THE EFFECTS OF DIFFERENT FATIGUING PROTOCOLS ON LANDING MECHANICS AND KNEE KINESTHETIC SENSE

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INTRODUCTION

The fact that injuries tend to occur more frequently late in games has led to speculation that fatigue may be responsible (Pinto et al. 1999). Studying movements while fatigued may be a good way to understand mechanisms of injury. However there are many different ways to induce fatigue and it is not clear which is best to simulate what happens in an actual game situation. In jumping and landing fatigue may affect both the mechanics and the kinesthetics sense of the landing. Lattanzio et al. (1997) tested the effect of three different cycling general fatiguing protocols on knee joint position sense in both genders and found one of the protocols affected knee joint position sense in males only while the other two affected both genders. Gehring et al. (2009) found no change in knee mechanics and normalized ground reaction force (NGRF) following a leg press fatiguing protocol. However, Kernozek et al. (2008) found that after a squatting protocol both genders flexed the hips more after touchdown but only males flexed the knees more after touchdown. It remains unclear what the ideal protocol would be that simulates the effect of real game participation on landing mechanics and kinesthetic sense. The purpose of this study was to compare the effects of a running and a squatting general fatiguing protocol on landing mechanics and knee position sense to the effects of participating in a basketball game.

METHODS

Twelve active college students (6 males, 6 females) volunteered to participate in the study. Participants were excluded if they had any orthopedic condition that would prevent them from jumping.

Participants came on three different days to undergo the three fatiguing protocols. They performed three maximal vertical jumps on a force platform (1200 Hz, AMTI). They also underwent knee position sense testing during which they were asked to reproduce ten different knee positions. Participants then underwent three different fatiguing protocols. One protocol had participants perform repeated squats until they could no longer continue, a second had them run on a treadmill at 10 km/hr and 10% grade for 5 min, and a third had subjects participate in a 15-20 min full-court basketball game in which the winning team scored 12 baskets. After the fatiguing protocol the three maximal jumps and knee position sense testing were repeated.

The Wilcoxon signed-rank test was used to compare the peak knee flexion angle, peak NGRF, and sum of absolute errors in knee position reproduction in pre and post fatigue conditions for the three fatiguing protocols.

RESULTS AND DISCUSSION

The Wilcoxon signed-rank test showed peak knee flexion angle significantly increased as a result of fatigue from the run and squat protocols, $p<.05$ (Figure 1). There was a non-significant trend toward the same result following the basketball game ($p=.08$).
No changes in NGRF were observed after the basketball and running protocols, $p=1.0$ and $p= 0.81$, respectively; however, peak

NGRF significantly decreased post fatigue after the squat protocol, p<.05 (Figure 2).

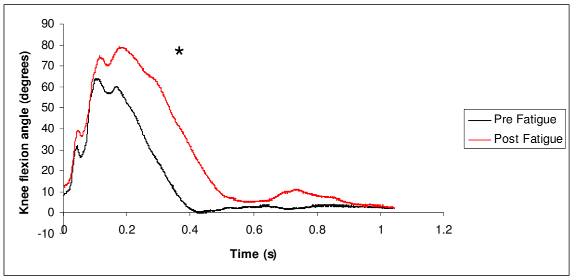

Figure 1. Knee flexion angle for the Squat condition
*Significant difference in peak between pre and post fatigue, p<.05

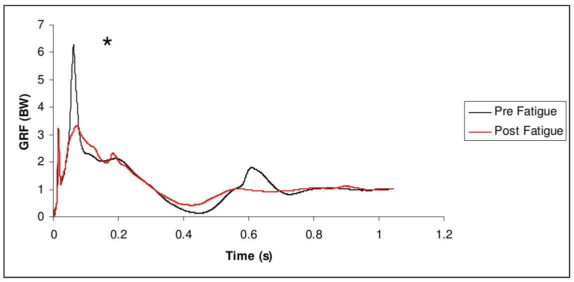

Figure 2. NGRF for the Squat condition
*Significant difference in peak between pre and post fatigue, p<.05

Our results are similar to Gehring et al. (2009) when it came to the basketball and running conditions. Although the running protocol produced a significant increase in peak knee flexion angle and the basketball protocol produced a non-significant increase in peak knee flexion angle, further observation revealed that knee flexion angles at peak GRF did not change. We did not initially look at that variable but results indicate it is a more important variable as its significant increase led to a reduction in NGRF in the squatting condition, which did not change for the basketball and running conditions. The significant changes observed following the squat condition are similar to those reported by Kernozek et al. (2008) suggesting the changes are task specific.

Both the basketball and running protocols led to a significant increase in absolute error when reproducing knee positions post fatigue, p<.05 (Figure 3). However the squatting protocol produced only a non-significant increase in absolute error, p=0.12.

Perhaps the changes in knee kinesthetic sense led to the changes observed in knee mechanics. Perhaps as knee kinesthetic sense decreased the body made other adjustments to reproduce similar landing mechanics as seen in the basketball and running conditions.

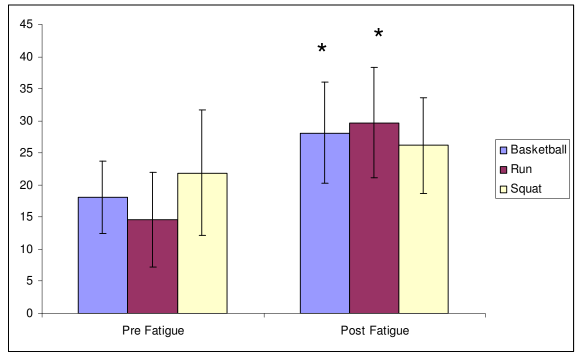

Figure 3. Mean sum of absolute errors in reproducing knee position for all conditions
*Significant difference between pre and post fatigue, p<.05

SUMMARY/CONCLUSIONS

This study compared the effects of running and squatting fatiguing protocols on landing mechanics and knee position sense to the effects of playing basketball on these variables. Although neither protocol showed identical changes to those after basketball, the running protocol produced similar changes in NGRF and knee position sense. Of the three fatiguing protocols tested here, the running protocol used in this study is the best choice for simulation of a real game situation.

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