

## **Comparison of Lower Extremity Kinematics and Kinetics of ACL Deficient and Healthy Subjects During Different Cut Tasks**

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### **Introduction**

In spite of knee instability due to anterior cruciate ligament (ACL) deficiency, subjects may attempt to continue with recreational sports by adapting their motor control patterns through rehabilitation. Tasks that are especially problematic for ACL deficient subjects are cutting activities. Theoretically the crossover cut style induces knee internal rotation [2], which is a secondary function of the ACL [4]. A recent case study documented knee internal rotation instability in an ACL deficient subject during a crossover cut task [2]. In contrast, the side step cut style is theoretically less problematic since it induces knee external rotation, which does not load the ACL [4]. Hence, low functioning ACL deficient subjects are expected to show greater adaptations during a crossover cut style than a side step cut or equivalent straight ahead task [1]. The purpose of this study was to compare lower extremity kinematics and kinetics of healthy and ACL deficient subjects during a step down (ST), step down and side step cut 45 ° (ST-SS) and step down and crossover cut 45 ° task (ST-CO).

### **Statement of Clinical Significance**

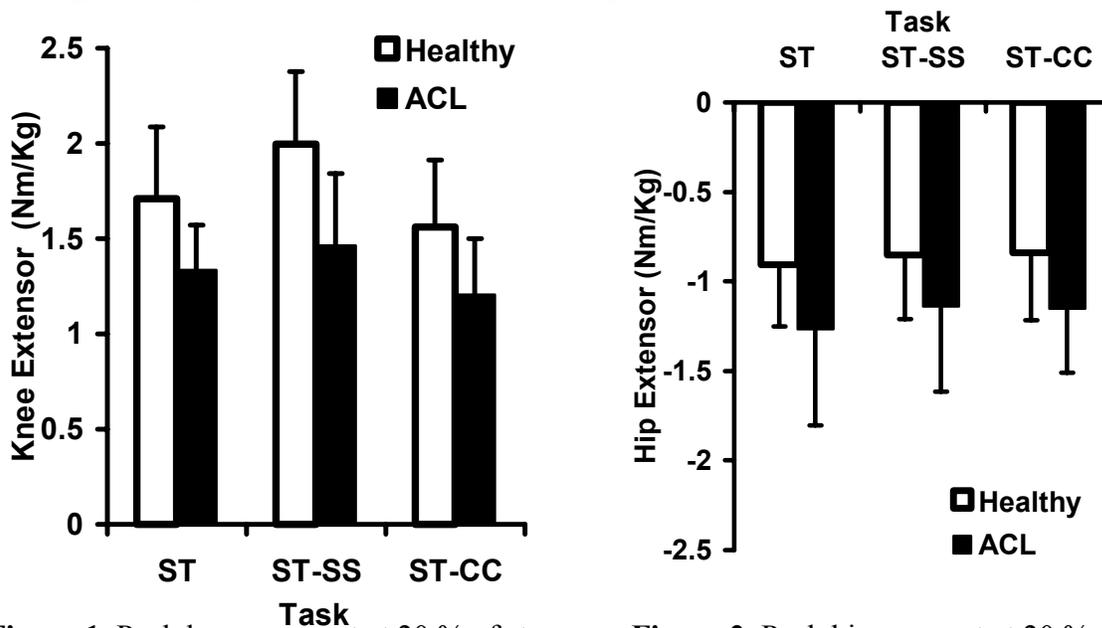
This data will provide a description of the motor control adaptations exhibited by low functioning ACL deficient subjects during cutting activities. Subsequent studies will test whether training programs alter these kinematic and kinetic patterns, improving knee stability.

### **Methodology**

Fifteen ACL deficient (height =  $1.55 \pm 0.09$  m and mass =  $79.5 \pm 18$  kg) and 14 healthy subjects (height =  $1.7 \pm 0.07$  m and mass =  $70.0 \pm 15.4$  kg) were recruited for the study. Functional scales indicated the ACL deficient subjects had little difficulty with ADL activities (KOS-ADL score =  $90 \pm 7$  %) however had more difficulty with sports (KOS-Sports score =  $61.2 \pm 19$  %). All subjects had experienced greater than 2 episodes of giving way since their injury and were at least 4 months post injury ( $53.8 \pm 67$  months). Three markers were placed on the foot, leg, thigh and pelvis segments and tracked using the Optotrak Motion Analysis System at 60 Hz. The kinematic data was subsequently filtered and combed with force plate and anthropometric data to estimate lower extremity joint angles, moments and powers using the Kingait3 software package (Mishac Kinetics, Waterloo, CA). At a walking speed of 1.34 m/s subjects stepped down from a 21 cm curb and continued straight ahead (ST), side step cut 45° (ST-SS) and crossover cut 45 ° (ST-CC). The edge of the curb was placed 50 % of the subjects stride length from the center of the force plate. Foot progression angle (<10°) and cutting angle (40 to 45°) were comparable across groups and cut tasks (ST-SS versus ST-CO). At selected points of stance peak knee angles and moments were compared using separate mixed two-way ANOVA. The two factors were group (ACL Deficient and Healthy) and task (ST, ST-SS and ST-CC).

## Results

The peak knee joint sagittal plane angles at 20 % of stance were significantly lower by 3.9° for the ACL deficient subjects compared to the healthy subjects ( $p < 0.038$ ) across the 3 tasks. The ST-SS and ST-CO tasks resulted in a significant 9° difference in peak transverse plane knee motion between the ST-SS and ST-CO tasks ( $p < 0.000$ ); the ST-SS induced knee external rotation and the ST-CC task induced knee internal rotation. Yet, there was no difference in peak knee transverse plane angles between healthy and ACL deficient subjects. At 20 % of stance the peak knee (Figure 1) and hip extensor moments (Figure 2) were significantly different across tasks. The peak hip transverse plane moments at 20 and 70 % of stance were also significantly lower in the ACL deficient subjects across tasks.



**Figure 1.** Peak knee moment at 20 % of stance. **Figure 2.** Peak hip moment at 20 % of stance.

## Discussion

The new findings of this study suggest that ACL deficient subjects show equal adaptations of the sagittal plane moments during early stance of straight ahead and cut tasks. The lower knee sagittal plane moments (Figure 1) used by the ACL deficient subjects at 20 % were associated with a higher hip extensor moments (Figure 2). The sagittal plane knee and hip moments at 20 % of stance are associated with hamstring, soleus and quadriceps activity and hence, are potentially balanced by varying contributions of these muscle groups[3]. The transverse plane knee angles confirmed the crossover cut style is associated with knee internal rotation and the side step cut style knee external rotation, however both healthy and ACL deficient subjects showed similar angles suggesting transverse plane knee stability was maintained. Further analysis of transverse plane kinematic and kinetic data will provide a model of inter-joint coordination of the stance limb during cutting tasks.

## References

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