Editorial Commentary: Lateral Extra-articular Reconstructions With Anterior Cruciate Ligament Surgery: Are These Operative Procedures Supported by In Vitro Biomechanical Studies?

Abstract: There remains controversy on the role of a concurrent lateral extra-articular procedure with anterior cruciate ligament (ACL) reconstruction. Previous biomechanical studies often are historical and inconclusive. Studies show the anterolateral ligament and iliotibial band are secondary restraints and, when injured in conjunction with the ACL, produce gross (Grade 3) pivot-shift subluxations. Recent robotic studies show a well-placed bone-patellar tendon-bone reconstruction does restore time-zero kinematics with a negative pivot-shift. Accordingly, a lateral extra-articular procedure does not provide any further resistance to the pivot-shift. Extra-articular reconstructions may produce a modest unloading of an ACL graft and reduce a few degrees of abnormal internal rotation at high flexion angles but at the expense of overconstraining the knee joint. The conclusion appears warranted at this time that biomechanical studies do not support the routine addition of anterolateral ligament or iliotibial band tenodesis procedures with ACL reconstructions. These procedures may, however, still play a role in select ACL chronic or revision knees with gross anterior subluxations.

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In their article, "Biomechanical Results of Lateral Extra-articular Tenodesis Procedures of the Knee: A Systematic Review," Slette et al.[1] delve into an important clinical problem that is being debated at many meetings and is the subject of many recent publications.[2-19] Only 10 of 506 publications indicated by the search terms met the inclusion criteria for systematic review in the 35-year search window from 1980 to 2015. The majority of the selected articles may be considered historical, because 8 of 10 were published before 1997. Although not in the authors' search window, there are recent 2016 publications that need to be brought into this analysis.

The most important consideration for the use of a lateral extra-articular reconstruction, or tenodesis, is to resist the pivot-shift subluxation in conjunction with an anterior cruciate ligament (ACL) reconstruction. The pivot-shift phenomena is the primary instability pattern that the patient experiences and must be corrected by surgery for a successful result. It should be noted in the 10 publications selected for this review that no study examined the effect of a lateral extra-articular tenodesis (LET) on the pivot-shift phenomena as an outcome measure or conducted biomechanical studies designed to address this outcome. Therefore, the reader has no knowledge of the ability of a LET or anterolateral reconstruction (ALL) to decrease the pivot-shift in his/her patients when combined with an ACL reconstruction. Accordingly, it would seem premature of the authors to advise consideration of a LET or ALL procedure with an ACL reconstruction when one does not know its effect on the pivot-shift phenomena.

Two recent publications have used more modern robotic techniques to examine the effect of an ALL reconstruction on the pivot-shift phenomena. One study used a 3-degree-of-freedom pivot-shift simulation (10 N-m valgus, 5 N-m internal rotation, flexion),[10] and a study performed in our laboratory used a 4-degree-of-freedom simulation (100 N anterior, 5 N-m internal rotation, 7 N-m valgus, flexion).[20] We recommend the latter loading profile for pivot-shift simulation as previously published,[21-23] and rotational knee stability is best defined by the position or translation of the lateral and medial tibiofemoral compartments and not by degrees of tibial rotation. Moreover, Nitri et al.[10] showed that the addition of the ALL reconstruction to the ACL reconstruction had a minimal effect on the pivot-shift. After ACL reconstruction, there was a residual abnormal internal rotation of 2.2° after ALL sectioning, which was restored to within 0.4° by the ALL reconstruction.[10] These changes are slight

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and not clinically significant, but Nitri et al.[10] concluded that a concurrent ALL reconstruction maybe considered to improve rotatory knee instability.

In our robotic study, the ACL reconstruction restored normal knee kinematics, including the pivot-shift and, consistent with the first study, there was a modest increase in the internal rotation limit after ALL+ iliotibial band (ITB) sectioning (5.1°; (95% confidence interval 3.6-6.7) at 60° knee flexion). The addition of an ALL reconstruction had no effect on the pivot-shift and returned the internal tibial rotation limit to normal native values.[20] In summary, our study and 2 studies quoted by Slette et al.[24,25] show a slight increase in internal tibial rotation at high flexion angles that is not corrected by a bone–patellar tendon–bone (BPTB) ACL reconstruction. The clinical significance of this is in question and will be further discussed.

An added concern of the reviewed articles in this publication is the lack of consistency in the injury model studied. It is known in the literature that removal of the ACL and then subsequent removal of secondary ligament restraints produces increasing knee translations and rotations.[26-28] To make sense of the efficacy of a LET or ALL reconstruction, these procedures are best studied in an actual simulated injury model, the most appropriate being ACL sectioning with additional sectioning of the anterolateral structures. Otherwise, it is unknown what deficit the LET or ALL procedure is reconstructing. In this review, only 2 articles studied the effect of a combined ACL and LET reconstruction after injury to the ACL that also included sectioning the anterolateral structures.[24,25] In the study by Samuelson et al.,[25] with reconstruction of the ACL alone, there was a residual increase of 8° of internal rotation at 60° and 90° knee flexion with the anterolateral structures sectioned. The LET corrected the internal rotation deficit but overconstrained the joint by approximately 8-15°. In the study by Butler et al.,[24] the ACL reconstruction (rope) also left the knee with an abnormal increase of 4.4° internal rotation at 30° knee flexion with the ITB sectioned, and a subsequent ITB tenodesis corrected this however overconstrained the joint by 3°.

One may reasonably conclude that a well-placed ACL reconstruction restores native kinematics and resists the pivot-shift at time-zero as long as the anterolateral structures are intact. When these structures are deficient, however, as in grossly unstable knees (Grade 3 pivot-shift), there will be a residual increase in internal tibial rotation of 5-8° at high flexion angles that the ACL reconstruction does not correct.

The critical question is what is the clinical instability pattern demonstrated by 5-8° increased internal rotation at high flexion angles in the aforementioned knees? The authors suggest a wider use of the LET, stating that "consideration should be given to reconstructing the anterolateral structures and the ACL concurrently to maximally restore both anterior tibial translation and rotatory stability."[1] Again, this would be difficult to support, because we do not understand the clinical instability pattern that exists for these few degrees of increased internal rotation. The authors correctly point out that a LET procedure produces a significant overconstraint of internal rotation, in some studies as high as 15°, which limits and inhibits physiologic rotation with tibial extension and the screw-home mechanism, and could be a factor for future joint arthrosis.[1] I agree with these concerns. It seems wise not to recommend the routine use of an ALL or ITB reconstruction until their clinical efficacy is determined and the procedures can be performed without a serious concern of overconstraining and limiting joint internal rotation.

Finally, the effect of a LET or ALL reconstruction on ACL graft forces should be noted to be very modest at best. In the study by Engebretsen et al.,[29] the ITB tenodesis was tensioned to 27N (6 lbs) with the knee externally rotated, and the force in the ACL graft dropped from approximately 60 N to 35 N (13.5 lbs to 7.9 lbs) under anterior tibial loading. These findings are in agreement with our results in that an ALL reconstruction tensioned to 8.9 N (2 lbs), so as not to purposefully overconstrain the joint, decreased ACL graft forces by only 19.5 N (4.4 lbs) at 60° knee flexion under internal rotation loading.[20] We also showed a very slight decrease in ACL graft forces of 34.7 N (7.8 lbs) in the pivot-shift test.[20]

In summary, all of these biomechanical studies considered together would lead to some preliminary conclusions. (1) Two robotic studies[10,20] published since the aforementioned review show the addition of an ALL reconstruction to an ACL reconstruction has no effect on the pivot-shift, because the ACL reconstruction at time-zero does resist the pivot-shift subluxation even with deficient ALL and ITB structures. (2) There is no residual abnormal internal tibial rotation when an ACL reconstruction is performed with intact anterolateral structures.[10,20,24,25] (3) There is a modest remaining increase in internal rotation when an ACL reconstruction is performed with deficient anterolateral structures (range: 5-8° at high flexion).[10,20,24,25] (4) Whether a LET or ALL reconstruction is indicated for this residual increase in internal rotation needs to be studied to define the clinical instability pattern and whether in fact it needs to be corrected. (5) When an ACL reconstruction and ITB or ALL procedure is performed together, the correction of the abnormal internal rotation may occur at the expense of overconstraining normal joint internal rotation.[24,25] (6) Current biomechanical studies do not support the routine concurrent use of an ALL or LET reconstruction at the time of ACL reconstruction.[18,20]

It is acknowledged these conclusions only apply to time-zero biomechanical effects in studies using a well-placed BPTB graft. Further biomechanical studies are necessary for conclusions on other ACL grafts. There is a need for well-planned clinical studies along with the need for objective measurement of pivot-shift subluxations in patients before and after surgical reconstruction.

In my own practice, I use an ITB tenodesis operation in combination with ACL reconstruction only in select chronic or revision circumstances of grossly unstable knees (Grade 3 pivot-shift) with the goal of restoring internal rotation and providing some unloading of the ACL reconstruction. I have only had to use it 2-3 times per year at most in tertiary referrals of multiple-operated ACL revision cases (approximately 50 patients a year). In revision knees I always use autografts either of the same limb or, if required, a contralateral BPTB harvest or, as a last choice, a quadriceps-patellar bone graft. I do have a concern with using a semitendinosus-gracilis graft and other soft tissue grafts and allografts in Grade 3 pivot-shift positive knees with a lack of secondary restraints, as my clinical anecdotal experience has shown a greater rate of failure. It may be that there is an indication for a LET or ALL reconstruction in grossly unstable knees in which these soft tissue grafts are used.[30]

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