

# ANATOMY OF THE EXTENSOR MECHANISM INFLUENCES TIBIAL TRANSLATION DUE TO QUADRICEPS CONTRACTION IN THE ACL DEFICIENT KNEE

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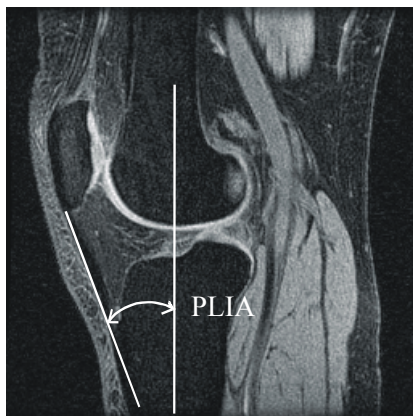
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## INTRODUCTION

Anterior tibial translation occurs during contraction of the quadriceps at certain knee flexion angles due to the geometry of the knee extensor mechanism, in particular the patellar ligament insertion angle (PLIA) (Figure 1). A greater PLIA can correspond to a greater component of force on the tibia in the anterior direction. The anterior motion of the tibia is restricted by soft tissue structures, in particular, the anterior cruciate ligament (ACL). In knees with a compromised ACL, the importance of the PLIA is hypothesized to be more significant in determining the amount of translation for a given quadriceps force. We tested the hypothesis that anatomical variations in the extensor mechanism (defined by the PLIA) would influence the amount of anterior tibial translation in the ACL deficient knee.



**Figure 1:** MRI image showing the PLIA

## MATERIALS AND METHODS

The ACL deficient group consisted of five subjects (age =  $32.4 \pm 13$  yrs, 1 female, avg. 103 mo. past injury). The control group consisted of six subjects with no musculoskeletal involvement (age =  $27.5 \pm 8$ , 4 females). Magnetic resonance imaging (3DSPGR) was used to measure the PLIA for each subject.

Each subject was tested bilaterally using a KT-1000 Knee Ligament Arthrometer in combination with a Cybex 350. The rotation axis of the Cybex resistance arm was aligned with the flexion-extension axis of the knee and the lower limb attached to the resistance arm with a foot plate. The KT-1000 was placed on the anterior aspect of the tibia with the tibial sensor pad placed on the tibial tubercle and the patella sensor pad resting on the patella. Measurements were obtained as the quadriceps produced a torque of 1% and 2% body-weight times height ( $BW \cdot Ht$ ), at joint angles of 10°, 20°, 40°, and 60°. These torques represented the physiological loads seen during the mid-stance phase of walking. With the subject's leg muscles relaxed, a manual 89N measurement of passive knee laxity was taken. Normalized knee motion was calculated by subtracting the passive tibial translation from the anterior tibial translation measured during quadriceps active translation.

## RESULTS

The anterior tibial translation for ACL deficient knees showed a correlation between quadriceps activation at 10° and 20° knee flexion angle that was not seen in the control population (Table 1, Figure 2). At angles of 40° and 60°, there was no correlation for both ACL deficient and control populations.

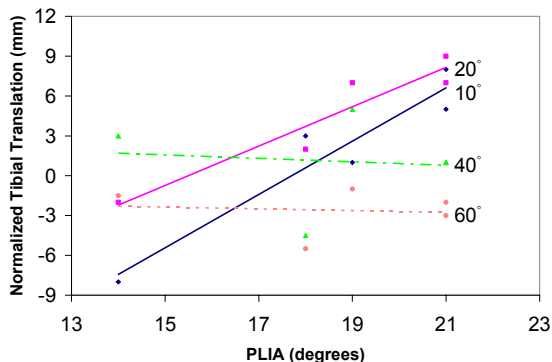
**Table 1:** R<sup>2</sup> values for Controls and ACLD  
1%BW\*Ht

Knee Angle	Controls R <sup>2</sup>	ACLD R <sup>2</sup>
10°	0.01	0.91
20°	0.03	0.90
40°	0.01	0.03
60°	0.03	0.01

2%BW\*Ht

Knee Angle	Controls R <sup>2</sup>	ACLD R <sup>2</sup>
20°	0.01	0.92
40°	0.02	0.06
60°	0.02	0.04

As Figure 2 shows, for ACL deficient subjects, as the PLIA increases, the amount of anterior tibial translation will also increase at 10° and 20°.



**Figure 2:** Relationship between normalized tibial translation and PLIA for 10°, 20°, 40°, and 60° knee flexion angle for 1% BW\*Ht.

## DISCUSSION

These results demonstrate that individual variations in the anatomy of the extensor mechanism influence the amount of quadriceps induced anterior tibial translation that occurs in the ACL deficient knee. Reducing tibial translation reduces shear at the articulating surfaces. Mechanical shear stress at a joint results in thinner cartilage (Carter and Beaupre 2001). A quadriceps avoidance gait may reduce the tibial translation, thereby reducing the individual's risk for osteoarthritis in the affected knee (Berchuck, et al, 1990). For an ACL deficient individual with a small PLIA, adopting a quadriceps avoidance gait may not be as critical, because less tibial translation will occur. However, it may be particularly important for an ACLD individual with a large PLIA to adopt the quadriceps avoidance gait in order to minimize tibial translation, thereby reducing risk for osteoarthritis.

## REFERENCES

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## ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of NIH grant #AR39432, and the National Science Foundation Graduate Student Fellowship Program.