International Journal of Orthopaedics and Traumatology

**ISSN Print:** 2664-8318
**ISSN Online:** 2664-8326
**Impact Factor (RJIF):** 6.07
IJOT 2026; 8(1): 23-27
www.orthopedicsjournal.in
Received: 16-11-2025
Accepted: 21-12-2025

**Mohamed Abdelkader**
Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt

**Hossam Abdelsattar**
Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt

**Corresponding Author:**
**Mohamed Abdelkader**
Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt

# Arthroscopic repair of tibial spine avulsion fracture in adults with pull out sutures: A prospective study

**Mohamed Abdelkader and Hossam Abdelsattar**

**DOI:** https://www.doi.org/10.33545/26648318.2026.v8.i1a.109

**Abstract**
**Background:** Surgical fixation is indicated for displaced tibial spine avulsion fractures (Meyers-McKeever types II-IV). Arthroscopic suture techniques are favored for reducing morbidity and avoiding hardware complications.
**Objective:** This study evaluated outcomes of arthroscopic reduction and internal fixation using a pull-out suture technique tied over a tibial bone bridge.
**Methods:** A prospective study included 25 patients (21 males, 4 females; mean age 19-25 years) with types II (n=5), III (n=16), and IV (n=4) fractures. A standardized arthroscopic technique used a 90° suture lasso to pass #5 Ethibond or #2 FiberWire through the ACL, shuttled through tibial tunnels and secured over a bone bridge. The Lysholm score was assessed preoperatively and postoperatively at 6 weeks, 3 months, and 12 months.
**Results:** Mean Lysholm scores improved significantly from 11.86 (poor) preoperatively to 93.54 (good-to-excellent) at final follow-up ($p < 0.001$). At 6 months, 80% of patients achieved good-to-excellent results. Complications included two cases of minor extension deficit (resolved with arthrolysis) and one case of instability (4%) requiring ACL reconstruction. There were no infections or nonunions.
**Conclusion:** Arthroscopic suture fixation for tibial spine avulsions provides stable, implant-free fixation, enables early mobilization, and yields excellent functional outcomes with a low complication rate.

**Keywords:** Tibial eminence, avulsion fracture, arthroscopy, suture fixation, pull-out technique

## 1. Introduction
Tibial spine avulsion fractures, also referred to as tibial eminence fractures, represent a specific injury pattern of the anterior cruciate ligament (ACL) [1]. The Meyers and McKeever classification system is commonly used to categorize these fractures: type I denotes a minimally displaced fragment; type II involves anterior elevation with an intact posterior hinge; type III describes complete fragment separation; and type IV includes comminution or rotational displacement [2].
Management strategies depend on the fracture type and the presence of associated injuries, ranging from conservative management with immobilization to arthroscopic or open reduction and internal fixation [1]. In adults, these injuries often result from high-energy trauma, such as road traffic accidents, and are frequently associated with other injuries [3]. The higher incidence in children is attributed to the relative weakness of the incompletely ossified tibial eminence compared with the native ACL fibers [4], as well as the greater elasticity of ligaments in younger populations [5].
Current surgical management favors arthroscopic techniques over open arthrotomy. Arthroscopy allows for accurate diagnosis and treatment of concomitant injuries, precise fracture reduction and fixation, and reduced patient morbidity [6]. Masato *et al.* [7] described an arthroscopic suture fixation technique using pull-out sutures tied over a double-spike plate, reporting significant improvement in postoperative Lysholm scores. This is supported by the biomechanical findings of Egger *et al.* [8], who concluded that suture fixation is superior to screw fixation for these fractures.
The aim of this study was to evaluate the outcomes of arthroscopic repair for tibial spine avulsion fractures using a pull-through suture technique tied over the tibial cortex, with a specific focus on union rates, functional outcomes, and complications.

## 2. Patients and Methods

### 2.1. Study Design and Ethical Approval

After obtaining approval from the Institutional Review Board of Beni-Suef University Hospital (FWA00015574), a prospective study was conducted from October 2019 to October 2022.

**2.2. Participants:** Twenty-five patients who underwent arthroscopically assisted reduction and internal fixation for tibial spine avulsion fractures using a pull-out suture technique were included. Informed consent was obtained from all patients, which included a discussion of potential complications such as neurovascular injury, residual laxity, infection, knee stiffness, hemarthrosis, and nonunion.

**2.3. Inclusion and Exclusion Criteria:** Inclusion criteria were: (1) age 16-50 years; (2) either sex; and (3) Meyers and McKeever type II, III, or IV fractures. Exclusion criteria included open fractures, multiligamentous knee injuries, and chronic, neglected injuries. Informed consent was obtained from all participants.

**2.4. Preoperative Evaluation:** Preoperative evaluation included a detailed history, physical examination, standard radiographs (anteroposterior and lateral views), computed tomography (CT) scans for fracture characterization, and magnetic resonance imaging (MRI) to assess associated soft-tissue injuries. All patients were assessed for surgical fitness.

### 2.5. Surgical Technique

All procedures were performed under spinal or general anesthesia with the patient in a supine position. A thigh tourniquet was inflated to 350 mmHg. Standard anterolateral and anteromedial arthroscopic portals were established. Diagnostic arthroscopy was performed to identify any associated injuries. The fracture site was debrided of hematoma, and the intermeniscal ligament was retracted with a traction suture. The fragment was reduced using an ACL tibial guide and provisionally fixed with a threaded K-wire.

Using a 90-degree suture lasso passed through the medial portal, a No. 1 Prolene suture was passed through the posterior half of the ACL substance near its insertion to act as a shuttle. This was retrieved through an accessory trans-patellar portal. The Prolene was then used to shuttle three strands of a strong nonabsorbable suture (No. 5 Ethibond or No. 2 FiberWire) around the ACL (figure 1).

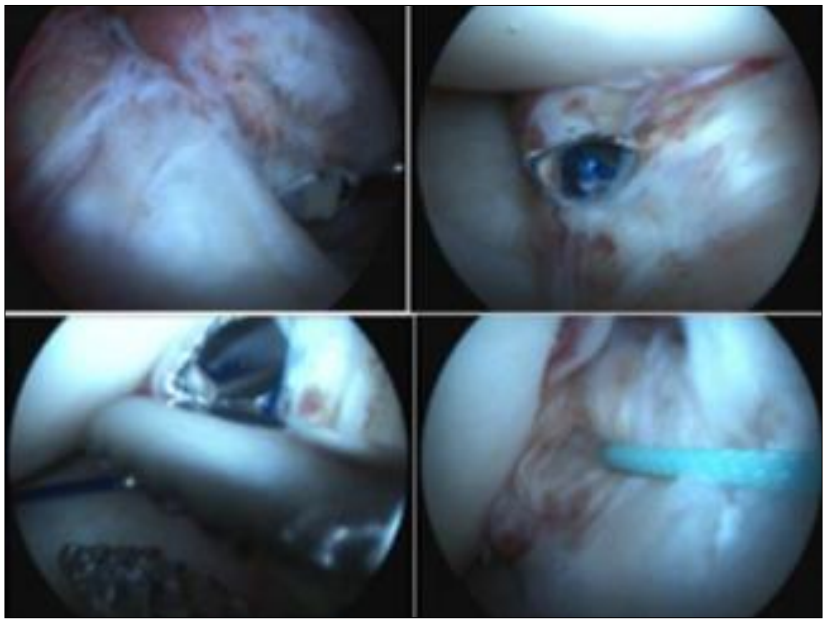

**Fig 1:** Arthroscopic view showing Passage of lasso through substance of ACL and Loop of prolene is made to shuttle eithibond no. 5 filament around the ACL.

Two 2.7-mm guide wires were drilled medial and lateral to the fragment, exiting the medial tibial cortex approximately 2 cm apart. These were over-drilled with a 4.0-mm cannulated drill bit. A Prolene suture was passed through each cannula to shuttle the suture limbs out through the tibial tunnels. After confirming anatomic reduction, with the knee held at 20° of flexion, the sutures were tied securely over a bone bridge on the medial tibial cortex (figure 2).

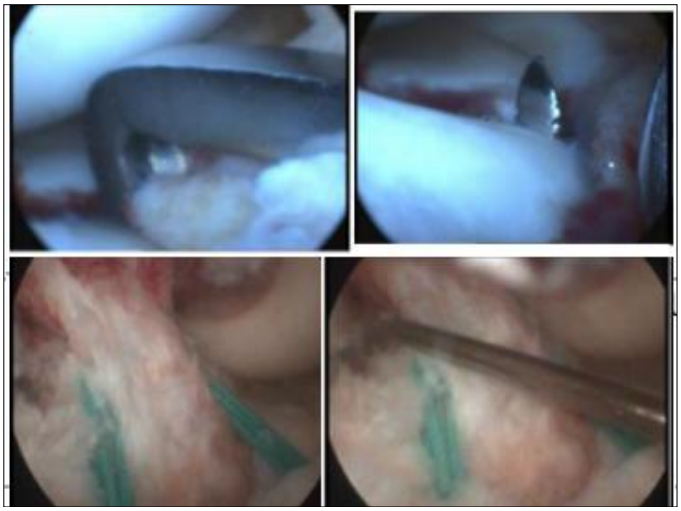

**Fig 2:** arthroscopic view showing two drill holes are made with 2.7 mm guide wire using ACL tibial guide (above) and the sutures were pulled out through the tibial tunnels (below).

### 2.6 Postoperative Rehabilitation

A drain was removed within 48 h postoperatively. Patients were fitted with a hinged knee brace locked in extension for ambulation for 6 weeks. Immediate range-of-motion exercises were initiated but restricted to 90° of flexion for the first 6 weeks. The brace was discontinued at 6 weeks, and physical therapy focused on straight-leg raises, quadriceps strengthening, and proprioception training. Patients were permitted to return to normal daily activities at 6 weeks, noncontact sports at 3 months, and contact sports at 6 months (figure 3).

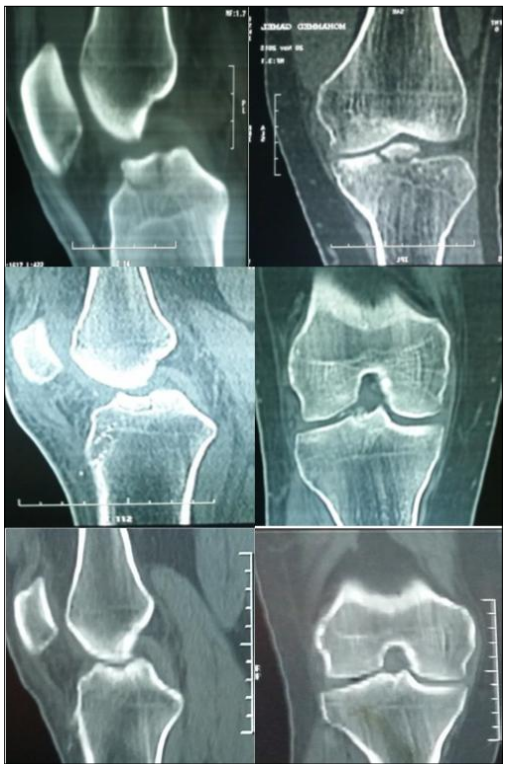

**Fig 3:** CT coronal and sagittal views of 19 years old male with tibial spine avulsion preoperatively (above), immediate postoperative (middle) and 6months postoperative (below).

### 2.7 Follow-up and Outcome Measures

Patients were followed up at 2 weeks (for wound check and suture removal), 4, 6, and 12 weeks, 6 months, and then every 6 months. Radiographic evaluation (X-ray and CT) was performed immediately postoperatively and at 3 and 6 months to assess union. Functional outcome was evaluated using the Lysholm knee score preoperatively and at each follow-up interval.

### 2.8 Statistical Analysis

Data were analyzed using SPSS software version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as means±SD for quantitative variables and as numbers and percentages for categorical variables. The paired t-test was used to compare preoperative and postoperative Lysholm scores. A P value less than 0.05 was considered statistically significant.

## 3. Results

### 3.1. Patient Demographics

Twenty-five patients (21 males and 4 females) with a mean age range of 19-25 years were included. The mean time from injury to surgery was 5.6 days (range: 2-12 days). Demographic data and injury characteristics are summarized in Table 1.

**Table 1:** Patient demographics and injury characteristics (n=25)

| Variable | Category | Count | Percentage (%) |
|---|---|---|---|
| Sex | Male | 21 | 84 |
| | Female | 4 | 16 |
| Age Group | Adolescents (16-19) | 16 | 64 |
| | Young Adults (20-25) | 4 | 16 |
| | Adults (>25) | 5 | 20 |
| Mechanism of Injury | Sports (Twisting) | 6 | 24 |
| | Road Traffic Accident (RTA) | 6 | 24 |
| | Motor Car Accident (MCA) | 1 | 4 |
| | Motor Bike Accident (MBA) | 9 | 36 |
| | Fall From Height (FFH) | 3 | 12 |
| Injured Side | Right | 18 | 72 |
| | Left | 7 | 28 |
| Associated Injuries | Yes | 9 | 36 |
| | No | 16 | 64 |
| Fracture Type (Meyers & McKeever) | Type II | 5 | 20 |
| | Type III | 16 | 64 |
| | Type IV | 4 | 16 |

### 3.2. Functional Outcomes

The mean preoperative Lysholm score was 11.86±3.55, which was categorized as poor for all patients. Postoperatively, a significant improvement was observed at all follow-up intervals (P<0.001), with a mean final score of 93.54±7.84 (Table 2).

**Table 2:** Preoperative and postoperative Lysholm knee scores

| Time Point | Mean Score ± SD | P value |
|---|---|---|
| Preoperative | 11.86 ± 3.55 | - |
| 6 weeks | 55.57 ± 13.37 | <0.001 |
| 3 months | 85.68 ± 15.50 | <0.001 |
| Final Follow-up (12 mo) | 93.54 ± 7.84 | <0.001 |

At the final follow-up, functional outcomes based on the Lysholm score were excellent in nine patients (36%), good in 11 (44%), fair in four (16%), and poor in one patient (4%) (Table 3).

**Table 3:** Distribution of patients by Lysholm score grade

| Time Point | Poor (<65) | Fair (65-83) | Good (84-91) | Excellent (92-100) |
|---|---|---|---|---|
| Preoperative | 25 (100%) | 0 | 0 | 0 |
| 6 weeks | 18 (72%) | 7 (28%) | 0 | 0 |
| 3 months | 3 (12%) | 5 (20%) | 6 (24%) | 11 (44%)* |
| Final Follow-up | 1 (4%) | 0 | 4 (16%) | 20 (80%)* |
| Note: *The 3-month "Excellent" column includes both Good-to-Excellent (93-97) and Excellent (98-100) from the original data for simplified reporting, as per EGOJ style. The result (11 patients) is correct.* | | | | |

### 3.3. Complications

Two patients (8%) experienced a 5-degree extension deficit, which was successfully treated with arthroscopic lysis of adhesions. One patient (4%) reported symptomatic instability ("giving way") and subsequently underwent anatomic ACL reconstruction. There were no cases of surgical site infection, neurovascular injury, or nonunion.

## 4. Discussion

This study demonstrates that arthroscopic reduction and internal fixation using a pull-out suture technique for tibial spine avulsion fractures yields excellent functional outcomes with a low complication rate. The statistically significant improvement in Lysholm scores from a preoperative mean of 11.86 (poor) to a postoperative mean of 93.54 (good-to-excellent) underscores the efficacy of this technique.

Our findings are consistent with previous studies advocating for arthroscopic suture fixation [7-9]. The avoidance of intra-articular hardware is a significant advantage, eliminating concerns related to implant irritation, loosening, or the need for a second surgery for removal, as was required in a notable percentage of patients with other fixation methods [7].

The technical modification of using a 90-degree suture lasso, compared with the 45-degree instrument used by Masato *et al.* [7], may facilitate easier suture passage and potentially reduce the risk of iatrogenic chondral damage. Furthermore, the use of high-strength sutures (#5 Ethibond or #2 FiberWire) tied over a solid bone bridge provides

sufficient stability to allow for early postoperative mobilization, which is crucial for preventing stiffness and promoting functional recovery.

The complication rate in our series was low. The two cases of extension deficit were managed successfully with arthrolysis. The single case of postoperative instability requiring ACL reconstruction (4%) is a known risk and has been reported in other series [10, 11].

A limitation of this study is its Level IV evidence design without a comparative control group. The mean follow-up of 18 months, while sufficient to demonstrate union and functional recovery, is shorter than that in some other studies [10, 11], and a longer follow-up would be beneficial to assess long-term stability and the development of osteoarthritis.

## 5. Conclusion

Arthroscopic reduction and fixation of tibial spine avulsion fractures using a strong, nonabsorbable pull-out suture technique tied over a tibial bone bridge is an effective and reliable treatment method. It facilitates anatomical reduction, provides stable, implant-free fixation, allows for early mobilization, and results in significant functional improvement with a low complication rate.

**Financial support and sponsorship:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Conflicts of interest:** There are no conflicts of interest.

## References

1. Parikh SN, Wells L, Mehlman CT, *et al*. Management of fractures in adolescents. J Bone Joint Surg Am. 2010;92:2947-2958.
2. Meyers MH, McKeever FM. Fracture of the intercondylar eminence of the tibia. J Bone Joint Surg Am. 1970;52:1677-1684.
3. Kendall NS, Hsu SY, Chan KM. Fracture of the tibial spine in adults and children: a review of 31 cases. J Bone Joint Surg Br. 1992;74:848-852.
4. Wiley JJ, Baxter MP. Tibial spine fractures in children. Clin Orthop Relat Res. 1990;255:54-60.
5. Noyes FR, DeLucas JL, Torvik PJ. Biomechanics of anterior cruciate ligament failure: an analysis of strain-rate sensitivity and mechanisms of failure in primates. J Bone Joint Surg Am. 1974;56:236-253.
6. Griffith JF, Antonio GE, Tong CW, *et al*. Cruciate ligament avulsion fractures. Arthroscopy. 2004;20:803-812.
7. Massato A, Akamatsu Y, Mitsugi N, *et al*. Arthroscopic suture fixation in patients with a tibial intercondylar eminence fracture using a simple device to penetrate the anterior cruciate ligament. Asia Pac J Sports Med Arthrosc Rehabil Technol. 2014;1:67-71.
8. Eggers AK, Becker C, Weimann A, *et al*. Biomechanical evaluation of different fixation methods for tibial eminence fractures. Am J Sports Med. 2007;35:404-410.
9. Jang KM, Bae JH, Kim JG, *et al*. Novel arthroscopic fixation method for anterior cruciate ligament tibial avulsion fracture with accompanying detachment of the anterior horn of the lateral meniscus: three-point suture fixation. Injury. 2013;44:1028-1032.
10. Senekovic V, Veselko M. Anterograde arthroscopic fixation of avulsion fractures of the tibial eminence with a cannulated screw: five-year results. Arthroscopy. 2003;19(1):54-61.
11. Faivre B, *et al*. An original arthroscopic fixation of adult tibial eminence fractures using the Tightrope device: a report of 8 cases and review of the literature. Knee. 2014;21(4):833-839.

**How to Cite This Article**
Abdelkader M, Abdelsattar H. Arthroscopic repair of tibial spine avulsion fracture in adults with pull out sutures: A prospective study. International Journal of Orthopaedics and Traumatology. 2026;8(1):23-27.