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OUTCOMES OF ARTHROSCOPIC SUTURE ANCHOR FIXATION IN DISPLACED TIBIAL SPINE AVULSION FRACTURES: A PROSPECTIVE STUDY

Orthopaedics

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ABSTRACT

Background: Tibial spine avulsion fractures are uncommon intra-articular injuries involving the tibial attachment of the anterior cruciate ligament (ACL). Displaced fractures frequently require surgical intervention to restore knee stability and function. Arthroscopic fixation using suture anchors has gained popularity because it allows anatomical reduction while avoiding complications associated with open surgery and screw fixation.**Aim:**To evaluate the functional and radiological outcomes of arthroscopic suture anchor fixation in displaced tibial spine avulsion fractures.**Materials and Methods:**prospective observational study was conducted between December 2023 and February 2025. Fifteen patients with Meyers and McKeever Type II and III tibial spine fractures underwent arthroscopic reduction and suture anchor fixation. Patients were followed for six months. Functional outcomes were assessed using the Lysholm Knee Score and IKDC grading. Radiological union, knee range of motion, and complications were documented.**Results:**Fifteen patients were included (mean age 20.6 years). Nine patients (60%) sustained Type III fractures, while six (40%) had Type II fractures. Road traffic accidents accounted for 53.3% of injuries. Radiological union was achieved in all patients. The mean postoperative Lysholm score was 92.8 ± 7.3. Eleven patients (73.3%) achieved IKDC Grade A, three (20%) Grade B, and one (6.7%) Grade C. Mean knee flexion at final follow-up was 132.3°. No fixation failure, infection, or revision surgery was observed.**Conclusion:**Arthroscopic suture anchor fixation is a safe and effective treatment for displaced tibial spine fractures, providing excellent functional outcomes, stable fixation, complete fracture union, and early rehabilitation.

KEYWORDS

Tibial spine fracture, ACL avulsion, Arthroscopy, Suture anchor, IKDC, Lysholm.

INTRODUCTION

Tibial spine fractures are avulsion injuries involving the insertion of the anterior cruciate ligament on the intercondylar eminence of the tibia. These injuries are common in skeletally immature patients but are increasingly reported in adults following high-energy trauma such as road traffic accidents and sports injuries.

Meyers and McKeever classified these fractures into Types I–III, with Zaricznyj later adding Type IV to describe comminuted injuries. While Type I injuries are generally treated conservatively, displaced Type II and III fractures usually require operative fixation to restore ACL tension and prevent chronic instability.

Arthroscopic fixation has largely replaced open reduction because it allows direct visualization of the fracture, management of associated intra-articular pathology, minimal soft tissue dissection, and early rehabilitation. Various fixation techniques have been described, including cannulated screws, pull-out sutures, suture anchors, and suspensory fixation devices. Suture anchor fixation offers the advantages of secure fixation even in comminuted fragments and avoids the need for implant removal.

This prospective study evaluates the clinical and radiological outcomes of arthroscopic suture anchor fixation in displaced tibial spine fractures.

MATERIALS AND METHODS

Study Design

This was a **prospective observational study** conducted to evaluate the functional and radiological outcomes of arthroscopic suture anchor fixation in displaced tibial spine avulsion fractures.

Study Setting

The study was carried out in the **Department of Orthopaedics, Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru, Karnataka, India.**

Study Duration

Patients were recruited between **December 2023 and February 2025**, with each patient followed for a minimum period of **6 months** after surgery.

Sample Size

A total of **15 consecutive patients** fulfilling the eligibility criteria were enrolled in the study.

Inclusion Criteria

- Age between **13 and 40 years**
- Fresh displaced tibial spine avulsion fractures presenting within **3 weeks of injury**
- **Meyers and McKeever Type II or Type III** fractures confirmed on plain radiographs and MRI

Patients willing to undergo arthroscopic fixation and provide written informed consent

Exclusion Criteria

- **Meyers and McKeever Type I** fractures managed conservatively
- Chronic or neglected ACL tibial avulsion injuries (>3 weeks after injury)
- Previous ligament reconstruction or surgery involving the affected knee
- Pathological fractures
- Open fractures
- Polytrauma patients unable to comply with the rehabilitation protocol
- Associated neurovascular injuries around the knee

Preoperative Assessment

A detailed history regarding the mechanism of injury, associated symptoms, and time since injury was obtained. Clinical examination included assessment of knee swelling, tenderness, range of motion, and ligamentous stability wherever pain permitted. Standard anteroposterior and lateral radiographs of the affected knee were obtained in all patients. Magnetic resonance imaging (MRI) was performed to classify the fracture according to the Meyers and McKeever classification and to identify associated meniscal, ligamentous, and chondral injuries.

Surgical Technique

All procedures were performed under spinal anesthesia with the patient in the supine position and a pneumatic tourniquet applied to the affected limb. Standard anterolateral and anteromedial arthroscopic portals were established. Diagnostic arthroscopy was performed to evaluate associated intra-articular injuries. Hemarthrosis and fracture hematoma were evacuated, and the fracture bed was debrided to remove fibrous tissue and interposed soft tissues.

The avulsed tibial spine fragment was anatomically reduced using an arthroscopic probe. Suture anchors loaded with high-strength non-absorbable sutures were inserted into the ACL tibial footprint. Sutures were passed through the ACL substance using a suture-passing device and securely tied after confirming anatomical reduction and stable fixation. Associated meniscal injuries, if present, were treated during the same procedure according to standard arthroscopic principles.

Postoperative Rehabilitation

The operated limb was immobilized in a hinged knee brace for two weeks. Quadriceps isometric exercises and ankle pump exercises were initiated on the first postoperative day. Passive knee range-of-motion exercises were commenced within one week, followed by progressive active range-of-motion exercises. Partial weight-bearing was allowed after two weeks, progressing to full weight-bearing once clinical and radiological evidence of fracture healing was observed. Return to sporting activities was permitted after restoration of full range of motion, muscle strength, and knee stability, typically between four and six months postoperatively.

Outcome Measures

The following outcome measures were assessed:

- **Lysholm Knee Scoring Scale**
- **International Knee Documentation Committee (IKDC) grading**
- Knee range of motion measured using a standard goniometer
- Radiological union assessed using serial anteroposterior and lateral radiographs
- Postoperative complications including infection, knee stiffness, instability, fixation failure, loss of reduction, and need for revision surgery

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA)**. Continuous variables were expressed as **mean ± standard deviation (SD)**, while categorical variables were presented as frequencies and percentages. Normality of continuous variables was assessed using the **Shapiro–Wilk test**. Comparison of preoperative and postoperative functional scores was planned using the **paired Student's t-test** for normally distributed variables or the **Wilcoxon signed-rank test** for non-normally distributed variables. Associations between categorical variables were analyzed using **Fisher's exact test** because of the small sample size. A **p-value <0.05** was considered statistically significant.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru. Written informed consent was obtained from all participants before enrolment in the study.

RESULTS

Patient Demographics

The study included 15 patients with a mean age of 20.6 years. Nine patients were male (60%), and six were female (40%).

Table 1: Mechanism of Injury

Mechanism	Number	Percentage
Road traffic accident	8	53.3
Sports injury	4	26.7
Self-fall	3	20.0

Table 2: Fracture Classification - Meyers and McKeever

Type	Number	Percentage
Type II	6	40.0
Type III	9	60.0

Functional Outcome

The mean postoperative Lysholm Knee Score at six months was 92.8 ± 7.3. According to IKDC grading, eleven patients (73.3%) achieved Grade A, three (20.0%) Grade B, and one (6.7%) Grade C.

Range of Motion

The mean final knee flexion was 132.3°, with most patients regaining full extension.

Radiological Outcomes

Radiological union was achieved in all patients within the planned follow-up period. No secondary displacement, fixation failure, or loss of reduction was noted.

Complications

No superficial or deep infections, arthrofibrosis requiring intervention, hardware-related complications, or revision procedures were recorded during follow-up.

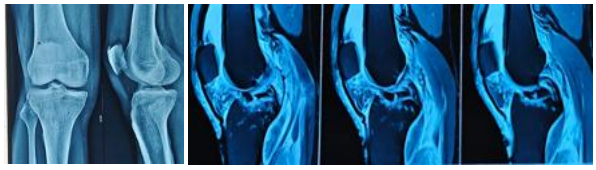

Figure 1: Pre-operative Radiographs showing Tibial Spine avulsion fracture

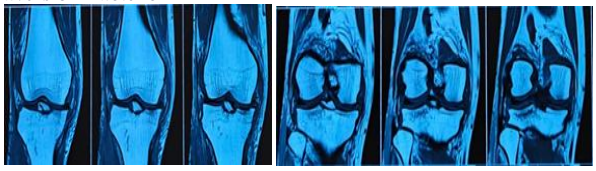

Figure 2 : Intra-operative images showing sutures passed through ACL

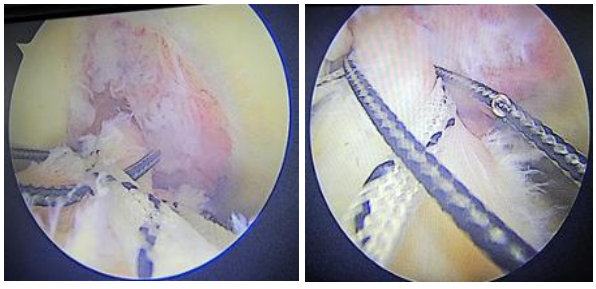

Figure 3 : Post-operative Radiograph fixation with suture anchor and suturedisc

DISCUSSION

The present prospective study demonstrates that arthroscopic suture anchor fixation yields excellent clinical and radiological outcomes in displaced tibial spine fractures. Complete fracture union was achieved in all patients, with favourable functional recovery reflected by a mean postoperative Lysholm score exceeding 90 and the majority of patients attaining IKDC Grade A.

The predominance of high-energy trauma, particularly road traffic accidents, reflects the epidemiological pattern observed in adult populations, whereas pediatric series more commonly report sports-related injuries. The high union rate observed in our study is consistent with previous reports by Ahn et al., Edmonds et al., and Huang et al., who also demonstrated excellent healing following arthroscopic fixation[4,7,8].

Suture anchor fixation offers several theoretical and practical

advantages over screw fixation. It permits secure fixation of small or comminuted fragments, eliminates the need for implant removal, reduces the risk of fragment fragmentation, and allows simultaneous treatment of associated intra-articular injuries through the arthroscope. The restoration of knee motion observed in this series is likely attributable to stable fixation combined with an early rehabilitation protocol. Importantly, no cases of postoperative instability or fixation failure were encountered.

Although encouraging, the findings should be interpreted in the context of the relatively small sample size and limited follow-up duration. Larger comparative studies with longer-term follow-up are required to establish whether suture anchor fixation offers superior outcomes to alternative fixation methods.

CONCLUSION

Arthroscopic suture anchor fixation is a reliable and minimally invasive technique for the management of displaced tibial spine avulsion fractures. The procedure provides anatomical reduction, stable fixation, excellent functional recovery, complete radiological union, and a low complication rate. Based on the findings of this prospective study, arthroscopic suture anchor fixation represents an effective treatment option for Meyers and McKeever Type II and III tibial spine fractures.

DECLARATION BY AUTHORS

Ethical Approval: The study was approved by the Institutional Ethics Committee
Source of Funding: No funding was received for this study.
Conflict of Interest: The authors declare no conflict of interest.

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