DIFFERENCES IN EXTERNAL KNEE ADDUCTION MOMENT BETWEEN ACL RECONSTRUCTED AND CONTRALATERAL KNEES

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INTRODUCTION
An increased risk for osteoarthritis (OA) persists even after reconstruction of a ruptured ACL [1]. It has been reported [2] that the failure to restore the normal kinematics of the knee following ACL injury can lead to OA. It has also been reported that ACL reconstructed (ACLR) knees experience a greater magnitude external knee adduction moment (KAM) [3]. This is important since the KAM has been shown to be correlated with the progression and severity of OA in subjects with idiopathic OA [2,4]. A change in loading can possibly attribute to premature clinical OA in ACLR knees.

KAM is the product of the frontal plane ground reaction force (GRF) and the moment arm. Lateral trunk lean has been shown as one mechanism that affects KAM, possibly by changing the length of the moment arm [5].

The purpose of this study was to test for differences in external KAM and possible mechanisms for change. This study tested the hypothesis that there are differences during the stance phase of walking in peak KAM, moment arm in the frontal plane, lateral trunk lean, and GRF for the ACLR knee when using the healthy, contralateral as a control.

METHODS
Forty-five subjects with unilateral ACL reconstructions and no other history of serious lower limb injury (29 ± 6.3 yrs, 1.7 m, 73 kg, 22 left legs, 19 females, 26 ± 3.4 mos. past surgery, 2.24 ± 1.7 mos. between injury and surgery, 41 achilles allograft, 3 patellar tendon autograft, 1 patellar tendon allograft) participated in this study after providing IRB-approved informed consent. Exclusion criteria included the presence of OA or history of other serious ligamentous injury to either lower limb. A 9-camera opto-electronic system and a multi-component force plate were used to record the kinematics and KAM. The frontal plane moment arm, defined as the perpendicular distance from the GRF to the knee joint center, and trunk lean (measured from the lab vertical, positive towards stance limb) was calculated with methods based on previous studies at the time coincident with peak KAM [5]. Subjects performed three trials of walking at their self-selected normal walking speed for each leg. A paired Student’s T-test, with an alpha value of 0.05, was used to determine significant differences in ACLR versus contralateral knees.

RESULTS AND DISCUSSION

Figure 1: External knee adduction moment (KAM) during stance phase of walking
There was a significant reduction in the first peak of KAM of the ACLR knee compared to the healthy contralateral (2.50±0.66, 2.75±0.60 %Bw*Ht respectively, p=0.004, Fig. 1) as well as a decrease in frontal plane moment arm length (2.43±0.55, 2.65±0.47 %Ht, p<0.001, Fig. 2) and an increase in trunk lean (2.28±1.76°, 1.43±1.95°, p=0.024, Fig. 2). These results supported the first part of our hypothesis that there would be differences in KAM, frontal plane moment arm, and lateral trunk lean between ACLR and healthy contralateral knees during stance phase of each respective side. No significant differences were found in the magnitude of the GRF (112.1±10.7, 113.1±9.7%BW, p=0.45) which refuted the final part of our hypothesis.

Figure 2: Frontal plane moment arm and trunk lean

A reduction in peak KAM of the ACLR knees suggests a load reduction in the medial compartment of the knee. The lower peak KAM seems to be a result of a shorter moment arm which is possibly caused by increased trunk lean. Increased trunk lean can reduce the frontal plane moment arm by shifting the body’s center of mass to be more in line with the knee joint center during stance phase.

It is unknown why subjects exhibit an increase in lateral trunk lean towards the affected limb. It is possible that subjects experienced pain near the time of injury and/or surgery and altered their gait accordingly. This change may have persisted even well past the presence of pain. Subjects may also be attempting to align the body’s center of mass and knee joint center in order to counteract lost proprioception or lack of stability due to the injury. Furthermore, the differences might be a result of other unknown compensatory reasons which warrant further investigation.

The results of this study differ from the study by Butler et al. [3] which found an increase in KAM in ACLR knees versus a healthy control population. However, the aforementioned study did not report the presence of OA, meniscal or cartilage damage. Also, subjects were 5.3±4.4 yrs past reconstruction. Subjects may have already had progressive OA and exhibited an increase in KAM accordingly [4]. It is possible that individuals may experience a shift from a decreased KAM following ACL reconstruction, to an increased KAM coinciding with the progression of OA.

CONCLUSION
The most important finding of this study was a difference in KAM of ACLR and healthy contralateral knees. Long term effects of this difference are still unknown. Therefore, future longitudinal studies are needed in order to better understand the effects of a decreased KAM as well as the role of increased lateral trunk lean on long-term joint health.

REFERENCES
1. Lohmander LS 2004 Arthritis Rheum., 50(10), 3145-3152