ACL Rupture Increases Knee Adduction Moment During Gait

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Introduction: It is widely accepted that an ACL rupture increases the risk of secondary knee injuries such as meniscal and osteochondral lesions [1]. These injuries are usually linked to biomechanical changes caused by the ACL tear. Gait analysis has become an innovative tool to quantify these biomechanical changes, for example in allowing the estimation of in vivo forces occurring at knee level. It was recently shown, using an instrumented implant, that knee adduction moment is highly correlated with medial compartment force [2]. An increase in this medial force may contribute to the development or progression of knee osteoarthritis (OA)[3]. It is also known that the ACL deficient (ACLD) population shows faster progression of OA. Therefore, the hypothesis of the project was that this population would have higher knee adduction moments during gait.

Materials and Methods: Fifteen ACLD patients, without any other musculoskeletal pathology other than meniscal injury, took part in the study. The ACLD group was composed of 12 males and 3 females (aged 26 ± 5 years, height 1.72 ± 0.08m, weight 73.9 ± 9.3 Kg). After signing a consent form, patients underwent a treadmill gait analysis. Their results were compared to those of a control group composed of 10 healthy participants (10 males, aged 29 ± 4 years, height 1.77 ± 0.06m, weight 75.1 ± 8.0 Kg). Age, height and weight between the two groups were not statistically different. The gait analysis protocol consisted of a treadmill walking habituation period of 10 minutes prior to two 30 second gait trials at self selected comfortable speed. 3D ground reaction forces and moments were measured by the ADAL3D-F-COP treadmill. 3D knee kinematics were measured using reflective markers mounted on rigid bodies fixed on an attachment system [4]. The markers' 3D trajectories were captured by a six camera VICON motion analysis system. Calibration followed the functional and postural method [5]. 3D knee joint moments were then computed using inverse dynamics [6] and were normalized to patient bodyweight and height. Finally, a frontal functional alignment (varus/valgus) was measured. Significant differences between groups for every parameter were verified with an unpaired student t-test.

Results: The ACLD and control group presented a varus functional alignment with mean values of 2.0 ± 3.2° and 0.3 ± 3.0° respectively. During gait, walking speed was 1.0 ± 0.1m/s for the ACLD group and 1.08 ± 0.1m/s for the control group. Functional alignment and gait velocity were not statistically different between groups. Group mean adduction moment patterns for each group displayed two distinctive adduction peaks. The mean adduction moment value along a gait cycle was significantly higher (p=0.01) for the ACLD group (0.94±0.14) compared to the control group (0.74±0.24). Three out of 10 asymptomatic participants and 5 out of 15 ACLD patients displayed a single peak adduction moment pattern. Among these subjects, the adduction moment peak was significantly higher (p=0.02) for the ACLD group compared to the control group with values reaching 2.65±0.36 and 1.78±0.34 respectively (fig. 1). The mean adduction moment value and range were also significantly higher for the ACLD group. In regards to the subjects presenting a two adduction moment peak pattern, the second adduction moment peak was significantly higher (p=0.01) for ACLD patients (2.34±0.30) than for the control group (1.89±0.31) (fig. 2). The mean adduction moment value was also significantly higher.

Discussion: It was recently demonstrated [3] that for an OA and asymptomatic population, two distinct adduction patterns are present: a single or double peak adduction moment pattern. The same finding was made in this study on ACLD patients. Independently of the type of adduction moment pattern adopted by the ACLD patients, they showed a significant increase in their adduction moment during stance phase. It was important to rule out the effect of lower limb alignment and gait velocity since they are known to affect knee adduction moment during gait. Results from the present study are important since the ACLD population tends to develop signs of OA in long term follow ups. Future studies should evaluate the impact of different ACL treatments or gait strategy adaptations on knee adduction moment.

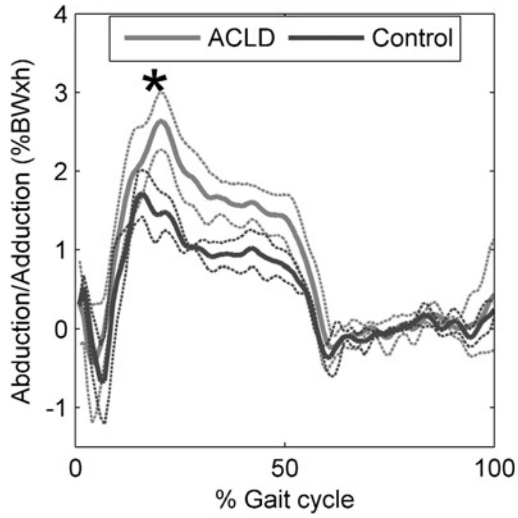

Fig.2 Single peak adduction moment pattern

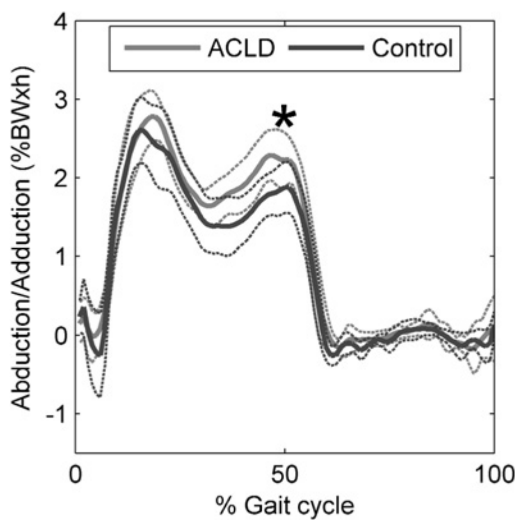

Fig.2 Double peak adduction moment pattern

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