



## CLINICAL OUTCOME OF ARTHROSCOPIC REDUCTION AND FIXATION BY PULL THROUGH SUTURE TECHNIQUE IN TIBIAL SPINE FRACTURES

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**ABSTRACT** **Background** -Tibial spine avulsion fracture is bony avulsions of anterior cruciate Ligament (ACL) from its attachment on the anteromedial portion of the intercondylartibial eminence. If not treated well, Tibial spine fractures can lead to non-union or malunion, which can lead to significant disability in the form of flexion deformity, loss of extension, or instability.

**Aims And Objectives:** This study was conducted with the aim of evaluating clinical outcome of arthroscopic reduction and fixation of fractures by pull through suture technique and complications associated with the procedure. **Material And Method:** This prospective with retrospective study analyzed 20 patients (16 males and 4 females), with mean age of  $28.6 \pm 9.8$  years (range, 15-55). Patients were classified by Meyers and McKeever type III (n=16) and IV (n=4) and were operated arthroscopically by pull through suture technique. They were followed over a mean period of  $10 \pm 2.8$  months. Postoperative assessment was done by using Lachman test, Lysholm knee score and international knee documentation Committee (IKDC) score. Objective assessment of anterior translation of tibia was done by using indigenously developed device named Laxometer. **Results:** At the end of follow up, 17 of 20 patient had no or minimal anterior translation of tibia by Lachman test. The mean preoperative Lysholm score in 20 knees was 38 (range 29 to 55) and mean post-operative Lysholm score was 96 (range 83-100). At the end of follow up 17 of 20 (85%) patients assessed by IKDC score were normal/ nearly normal grade A/B and 3 patients were abnormal (grade C). All patients achieved union within 3 months (range 8 to 17 weeks). 20% patients had restricted range of motion. **Conclusion:** Arthroscopic pull through suture technique has good clinical outcomes in both type III and type IV fractures, and in all age groups (open and closed physis) with minimal complications. This was evidenced by no instability and residual ACL deficiency, postoperatively at 1 year. Most patients have excellent recovery with full return of knee range of motion.

### KEYWORDS :

#### INTRODUCTION

Tibial intercondylar eminence fracture involves bony avulsion of the ACL insertion from the tibial spine.<sup>1</sup> Tibial spine fracture is usually, a result of low – velocity injuries, such as fall from a bicycle or motorcycle and sports. It occurs when an axially loaded knee undergoes hyperextension, and the femur rotates externally with or without valgus force or may also result from direct blow on distal femur when knee is in flexion.<sup>2</sup> Concomitant injury to a collateral ligament and menisci may also occur, and there is evidence that associated injuries are common in adults.<sup>3</sup>

Mayers and McKeever<sup>4</sup> classified avulsion fractures into three types which was later modified by Zaricznyj.<sup>5</sup>

*Type I* – Undisplaced fracture

*Type II* – Partially displaced with intact posterior hinge with partial displacement of the anterior margin

*Type III* – Completely displaced fracture fragment

Type III A – No rotational malalignment

Type III B – Rotated fragment with cartilaginous surface facing the raw fracture bed

*Type IV* – Comminuted avulsed fragment.

If not treated well, tibial spine fractures can lead to non-union or malunion, resulting in significant disability in the form of flexion deformity, loss of extension, or instability<sup>6-8</sup>. Hence, it is important to reduce accurately and fix type III and IV fracture to prevent such complications.

The treatment recommendation for Type I and Type II fractures is non operative with immobilization in a hinged knee brace in full extension for 4 to 6 weeks.

Surgical management is recommended for all Type III and Type IV fractures due to very high rates of nonunion in those treated without surgical fixation<sup>9</sup>.

#### MATERIAL AND METHODS

This was a retrospective and prospective study on 20 patients over a period of 2 years between August 2018 to August 2020. Patients with tibial spine fractures undergoing arthroscopic reduction and fixation by 'pull through suture technique' presenting in the department of Orthopedics surgery of CCS Hospital at NSCB Subharti Medical College, Swami Vivekanand Subharti University, Meerut, participated in this study.

#### Inclusion Criteria-

Inclusion criteria were displaced (type III and type IV) tibial spine avulsion fractures with anterior knee instability, presenting within 4 weeks of injury. Patients with both open (skeletal immature) and closed physis (skeletal mature) were included in the study.

#### Exclusion Criteria-

Subjects were excluded from participation in the study if they had: Associated degenerative changes (Kellgren and Lawrence Grade 3 and above), associated injuries of posterior cruciate ligament, associated ipsilateral bony injuries of femur and tibia, and associated injuries of postero-lateral complex. For all prospective cases, detailed history regarding mode and mechanism of injury was taken, followed by clinical examination and the patient was documented.

Objective assessment of anterior translation of tibia in 30° and 90° position was done by using indigenously developed device named Laxometer. This device has been developed in the department of orthopaedics, Subharti Medical College<sup>10</sup>. Aditya Kumar Singhal *et al*<sup>11</sup> did study on Laxometer and reported that it is basically based on the principles of Rolimeter which is commercially available device and claim to be as effective as KT-8000 meter for measuring anterior translation in ACL deficiency knee.

The anterior displacement of tibia on doing Lachman and anterior drawer test can be quantified by directly measuring the displacement on the guide as shown in figure below.



**Figure 1** A: Showing Laxometer. B: Showing Lachman test with the help of Laxometer.

#### Pre-operative Workup-

Knee range of motion was evaluated with a Goniometer. Knee function was evaluated by Lysholm and IKDC (International Knee Documentation committee) Scoring.<sup>12-13</sup>

#### Investigations

X-rays of the involved knee AP (Antero-posterior) and Lateral Views (in full extension) were done to confirm the diagnosis. MRI was done to note the presence of associated intraarticular injuries and to rule out any concomitant injuries.

#### Operative Procedure

##### Surgical Technique:

Patients were positioned supine on the operating table after spinal/general or epidural anaesthesia and a well-padded tourniquet is applied high over the thigh. Diagnostic arthroscopy was performed through standard anterolateral portal. Standard anteromedial portal was made and a suture cannula was inserted. The tibial spine avulsion was identified and the type of fracture confirmed by probing. A trans-patellar tendon portal was made as an accessory working portal. The avulsed fragment was reduced using ACL tibial guide. An 18-gauge IV cannula needle preloaded with no.1-0 PDS (Polydioxanone suture) was inserted into the joint parallel to the medial tibial condyle and the ACL was pierced at the junction of its attachment with bony fragment slightly posteriorly. The PDS suture at the tip was held with the help of grasper and negotiated out of the AM portal. The IV cannula was withdrawn and the limb of PDS was also taken out through the AM portal. The PDS was replaced by fiber wire no. 1 and the two ends were held by artery forceps. Now the tip of ACL tibial guide was placed via trans-patellar portal over lateral most edge of the avulsion crater and a 1 cm incision was made over the entry of sleeve of the ACL tibial guide just medial to tibial tuberosity. A tibial tunnel was drilled using 1.8 mm K-wire and the tip visualized at the crater edge. The wire and the jig were removed and a needle of no. 18 IV cannula loaded with PDS no. 1 was negotiated through the tunnel. The advanced end of the PDS was pulled out through AM portal by suture grasper and the end of fiber wire exiting from lateral border of ACL was pulled through the tibial tunnel with help of PDS by suture shuttling technique. A similar tunnel was drilled at medial edge of the crater ensuring a 1 cm of bony bridge intact between the two tunnels and the other end of fiber wire exiting from medial border of ACL was retrieved through the tunnel in similar fashion. The two ends of the fiber wire were tied over the bony bridge keeping the knee in 30 degree of flexion visualizing adequate reduction. Finally, the knee was completely extended to check for inter-condylar roof impingement with fixed avulsed tibial spine. The incisions were closed in layers.

#### Post-operative Evaluation And Rehabilitation:

In the immediate postoperative period the patient was put on compression bandage for three days along with knee brace following which walking with walker and quadriceps isometric exercises were initiated. Closed chain knee mobilization was started after two week and 90° flexion achieved over three weeks. The patients were allowed non weight bearing ambulation with walker from the second post-op day. Gradual knee mobilization was encouraged from third week onwards and partial weight bearing was allowed after four weeks. Full weight bearing was allowed after complete fracture union. Return to sports was permitted at 6 months postoperatively, after knee stability, range of motion, muscle strength, and proprioception were restored.

#### Follow-up Protocol

Patients were evaluated monthly for first 6 months then quarterly till one year. Antero-posterior and lateral radiographs of the knee were taken at 1, 2 months and 3 months and later on requirement basis post-operatively to assess fracture healing. A fracture was considered united if no fracture line was visible radiographically. At 6 months after surgery, all patients were evaluated for antero-posterior laxity

(Lachman-Noulis). Knee range of motion was evaluated with a goniometer. Knee function was evaluated by the Lysholm and International Knee Documentation Committee (IKDC) scores.

#### Final Evaluation

Final grades were given to each knee at 6th month of follow up based on clinical evaluation including Lachman's test, IKDC subjective knee evaluation score and modified Lysholm's score.

#### OBSERVATION AND RESULTS

The patients included in this study were of mean age of 28.6 ± 9.8 years (range, 15-55) with 15 (75 %) males and 5 (25 %) female, respectively. Road traffic accident accounted for the majority of injuries i.e., 17 (85 %) and sports injury in 3 (15 %) cases. The cases were classified according to Meyers and McKeever classification, as per our inclusion criteria, there were 16 (80 %) type III fractures and 4 (20 %) type IV fracture.

At the time of admission, we evaluated the condition of physis and found that the physis was closed in 13 (65%) and open in 7(35%) cases. Union time evaluated in our study has a mean time of 3 months.

In our study, Preoperative Lysholm knee score in all 20 (100%) patients were poor (<65) which significantly improved postoperatively at one year to Excellent (95-100) in 19 (95%) patients and good (84-94) in 1 (5%) patient respectively.

In our study, preoperative IKDC Rating was Abnormal (C) in 4(20%) patients and severely abnormal (D) in 16(80%) patients which improved significantly postoperatively at one year to Normal(A) in 18(90%) and Nearly normal (B) in 2(10%) respectively.

The means of Lysholm and IKDC scores at 6 and 12 months are compared in Table below. At every follow-up, there was significant improvement in Lysholm score and IKDC score. Mean changes in Lysholm score and IKDC SCORE at final follow-up was 3.4 and 4.05, respectively. The mean follow up duration was 10±2.8 months.

**Table 1: Changes In Mean Of Lysholm Score And IKDC Score Over Time**

Score	6 months	12 months	Mean changes at final follow up
Lysholm score	92.75	94.80	3.4
IKDC score	92.50	94.15	4.05

In our study preoperative Lachman grading was I in 3 cases, grade II in 16 cases and grade III in 1 case which improved postoperatively at one year and found to have grade 0 in 17 cases and grade I in 3 cases. In our study, we clinically assessed Lachman test and graded using Laxometer preoperatively and post operatively at final follow-up, we found that there was significant laxity in 3 cases.

In our post-operative study, the range of motion at 3 months was less than 90 degree in 14 patients, 90-130 degree in 6 patients and 130-150 degree in 0 patient. At 6 months, the range of motion was less than 90 degree in 3 patients, 90-130 degrees in 10 patients and 130-150 degree in 7 patients. At 1 year the range of motion was less than 90 degree in 0 patient, 90-130 degree in 2 patient, 130 to 150 degree in 18 patients. There was significant improvement in range of motion at every follow-up.

In this study, very few post-operative complications were seen. Superficial wound infection was seen in 1, and Joint stiffness was seen in 2 cases, respectively.

#### DISCUSSION

Arthroscopy has become a pervasive and prevalent technique in the treatment of tibial spine avulsion fracture. Tibial spine is the site of anterior cruciate ligament ACL attachment, its avulsion is associated with ACL insufficiency leading to anterior knee instability, extension loss, quadriceps weakness and chondromalacia.<sup>14,15</sup>

Tibial spine fractures are more common in children and adults. Several treatment options are available in adults like screws, wires, staples and sutures for arthroscopic fixation of tibial spine fractures; studies suggest that pull through suture technique seem to be the preferred surgical technique though there have been conflicting results as well.

Our study reported excellent results which suggest the effectiveness of the procedure. The operative technique presented here has several advantages:

- A) The pull through suture fixation technique requires no further surgery for implant removal.
- B) Ethibond intra-ligamentous sutures are sewn into the ACL base rather than into the avulsed bone; thus, even reduction and fixation of type III or IV fractures are easily performed
- C) Pull through Suture fixation is superior to screw fixation for treating avulsion fracture of the ACL because screw fixation may potentially break the bone fragments, hence can be used in comminuted fractures.

In the current study, approximately all patients achieved bony Union without tibial eminence tilt, pain and loss of knee extension. It is supposed that it may be correlated with the clinical outcome scoring besides all the patients reported their good range of motion except one with arthrofibrosis.

*Vivek Pandey et al* 2017<sup>16</sup> conducted a study to assess the clinical and radiological outcomes of arthroscopic reduction and fixation of tibial spine avulsion in 26 patients with both open physis and closed physis and found that all avulsion fractures had good reunion at 3-month follow-up. At the final follow-up, all patients achieved complete range of movement with no significant instability.

In our study Lysholm and IKDC score for both type III and type IV fracture had no significant difference, similar to the study by *Vivek Pandey et al*<sup>16</sup>.

*Sinha et al* 2017<sup>17</sup> conducted a study to evaluate arthroscopic fixation of tibial spine avulsion in skeletally immature patients (n=10) using a non-absorbable suture. McKeever Type 2 and 3 were included in the study. The study suggested that suture fixation was a simple, reproducible and cost-effective technique.

In our study, the average duration between injury and surgery was 10.25 days. Most of the authors have reported almost same interval between injury and surgery in literature (*Vivek Pandey et al*<sup>16</sup>, *Kejie Wang et al*<sup>18</sup>, *Weixiong Liao et al*<sup>19</sup>).

Radiological study found that the mean union time in our study is three months with a range of 8 to 17 weeks which is comparable to several other studies. At final follow-up, there were no symptoms of instability and no clinical signs of Non-union or ACL deficiency in any patient. All 20 patients had a negative Lachman test and no pivot shift phenomenon.

The mean IKDC score in patients with type III fracture was  $94.2 \pm 1.5$  and in patients with type IV fractures was  $93.5 \pm 1.7$ , respectively. The difference in IKDC score between fracture types was not statistically significant (independent t-tests,  $P=0.449$ ). The mean Lysholm score at 1 year follow up was  $94.8 \pm 1.7$  and the mean IKDC score was  $94 \pm 1.5$ , respectively. The Lysholm and IKDC score reported in the present study were comparable to other studies done by *Kejie Wang et al*<sup>18</sup>, *Weixiong Liao et al*<sup>19</sup> and *Yanhao Yuan et al*<sup>20</sup>. This suggests that this procedure gives good clinical outcome. In present study, we found that there was significant improvement in IKDC rating at final follow up when compared between the pre-operative and post-operative patients. *Montgomery et al* 2002<sup>21</sup> reported 9 of 17 (53%) cases of severe difficulty in regaining motion postoperatively. *Sapre V et al* 2015<sup>22</sup> reported 1 of 10 cases of postoperative arthrofibrosis. The author believed that suture pull through technique for tibial spine fracture is a minimally invasive technique with good functional outcome and minimal postoperative complications.

In our study, there was no major postoperative complication like infection, deep venous thrombosis, or neurovascular deficit. One case of superficial skin infection was reported and managed conservatively. Arthrofibrosis was reported in 2 patients and were improved later by physiotherapy. There were no symptoms of instability and no clinical signs of ACL deficiency in any patient post-operatively at 1 year.

#### Limitation Of Study:

The limitations of the present study were a small sample size, absence of a control group and a relatively small follow-up duration ( $10 \pm 2.8$  months). The study was not a randomized comparative study which may cause selection bias. A comparative study on a large sample size of patients with long term follow-up could shed more light on the outcome of suture pull through technique

#### CONCLUSION

In the present study with tibial spine fractures, arthroscopic reduction with suture pull through technique was successfully achieved in 20 patients. The rate of complication was low. We can conclude that these fractures were seen in all age groups and were more common in males. Suture pull technique has good clinical outcomes in both type III and type IV fractures, and in all age groups (open and closed physis). This was evidenced by no instability and residual ACL deficiency, postoperatively at 1 year. Most patients have excellent recovery with full return of range of motion.



Fig.2:- Pre-op x-ray showing Tibial spine avulsion fracture



Fig.3: Post-op x-ray showing Union

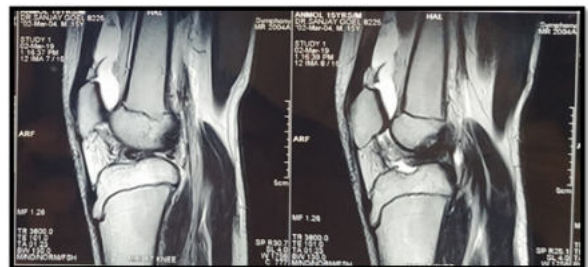


Fig.4: Pre-op MRI Image Showing Avulsion Fracture Of Tibial Insertion Of ACL

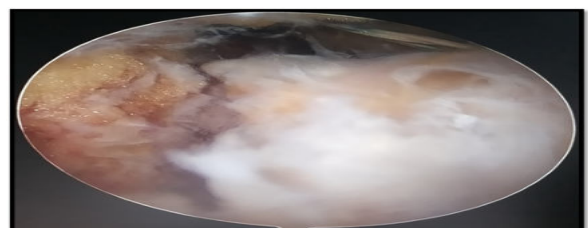


Fig.5: Intra-op Arthroscopic Image Showing Avulsion Of ACL From Tibial Spine



Fig.6: Intra-op Arthroscopic Image Showing Fixation After Pull Through Suture Technique

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