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Previous history of concussion and risk of sustaining another concussion

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Introduction

Concussion is broadly defined as a pathophysiological brain injury elicited by a direct or indirect impact transmitting biomechanical forces to the brain. Concussion is often followed by spontaneous deficits in neurological function, including physical symptoms such as headaches, dizziness and balance problems, compromised cognitive function, emotional manifestations or sleep disturbances. These functional disturbances can resolve within 24 hours to 7 days[28,35], but can be prolonged in a certain subset of individuals, even lasting several months after a concussion[23].

Rugby is a collision sport which frequently involves impact between players. It has a global participation of more than 5 million players[6]. A high incidence range of 1.4 – 4.0 concussions per 1000 player hours in professional rugby union[5,37], surpasses the incidence in American football but equates to that of elite ice hockey [22]. Concussion can also result in time loss from game play with up to 57 days/1000 hours lost in a single season[5].

In South African rugby, catastrophic TBI had an average incidence of 0.19 per 100 000 junior players (95% CI 0 to 0.56) and 0.62 per 100 000 senior players (95% CIs 0 to 2.01) in the period 2008-2011 resulting in 4 fatalities recorded over this period[7]. Similar catastrophic injury rates were observed in New Zealand and Australian rugby[15,33].

International injury prevention and management programmes (e.g. RugbySmart, BokSmart and Rugby Ready), consist of extensive concussion education, provide practical guidelines, and are currently also employed within rugby structures in an attempt to reduce catastrophic injuries and monitor player welfare[7,33].

However, as a result of the growing popularity of rugby, and the potential significant adverse effects of sustaining a concussion, identifying further prevention and intervention strategies remains important.

Concussion history as a risk factor

A history of previous concussion is described as one or more concussion(s) sustained prior to the observation period of the specific study or case. Although by necessity, concussion history is collected retrospectively, and this raises potential confounders. Patient recall, self-reported concussions, differing concussion definitions and the subjectivity of the treating physician can all contribute to underreporting thereby confounding the accuracy of the individuals' true concussion history.

Given the current understanding of concussion, some of these obstacles are difficult to solve. Even though many studies adhere to the recommended concussion definition outlined by international concussion consensus statements[2,27,28,30], it remains prudent to consider the aforementioned potential confounders when interpreting the findings within the scientific literature.

Numerous studies report an existing relationship between a history of at least one previous concussion and the risk of a subsequent concussion injury. Studies (previously reviewed[1]), when comparing athletes who had a history of previous concussions to those with no previous concussions, found that the previously concussed athletes had a 6-fold greater risk of sustaining a concussion.

The few studies which do show contrasting findings, i.e. a history of concussion having no effect on subsequent risk, are often of lower quality study design, with small sample sizes, weaker measures of risk estimate and no confidence intervals, thereby limiting the interpretation of results[11–13].

Furthermore, no studies have ever shown a decreased concussion risk in those individuals who have a concussion history. The evidence, expectedly, therefore points with high confidence towards a relationship between concussion history and a greater risk of subsequent concussions.

Potential contributing or confounding factors

McCrory (2004)[29], however, argues that the risk of a history of previous concussions as discussed earlier, could merely be a reflection of increased sport exposure and does not necessarily represent an inherent increased likelihood of physically sustaining a concussion.

Many studies also record self-reported concussion history which is not as reliable as physician-recorded concussions. A study which reported an almost 6-fold increased risk of sustaining subsequent concussions in those players who had a previous concussion, addressed some of these reliability issues, as only medical records were used in this study to record concussion history[41].

Concussion history was shown to be a risk factor with similar risk estimates between the varying levels of sport exposure ranging from school to semi-professional sport. This relationship was also observed in different high-impact contact sports including rugby union, American football and ice hockey with the highest subsequent concussion risk (6-fold increased risk) cited in American football[1]. There is, however, little to no evidence for concussion history as a risk factor in non-contact sports.

Moreover, a playing style or behaviour can further compromise safety during game time with overly aggressive behaviour, possibly increasing concussion injury risk in either the aggressor or their opponents[14,17,20,21].

At a gross level, decreased cerebral blood flow, reduced oxidative metabolism and alterations to cerebral capillary diameter have been reported following severe traumatic brain injury (TBI)[40]; which also occurs, to a lesser extent, following less severe forms of TBI[16]. At a neural level, abnormal alterations to the functional connectivity in certain brain regions have been reported following TBI and may explain some of the physical signs and symptoms of concussion[26,36].

Furthermore, studies have shown poorer outcome on neurocognitive tests and academic performance for asymptomatic athletes who had a history of multiple concussions compared to those with no history[9,10,31]. Poor neurocognitive ability which persists post injury, potentially highlights individuals who are more vulnerable to sustaining subsequent concussions and poor recovery from injury[19].

Therefore, a history of previous concussions could simply be a proxy for another more directly associated risk factor ranging from increased player exposure, player behaviour, increased susceptibility due to physical changes in the brain, or could be related to a more susceptible genetic profile[24,38].

As there is limited current research on possible risk factors[1], the evidence supporting concussion history and its relation to subsequent concussions, indicates the importance of collecting concussion history details pre-participation or pre-season, in identifying or highlighting potential high risk individuals[29].

The long term effect of multiple concussions

The debilitating, often fatal 'second impact syndrome', has been described as an event following a second head impact before an initial concussion has resolved[25,39]. Other authors refer rather to "malignant cerebral oedema" as a condition characterised by brain swelling, haematoma and sometimes death[8], with young athletes being more vulnerable[28,39].

Although our understanding of this acute syndrome is still developing, animal models[18] seem to support the theory of an initial vulnerable period in which an unrecovered previous concussion increases an individual's severity and risk of a successive concussion[41].

In human studies, this was partly indicated when youth athletes with preseason concussion-like symptoms (dizziness, neck pain or headaches) sustained more concussions during the season compared to those who did not report concussion-like symptoms[35]. Moreover, an increased preseason rating of concussion symptoms was observed in high school athletes who sustained 2 or more previous concussions, compared to those with one or no previous concussions[34].

If unresolved concussions could increase an individual's likelihood of subsequent concussions or concussions with severe outcomes, then it is plausible that multiple concussions may play a role in increasing susceptibility to severe or long term deficits. Unfortunately, evidence for the effect of multiple concussions on long-term outcomes are currently inconclusive[3,4,9], suggesting a need for robust research to further elucidate this.

Conclusion

Overall, the published literature provides strong support for a history of previous concussions increasing the susceptibility of a player incurring subsequent concussions. Concussion history is most likely a proxy for underlying factors such as high-risk, aggressive behaviour or a dangerous playing style and increased exposure to high collision sports[29,32]. It is still, however, imperative to record a detailed and reliable concussion history as part of a standard preseason sport assessment, at all playing levels. Previous concussion is therefore a significant modifying factor influencing both player management and return to play decisions. A detailed concussion history not only identifies potential "high risk" athletes to monitor but also provides the opportunity for a treating physician or medical staff, in the event of a sustained concussion, to adequately manage the athlete on an individual-basis.

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