MUSCULAR CONTRIBUTIONS TO IN VITRO TIBIOFEMORAL CONTACT MECHANICS IN THE ACL DEFICIENT KNEE

Paul Gauthier[1], K. Brent Smale[1], Geoffrey Dervin[2], Daniel. L. Benoit[1, 3]

[1] School of Human Kinetics; [2] Faculty of Medicine, [3] School of Rehabilitation Sciences; University of Ottawa, Canada

Introduction

Abnormal contact mechanics of the tibiofemoral joint is believed to influence the development and progression of joint derangements. As such, understanding the factors that regulate joint stability may provide insight into the underlying injury mechanisms. Muscle action is believed to be the most important factor since it is the only dynamic regulator of joint stability. Furthermore, abnormal muscle control has been experimentally linked to the development of OA [Herzog, 2007] and in vivo ACL strain [Fleming, 2001]. However, the individual contributions to knee joint contact mechanics remain unclear. Thus, the purpose of this study was to examine the effects of individual muscle contributions on the tibiofemoral contact mechanics using an in-vitro experimental protocol.

Methodology

Contact mechanics of 6 fresh frozen cadaver knee specimens were evaluated using the UofO Oxford knee loading device. Various combinations of quadriceps-hamstring co-contraction ratios were applied to the knee while it was "suspended" between the hip and foot components of the device. Loads of six muscle groups were computed using a hill-type musculoskeletal model [Buchanan, 2004]. Simulated ground reaction forces were also applied to the knee to represent force profiles of weight acceptance during gait as it has been shown to produce peak knee joint force in the gait cycle [Shelburne et al., 2006]. For respective medial and lateral joint compartments, the mean contact area (MC-*CA and LC-CA*), mean contact pressure (MC-CP and LC-CP), peak pressure (*MC-PP and LC-PP*), and centre of force displacement (MC-COFD and LC-COFD) were determined using a 4011 piezoelectric sensor form Tekscan (Tekscan Inc. Boston, MA). Additionally, the ACL was resected and measurements were repeated. Pearson correlations (r) examined the reliability of measurements as well as the effect an ACL transection on articular loads.

Results

Positive correlations were computed for the following: COFD with intact ACL (r=0.99), COFD with resected ACL (r=0.82), MC-COFD pre vs. post ACL- resection (0.91) (Fig.1). Furthermore, preliminary results indicated a positive correlation between MC-CA and ACL integrity (r=0.97) (Fig.2).

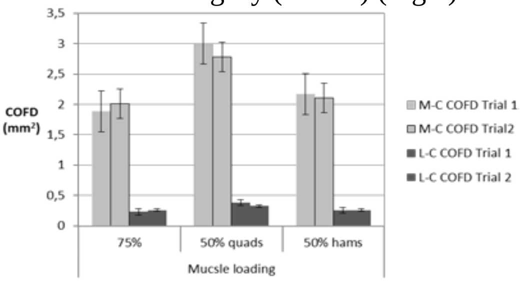

Figure 1: Medial and lateral compartement mean contact area (mm^2) comparison: trial 1 vs. trial 2

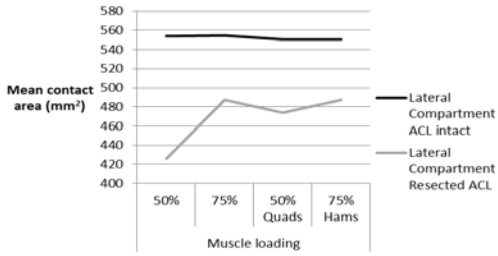

Figure 2: Lateral compartment mean contact area (mm^2): ACL vs. resected ACL

Discussion

The repeatability of the measured dependant variables validates the use of the knee-loading device. Interestingly, contact mechanics are more variable post ACL resection for a given muscle loading condition, indicating a decrease in knee joint stability. Also, the COFD is dependent on the different ratios of muscle loads applied to the knee, which demonstrates the importance of muscle action to the modulation of contact forces.

References

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