ORV Arthroscopic Reduction and Internal Fixation of Tibial Eminence Fractures

Daniel M. Myer, M.D., Gregory J. Purnell Jr., M.D., Paul E. Caldwell III, M.D., and Sara E. Pearson, Ph.D.

Abstract: Tibial eminence fractures are an uncommon but well-described avulsion of the anterior cruciate ligament. Treatment principles are based on the amount and pattern of fracture displacement. Management has evolved from closed reduction and immobilization to arthroscopic reduction and internal fixation followed by early rehabilitation. Various fixation methods have evolved, ranging from arthroscopic reduction and percutaneous screw fixation to arthroscopic suture repair. We present a technique for arthroscopic reduction and internal fixation using a cannulated drill bit and high-strength suture. This technique facilitates anatomic reduction with uncomplicated tunnel placement and suture passing in an effort to allow strong fixation and early rehabilitation.

Fractures of the tibial intercondylar eminence were once thought to occur only in the pediatric population, but these avulsion fractures of the anterior cruciate ligament (ACL) occur in adults as well. Clinical evaluation, along with advanced imaging techniques such as computed tomography and magnetic resonance imaging, has helped characterize the fracture pattern in an effort to allow for improved classification and subsequent treatment options.

Type I (nondisplaced) fractures are commonly treated by immobilization of the knee in full extension. The treatment of type II, III, and IV fracture patterns is certainly more variable. Though controversial, treatment of displaced fractures (type III), comminuted fractures (type IV), and patterns under which a closed reduction does not fully reduce the fragment is more amenable to arthroscopic evaluation and anatomic reduction with internal fixation.

Historical open reduction and internal fixation techniques have dissipated with the evolution of arthroscopy. The ability to arthroscopically evaluate the fracture pattern and address concomitant intra-articular pathology has allowed arthroscopic-assisted reduction and fixation to become the gold standard for fixation. Multiple techniques for arthroscopic reduction and internal fixation (ARIF) have been developed in an effort to improve fracture reduction and stability.

Arthroscopically assisted methods include both retrograde and antegrade techniques and incorporate metal, absorbable, and nonabsorbable materials. Many case reports and techniques have been described, and concerns regarding fracture fragment comminution and stability, fixation pullout strength, and the need for hardware removal have arisen. Retrograde and antegrade screws have been commonly used for fixation, but several potential problems exist: screw purchase with fragment comminution, as well as the potential need for hardware removal and transphyseal fixation in the skeletally immature patient.

Arthroscopic suture fixation has also evolved over the years, including suture loop transporters, multiple drill tunnels, retrograde guides, and various tissue penetrators for suture passage. Recently published literature has proposed that fixation with the EndoButton (Smith & Nephew, Andover, MA) may provide greater initial fixation strength than that with sutures or suture anchor fixation, but potential implant impingement and the need for hardware removal may supersede the...
Bong et al.15 have shown that suture fixation is biomechanically stronger than screw fixation. Our technique incorporates many of these principles but also uses a cannulated drill bit to facilitate suture passage while maintaining fracture reduction and limiting surgical steps.

**Surgical Technique**

A traditional knee arthroscopy setup is adequate to assess and perform arthroscopic-assisted reduction and internal fixation of a displaced tibial eminence fracture (Fig 1). A diagnostic knee arthroscopy is performed to confirm displacement of the tibial eminence fracture, as well as to address additional knee pathology (Video 1).

After a comprehensive arthroscopic examination has been performed, a hook probe is used to lift the avulsed fragment to allow access to the fracture bed. A mechanical shaver is used to carefully prepare the fracture site by debriding hematoma and removing smaller fracture fragments.

![PORTAL SITES](image)

**Fig 1.** Frontal view of knee showing tibial eminence fracture and inset showing arthroscopic portal setup for fixation. (PCL, posterior cruciate ligament.)

Once reduction of the fracture is performed, a superior percutaneous 4.5-mm K-wire may be used to obtain provisional fixation (Fig 2). A central transfemoral portal may be created for viewing to allow for traditional medial and lateral working portals. A 90° SutureLasso (Arthrex, Naples, FL) is passed through the base of the ACL just proximal to its tibial insertion site on the fracture fragment and retrieved through the other working portal. A No. 5 FiberWire (Arthrex) is then shuttled through the base of the ACL with the SutureLasso (Fig 2). This procedure can be repeated to shuttle subsequent FiberWire sutures through the base of the ACL as needed.

The Adapteur ACL guide system (Arthrex) is used to drill 2 parallel tunnels within the tibia. The Adapteur drill guide C-ring is set at 60°, and the compression-fracture marking hook is positioned just medial to the ACL insertion on the fracture fragment, with care taken not to displace the reduction. The ACL drill guide is then used to localize an area on the anterior-medial aspect of the tibia, with care taken to avoid the pes anserine insertion. A 1-cm incision is made, and the anterior aspect of the tibia is exposed so that the drill guide sits flush on the cortex. The 4.0-mm cannulated drill bit (Arthrex) is then drilled until contacting the marking hook within the knee (Fig 3). The ACL guide and sleeve are subsequently removed. The surgeon unscrews and removes the inner drill bit while leaving the outer cannulated drill sleeve in place. A Nitinol suture loop (Arthrex) is then passed up through the outer cannulated drill bit into the knee. The loop of the Nitinol wire is subsequently retrieved with the grasper out the working portal, and the outer cannulated drill sleeve is removed. One end of the No. 5 FiberWire is then shuttled by use of the Nitinol loop from the working portal down the medial tunnel and out the anterior aspect of the tibia (Fig 3).

This sequence of steps is repeated as a second drill hole is placed just lateral to the ACL insertion on the fracture fragment and parallel to the initial drill hole by the same technique. When drilling the second tunnel, the surgeon should allow adequate distance between tunnels for a bony bridge. The other end of the No. 5 FiberWire is then shuttled by use of the Nitinol loop from the working portal down the medial tunnel and out the anterior aspect of the tibia (Fig 3).

Alternatively, the sutures can be tied over a metallic biceps button (Arthrex). At the conclusion of the procedure, the wounds are closed in routine fashion and a sterile dressing is applied. A locked hinge brace and crutches are used in the postoperative period to protect the fracture fixation.
Fig 2. Sagittal-section view of knee showing provisional fixation of tibial eminence fracture with percutaneous K-wire and expanded view of suture passage and retrieval through ACL in preparation for fixation. (PCL, posterior cruciate ligament.)

Fig 3. Sagittal-section and frontal views of knee showing tibial tunnel drilling in parallel fashion through tibial eminence fracture fragment and suture passage from knee down through tibial tunnel in preparation for repair.
Many different techniques have been described for arthroscopic-assisted reduction and internal fixation for tibial eminence fractures. Cannulated screw fixation has been shown to have good strength and fracture stabilization, but concerns exist when smaller or comminuted fracture fragments are present. The potential for hardware impingement with the subsequent loss of knee extension, coupled with the possibility of screw removal, has led to the development of more facile techniques for suture fixation. Arthroscopic reduction with suture fixation has advanced to become the preferred method of treatment for displaced or comminuted avulsion fractures of the tibial eminence.2 Direct intra-articular viewing allows for anatomic reduction and treatment of any concomitant pathology (Table 1). The addition of the cannulated drill significantly simplifies the process of suture passage while maintaining fracture reduction and minimizing surgical steps.

Table 1. Pearls Regarding Arthroscopic Reduction and Internal Fixation of Tibial Eminence Fractures

| A central transtendon viewing portal greatly facilitates viewing and suture passage. |
| A temporary K-wire fixation allows ease of transtibial drilling without a loss of reduction. |
| The surgeon should make sure all soft tissue is removed from the anterior tibia before tying. |

Fig 4. Sagittal-section and frontal views of knee showing completed transtibial drilling through fracture fragment and ACL with final suture shuttling and completed repair of tibial eminence fracture.

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