# COMPARISON OF RAMP AND 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.

These higher joint reaction forces have been suggested as being one reason why many people who ascend or descend stairs frequently have developed joint injuries. A need exists to find a method of vertical movement that eases the reaction forces to a point where fewer joint injuries occur. A solution may lie in the use of ramps. Unfortunately, few studies comparing the benefits and faults of ramps and stairs exist.

This project investigated the differences in the moments and powers of the joints of the lower extremity during stair and ramp descent. This knowledge may be used to determine the differences between these two styles of gait and be applied to rehabilitative interventions such as hip, knee and ankle replacements. This information may also be used to develop more efficient prosthetic devices.

## METHODS

A sample population of five male and five female volunteers were used for this study. Subjects were asked to walk five times down a ramp set at a 10-degree decline at a normal gait speed, followed by five stair descent trials (30 cm tread, 20 cm riser). Kistler 9286AA and 9281B force plates were used to collect the force data on the second and fourth step. A Panasonic VHS camera collected the sagittal view trajectories of markers placed on the left side of the body. The force and motion data were processed using the Biomech Motion Analysis System and Bioproc2 to determine the ankle, knee and hip moments and moment powers. The data normalized to body mass and were ensemble averaged and all statistics were calculated at +/–1.96 standard deviations.

## RESULTS AND DISCUSSION

The kinetics of ramp and stair descent differ from each other in the ankle and hip joints while the knee joint had similar power and moment requirements for both methods of descent. During stair descent, the higher peaks seen during eccentric plantar flexor activity in the ankle at foot-strike (FS) demonstrated that the ankle acted as a shock absorber and functioned to help control the body's descent to the next step. During ramp descent, however, a higher ankle plantar flexor peak occurred during the push-off phase.

With respect to the hip, few similarities existed between the kinetics of ramp and stair descent; stair descent had minimal hip activity while ramp descent had a profile similar to that of walking (Winter, 1991). Unlike the ankle and the hip, the knee showed similar phases of activity for ramp and stair descent; the same peaks were present at FS and at toe-off (TO). These peaks occurred as result of the use of the knee as a shock absorber of the leg. The knee first dissipated energy at FS and then at TO, and since the body was being lowered, the knee dissipated more energy as the contralateral foot contacted the lower surface.

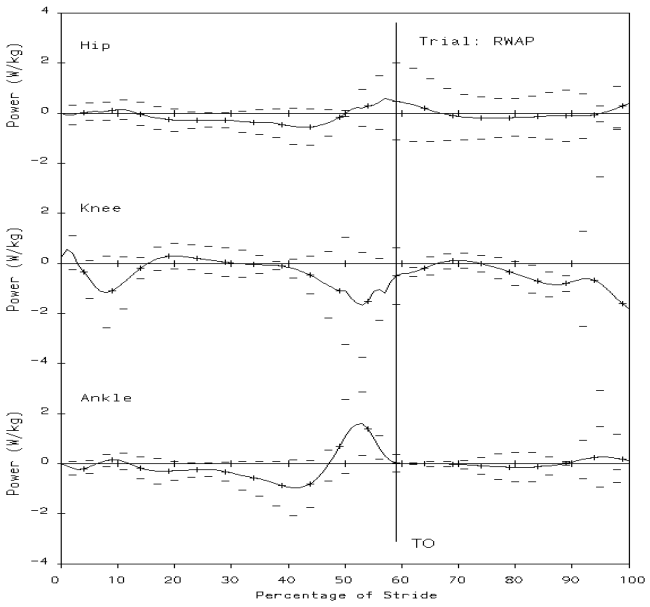


**Figure 1:** Typical hip, knee and ankle moment powers for ramp descent (TO=toe-off). Errors bars represent 95$^{th}$% confidence intervals.

## SUMMARY

Each style of gait affected the joints differently. Ramp descent required more hip activity than stair descent, as well as a more forceful push at toe-off (60% of cycle in Figure 1). The ankle had a more stressful eccentric plantar flexor activity at foot-strike during stair descent (10% of cycle in Figure 1). The knee did not show any significant difference in stress between ramp and stair descent. The support moment was noticeably higher for stair descent than for ramp descent.

The lack of significant results suggests that neither mode of descent is better for knee problems; however, the results do suggest that persons with ankle pathologies or having recently undergone ankle replacement surgery should consider avoiding stairs and use ramps instead.

## REFERENCES

Winter, D.A. (1991) *Biomechanics and Motor Control of Human Gait.* 2nd ed. Waterloo: Waterloo Biomechanics

Yu et al. (1997) *Clinical Biomech,* **12**, 286-293.