons) and flanks (35.7 per 1000 player-seasons) were at greatest risk of ligament injuries. Fourteen (11%) of the ligament injuries were sustained by players who, at the time of injury, were substituting in an unfamiliar position.

Eighty-seven (68.5%) of the 127 ligament injuries occurred during match play, 32 during match practice, 5 during physical exercises and 2 during skills training.

Table 8.4 The number, rate of recurrence, percentage distribution and average number of days out of rugby due to ligament injuries.

LIGAMENT INJURED	NUMBER OF INJURIES	RECURRENT INJURIES	DISTRIBUTION (%)	AVERAGE DAYS OUT #
KNEE	43	9	33.9	35.4 (1n,1s)
ANKLE	35	12	27.6	22.9 (1s)
SHOULDER	15	4	11.8	22.8 (1s)
WRIST	10		7.9	18.4
NECK	9	3	7.1	35.0
BACK	7	4	5.5	16
CHEST	2		1.6	7
ELBOW	2		1.6	42
FINGER	2		1.6	--
HIP	1		0.8	--
HAND	1		0.0	7
TOTAL	127	32	99.9	17.1

Calculated only for cases where a player sustained only 1 specific injury during 1 injury incident.

(1n) = 1 player was never to return to rugby.

(1s) = 1 player did not return to rugby during the 1991 season.

Three of the 85 players who reported ligament injuries only were out of rugby for the remainder of the season, while 1 would never return to rugby. The remaining 81 players were out of rugby for a total of 2240 days (average 27.7 days). On average, the knee (35.4 days), neck (35 days), ankle (22.9 days) and shoulder ligament injuries (22.8 days) kept players out of rugby for the longest period (Table 8.4).

Seventy-four (58.3%) of ligament injuries were treated by General Practitioners and 38 (30.6%) by medical specialists. One hundred (78.7%) of the consultations took place at

private practices and 19 (15%) at hospitals (Table 8.2). Only 4 (3.1%) players did not receive any medical treatment for their ligament injuries.

(a) Knee ligament injuries

Forty-three (8.6%) of all ligament injuries reported were to the knee. After concussion injuries (18.0 per 1000 player-seasons), this was the highest incidence (10.8 per 1000 player-seasons) for a specific injury reported. The 43 knee ligament injuries accounted for 33.9% of all ligament injuries, 34 (79.1%) of which were reported as knee ligament injuries only. Of the 9 knee ligament injuries reported with other injuries, 4 each were in association with knee dislocations and knee meniscus damage and 1 with a thigh muscle bruise. On 9 (20.9%) occasions the injury was a recurrence of previous rugby injury.

The phases of play during which knee ligament injuries most commonly occurred were while being tackled (41.9%), during loose-scrums (30.2%) and open play (11.6%). Tackling accounted for only 7.0% and scrums for 4.7% of these injuries. Knee ligament injuries only, kept players from rugby participation for an average of 35.4 days (Table 8.4).

(b) Ankle ligament injuries

Thirty-one of the 35 ankle ligament injuries were lateral and 4 were medial ligament injuries. Combined they accounted for 27.6% of all ligament injuries. Thirty-one (88.6%) were reported as ankle ligament injuries only, while the remainder were reported in association with 2 fractures, 1 muscle and 1 dislocation injury. On twelve (34.3%) occasions the injury was the recurrence of a previous rugby injury.

The phases of play during which ankle ligament injuries most commonly occurred were open play (31.4%), while being tackled (27.7%) and during loose-scrums (22.9%). Tackling accounted for only 11.4% and scrums for 2.8% of these injuries. Ankle ligament injuries only, kept players from rugby participation for an average of 22.9 days (Table 8.4).

(c) Shoulder ligament injuries

The 15 shoulder ligament injuries accounted for 11.8% of all ligament injuries. Six (40%) were reported as shoulder ligament injuries only, while the remainder were reported in association with 5 muscle, 3 dislocation and 2 fracture injuries. Four were reported as a recurrent rugby injury.

The phases of play during which shoulder ligament injuries most commonly occurred were while being tackled (46.7%), tackling (36.4%) and during loose-scrums (13.3%). One of the 6 players who reported shoulder ligament injuries only, was out of rugby for the remainder of the season. The remaining 5 were out of rugby for a total of 114 days (average 22.8 days), an average similar to the average amount of time (22.9 days) that players spent out of rugby for ankle ligament injuries (Table 8.4).

(d) Neck ligament injuries

Nine neck ligament injuries were reported compared to the 19 reported in the 1984 study (Roux, 1992). Three of the 9 injuries sustained were reported as neck ligament injuries only (Table 8.5). Of the 6 neck ligament injuries reported with other injuries, all were in association with muscle injuries, while 1 was also reported with a cervical fracture. One in 3 (33.3%) neck ligament injuries were a recurrence of a previous rugby injury.

Seven (77.8%) of the 9 neck ligament injuries occurred during match play, 1 during a match practice and 1 during physical exercises. Of all neck ligament injuries, 4 each were sustained by under-19 and under-15 and 1 by an under-14 player.

When level of play was taken into account, B-team players from all age-groups sustained 2 neck ligament injuries, while players in lower than B teams sustained the remaining 7.

Seven (77.8%) of the 9 neck ligament injuries were sustained by forward players, with 6 occurring to front-row players. Four of these were sustained during scrums and 2 during

loose-scrums. Interestingly, 2 of the scrum injuries were sustained by non-front row players whilst substituting in that position, a lock was injured at prop and a flank was injured at hooker.

The 3 players who reported neck ligament injuries only, were out of rugby for a total of 105 days (average 35 days). Three of the 6 players who reported neck ligament injuries in association with other injuries were never to return to rugby and 1 other did not return that season.

Table 8.5 Classification of neck ligament injuries reported in the 1991 study.

INJURY NO.	OTHER ASSOCIATED INJURIES	MATCH/ PRACTICE	AGE/ LEVEL	POSITION	PHASE	DAYS OFF RUGBY
1)	NECK MUSCLE/ CERVICAL FRACTURE	MATCH	15 C	PROP	SCRUM	FOREVER
2)	NECK MUSCLE	MATCH	19 C	PROP	BEING TACKLED	FOREVER
3)	NECK MUSCLE	MATCH	19 E	CENTRE	LOOSE SCRUM	FOREVER
4)	NECK MUSCLE	MATCH	14 C	WING *	TACKLING	1 SEASON
5)	NONE	PRACTICE	19 B	FLANK	FITNESS	42
6)	NONE	MATCH	15 D	PROP **	SCRUM	42
7)	NONE	MATCH	15 E	HOKKER	LOOSE SCRUM	21
8)	NECK MUSCLE	PRACTICE	15 C	HOKKER #	SCRUM	14
9)	NECK MUSCLE	MATCH	19 E	PROP	SCRUM	7

* Player was a specialist centre and was injured whilst substituting at wing.

** Player was a specialist lock and was injured whilst substituting at prop.

Player was a specialist flank and was injured whilst substituting at hooker.

(e) Back ligament injuries

Seven back ligament injuries were reported compared to 11 reported in the 1984 study (Roux, 1992). Six of these were reported in association with 5 muscle injuries and one with a displaced thoracic disc. Four (57.1%) out of 7 injuries were reported as a recurrent rugby injury, making this ligament injury the one with the highest rate of recurrence.

Three back ligament injuries were sustained by players in the hooker position, 2 of whom were specialist flanks substituting at hooker at the time of injury. Of the 7 back ligament injuries, 3 each were sustained during scrums and whilst being tackled.

(f) Elbow, wrist, hand, finger ligament injuries

Two elbow, ten wrist, 1 hand and 2 finger ligament injuries were reported. Nine of these 15 ligament injuries were reported as ligament injuries only and 6 were reported with other injuries. One elbow ligament injury was reported in association with an with elbow dislocation, 3 wrist ligament injuries were reported in association with 2 wrist fractures and 1 shoulder muscle injury, and 2 finger ligament injuries were reported in association with a finger fracture and a finger dislocation.

(g) Chest and hip ligament injuries

Two chest and 1 hip ligament injury were reported. One of the chest ligament injuries was reported as a ligament injury only and the other with an associated rib dislocation. The hip ligament injury was reported in association with a thigh muscle injury.

8.2.7 Fracture injuries

Fracture injuries, which occurred at a rate of 31.1 per 1000 player-seasons, were the second most common type of injury reported (Table 8.1), accounting for 24.9% of all injuries, compared to 29.1% in the 1984 study (Roux, 1992). Of the 124 reported fracture injuries, 102 were reported as fracture injuries only. The remaining twenty-two were reported in association with 26 other injuries, 30.8% of which were muscle, 30.8% were ligament and 19.2% were concussion injuries. Four (3.1%) of the fractures were reported as a recurrent rugby injury.

The most common fracture sites were the clavicle (23.4%), forearm and wrist (22.2%) and fingers (15.3%) (Table 8.6). Two neck and 2 trunk vertebral fractures were reported in

1991 compared to 5 neck and 4 trunk vertebral reported in the 1984 study (Roux, 1992). Two cranium fractures were also reported compared to none in 1984.

When anatomical site was considered, most fractures (71.8%) occurred to the upper limb, followed by the lower limb (15.3%). This is in contrast to ligament injuries where the majority (62.2%) occurred to the lower limbs, with only 26% occurring to the upper limbs.

Backline players (43.0 injuries per 1000 player-seasons) were at 2.1 greater risk of fracture injuries than forwards (20.7 per 1000 player-seasons), with wing and centre (56.4 per 1000 player-seasons) being the highest risk positions. Eight (6.5%) of the fracture injuries were sustained by players who, at the time of injury, were substituting in an unfamiliar position. When age-group was considered, under-14 and under-15 players were at 1.3 times greater risk of sustaining fracture injuries than other types of injuries.

Four of the 102 players who reported fracture injuries only, were out of rugby for the remainder of the season, and 2 would never return to rugby. The remaining 96 were out of rugby for a total of 3854 days (average 40.1 days). Of these 96 fracture injuries, on average, the ankle (61 days), humerus (55 days), foot (46.7 days), tibia/ fibula (45.5 days), clavicle (45 days) and forearm and wrist (41.7 days) kept players out of rugby for the longest period (Table 8.6).

Eighty-four (67.7%) of the players who sustained fracture injuries consulted General Practitioners and 36 (29%) consulted medical Specialists. Eighty-seven (70.2%) of the consultations took place at private practices and 35 (28.2%) at hospitals (Table 8.2).

(a) Facial fractures

Two of the 6 facial fractures were to the cranium, 3 to the nose and 1 to the teeth. Both cranium fractures were sustained during match play, 1 while executing a tackle, with the player losing consciousness for in excess of 5 minutes and subsequently never returning to

rugby participation. The other occurred during a loose-scrum, with the player suffering a minor concussion and returning to rugby after 28 days.

Table 8.6 The number, rate of recurrence, percentage distribution risk and average number of days out of rugby due to fracture injuries.

FRACTURE	NUMBER OF INJURIES	RECURRENT INJURIES	DISTRIBUTION (%)	AVERAGE DAYS OUT #
CLAVICLE	29	(1)	23.4	45.0 (1s)
FOREARM/ WRIST	28	(1)	22.6	41.7
FINGER	13		10.5	30.3
HUMERUS	8		6.5	55.0 (1n,1s)
RIB	8	(1)	6.5	29.2
ANKLE	7		5.6	61.0 (1s)
HAND	6		4.8	30.8
TIBIA/ FIBULA	5		4.0	45.5 (1s)
NOSE	3	(1)	2.4	17.5
SCAPULA	3		2.4	27.3
FOOT	3		2.4	46.7
TOE	3		2.4	14.3
SKULL	2		1.6	--
NECK	2		1.6	-- (1n)
TRUNK VERTEBRA	2		1.6	90
TEETH	1		0.8	60
PATELLA	1		0.8	14
TOTAL	124	(4)	99.9	40.1

Calculated only for cases where a player sustained only 1 specific injury during 1 injury incident.

(1n) = 1 player was never to return to rugby.

(1s) = 1 player did not return to rugby during the 1991 season.

(b) Vertebral fractures

Two neck and 2 trunk vertebral fractures were reported, all of which occurred during match play (Table 8.7).

One neck fracture were reported by an under-15B prop during a scrum and occurred in association with a neck muscle and neck ligament injury. The other was reported by an under-19A centre, who was substituting at flyhalf at the time of the injury and which occurred while being tackled in a head high tackle executed at high speed and from a front-on direction. Neither player would ever return to playing rugby.

One trunk vertebral fracture, sustained by an under-16B centre while tackling was reported as a fracture injury only and required the player to abstain from playing rugby for 90 days. The other, reported in association with a severe concussion (loss of consciousness in excess of 5 minutes) and a neck muscle injury, was sustained by an under-19B wing, who was substituting at fullback, and who was injured while being tackled. The tackle, executed at high speed and from side-on, was both late and high (around the neck). This player would never return to playing rugby.

Table 8.7 Classification of neck and trunk vertebral fractures in the 1991 study.

FRACTURE	OTHER ASSOCIATED INJURIES	MATCH/ PRACTICE	AGE/ LEVEL	POSITION	PHASE	DAYS OFF RUGBY
NECK	NONE	MATCH	19 A	FLYHALF *	BEING TACKLED	FOREVER
NECK	NECK MUSCLE/ NECK LIGAMENT	MATCH	15 E	PROP	SCRUM	FOREVER
TRUNK	NONE	MATCH	16 B	CENTRE	TACKLING	90
TRUNK	NECK MUSCLE/ CONCUSSION	MATCH	19 B	FULLBACK #	BEING TACKLED	FOREVER

* Player was a specialist centre and was injured whilst substituting at flyhalf.

Player was a specialist wing and was injured whilst substituting at fullback.

Compared to the 9 vertebral fractures (5 neck and 4 trunk) reported in the 1984 study (Roux, 1992), 4 of which occurred during loose-scrums and 3 during scrums, this study reports a small but encouraging reduction of these injuries, particularly during scrums and loose-scrums.

(c) Rib fractures

Eight players sustained rib fractures, which accounted for 6.5% of all fractures reported (Table 8.6). Five were reported as rib fractures only, while the other 3 were reported in association with a chest muscle injury, a concussion injury and damage to a kidney. Seven (87.5%) of these fractures occurred during matches. Rib fractures only, kept players from rugby participation for an average of 29.2 days, making this one of the less severe fracture injuries in terms of recovery time (Table 8.6).

(d) Scapula fractures

Three scapula fractures were reported, all of which were reported as scapula fractures only. One was sustained by an under-16 A-team fullback while being tackled, 1 by an under-14 A-team wing while being tackled and 1 by an under-14 D-team wing while tackling. The total number of days off rugby due to injuries reported as scapula fractures only, was 82 (average 27.3).

(e) Clavicle fractures

Clavicle fractures, which accounted for 23.4% of all fractures, were the most commonly occurring fracture injuries. Twenty-seven (93.1%) of the 29 clavicle fractures were reported as fracture injuries only. The remaining 2 were reported in association with a shoulder muscle and a shoulder ligament injury. Clavicle fractures only kept players from rugby participation for an average of 45 days.

(f) Humerus fractures

Eight players sustained humerus fractures, which accounted for 6.5% of all fractures reported (Table 8.6). Six were reported as humerus fractures only, while the other 2 were reported in association with a shoulder muscle injury and a shoulder dislocation injury.

Humerus fractures kept 5 players from rugby participation for an average of 55 days, the sixth player would never return to rugby, making this the second (to the ankle) most severe fracture in terms of recovery time (Table 8.6).

(g) Wrist (including ulna and radius) fractures

Wrist fractures, which accounted for 22.6% of all fracture injuries, were the second most commonly occurring. Twenty-four (85.7%) of the 28 wrist fractures were reported as fracture injuries only. The remainder were reported in association with either shoulder muscle or wrist ligament injuries. Wrist fractures only kept players from rugby participation for an average of 41.7 days

(h) Hand and finger fractures

The combined number (19) of fractures occurring to the hand (6) and fingers (13), accounted for 15.3% of all fracture injuries. Seventeen (89.5%) of these 19 fractures were reported as fracture injuries only, with the remaining 2 being reported in association with a finger ligament and a hand muscle injury. Hand fractures only kept players from rugby participation for an average of 30.8 days, and finger fractures only, for an average of 30.3 days (Table 8.6).

(i) Patella, tibia and fibula injuries

The combined number (6) of fractures occurring to the tibia (1), fibula (2), both tibia and fibula simultaneously (2) and patella (1), accounted for 4.8% of all fracture injuries. Four (66.7%) of these 6 fractures were reported as fracture injuries only. One fibula fracture was reported in association with an ankle ligament injury and 1 of the combined tibia/fibula fractures with an associated ruptured tibial artery.

(j) Ankle fractures

Seven players sustained ankle fractures, accounting for 5.6% of all fractures reported (Table 8.6). Five were reported as ankle fractures only, with the other 2 being reported in association with an ankle ligament and an ankle dislocation injury. Ankle fractures only kept players from rugby participation for an average of 61 days, making this the most severe fracture injury in terms of recovery time (Table 8.6).

(k) Foot and toe fractures

The combined number (6) of foot (3) and toe (3) fractures accounted for 4.8% of all fracture injuries, all of which were reported as fracture injuries only. The average number of days off rugby due to injuries reported as foot fractures only was 46.7, and due to toe fractures only was 14.3 days.

8.2.8 Internal and Other injuries

Twenty-four other injuries were reported, 12 involved damage to the knee meniscus, 7 were displaced or damaged intervertebral discs with probable facet joint sprains, 1 each a bruised eye socket, a bruised coccyx, a torn finger nail, a bruised trachea and a brachial plexus injury resulting in temporary paralysis of the arm musculature. Twelve of these injuries were also reported to have been sustained in association with other specific injuries, eleven of which were muscle or ligament damage at the same site (knee or vertebrae), and the twelfth player was unfortunate enough to suffer a damaged cervical disc and a broken nose in the same scrum and within seconds of each other. Two of the slipped intervertebral disc injuries and 1 knee meniscus injury were reported as recurrent rugby injuries.

One injury was reported as a chronic “cervical disc” injury, and occurred as a result of continued scrum pressure on the neck of an under-19A hooker over a period of 2 seasons. This player would never return to playing rugby.

Of the 6 acute intervertebral “disc” injuries, 3 occurred in the scrum and 3 in the loose scrum. Two of the scrum injuries were sustained by props and 1 by a hooker. In terms of days off rugby, “slipped disc” injuries varied in severity. Two players who were forced to miss rugby for the remainder of that season, 2 missed playing rugby for 10 weeks, 1 for 3 weeks and the other for 2 weeks.

Four internal injuries were reported, 2 of which were damaged tibial arteries, 1 a bruised intestine and 1 a bruised kidney.

8.3 DISCUSSION

Ligament (25.5%), fracture (24.9%) and muscle injuries (21.5%) were the types of injury most commonly occurring in this study (Table 8.1), compared to fracture (27.9%), ligament (27.6%) and muscle (17.7%) injuries occurring most commonly in the combined 1983 and 1984 studies (Roux, 1992). The percentage occurrence of the different injury types are markedly different amongst the various rugby injury studies. Compared to the 14.5% concussion injuries reported in the present study, Williams (1984) reported 5.0%, Sparks (1985) 6.3%, Davidson (1987) 1.0%, Roux (1992) 12.8%, Upton *et al.* (1996) 14.3% and Bird *et al.* (1998) 3.8%. Similarly, the percentage occurrence of fracture injuries in the present study was 24.9% compared to Williams (1984) 20.0%, Sparks (1985) 9.3%, Davidson (1987) 7.0%, Roux (1992) 27.9%, Upton *et al.* (1996) 27% and Bird *et al.* (1983) 5.1%.

Injury data from the various studies are thus remarkably conflicting. It is postulated that the major contributors to these differences are the following;

(a) Definitions of injury

The effect of the different definitions of injury used by the numerous rugby injury researchers is best illustrated by comparing data from the present study and that of

Bird *et al.* (1998). Bird *et al.* included all injuries that caused the player to seek medical attention or miss at least 1 scheduled game or practice. Accordingly, in 65% of the injury events reported in their study, the player received medical attention only and did not miss a practice nor match. None of these injuries, the majority of which were sprains/ strains or haematomas, would have been reported in the present study. This may explain why Bird *et al.* (1998) reported fractures occurring in only 5.1% of all injury incidents compared to 24.9% in the present study.

(b) Research methods

Roux (1992) showed that between 40% and 50% fewer rugby players were recorded as injured when monitoring of injuries was done via correspondence versus personal communication, and that concussion injuries in particular were subject to under-reporting when employing the former method. The present study also suggests that the attitudes of co-ordinators toward the study may influence results, particularly when the pyramid method of data collection is employed and where no reimbursement is offered. Further, injury patterns differ in the various playing populations. The risk of injury rises with increasing age from schoolboy to International rugby and injury patterns during the various phases of play also differ at each of these levels of play (Noakes and du Plessis, 1996).

(c) Weather and ground conditions

Williams (1984) showed that more fractures occurred when playing fields were hard or firm, possibly explaining the lower percentages of these types of injuries occurring in Williams and Sparks' (1984) studies, where rugby was played on the soft playing fields in Great Britain. However, Williams (1984) found no difference in the occurrence of concussion injuries on hard or soft playing fields. Davidson (1987) suggested that more upper limb injuries, with particular reference to clavicle fractures, occurred on firmer playing fields, while Davies and Gibson (1978) showed more head and neck injuries occurring on wet surfaces. Inglis and Stewart (1981) however, found that the condition of the playing surface did not effect injury trends.

Evaluation of the effect of different weather and field conditions on the incidence of injuries in the present study was rendered futile as weather patterns, and thus field conditions, varied greatly in the geographic area of the study and no record was kept of the prevailing conditions in matches and practices where injury did not occur. However, that striking the ground was responsible for 33.3% of concussion injuries in this study, suggests that the firmness of the playing surface may play a role in this specific injury.

It is concluded that different definitions of injury and methods of data collection complicate comparative analysis and are thus possibly counter-productive to the interpretations of rugby injury research across studies. As research methods and procedures (constants) are not standardised in the various rugby injury studies, it is not possible to compare the effect on injury of variables such as age, level of play, weather and ground conditions in the different studies. Standardised methods and procedures in future rugby injury research are essential.

8.3.1 Concussion

Noakes and du Plessis (1986) expressed the growing concern that each episode of concussion leaves residual brain damage, the seriousness of which had only recently been appreciated (Gronwall and Wrightson, 1974; 1975; Rimel *et al.*, 1981; Levin *et al.*, 1987; Shuttleworth-Jordan *et al.*, 1993). Considering that the time taken for consciousness to return is an indicator of the number of nerve cells damaged and the severity of the (irreversible) damage (Levin *et al.*, 1987), it is concerning that 19.4% of concussed players in this study reported a loss of consciousness for a period of 1 to 5 minutes and 18.1% for a period in excess of 5 minutes. However, this high percentage (37.5%) of players who reported losing consciousness for in excess of 1 minute may be inflated as some (less severe) concussion injuries may have been under-reported, probably due to a combination of the high degree of clinical suspicion required in diagnosing the injury and the fact that injuries were monitored via correspondence.

In the present study, 1-in-3 (33.3%) of all concussions were reported as recurrent, while in a retrospective study (Chapter 5 of this thesis), 471 schoolboy rugby players reported having sustained 888 concussion injuries - an average of 1.9 concussions per player - further indicating the recurrent nature of these injuries. Bird *et al.* (1998) reported 30% of concussion injuries in their study as recurrent.

Of greater concern is that 7 players in the present study returned to rugby within 1 week, 7 within 2 weeks and 29 within 3 weeks of a diagnosed concussion injury. Thus of 54 concussed players, only 11 (20.4%) players followed recommendations by both medical and rugby authorities that 3 weeks rest from participation should follow a concussion injury. Williams (1984) showed that 16% and Sparks (1984) that 94% of players returned to rugby within 3 weeks of their concussion, while Bird *et al.* (1998) showed 78.9% of concussed players who were placed on a 3 week 'stand down' from rugby returned to rugby within 3 weeks of injury. Further, 9 of the 22 concussed players in the Bird *et al.* study (1998) continued playing in the game in which the injury was sustained. One must also consider the likelihood that a certain number of players will sustain mild concussions which will pass undiagnosed and thus where a rest period is not even considered. Further, there is evidence in the literature to suggest that concussion may be graded and that return to sport can therefore vary depending on the degree of severity of concussion (McCrorry, 1984; Cantu, 1996).

It is concluded that the potential danger of rugby players sustaining residual (potentially serious) brain damage is exacerbated by the recurrent nature of concussion injuries, combined with the assumption that several of these injuries may pass undiagnosed, and the fact that in most cases, the majority of players do not follow recommendations by medical and rugby authorities that 3 weeks rest from participation should follow a concussion injury. Not only the players' parents, but also their coaches should take responsibility for enforcing the recommended 3 weeks of non-participation. This is best achieved by simply not selecting players in the team during this recovery period.

8.3.2 Recurrent injuries

Nearly 1-in-5 (18.5%) of all injuries were reported as a recurrent rugby injury in the present study compared to 17% reported by Lee *et al.* (1997). Bird *et al.* (1998) reported 39% of injuries occurring to the same body site, at some point in the past. It appears however, that the 39% may not all be a recurrent type of injury as they report only on the site of injury. Concussions (33.3%), muscle (26.2%) and ligament (25.2%) injuries were the most commonly recurring injuries in the present study, while fractures (3.1%) and dislocations (5%) were the least commonly recurring.

Although only a small number (5) of hamstring injuries were reported in this study, 3 were reported as a recurrent injury. This supports the findings of Agre (1985) and Safran *et al.* (1989), who reported that many acute hamstring injuries become recurrent, often as a result of inadequate treatment or rehabilitation, or too early a return to activity.

It is concluded that one of the major factors predisposing a player to particularly concussion, muscle and ligament injuries, is sustaining the initial injury. Concussed players should be appropriately rested and, upon returning to rugby, should consider wearing head protection. However, cognisance is taken of the fact that, at the time of writing this thesis, no sound research in the area of protective gear in rugby was available. Players who sustain muscle and ligament injuries should ensure that their injuries are adequately rested and rehabilitated before returning to participation and they should consider appropriate preventative or protective strapping or devices. Chapter 2 of this thesis shows that thermal pants may have a role in preventing recurrent hamstring injuries, but that complete rehabilitation after injury is more significant in preventing recurrence.

8.3.3 Muscle injuries

Muscle strains and tears are predominantly non-contact (intrinsic) injuries and were more common (72.9%) than muscle bruising (27.1%), which was a result of direct trauma (an extrinsic injury). The low number (1%) of hamstring injuries sustained by players in this

study may be explained by Williams (1984) who showed that these injuries occurred more commonly among top players than schoolboys. Supporting this finding, a study of provincial players found that 6 hamstring muscle tears constituted 16% of all injuries (Chapter 3 of this thesis).

8.3.4 Ligament injuries

Almost identical to the findings in the 1984 study (Roux, 1992), ligament injuries were the most commonly occurring type of injury in this study, while after concussions (14.5%), knee ligament (8.6%) and ankle ligament injuries (7%) were the most commonly occurring of all specific injuries. Other interesting findings were that 1-in-4 ligament injuries were reported as recurrent; that there was a 44 % reduced risk of neck ligament injury (2.3 vs. 4.1 per 1000 player-seasons) and a 26% reduced risk of trunk ligament injuries (1.8 vs. 2.4) in the present study when compared to the 1984 study (Roux, 1992); and that this reduction took place primarily amongst the more skilled A- and B-team players. A-team players sustained none of the 9 neck ligament injuries and only 2 of the 7 (28.6%) trunk ligament injuries in the present study, compared to A- and B-team players sustaining 68.4% of the neck and 72.7% of the trunk ligament injuries in 1984.

8.3.5 Fractures

Fracture injuries were the second most commonly (24.9%) occurring type of injury in this study and in the 1984 study (29.1%) (Roux, 1992). Fractures occurred most frequently during the phases of being tackled (15 per 1000 player-seasons) and thus backline players, who are more often involved in the tackling phases, were at 2.1 times greater risk than forward players.

Fractures to the cervical vertebrae potentially have the most catastrophic consequences. Two neck and 2 trunk vertebral fractures were reported in this study compared to 5 neck and 4 trunk vertebral reported in the 1984 study (Roux, 1992). This represents a 53% risk reduction of neck injuries (0.5 vs. 1.07 per 1000 player-seasons) and a 41% reduction in

trunk vertebral injuries (0.5 vs. 8.5 per 1000 player-seasons). Although this is an encouraging decrease in the number of these injuries, the small sample size precludes a significant finding. In neither of the studies did these vertebral fractures result in permanent paralysis, although 6 of the combined 7 cervical fractures prevented players from ever returning to rugby as did 2 of the 6 trunk vertebral fractures.

Up to the age of about 18 years bone growth takes place at the growth plates which constitute softer, cartilaginous bone that is neither as rigid nor strong as calcified bone. That under-14 and under-15 players were at 1.3 times greater risk of sustaining fracture injuries when compared to other types of injuries, confirms this increased risk amongst younger players.

It is concluded that younger players are at greater risk than older players of sustaining a fracture injury and thus should be made aware of the risk situations for their respective playing positions. Chapter 5 of this thesis demonstrated that only 44% of high school rugby players felt that falling on an outstretched arm when tackled was an injury risk, and only 72% felt that falling on the point of the shoulder when tackled was an injury risk. Further, it is suggested that there is an important role for coaches in teaching correct technique in contact situations.

8.3.5 Days out of rugby

Twenty-one players sustained injuries that prevented them from ever returning to rugby, compared to 9 such injuries in the 1984 study (Roux, 1992) and a further 25 were unable to return to rugby for the remainder of the 1991 season, compared to 17 in 1984. The 352 (84.8%) players who reported only 1 specific injury and for who the exact number of days out of rugby could be determined, were out of rugby for a total of 9248 days (average 27.7 days) compared to the average of 22.7 days in the 1984 study. The average period out of rugby in the present study and in Roux's study (1992) was considerably greater than the period (7 days) which qualified injuries for the studies. The disparity may be a result of

possible under-reporting of injuries of a less serious nature and that in 19% of injury incidents, players indicated missing in excess of 7 weeks of rugby.

Dislocation injuries kept players out of rugby for an average of 44.9 days, compared to an average of 40.1 days for fracture, 27.7 days for ligament, 17.1 days for muscle and 14.2 days for concussion injuries (Table 8.1). In the present study, 53% of lower limb fractures compared to only 27% of upper limb fracture injuries kept players from rugby for more than 6 weeks. Williams (1984) showed that lower limb injuries kept players off work for an average of 7 weeks compared to an average of 3 weeks for upper limb injuries. Further, Williams (1984) found that 72 players (13%) missed more than 24 working days due to their injury, and that a few university students were forced to leave college and restart their course the following year.

The highest average days spent out of rugby for specific **muscle** injuries, were those to the neck (22.7 days), calf and chest (21 days) and back (19 days) (Table 8.4); for specific **ligament** injuries, were those to the knee (35.4 days), neck (35 days), ankle (22.9 days) and shoulder (22.8 days) (Table 8.4); and for specific **fracture** injuries, were those to the ankle (61 days), humerus (55 days), foot (46.7 days) tibia/ fibula (45.5 days), clavicle (45 days) and forearm and wrist (41.7 days) (Table 8.6).

It was concluded that, while certain injuries are intrinsic to the game of rugby, they are amongst others, disruptive to sport participation, school work, and in older (than schoolboy) populations, to university study and vocation. Accordingly, players, coaches, parents of players and administrators should strive to minimise the chances of players sustaining avoidable injuries by using all techniques available to them. These include amongst other things, correct skills practice, a comprehensive knowledge of risk factors and situations, comprehensive pre-season training, wearing of protective devices, correct rehabilitation after injury, correct attitudes of coaches and players towards the game.

8.4 SUMMARY

1. That research methods and procedures are not standardised in the various rugby injury studies, hampers comparative analysis of the effect on injury of variables such as age, level of play, weather and ground conditions.
2. The danger of rugby players sustaining residual (potentially serious) brain damage from concussion injuries is exacerbated by;
 - the recurrent nature of concussion injuries,
 - the assumption that several of these injuries may pass undiagnosed,
 - the fact that the majority of players do not follow recommendations by medical and rugby authorities that 3 weeks rest from participation should follow a concussion injury.
3. One of the major factors predisposing a player to particularly concussion, muscle and ligament injuries, is having previously sustained a similar injury.
4. Younger (under-14 to under-16) players are at greater risk of sustaining a fracture injury than older (under-19) players.
5. Although intrinsic to the game of rugby, injuries are amongst others, disruptive to sport participation, schoolwork, and in older (than schoolboy) populations, to university study and vocation. Thus players, coaches, parents of players and administrators should strive to minimise the chances of players sustaining avoidable injuries by using all techniques available to this means. Further, financial costs are also be incurred as a result of rugby injuries, the magnitude of which is not generally known. Accordingly, the financial costs arising as a result of rugby injuries will be investigated in the following Chapter.

CHAPTER NINE

THE FINANCIAL COST OF RUGBY INJURIES

9.1 INTRODUCTION

The costs of rugby union injuries has not previously been analysed in South Africa. However reports from New Zealand suggest that rugby union injuries have the highest overall cost of all sporting codes (ACC Injury Statistics, 1990). The estimated cost was 19.3 million New Zealand dollars in 1990 (Dixon, 1993) and in excess of 25 million in 1992 (Wilson *et al.*, 1999). Dixon (1993) suggested that the 1990 figures were likely to be an underestimation.

In South Africa, medical treatment in the private sector ranges from set-rates determined by medical-aid, to rates more than twice these suggested amounts, which are charged by Medical Professionals contracted out of Medical-aid schemes. While provincial hospitals charge subsidised rates, the treatment received at these hospitals is hampered by severe under-staffing and is compounded by excessive week-end influxes of trauma patients.

The schools that were surveyed in the present study all offered different forms of medical cover. These included; comprehensive medical cover, permanent disability cover only, cover for expenses over and above medical-aid costs up to a maximum amount of R1000, a total maximum cover of up to R1000 and no cover at all. Some schools insisted on compulsory subscriptions to policies and others offered voluntary participation to parents. Premiums for these various policies were covered by schools in some instances and by parents in others.

Included in the questionnaire that all injured players in the present study were required to complete, was an addendum that sought the financial costs of medical treatment arising from the injury.

Accordingly, the aim of this Chapter was to assess the potential costs that may be incurred as a result of injury to schoolboy rugby players. Further, these data will be used to estimate the cost of rugby injuries to all registered rugby players throughout South Africa.

9.2 METHODS

The study population, definition of rugby injury and methods of data gathering are described in Chapter 4 of this thesis. Attached to each injury questionnaire was an addendum that sought the costs arising from consultations, medication, bracing, hospitalisation and any other medical procedures resulting from the injury. This addendum was to be completed by the parent or guardian and returned by post after all costs arising from the injury were known.

The average cost of each specific injury for which forms were returned were used to estimate the cost of similar injuries for which no forms were returned. As these data were collected during the 1991 rugby season, the inflation of medical cost according to the Representative Association of Medical Services (RAMS) was applied in order to predict the cost in 1999. This inflation was based on the actual inflation rate applied to medical-aid schemes during this period.

Thus, at the time of this study, medical costs incurred as a result of injuries varied according to whether medical doctors and/ or hospitals were contracted into or out of medical-aid schemes. For this reason, when calculating the average cost of those injuries for which only few forms were returned, Figures may well have been either exaggerated or under-estimated, depending on which criteria of treatment were sought. Further, these inaccuracies would have been exacerbated when extrapolating the data (average cost of injuries) from this study to represent cost of injuries sustained in a larger population. Therefore, although these data might be inaccurate, they are never-the-less presented to give an indication of the potential costs that may be incurred as a result of rugby injuries.

In certain cases, players reported sustaining more than one injury in a particular injury incident. The author used his discretion in deciding which injury contributed primarily to the medical costs, and then discarded the associated injury that would have incurred a lesser cost. For example, a dislocation injury that required surgical reduction was always reported in conjunction with an associated ligament injury. The primary injury in this case was considered to be the dislocation. Similar incidents occurred where facial fractures were considered the primary injury when reported in association with a concussion or laceration.

9.3 RESULTS

Four hundred and fifteen (10.4%) of the 3990 players in this study reported sustaining a total of 498 injuries during the 1991 season. Of these 415 players, 396 (95%) consulted one or more medical practitioners (initially a general practitioner 279, physiotherapist 28, medical specialist 89) as a direct result of their injury; the remaining 19 indicated that their injury did not require medical consultation. Of all initial consultations, 286 (72%) took place at a private practice, 80 (20%) at hospitals, 17 at the playing field and 13 at other venues. Sixty-one players were hospitalised for one or more nights, totalling 136 nights.

9.3.1 Costs for forms returned

Unfortunately, only 99 correctly completed *injury cost* forms were returned. In eight of these cases, players indicated that they had sustained more than one specific injury. The total cost incurred by the 99 primary injuries was R58 413, a Figure that is extrapolated to R130 832 in the year 1999 (Table 9.1).

Table 9.1. Total and average cost (\pm SD) of each type of medical treatment/consultation required by the 99 players who returned correctly completed injury cost forms.

MEDICAL REQUIREMENT	n (99 players)	TOTAL COST IN RANDS		AVERAGE COST IN RANDS			
		1991	1999	1991	\pm SD	1999	\pm SD
Hospitalisation	32	19222	41577	601	694	1299	1501
General Practitioner	85	8979	22923	106	125	270	319
Specialist	32	8968	23111	280	265	722	683
X-ray	56	7363	14616	131	175	261	347
Physiotherapist	20	3468	6752	173	127	338	247
Medication	36	2959	5874	82	66	163	131
Anaesthetist	7	1998	5149	285	203	736	519
Bracing	15	857	1701	57	47	113	93
Chiropractor	1	66	131	66	-	131	-
Other	12	4533	8998	378	317	750	629
TOTAL	296	58413	130832				

Eighty-five of the 99 injured players incurred a General Practitioners fee, 32 incurred a medical Specialists fee, and 20 incurred physiotherapy fees (Table 9.1). Fifty-six incurred fees for X-rays, 36 for various medications and 15 were required to purchase protective bracing as a result of their injury. Of the 32 players who were hospitalised, 19 were required to remain overnight, for a total of 46 nights of hospital care. Hospitalisation fees, followed by anaesthetists and specialists fees were the greatest (Table 9.1).

(a) Fracture injuries

Cost of fracture injuries varied according to the treatment required. This varied from surgical reduction of a fracture with the corresponding theatre, medical specialists and hospitalisation costs, to the costs of an x-ray and a single consultation during which the affected area was splinted.

Of the 124 players who sustained fracture injuries, 37 (30%) returned correctly completed forms. Fractures to the humerus, tibia and fibula, skull and ankle incurred the greatest cost, and those to the toe and scapula the least (Table 9.2). Nine of these 37 players were hospitalised for a total of 22 days and ten were forced to miss a total of 45 days of school.

Table 9.2 Total and average cost in rands incurred as a result of fracture injuries for players who returned correctly completed injury cost forms in the 1991 season, and the estimated inflated costs for 1999.

BONE FRACTURED	FORMS RETURNED	TOTAL COST IN RANDS		AVERAGE COST IN RANDS	
		1991	1999	1991	1999
Humerus	1	5733	13759	5733	13759
Tibia/ Fibula	2	6119	14687	3060	7344
Skull	1	1231	2954	1231	2954
Ankle	2	2017	4841	1008	2419
Wrist	8	6267	15041	783	1879
Nose	2	1320	3168	660	1584
Finger	6	2670	6408	445	1068
Collarbone	8	3284	7882	411	1058
Teeth	1	350	840	350	840
Hand	3	592	1421	197	473
Scapula	2	262	629	131	314
Toe	1	39	94	39	94
TOTAL	37	29884	71722	808	1939

(b) Ligament injuries

Of the 127 players who sustained ligament injuries, 22 (17%) returned correctly completed forms. Ligament injuries to the neck, knee and shoulder incurred the greatest cost, and those to the ankle the least (Table 9.3). Three of these 22 players were hospitalised for a total of five days and six were forced to miss a total of 17 days of school.

Table 9.3 Total and average cost in rands incurred as a result of ligament injuries for players who returned correctly completed injury cost forms in the 1991 season, and the estimated inflated costs for 1999.

LIGAMENT	FORMS RETURNED	TOTAL COST IN RANDS		AVERAGE COST IN RANDS	
		1991	1999	1991	1999
Neck	1	1069	2566	1069	2566
Knee	6	5772	13853	962	2309
Shoulder	4	2883	6919	721	1730
Elbow	2	1389	3334	695	1668
Ankle	9	3801	9122	422	1013
TOTAL	22	14914	35794	678	1627

(c) Muscle injuries

Of the 107 players who sustained muscle injuries, 14 (13%) returned correctly completed forms. Muscle injuries to the neck and back incurred the greatest cost, and those to the thigh the least (Table 9.4). Two of these 14 players were forced to miss a total of 3 days of school, none were hospitalised.

Table 9.4 Total and average cost in rands incurred as a result of muscle injuries for players who returned correctly completed injury cost forms in the 1991 season, and the estimated inflated costs for 1999.

MUSCLE	FORMS RETURNED	TOTAL COST IN RANDS		AVERAGE COST IN RANDS	
		1991	1999	1991	1999
Neck	1	465	1116	465	1116
Back	2	865	2076	433	1039
Calf	2	573	1375	287	689
Arm	1	215	516	215	516
Shoulder	5	857	2057	171	410
Thigh	3	169	406	57	137
TOTAL	14	3144	7546	225	540

(d) Dislocation injuries

Of the 20 players who reported dislocation injuries, 4 (20%) returned correctly completed forms. One player sustained a patella dislocation and was hospitalised for five days and missed 10 days of school; 1 suffered a cervical dislocation and was hospitalised for six days, during which time he missed five days of school; 1 player sustained an elbow dislocation and spent one day in hospital; and another player sustained a rib dislocation, was not hospitalised, but missed one day of school due to the injury.

(e) Concussion

Of the 72 players who reported concussion injuries, 14 (19%) returned correctly completed forms. Two of these 14 players were each hospitalised for one day and together they missed a total of six days of school.

(f) Lacerations

Of the 20 players who reported laceration injuries, 6 (33%) returned correctly completed forms. None of these six players were hospitalised, while one missed two days of school.

(g) Other injuries

Of the 28 players who reported other injuries, 2 (7%) returned correctly completed forms. One player incurred a R205 medical account for damage to a knee meniscus, was not hospitalised, and did not miss any days from school.

Another player incurred a cost of R1003 for damage to a thigh nerve and was hospitalised for three days, all of which were school days.

9.3.2 Extrapolated costs

Table 9.5 shows the extrapolated total and average cost of each type of injury sustained by schoolboy rugby players in the 1991 season and the estimated inflated costs for 1999. On average, dislocations, fracture and ligament injuries incurred the greatest expense, while players who sustained concussions and lacerations incurred the least expense.

Table 9.5 Extrapolated total and average cost of each type of injury sustained by schoolboy rugby players in the 1991 season and the estimated inflated costs for 1999.

INJURY	TOTAL INJURIES*	FORMS RETURNED	TOTAL COST IN RANDB		AVERAGE COST IN RANDB	
			1991	1999	1991	1999
fractures	124	(37)	107466	240700	866	1940
ligaments	106	(22)	78315	175408	739	1655
muscles	70	(14)	18797	42101	269	602
dislocations	18	(4)	22182	49683	1232	2759
concussions	55	(14)	11090	24839	201	450
lacerations	20	(6)	2933	6569	146	327
internal/ other	22	(2)	14650	32813	666	1492
TOTAL	415	(99)	255433	572112	588	1318

* Where more than 1 injury occurred in an injury event, only that which the author regarded as the primary injury, thus contributing primarily to the medical cost, is reported.

9.4 DISCUSSION

Injury data from Chapter 6 of this study shows that in the 1991 season, 415 out of 3990 (1 in every 9.6) schoolboy players sustained a rugby injury severe enough to warrant missing 7 days or more of rugby, and that this Figure may be underestimated by as much as 40-50% due to under-reporting of injuries. Further, research has shown that club and provincial rugby players are likely to be injured even more frequently than schoolboy players (Davidson *et al.*, 1978; Myers, 1980; Wessels, 1980) and that high school players (under-14 to under-19) are likely to be injured more frequently than junior school players (under-13 and younger) (Nathan *et al.*, 1983).

Of the estimated 303 551 registered rugby players in South Africa in 1998 (IRB handbook, 1998), 137 309 are 12 years and younger, 106 242 are 13 to 19 years old and 60 000 are club players. According to the most accurately controlled studies conducted amongst these populations in South Africa, the injury rate amongst junior school players was 1 injury per every 16 players (Nathan *et al.*, 1983), amongst high school players was 1 injury per every 3.5 players (Nathan *et al.*, 1983) and amongst club players was 1 injury per every 1.05 players (Clark *et al.*, 1990). In both of these studies, an injury was defined as one which would cause a player to miss 7 or more days of rugby. Thus it may be extrapolated that 8 582 junior school, 30 355 high school and 57 143 club players (totalling 96 080 players) per season will sustain an injury that will prevent rugby participation for 1 week or more. Findings from the present study suggest that 95%, thus 91 276 of these players will seek medical attention for their injuries. Accordingly, if the average cost of an injury in 1999 is R1318 (according to the present study), then the total cost of the estimated total of 96 080 injuries to South African rugby players in the 1999 season is R126 633 344.

In New Zealand, sports injury care is provided in both the public and private sectors and is paid for by the Accident Compensation Corporation (ACC) at no cost to the victim (Burry, 1986). In 1990, Dixon (1993) found that 24 767 persons attended the Accident and Emergency (A&E) department or were admitted to a public hospital for injuries sustained while playing rugby. The incidents for these injuries for under 15 year olds was 1 injury

per every 14 players and for older than 15 year olds was 1 injury per every 6 players. Further, Dixon suggested that these incidents were likely to be an under-estimation as a number of players sought treatment at private clinics and were not referred to A&E or Hospital. In 1992, rugby injury to a percentage of the total of 207 000 registered rugby union players in New Zealand (Dixon, 1993) cost the ACC in excess of 25 million New Zealand dollars (Wilson *et al.*, 1999).

The previous Chapters, as well as this one have shown that rugby injuries bear a financial burden, are disruptive to sport participation and often result in absence from school. In the study of Williams (1984), 72 (13%) players each missed more than 24 work days, while there were a few students who were forced to leave college and restart the year. Further, certain injuries, particularly to joints, to the spine and to the brain (Gronwall and Wrightson, 1974, 1975, 1980; Rimel *et al.*, 1981; Levin *et al.*, 1987; Shuttleworth-Jordan *et al.*, 1993) may result in long term complications which may be debilitating and bear financial burden.

The above findings suggest that there is a necessity, not only for insurance against the initial medical costs as a result of rugby injury, but also possibly against loss of income, disability and even death amongst certain rugby playing populations. In Wales, the Welsh Rugby Union (W.R.U.) offers a well-defined insurance policy for loss of time from work, as well as a compulsory Death and Disability policy. This cover is extended to all affiliated bodies of the W.R.U., which includes all schools.

That schools surveyed in the study offered varied degrees of medical cover and that subscription to these were not always compulsory, meant that in several cases, the cost arising from rugby injury was not comprehensively insured. Accordingly, players/ parents/ guardians were often at risk of severe financial burden in the advent of injury. It is thus suggested that every schoolboy wishing to participate in rugby should be comprehensively insured against all potential medical costs arising from a rugby injury.

9.5 SUMMARY

This is the first study in South Africa that has attempted to assess the financial cost involved as a direct result of rugby injury. Although these data may be inaccurate as a result of extrapolation, the study shows that,

1. Due to inadequate medical insurance, schoolboy's parents/ guardians were often at risk of severe financial burden in the advent of rugby injury.
2. The cost of rugby injury to the 303 551 registered South African rugby players in 1999 is estimated at R126 633 344.

CHAPTER TEN

CONCLUSIONS

10.1 Schoolboy rugby

The overall impression gained from this thesis was that the law changes introduced to schoolboy rugby in 1990 and 1991 did not succeed in their objectives to decrease the risk of injury during specific phases of play, but that they did contribute to changes in injury patterns. Further, the possible adoption of modern playing patterns around that time might have further contributed to the changes in injury patterns identified by this study. These findings suggest that in order to make the game both safer and more attractive, more effective law changes should be sought, and that the effectiveness of these changes should be scientifically assessed. Global findings in rugby injury research is that the tackling phases, followed by the loose scrum contribute to the majority of injuries. It follows that any current attempts to reduce rugby injuries should address these facets of play.

Interestingly however, Chapter 3 of this thesis suggests that correct preparation of players for the game of rugby may be more effective in reducing injuries than making amendments to laws.

Unfortunately a dilemma affecting schools rugby in South Africa is that progressively less money is available to reimburse teachers or coaches for extra curricular sports coaching. Thus, few schools have high quality coaches in charge of rugby teams. Accordingly, it is suggested that the South African Rugby Football Union (SARFU), in conjunction with local Provincial Education Departments, should facilitate the circulation to all schools of documentation detailing basic rugby coaching skills, pre-season player preparation and various other techniques known to prevent injuries. Even more effective would be for rugby authorities to actively assist in the training and support of schools coaches.

Finally, all schools should ensure that all pupils' parents/ guardians are made aware of the potential cost of rugby injuries, and accordingly that they are advised regarding the need for appropriate medical insurance.

10.2 Provincial rugby

A spectators observation of the modern game of rugby as seen during the Southern Hemisphere's Super 12 competition over the past few years, suggests that the speed of play and the frequency of high speed contact may be increasing. The general playing strategy is for heavy-weight 'runners' to take a 'crash- ball' and attack the advantage line in the channel at flyhalf and inside centre. In so doing, the opposition backline players are committed to the ensuing ruck, while the ball is then recycled for the next passage of play. To counter these attacking movements, defenders, often the backline players, are required to make heavy offensive tackles. Accordingly, players are required to train to become fitter, faster and stronger than previously, a trend that has been marked by an increased usage by rugby players of creatine-mono-hydrate and various other legal ergogenic aids to boost lean body mass. There is little room for a slightly built rugby player in the modern game, save possibly for the wing position.

Further, international level rugby is now played for up to 11 months of the year, with inter-provincial or international games scheduled on a weekly basis. Apart from the attraction of match fees, players at these levels are pressured to participate in every game by the coaches' or teams' desire for success and also their own desire not to be replaced in the team by a rival to their position.

Accordingly, top level players are subject to frequent incidents of high speed collisions during matches and on a weekly basis, yet are availed precious little recuperation time.

It is concluded that although the style of play described above is particularly pleasing to spectators, it is counterproductive in that, as identified in Chapter 7 of this thesis, speed of play is the major aetiological factor responsible for injury. As the speed of play in the

modern game increases, so the players are required to get fitter and to maximise their lean body mass, which in turn facilitates even higher impact collisions. It seems that if the game continues to evolve in this manner, it will realise progressively faster and more flowing play played by progressively faster and heavier players, who in turn may experience a progressive increase in the risk of injury from these high impact collisions.

10.3 Rugby injury research

American football players both practice and compete wearing padding to protect knees, thighs, elbows, shoulders and the head, as well as compulsory strapping to protect amongst others, the ankle joints. Although high speed collisions do occur, their occurrence in American football are possibly less frequent than those experienced amongst rugby union players, who wear little or no protective clothing. Accordingly, if current patterns of play in rugby union do not yield to patterns involving less emphasis on high impact offensive/defensive contacts, then rugby authorities may be encouraged to investigate the usage of additional protective clothing, perhaps along the lines of that used during full-contact match practice. It is also necessary to make sure that the padding does not injure the opposition players. Modern sciences may be able to provide these protective devices using light-weight and non-restrictive materials, so as not to detract too far from the appearance of the traditional game. Certainly in South Africa, rugby is steeped in tradition.

That comparative analysis amongst rugby injury studies world-wide continues to be hampered by non-standardised research methods, is absurd. The onus should be on the International Rugby Board to take responsibility for addressing this dilemma. A start may be to appoint a team of researchers to convene with the objective of standardising rugby injury research world-wide.

Following the initiation of studies which employ these standardised research methods, consultation with rugby technical analysts/ advisors/ coaches may assist to further identify means whereby injury can be minimised during the various patterns of play or facets of the

game. This is especially important as it is the coaches who are responsible for evolving playing strategies and patterns.

In conclusion, this thesis suggests that from under-14 to International rugby playing levels, a varying percentage of rugby injuries may be avoided by employing certain short-term and long-term measures. Short-term measures include the education of players (and coaches) regarding techniques known to prevent injuries, the employment of safe coaching principles, correct pre-season physical preparation of players for each specific position, and following an injury, adequate rest, rehabilitation and preventative strapping/protection. Long-term measures, which necessitate continued scientific research, include standardising rugby injury research world-wide, a constant analysis of existing laws and patterns of play to identify possible solutions for high risk situations, and assessing the merits of further protective clothing.

CHAPTER ELEVEN

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FORM "B" (TEACHER)

INVESTIGATION INTO THE OCCURRENCE AND PREVENTION OF RUGBY INJURIES

WEEKLY INJURY REPORT

NAME OF SCHOOL: York Hill School.....INSTRUCTIONS:

- * Only injuries that qualify for the purpose of this study must be recorded. (See general instructions and FORM A.) Please enter a nil response if no injuries occurred in a team.
- * This report must be completed weekly by the responsible teacher and be returned by post on the Friday immediately following the week covered by this report.
- * Pupils' individual injury reports (FORM A) must be attached to this weekly report.
- * Injured players who are absent must complete FORM A which must then be sent as soon as possible

Report for the week ending SATURDAY 20 / 4 / 1991.

Summary of injuries sustained

Team	Number of matches played	Number of injuries
Under 19A	1	0
19B	1	0
19C		
19D		
19E		
19F		
19G		
19H		
16A		
16B		
16C		
16D		
16E		

2. Summary of injuries sustained (continued)

Team	Number of matches played	Number of injuries
Under 15A	1	0
15B		
15C		
15D		
15E		
Under 14A		
14B		
14C		
14D		
14E		
14F		
14G		
		TOTAL

Thank you for your co-operation.

HAVE YOU ATTACHED THE INDIVIDUAL PUPILS' REPORTS?

Please return to:

Research Section
 Att. Mr G J Swanepoel
 Room 240
 P. O. Box 13
 CAPE TOWN
 8000

Signature of teacher

Signature of Principal



School stamp

24/4/91
 Date

APPENDIX II

FORM "A" (INJURED PLAYER)

INVESTIGATION INTO THE OCCURRENCE AND PREVENTION OF RUGBY
INJURIES

This form is to be completed by

- a) All players who have missed 7 days or more of rugby due to a rugby injury. (including matches and practices.)

OR

- b) All players who have suffered concussion due to rugby. By concussion is meant a blow to the head, causing the player to be disorientated or confused, or a loss of consciousness, no matter how short the time interval might be; even one second is long enough. (Fill in the form even if the player did not leave the field of play.)

OR

- c) All players who, while playing rugby, sustained a laceration (severe cut) which required stitches. (Fill in the form, regardless of whether or not this injury kept the player out of rugby .)

- d) This questionnaire consists of the following Sections:

- A - PERSONAL DATA
- B - INJURY DATA
- C - SPECIFIC INJURY DATA
- D - MEDICAL TREATMENT
- E - MEDICAL COSTS RECORD

Please ensure that you have completed all the sections thoroughly and correctly, and that you hand SECTION E: MEDICAL COSTS RECORD to your parent/guardian as soon as possible. Thank you for your co-operation in this study.

5 Complete this question only if the injury occurred during tackling or while being tackled.

Was the tackle:

fair..... or unfair (high, early, etc).....
at high speed: Yes..... No.....
from: head on... side on.. behind..
around: neck. shoulders hip/waist. legs..

6 If you are a forward and were injured during the kick off/in, state whether you were in the receiving team.. the attacking team. and/or the ball catcher..

7 If you were injured via foul play, was it due to:
a) dirty play e.g. punch, kick (state).....
or b) dangerous play e.g. collapsing scrum, stiff arm tackle (state).....

8 When injured, were you in possession of the ball?
Yes. No.

9 Did the injury occur during a match. or practice.
or a social game (e.g.house matches)

10 If the injury occurred during a practice, state whether it was during:
match practice.....
physical exercise.....
skills training.....

11 Date of injury:/...../1991

12 In the space provided below, please give a brief account of how the injury occurred.....
.....
.....
.....

13 In your opinion, could the injury have been avoided?
Yes. No.

- 14 What was the final score of the match in which you were injured? (If injury occurred during practice, ignore this question) Your team's score.....
Opponents' score.....
- 15 Was the game played at home. or away?.
- 16 How many seasons have you played in the position in which you were injured?
Fewer than one. One to two. More than two.
- 17 At the time of injury, were you in your usual team
in a higher team..
or in lower team..
- 18 Were you wearing a mouth-guard at the time of your injury? Yes. No.
- 19 At what time of the game did the injury occur?
Early in the 1st half. Later in the 1st half.
Early in the 2nd half. Later in the 2nd half.
- 20 With regard to the playing field, was it
firm. soft. or wet/slippery?...
- 21 Was the grass cover good. or poor?...
- 22 For how many years have you played rugby?.....years

C. SPECIFIC INJURY DATA

INSTRUCTIONS

- * Identify under PARTS 1, 2, 3, 4, 5, 6 and 7 what type of injury you sustained.
- * Once you have identified the type of injury, put a cross in the block which indicates the exact location of the injury. Example: if you fractured your collarbone, then under PART 4: FRACTURE INJURIES put an X in the block next to collarbone.
- * If you sustained more than one injury during one incident, then complete all the appropriate PARTS, e.g. collarbone fracture and shoulder muscle injury: Fill in under PART 2: MUSCLE INJURIES and PART 4: FRACTURE INJURIES.
- * If you had an injury which you cannot fit into PARTS 1, 2, 3, 4, 5, 6, or 7, then fill in PART 8.

PART 1: CONCUSSION

Was the duration of loss of consciousness
less than 1 min. 1 - 5 mins. more than 5 mins. ?

What struck your head? (Be specific).....

Have you previously been concussed?.... If Yes, how many times?..

PART 2: MUSCLE/TENDON INJURIES

Was it a muscle/tendon strain. tear. or bruising.. ?

Of which muscle/muscles?

Neck	<input type="checkbox"/>	Back	<input type="checkbox"/>	Buttock	<input type="checkbox"/>	Hand	<input type="checkbox"/>
Shoulder	<input type="checkbox"/>	Chest	<input type="checkbox"/>	Groin	<input type="checkbox"/>	Hamstring	<input type="checkbox"/>
Arm	<input type="checkbox"/>	Stomach	<input type="checkbox"/>	Thigh	<input type="checkbox"/>	Calf	<input type="checkbox"/>

PART 3: LIGAMENT INJURIES

Neck	<input type="checkbox"/>	Elbow	<input type="checkbox"/>	Chest	<input type="checkbox"/>	Ankle	
Shoulder	<input type="checkbox"/>	Wrist	<input type="checkbox"/>	Hip	<input type="checkbox"/>	Lateral	<input type="checkbox"/>
Back	<input type="checkbox"/>	Finger	<input type="checkbox"/>	Knee	<input type="checkbox"/>	Ankle	
						Medial	<input type="checkbox"/>

PART 4: FRACTURE INJURIES

Skull	<input type="checkbox"/>	Collarbone	<input type="checkbox"/>	Scapula	<input type="checkbox"/>	Pelvis	<input type="checkbox"/>
Nose	<input type="checkbox"/>	Humerus	<input type="checkbox"/>	Sternum	<input type="checkbox"/>	Femur	<input type="checkbox"/>
Cheekbone	<input type="checkbox"/>	Ulna	<input type="checkbox"/>	Ribs	<input type="checkbox"/>	Tibia	<input type="checkbox"/>
Jaw	<input type="checkbox"/>	Radius	<input type="checkbox"/>	Trunk	<input type="checkbox"/>	Fibula	<input type="checkbox"/>
				vertebrae	<input type="checkbox"/>		
Teeth	<input type="checkbox"/>	Wrist	<input type="checkbox"/>	Fingers	<input type="checkbox"/>	Ankle	<input type="checkbox"/>
Neck	<input type="checkbox"/>	Hand	<input type="checkbox"/>	Toe	<input type="checkbox"/>	Foot	<input type="checkbox"/>
Vertebrae	<input type="checkbox"/>						

PART 5: DISLOCATIONS

Jaw	<input type="checkbox"/>	Hip	<input type="checkbox"/>	Finger	<input type="checkbox"/>
Neck	<input type="checkbox"/>	Knee	<input type="checkbox"/>	Toe	<input type="checkbox"/>
Shoulder	<input type="checkbox"/>	Ankle	<input type="checkbox"/>	Other (specify).....	

PART 6: LACERATIONS (severe cuts which required stitches)

Head and face Trunk Limbs

PART 7: INTERNAL INJURIES

Ruptured: Artery Spleen Kidney Intestine

PART 8. OTHER INJURIES NOT MENTIONED ABOVE (e.g. severe

haematoma, bone bruising).....
.....
.....

D. MEDICAL TREATMENT

1. Describe your injury in a few words. (i.e. what was the doctor's diagnosis?)

2. Was this a recurrence of an old injury? YES. NO.

3. Was First Aid administered at the field?
YES. NO.
If YES, by whom? Doctor..... Referee.....
First aider..... Parent.....
Coach..... Player.....
If NO, why not? Not available Not necessary

4. Did you see a General Practitioner..
Physiotherapist..
or Specialist.. ?

5. If you consulted one of the above then indicate where you saw them.
at playing field.....
at hospital.....
at private practice....
other.....

6. Were you hospitalised? YES. NO.
If YES, for how many days?

IMPORTANT: PLEASE TAKE CAREFUL NOTE OF, AND ADHERE TO THE INSTRUCTIONS GIVEN AT THE TOP OF THE FOLLOWING PAGE HEADED "E: MEDICAL COSTS RECORD".

PLEASE HAND THIS FORM TO THE RESPONSIBLE TEACHER.

Thank you for your co-operation.

E. MEDICAL COSTS RECORD

INSTRUCTIONS TO PUPILS:

Please detach this page and give it, as soon as possible, to your parent/guardian to complete.

Research Section
Mr G.J. Swanepoel
Room 240
P.O.Box 13
CAPE TOWN
8000

Dear Parent/Guardian

The injury your son has sustained is part of a comprehensive rugby injury study being conducted by the Education Department in conjunction with the UCT Medical School. Your assistance in this study would be greatly appreciated. We request that you record in the space provided below, all medical expenses that were incurred as a result of your son's injury.

EXPENSES INCURRED	AMOUNT
(Hospitalisation, Consultations, Medication etc.)	
.....	R.....
.....	R.....
.....	R.....
.....	R.....
.....	R.....
.....	R.....
.....	R.....
.....	R.....
	TOTAL R.....

Once all the medical expenses have been covered, we kindly request that you mail this form to the above address, or alternatively that you keep it and we will contact you at a later stage.

THANK YOU FOR YOUR ASSISTANCE IN THIS STUDY.

3. List any other serious injuries which you might have sustained while playing rugby. Ligament injuries, muscle tears, dislocations, severe lacerations, internal injuries or other serious injuries apply here. (State type of injury and year.)
-19..
-19..
-19..
-19..
-19..
-19..

C. GENERAL

(Tick appropriate block)

- 1.1 Do you own a gum-guard? Yes. No.
- 1.2 If you answered Yes, how often do you wear it?
Always.. Sometimes.. Never..
- 1.3 If you answered No, is it because:
- they are too expensive.....
- you don't know enough about them..
- you think they are unnecessary....
- 2.1 If you are not a specialist front-row forward, have you ever had to scrum in that position as a substitute during a match or practice? Yes.. No..
- 2.2 Were you ever injured while substituting in this position? Yes. No.
3. Have you over the past 6 weeks participated in a regular endurance training programme? i.e. a minimum of 30 minutes per session (continuous) twice weekly for the full 6 weeks. (e.g. jogging, aerobics) Yes. No.
4. Have you ever followed such a strict programme before the start of previous seasons? Yes. No.

5. Have you over the past 6 weeks participated in a regular strength training programme, using weights or resistance? (Answer Yes if you did a minimum of 2 strenuous sessions per week for the past 6 weeks.) Yes.. No..
6. Have you ever followed such a strict strength training programme before the start of previous seasons? Yes. No.
7. With regard to hamstring flexibility, can you at any required moment, while standing with your feet together, reach down and comfortably touch your toes with your knees straight? Yes.. No..
- 8.1 Are you aware of the various methods that can be used to strengthen your neck muscles? (front, back and side muscles.) Yes. No.
- 8.2 If you answered Yes, describe one method.....
.....
.....
9. At the time of filling in this report, have you participated in more than 12 sessions of neck-strengthening over the past 6 weeks? Yes. No.
10. Have you ever followed a thorough neck-strengthening programme before the start of previous seasons? Yes. No.
- 11.1 Which of the following do you think could place you at risk of being injured? (tick more than one if necessary.)
- a) Falling on an outstretched arm while being tackled....
- b) Falling on the point of your shoulder while being tackled.....
- c) Pushing the ball back between your legs while being held by an opponent in a loose scrum....

11.2 Which of the above (a,b or c) is in your opinion potentially the most dangerous? State why you think it is.

12. At the time of filling in this form, could you give an accurate as possible estimation of the amount of time in hours/minutes you have spent on the following this season: (state "hours" or "minutes")

a) practising falling techniques.....
 b) tackling practice (i.e. tackling a moving object).....
 c) listening to verbal coaching/lecturing on tackling techniques.....

13. Do your parents Encourage (E) or Discourage (D) you to play rugby? (Fill in "E" or "D" for each parent)

Father. E.. Mother....

14. Did your father play rugby? Yes... No...
 If Yes, at what level? School.....
 Club/University..
 Provincial.....
 Springbok.....

15. Briefly state two main reasons why you play rugby.

PLEASE HAND THIS FORM TO THE RESPONSIBLE TEACHER

Thank you for your co-operation

Good luck and enjoy the season.

APPENDIX IV

HAMSTRING QUESTIONNAIRE

PERSONAL DETAILS

Name.....Tel.no(H).....

Height(cm)..... Weight(kg).....Date of Birth.....

Club/school.....Team.....Position/s.....

Can you bend forward, and comfortably touch your toes, with your legs straight and feet together? YES NO

INJURY HISTORY

(Tick appropriate block where necessary)

1. Briefly and CLEARLY explain your problem that you experienced during the season.

.....
.....
.....

3. How long have you been experiencing problems?.....

4.1 Have you previously torn pulled or strained your muscle?

4.2 If so, in which leg, dominant or non-dominant?

4.3 If you have previously injured the muscle, then clearly state
i)WHEN the injury occurred (if it occurred more than once, then supply more than one answer in each category of 4.3)

.....
ii) HOW it happened (ie. what were you doing at the time of injury)
.....
.....

iii) At the time of injury, was the muscle strapped or protected?
YES NO

iv) If YES, with what?.....

4.4 How long were you off rugby on each occasion? (days).....

5. At which part of the muscle is your problem experienced?

top(under buttock) upper half middle lower half
behind knee whole muscle other (state).....

6. What style of boots do you wear, high cut or low cut?

- 7.1 Did you wrap/strap/cover the muscle? YES NO
- 7.2 Exactly what did you use to do so?.....
- 7.3 For approximately how many weeks have you been using his form of protection?.....
- 7.4 How often did you use it during practices?.....
and for how many matches matches did you use it?.....

8 Please clearly describe exactly how you felt that the strapping/guard helped in protecting the muscle.
.....
.....
.....

- 8.2 Did you ever injure the muscle while wearing the protection?....
- 9.1 Did you use a warming gel/cream? YES NO
- 9.2 if yes, i) state which brand.....
ii) how often do you use it?.....

10. With regards your warm up and stretching procedures prior to starting a match or practice;
- i) do you jog/run at all?....ii) if yes, how far?....m/how long...min
- iii) do you jog/run before during and/or after you stretch?
- v) do you stretch your hamstrings while standing or seated?
- vi) for approximately how long do you hold each stretch?.....sec.
- vii) do you follow this procedure before matches AND practices?.....

11. Any other details you feel may be relevant to this study?.....
.....
.....

PLEASE RETURN THIS FORM BY POST AT YOUR EARLIEST CONVENIENCE.
Your time and assistance in this study is much appreciated, THANK YOU.

APPENDIX V

INJURY FORM

INSTRUCTIONS : You are required to complete this form if;

i) due to an injury to your hamstring/calf muscle, you were unable to run unhindered and at FULL-SPEED at any stage during the match or practice at which you were injured, or during the next match or practice following the injury,

OR

ii) due to an injury to your hamstring/calf muscle, you were unable to participate in the following match or practice.

INJURY DETAILS

(Where blocks are provided, please tick the appropriate block/s)

1. Name.....

2. Do you fit into category i) or ii) above?....

3. Site of injury; if hamstring if calf
left or right leg..... left or right leg.....
where in muscle: top(under buttock) just below knee
upper half upper half
middle middle
lower half lower half
behind knee achilles tendon
other(state)..... other(state).....

4.1 Did the injury occur during a match practice or other?

4.2 If OTHER, please state.....

4.3 If during PRACTICE, was it during match practise
skills training
physical exercises
other(state).....

4.4 If during a MATCH, state your team and position.....

4.5 when in the game did it occur? 1st quarter 2nd quarter
3rd quarter 4th quarter

5. Give a brief account of how it happened (ie. what were you doing?)

.....
.....
.....

6.1 Severity; was it a complete tear moderate tear minor tear
severe strain minor strain stiffness
other(state).....

6.2 Approx. how long will you be unable to run at full-speed?.....

7.1 Was the muscle protected or covered at the time of injury?.....

7.2 If YES, with what?.....

8.1 Did you use a warming gel/cream prior to injury?.....

8.2 If YES, what did you use?.....

9. Were you in possession of the ball at the time of injury?.....

10. Was the playing field; firm soft or wet/muddy?

11. With regards to the weather, was it;

- i) warm cool cold
- ii) heavy rain light rain not raining
- iii) strong wind light wind no wind

12. With regards to the warm-up and stretching procedures that you followed prior to injuring yourself;

- i) did you jog/run to warm-up?.....
- ii) if so, how far did you jog/run? (estimate in metres).....
- iii) did you jog/run before during and/or after stretching?
- iv) did you stretch your hamstrings standing seated or both?
- v) about how long did you spend warming up and stretching?.....min

13. What treatment did you receive immediately after injury?.....

.....
.....

15. What treatment did you receive on the following few days?.....

.....
.....

After returning this to me, please remember to continue to return the tri-weekly forms, regardless if you continue playing or not.

THANK YOU FOR YOUR CO-OPERATION