THE EFFECT OF MOVEMENT SPEED AND EXTERNAL LOAD ON JOINT CONTRIBUTIONS DURING LOWER EXTREMITY EXTENSIONS

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INTRODUCTION

Determining the individual joint contributions during a variety of tasks has been the goal of many biomechanical investigations striving to quantify mechanical demand and provide insight into how multi-joint movement is controlled. Many of these investigations have been conducted with the task performed under a single set of experimental conditions, limiting the generalizability of the results to other movement conditions. They also do not provide information on how the joint contributions are adjusted in order to meet differing task objectives.

The purpose of this investigation was to examine the effect of movement speed on the mechanical demand distribution across the lower extremity joints during the barbell squat activity, and to determine if mechanisms by which this distribution occurred were load-specific.

METHODS

Eighteen healthy, young adults who were familiar with the squat exercise performed 3 sets of 3 repetitions of a squat under two different loading conditions (25% and 50% of a 3 repetition maximum) and two different movement speed conditions (self-selected and as fast as possible). Standard inverse dynamics techniques were used to calculate the instantaneous net joint moment (NJM), angular velocity (ω) and NJM power (P). Average NJM, ω, and P were calculated using numerical integration. The average P at the hip, knee, and ankle were summed to create a lower extremity power score. The percent contribution of each joint was determined as the quotient of the individual P divided by this score. The relative adjustments in the average NJM and ω between the self-selected and fast conditions were calculated by dividing the outcome variables associated with the fast condition by the like outcome variables associated with the self-selected condition (F/SS). For all analyses, alpha was set at 0.05.

RESULTS AND DISCUSSION

The percent contribution for each joint under each condition is presented in Figure 1. The contribution from the hip and ankle significantly increased with load, but significantly decreased with speed. Conversely, the contributions of the knee significantly decreased with load but significantly increased with speed. There were no significant interactions.

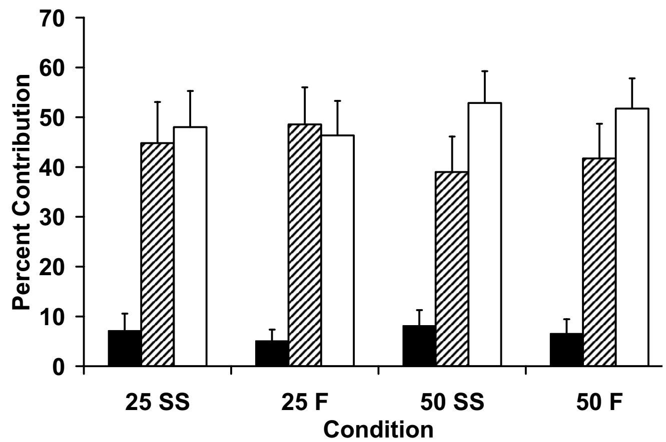

Figure 1. Percent contribution of the ankle (black), knee (striped) and hip (white) for the 25% and 50% self-selected (SS) and fast (F) conditions.

Analyses of the average NJM and angular velocity at each joint (Table 1) indicate that the redistribution of demand as a result of increased movement speed was brought about by specific changes in the average NJM at each joint. While the changes in angular velocities were greater than changes in NJM, they were not significantly different between joints.

CONCLUSIONS

A different, but identifiable movement control strategy appears to be employed in response to increases in movement speed compared to increases in external resistance. However, the magnitude of the speed response strategy is affected by external loading. The results of this investigation indicate that the joint contributions quantified under one set of experimental conditions are not generalizable to other experimental conditions.

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Table 1: Relative adjustment from self-selected to fast movement speed for the average net joint moment (NJM) and average angular velocity (ω).

Condition	Relative Adjustment from Self-Selected to Fast Movement Speeds					
	25%			50%		
	Ankle	Knee	Hip	Ankle	Knee	Hip
Average NJM	0.84 ± 0.37	1.23 ± 0.13	1.09 ± 0.11	0.95 ± 0.25	1.16 ± 0.16	1.08 ± 0.07
Average ω	1.67 ± 0.28	1.70 ± 0.19	1.79 ± 0.26	1.54 ± 0.20	1.56 ± 0.23	1.66 ± 0.33