Hip, Knee, and Ankle Contributions are Affected During Sloped Walking in Individuals with Anterior Cruciate Ligament (ACL) Reconstruction

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Previous research has found that individuals with anterior cruciate ligament (ACL) reconstruction have a higher propensity to develop degenerative joint disorders such as osteoarthritis.[1] While possible contributing factors to this condition have been studied, very little research has been done on the exact joint moment contributions of the lower extremity during locomotion, specifically during sloped walking.

For this study we recruited 17 individuals who had undergone one ACL tear and reconstructive surgery. All participants were at least four months post operation and cleared to return to their activity by a clinician. Further, no participants had other lower extremity surgery or participated in physical therapy for any lower extremity injury within the last year. All participants walked under three different conditions on our instrumented split-belt treadmill. The split-belt treadmill, designed with two separate belts for each foot with force plates set in both belts, allowed us to gather independent kinetic data for each limb during walking. The participants walked on a level surface, 10 degree incline, and 10 degree decline at 1.3 m/s, 1.0 m/s, and 1.0 m/s, respectively, for two minutes without stopping. We used a 17-camera Vicon (Vicon, Oxford, OH) motion-capture system to record kinematic data. The instrumented treadmill gathered force data, and joint moments were calculated by Vicon Nexus' Plug in Gait Model.

We analyzed the relative joint moment contribution of each limb--that is, the peak moment contributed to the action of propulsion by the ankle, knee, and hip during stance phase. These values are represented as percentages in Figure 1 for comparison of the contribution of each joint. Upon analysis we found no significant differences between limbs for any condition. There was a significant effect of condition at the hip and ankle across all three conditions, and at the knee between flat and decline, and flat and incline conditions.

These results indicate that joint moment contributions changed during walking on incline and decline surfaces. The contribution of knee joint moment increased by around 37% during the decline condition compared to flat and incline conditions. Because we did not find any asymmetries between limbs, these findings reveal that it is possible for healthy young adults to maintain a symmetric gait post-ACLR. Additionally, these results support the possibility that an asymmetric gait may not be a significant contributing factor to the development of osteoarthritis, as previously thought.

Future research should investigate motions in the frontal plane, such as knee abduction (also known as "knock-kneed" pattern), as well as utilize a matched healthy control group for a more complete analysis of potential implications for the development of osteoarthritis.

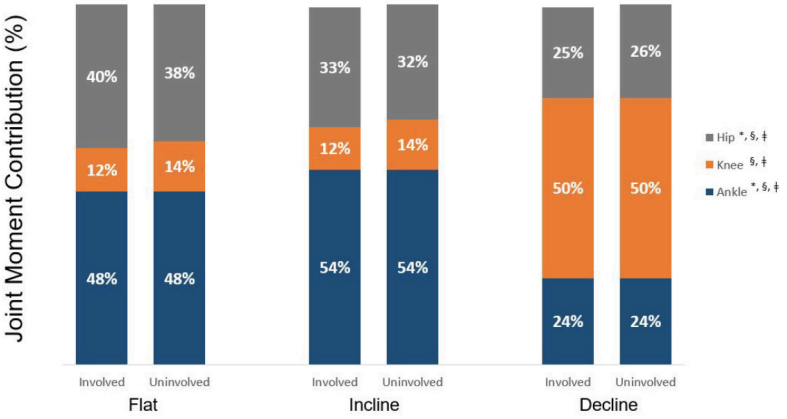

Figure 1. Differences among flat and incline (*), flat and decline (§), and incline and decline (ǂ) (p<0/05). The "Involved" column represents the ACLR limb, while the "Uninvolved" represents the contralateral, healthy limb. Joint Moment Contribution= [(Peak Joint Moment)/ (Σ Hip, Knee, Ankle Joint Moments)] x 100.

Statement of Research Advisor

Katie has executed a study that will inform clinicians and researchers that strive to reduce the onset of re-injury and osteoarthritis development in people with ACL reconstruction. Her work will have a large impact on advising people with ACL reconstruction throughout walking and running during uphill and downhill locomotion.

– *Jaimie Roper, Kinesiology*

References

[1] Barenius, B., Ponzer, S., Shalabi, A., Bujak, R., Norlén, L., & Eriksson, K. (2014). Increased risk of osteoarthritis after anterior cruciate ligament reconstruction: a 14-year follow-up study of a randomized controlled trial. *The American journal of sports medicine, 42*(5), 1049-1057.