Incidence and severity of neck injury in Rugby Union: A systematic review

Michael S. Swain a,*, Reidar P. Lystad a, Henry Pollard b, Rod Bonello a

a Macquarie Injury Management Group (MIMG), Faculty of Science, Macquarie University, Sydney, Australia
b Department of Medicine, the University of Notre Dame, Sydney, Australia

Abstract

Objectives. To collate and appraise incidence and severity data for neck injury in Rugby Union. To report risk factors for neck injury in Rugby Union that are supported by incidence and severity data. Design. Systematic review. Methods. Original journal articles were retrieved from electronic searches of AusportMed, AUSPORT, Scopus, Medline (Ovid), CINAHL, Mantis, and Pubmed databases and relevant bibliographic hand searches. Selection criteria were restricted to: (a) prospective study designs including cohort, case–control, and intervention methodologies; (b) populations of Rugby Union players, either male or female of any age; (c) studies must report on neck injury incidence and/or severity specifically; (d) articles with republished neck injury data were excluded. The STROBE Statement was adapted for the quality assessment of included studies and categorised as either poor, moderate or good. Results. Thirty-three original articles met the selection criteria. Wide variation of injury and exposure definitions and population sampling was identified in the included articles. Neck injury incidence ranged between 0.26 (CI: 0.08, 0.93) and 9.17 (CI: 1.89, 26.81) per 1000 player hours for mixed populations that adopted an all inclusive sports injury definition. There is a paucity of severity data and analytical data which evaluates causal roles of risk factors for neck injury in Rugby Union. Conclusions. Meaningful understanding of neck injury incidence and severity in Rugby Union is restricted to a few studies which adopt comparable methodological construct. This paper provides an index for future neck injury studies in Rugby Union. © 2010 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.

Keywords: Epidemiology; Rugby; Football; Neck injury; Athletic injury

Contents

1. Introduction ................................................................. 384
2. Methods ................................................................. 384
3. Results ................................................................. 385
4. Discussion ............................................................. 386
5. Conclusion ............................................................ 388
Practical implications .................................................. 388
Acknowledgments ....................................................... 388
Appendix A. Supplementary data .................................. 388
References ............................................................... 388

* Corresponding author.
E-mail address: mikeswain@unwired.com.au (M.S. Swain).

1440-2440/$ – see front matter © 2010 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.jsams.2010.10.460
1. Introduction

Neck injury in Rugby Union (RU) may result in neck pain, reduced neck mobility, neck deformity, neurological symptoms (sensory and motor loss), altered mental state, or secondary injury (e.g. faciomaxillary, eye or limb trauma). Athletes may require on-field evaluation and treatment, and/or referral to hospital emergency departments. Although time loss from play, work/school or social activities may occur subsequent to injury, hospital based management is frequently not required.

Heightened awareness of neck injury in RU is related to the nature of the sequelae of neck injuries, fatal and non-fatal alike. Non-fatal catastrophic neck injury from RU participation is associated with high financial costs to the healthcare system. Most notably, it has been suggested for every debilitating spinal cord injury there may be as many as ten near misses.

Reports of catastrophic neck injuries have dominated the epidemiological data available in RU. Case reports, case series, cross sectional studies and retrospective reviews (Supplement 1) which fit the definition of catastrophic, non-catastrophic, or career ending spinal injuries have portrayed much of the epidemiological landscape regarding neck injury in RU. It is not scientifically sound to rely on case report study design to indicate injury patterns in sport, and yet it has been common practice for neck injuries in RU. While etiological factors are assumed to be similar, the study designs fail to provide rigorous interpretation of incidence and severity. Furthermore definitions utilised in such studies, if at all, are limiting, depicting only the 'tip-of-the-iceberg' of the most sinister neck injuries. As such, these definitions are a subset of neck injury which is the submerged part of the iceberg which is to be evaluated in this systematic review.

Data on injury incidence and severity provides a yardstick in the first step of prevention of sport injuries. The primary purpose of this paper is to review and collate incidence and severity data on all neck injury in RU as reported in the literature. The secondary aim is to identify risk factors for neck injury in RU that are supported by incidence and severity risk data.

2. Methods

A comprehensive search of the literature was conducted by the first author (MSS), which consisted of an electronic search of the AusportMed, AUSPORT, Scopus, Medline (Ovid), CINAHL, Mantis, and Pubmed databases from the earliest available record to March 2009. Key words used in the literature search were “RUGBY” in combination with “INJURY” (including truncated terms) and “NECK” or “CERVICAL”. In addition bibliographies of included studies, and previous review articles were searched to identify potentially eligible studies not captured by the electronic searches. Duplicates and reprints were identified and removed. Titles and abstracts of the retrieved articles were screened for relevance, with non-relevant articles being discarded. Conference proceedings, abstracts, generic non-peer reviewed articles, letters, reviews and commentaries retrieved from electronic searches were identified, logged and discarded prior to application of the selection criteria. Non-English articles were logged and discarded. Full text versions of potentially relevant articles were retrieved and evaluated for inclusion.

Two reviewers (MSS and RPL) independently applied the selection criteria to the retrieved articles. Inclusion criteria for retrieved articles were set at (a) prospective study designs with case–control, cohort and intervention methodologies; and (b) study population consisting of RU players, both male and female of any age. Seven aside and ten aside variants of the games were included. Populations from other football codes (e.g. rugby league and soccer) as well as wheelchair variants of the game were excluded; (c) studies must report on neck injury incidence and/or severity specifically. The description of “neck region” was adopted from Guzman et al.; (d) articles with republished neck injury data were excluded. In such cases the review authors identified the less informative report for exclusion. A reject log (Supplement 2) was maintained of all relevant articles which did not meet the inclusion criteria.

In this review the methodological quality of included studies was assessed by two independent reviewers (MSS and RPL) using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) Statement. The STROBE Statement (available at: http://www.strobe-statement.org/index.php?id=available-checklists) is a 22 point checklist developed by an international collaborative effort of epidemiologists, methodologists, statisticians, researchers and journal editors. It flags key aspects of information dissemination particularly pertaining to methodological construct, results reporting and conflict of interest. Although the STROBE Statement was not specifically designed to assess methodological quality, it has recently been adopted as a quality assessment tool for observational studies by a number of authors. As per Olmos et al., studies were arbitrarily categorised as either poor, moderate, or good, with percentage of fulfilled items from the STROBE statement checklist cut-off values of <50%, 50–80%, and >80%, respectively.

Data on study methods, region of study, sample population, exposure, incidence and severity was extracted and tabulated. In addition, data on risk factors and injury types were extracted, tabulated and summarised. Where possible, if not mentioned in the published article, incidence (percentage and injury rates) was calculated from presented data on number of neck injuries, number of total injuries and RU exposure. In these instances injury rate was expressed per 1000 reported exposures. Furthermore, 95% confidence intervals were calculated using the method provided by Ulm. For meaningful comparison, sports injury definitions of included studies were categorised into broad groups guided by the commentary of Brooks and Fuller. These groups consisted of: medical
attention/treatment injury – which is any injury that requires the assistance of sports medicine personnel with or without time loss from training or completion; full-inclusive time-loss injury – which is any injury that results in time lost from competition and/or training; semi-inclusive time-loss injury – which is any injury that results in time lost from competition only; and all inclusive injury – which is an injury that requires the assistance of sports medicine personnel and/or that which results in time loss from competition and/or training. When necessary, authors were contacted to clarify data from their published reports. No quantitative data synthesis (meta-analysis) was performed due to heterogeneous study designs.

3. Results

Electronic database searches initially retrieved a total of 3069 citations (AusportMed: 61; AUSPORT: 221; Scopus: 926; Medline: 517; CINAHL: 296; Mantis: 299; and Pubmed: 749). Duplicates (1995 citations) and reprints (11 citations) were removed from the retrieved list. Screening titles and abstracts for relevance revealed 634 non-relevant citations that were discarded. Furthermore, 255 citations articles were identified as conference proceedings, abstracts, generic non-peer reviewed articles, letters, literature reviews, commentaries or non-English publications and were similarly discarded. One article could not be retrieved. Hand searches of bibliographies and reference lists identified four additional relevant articles. The selection criteria were applied to a total of 177 articles, of which 144 articles did not meet the selection criteria and were excluded from this review. A list of excluded studies is provided in Supplement 2. Thus, this review is comprised of a total of 33 articles that satisfied the selection criteria.

The data retrieved from the included studies was characterised by disparate data collection methods, utilisation of injury definitions, methods of describing incidence and severity, and calculation of exposures. Relevant data is summarised in Supplement 6 and 7. Overall, the quality of reports retrieved was moderate to good (Supplement 6), however two studies had internally conflicting data on neck injury incidence.28,26

Review of injury definitions of the 33 included studies (Supplement 6) reveals that none of the included studies adopted a sole definition of medical attention/treatment.19 Five studies31,32,37,38,30 adopted a fully-inclusive time-loss definition,19 five studies28,30,39,42,48 adopted a semi-inclusive time-loss definition19 and eight studies31,32,37,38,40,41,44,53 adopted an all inclusive (both time-loss and medical attention) definition. Other less conventional definitions were adopted by four studies,27,43,51,56 while 11 studies21–23,25,34,35–47,49,52,55 failed to define injury in the report. Examples of less conventional definitions of sports injury include: the presence of pain, discomfort or disability; any physical complaint; physical damage; and temporary stoppage of the game or the substitution of a player. Methods of either recording or presenting data on rugby exposure and sub-group populations of male, female or youth as well as amateur versus elite differed in the aforementioned definition groups (Supplement 6).

Neck injury during tournament play was reported to account for between 2.1%56 and 14.3%53 of all injuries in RU populations.

Six of the 33 included studies26,33,35,40,41,53 that adopted broad all inclusive injury definitions presented adequate data so that injury rate could be calculated for comparison across two player populations. The neck injury rate calculated for three study populations33,35,53 of professional women ranged from 0.26 (CI: 0.08, 0.93) to 1.36 (CI: 0.59, 2.68)/1000 player hours (Supplement 7). Similarly the neck injury rate calculated for all inclusive defined populations of professional men ranged from 0.5 to 9.17 (CI: 1.89, 26.81)/1000 player hours across three different studies26,40,41 (Supplement 7). Based on these broad injury definitions, there does not appear to be a meaningful difference in the incidence of neck injury between professional men and women of all inclusive defined studies.

Four studies28,39,42,48 utilised a semi-inclusive time-loss definition which allowed for meaningful comparison (Supplement 7). In three of these studies the professional adult male neck injury rates ranged from 1.00 (CI: –0.77, 2.95) to 2.73 (CI: 0.89, 6.41)/1000 match player-hours.28,39,42 Comparatively one semi-inclusive time-loss defined study48 of male youths reported an injury rate of 3.3 (CI: 2.7, 4.0)/1000 match player-hours (Supplement 7). After consideration of injury rate confidence intervals there does not appear to be a difference in neck injury rate between professional men and male youth in studies which use a semi-inclusive time-loss sports injury definition.

Comparison between the different time based injury definitions is possible (Supplement 3) for five articles31,32,37,38,40 of elite men populations. The articles which report neck injury rate via a fully-inclusive time-loss definition31,32,37,38 found match neck injury incidence to range between 3.75 (CI: 2.50, 5.00) and 8.75 (CI: 6.75, 11.25)/1000 player hours match exposure, while training injury rate ranged between 0.03 (CI: 0.00, 0.08) and 0.1 (CI: 0.0 0.4)/1000 player hours. The article by Holtzhausen et al.40 adopts an all inclusive time loss sports injury definition and reports a lower match neck injury rate at 1.4/1000 game hours and training injury rate at 0.4/1000 training hours. This finding appears to confirm commentator reports57,58 that non-uniform methods of defining sports injury in epidemiological studies results in significant variability of reported injury incidence rates across those studies.

Six studies29,32,37,38,40,44 report on training injury incidence (Supplement 7). Bird et al.29 report training neck injury to account for 2.6% of all training injuries. Three studies32,37,38 used a comparable fully-inclusive time-loss injury definitions in populations of professional men. In this group, the neck injury rate ranged from 0.0 (CI: –) to 0.1 (CI: 0.0, 0.8)/1000 training player-hours. Two studies40,44 adopted comparable all inclusive injury definitions in pop-
ulations of amateur and professional men. In this group neck injury rate ranged from 0.40 (CI: 0.05, 1.47)/1000 training player-hours to 0.41 (CI: 0.01, 3.30)/1000 training athletic exposures. It appears training neck injury rate across studies with differing injury definition and sub-population has similarly low training injury rates particularly when compared to match play.

There is a paucity of neck injury severity data in the retrieved literature (Supplement 7). Four reports, all of the same sub-population (professional men), allow comparison of severity data. Fuller et al. reports the severity of cervical spine injury over two seasons. The study included 546 participants and reported a total of 1228 days absent (380 days recurrent injuries), the average to be 13 days absent, the median to be 5 days absent, and no catastrophic spinal injuries to occur during the study period. In this study only one of the 86 new injuries resulted in the athlete retiring from the game. Two reports by Fuller et al. and two reports by Brooks et al. allow comparison of injury severity for match play versus training as well as between forward versus back positions of play. Considering the wide confidence intervals reported for the average injury severity, there does not appear to be a difference in injury severity between the forward or back positions. Similarly there does not appear to be a difference in neck injury severity between match and training participation.

Cervical facet joint sprain, neck muscle strain and cervical nerve root/brachial plexus neuropathy appear to be the most frequently occurring neck injuries in RU (Supplement 7). Further, these injuries appear to contribute the greatest overall time loss (severity) from RU participation.

There is very little analytical data to confirm or refute causal relationships with proposed risk factors. Fuller et al. provides the most comprehensive analysis of risk factors for cervical injury in RU. They identify game play, forward position, end of season and end of game factors as significant incidence risk factors in their study population of professional men. Supplement 4 provides a summery table of extracted risk factors with supportive data.

In the studies that report neck injury rate for professional men’s RU ranges from 8.75 (CI: 6.75, 11.25) to 8.97 (7.14, 11.27) neck injuries per 1000 player match hours for forwards, while the rate for back ranges from 3.60 (CI: 2.45, 5.29) to 3.75 (CI: 2.50, 5.00) neck injuries per 1000 player match hours. This appears to confirm the finding of Fuller et al. The aforementioned RU neck injury rate results comparisons between gender types and age of similarly defined studies however provides no firm difference in incidence risk if one indeed exists.

4. Discussion

This review presents data on the probability and consequence as well as accompanying risk evaluation data for neck injury in RU. In doing so it summarises information pertaining to the initial steps in the sequence of RU neck injury prevention. It has been suggested the true incidence of either spinal cord or all cervical injuries in rugby players in any rugby playing country are unknown. From the result of this review elements of this sentiment still hold true in the broader epidemiological construct.

Debate exists over accurate and reliable injury definition in team sports, which may account for the plethora of injury definitions utilised by the studies included in this review. Injury definition and exposure reporting heterogeneity among included studies limited comparability of data in this study. Indeed only five of the 33 retrieved articles in this review had comparable construct to evaluate the impact of sports injury definition between the fully-inclusive time-loss and the all inclusive sports injury definition categories. The noted disparity across injury definitions highlighted by our review interestingly conflicts with current view that broad all encompassing injury definitions inflate injury rates due to their propensity to capture minor (no time-loss) injury. While this finding may give credence to supporters of a broad classification of sports injury definition, it should be viewed with caution due to the small population and exposure time of the study which provided the data.

Methods of reporting neck injury incidence varied to include the absolute number of neck injury in a season, proportions of neck injury in a season and neck injury rates. Historically it was noted that all included studies prior to the year 2000 reported neck injury incidence as either absolute numbers or proportions of neck injuries over a given period, such as a playing season. Only in recent times has the trend emerged to report neck injury incidence in injury rate format. Hodgson explains, meaningful comparison of injury risk and rates can only be applied in the presence of athlete exposure time. Therefore those studies which fail to report injury rates were largely meaningless for purposes of comparison.

In this review several studies present combined match/game and training data into the incidence data. This method as described by Brooks and Fuller can be misleading because the data depend on the ratio of match and training exposure as well as the ratio of match and training injury. The net effect is a diluted overall injury rate, therefore comparison was not attempted for combined match/training data in this review. In order to facilitate more meaningful comparisons, it is recommended that all future epidemiological investigations in RU report match and training data separately.

Presumably RU has evolved in the past decade. Of the 33 studies retrieved only ten prospective studies provide neck injury data from the year 2000 onward. Of these recent articles six report were of elite athlete populations, four were elite men and two were elite women. In the same period three studies report on amateur athletes. Two of which report on amateur
boys, and one which reports on amateur collegiate men and women. Considering amateur players account for the vast majority of those who play RU there is a deficiency in amateur men and women RU neck injury data in the literature.

A noteworthy point from this review is the identified problem of small participant numbers and neck injury events in the included studies. Sample size directly affects the ability to demonstrate that there is a relationship between a risk factor and injury if that relationship does indeed exist. Bahr and Holme suggest calculation of sample size should be performed specific to the type of statistical test which will be used to evaluate the main effect. They advise moderate to strong associations can be detected with 30–40 injury cases, whereas small to moderate associations would need more than 200 cases. In this review it was observed that low statistical power limited the strength of associations made for neck risk factors. We found participant numbers varied greatly from 25 to 38933. Further, injury count varied from 156 to 9648 which falls short of the small to moderate associations recommended by Bahr and Holmes. Of concern was the under reporting of this methodological consideration in the literature. That is, study power may have been a limiting factor in articles which evaluate neck injury risk factors.

There is inconsistent employment of severity as an outcome measure for neck injury in RU. This has implications in the assessment of neck injury risk factors in that consequence risk for neck injury in RU is rarely evaluated for consideration through prospective measures. Furthermore studies that report neck injury severity display disparate reporting methods. As a result meaningful comparison and interpretation of neck injury severity data in RU is limited at present.

Recent consensus on injury definitions and data collection procedures for studies in RU has been established. The many aforementioned inconsistencies in incidence and severity data reporting and methodological construct identified in this study dramatically limited possible intra- and cross-study comparison. Future neck injury studies in RU should conform to the consensus document utilising a single definition of injury. This in turn will allow a greater intra- and cross-study comparison and meaningful interpretation of data in future studies.

The second step in the sequence of prevention is to establish the relationship between potential risk factors and sports injuries. In most cases the most favourable method to achieve this is to conduct a prospective cohort study. In the broader literature several risk factors for neck injury in RU have been tentatively identified. As such tentatively identified risk factors are based on descriptive epidemiology. They are largely based on anecdotal evidence, extrapolation from other injury sites or descriptive study designs. This review includes only those study designs that can analytically assess risk factors for sports injury. The opinion of the authors of this review concur with Brooks and Fuller, in that "Descriptive studies such as case reports and cross sectional studies may identify associations between the incidence of injury and risk factors, however they cannot confirm that causal relationships exist. Analytical studies on the other hand, such as case-control, cohort and intervention studies, do enable comparisons or causal relationships between risk factors and injuries to be investigated.” The major benefit of including only prospective study designs in this review is that they more accurately quantify exposure time. In turn estimates of injury risk and incidence become more accurate. The major disadvantages faced by including retrospective study designs would be recall bias, over estimation of exposure time, incomplete response/non-response, and invalid injury description. The injury prevention model proposed by Van Mechelen has been modified in recent times to scientifically reflect on the validity and suitability of proposed risk factors.

No longer is it adequate to assume the legitimacy of proposed risk factors. Descriptive studies importantly show the problem and sets hypothesis. Analytic studies follow-up on hypothesis to evaluate causal relationship. It can be said this epidemiological process has not been rigorously applied as yet for neck injury in RU.

In this review all studies that assess risk with playing position report forwards to have higher incidence risk of neck injuries than backs while higher severity risk does not appear to be apparent. Four studies highlight the front row position to have the highest incidence of neck injury. Player position appears to be an incidence risk factor, but not a severity risk factor for neck injury in RU.

Three studies compare descriptive neck injury data in men and women RU players. Discrepancy in incidence risk exists concerning gender amid these studies. When injury rates from studies with all inclusive sports injury definition were compared, the incidence of neck injury in elite men fell within the range of that of elite women by the descriptive study designs. The findings of this study suggest there does not appear to be a demonstrable difference in neck injury incidence across age groups, however formal statistical interpretation has not been undertaken. Again there is insufficient data to suggest that gender type is a severity risk factor for neck injury in RU.

Five reports compare neck injury incidence data in RU athletes of different ages. There is discrepancy over the significance of players’ age as an incidence risk factor. Meaningful interpretation of these discrepancies is limited by the descriptive study designs. The findings of this study suggest there does not appear to be a demonstrable difference in RU neck injury incidence across age groups, however formal statistical interpretation has not been undertaken. Again there is insufficient data to suggest age alone is a severity risk factor for neck injury in RU.

Other potential neck injury risk factors identified in this review include static play, wet pitch, late season play, and late period of games. Factors which do not appear to be significant from this review include player stature, play body mass, player body mass index, and utilisation of headgear and grade of play. However these findings are all limited to individual studies therefore further research is required to correlate and confirm these findings. There is still much uncertainty surrounding tentatively identified risk factors in the literature.
The authors acknowledge that there can be well-constructed retrospective studies as well as poorly constructed prospective studies that evaluate the topic of neck injury in RU. In this study the authors have reviewed only prospective studies to eliminate selection and recall bias inherent to retrospective study designs. Further the authors of this study acknowledge the importance of descriptive studies in risk identification. It is not the intention of this paper to review all risk factors for neck injury in RU, only those which have been reported through prospective study designs.

The quality assessment tool in this review was not designed to assess for methodological quality. This may reflect the medium to good quality weighting given to some studies with low injury counts. As highlighted by Sanderson et al., there is not a single obvious candidate tool for assessing quality of observational epidemiological studies, such as neck injury in RU. The STROBE statement provides a suitable starting point for development of a quality assessment tool.

5. Conclusion

This study highlights the importance of methodological considerations in epidemiological studies. Wide variation of injury and exposure definitions and population sampling was identified in the included articles. Meaningful understanding of neck injury incidence and severity in RU is restricted to a few studies which adopt a comparable methodological construct.

Neck injury incidence ranged from 0.26 (CI: 0.08, 0.93) to 9.17 (CI: 1.89, 26.81)/1000 player hours for mixed RU populations that adopted an all inclusive sports injury definition. There is a paucity of both neck injury severity data and analytical data evaluating causal relationships of proposed risk factors. This paper provides direction for future epidemiological neck injury studies in RU. Recent consensus on injury definitions and data collection procedures for studies in RU promises to provide greater intra and cross-study comparison in future studies. Future studies which propose preventive measures in the epidemiology of neck injury in RU are encouraged to adhere to this more accurate evaluation framework for the benefit of stakeholders and athletes alike.

Practical implications

- Understanding of the probability and consequences of neck injury in Rugby Union is hindered due to mixed methods of study designs in the literature.
- There is a significant lack of consequence data for neck injury in Rugby Union which impedes further discernment of risks that influence neck injury severity.
- To date only limited scientific rigor has been applied to identifying risk factors for neck injury in Rugby Union.

Acknowledgments

The authors of this study would like to thank the authors who responded to our requests to provide clarification of the data from their publications. Further, the authors would like to acknowledge the insightful feedback provided to reviewers of this manuscript. No external financial support was received in the generation of this manuscript. The authors have no conflict of interest directly related to the content of this manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jsams.2010.10.460.

References


Further reading