DESCENDING STAIRS, FORWARDS AND BACKWARDS

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INTRODUCTION

The purpose of this project was to investigate the mechanics of descending stairs in the forwards and backwards directions compared with level walking. Recognizing that descending stairs is more difficult and dangerous than ascending stairs and that falls from stair descent especially in the elderly can be fatal (Winter, 1995), the idea behind this project was to determine whether descending stairs backwards was safer and easier than descending in the usual forwards direction. With backwards descent a fall tends to be less injurious because the fall is towards the stairs rather than down the stairs but does it require greater effort?

METHODS

Six subjects (3 females, 3 males) participated in the study. They first descended stairs at their own pace for five trials and then repeated the descent five times facing backwards. The stairs (20 cm rise, 30 cm tread) were equipped with force platforms (Kistler) on the last two steps and on the landing. Digital cameras on either side of the stairs filmed each side of the subject. Only the data from the first step down will be presented.

Sagittal planar, inverse dynamics were applied to obtain the forces and moments of force at the ankle, knee and hip joints. Moment powers were then computed from the products of the joint angular velocities and the moments of force (Winter, 1987). The powers were time integrated to obtain the works done throughout the descent for the leg closest to the camera. Lastly, the support moment was computed by adding the three moments after assigning extensor moments a positive direction (Winter, 1980). That is:

$$M_{support} = M_{ankle} + M_{knee} + M_{hip}$$

The support moments were then normalized to body mass and compared to the support moments obtained by Winter (1987) for preferred-speed, level walking.

RESULTS AND DISCUSSION

The support moments for descending stairs had similar double peaks as occur with level walking. The first peak was consistently smaller for the forwards descent (Figure 1) but larger for backwards descent (Figure 2). Furthermore, the magnitudes of the support moments were approximately 40-60% larger on average for both forwards and backwards descent compared to level walking (Winter, 1987).

Another important difference between the two descents was the locations of the centers of pressure of the ground reaction forces. For forward descent, they tended to be close to the edge of the step but for backwards descent they were consistently farther from the edge. Thus, the chance of tripping was greatly reduced when backing down the steps.

The moments and their powers were generally higher than level walking but were inconsistent across subjects. Some subjects required higher knee kinetics while others higher hip kinetics. Generally, the ankle moments and powers were not greater than walking.

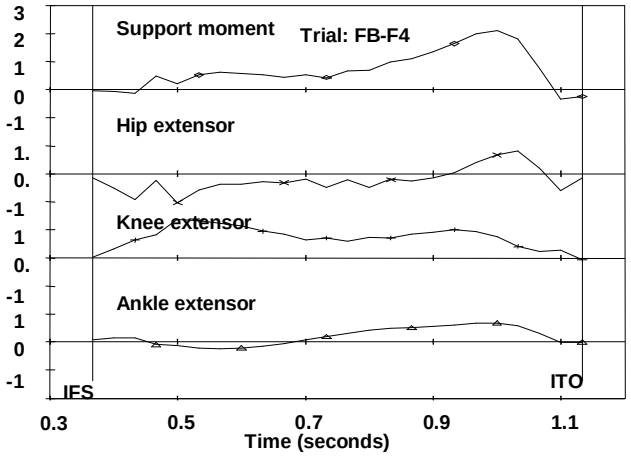

Figure 1. Typical support moment and hip, knee and ankle moments (N.m/kg) for the first step down during forwards stair descent (positive means extensor moment).

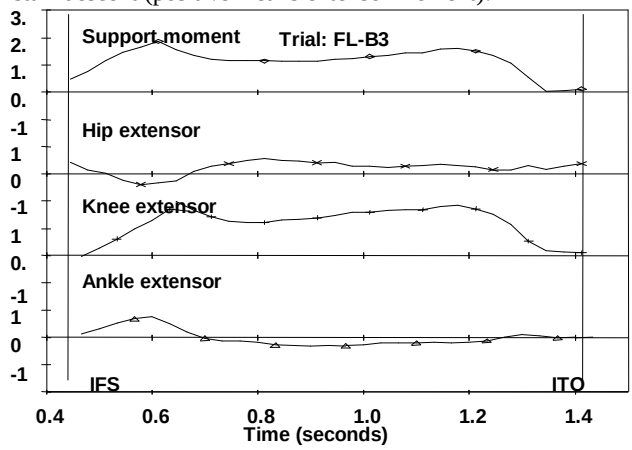

Figure 2. Typical support moment and hip, knee and ankle moments (N.m/kg) for the first step down during backwards stair descent (positive means extensor moment).

SUMMARY

Forwards and backwards stair descents require higher levels of joint moments of force and power than level walking but are relatively equal to each other. Backwards descent appeared to be safer because the forces were applied farther from the stair edge.

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