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SCAT3 testing for signs and symptoms of concussion in rugby union players

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ABSTRACT

This study is an investigation into the reliability of the Sport Concussion Assessment Tool (SCAT3) and methods of testing suspected concussion within amateur rugby union players. The aims of the research are to provide insight into how the reliability of concussion testing could be improved and how any limitations found could be mitigated to improve the accuracy of assessments.

An assessment of the common injuries acquired by rugby players, especially head injuries, was made, the accompanying risks of concussion were also appraised. Rugby players from Ponteland Rugby Football Club (PRFC) were the subjects of the research, providing immediate benefit to the physiotherapists and medical team of PRFC. Other lower league amateur clubs that may not have such an experienced medical support network as professional-level clubs can all also realise these same benefits.

It is not just medical support teams that should be more informed, but also the players themselves, everyone involved in the sport should have greater awareness of the signs and symptoms of concussion and the accompanying long-term risks of playing with an untreated concussion.

KEYWORDS

SCAT3, Concussion, Signs, Symptoms, SRC, Injury, Assessment, Baseline Test.

INTRODUCTION

Throughout 120 countries in the world there are more than 6.6 million people playing rugby on a regular basis (World Rugby, 2017). The game of rugby union is a full contact sport: two teams of 15 players engage in the physical activity of tackles, scrums, line-outs, rucks and mauls to attack or defend, with the aim of scoring a try (Kaplan *et al.*, 2008). Unsurprisingly, due to the nature of rugby union it has one of the highest rates of concussion in all full contact sports (Gardner *et al.*, 2014).

As stated by Shaw (2002), concussion is an injury to the brain's soft tissue due to the acceleration or deceleration of forces to the head. This can be a result of a direct blow to the head or the body coming to an abrupt stop, causing the brain to carry on the momentum and collide with the bone of the cranium.

Any symptoms during the acute stage (the 72 hours following after the injury) can often change quickly or may be delayed, making it the most difficult sporting injury to

recognise, assess and manage (McCrory *et al.*, 2017).

Of course, if the person is unconscious it makes the diagnosis more straight forward. However, more than 90% of sport-related head injuries do not show clear or obvious signs. Often there is no loss of consciousness or amnesia, and only mild effects on balance and orientation (McCrea, 2001).

As identified by McCrory *et al.* (2017), concussion must be suspected if the player in question has one or more of the following: clinical symptoms (a headache or feeling emotional), physical signs (unconsciousness or amnesia), balance impairment (less stable when standing or walking), behavioural changes (aggression and appearing to act out of character), cognitive impairment (slowed down reaction times, disturbed sleep or feeling drowsy). However, the overall impact on the person's mental status can be much subtler and harder to identify, and so SCAT3 testing should be used as a guide and if in doubt the player should seek a full medical assessment (McCrea, 2001).

A study by Kaplan *et al.* (2008) identified that the highest number of mechanisms of injury in rugby union occur during tackles; either a player tackling another or being tackled themselves, with reported figures in the range of 36%-57%. In terms of the types of injury in professional-level rugby union, injuries to the head and neck account for 14%-29%, which encompasses multiple definitions of injury and does not single out concussion alone (Bathgate *et al.*, 2002; Brooks *et al.*, 2005; Jakoet and Noakes, 1998; Targett, 1998).

Furthermore, although it has been identified that rugby has a high association with concussion, the statistics may be greatly underestimated. Players may not be aware of

minor symptoms or may not wish to bring it to anyone's attention so that they can remain on the pitch and continue playing (Kaplan *et al.*, 2008). This leads to cases of concussion going untreated with an increased risk of repeat concussion and the potential of a more serious subsequent head trauma leading to possible long-term damaging effects (Barth *et al.*, 2001).

SCAT3 TESTING IN RUGBY UNION

PRFC, based at Ponteland Leisure Centre, is a member of the Northumberland Rugby Union and governed by the national Rugby Football Union (RFU). The club has two qualified physiotherapists based in the club house twice a week during training sessions, and as pitch-side medical support on match days.

At the start of a new season, each player must undergo a baseline test using the SCAT3 to determine their baseline score. The SCAT3 is the standardised method used to assess injured athletes over the age of 13 for concussion (Concussion in Sport Group (CISG), 2013). Any post-injury tests are then compared and interpreted to assist in decisions about whether the player is suffering with concussion or not.

The CISG developed the SCAT which is the most widely used testing method currently available (Echemendia *et al.*, 2017; King *et al.*, 2017; Morton, 2015). However, the latest literature surrounding the topic highlights a number of factors that influence the reliability of the SCAT3 test, especially in contact sports such as rugby union, which will be discussed in detail.

The tool has been developed over recent years following the first International Conference on Concussion in Sport, held in Vienna in 2001. The conference was established for representatives across

international sporting federations to come together and discuss the health and safety of athletes who may suffer concussion, creating a model to use internationally to assess and manage concussion more effectively (Aubry *et al.*, 2002).

The original SCAT tool was published in 2005, which was superseded by the SCAT2 in 2008, providing a more detailed assessment. It was updated again to the SCAT3 in 2013, with the addition of a separate Child-SCAT3 for those under 12 years of age (King *et al.*, 2014).

The SCAT3 consists of various tests: a symptom evaluation whereby the individual must score themselves from 0 (none) to 6 (severe) for 22 different symptoms; a cognitive assessment to test orientation, immediate memory, concentration and delayed recall; a neck, balance and coordination examination (CISG, 2013).

Since amendments and adaptations have been made to the original SCAT test, the SCAT3 is now more detailed and extensive. This could be considered too time consuming, especially when completing baseline tests in larger teams (Eckner and Kutcher, 2010). Therefore, time and resources may not be available to ensure testing is completed when required or that it is done accurately. Prior to the detailed tests, two sideline assessments are used to indicate if the player needs emergency management, if so they should be removed from play immediately (CISG, 2013).

Firstly, the Glasgow Coma Scale (GCS) is a clinical scale giving a score out of 15 to assess the severity of a brain injury (Teasdale and Jennett, 1974). Anything below 8 is classed as severe, 9-12 as moderate and, as most typically identified in rugby, 13-15 being the mild end of the spectrum (RFU,

2017). Maddocks Score questions are also used, asking the player questions such as what club they are at, what is the score, where did they play in their last match, to assess attention and memory recall (Maddocks *et al.*, 1995).

If a player fails to accurately answer these questions they should be removed from the field of play immediately. The application of an assessment and treatment should be considered to permit time for full recovery and then a graduated return to play, according to the RFU's Return to Play procedure (RFU, 2017).

As stated by Robinson (2017), the SCAT3 test does not take into consideration the possibility that individuals who are deemed 'healthy', may display elements of the symptoms without being concussed. Every individual has their own benchmark of mental and physical ability, and so when testing for concussion they may have symptoms even when they are not actually concussed.

Cottle *et al.* (2017) found that pre-existing symptoms can influence neurocognitive performance and increase symptom scores. Therefore, a baseline test is extremely important, rather than using normative data, to ensure the player follows the correct return to play procedure. Otherwise any pre-existing symptoms they have, which are, in fact, unrelated to concussion, could delay their return to play (Cottle *et al.*, 2017).

The focus on sport-related concussion (SRC) has become more prevalent over the last 30 years, with it being the most common type of traumatic brain injury in sports (Noble and Hesdorffer, 2013) and posing the potential risk of long term damage, such as chronic traumatic encephalopathy (CTE) due to repeat trauma (Makdissi *et al.*, 2014).

As stated by Makdissi *et al.* (2014) cases of mental health problems found in retired NFL players have led to greater attention to the identification and management of concussion injuries across all contact sports. There is now evidence supporting the theory of the impact a head injury has on the brain, which has raised the need for a better understanding and management of SRC (King *et al.*, 2014; Malcolm, 2009).

Since 2001, there have been five meetings of the International Conference on Concussion in Sport. The CISG discuss the progressing science and knowledge around the topic and update a consensus document, used as a guide for healthcare providers working with anyone playing sport whether it be at amateur or professional level (McCroory *et al.*, 2013; McCroory *et al.*, 2017).

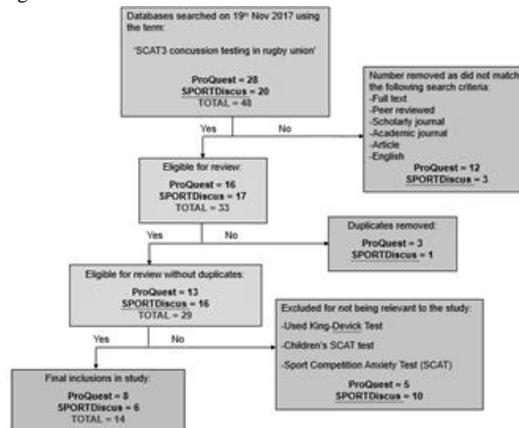
METHOD

The search term ‘SCAT3 concussion testing in rugby union’ was used to search publications within the ProQuest and SPORTDiscus databases, to gather relevant secondary research for this study. The initial results were filtered to remove any publications that did not match the following inclusion criteria; full text, peer reviewed, scholarly journals, academic journals, article documents and written in English.

Any duplicated journals within the database were removed, as well as a manual process of cross referencing to compare the two database results to ensure there was no duplication. Finally, a manual review was carried out to discard any journals that were deemed irrelevant to the study and not necessary for inclusion. This included any articles focusing on children’s concussion, alternative concussion tests such as the King-Devick Test, and the Sport Competitive Anxiety Test which also uses the acronym SCAT.

See Figure 1 for the systematic process followed. From the initial 48 journals that were found, 34 were discarded, resulting in the final count for this study totalling 14.

Figure 1. The Review Process



RECOGNISING SPORT RELATED CONCUSSION INJURIES

The ability to recognise SRC when pitch-side during a rugby match can be challenging even for a trained medical practitioner, especially when the signs and symptoms can be subtle and overlooked (King *et al.*, 2014; Putukian, 2017). Albrecht *et al.* (2013) highlighted a major misconception of the cause of SRC: many believe a blow to the head is the only cause, whereas in fact any force to the upper body or whiplash can result in a head injury.

There is also the common belief, even amongst doctors, that if the player has not lost consciousness then it is not SRC (Malcolm, 2009). This is a real concern, as it is reported that only 8%-9% of SRC results in loss of consciousness (King *et al.*, 2014). Therefore, if there is a lack of education and ability to recognise the signs in order to take action, then the chance of a second SRC occurring is increased with potential subsequent injuries being more severe (Malcolm, 2009).

In a study by Cross *et al.* (2016) it was reported that, of the 150 rugby union players who tested positive for SRC, 60% were more

likely to suffer a secondary injury (of any kind) during the same season when returning to play. No matter how reliable the SCAT3 test may be deemed, if the mechanism of injury is not witnessed, signs and symptoms are not recognised in the first instance, or if SRC is tested and positively diagnosed but not managed correctly, the player is more likely to suffer further injuries during that season once they return to play than those who have not had a SRC.

The recognition and analysis of symptoms can also be misleading when comparing SCAT3 post-injury test results with pre-injury baseline test results. Robinson (2017) states that the results of the symptom scale can be invalid if the player had any conditions prior to a SRC, such as dehydration or tiredness. It may suggest their baseline results as being concussed when they were not. Therefore Robinson (2017) suggests a baseline should be completed multiple times over a 7-day period to account for variations. There have been attempts at producing a standard baseline score, however results have been inconsistent between studies with no definitive result (Robinson, 2017).

For this reason, McCrory *et al.* (2017) state that baseline tests can be useful but are not essential for interpreting post-injury SCAT3 results. In cases where the baseline is used in comparison, the person administering the test should replicate it under the same conditions for better consistency and reliability.

However, Thomas *et al.* (2016) argue that pre-season baseline tests are important and should be done as an absolute minimum, with frequent tests being carried out during the season to monitor any changes in scores and any potential unnoticed SRC. This is supported by Putukian *et al.* (2017) who

state that if there are no baseline results then it is more difficult to judge a player's decline.

Both opinions can be argued: a baseline test can be misleading therefore reducing validity when it comes to comparison, but if a baseline test and future tests are done regularly throughout the season it could flag up any causes for concern. Even if they are not 100% reliable they may be considered better than nothing at all.

Mrazik *et al.* (2013) also reported that SCAT3 results are influenced by variables other than concussion, such as the fitness level of the player, fatigue and also whether the test was completed pre or post physical activity, with an increase in symptoms immediately after exercise. Thomas *et al.* (2016) support this finding, suggesting more research is needed to assess players during activity such as at half time, to see the degree of change in SCAT3 scores following physical activity in the first half of the game. Therefore, if a SRC does occur during the second half, a more reliable SCAT3 test can determine the severity of the injury, with consideration to these external variables.

Echemendia *et al.* (2017) noted that numerous studies found that females reported more symptoms and with higher severity than males at baseline tests. Therefore, until more research is done to provide clarity, these variables must be considered when assessing a suspected SRC. It highlights the importance of knowing the players and their individual characteristics to help recognise any changes in their normal behaviour (Mrazik *et al.*, 2013).

AWARENESS AND UNDERSTANDING

The need to increase awareness and promote knowledge transfer is crucial, especially within amateur clubs such as PRFC. This

increased awareness should not only be widespread amongst staff that have medical training but also the players, coaches, referees and parents, to ensure they are aware of SRC and how to recognise and manage it as effectively as possible (McCrorry *et al.*, 2013).

In a study by Malcolm (2009), nine doctors, ten physiotherapists, sixteen players and seven coaches from English elite rugby union clubs were interviewed to investigate medical uncertainty of SRC. The study highlighted that the majority of the medical personnel interviewed had elements of uncertainty and confusion when trying to define and diagnose SRC, often allowing other factors such as the individual player's performance, their role in the team and their past injury history to dictate their decision.

From the perspective of the players and coaches interviewed, there was uncertainty in the form of whether they would be taken off the pitch following a head injury, how long they would be out for recovery and whether they respect the clinician's skill and knowledge to diagnose and give correct return to play advice.

Studies have reported that 16%-51% of coaches were unable to recognise, manage or implement preventative SRC techniques and 40%-42% believed SRC would only occur when there is loss of consciousness (King *et al.*, 2014). Although difficult to enforce, this highlights the necessity for further education to improve the knowledge for all involved.

The general understanding, assessment and diagnosis of SRC can cause conflict of interests, due to external pressures influencing the decision-making process. Particularly for amateur clubs, who may not have trained medical staff or a physiotherapist pitch-side during a match, it

may be up to the coach to have knowledge of concussion in case an incident arises. As stated by Albrecht *et al.* (2013), this can cause a conflict of interest as to whether they prioritise the health and welfare of their player and take them off the pitch, or whether they allow them to continue to play on in the hope of winning the game.

In cases where the diagnosis of SRC is made by a qualified physiotherapist or sports therapist, it may be influenced and undermined by the player or team members. This could result in poor decisions being made to avoid that conflict and to maintain a positive relationship with the team (Malcolm, 2009).

Morton (2015) discusses the external pressures placed on medical staff to correctly diagnose SRC, such as time constraints mid-match and being pressurised by the coach or other team members to keep the player on the pitch. A diagnosis can also be influenced by a player's awareness and willingness to be honest in reporting any symptoms they are experiencing, especially when completing the symptom scale on the SCAT3 test (King *et al.*, 2014).

Being a subjective test, the SCAT3 cannot provide an objective diagnosis, but it can give an indication of the number of symptoms a player may have following an incident and the severity of it. The player can then be retested to see if any further symptoms develop over time, as some will not be visible immediately (Makdissi *et al.*, 2014). However, the reliability of the SCAT3 symptom scale depends not only on the honesty of the player to report the true severity of their symptoms, but also on them seeking medical advice rather than trying to hide any signs, which is not unusual in sport (Malcolm, 2009).

INJURY MANAGEMENT

The CISG created the 11 R's of SRC to aid in the management of a suspected injury: Recognise, Remove, Re-evaluate, Rest, Rehabilitation, Refer, Recover, Return to sport, Reconsider, Residual effects and Risk reduction (McCrory *et al.*, 2017). As previously discussed, the ability to recognise SRC is challenging, with a cause for concern if the relevant people are not aware of, or do not follow the management process and graduated return to play (RTP) procedure when SRC has been diagnosed.

King *et al.* (2014) reported that studies have highlighted only 27%-32% of the discharge advice given by healthcare professionals to patients with SRC followed RTP guidelines. Also, the player's compliance with RTP procedures is reported as being low, with 33-100% non-compliance, even after receiving RTP advice and guidance (King *et al.*, 2014). Therefore, confusion and inconsistencies in the use of guidelines and the lack of cooperation from the player can cause complications, especially if returning to play too soon after a SRC (Makdissi *et al.*, 2014).

The graduated RTP procedure gives six specific stages the player must complete, only proceeding to the next if they are without any symptoms for the following 24 hours; 1) physical and cognitive rest; 2) light aerobic exercise; 3) sport specific exercise; 4) non-contact training drills; 5) full contact training; 6) return to play; any development of symptoms requires the player to go back to the previous stage until they can complete it symptom free (McCrory *et al.*, 2013). However, the amount of rest needed at the acute stage is not proven: 24-48 hours is said to be beneficial, but more research is required to clarify the type and amount of rest needed, and the long-term effect it may have on recovery (McCrory *et al.*, 2013).

Guidance from the English Rugby Football Union (RFU) states that the minimum timespan of a player returning to play is seven days, if they have access to full-time medical staff. But for those without, two weeks rest is advised before continuing with the RTP procedure, meaning the earliest RTP for an adult in an amateur club is 19 days (Morton, 2015).

The research by Cross *et al.* (2016) suggests that the RTP procedure could be deemed as too short, with recovery and rest given priority. They argue that this process is designed only to assess the degree to which symptoms are aggravated and provoked, rather than being a functional rehabilitation plan which should concentrate on neuromuscular control, proprioception and coordination abilities. This is supported by Nobel and Hesdorffer (2013) who stated that 10% of those with SRC will take longer than the typical two weeks to recover, and those who have had a previous SRC or have psychiatric issues will take much longer to make a full recovery.

This then relates back to the honesty of the player when completing SCAT3 tests throughout their recovery period. Also, their adherence to the RTP procedure to ensure that they truly making a full recovery, rather than hiding symptoms to try and speed up the process, to RTP within the minimum amount of time (King *et al.*, 2014; Malcolm, 2009).

RECOMMENDATIONS

The findings of this study suggest that more research is needed into the long-term effects of SRC and players who sustain repeated injuries, not only in rugby union but across all contact sports. Current guidelines and assessment tools focus more on the subjective analysis of players and their symptoms, rather than investigating from an objective viewpoint, with little consideration

of any potential changes to the brain over a prolonged period (Nobel and Hesdorffer, 2013).

A common theme highlighted throughout the literature is the amount of confusion, uncertainty and poor level of education regarding the diagnosis and management of SRC (King *et al.*, 2014; Malcolm, 2009; Putukian, 2017). It is more prominent in today's media and highlights the need for further research and understanding (BBC, 2015).

SRC is considered to be very much an individual injury, varying case by case, making it difficult to diagnose and therefore thought to be vastly underreported (King *et al.*, 2014; McCrory *et al.*, 2017). However, this does not create an excuse for it to be ignored and considered less important than musculoskeletal injuries just because it cannot be physically seen.

A combination of assessment tools should be utilised to test for SRC as reliably as possible; such as the SCAT3 test being accompanied by neuropsychological testing and thorough medical examinations to ensure that early RTP is avoided (Albrecht *et al.*, 2013; Thomas *et al.*, 2016). No matter what assessment tool is used, SCAT3 or any other assessment method, it should not be the only method used and should be combined with medical judgement to make a thorough diagnosis (Putukian, 2017).

CONCLUSION

The reliability of the SCAT3 test is inconclusive due to the numerous variables and external factors that are said to affect the reliability of results. As previously mentioned, a player's fitness level and whether the test is conducted pre or post exercise is thought to have significant impacts on findings, therefore further research is required to give more clarity

(Echemendia *et al.*, 2017; Mrazik *et al.*, 2013; Thomas *et al.*, 2016).

The chances of SRC occurring in rugby union or other contact sports are never going to be completely eradicated (McCrory *et al.*, 2017), but the amount of SRC injuries can be reduced and managed more effectively through better education of all those involved in the sport, including the player themselves (King *et al.*, 2014). The introduction of side-line video could assist in the identification of the mechanism of injury, in the attempt to reduce the number of missed injuries (McCrory *et al.*, 2017), however, this is likely to be unfeasible for amateur level clubs due to the financial implications.

This study will be of use to amateur rugby clubs, such as PRFC, to highlight the importance and potential dangers of SRC. The amount of academic literature available regarding SRC is extensive and only a small sample has been analysed in this study. Therefore, more research papers could be analysed to take on board additional findings and comparisons of SRC in rugby union and across other sports, as well as investigating any differences in gender or age groups.

The next formal review and update of the CISG consensus statement is due by 31 December 2020 (McCrory *et al.*, 2017). In the meantime, studies and advancements in knowledge should be closely monitored, to ensure that the most up to date information and guidance is filtered down to grass root level, and that any changes or developments in procedures and management techniques of SRC are followed by all levels and not just by professional clubs.

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