PROTECHT

WHY MEASURE CONTACT?

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ISSUE 1: Practitioners are not inclined to understand or measure contact in a scientific way

- Contact sport is comprised of two main physical demands: locomotion and contact.
- These physical demands result in increased muscle damage, hormonal disruption, and impaired neuromuscular performance. But contact is deemed to have a greater relationship with muscle damage and subsequent neuromuscular dysfunction.
- Contact load is the most highly valuable demands to measure due to its relationship with performance, injury, and recovery.

ISSUE 2: Current methods use count contact which is subjective and does not give an adequate view of contact load on which to base often complex training and conditioning decisions

- Having a means to monitor these demands is essential and informs the balance between prescribed training and ensuing recovery so that performance is optimised, and injury/illness minimised
- Historically, contact demands have been measured by contact count through video analysis. This is highly subjective as it takes no account of the size and severity of the impacts. It also under reported contact load by over 20%.

ISSUE 3: Data is looked at in individual siloes and not considered holistically or where and how it influences key decisions that need to be made about an athlete's condition and performance.

- It is now possible to accurately measure objective impacts live sustained by an athlete in training or in a competition for their contact load and each impact is measured by its intensity, duration and direction using the **PROTECHT** system.

WHY MEASURE CONTACT?

Contact sports, such as rugby union (rugby) involve repeated high intensity bouts of work with limited rest periods over an extended duration. These high-intensity bouts of work are comprised of physical contact (contact and collisions) and locomotion (high-intensity stretch shortening cycle movements) [1–4] (Figure 1).

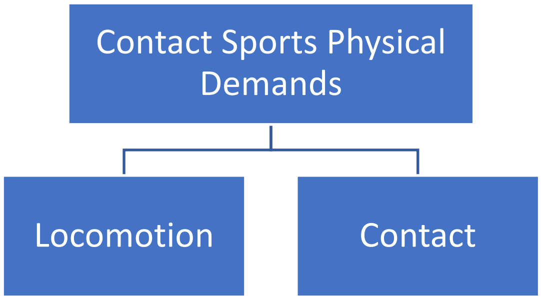

Figure 1: Physical demands of contact sports.

These physical demands (external loads) result in large physical and metabolic loads which cause elevated levels of muscle damage, hormonal disruption and impaired neuromuscular function post-competition [5–7] (Figure 1), which can take up to 5 days for an athlete to fully recover to baseline levels [8]. In-season competition for a number of contact sports such as rugby and American Football often occur within 120-168 hours (5-7 days) of each other leaving short periods for technical, tactical and physical training as well as the recovery of the athlete to sustain performance for following competitions [9]. Consequently, the challenge for coaches and support staff is to prescribe a sufficiently fatiguing stimulus during training to maintain competition readiness whilst not evoking deleterious side-effects such as increased recovery time or injury/illness [10].

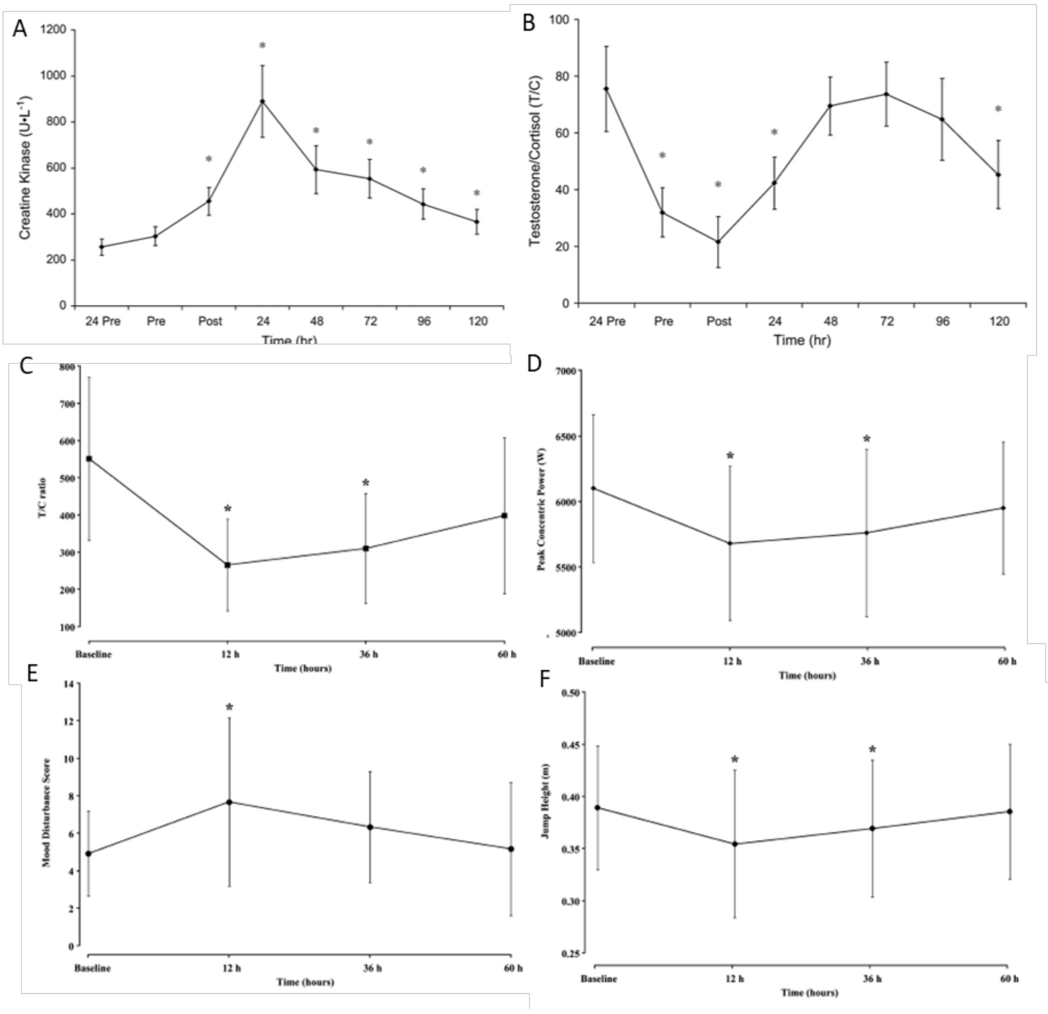

Figure 2: Post competition time-course changes of muscle damage measured via creatine kinase (A) , hormonal disruption measured via testosterone/cortisol (T/C) ratio (B , C), mood disturbance scores (D) and neuromuscular performance measured via peak concentric power (E) and jump height (F). Source (A-B):[8] *Source (C-F):* [11]

Muscle damage has been shown to be directly associated with impaired neuromuscular performance [12–14]. Research investigating the competition demands and subsequent athlete response highlights that sprint distance and number of sprints are associated with increases in muscles damage [12,15,16], but it is only an incomplete part of the picture for contact sports. What limited research has shown for contact sports is that the increases in muscle damage following competition are largely determined by the extent of mechanical damage induced through physical contact [7,17,18]. The authors highlighted that contact was significantly related to changes and increases in muscle damage levels [17], more so than sprinting distance or number of sprints performed (r = 0.92 v 0.80) (Figure 3).

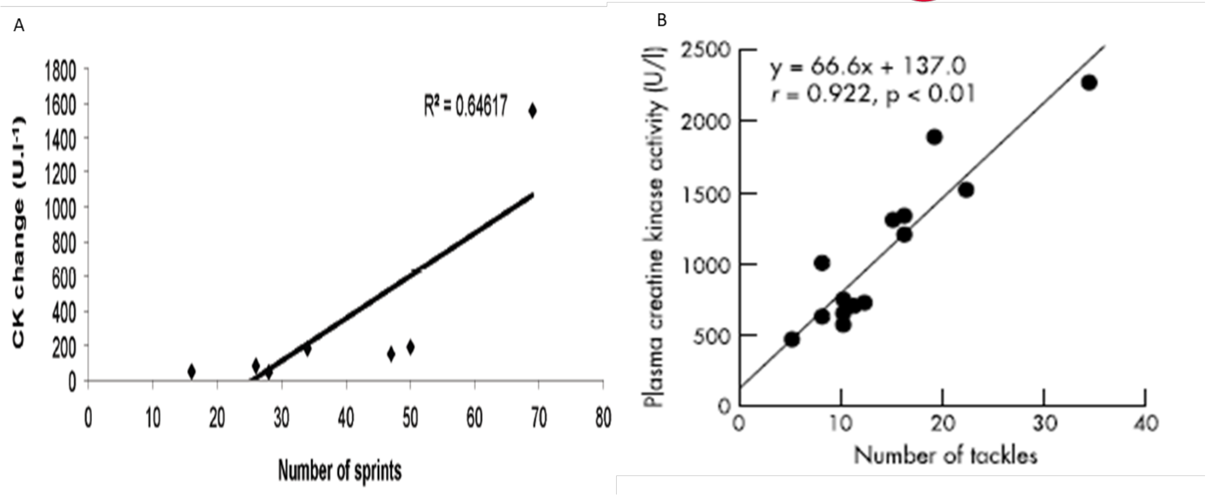

Figure 3: Muscles damage represented through blood creatine kinase levels and its relationship with number of sprints and tackles. Source A:[15] *, Source B:* [7].

The greater increases in muscle damage associated from contact may be explained by the blunt force trauma from physical contacts, which disrupts skeletal tissue structural integrity; subsequently increasing cell permeability and the diffusion of soluble enzymes such as creatine kinase (marker of muscle damage) into the interstitial fluid [16,19]. This is represented in rugby union where forwards attain significantly higher levels of muscle damage when compared to backs, with the difference in physical competition requirement where forwards perform a greater amount of contact and less amount of high speed running, whereas backs perform less contacts and a greater amount of high speed running [6,16].

Monitoring has been used extensively in high performance sport to measure the external load undertaken by the athlete and their subsequent response (internal load). The data gleaned from monitoring informs training load prescription, such that performance is optimised and injury/illness minimised [20]. There is a plethora of scientific literature and understanding regarding the relationship between external load and performance or injury in sport [20,21]. However, external load has been primarily limited to measuring the running demands of training and competition [22]. For example, rugby practitioners use a wide range of variables to monitor the running demands throughout competition, which can be used to inform training practices and prescription of running load (Figure 4A). However, consideration of the contact demands in rugby like many other contact sports has been predominantly limited to the measurement of contact count via subjective means [22] with no consideration or ability to quantify the magnitude of the contact during training.

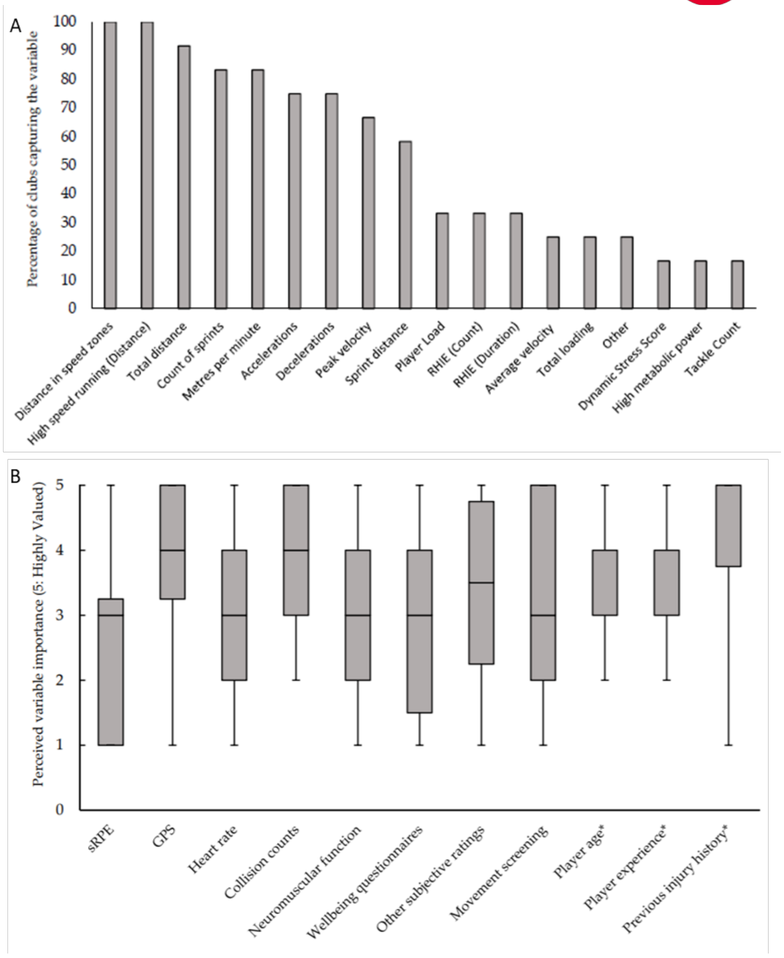

Figure 4: Example of running variables collected by GPS technology and percentage of use by rugby practitioners, in addition to contact demand variable and use (A) and perceived importance of monitoring variables professional practitioners (B). Source: [22].

Despite its simplicity, contact count is still considered by rugby practitioners to be the most highly valued measure to monitor (Figure 4B) [22] due to its association with performance [23,24], recovery [11] and injury [25,26], yet it is one of the most under reported metrics. This could be related to factors such as the labour-intensive nature of video analysis and the subjectivity of the information produced, which has shown to under report the contact load of the athlete by over 20%. As a result there is currently a lack of understanding surrounding individual contact events and the contact load undertaken during competition, training and subsequently the overall load that an athlete experiences [27]. Greater knowledge of contact events and contact load is fundamental for practitioners to enhance/optimise training as conditioning for competition should be founded on evidence based research which quantifies the match play demands of that competition [28,29]. If the contact demands are unknown, practitioners cannot specifically prepare athletes to meet those competition demands. Increasing the understanding of the contact demands enables assessment of the acute, and change in acute or chronic external contact load placed upon the athlete, thereby reducing risk of injury associated with changes in acute, and low or to high levels of chronic loads [20,21,30,31].

The risk of sustaining injury while playing rugby is higher than many other sports [32] due to contacts being an integral part of the game [33]. Currently, individual contact events and contact phases, account for 67 - 72% of all time-loss competition injuries [26,34], with concussion being the highest injury received (20%) by an athlete [34,35]. This is in contrast to training injuries, where the majority occur from non-contact events, such as running [33,36]. The vast differences in injury mechanisms in competition and training potentially suggests that the contact load and activities undertaken in training does not adequately prepare athletes to meet the demands of the competition (Figure 5).

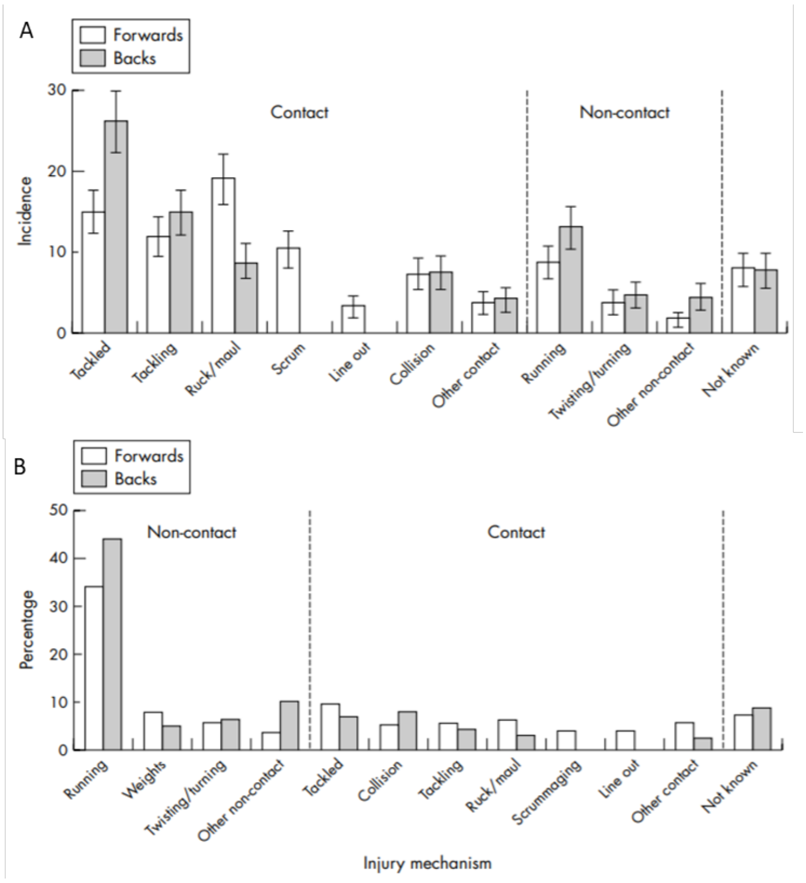

Figure 5: Difference between competition (A) and training (B) injury mechanism in rugby union. Source A: [26], *Source B:* [36].

These statistics might also flag that in-game monitoring of subjective cumulative contact load cannot accurately be measured currently and therefore cannot be used to indicate athletes who are at a higher potential risk of subsequent injury. If the contact demands of competition can be objectively established, training can be specifically developed to allow athletes to meet those demands and appropriately progress to the required load. Failure to expose athletes to the required load may result in impaired performance and increased injury risk [37,38]. This would be particularly pertinent for athletes returning from injury or periods of inactivity, who may be more susceptible to injury, owing to large spikes in external load upon restart and lower chronic training levels [31,38,39].

In light of recent calls to better understand the complex relationship between load, performance and welfare [40], consideration of factors within the training monitoring model [37,41] beyond external running load is required, such as external contact load, athlete individual characteristics, internal load, psychological indices and outcomes measures i.e. performance or welfare (injury or illness) [27,40,42]. However, a means of accurately measuring objective contact data is needed first, to understand the influence this essential piece plays within the training monitoring puzzle. With the advancement in technology embodied in the **PROTECHT** system it is now possible to accurately measure the contact demands objectively for an athlete and team in training and competition. This system combines accelerometers and gyroscopes, validated for accuracy and safety, embedded in a conventional mouthguard, to ensure the optimal coupling with an athlete, together with the necessary software to interpret and display that information live.

SUMMARY

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