

## Failed Exploration of Rotational Instability in Single- and Double-Bundle ACL Reconstruction

To the Editor:

We read with interest the article by Ho et al.<sup>1</sup> entitled "Equal Kinematics Between Central Anatomic Single-Bundle and Double-Bundle Anterior Cruciate Ligament Reconstructions." This article, which compared translational and rotational stability in single- and double-bundle anterior cruciate ligament (ACL) reconstruction using a navigation system, attempted to find objective differences between the 2 reconstruction techniques.

We were surprised that the study was unable to detect significant differences in rotational laxity between ACL-deficient and ACL-intact knees. These findings are in contrast to several recent in vivo studies that showed a difference in rotational stability between the 2 states<sup>2,3</sup> and suggest that the joint positioning and loading used for this study may be unsuitable for comprehensive evaluation of ACL (or graft) function. Given that improvement in rotational control is reported to be one of the major advantages of the double-bundle reconstruction,<sup>4</sup> the inability to detect any rotational abnormalities in the ACL-deficient state makes the results of this study difficult to interpret. Most cadaveric studies have used a simulated pivot-shift test for assessing rotational stability<sup>5</sup>; this test routinely distinguishes between ACL-intact and ACL-deficient joints and has been used previously to identify differences between double- and single-bundle reconstructions.<sup>4</sup> Given that the simulated pivot-shift test can be performed with a navigation system,<sup>6,7</sup> it is unfortunate that it was not included in this study.

We do appreciate the authors' approach of putting the single-bundle graft in an anatomically centered position. Furthermore, drilling of the femoral tunnel, for the single-bundle reconstruction, through the anteromedial portal ensures better femoral tunnel positioning. Surprisingly, the same technique was not used for the double-bundle reconstruction. Most investigators would agree that anatomic positioning of the tunnels is essential for superior clinical outcome and that transtibial tunnel drilling may lead to nonanatomic, high anteromedial bundle positions.<sup>8,9</sup>

We look forward to the authors' response in hopes of improving our level of knowledge of the ACL.

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### Author's Reply

We appreciate the letter from Drs. Lorenz, Tashman, and Fu about our article. They raise some important issues related to rotational laxity in the ACL-injured and ACL-reconstructed knee.

We agree with the authors of the letter, and it is well documented, that the ACL-deficient knee does have a rotational abnormality—increased internal rotation under internal

torque.<sup>1-3</sup> This increase in internal rotation occurs near extension but is relatively small—up to 4°. We documented a 2.4° increase ( $P = .06$ ) in internal rotation with internal torque at 30° of flexion, and using the same testing system, we have reported a 3.5° increase ( $P < .001$ ).<sup>3</sup>

The major change in knee kinematics that occurs with ACL injury is not the small increase in internal rotation but rather a

large increase in anterior translation. This is largest near 30° of flexion with anterior force. Lorenz et al. have applied internal and valgus torques to ACL-deficient knees in vitro and documented increased anterior translation. We have also reported increased anterior translation in ACL-deficient knees with internal torque alone.<sup>1,3</sup> The increase in anterior translation in ACL-deficient knees with anterior force is larger than with rotatory torques.<sup>2</sup> After proper ACL reconstruction with either a double-bundle or a central anatomic single-bundle graft, anterior translation will return to normal whether tested with anterior force or rotational torque. An ACL-reconstructed knee with normal anterior translation with anterior force will also have normal anterior translation with rotatory torques.<sup>1-3</sup> What Lorenz, Tashman, and Fu have termed “rotational laxity” is in fact a measurement of linear anterior translation. Interestingly, the increase in internal rotation in ACL-injured knees also appears to return to normal if anterior translation is normal.

Much of the clinical concern about stability in ACL-reconstructed knees has been linked to knees with abnormal pivot-shift tests despite having Lachman tests with firm endpoints. The clinical pivot-shift test is a dynamic test combining valgus, internal torque, and flexion of the knee. The sudden shift and rotation of the tibia are identified by the examiner as a hallmark of an ACL injury. Information from instrumented laxity tests indicates that knees with greater anterior translation will have higher grades on the pivot-shift test.<sup>4</sup> Clinically, it is known that a graft that does not adequately restore normal anterior translation may still provide an endpoint to a Lachman test but result in an abnormal pivot-shift test. Unfortunately, clinician estimates of anterior translation with a Lachman test vary greatly, and it is a firm endpoint that is most identifiable. The knee with an overly vertical graft will have increased anterior translation, an endpoint on the Lachman test, but an abnormal pivot shift. It has been said that this knee does not have rotational stability. Indeed, in the clinical setting it is the pivot-shift test with rotational torques that is sometimes the better discriminator of functional stability. Yet in vitro tests show that it is the persistence of abnormal anterior translation that is the underlying biomechanical abnormality. Clinically, it is our observation that with careful examination, a knee with

normal anterior translation with the Lachman test will also have a normal pivot-shift test. Our in vitro study documented that a central anatomic single-bundle graft will equal a double-bundle graft in restoring anterior and internal rotational stability.

We thank our colleagues from Pittsburgh for truly leading us to a greater understanding of knee kinematics, ACL anatomy, and reconstruction technique. We followed their recommendations for double-bundle reconstruction as they were practiced by the senior author at the time our study was undertaken. Single- and double-bundle ACL reconstruction techniques continue to evolve, and further improvements will surely follow.

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