American Journal of Sports Science and Medicine, 2019, Vol. 7, No. 1, 10-15
Available online at http: //pubs.sciepub.com/ajssm/7/1/2
Published by Science and Education Publishing
DOI: 10.12691/ajssm-7-1-2

Concussion: A Growing Concern in the Rugby Fraternity

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Received September 01, 2018; Revised October 10, 2018; Accepted January 24, 2019

Abstract Rugby is a team contact sport that is popular in many countries. Concussion remains one of the inherent risks of participation in rugby union with Certain facets of play, as well as specific tactics and strategies in contact and collision predispose athletes to a greater chance of sustaining a concussion. While other injuries incurred by rugby players have been well studied, less focus and attention has been directed towards concussion. The Third International Conference on Concussion in Sport defined concussion as a complex pathophysiologic process induced by traumatic biomechanical forces. World Rugby (previously known as the International Rugby Board or IRB) has acknowledged that there is a significant risk associated with concussions, and have subsequently implemented a risk management strategy [1]. This systematic review aims to evaluate the available evidence on concussion in Rugby Union (here- after referred to as 'rugby') and to conduct an analysis of findings regarding the incidence of concussion and players knowledge on concussion. Data was collected through Library Research on Masinde Muliro university of science and technology, Kenya rugby union, Kenya rugby football clubs, internets and Hospitals and clinics affiliated to Rugby. A desk review was also conducted and a search done PsycINFO®, MEDLINE™, Embase, SPORTDiscus™, Crossref, British Journal of Medicine (BMJ) Genamics Journal Seek, Global impact factor.com, Google Scholar, Academic keys, Open Academic Journals Index, Sherpa/RoMEO (University of Nottingham), Chemical Abstracts (CAS) and Open-j-Gate. Precisely the pathophysiology of concussion is not well known but recent research show that moderate to severe brain injury causes intricate torrent of neurochemical changes in the brain. The assumption is that similar changes occur in concussion. Paucity of literature exists on player knowledge of concussion or the rate of reporting of this injury despite there now being over 20, 000 adult rugby players in Ireland only but other studies showed that participants displayed a relatively high level of knowledge with regard to what constitutes a concussion, the risk that a history of concussion holds with regard to future concussion, and the authority that should rest with medical doctors in clearing players to Return To Play following concussion. In future Biomechanical research should be done with other clinical based research to improve on sideline concussion recognition and treatment modalities. In conclusion more research on concussion education, sensitization and awareness on concussion to help reduce incidences of concussion.

***Keywords**: concussion, rugby, return to play. brain injury, recovery*

Cite This Article: Wangui Anthony Muchiri, Oloo Micky Olutende, and Issah W. Kweyu, "Concussion: A Growing Concern in the Rugby Fraternity." *American Journal of Sports Science and Medicine*, vol. 7, no. 1 (2019): 10-15. doi: 10.12691/ajssm-7-1-2.

1. Background

In 1823, the sport of Rugby Union or 'rugby' as it is colloquially known was conceptualized at the local high school in the small English town of Rugby. The sport closely resembled that of Rugby League, but forged its own identity as an independent sport following separation from rugby league [2]. Rugby is a team contact sport that is popular in many countries. In France, there were more than 390, 000 licensed players in the French Rugby Union in 2010 including 4.5% women, with an increase in membership of 40% in the last five years [3]. The Third International Conference on Concussion in Sport defined concussion as a complex pathophysiologic process induced by traumatic biomechanical forces [4]. Concussion is an entity that can occur not only from direct head trauma, but also from a force transmitted to the head, even if seemingly mild [5]. The incidence of concussion is the highest in sports that involve frequent high-impact collisions, for example those seen in rugby union, in comparison to other team sports such as soccer. [6]. Certain facets of play, as well as specific tactics and strategies in contact and collision sports predispose athletes to a greater chance of sustaining a concussion. For example, the tackle phase of play in rugby union has a higher association with concussion events. Despite concussion being regarded as a common injury in rugby codes, paucity of literature exists into the chronic effects

of head injuries. To date studies in retired elite rugby union players with a history of concussion have explored cognitive outcomes [7] Regional study in the Waikato region of New Zealand went beyond hospital data for Traumatic Brain Injury (TBI) and found 790 per 100, 000 [8]. The Feigin et al. (2013) study identified a sample of 1369 people with TBI in the Waikato region, and revealed peaks in TBI incidence occurred in 0 to 4 year old and 15 to 34 year old. Males were also more likely to experience TBI than females, with 69% of the sample being of male gender. In England Concussion is the most frequently reported injury in rugby union and rugby league and It is now the most commonly recorded injury in professional rugby union due to its increasing in incidence [9]. In south Africa, the incidence of concussion in high-level under-18 rugby union players were calculated at 5.8 concussions per 1000 player-exposure hours and an incidence of 6.8 concussions per 1000 player - exposure hours was observed across four youth week rugby tournaments (under - 13, under - 16, and under - 18) [10]. Interestingly, overall concussion rates (game and practice combined) in American collegiate rugby union players was recently shown to be significantly higher than that in collegiate football players [11].

World Rugby (previously known as the International Rugby Board or IRB) has acknowledged that there is a significant risk associated with concussions, and have subsequently implemented a risk management strategy, World Rugby used current scientific evidence and the 2012 international consensus statement for concussion in sport [12] to advise on concussion prevention, identification and management at various levels of play. but despite this the cases of concussion are still on the rise with the popularization of the game [13].

The Massey University researchers surveyed the tournament's 48 games and found that seven of the 13 players they deemed to have been concussed returned to the field or played in another match, against International Rugby Board guidelines [14]. There is growing international attention towards understanding the relationship between repetitive concussions experienced in sport and the development of chronic neurological impairment later in life [5]. The aim of the current review is to systematically evaluate the available evidence on concussion in Rugby Union (here- after referred to as ‘rugby’) and to conduct an analysis of findings regarding the incidence of concussion and knowledge of players on concussion. To examine and address this issue, observational, cohort, correlational, cross-sectional, and longitudinal studies were included in the review.

2. Methodology

The following methods were used to collect data.

Library research This was conducted in the following centers and libraries in Masinde Muliro university; 1. Kenya Rugby Union. 2. Kenya Rugby Football Clubs. 3. Internet. 4. Hospitals and clinics.

Desk review was done using the following descriptors ‘Rugby Union’, ‘rugby’, ‘union’, and ‘football’, in combination with the injury terms ‘athletic injuries’ ‘concussion’, ‘sports concussion’, ‘sports-related concussion’, ‘brain concussion’, ‘brain injury’, ‘brain injuries’, ‘mild traumatic brain injury’, ‘mTBI’, ‘traumatic brain injury’, ‘TBI’, ‘craniocerebral trauma’, ‘head injury’, and ‘brain damage’. The search was done in PsycINFO®, MEDLINE™, Embase, SPORTDiscus™, Crossref, British Journal of Medicine (BMJ) Genamics Journal Seek, Global impact factor.com, Google Scholar, Academic keys, Open Academic Journals Index, Sherpa / RoMEO (University of Nottingham), Chemical Abstracts (CAS) and Open-j-Gate.

3. Results

3.1. Epidemiology of Concussion

A number of published articles deliver sufficient detail (i.e., player exposure hours, number of concussions recorded, and/or the incidence of concussion per 1, 000 player hours) have been published. According to the RFU website, studies showed concussion has become the most common match injury, and for the first time, concussion incidence in the 2012-2013 season was above the expected variation during the 11-year study period of the English professional Rugby Survey [9]. From the review by Koh et al, [15] the incidence of concussion in rugby seems to range between 1.03 and 9.05 per 1000 player- game hours. Moreover, concussions may occur during training (0.02/1000 player-hours), although their incidence is lower than that during match play [16]. Further research shows that head injuries are common and account for about 25 % of injuries during play (this includes concussions, laceration, bruises, etc.). Professionally English Rugby has rates of approximately 3.9 per 1, 000 player match hours (i.e., one concussion in every six games amongst all the players involved) [9] whereas studies at the community/amateur adult level done by Roberts et al. suggest that concussion occurs at a rate of 1.2 per 1, 000 player match hours (i.e., one in every 21 games) [17]. The incidence of match play ‘time-loss’ injuries reported in the men’s rugby-15s literature was 4.73 cases in 1, 000 player match hours ranging from 0.19 [18] to 17.1 [19]. In other studies, Retired players self reported an average of 8.5 concussions (where they missed competing the following week), with their last concussion occurring a mean 18.7 years previously [7]. In rugby 7s the incidence rates were 3.01 concussion per 1, 000 player match hours ranging from 2.0 [20] to 8.3 [21] the rates of injury in matches differ considerably from rates of injury during training. Holtzhausen et al found that it was quite rare (0.07 concussion per 1, 000 player practice hours), ranging between 0.0 [23] and 1.5 [22] concussions per 1, 000 player practice hours [16,20,22,23,24]. This clearly shows that the incidences of concussiona are high in 15s rugby than in 7s due to the difference in physicality of the two types of games. The disparity in incidences of concussion between team Practice and matches is due to poor documentation during patcice and lack of trained persnnel in tarining sessions to document concussion cases hence the low incidences in training sessions this was also supported by a study done by Gardner and colleagues [2]. The National Rugby League (NRL), did a survey of medically diagnosing concussions in three clubs from the 2013 season revealed

an incidence rate of 14.8 concussions per 1000 player match hours [25]. A survey of over 15-year period (1998-2012) on an NRL club revelead a rate of 28.3 concussion per 1000 player match [26]. Since not all studies used the standardized method for presenting injury information (i.e. number of injuries per 1, 000 player-hours of exposure), that allows comparison between different groups with different number of matches, calculations were required to convert the data of some eligible studies.

3.2. Pathophysiology of Concussion

Concussion is a Trauma-induced change in mental state that may not always involve Loss in consciousness [27] it is the most common among traumatic brain injury (TBI) worldwide [28,29]. Precisely the pathophysiology of concussion is not well known but recent research show that moderate to severe brain injury causes intricate torrent of neurochemical changes in the brain. The assumption is that similar changes occur in concussion [30]. The rapid onset of short of short-lived impaired of neurologic function which may resolve spontaneous is what is experts agreed unanimously as concussion [4]. Concussive head injury causes the brain to experience a mechanical "shake," by virtue of the action of the acceleration and deceleration forces transmitted to the head immediately after the impact, initiating a complex cascade of subsequent neurochemical and neurometabolic events [31]. Brain injury causes a release of excitatory amino acids (EAA), induces ion flux resulting in decreased blood glucose, oxidative metabolism and blood flow [32,33]. This results in further changes of neuronal ionic homeostasis. Among the EAAs, glutamate plays the pivotal role by binding to the kainite, N-methyl-d-aspartate, and D-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid ionic channels. N-methyl-d-aspartate receptor activation is responsible for a further depolarization, ultimately causing an influx of calcium ions into the cells. The essential point of this post-Traumatic ionic cellular derangement is mitochondrial calcium overloading [34,35,36] responsible for inducing changes of inner membrane permeability with consequent malfunctioning, uncoupling of oxidative phosphorylation, and finally, organelle swelling [37,38]. This mismatch in neurological changes may account for the symptoms and behavioral changes that are often associated with concussion. When this change resume to normal the symptoms usually disappear. The damage on the reticular activating system accounts for the loss of consciousness which recovers relatively fast and therefore consciousness is regained fairly soon after injury [39]. Signs and symptoms of a concussion can be physical, emotional, postural, or cognitive. In particular, prospectively validated signs and symptoms include amnesia, loss of consciousness, headache, dizziness, blurred vision, attention deficit, memory, postural instability, and nausea [40,41,42] Furthermore, behavioral changes (e.g., irritability), cognitive impairment (e.g., slowed reaction times), and sleep disturbances (e.g., drowsiness) also may be observed [4].

3.3. Knowledge of Concussion

Little is known, on player knowledge of concussion or the rate of reporting of this injury despite there now being over 20, 000 adult rugby players in Ireland [43]. The players Knowledge on concussion can be tested on their identification of concussion symptoms. A study done by Baker and colleagues on Ireland under 20 reported that on average, at least two symptoms (as listed on the SCAT-2) that could be experienced in the presence of concussion was identified by the players [44]. Paolo Boffano et al researched on 4 rugby amateur clubs and identified that 38.5% of his population reported that they had not been informed by anyone about symptoms of concussion and its consequences. Among these, 7 players thought they could return to play immediately after a concussion during the very same match, whereas the remaining 18 players knew that an immediate return-to-play is not advised. [45] in other studies participants displayed a relatively high level of knowledge with regard to what constitutes a concussion, the risk that a history of concussion holds with regard to future concussion, and the authority that should rest with medical doctors in clearing players to RTP following concussion [46].

Considering the concussion knowledge differences in rugby playing experience and level of play of players a study done by Walker showed there is a discrepancy in knowledge between professional and amateur rugby players implying that there is a better chance of a player being exposed to concussion information at provincial level compared to club level or high school level where minimal medical assistance is available [46]. Players knowledge on concussion can be bridged through education to players on Risks, signs and symptoms of concussion to their health. A study by Patricios exhibited that there was less adequate knowledge on the field-side management of players suspected of having a concussion and a low level of knowledge with respect to concussion-related RTP guidelines. In addition, concussion knowledge did not appear to be related to RTP attitudes. While current concussion education initiatives appear to have been partially successful, additional methods of facilitating attitudinal and behavioral changes need to be considered [47].

3.4. Diagnosis of Concussion

One of the first challenges in responding to sports-related concussions is to recognize that a player may have sustained a concussion and therefore should be removed from the activity for further evaluation. Current on-field detection methods rely heavily on sideline medical staff to identify if a player is exhibiting concussive symptoms on the field [48]. The assessment of an injured player is facilitated by the presence of a certified athletic trainer, team physician, or other health care provider at the venue (e.g., field, gymnasium, or rink) where the injury occurred [49] a number of standardized tools have been agreed upon for the initial assessment of an individual for a possible concussion by qualified and certified personnel. The most accepted tool is the pocket concussion tool [50].

Others tools have been developed to diagnose the severity of concussion are the Teasdale and Jennett published Glasgow Coma Scale (GCS) in the Lancet

in 1974 as an aid in the clinical assessment of post-traumatic unconsciousness [51]. The GCS has three components: eye (E), verbal (V) and motor (M) response to external stimuli. The best or highest responses are recorded [51]. The Standardized Assessment of Concussion (SAC) was developed to provide clinicians with a more objective and standardized method of immediately assessing an injured athlete's mental status on the sport sideline within minutes of having sustained a concussion. The instrument is intended as a supplement to other methods of concussion assessment (eg, neuropsychological evaluation, postural stability testing) but not meant to be a stand-alone measure to determine the severity of injury or an athlete's readiness to resume participation after concussion [52,53].

Test	Function Assessed
Glasgow Coma Scale (GCS) [51]	Degree of brain impairment
Standardized Assessment of Concussion (SAC) [52,53]	Memory and attention processes
Sport Concussion Assessment Tool (SCAT) 3 and Child SCAT3 [12]	Compilation of: GCS, SAC, BESS, symptom checklist, and neck evaluation
Military Acute Concussion Evaluation (MACE) [54]	Compilation of event history, symptom checklist, modified SAC, neurological screening
Balance Error Scoring System (BESS) [55]	Central integration of vestibular, visual, and somatosensory information
Sensory Organization Test (SOT) [56]	Central integration of vestibular, visual, and somatosensory information
King-Devick Test [57]	Saccadic eye movements
Clinical reaction time (RTclin) [58,59]	Reaction time

3.5. Recovery (Return to Play (RTP)

A structured and well supervised by trained and certified personnel concussion rehabilitation protocol is conducive to optimal injury and safe return to play [27,60]. Walker & Psych not from their study that their participants displayed a relatively high level of knowledge with regard to what constitutes a concussion, the risk that a history of concussion holds with regard to future concussion, and the authority that should rest with medical doctors in clearing players to RTP following concussion [46]. These findings were consistent with other studies in regards to RTP from concussion [61,62,63]. In Sye et al. study coaches stated they would “keep the patient calm and responsive while medical attention was being sought”, “use the SCAT”, and “ensure an appropriate recovery period.” [62]. this clearly shows that coaches have knowledge of Sports Concussion the RTP is a graded rehabilitation protocol that its end point is a return to play/match/competition. It is a stepwise process that entails;

1. No activity and complete rest until the player is asymptomatic.
2. Neuropsychological test parameters return to baseline values.
3. Exercise rehabilitation program: a) light aerobic exercise (walking and stationary bike); b sports specific training (running drills, ball handling skills); c) Non-contact drills; d) Full-contact practice; e) Game play.

The player has to proceed step by step in advance to the last level of recovery only if He / She is asymptomatic. [27] the above return to play protocol was also adopted by World Rugby (WR) after the Ist (Vienna) and 2nd [(prague) International Symposia on concussion in Sport [4].

3.6. Prevention of Concussion

There is no good clinical evidence that currently available protective equipment will prevent concussion although mouth-guards have a definite role in preventing dental and orofacial injury [4] studies in Biomechanics have shown a reduction in forces to the brain with the use of Head gear and helmets however these studies have not been translated to show a reduction in concussion incidences. [64]. Tierney et al observed that certain techniques can help reduce the risk of head impacts occuring on players as the tackle was major cause of concussion players [65]. Neurologically An acute injured brain may be capable of recovering after the fist blow, but a second blow during energy failure can lead to irreversible neuronal injury and massive cell death [66] this underpins the neeed for a conclusive Graduated Return to play Protocol before clearance for return to play. Educating players on sypmtoms and health effects of concussion assists players to recognize and advice pitchside medical officials to remove players whove concusssed from the field of play for further concussion tests.

4. Guidelines and Recommendations on Concussion

To gain a broader understanding of concussion and head impacts in rugby, future studies should combine biomechanical research with other clinical-based research such as medical imaging, blood testing, ocular micro-tremor, and genetic analysis. For on-field detection, approaches such as Model-Based Image-Matching (MBIM). Consensus documents on concussion should reflect on the current state of knowledge and needs to be modified according to the development of new knowledge. This provides an overview of issues that may be of importance to healthcare providers involved in the management of sports related concussion [4]. Education should be an integral part in the management of concussion. Athletes, referees, administrators, parents, coaches and healthcare providers must be educated regarding the detection of concussion, its clinical features, assessment techniques and principles of safe return to play.

5. Conclusion

Concussion is a major issue in Rugby Union at present with high injury incidence and severity. Within the game, the tackle is the main cause of concussion with the tackler at highest risk. Currently detection of concussion depends highly on the sideline medical staff to identify a player exhibiting concussion symptoms with the Video review being used in more professional matches. The suggestion of using Biomechanical research using wearable head

sensors can potentially improve this identification protocol by reliably measuring concussion injury thresholds and reduce effects of concussion. Extensive education programs through web-videos, social media, refresher courses to Athletes, referees, administrators, parents, coaches and healthcare providers should be intensified to grassroots/amateur rugby to increase awareness, knowledge and improve their attitude on concussion.

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