THE EFFECT OF LOWER EXTREMITY FATIGUE ON SHOCK ATTENUATION DURING LANDING

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INTRODUCTION

The forces that are imposed on the body due to landings must be absorbed primarily in the lower extremity. Muscles assist in the absorption of these impact forces [1], and it has been shown that a fatigued muscle decreases the body's ability to attenuate shock from running [2]. The purpose of the study was to determine the effect of lower extremity fatigue on shock attenuation and joint mechanics during a drop landing. It was hypothesized that lower extremity fatigue would cause a decrease in the shock attenuation and alter joint mechanics.

METHODS

Ten active, non-pathologic male participants, 19 to 27 years of age, were recruited for participation. Each participant took part in a fatigue landing protocol (FLP) that was similar to that utilized by Madigan & Pidcoe [3]. The FLP included cycles of a drop landing, a maximal countermovement (CM) jump, and five squats repeated until exhaustion. Accelerometers attached to the skin were used to measure tibia and head accelerations. Shock attenuation was calculated through a transfer function [4]. Sagittal plane lower extremity kinematics were collected using an electromagnetic tracking system and kinetics were collected using a force plate. A repeated-measures ANOVA ($p < 0.05$) was performed on each of the dependent variable across the cycles of the FLP.

RESULTS AND DISCUSSION

The power output for the CM jumps performed in each cycle significantly decreased from 1197 ± 273 W to 805 ± 182 W. This indicated that the FLP elicited fatigue, and the individual joint work values indicated that the knee experienced the greatest decrement in performance (Figure 1a), as was anticipated. However, there were no significant changes in tibia and head acceleration or in the shock attenuation (Table 1). The range of motion at the ankle significantly decreased as the FLP progressed, but the knee and hip ranges of motion were not significantly different (Table 1). Hip joint work significantly increased, and ankle work showed a decreasing trend, consistent with a distal to proximal redistribution of joint work (Figure 1b). The total work done by the lower extremity remained approximately constant throughout the FLP, which was expected since the drop height remained constant. Interestingly, the knee joint work during landing was not significantly different from the beginning to end, even though the corresponding jump performance dramatically worsened at the knee.

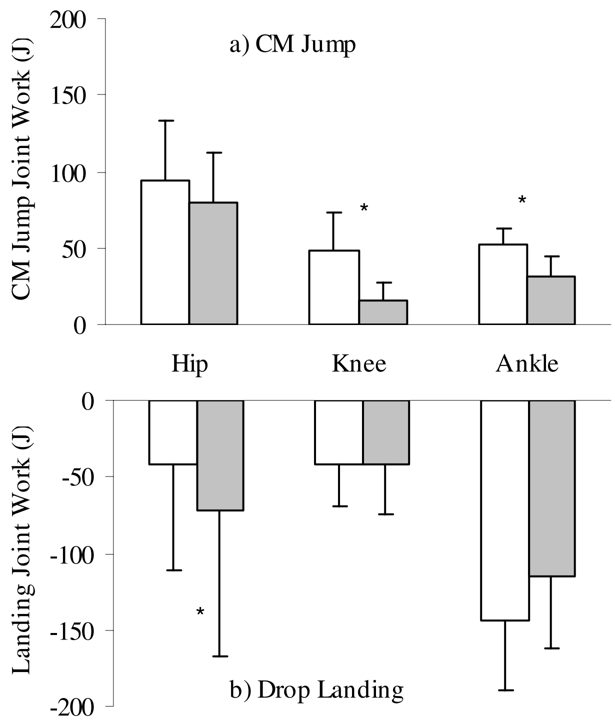

Figure 1. Group mean net joint work for the a) countermovement jump and the b) drop landing for the first (white bars) and last (gray bars) cycles. * indicates significant difference ($p < 0.05$).

CONCLUSIONS

This change in work distribution is thought to be a compensatory response to utilize the larger hip extensors that are better suited to absorb the mechanical energy of the impact. The results suggested that the lower extremity is able to adapt to fatigue though altering kinematics at impact and redistributing work to larger proximal muscles.

REFERENCES

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Table 1: Group mean (± SD) acceleration and kinematic variables for the first and last cycles of the FLP. * indicates a significant difference between time points ($p < 0.05$).

	Tibia Acceleration (g)	Head Acceleration (g)	Transfer Function (dB)	Ankle ROM (°)	Knee ROM (°)	Hip ROM (°)
First Cycle	13.2 ± 4.2	3.9 ± 1.3	-12.1 ± 3.2	48.1 ± 6.4*	46.7 ± 11.9	37.9 ± 15.4
Last Cycle	12.3 ± 1.9	3.8 ± 1.1	-14.1 ± 3.9	43.6 ± 5.0	44.2 ± 16.5	45.9 ± 27.5