

Original Research Article

Arthroscopic treatment of displaced tibial eminence fractures using wire loop technique

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ABSTRACT

Background: Several techniques of arthroscopic treatment of tibial spine avulsion fractures have been described in the literature. We conducted a study to analyze the results of arthroscopic assisted wire loop technique for treatment of tibial spine avulsion in adults and pediatric patients.

Methods: From June 2011 to December 2016, 52 patients with tibial spine fractures were surgically treated with arthroscopic reduction and wire loop fixation. Forty-four patients were adults and eight were in their pediatric age group. The age group ranged from 9 years to 52 years with the mean age of 26.2 years. 28 patients were type 2 and 24 were of type 3 fracture as classified by Myeres and Mckeever's classification. The final analysis was done using clinical tests, radiological evaluation and International Knee Documentation Committee (IKDC) and Lysholm score.

Results: At final follow-up, the mean IKDC and Lysholm knee scores were, 92 and 93 respectively. All patients had a complete functional recovery and were able to return to work and to resume their activities.

Conclusions: Arthroscopic wire loop fixation is an excellent method for tibial eminence fracture in adults and children which gives excellent results in form of control tension on ACL on each side of avulsed fragment and also gives adequate mechanical strength for early rehabilitation.

Keywords: Arthroscopy, Wire loop technique, Tibial spine avulsion, Anterior cruciate ligament, Knee joint

INTRODUCTION

Tibial eminence fracture is a bony avulsion of the anterior cruciate ligament from its insertion on the anteromedial tibial eminence.¹ These injuries are commonly seen in children aged between 8-14 years and are usually sports related, however in adults these injuries are mainly related to high energy trauma usually road traffic accidents and concomitant injury to the menisci, articular cartilage, and collateral ligaments can also be seen.²⁻⁸

Meyers and McKeever in 1959 described the severity of the displacement of fracture into 3 types, type I fractures have minimal or no displacement of the fragment, type II fractures have anterior one half avulsion of the eminence, but seated posterior part, and type III fractures have displaced fragment.⁹ Zaricznyj further modified and divided type III fractures into classes A and B, where type IIIA describes the pathology when the fragment with complete separation is displaced minimally, and type IIIB the pathology when the fragment is twisted or fragmented resulting in rotational malalignment.¹⁰

Treatment is based on these characteristics and tailored to each fracture pattern. Displaced tibial eminence fractures disrupt the continuity of the femur-ACL tibial viscoelastic chain and can cause mechanical block to knee extension. The goals of treatment, therefore, are to restore continuity of the ACL and its stabilizing function, eliminate the mechanical block caused by the fragments, and restore congruity of the tibial plateau.^{4,11} Various type of fixation methods using open reduction and internal fixation using screws, staples, anchors and arthroscopically assisted internal fixation has been reported for fixation of tibial eminence fractures. Higher incidence of complications was associated with open reduction techniques such as infections, increased surgical time, prolonged recovery time and arthrofibrosis after surgery.¹² Recent literature suggests that arthroscopic fixation provides a stable construct and allows early mobilization with good functional outcome.^{13,14}

The goal of this study was the assess the functional outcome of arthroscopy assisted tibial spine fixation with wire loop technique.

METHODS

This prospective study was done in tertiary care center. This study was examined and approved by the Human research ethics committee. The study period was between 2011 to 2016. All patients with type 2, type 3 ACL avulsion fracture were included in the study. Complete multiligamentous injury, comminuted proximal tibia fracture, intrasubstance tear of ACL, neurological involvement of patient was excluded from the study.

Total of 55 patients underwent arthroscopic tibial spine fixation out of which 3 patients were lost to follow-up and hence 52 patients were included in the final analysis.

In those 52 patients, 44 Adults and 8 Pediatric cases of ACL avulsion fractures treated with arthroscopic wire loop fixation.

The injuries were diagnosed by means of plain radiographs of the knee joint in anteroposterior and lateral views, and by clinical examination.

All patients presented with hemoarthrosis and limitation of range of motion, and had positive Lachman's test results. Fractures were classified according to Myer's and McKeever's classification

Patients were assessed by Lysholm functional knee score as excellent (100–95 points), good (84–94 points), fair (65–83 points), or poor (<64 points) and IKDC score.¹⁵ Range of motion, limb malalignment, and shortening were assessed, and stability of the knee was clinically evaluated by the anterior drawer test. Quadriceps wasting was also measured. Follow-up anteroposterior and lateral

radiographs were assessed for fracture reduction, union, and loop wire position.

Operative procedure

The patient was positioned supine. A single dose of iv cephalosporin was administered before inflation of a high thigh tourniquet. Standard anteromedial and anterolateral portals are made. Wash and debride the fracture bed and joint. 1 cm incision is made on the anteromedial aspect of proximal tibia 1 cm medial to tibial tuberosity. Using ACL zig guide, Drilling is done with beath pin through edge of crater on one end (Figure 1A). 24 gauge ss wire is passed arthroscopically through the same beath pin tract either through edge of crater (when fragment is small) or avulsed fragment using plastic DJ stent sleeve (Figure 1B). SS wire is pulled inside the joint and a wire loop is created just anterior to ACL fibres. Using ACL zig again on the other side of crater, drilling is done with beath pin to create a small tunnel (Figure 1C). Thus, two small tunnels are made with one centimeter bridge of metaphyseal cortex of tibia. Beath pin is removed and reinserted with free hand technique in the same tunnel with 'eye' inside the joint. Intra articular SS wire loop end is passed through the eye of the beath pin (Figure 1D). Beath pin along with SS is wire pulled out gradually (Knee remains in 80-90 degree of flexion). Both ends of SS wire are twisted, tightened and cut over the bone bridge, one cm medial to the tibial tuberosity (At the site of previous incision), keeping knee in 20-30 degrees of flexion. (Figure 1E and 1F). Reduction of the avulsed fragment is maintained inside during this. Assessment of reduce fragment and acl tensioning is done. Closure is done with ethilon 3-0.

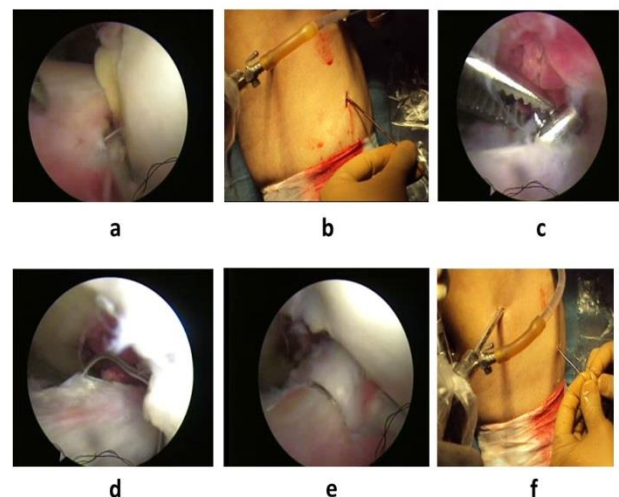


Figure 1: Operative technique. (a) drilling and beath pin insertion; (b) SS wire passed in joint; (c) drilling done again to make second tunnel; (d) SS wire loop passed through eye of beath pin; (e, f) both ends of SS wire twisted and tightened.

Rehabilitation protocol

Long knee brace, static quadriceps exercise started same day. 3 weeks of immobilization was given in extensor knee brace. Closed chain knee bending/CPM was started at the end of 2-3 weeks.

Toe touch weight bearing allowed with crutch/walker at 4 to 6 weeks depending upon tibial bone bruise and other injuries.

Full weight bearing was allowed after 4-6 weeks. Sports activity was allowed after 6-9 months. Patients followed up at 4 weeks, 3 months, 6 months, 12 months and 24 months.

Statistical analysis

STATA 14.0 was used for data variation analysis. The mean and range for all continuous variables were obtained. The p value for statistical significance was set at $p < 0.05$.

Outcome measures

X-ray is done to evaluate union at 1 month and 3 months. Range of motion is assessed using goniometer.

Instability is assessed using Lachman test and anterior drawer test, and graded as grade 1 (0-5 mm), grade 2 (5-10 mm), grade 3 (>10 mm)

Functional outcome assessed using Lysholm score and IKDC (International Knee Documentation Committee) score at 24 months.

RESULTS

Total of 52 patients were included in the final analysis, out of which 33 were male and 19 were female. The age group ranged from 9 years to 52 years with the mean age of 26.2 years. 28 patients were type 2 and 24 were of type 3 fracture as classified by Myeres and Mckeever’s classification. Detailed analysis of pediatric and adult cases was done.

Paediatric cases

Total of 8 pediatric cases were treated with arthroscopic wire loop fixation. Among these mean age was 12 years (range 9 to 16 years) with 7 males and one female patient (Figure 2). In 6 cases injury was due to fall from bicycle and other sports. And two children got injury in road traffic accident. There were five patients with type 2 fracture and three with type 3 fracture as per Myeres and Mckeever’s classification (Figure 3). One child was having lateral meniscus injury, treated with partial meniscectomy. All the children achieve near full (0-120) to full (0-140) range of motion post operatively. All children return to their pre injury level of activity at two

year follow up. Only one child was having grade one laxity, on Lachman test. But clinically child is not having instability. Mean IKDC subjective score was 93.2. The mean Lysholm score was 94.8 (Table 1) (Figure 4). The mean follow up was 31 months (24 to 54 months).

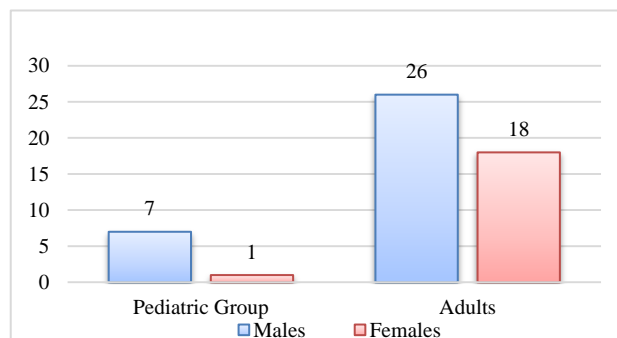


Figure 2: Demographic data of adult and pediatric group.

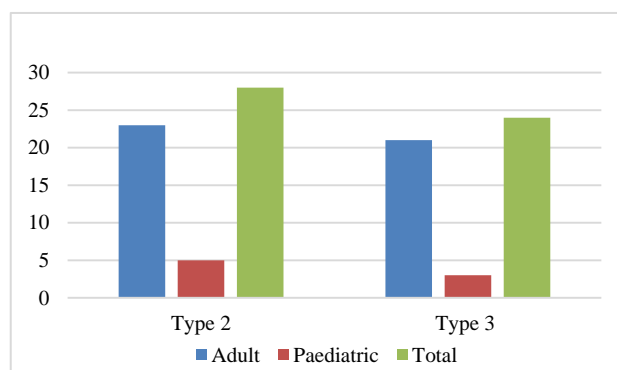


Figure 3: Fracture distribution in adult and pediatric group.

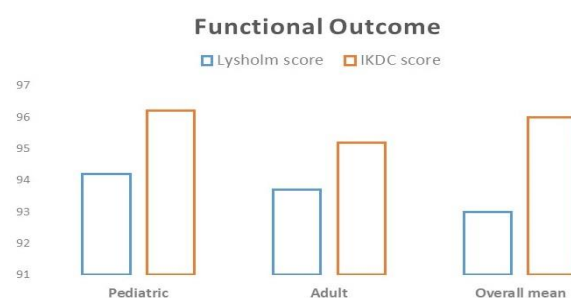


Figure 4: Functional outcome with Lysholm and IKDC scores.

Adult’s cases

In 44 adult cases male patients predominated female patients (males=26, females=18) with the mean age of 29.2 years with the range being 20-52 years (Figure 2). Road traffic accidents and fall due to various activities are the two major causes identified. On classifying the fracture 23 were of type 2 and 21 were of type 3 (Figure

3). Out of 44 cases 36 patients got full range of motion as compared to opposite side. 4 patients had 0-130 range of motion. 1 patient had 0-120 and 1 patient had 0-110 range of motion. 2 patients had developed fixed flexion deformity, and ultimately both patients required ACL reconstruction. Total of 14 patients had associated injury. Out of 14, eleven had knee injuries. Lateral meniscus is torn in 4 patients, medial meniscus is torn in 3 patients, mcl tear grade 2 in two patients and grade 1 tear in one patient. PCL grade two tear present in one patient. Two patients had associated tibial plateau fractures (Schatzker type 1 and 2). The mean follow up was 43 months (16 to 59 months) functional outcome assessed with lysholm score showed excellent results in 24 cases, good result in 18 cases and fair results in two cases. Mean IKDC subjective score was 91.25. The mean Lysholm score was 93.7 (Table 1 and Figure 4). The detailed comparative analysis of preoperative and postoperative functional outcome score is given in Table no 2. When stability was checked with Lachman test and anterior drawer test, five patients had laxity. Three patients had grade 1 laxity and two patients had grade two laxity. Bony union was achieved in all patients (Figure 5).

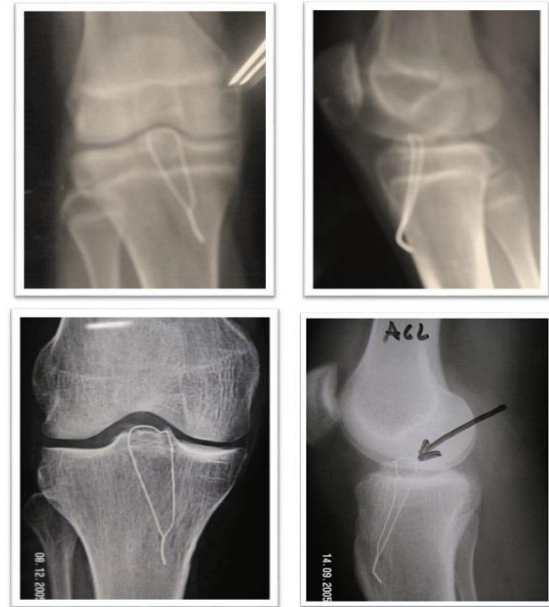


Figure 5: X-ray knee with wire loop in skeletally immature and adult patient after bony union.

Table 1: Functional outcome.

Mean IKDC score in paediatric group	93.2 (range 89-100)
Mean Lysholm score in paediatric group	94.8 (range 90-98)
Mean IKDC score in adults	91.25 (range 88.3-96.2).
Mean Lysholm score in adults	93.7 (range 85-99)

Table 2: Comparison of Lysholm and IKDC score in adults before and 20 months after surgery.

Lysholm score	N	Mean	SD	Min	Max
Pre surgery	44	34.57	5.76	20	45
Post-surgery	44	93.70	4.44	85	99
Paired difference	Mean	S.E.	Upper 95% CI	Lower 95% CI	P value
	59.13	1.096	56.61	61.03	<0.0001
IKDC score	N	Mean	SD	Min	Max
Pre surgery	44	32.48	2.96	24.43	37.96
Post-surgery	44	91.25	3.32	88.34	96.26
Paired difference	Mean	S.E.	Upper 95% CI	Lower 95% CI	P value
	58.77	0.753	57.26	60.29	< 0.0001

DISCUSSION

Surgical treatment of displaced intercondylar eminence fracture is essential to prevent complications and early return to functional activity. Screws and sutures are the primary surgical modalities for tibial spine fracture repair, both having exhibited very good clinical and radiographic outcomes.¹⁶ Disadvantages with screw fixation include possible further comminution during insertion, possible impingement of the screw head during knee extension, and the requirement of a secondary procedure for screw removal¹⁷ Open surgery allows anatomic fracture reduction and secure fixation for early

mobilization but causes some morbidity. Arthroscopic fixation of eminence fracture has become the gold standard nowadays because of excellent visualization, accurate reduction and rigid fixation. It also allows management of concomitant lesions of the meniscus and cartilage. It reduces complications and morbidity of patients.^{6,18}

In our study, common age of presentation in paediatric group (n=8) is 8-14 years and in adult group (n=44) is 20-51 years. With contrast to many studies, we found higher incidence among adults than children. This may be due to higher incidence of road traffic accidents in this area. As

road traffic accidents are the major cause of eminence fracture in adults. Kendall et al found the incidence of this type of injury in adults higher than that in children.³

Among eight pediatric cases, six patients had full range of motion and other two got near full range of motion. Although one child was positive for Lachman test, all the patients returned to their pre injury functional level.

In adults 80% patients got full knee rom. When functional outcome was checked using Lysholm score, 42 cases got good to excellent outcome. Only two cases had fair outcome. Both these cases are associated with tibial plateau fractures, later on required ACL reconstruction.

Five patients were positive for grade 1 to grade 2 anteroposterior laxity. But none of them had feeling of instability. It suggests the laxity is due to stretching of ACL fibres at the time of injury.¹⁹

Suture as well as screw fixation techniques have been studied in cadaver models. Bong et al reported that the initial ultimate strength was higher with 3 No.2 fiber wire sutures than with a 4 mm×40 mm partially threaded cannulated screw with a washer.²⁰ Eggers et al in his study, concluded that suture fixation provides more biomechanical strength than does screw fixation.²¹ Seon et al reported that both the screws and suture fixation technique produced a relatively good result in terms of functional outcome and stability.²²

In this study we have used a 24-gauge thin SS wire is used to create loop just anterior to ACL fibres, which does not cause any impingement/discomfort to the patient and we achieved excellent results in 94% of cases. Unlike suture fixation in this technique loop is created just anterior to the ACL fibres. So less chances of damage to ACL fibres. As it is not protruding out into the joint like screws, chances of damage to the cartilage is also very less after fracture healing. Avulsed fragment is not always required to drill or puncture, so we can use it even when the fragment is smaller or with comminution of the fragment. For tunnel preparation, beath pin is used, which is just 1.8 mm in diameter, which reduces chances of physeal plate damage in children. No patient has reported growth disturbance or limb length discrepancy. Thus, it has many advantages over the other method of fixation such as screw fixation, pull out suturing.⁵

This technique requires proper instrumentations and good experience in arthroscopic fixation. Once learnt, it is safe and reproducible. Clinical results of technique are equal to that of screw fixation and pull out suturing.

CONCLUSION

Arthroscopic wire loop fixation is an excellent method for tibial eminence fracture in adults and children which gives excellent results in form of control tension on ACL

on each side of avulsed fragment and also give adequate mechanical strength for early rehabilitation.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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