Influence of Current ACL Tear on Gait Mechanics

Intro: The purpose of our study was to determine the effect of an Anterior Cruciate Ligament (ACL) tear, with and without the use of a Breg Fusion knee brace, on same leg arthrokinematics during gait in an ACL deficient knee. The ACL is a critical structure in controlling knee joint stability and movement, and its rupture is one of the most common sports related injuries. The loss of the ACL causes anterior displacement of the tibia relative to the femur. After an ACL injury, individuals need stronger hamstring contractions to draw the tibia posteriorly. We hypothesized that if there is decreased knee flexion during swing phase and increased extension during stance phase in a lower extremity with an ACL deficient knee, then there will be compensations at other LE joints.

Methods: The subject was a 19 year old Caucasian male with a complete left ACL tear and history of bilateral ACL repairs. The subject gave consent before participating. The subject walked at a self selected pace while wearing sneakers over a level surface for 25 meters with the Breg Fusion ACL brace on the L knee three times. He then completed this same task three times without an ACL brace. The same start location was used for each trial with left foot initial contact on a force plate during ambulation. Vicon 3D motion capture analysis was used to record and interpret data of over ground walking at a self-selected pace. For the hip, knee, and ankle, the sagittal and frontal plane were analyzed on the left lower extremity. The data was compiled to find the average values for the angles of max flexion, extension, abduction and adduction at each joint. Reflective skin markers were placed on the ASIS, PSIS, calcaneus, lateral thigh, lateral knee joint line, lateral tibia, lateral malleolus, dorsal aspect of the foot on the head of the second metatarsal.

Results: In the sagittal plane, there were no differences in peak hip flexion and extension. In the frontal plane, we found decreased peak left hip adduction and increased abduction with the brace on. In the sagittal plane, there was slight increase in knee flexion with brace during swing phase. At 68% of the gait cycle, the peak knee flexion was 69 degrees with the brace, and 63 degrees without brace. At 90% of the gait cycle, the peak knee extension without the brace was 5 degrees, lacking 2 degrees with the brace on. In the sagittal place, there was 18 degrees of plantarflexion without the brace, and 24 degrees of plantarflexion with the brace at toe off. There was a loss of 5 degrees for peak ankle dorsiflexion with the brace at heel off. In the frontal plane, there was a decrease in peak ankle inversion with the brace at toe off. There was a less rigid foot at push off due to decreased inversion and an associated lower arch.

Discussion: This study adds to existing literature on the biomechanical effects resulting from an ACL tear. The data shed light on specific quantitative changes that can occur at each joint resulting from mechanical compensations during gait due to musculoskeletal imbalances. It is important for therapists to look not only at the injured joint but also the proximal and distal joints for effective treatment planning. Therapists should frequently conduct re-assessments of ROM and strength at each lower extremity joint on the injured side.

Conclusion: In the end, we accepted our hypothesis. Compensations are common with ACL tears. The largest compensations were found at the ankle. As physical therapists, it is important to strengthen the Tibialis Anterior, Gastrocnemius, Quadriceps, and Gluteus Medius in individuals with ACL tears to promote proper lower extremity alignment.

Clinical Implications: Without the brace, there was a valgus knee alignment with increased hip adduction, femur relative to the pelvis, and increased knee abduction, tibia relative to the femur. With the brace, there was better alignment, displaying increased knee flexion, and decrease knee extension, abduction, and hip adduction. Rehab without the brace on should focus on increasing the lateral hip strength and maintaining proper lower extremity alignment with activities. Rehab with the brace will promote proper lower extremity alignment, however, make sure to encourage active maintenance of that alignment instead of allowing the brace to be the only support. The brace will facilitate increased flexion at the knee joint which will need to be countered in rehab with posterior chain strengthening. The greatest compensations were at the ankle with the brace due to the brace limiting knee flexion and extension associated with torn ACLs. Due to the increased compensations, encourage ankle strengthening and alignment.

Limitations: There was only one subject, therefore, no control group. The subjects past medical history included bilateral ACL repairs. There was no data on the right leg. The study would not be able to be replicated in a typical clinic without 3D Motion Capture Analysis software.

Resources:
1.Ren S, Yu Y, Miao X, et al. Three dimensional knee kinematics and kinetics in ACL-deficient patients with and without medial meniscus posterior horn tear during level walking. *Gait Posture.* 2018;66: 26-31.

2. Zhang LQ, Shiavi RG, Limbird TJ, Minorik JM. Six degrees-of-freedom kinematics of ACL deficient knees during locomotion - compensatory mechanism. *Gait Posture.* 2003;17:34-42.

3. Yu X, Li C, Liu Y, Ma X, Wang W. Three-dimensional gait analysis of anterior cruciate ligament before and after injury. *J Bioengineer & Biomedical Sci*. 2017;07:215.