THE INFLUENCE OF FATIGUE ON THE ANTERIOR CRUCIATE LIGAMENT DURING SIDE-STEPPING

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries are one of the most devastating soft tissue injuries and occur frequently in sports that involve constant change of body direction while running at speed. Non-contact mechanisms involve no direct physical contact with another player or object and account for more ACL injuries than contact mechanisms [1]. Cochrane et al., [1] report that of the non-contact ACL injuries, sidestepping comprised the majority (37%) of the total ACL ruptures. Generally fatigue is implicated in sports injury with research showing that injuries occur late in the first and second halves of games [2].

Fatigued athletes have previously demonstrated reduced peak extension moments of the quadriceps and reduced peak flexion moments of the hamstrings during sidestepping and crossover cutting tasks [3]. As muscular fatigue is inevitable in team sports, analysis of the fatigue-loading relationship of the knee is an important addition to the ongoing study of knee injuries and the establishment of preventative measures.

Therefore, the aim of this study was to assess the impact of a prolonged running protocol, designed to induce fatigue and simulate a game of Australian Rules Football (ARF), on knee loading.

METHODS

Eight healthy male subjects, who played in semi-professional and amateur ARF teams, volunteered for participation. They completed a series of straight line runs, sidesteps (SS) and crossover cuts (XO) before and after a simulated game of ARF (4 x 20 min) on a non-motorised treadmill. Kinematic data (Vicon MX motion analysis) were analysed at foot strike of the sidestepping manoeuvres and kinetic data (AMTI force plate) were analysed during pre contact (PC) and weight acceptance (WA) stages of the gait cycle. A two-way repeated measures ANOVA was used to test for statistical differences.

RESULTS AND DISCUSSION

Results demonstrated that the knee was significantly more flexed at contact following fatigue (figure 1), when compared to pre-fatigue states. Fatigue was a further factor contributing towards a significant increase in knee flexion/extension. Significant differences were also observed between SS and XO trials with respect to flexion/extension and internal/external rotation moments (figure 2).

Larger knee angles at foot strike in post fatigue states suggest the SS actions require more time to perform when participants are fatigued. Increases in knee extension moments in post fatigued states indicate the knee joint must withstand significantly larger forces once fatigued.

CONCLUSIONS

As a consequence of these results it is suggested that muscles be trained following fatiguing efforts, rather than in rested states alone. Training should incorporate technique changes in the SS/XO action, especially during the WA phase, after the participant has undertaken prolonged exercise efforts. The dominant effect of the knee extensors during knee flexion highlights the need to strengthen the knee flexors concentrically, to balance the forces acting on the ACL. The large increases in abduction and external rotation moments once fatigued is evidence for the need to train medial and lateral muscles surrounding the knee to better counteract the valgus and internal rotation forces that are prevalent in SS.

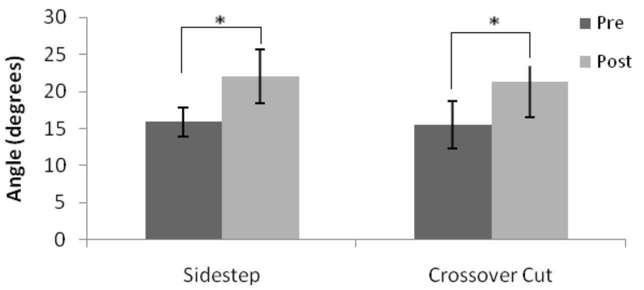

Figure 1: Average knee flexion angles at foot strike. Full extension = 0°.

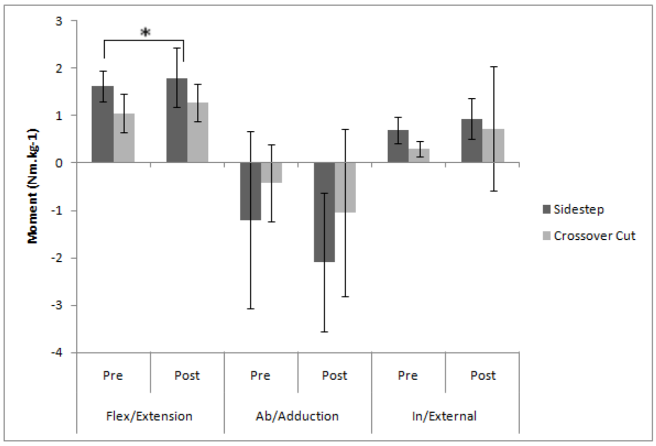

Figure 2: Average normalised knee moments pre and post fatigue at weight acceptance. Positive moments represent extension, abduction and external rotation. * Represents a significant difference of fatigue at $p < 0.05$ level. Note there was also a main effect of manoeuvre type for flexion/extension and internal/external rotation moments, $p < 0.05$.

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