Arthroscopic Absorbable Suture Fixation for Tibial Spine Fractures

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Abstract: The purpose of this technical note and accompanying video is to describe a modified arthroscopic suture fixation technique to treat tibial spine avulsion fractures. Twenty-one patients underwent arthroscopic treatment for tibial spine avulsion with our technique; they were clinically and biomechanically evaluated at 2 years' follow-up and showed optimal clinical and radiographic outcomes. Repair with this arthroscopic technique provides a significant advantage in the treatment of type III and IV fractures of the tibial eminence by obtaining arthroscopic fixation within the substance of the anterior cruciate ligament: suture methods based on the avulsed bone fragment are technically impossible, but sutures through the base of the ligament itself provide secure fixation, reducing the risks of comminution of the fracture fragment and eliminating the time for hardware removal. This arthroscopic technique restores the length and the integrity of the anterior cruciate ligament and provides a simplified, reproducible method of treating patients, including young patients, with low hardware costs in comparison to sutures using anchors or other hardware.

Isolated tibial spine avulsion fractures are relatively uncommon, with an incidence of approximately 3 per 100,000 per year.[1] This fracture typically occurs in the skeletally immature patient. Similar to anterior cruciate ligament (ACL) tears, tibial spine fractures can occur from injuries such as falls; skiing, soccer, and football injuries; and injuries due to motor vehicle accidents.[2]

Meyers and McKeever[3] classified 3 types of tibial spine fractures: nondisplaced (type I), partially displaced or hinged (type II), and displaced (type III). Zaricznyj[4] added a fourth type to this classification to better describe comminuted fractures. Various fixation devices have been introduced for arthroscopic reduction and internal fixation of ACL tibial avulsion fractures.

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Twenty-one patients, with a mean age of 28 years (range, 9 to 60 years), were treated by arthroscopic reduction and resorbable suture fixation and returned for follow-up at a mean of 24 months (range, 12 to 33 months). According to the Meyers-McKeever-Zaricznyj classification, 9 cases were type II, 8 were type III, and 5 were type IV (Fig 1). At the time of follow-up, clinical and radiographic outcomes (Fig 2) were good to excellent.

This technical note and accompanying video describe a modified arthroscopic suture fixation technique to treat tibial spine avulsion fractures.

Surgical Technique

The patient is placed in the supine position, under spinal anesthesia. A tourniquet facilitates visualization. Calf compartments must be continually palpated to ensure that fluid extravasation does not result in compartment syndrome. Whereas intercondylar eminence avulsion fractures are typically contained injuries, they may be associated with capsular disruption.

Standard knee arthroscopy is performed with superomedial (inflow), anterolateral (optical), and anteromedial (instruments) portals using a 30° 4.0-mm arthroscope. Initially, a complete diagnostic arthroscopy is performed. Fracture debris and blood clots are debrided so that the avulsed bone fragment and fracture site are well visualized.

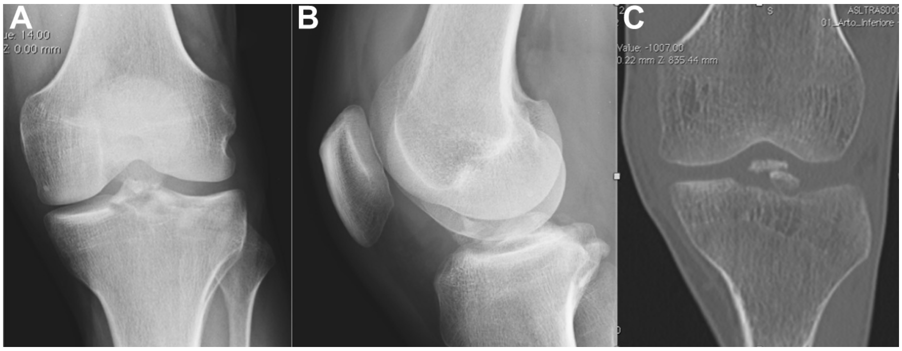

Fig 1. (A, B) Preoperative radiographs and (C) computed tomography scan showing an example of a type IV tibial spine avulsion.

Thorough lavage is required to remove hemarthrosis or loose chondral or osteochondral fragments. Treatment of the avulsion fracture is recommended before treatment of associated pathology to prevent iatrogenic fracture displacement.

Trial reductions can be performed with a probe. The reduced fragment is fixed temporarily with a 1.5-mm-diameter K-wire that is inserted percutaneously from the anterosuperior aspect of the knee joint. A 1-inch longitudinal incision is made just medial to the tibial tubercle and carried down to the bone. An ACL tibial drill guide is introduced in the anteromedial portal, and the arthroscope is placed into the inferomedial patellar portal. Two 2.4-mm K-wires are drilled through the guide from the proximal tibia through the reduced fragment into the joint. One is just to the medial side and the other is just to the lateral side of the insertion of the ACL, as shown in Video 1. Two buttonholed K-wires, loaded with 2 No. 2 Vicryl sutures (Ethicon, Somerville, NJ), are passed through the 2 holes.

Next, a 90° suture lasso (Arthrex, Naples, FL) is placed percutaneously (or through an accessory portal) through the fibers of the ACL in its mid-coronal plane and as close to the bony fragment (distal) as possible and is passed through both Vicryl sutures. The suture lasso is finally loaded with No. 2 TiCron suture (Covidien, Mansfield, MA). The Vicryl suture loops are retracted to the drilled holes, obtaining reduction of the tibial spine. After the provisional fixation pin is removed, the surgical sutures exiting from the anterior tibia are tied firmly over the small bony bridge, as shown in Video 1. This allows the loop to be placed snugly over the avulsed fragment. The wounds are then closed in a routine fashion.

The reduced fragment is re-examined under arthroscopic vision with a probe testing its fixation during knee

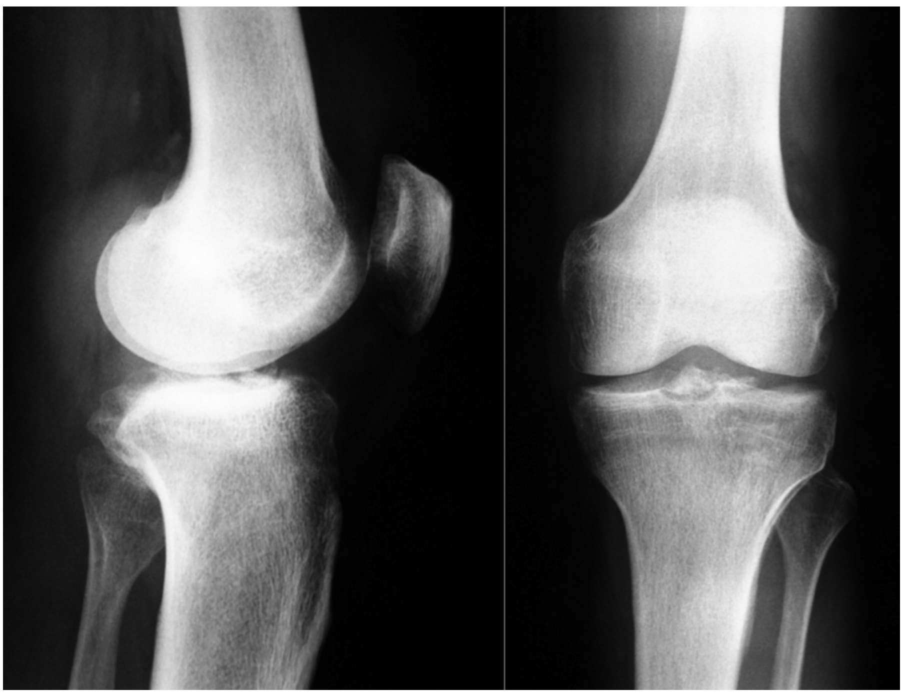

Fig 2. Control radiographs obtained 8 weeks postoperatively.

Fig 3. Postoperative control radiographs.

flexion and extension motion. Postoperative control radiographs are mandatory (Fig 3). Table 1 lists technique tips.

Discussion

Surgical treatment of displaced intercondylar eminence fractures is essential to prevent nonunion or malunion.[5] Open surgery allows anatomic fracture reduction and secure fixation for early mobilization but causes some morbidity.[6] Successful arthroscopic reduction and fixation have been described in the recent literature.[6]

McLennan,[7] in 1982, first advocated the advantages of arthroscopic treatment for tibial eminence fractures in terms of minimal morbidity and treatment of associated lesions. Berg[8] reported 2 arthroscopic suture failures after repair of comminuted intercondylar eminence fractures caused by unstable fixation.

Suture fixation methods are fundamentally divided into 2 classes. One is based on the ACL itself (ligament suture methods),[9] and the other is based on the avulsed bone fragment (avulsed bone fragment suture methods).[10] When the fracture of the intercondylar eminence of the tibia is comminuted or small in size, suture methods based on the avulsed bone fragment are technically impossible, but sutures through the base of the ligament itself provide secure fixation. Ligament suture methods require special instruments to place intraligamentous sutures and a suture passer to thread ligament sutures in the joint. Medler and Jansson[10] describe the only other method in which the sutures can be tied together outside the joint.

Table 1. Tips for Performing Absorbable Suture Technique

- Use a spinal needle during the creation of the working portal to obtain the correct angle.
- With a shaver, remove hemarthrosis, clots, and osteochondral fragments as necessary to obtain an optimal view of the fracture site.
- Temporarily check the correct reduction of the avulsed fragment with a probe, extending the knee, and fix it with a provisional fixation pin.
- Pass the suture first in the posterior part of the ACL fibers with a curved suture passer, using the enlarged lateral portal to regain the carrying wire.
- Remove the fixation pin and tie the suture; if the implant is not stable enough, repeat the previous step, passing the suture in the posterior fibers of the ACL.

Commonly used screw methods can easily crush bony bone fragments and cut ligaments, increasing the likelihood of damaging the open physis and requiring a second procedure to remove the implant.[11] In addition, the operative space is limited. In conventional fixation methods, fixation occurs in the middle of the fragment. The uniquely designed tension-band wire fixation method can firmly fix the anterior border of the fragment, which is exactly consistent with the biomechanical characteristics of the ACL force load. In the literature it was reported that the tension-band wire fixation method provided significantly higher pullout strength than the other fixation methods.[12] Moreover, this technique is easily reproducible with low hardware costs compared with sutures using anchors or other hardware. The advantages and disadvantages of the techniques mentioned are summarized in Table 2.

At the time of follow-up, the percentage of good results and very good results in our patients treated with the described technique were 60% and 40%, respectively, with Lysholm knee scoring and 20% and 80%, respectively, with the Marshall scoring system. All 21 patients showed radiologic bone union at 8 weeks (range, 6 to 10 weeks) postoperatively, supporting the excellent clinical and biomechanical data collected. These excellent data support that arthroscopic absorbable suture fixation for tibial spine fractures is a reliable technique for all types of tibial spine fractures and can also be used in young patients.

Table 2. Advantages and Disadvantages of Tibial Spine Repair Techniques

Technique	Advantages	Disadvantages
Arthroscopic absorbable suture fixation	• Minimal morbidity and treatment of associated lesions • Low risk of bone fragmentation and ligament cutting • Applicable in highly fragmented fractures • Low risk of physis damage • Higher pullout strength and early motion • Easily reproducible • Low cost of hardware • No need for hardware removal	• High learning curve linked to knee arthroscopy surgical technique
Arthroscopic cannulated screw fixation	• Minimal morbidity and treatment of associated lesions • Stable fixation and early motion	• Risk of bone fragmentation and ligament cutting • Not applicable in highly fragmented fractures • Higher risk of physis damage • Need for second intervention for hardware removal • Higher cost of hardware • Limited operative space • High learning curve linked to knee arthroscopy surgical technique
Open reduction and internal fixation	• Direct vision of lesion • Lower learning curve	• Higher morbidity • Delayed beginning of motion

References

1. Hargrove R, Parsons S, Payne R. Anterior tibial spine fracture—An easy fracture to miss. *Accid Emerg Nurs* 2004;12:173-175.
2. Mann MA, Desy NM, Martineau PA. A new procedure for tibial spine avulsion fracture fixation. *Knee Surg Sports Traumatol Arthrosc* 2012;20:2395-2398.
3. Meyers MH, McKeever FM. Fracture of the intercondylar eminence of the tibia. *J Bone Joint Surg Am* 1970;52:1677-1684.
4. Zaricznyj B. Avulsion fracture of the tibial eminence: treatment by open reduction and pinning. *J Bone Joint Surg Am* 1977;59:1111-1114.
5. Kendall NS, Hsu SYC, Chan K- M. Fracture of the tibial spine in adult and children. A review of 31 cases. *J Bone Joint Surg Br* 1992;74:848-852.
6. Oohashi Y. A simple technique for arthroscopic suture fixation of displaced fracture of the intercondylar eminence of the tibia using folded surgical steels. *Arthroscopy* 2001;17:1007-1011.
7. McLennan JG. The role of arthroscopic surgery in the treatment of fractures of the intercondylar eminence of the tibia. *J Bone Joint Surg Br* 1982;64:477-480.
8. Berg EE. Comminuted tibial eminence anterior cruciate ligament avulsion fractures: Failure of arthroscopic treatment. *Arthroscopy* 1993;9:446-450.
9. Matthews DE, Geissler WB. Arthroscopic suture fixation of displaced tibial eminence fractures. *Arthroscopy* 1994;10:418-423.
10. Medler RG, Jansson KA. Arthroscopic treatment of fractures of the tibial spine. *Arthroscopy* 1994;10:292-295.
11. Parr RR. Arthroscopic reduction and headless cannulated compression screw fixation of adults' tibial eminence fractures. *Am J Orthop* 2006;35:558-561.
12. Gan Y, Xu D, Ding J, Xu Y. Tension band wire fixation for anterior cruciate ligament avulsion fracture: biomechanical comparison of four fixation techniques. *Knee Surg Sports Traumatol Arthrosc* 2012;20:909-915.