Technical Note

All-Inside Anterior Cruciate Ligament Tibial Avulsion Repair

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Abstract: Anterior cruciate ligament (ACL) tibial avulsion occurs predominantly in children and young adults. It is seen in association with injuries due to hyperextension usually involving movements that are similar to riding a bicycle. Bony ACL avulsion is associated with severe restriction of knee range of motion, swelling, inability to bear weight, and continuous pain. Acute swelling does not allow a conclusive clinical examination. Bony ACL avulsion from the tibial side has been treated by various methods ranging from conservative management to a wide range of operative procedures. The various operative procedures that have been described require challenging operative skills, time, and resources, making these techniques demanding and technically challenging. We describe a technique for the treatment of Meyers-McKeever type II, III, and IV bony tibial ACL avulsions that uses regular anterolateral and anteromedial portals with an additional transpatellar portal. The avulsed fragments along with the ACL are held and buttressed with the help of FiberWires and fixed with the intra-articular portion of the proximal tibia. The technique is performed in an all-inside manner and is easy to master, even for beginners.

Surgical Technique

Preoperative Evaluation

A patient who complains of post-traumatic pain and joint laxity with restricted range of motion should undergo a thorough examination for ligament injuries, bony injuries, and various avulsions (Video 1). The imaging evaluation includes radiography (anteroposterior and lateral views), computed tomography, and magnetic resonance imaging for associated ligamentous-meniscal injuries and entrapments (Fig 1). A displaced ACL tibial avulsion classified as Meyers-McKeever type II, III, or IV is an indication for surgical intervention.

Patient Setup

The patient is placed in the supine position on the operating table with support under the glutei to prevent...
limb rotation and the foot on the table for knee flexion. With the patient under spinal anesthesia, a tourniquet is applied and the limb is prepared from the mid thigh to the foot (Fig 2).

**Arthroscopic Portal Placement**

Arthroscopy is performed with the patient in the supine position under lumbar spinal anesthesia. After a pneumatic thigh tourniquet is inflated, standard arthroscopic portals, comprising both standard anteromedial and high anterolateral portals, are used initially; a transpatellar tendon portal is subsequently created (Fig 3).

**Performance of Technique**

First, the knee joint is systematically inspected using a camera (GenXt; Smith & Nephew) inserted through the anterolateral portal, and debridement, if required, is performed to remove hematoma and loose chondral or osteochondral fragments. A thorough diagnostic evaluation is performed, and the bone fracture site is exposed. The ACL tibial avulsion site and its crater are prepared similarly to clearing the crater of fibrous tissue in delayed cases or blood clot in acute cases to facilitate further reduction.

Once the crater is adequately exposed and accessible, a Passport cannula (Arthrex) is inserted in the transpatellar tendon portal. A 5-mm titanium anchor or PEEK (poly-ether ether ketone) anchor (double-loaded Corkscrew, 5 mm × 15.5 mm; Arthrex) is advanced in the posterior wall of the crater without drilling (Fig 4). A total of 4 FiberWires (Arthrex) are passed through the ACL base...
and delivered from the base of the ACL substance, from posterior to anterior, using a suture shuttle device (Scorpion; Arthrex) or self-retrieving suture passer (Fig 5). Subsequently, 1 pair of similarly colored (center) FiberWires is tied using a knot pusher, and the remaining 2 peripheral FiberWires are left as is (Fig 6). Eventually, all 4 FiberWires are passed through a 5.5-mm knotless anchor (PEEK SwiveLock; Arthrex) and fixed over the intra-articular portion of the upper end of the tibia after a pilot hole is created (Fig 7).

**Final Examination and Postoperative Care**

The knee is again thoroughly inspected, and the fixed ACL is checked by probing under tension (Fig 8). The knee is then washed out and closed. Dressing is applied, and the knee is maintained in extension using a brace. Suture anchor placement in the upper end of the proximal tibia can be seen on the postoperative radiographic images (Fig 9). The sparing of the physis should be noted.

**Discussion**

ACL bony avulsion leads to a significant reduction in knee mobility. The various techniques that have been described have their limitations.³ Our suggested technique is an all-inside technique for ACL bony avulsion repair with minimal incisions and portals. This technique uses an extra transpatellar portal for the introduction of a Passport cannula to fix an anchor in the posterior wall of the crater without drilling. This forms the cornerstone of fixation. The requirements for this technique include a 5-mm double-loaded titanium anchor, 5-mm knotless anchor, 8-mm Passport cannula, and suture shuttle device.

Limitations of techniques such as pull-through suturing and corticocancellous screw fixation include lack of stability, anterior beaking of the anterior beaking of the avulsed fragment, distal fixation of the fragment, and weak fixation in skeletally immature patients. Moreover, the screw fixation technique may lead to hardware prominence, a probability of a second surgical procedure, and logistic drawbacks such as the involvement of an image intensifier, making this technique and many other techniques tedious and demanding high resources.

The described all-inside technique addresses all the drawbacks of routinely performed open and arthroscopic techniques. The advantages are that this

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**Fig 3.** Arrangements in the operating room with the knee in 90° of flexion using a standard anteromedial portal to insert the probe (green arrow) and using a standard anterolateral portal to insert the scope, trocar, and sheath (purple arrow) (Hopkins 2; Storz). The central transpatellar tendon portal is used to insert the Passport cannula (black arrow). As shown, the transpatellar portal is made just below the lower pole of the patella. (Pt, patient.)

**Fig 4.** As shown on a bone model view, a 5.5-mm double-loaded titanium-PEEK anchor (green arrow) is advanced in the central portion of the posterior wall (red arrow) of the avulsed anterior cruciate ligament crater (black arrow). The double-loaded titanium-PEEK anchor is inserted without drilling through the transpatellar tendon portal (black arrow in Fig 3) and secured.
technique uses only 3 portals, has a short operative duration, and can be performed in skeletally immature patients because it does not damage the physis at all. On the postoperative radiograph, the anchor placement and the sparing of the physis should be noted (Fig 9). In our recommended technique, a 5.5-mm anchor is placed in the crater, threads are passed through the ACL stump, and fixation to the upper end of the tibia is performed using a knotless anchor; the fixation is then complete.

Our technique has several limitations: (1) It uses an intact bridge between the ACL base and lateral meniscus to achieve additional compression of the fragment; however, if there is an associated injury to the anterior...
horn of the lateral meniscus, it should be separately repaired. (2) When a comminuted ACL avulsion is fixed by this technique, postoperative rehabilitation should be gradual to avoid the risk of suture cutout. The risk of suture cutout may be reduced by making additional knots over the base of the ACL stump or using an additional FiberWire. (3) This is to be considered only when there is large bony avulsion fragment, extending much posteriorly, even up to PCL footprint. In such a case, to pass the fiberwires from behind the ACL stump, first, the fiberwires must be passed through that large bony avulsion fragment (which is technically challenging) and then proceed with further reduction and fixation. (4) In case of an ACL avulsion with associated tibial plateau fractures, any arthroscopic procedure is better avoided because there is a substantial risk of fluid extravasation and a possibility of compartment syndrome. (5) Although ACL avulsions are predominantly injuries of young patients, they may occur in adults. In case there is coexisting osteoporosis, the stability of anchor fixation may be jeopardized, making fixation of an ACL avulsion by this technique a relative contraindication. Thus, a careful preoperative assessment is required.

In the postoperative period, the patient requires early knee mobilization but is restricted to non-weight-bearing activity for 2 to 3 weeks. In case

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**Fig 7.** (A) Arthroscopic view with knee in fully extended position and scope in anterolateral (A-L) portal showing pilot hole (blue arrow). This pilot hole is in the intra-articular portion of the upper end of the tibia. The tibial hole will be used for fixation of a knotless anchor. (B) Arthroscopic view from anterolateral portal with knee in full extension. The knotless anchor (red star and green arrow) is inserted through the transpatellar tendon portal. All 4 FiberWires (red arrow) are being passed through a 5.5-mm knotless anchor, and this anchor will be fixed over the intra-articular portion of the upper end of the tibia in the pilot hole (blue arrow). (C) A bone model view helps in understanding the final fixation. One should observe the reduced anterior cruciate ligament avulsion (black arrow), fixed with the help of fiberwires, at the upper end of the tibia, with a knotless anchor inserted in the pilot hole (green arrow).

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**Fig 8.** (A) Arthroscopic view with knee in 90° of flexion and scope in anterolateral (A-L) portal after reduction and fixation of avulsed fragment (black arrow). The tensioned FiberWires reduce the avulsed fragment completely into its crater. (B, C) Arthroscopic view with knee in 90° of flexion and scope in anterolateral portal. The final fixation is checked using a probe (red stars). Black arrow depicts final reduction and fixation of avulsed fragment.
of a severely comminuted ACL avulsion injury, rehabilitation should be guarded. Postoperative follow-up knee range of motion after 9 weeks can be seen in Figure 10.

The long-term evaluation needs consideration with respect to anchor pullout and fixation failure. The cost of the implant, as well as its availability, is another matter of concern.


References

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**Fig 10.** (A, B) Follow-up images at 9 weeks postoperatively (POST OP). Full range of motion (black arrows) was noted after 9 weeks.