THE EFFECT OF A GAME-SPECIFIC SHORT TERM FATIGUE PROTOCOL ON KICKING IN AUSTRALIAN FOOTBALL

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The purpose of this study was to three dimentionally evaluate the effects of a short term game specific fatigue protocol on the kinetics of elite and sub-elite Australian Footballers (AF) during a drop punt kick. Five AF players performed kicks pre and post fatigue protocol. Three dimensional data of the pelvis and kick leg was obtained using a three tower optotrak Certus system (200Hz) and joint torques and moments were calculated in Visual 3D from kick foot toe off until ball contact. Sprint time indicated the protocol induced fatigue. Hip flexion torque significantly increased following fatigue indicating a change in movement strategy similar to that found for jump landing. This greater hip reliant post-fatigue kicking strategy has implications for both skill enhancement and injury prevention.

KEY WORDS: Kicking, fatigue, kinetics.

INTRODUCTION: Australian Football (AF) is one of the most physically demanding sports. It is played on a ground with an area far exceeding that of any of the other football codes (e.g. ground area between 14000 and 19000 m^2 compared with between 6000 and 8000 m^2 for soccer and rugby codes) and is played for longer than other football codes (approximately 120 minutes compared to 90 min for soccer and 80 min for the rugby codes) (Ball, 2006). Players have been found to surge above 18km/hr on average 90.09 times per game for a total time of almost 6 minutes, equating to an average of 4 s per sprint over 18km/hr (Wisbey & Montgomery, 2007). This differs from soccer in which players cover 8-12km per game (Greig, 2006), and travel in speed zones above 16km/hr for averages of only 2.5 s (Bangsbo, 1994).
Kicking is a fundamental skill in Australian Rules Football (ARF). It is the most prevalent method of passing between players and the only method of scoring a goal (Ball, 2008). The ability of the performer to perform these kicks successfully is vital to their team's success (Forbes, 2003). Any factors that increase the kicker's ability to launch the ball longer must be enhanced, whilst any factors that decrease their ability to kick the ball a maximal distance or increase the chance of injury must be minimised.
Fatigue has been reported to be detrimental to performance in some skills (Kellis et al., 2006) and can increase injury risk (Gleeson et al., 1998). In soccer, Rahnama et al., (2003) showed that late in a game, players' leg muscle strength decreases due to fatigue. In turn this was proposed to affect kicking technique and leave players more susceptible to injury. This was supported by Apriantono et al. (2006), who found 3D kinetic and kinematic differences in maximal instep soccer kicking technique before and after a fatigue protocol. Altered technique under fatigue has also been reported in other sports skills such as landing (Coventry et al., 2006; Madigan and Pidcoe, 2003) and running (Derrick et al., 2002).
In spite of the influence of fatigue on technique and that AF is played for long durations and at relatively high intensities, there have been no published studies on AF kicking kinetics and no studies examining technique change under fatigue in AF. Further, many previous studies examining fatigue and technique change in other sports have not performed a game-specific fatiguing protocol. The purpose of this study was to three dimentionally evaluate the effects of a short term game specific fatigue protocol on the the kinetics of elite and sub-elite ARFs during a drop punt kick.

METHODS: Five elite and sub-elite AF players were recruited for this study. They performed a standardized warm up, consisting of jogging on a treadmill 10 min and stretching the muscles to be used in the kicking movement (hamstring, quadriceps, calf, hip flexor). Participants then had clusters of light emitting diodes placed on the trunk, pelvis, kick leg shank and thigh as well as a single LED on the kick foot. Each participant then performed three maximal distance kicks into a net using their preferred leg. An Optotrak Certus 3D motion analysis system (Northern Digital Incorporated, Ontario, Canada) captured 3D coordinate data of each kick from kick foot toe off until ball contact (BC). This data were smoothed using a Butterworth digital filter (cut-off frequency = 12Hz) and then used to calculate hip and knee joint torques and powers and foot speed in Visual3D.
Particpants then underwent a short term game specific fatigue protocol, adapted from Coutts & Duffield (2008) (Figure 1).

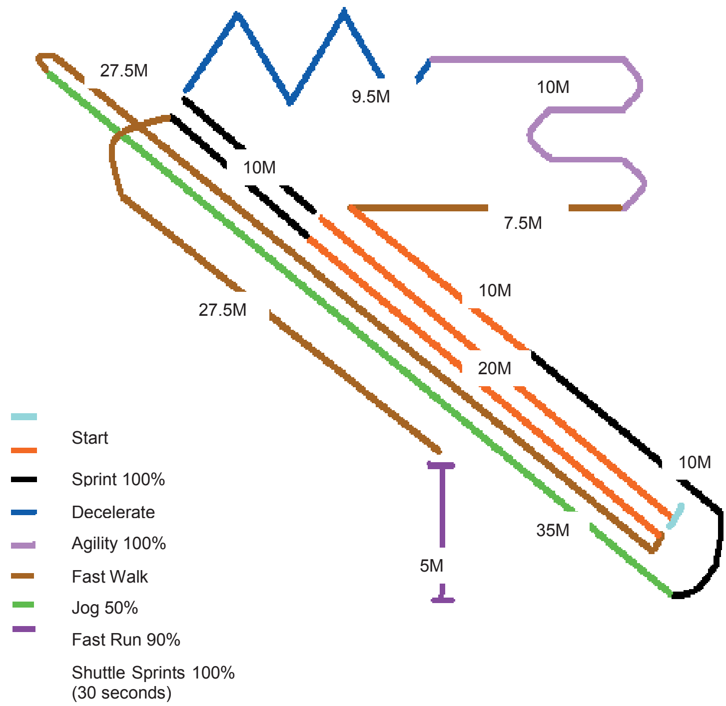

Figure 1: Short term fatigue protocol

The protocol included a 20m sprint at the beginning and towards the end that was timed with timing gates and used as an indicator of fatigue. Immediately after the protocol was completed the participant performed a single kick for maximal distance on their preferred leg. Two tailed paired t-tests were used to evaluate the difference between sprint times (to indicate fatigue) and between pre-fatigue and post-fatigue kick hip and knee powers and torques. Significant results ($p<.05$) were reported and effect sizes (ES) were calculated for comparison.

RESULTS: Sprint times significantly increased from the beginning to the end of the fatigue protocol (Pre =3.25s, Post=3.44s, p=0.002) (Figure 2). Maximal hip moment showed a significant difference, increasing from pre to post fatigue (Pre =204Nm, Post =226Nm, p=0.016) (Figure 3). Hip power at BC (Pre=-283W, Post=364W, p=0.077, ES=1.063) and maximal hip power (Pre=940W, Post=1169W, p=0.138, ES=0.891) displayed large ES.

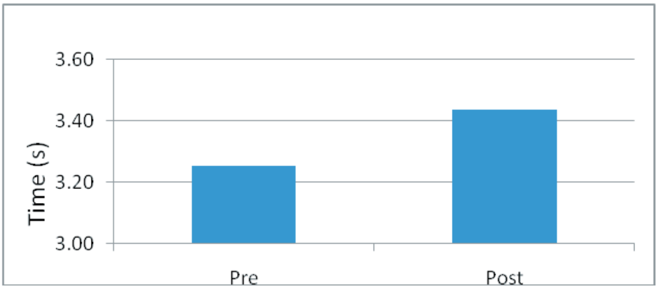

Figure 2: Group Mean Sprint times, Pre and Post Fatigue (s)

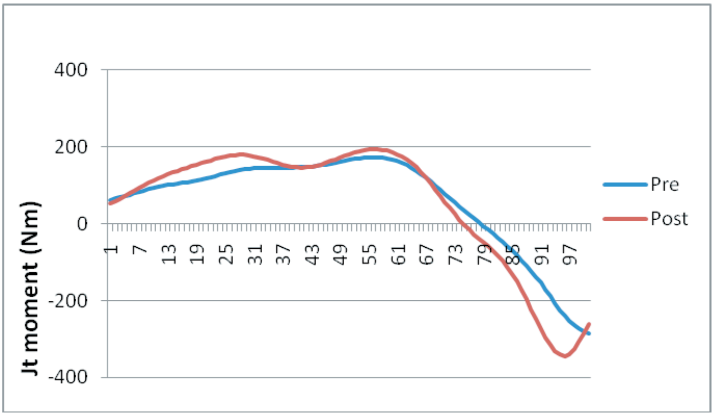

Figure 3: Single participant representation of Hip Moment, Pre and Post Fatigue

DISCUSSION: The significant post fatigue increase in maximal hip moment is an interesting finding that on the surface it appears counterintuitive. As fatigue reduces a muscles ability to generate force, it would be logical to assume that the protocol would cause a decrease in joint torques and powers. An increase in the contribution of the hip musculature post fatigue protocol was also found by Coventry et al. (2006) in a study on drop landings. The authors concluded that a decrease in energy absorption (negative work) at the knee and an increase in energy absorption at the hip was a coping mechanism that the body implemented to utilise the larger, supposedly more fatigue resistant, muscles that cross the hip to absorb more on the impact and protect the body from injury whilst fatigued. It is possible that the same coping mechanism is at play during kicking. The larger hip musculature appeared to be utilised to generate more hip flexion torque when the body was fatigued. Although not significant, the large ES found for an increase in maximal hip power and hip power at BC gives further support to the notion of a post fatigue hip strategy. Important also was the fact that no large or medium effects were evident at the knee indicating no substantial change in function at this joint.

Although these findings need more research with greater participant numbers, there are some practical implications of the initial findings that are worth further exploration. In AF there has been concern over the incidence of hip related injuries thought to be associated with kicking. A shift to kicking strategy that produces more torque and power at the hip might be a contributing factor to increasing the loads on this area and in turn influence injury. From a performance point of view, should these technial changes be substantiated in future work, there is a need to train the kicking skill under both pre and post fatigued states. While this

should be an obvious recommendation, in practice, many clubs will train the majority of kicking early in the training session when players are under little fatigue (Ball, 2003).
Future research needs to examine short term fatigue changes with a larger N. Some medium to large effects found in this study were not significant due to the low N and need further exploration to determine if they are statistically significant. Longer term fatigue protocols should also be examined specific to the AF game. Finally examining the effects of the altered technique on performance factors other than foot speed and distance is important in the applied setting of AF. The exploration of training methods to improve the fatigue resistance of the muscles that cross the knee may also be beneficial to possibly reducing the increase in load on the hip.

CONCLUSION: Joint kinetics change due to fatigue in the AF kick. A significant increase in maximal hip flexion torque post fatigue was evident among the players tested in this study. This post fatigue hip strategy has implications for skill enhancement and injury prevention.

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