Techniques for Fixing Anterior Cruciate Ligament Tibial Avulsion Fractures in Multiligament Knee Injuries

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Background: In patients with multiligament knee injuries, anterior cruciate ligament (ACL) tears are often reconstructed. Recent studies have shown good results when the ACL tibial avulsions are repaired. The advantages of ACL tibial avulsion repair are the preservation of the native anatomy, reduction in donor site morbidity, and lower risk of tunnel convergence.

Indications & Technique Description: We show 2 techniques for repairing ACL tibial avulsion fractures. The first case describes the use of hybrid fixation (screw and suture), with staged repair and reconstruction in a patient with high-energy knee fracture-dislocation. The second case describes the use of suture ACL repair via tunnels in a patient with a low-energy knee dislocation and an ACL tibial avulsion fracture. When repairing ACL tibial avulsion fractures, screw fixation is recommended for larger tibial fragments. In smaller comminuted fragments, tying sutures passed through the ACL via tibial tunnels may be more appropriate.

Results: Several studies have demonstrated good postoperative results in patients following the fixation of ACL tibial avulsion fractures. Both screw and suture fixation are effective methods of repairing ACL tibial avulsion fractures and have similar postoperative outcomes. It has been found that screw fixation is associated with a higher risk of subsequent surgery and implant removal than suture fixation.

Conclusion: The repair of ACL tibial avulsion fractures in multiligament knee injuries is an alternative to ACL reconstruction that demonstrates excellent postoperative patient outcomes, good patient satisfaction, and good return to sports.

Patient Consent Disclosure Statement: The author(s) attests that consent has been obtained from any patient(s) appearing in this publication. If the individual may be identifiable, the author(s) has included a statement of release or other written form.

Keywords: ACL tibial avulsion fractures; multiligament knee injuries; ACL repair; screw fixation; suture repair

VIDEO TRANSCRIPT

In this video, we discuss the fixation of anterior cruciate ligament (ACL) tibial avulsion fractures (TAFs) in multiligament knee injuries. We show 2 techniques and review the existing literature.

We have no disclosures.

ACL TAFs are bony avulsion injuries of the ACL from its insertion in the intercondylar eminence and can be classified according to the modified Meyers and McKeever classification system.[6] In multiligament knee injuries, concomitant ACL reconstruction is usually performed for ACL injury.[7] However, in ACL TAFs, good clinical outcomes can be achieved with tibial side repair. The benefits of ACL repair are the preservation of native anatomy, reduced donor site morbidity, and reduced risk of tunnel convergence.[3] Screw fixation can be used for large fragment avulsions. Suture repair via transtibial tunnels is recommended for comminuted fragments. The contraindications to repair are concomitant midsubstance ACL tears or poor ACL tissue quality.

The first case is a 24-year-old female admitted for right-knee dislocation. After reduction of the knee dislocation, her vascular status was confirmed to be intact with a computed tomography (CT) angiogram.

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Submitted November 27, 2022; accepted June 9, 2023.

One or more of the authors has declared the following potential conflict of interest or source of funding: Y.H.D.L. receives speaker fees from Smith & Nephew, Arthrex, and Mitek. American Orthopaedic Society for Sports Medicine (AOSSM) checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Video Journal of Sports Medicine (VJSM®), 3(4), 26350254231184906
DOI: 10.1177/26350254231184906

Her knee had a positive posterior tibial sag and a grade 3 posterior drawer. Her Lachman test was grade 2B. She also had a varus opening of more than 10 mm in knee extension and 30° of knee flexion compared with her contralateral knee, suggesting injury to her lateral knee structures.

The CT scan showed a comminuted intra-articular fracture involving the anteromedial aspect of the tibia adjacent to the ACL fragment and the intercondylar notch. The right-knee magnetic resonance imaging (MRI) revealed an ACL TAF, complete proximal posterior cruciate ligament (PCL) tear, and injury to the posterolateral corner with lateral collateral ligament (LCL), popliteofibular ligament, and popliteus tendon tears.

We planned a 2-stage repair. In the first stage, we will fix her anteromedial tibial plateau blowout fracture with a buttress plate and her ACL TAF. The ACL TAF will be repaired with a screw to fix her main fracture fragment and backup sutures to tension the ACL. In the same surgery, we will repair her posterolateral knee structures. In the second stage, approximately 6 months after her first surgery, with the TAF and tibial plateau fractures healed, we will remove all her implants and perform a PCL reconstruction.

For the surgery, the patient was positioned supine with a tourniquet applied. Her right knee was positioned hanging at 90° of knee flexion, enabling access to her knee. The other leg was placed in a leg holder and kept out of the surgical field. This is to aid the use of the image intensifier in the surgery.

The intra-articular pictures show high-strength sutures that were passed into the ACL stump. These extra-articular illustrations depict how the sutures were first passed and then used to tension the ACL as a screw was inserted during the fixation of the TAF fragment.

Intraoperatively, we are viewing the right knee from the anterolateral portal with instruments introduced from the anteromedial portal. There is widening in the lateral compartment, consistent with injury to the lateral knee structures. The ACL stump is inspected and noted to be of good tissue quality, compatible for repair. The bone fragment is inspected to see the size and determine its compatibility for screw fixation. The site of the screw insertion on the bone base also must be determined prior to suture passage. The base of the ACL bone bed is cleared to allow good reduction of the fragment. Using an antegrade suture passer, high-strength sutures are passed into the ACL stump starting close to the bone fragment. Luggage tag suture configurations are placed. Once the first suture is placed, it is used as a traction suture with tension on the ACL stump and fragment. This allows the second suture tag to be placed above the first, again in a luggage tag configuration. A third luggage tag suture is placed into the ACL remnant above the first two. These sutures allow the ACL stump and bone to be re-tensioned. The 3 sutures are used to reduce and stabilize the bone fragment into the fracture defect. All these sutures are passed through the fracture site and then emerge from the anteromedial cortex. These sutures are later fixed as backup fixation after the cannulated screw has been placed.

The anteromedial tibial plateau blowout fracture was stabilized with a buttress plate. A cannulated 2.8-mm screw was used to fix the bone fragment in the footprint of the ACL avulsion. This screw was placed through a mini-open incision. With the sutures tensioning the ACL and fragment, a cannulated wire was placed to guide the screw placement. These sutures were passed through the ACL and out from the blowout fracture site. They were then fixed with the knotless anchor in the proximal tibia.

This was followed by an open repair of all her torn lateral knee structures. The iliotibial band (ITB) distal avulsion was identified. After careful dissection, the common peroneal nerve was exposed, and neurolysis was performed. The biceps tendon avulsion from the fibula was repaired with 2 suture anchors. The anterolateral capsule avulsion from the tibia was repaired with a suture anchor. The distal popliteus stump was identified and reinserted with a suture anchor. The femoral LCL avulsion was repaired with suture anchor tape augmentation.

Her follow-up MRI at 6 months after surgery showed that the lateral-side repair was well healed. The ACL repair avulsion bone fragment and the tibial plateau fracture had also healed. We then proceeded with the planned removal of implants and staged PCL reconstruction.

There was no varus opening in extension or 30° of knee flexion. On second-stage arthroscopy, the lateral compartment was not widened and had no drive-through sign, confirming the integrity of the lateral side repair. The medial meniscus and medial compartment were normal.

During the second arthroscopy, we are viewing the right knee from the anterolateral portal. Prior to the PCL reconstruction, the cannulated screw at the base of the ACL has been exposed and removed through the mini-open incision. Here, we see the sutures from the ACL tibial avulsion repair. The ACL repair tension is good. The PCL reconstruction was performed with a hamstring autograft and is seen in this video alongside the healed ACL repair.

Six months after the second surgery, the patient had no instability. She had no posterior sag, and her Lachman was grade 0. The patient returned to jogging 6 months after the PCL reconstruction surgery. She also commenced indoor climbing at this point.

This case shows the fixation of an ACL TAF with a screw, sutures, and the need for staged repair and reconstructions in complex high-energy knee fracture-dislocations.

The second case is of a 54-year-old women. She fell off a bicycle and landed on her left knee and presented with knee pain and swelling. The radiographs and CT scan confirmed an ACL TAF. The MRI showed an ACL stump with an avulsed tibial fragment and complete medial collateral ligament (MCL) femoral avulsion.

We again are viewing the left knee from the anterolateral portal. The tibial bone fragment at the base of the ACL was inspected. It is small in size. Given the age of the patient, it was more friable and had a high chance of fragmentation. It was decided that the fixation should be achieved with the suture passed into 2 separate tunnels. A high-strength suture is first placed using an antegrade suture passer from the anteromedial portal, in a simple

configuration. With the suture passer now coming from the anteromedial portal, a simple suture is placed. A third simple suture is placed from the anteromedial portal. A guide wire is placed at the lateral edge of the tibial fracture site. This is then kept in place as a second wire is placed on the medial edge of the tibial fracture site. Both wires are reamed with a 3.5-mm reamer to create two separate bone tunnels at the edges of the tibial fracture site. The sutures are then used to reduce the fragment into the tibial defect and are tied to a button in extension. We see the sutures from the ACL tibial avulsion repair and the ACL repair tension is good. We see the opening of the medial compartment, which is consistent with a proximal MCL injury. The medial meniscus is repaired using an inside-out technique. After the open medial repair, the widened medial compartment is no longer present. These extra-articular illustrations show how the 3 sutures are passed into the ACL stump and then subsequently brought into the 2 tibial tunnels to reduce the TAF fragment. These pictures show the open repair of the MCL femoral avulsion using 2 suture anchors.

At 6 months postoperatively, the radiograph revealed that the TAF was well healed. The patient was able to return to recreational cycling.

Here are 4 pearls to ensure the successful repair of ACL TAFs. First, for additional fixation strength, we recommended backing up screw fixations with sutures—that is, hybrid fixation. Second, using specialized antegrade sutures allows ease of suture passage. Third, the use of high-strength sutures in simple or luggage tag configurations should be considered. Finally, the sutures should be fixed with the knee in near full extension. One potential pitfall is the fragmentation of the bone during fixation. We recommend the use of sutures to avoid this issue.

This slide summarizes our typical postoperative protocol after repair of ACL TAFs. From 0 to 3 weeks, patients are kept toe-touch weightbearing at 20% body weight with their range of motion limited at 0° to 90° with a knee brace. At 3 to 6 weeks, patients are allowed partial weightbearing at 50% body weight with their range of motion still limited at 0° to 90°. After 6 weeks, patients are allowed weightbearing as tolerated and full range of knee motion. Strengthening exercises are gradually reinitiated at 6 weeks postoperatively. The return to jogging usually commences after strength recovery. Return to sports or full recreational activities is generally expected after 9 months from surgery.

There are 3 studies which reviewed patient outcomes after ACL tibial avulsion repair. Dung et al[2] found that 92.9% of patients treated with suture fixation achieved excellent to good International Knee Documentation Committee (IKDC) scores. Furthermore, Pandey et al[5] found that all avulsion fractures were united following repair using sutures at a mean follow-up period of 31 months.

May et al[4] found that screw fixation had a higher reoperation rate, and patients older than 18 years of age had a higher risk of lower outcome scores. A systematic review by Chang et al[1] reported that there was no significant difference in postoperative clinical scores between screw and suture fixation. However, there was a higher risk of subsequent surgery and implant removal with screw fixation.[1]

Here are our references and thank you for watching our video.

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