BS Structured Summary

Article: Lateral Extra-articular Tenodesis Provides Superior Stability in ACL Reconstruction With Posterolateral Tibial Fracture

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Structured Summary: Lateral Extra-articular Tenodesis Provides Superior Stability in ACL Reconstruction With Posterolateral Tibial Fracture

Original Article: Lateral Extra-articular Tenodesis Provides Superior Stability in ACL Reconstruction With Posterolateral Tibial Fracture

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Journal: The American Journal of Sports Medicine

Year: 2026;54(6):1365-1375

DOI: 10.1177/03635465261423212

INTRODUCTION / BACKGROUND

Posterolateral tibial fractures (PLTFs) are frequent concomitant injuries in anterior cruciate ligament (ACL) rupture. Bernholt and colleagues identified posterolateral plateau impaction fractures in nearly half of knees with a primary ACL tear, and the type 3B depression variants are independently associated with high-grade pivot shift. The mechanism is one of ventral subluxation with internal tibial rotation: the femur impacts the posterolateral plateau and creates the so-called “apple-bite fracture” described by Menzdorf. Because these depressions compromise the bony support of the posterior horn of the lateral meniscus, a practical question arises: is it worth fixing this fragment when we reconstruct the ACL?

The trouble is that the literature lumps very different fracture grades under the same label. Current surgical indications recommend reduction and fixation for large impactions (above 5 mm), but the 2 to 5 mm gray zone has no defined guideline. Menzdorf proposed intervention for depressions above 2 mm when posterior horn support is compromised and the pivot is positive; Milinkovic, by contrast, demonstrated relevant biomechanical instability only in high-grade fractures, with a 10 mm depression. That leaves the intermediate range, precisely the most common one on MRI in patients with ACL injury, where management remains empirical.

Clinical relevance does not stop at immediate instability. Patients with type 3B depression fractures show worse functional outcomes after ACL reconstruction, and Flury showed that greater posterolateral plateau bone loss is associated with lower Tegner scores twelve months after surgery. The altered biomechanics redistribute joint load abnormally, potentially accelerating degeneration and compromising graft integrity. Against this backdrop, the study

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chooses a standardized 3 mm model to address the gray zone, rather than yet another study with heterogeneous fractures that preclude direct comparison.

OBJECTIVE

To evaluate, in a biomechanical model, the kinematic effects of different reconstruction states in an ACL-deficient knee combined with a standardized 3 mm PLTF, compared with the native knee. The primary hypothesis was that a 3 mm depression would not significantly alter tibiofemoral kinematics, and that ACL reconstruction combined with lateral extra-articular tenodesis (LET) would restore native stability better than reconstruction alone or reconstruction with fracture fixation.

METHODS

Eight unpaired fresh-frozen cadaveric knees (mean age 74.9 years) were tested on a 6 degrees of freedom industrial robot (KUKA) coupled to a force-torque sensor, with musculoskeletal simulation software (simVITRO). Each specimen underwent six sequential states: intact, ACL-deficient, ACL-deficient with PLTF, ACLR with PLTF, ACLR with LET and PLTF, and ACLR with reduction and internal fixation (RIF) of the PLTF.

The fracture was standardized at 3 mm depth, 15 mm width and 10 mm posterior depth, reproducing the Bernholt type 3B and Śmigielski grade 3. ACL reconstruction used a bone-patellar tendon-bone graft, femoral suspensory fixation and 60 N of tension at 10° of flexion. LET followed a modified Lemaire technique, tensioned to 20 N and fixed at 30° of flexion, before the ACL graft. Anterior tibial translation (89 N), internal and external rotation (4 Nm) were applied at 0°, 30°, 60° and 90°, and a simulated pivot shift (89 N + 4 Nm IR + 8 Nm valgus) at 0°, 15°, 30° and 45°. Clinically meaningful thresholds were defined a priori at 3 mm for translation and 3° for rotation.

MAIN RESULTS

For pure anterior tibial translation, none of the three reconstruction states differed from the native knee at any flexion angle, and the mean difference among them stayed below 1 mm. The presence or absence of the 3 mm PLTF did not significantly alter anterior translation when compared with isolated ACL sectioning, confirming the first part of the hypothesis: the 3 mm fracture, on its own, does not destabilize the knee.

The difference emerged in the simulated pivot shift. Only the addition of LET restored native anterior translation at all angles. Isolated ACL reconstruction and reconstruction with fracture fixation remained significantly looser than native on the pivot. In internal rotation, normalized to the deficient state, LET reduced rotation by 31%, 21% and 14% at 15°, 30° and 45°, against only 10%, 8% and 3% for reconstruction with fracture fixation. On the other hand, LET reduced internal rotation below native at 30° and 90° of flexion, a subtle sign of overconstraint worth noting.

Two secondary findings help interpret the rest. External rotation did not change significantly in any reconstruction state relative to native, though there was a tendency toward reduction,

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more marked with LET at 0°. And ACL reconstruction itself, in isolation, already increased internal rotation at 30° and 60° relative to native — an effect the authors attribute to graft tensioning, drawing on work by Tashman and Mae showing that graft tension shifts the joint's rotational baseline. The authors read part of the observed internal rotation increase as reflecting this tension-modified baseline rather than true laxity, which reinforces the recommendation to fix the LET before the ACL graft so as not to stack restraint.

AUTHORS' CONCLUSION

ACL reconstruction combined with LET provided superior restoration of anterior translational and rotational stability compared with reconstruction alone or reconstruction with PLTF repair, particularly in the pivot-shift test. Based on this cadaveric model, adding fracture fixation to ACL reconstruction for PLTFs up to 3 mm brought no biomechanical benefit over reconstruction alone.

The authors frame the clinical relevance cautiously: from a purely biomechanical standpoint there is no indication to repair PLTF fragments of 3 mm or less when performing ACL reconstruction. They note, however, that the long-term consequences of an untreated articular step-off — altered contact mechanics and a possible predisposition to post-traumatic osteoarthritis in young, active patients — were not addressed by this static in vitro model, and that the decision to forgo fixation should remain individualized.

💬 BS DISCUSSION

I like this paper because it untangles two questions we tend to blur in the OR: does the 3 mm fracture destabilize the knee? And, if I go after it, does that change anything? The answer on both counts was no. The isolated 3 mm fragment does not move the kinematic needle, and fixing it recovered nothing that the isolated reconstruction had not already achieved. Anyone who fixes a small posterolateral plateau by reflex, believing they are protecting the posterior horn of the lateral meniscus, needs to sit with this data.

But the point that interests me most is not the fracture — it is what the pivot showed. Pure anterior translation returned to normal with any of the three techniques, including the isolated ACL. On the pivot-shift test, which is where the rotatory instability that actually bothers the patient lives, only the LET group erased the difference at every angle. In other words: the problem with isolated ACL reconstruction in these cases is not how far the tibia slides forward, it is how much it rotates. And LET targets exactly that. This is the kind of finding that reinforces a decision many surgeons were already making clinically, now with direct biomechanical backing.

There are two cautions I would not let slide. First, overconstraint: LET pulled internal rotation at 30° and 90° below native. On the bench that is a number; in the patient, it is the line between stabilizing and stiffening. The authors suggest fixing the LET before the ACL graft, at 30° of flexion and neutral rotation, precisely so as not to stack tension. Worth taking seriously. Second, and this is the study's Achilles heel, the mean specimen age is 74.9 years. We are studying an indication that is, in the overwhelming majority, for

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the young athletic patient, in a septuagenarian knee. The authors acknowledge it, but that does not disappear just because it was declared.

Another reading I would handle carefully: the tested plateau had a slope within the normal range. We know that increased posterolateral slope runs alongside high-grade pivot and greater rotatory instability. The patient with the steep slope, who is precisely the one most prone to the pivot, may not behave like these specimens. So beware the mechanistic reading of “a 3 mm PLTF never needs fixation.” The study is bench-based, static, with a 50 N axial load, no musculature, no weightbearing. It answers a clean biomechanical question; it does not close the clinical decision.

What I take to discuss with the resident is simpler than it looks. Faced with an ACL plus a small posterolateral fracture, fixing the fracture is probably not what will hold the pivot — the LET is. But the 3 mm articular step-off left behind, what does it charge down the line in terms of post-traumatic osteoarthritis? The paper does not answer, and perhaps that is the question left on the table.

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