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Letter to editor

Theoretical Model Describing the Relationship between the Number of Tackles in Which A Player Engages, Tackle Injury Risk and Tackle Performance

Dear Editor-in-Chief

The tackle is a physical contest between opposing players contending for territory and ball possession. During an 80 minute rugby union match, a player will physically engage in the tackle contest, whether as a ball-carrier or tackler, between 10 to 35 times depending on the position of the player (Deutsch et al., 2007; Quarrie and Hopkins, 2008). During a match, tight forwards (position numbers 1-5, who primarily compete in the set phases such scrums and lineouts) engage in the tackle approximately 10-25 times, loose forwards (position numbers 6-8, who mainly competes for possession of the ball at rucks and assist the tight forwards in set pieces) are involved in 25-35 tackles, inside backs (position numbers 9,10,12,13, whose key responsibility is to execute tactics and distribute the ball) competes in 20-25 tackles, and outside backs (position numbers 11,14,15, who are typically quicker and expected to run into open spaces to cross the advantage line and score points) engage in 10-15 tackles (Deutsch et al., 2007; Quarrie and Hopkins, 2008). It follows that a player requires a high level of skill, physical tolerance and resistance to fatigue to repeatedly engage safely and effectively in the tackle. Understanding the physical demands of a tackle is important with many applications. Examples of these applications include the design and development of proper training drills and equipment, planning and management of training and recovery between training sessions and matches. Also, a better understanding of the physical demands contributes to the implementation of strategies designed to reduce the risk of injury and enables replicating the event in the laboratory for research (Austin et al., 2011; Frechede and McIntosh, 2009; McIntosh et al., 2000; Newman et al., 2005; Pellman et al., 2003b). Recently, methods to estimate the magnitude of impact (energy distributed between ball-carrier and tackler upon contact) in real match tackle contests have been developed to further our understanding of the physical demands of the tackle contest (Hendricks et al., 2014).

The physical demand of the tackle was determined by calculating the amount of energy distributed between the ball-carrier and tackler upon contact. This excess of energy may cause muscle damage and injury to the musculoskeletal system (Takarada, 2003). The estimated magnitudes of impact ranged from 902 joules (J) to 7608 J for front-on tackles, and 595 J to 6209 J for side-on tackles (Hendricks et al. 2014). Repeated exposure to these physical collisions during training and matches, and over a long competitive season may influence the injury risk profile and longevity of a player, and if not managed correctly, negatively affect performance (Gabbett et al., 2010a; 2012a). With that said, Hendricks et al. analysed injury-free tackle events, demonstrating player's ability to tolerate a range of impacts (Hendricks et al., 2014). The range of high impact, injury-free tackle events found in this study lends itself to McIntosh's multifactorial model for injury prevention in team sports (McIntosh, 2005). In the model, McIntosh proposes that the biomechanics of injury risk can be explained by the event either resulting from an overload of the system's tolerance levels, or a reduction in the system's tolerance levels through micro trauma to a point where normal loads cannot be tolerated. Indeed, studies have shown a positive relationship between the number of tackles made during matches and markers of muscle damage (Smart et al., 2008; Takarada 2003). Also, using an instrumented bag to measure tackle forces, Usman et al. found that repeated tackling decreased the amount of force produced by the tackler (Usman et al., 2011). The authors attributed this decrease in force to fatigue, and proposed that fatigue may be an important injury risk factor for tackling, and tackle effectiveness (Usman et al., 2011). Similarly in rugby league, Gabbett et al. has shown a decrease in tackling technique as fatigue levels increase (Gabbett, 2008). Given the impact measurements of the tackles analysed in the Hendricks et al. (2014) study, and considering all tackles were injury-free, the range of magnitudes of impacts found in the study may provide evidence for the physical tolerance levels of players during the tackle. In view of above-mentioned injury model (McIntosh 2005) and tackle studies (Gabbett, 2008; Smart et al., 2008; Usman et al., 2011; Takarada, 2003) and the momentum, impact magnitudes presented in the Hendricks et al. (2014) study, it is theorised that players have an upper limit for being able to endure repeated high energy impact tackles. If this upper limit is exceeded the risk of injury is substantially increased, and tackle performance is noticeably decreased (Figure 1). This upper limit is reached either through one or more very high-energy impact contact situations or, accumulates over a match or season following repetitive lower-energy impact situations. However, effective tackle skill training, proper physical conditioning, strength, power, equipment and attitude/motivation can offset this upper limit (McIntosh, 2005). For example, physically conditioned players with a high level of tackle skill may have the technical ability and physiological capacity to minimise the energy load on the body, thereby increasing their tolerance level for physical loads. Evidence to support this theory can be found in rugby union and rugby league. From physical conditioning perspective, well-developed physical qualities such lower body muscular power (vertical jump) and acceleration (10m sprint) is positively associated with better tackle ability (measured using a tackle technique assessment) (Gabbett et al., 2010b; 2011a). Moreover, physiological characteristics such as lower body muscular strength (1RM box-squat),

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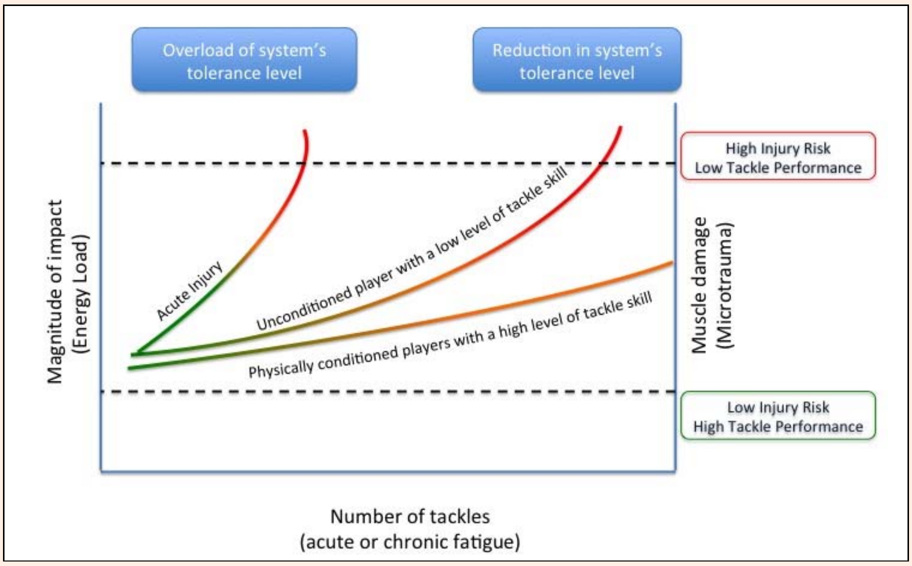

Figure 1. Theoretical model for the relationship between the number of tackles in which a player engages in (acute or chronic fatigue), magnitude of impact (energy load), markers of muscle damage (micro trauma) and how this relationship interacts with tackle injury risk (tolerance overload or reduction) and tackle performance.

lower body muscular power, and speed (10m and 40m sprints) improve tackle performance in matches (Gabbett et al. 2011b; Smart et al. 2011). Also, physical characteristics such upper body muscular strength (1RM weighted chin-up) and prolonged high intensity intermittent running ability has been shown to reduce the risk of injury during contact events in matches (Gabbett et al., 2012b). Interestingly, 40m sprint speeds of ≤5.25 seconds (compared to 40m sprint speeds of >5.25 seconds) decreased the probability of remaining injury free during contact events in matches (Gabbett et al., 2012). From a tackle skill perspective, technically skilled players attempts more tackles, execute more dominant tackles, and miss fewer tackles (Gabbett and Ryan, 2009). Furthermore, quicker decision-making time (≤ 80 milliseconds) during a reactive agility task may reduce the risk of contact injury in matches (Gabbett et al., 2012c).

In conclusion, a theoretical model building on previous work in conjunction with the findings of Hendricks et al. can be proposed (Figure 1). This model describes the relationship between the number of tackles a player engages in (acute or chronic fatigue), magnitude of impact (energy load), markers of muscle damage and how this relationship interacts with injury risk (tolerance overload or reduction) and performance.

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