COMPARISON OF LOADED AND UNLOADED STAIR DESCENT

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INTRODUCTION

Recent research regarding stairs has focused on muscle action and reaction forces while moving down stairs. For example, it is known that higher loads on the knee exist while descending the stairs (Yu *et al.*, 1997) as compared with level walking. McFayden & Winter (1988) have shown high peak powers at the knee when walking down stairs, while the hip is used for forward continuance. Unfortunately, few studies compare the mechanical differences in normal stair descent and loaded stair descent. The implications of loaded stairs descent may play on degenerative joint disease and other lower limb pathologies is of value. Knowing the stresses on the lower extremity joints can help with carrying limits in workplaces or daily activities.

METHODS

A sample population of three male and two female volunteers were used for this study. Subjects were asked to walk five times down stairs normally (30x20 cm steps), followed by five stair descent trials with the subject carrying a 16 kg load in the frontal plane. A Kistler 9281B force plate recorded the force data while digital camera collected the sagittal view trajectories of markers placed on the left side of the body. The kinematic data were combined with force platform data by inverse dynamics to determine the net moments and powers at the ankle, knee and hip (Robertson & Winter, 1980). The data were ensemble averaged and normalized to body mass. All data were processed using the Biomech Motion Analysis System.

RESULTS AND DISCUSSION

Figures 1 and 2 show the body mass normalized powers produced by the hip, knee and ankle moments of force during loaded and unloaded stair descent, respectively. The stride cycle for these figures begins and ends at toe-off. Foot-strike is indicated with a vertical line. There were no significant differences in the patterns of the net moments and powers at ankle, knee and hip joints between the loaded and unloaded conditions. In both the loaded and unloaded conditions large eccentric knee powers occurred just before toe-off but even though the peak power was smaller for the unloaded condition shown in Figure 2 the differences across subjects were not significant.

Notice the low powers at the hip for both conditions. This is typical for stair descent since the hip moments of force are not needed as much as during level gait since the horizontal distance to swing the leg is small–only 30 centimetres.

The ankle, like the other two joints, does not differ when a load is added. Its main function was to absorb energy after foot-strike (IFS) to cushion the toe landing during stair descent. It was not a significant contributor to push-off as occurs during level locomotion.

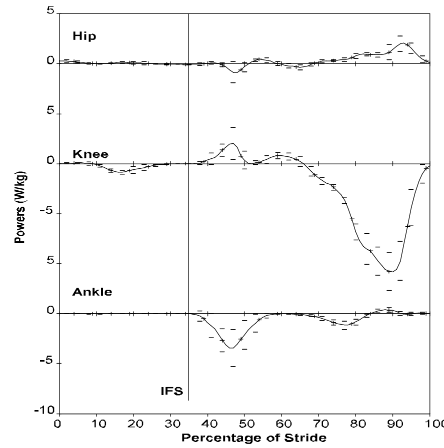

Figure 1: Typical moment powers (W/kg) of the hip (top), knee and ankle during loaded (16 kg) stair descent

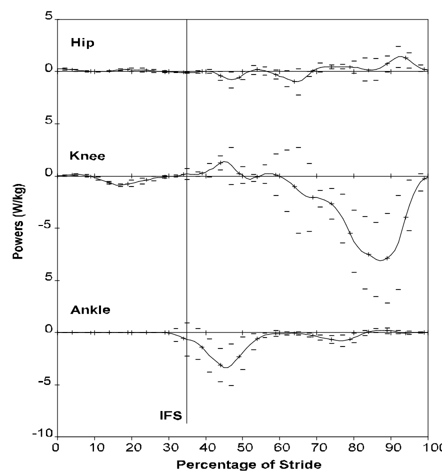

Figure 2: Typical moment powers (W/kg) of the hip (top), knee and ankle during unloaded stair descent

SUMMARY

The moment powers of the ankle, knee and hip failed to show any significant differences with the addition of a 16 kg frontal load. There was slightly greater knee eccentric extensor power but this was not significantly different across subjects due to the higher variability during the loaded condition.

REFERENCES

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