ACL INJURY CAUSES ROTATIONAL ABNORMALITIES AT THE KNEE DURING WALKING

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INTRODUCTION
Anterior-posterior (AP) translation and internal-external (IE) rotation of the knee are fundamental to the normal function of the knee. Studies of passive knee mechanics have shown that the anterior cruciate ligament (ACL) can influence rotational stability and motion of the knee (1). Thus, it is likely that under dynamic conditions such as walking the translational and rotational motion of the ACL deficient knee will be different than normal. Clinical evaluation of patients following ACL injury has demonstrated increased AP laxity relative to the contralateral knee. However, increased passive clinical laxity based on quantitative KT2000 measurement has not correlated with clinical outcome (2). Yet, alternations in translational and rotational motion of the knee during dynamic activities could have profound effects on secondary restraints such as the medial meniscus. The purpose of this study was to test the hypothesis that the translational and rotational motion of the knee during walking will be different from normal for patients with ACL deficient knees.

METHODS
Patients were selected with a complete rupture of the ACL (documented by examination and MRI) and minimal associated injury to the other major ligaments of the knee joint or articular surface of menisci. Eight patients (3 female, 5 male, age 42 ± 17 years, height 1.7 ± 0.2 m and weight 758 ± 231 N) were tested at a minimum of 6 months following index injury. In addition a matched group of normal subjects was tested.

All subjects were tested (following informed consent using an IRB approved protocol) during walking using a previously described point cluster technique (3) to measure six degrees of freedom motion at the knee. The point cluster technique uses 21 light reflective markers placed on the lower limb segments to create two cluster groups: one on the thigh and one on the shank. Motion was tracked using a four-camera optoelectronic digitizer.

This study focused on the relative AP and IE component of motion of the tibia relative to the femur. AP motion was measured from the midpoint of the tibial surface to a point fixed at the midpoint of the transepicondylar axis on the femur. The maximum dynamic ranges and peak values of motion curves were compared. Student’s t-test with an α = 0.05 was used to determine significance.

RESULTS
The temporal pattern of AP and IE motion of the tibia relative to the femur was common to all knees. At heel strike (Figure 1), the tibia is at its most externally rotated and anterior position. From here, the tibia internally rotates and moves posteriorly through stance phase. During swing phase the tibia rotates externally as the knee extends towards heel strike.

Interestingly the overall AP motion of the ACL deficient knee (3.8+/-.0.9cm) was significantly less than the control or contralateral knee (3.2+/-.0.7 cm). The difference in range was related to the control group having a greater anterior position (1.6+/-.0.6 cm) of the tibia relative to the ACL deficient group (0.9+/-.0.5 cm). The overall dynamic range of IE motion was not different between the ACL deficient and normal knees. However, the offset of the two curves was different causing the ACL deficient group (13.9+/-.5.2 degrees) to be significantly more internally rotated than normal (8.5+/-.1.8 degrees). The average offset of the ACL deficient knee was significantly more internally rotated than the contralateral knee (p < 0.05).

DISCUSSION
A surprising result of this study is that the AP displacement of the normal knee is greater than the ACL deficient knee during walking. The difference in AP motion appears to be coupled with a more internally rotated knee than the contralateral knee throughout the walking cycle. The internally rotated offset of the tibia for ACL deficient knee occurs at heel strike and appears to be caused by a loss of the normal screw-home movement of the knee (external tibial rotation with extension) during swing phase.

A knee that functions with the tibia more internally rotated will likely produce higher strains in the secondary structures such as the menisci and could be a possible cause for the degenerative changes that are often reported following ACL loss. The rotational offset identified in this study could be an important consideration in the evaluation of the ACL deficient knee. Perhaps surgical reconstruction and clinical evaluation should consider the rotational function of the ACL as well as AP laxity.

REFERENCES

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