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Management of Tibial Spine Avulsion Fractures by Pull Through Suture Method.

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ABSTRACT

Background: Avulsion fractures of tibial spine can be called as a variant of anterior cruciate ligament injuries and are described in both adults and children. **Surgical Technique:** The pull through suture technique offers a simple option of arthroscopic management of such injuries with minimal chances of loss of terminal extension due to bulky intra articular hardware as may be seen with screws. **Methods:** Between November 2013 and April 2016, the arthroscopic Pull Through Suture Method was used for 10 tibial spine avulsion fractures. All the patients were followed for a minimum of 6 weeks months post-operatively. **Results:** None of the patients had a positive anterior drawer test, Lachman test and pivot shift test at final follow-up. There was no patient with loss of terminal extension. **Conclusion:** The Pull Through Suture Method is a simple technique for management of tibial spine avulsion fractures.

Keywords: Tibial Spine Avulsion, Fracture.

INTRODUCTION

Any alteration in the anterior cruciate ligament (ACL) and its attachments can lead to alteration in knee kinematics and early secondary degenerative changes. The tibial eminence is anatomically the eminent confluence of the medial and lateral plateaus and contains two spines. The medial spine bears the broad attachment of the ACL. Insertion of ACL fans out from the tibial eminence and coalesces with the attaching fibers of the anterior horn of medial meniscus anteriorly and the anterior horn of the lateral meniscus posterolaterally. The anatomy of these attachments also known as transverse intrameniscal ligament is important as they may get interposed between the fracture bed and the fractured fragment thereby preventing a successful reduction. Tibial spine avulsion fractures, also known as tibial eminence fractures or ACL avulsion fractures, represent a variant of anterior cruciate ligament injury. Described first in 1895 by Poncet[1], it was only in 1959 that surgical management of type II injury of tibial spine was described by Meyers and McKeever.[2] Although commonly seen in children aged between 8-13 years as a sports related injury,[2-4] it can also occur in adults as a result of high energy trauma.[5] In such cases there is high incidence of associated injuries.

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The diagnosis is made on the basis of anteroposterior (AP) and true lateral radiographs [Figure 1]. In patients where better visualization of fracture fragments and degree of comminution is required a CT [Figure 2] scan of the knee can be done.[6] An MRI outlines the non-osseous concomitant injuries.[7,8]

Treatment of this injury depends on type of fracture and associated injuries[2,9] [Figure 3]. Anatomical reduction and rigid fixation are the guiding principle like in other fractures. In addition elimination of extension block and impingement due to displaced fracture fragments has to be addressed.

MATERIALS AND METHODS

Between November 2013 and April 2016, 10 patients of tibial spine avulsion fractures were treated by arthroscopic pull through suture method. There were no associated injuries in these patients. The patients' average age was 22years (range, 18 to 30 years). All patients were male and fall from a two-wheeler was the most common cause of injury. All the patients were operated within one week of injury. Post operatively the limb was put in a plaster cylinder for 4 weeks after which closed chain active exercises of the knee were started. Weight bearing as tolerated was allowed from first post op day except in patients with fracture lines in tibial metaphysis seen on CT or MRI, who were kept on toe touch weight bearing for 6 weeks. All the patients were followed for a minimum of 06 weeks postoperatively. The mean follow-up period was 14 months (range, 11/2 to 30 months) [Table 1]. Evaluation was done using radiographs and clinical examination.

Surgical Technique

The surgery was done with a standard knee arthroscopic setup. Few instruments, from the shoulder set are required for this surgery and include 90°suture lasso with wire loop (Arthrex), suture retriever, spinal needle no.18.

Standard anterolateral (AL) portal is made and adequate lavage is done to clear the hemarthrosis. Lavage is continued till clear fluid is seen in the outflow. This is important to have a clear vision of intraarticular structures [Figure 4]. Once the diagnostic round has been completed the anteromedial (AM) portal is created and the organized hematoma at the fracture site is removed with a mechanical shaver or a curette if required. In all cases the calf should be palpated at regular interval of time to assess compartment pressure. Once the fracture crater is adequately cleaned, the fracture is reduced and held with a K-wire from the supromedial portal or through a k wire passed with the help of tibial ACL jig [Figure 5]. The reduction is assessed with particular attention to the tibial articular surface. With the scope in lateral portal a 90° suture lasso is passed through medial portal and a bite is taken in posterior half of ACL substance as close to bony fragment as possible [Figure 6]. The cable loop is retrieved through the medial portal after the suture lasso is removed. Ethibond # 5 (or fiber wire no. 2) is passed through the loop and its pulled back so that now a double strand of ethibond is running through the ACL and both its arms are coming out through the AM portal [Figure 7]. Both arms are held in an artery forceps and kept away from the working area. Two drill holes are made with 2.7 mm guide wire and a tibial ACL jig, just medial and lateral to anterior cruciate ligament (ACL) and through the medial tibial cortex [Figure 8]. Spinal needle no.18 is passed through medial tibial drill hole. When the spinal needle is seen in the joint #1 prolene is passed through the needle for suture shuttle. The prolene loop is retrieved through the medial portal. Soft tissue bridges between both the ethibond threads exiting the lateral aspect of the ACL and the prolene loop are eliminated and the lateral ethibond threads are passed through the prolene loop outside the joint. The prolene loop is then pulled back while holding other end of ethibond with a hemostat. Both the lateral ethibond threads will be shuttled through the medial tibial tunnel. This step is repeated for ethibond threads exiting the medial aspect of the ACL and they are retrieved through lateral tibial tunnel. In full extension roof impingement is checked. If there is no obstruction to full extension sutures are tied independently over the suture wheel while the knee is held in full extension [Figure 9]. Post operatively the knee was put in a cylinder cast for 4 weeks after which closed chain active exercises of the knee were started. Weight bearing as tolerated was allowed from first post-op day except in patients with fracture lines in tibial metaphysis seen on CT or MRI, who were kept on toe touch weight bearing for 6 weeks.

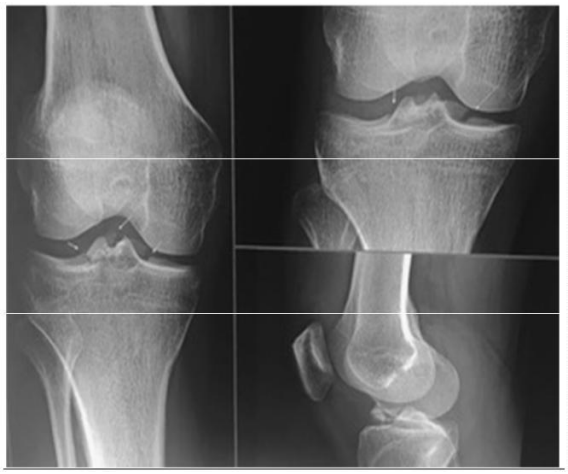

Figure 1: Pre-op radiograph.

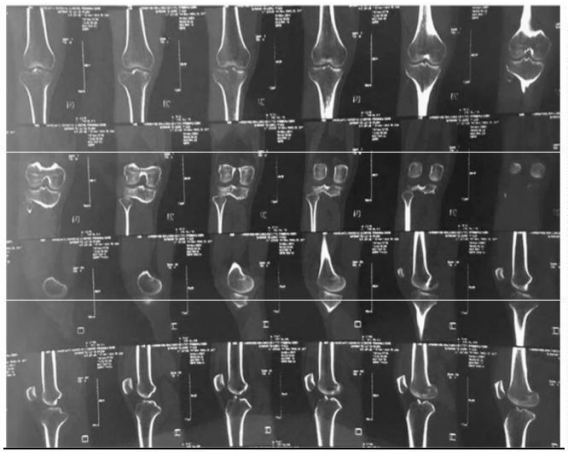

Figure 2: Pre-op CT showing comminution.

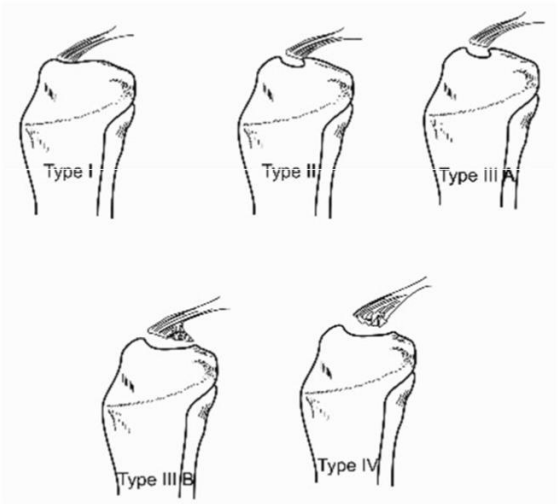

Figure 3: Classification of tibial spine fractures.
Type I: Undisplaced fracture of tibial eminence.
Type II: Partially displaced fracture.
TypeIII: Completely displaced Type III (further divided into IIIA and,
Type IIIA: involves only ACL insertion
Type IIIB: involves entire Intercondylar eminence.
Type IV:Comminuted fractures of tibial spine (later added by Zariczynj).

Table 1: Patient Demographics

Variable	Range
Number of patients	10
Age(years)	22 (18-30)
Gender	Males
Coexisting Injury	Undiplaced fracture of tibial metaphysis-1 (seen on CT)
Follow –up (months)	18 ($1^{1/2}$ to 30 months)

Figure 4: Fracture crater being cleaned.

RESULTS

On clinical assessment all the patients showed good or excellent clinical outcomes [Figure 10]. None of the patients had a positive anterior drawer test, Lachman test and pivot shift test at final follow-up. There was no patient with loss of terminal extension. Radiologically also union could be seen [Figure 11].

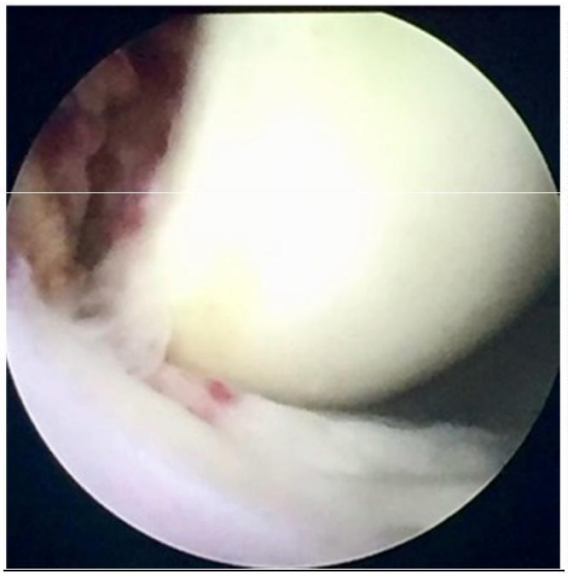

Figure 5: Fracture reduced and held with a k-wire.

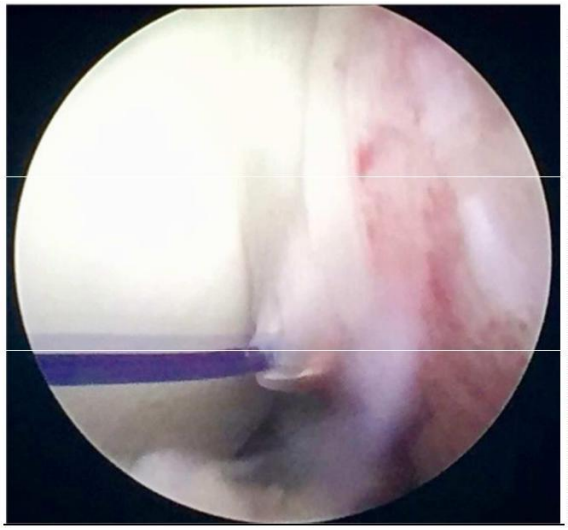

Figure 6: 90°suture lasso passed through ACL.

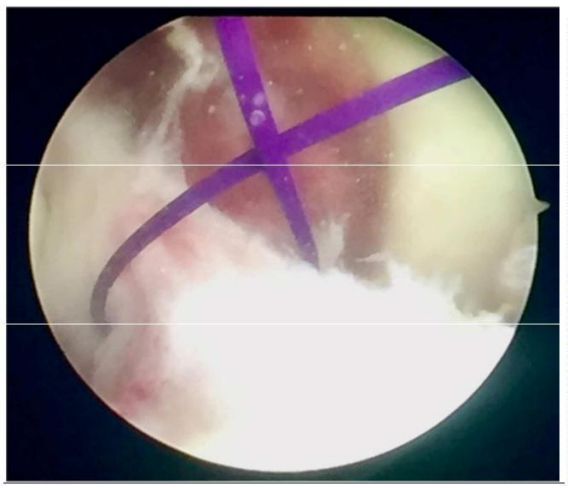

Figure 7: Suture loop passed through ACL.

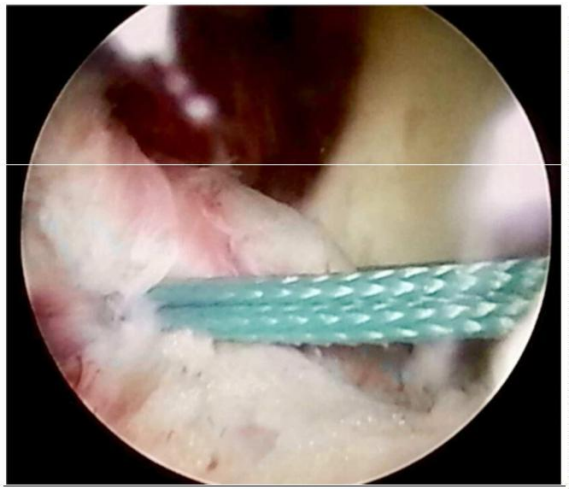

Figure 8: Doubled ethibond #5 pulled back through ACL.

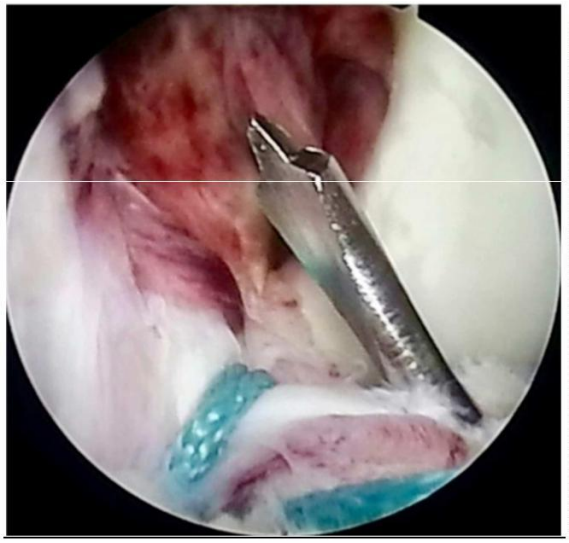

Figure 9: Tibial tunnel made just medial to ACL to retrieve lateral arm of ethibond.

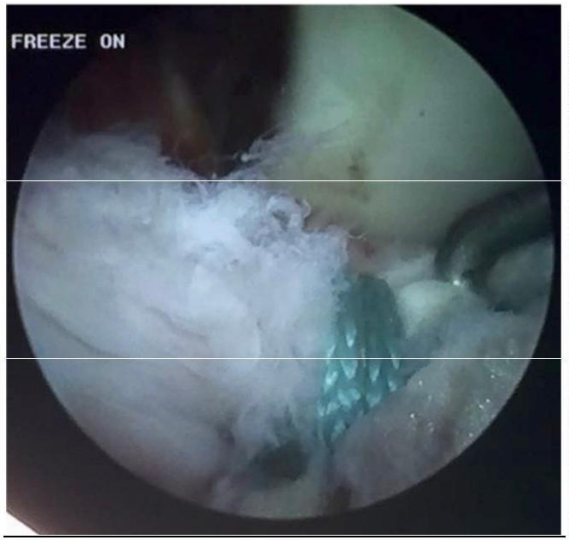

Figure 10: Ethibond pulled tight and tied over suture wheel.

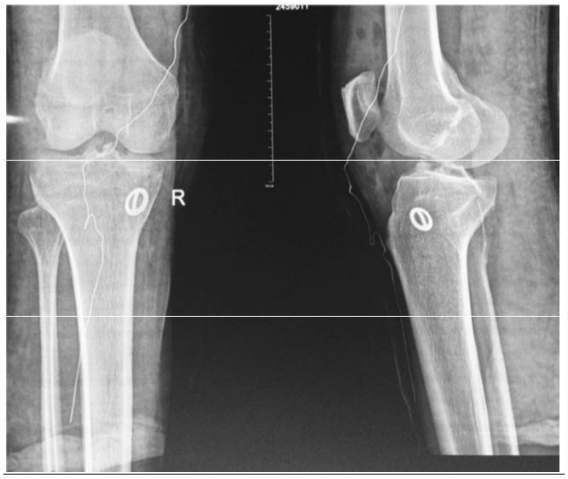

Figure 11: Immediate post op radiograph.

Figure 12: 6 weeks post op radiograph.

DISCUSSION

Tibial spine fractures are a disruption of the ACL complex.[10] Any residual displacement can lead to knee laxity. There is a tendency for late displacement even in anatomically reduced (closed) fractures.[11] Because of this reduction and fixation of all type II, III, and IV fractures is recommended. Faster rehabilitation, early mobilization, and decreased hospital stay have been made possible by arthroscopic management of this injury.

Other soft tissue injuries are commonly associated with tibial spine avulsion fractures.[5,12] These injuries include meniscal injury, ACL injury, and chondral injury. Identification and treatment of these injuries is important for a successful outcome. Arthroscopy allows for recognition and treatment of these associated soft tissue injuries as well.

Various arthroscopic methods of fixation have been described.[13,14] Hunter and Willis[12] and Jung et al.[14] have reported beneficial results with arthroscopic treatment of type II and III fractures.These are arthroscopic reduction and casting, and arthroscopic reduction and fixation with sutures, metal screws, bioabsorbable nails, Kirschner wire, and suture anchors. Fixation with a screw after arthroscopic reduction offers a firm

fixation[16] but screw insertion is possible only when the size of the fragment is >15mm.[3]This method is not indicated in the cases having small and comminuted fragments. For screw fixation, fracture fragment should be at least three times the size of the screw diameter to prevent disruption or weakening of the fracture fragment.[13] Hardware prominence is common with screw fixation, leading to notch impingement and extension loss. Hunter and Willis reported a 44% reoperation rate in patients treated with cannulated screws.[12]

Figure 13: Full extension at 6 weeks.

Arthroscopic reduction and percutaneous pinning is a simple procedure but fixation strength is relatively low, and chances of loss of reduction are always there. This technique is difficult if the fracture fragment is comminuted.[17]

An arthroscopic pull through suture is indicated for smaller comminuted fragments.[18] The advantages of suture fixation are no prominent hardware, no potential damage to an open physis, and better fixation in comminuted fractures.

In absence of comparative literature it is difficult to assess the best method of fixation. Some have reported a statistically significant difference in displacement favoring cannulated screw over ethibond sutures[19] where as others have found biomechanics of the suture fixation mechanically superior to cannulated screw fixation in cadaveric models.[20] Fiber wire sutures were found to be superior to ethibond sutures and 1 or 2 antegrade cannulated screws in both cyclical and single-cycle loading protocols.[21] Others have reported no significant difference between suture and screw fixations.[22,23] However it will be safe to conclude that comminuted fractures should be treated with suture fixation because screws are supposed not to provide adequate fixation in comminuted fractures.

Both Children and adolescents do well after fixation of tibial spine fractures.[12,24] Adults develop knee scores similar to post-ACL-reconstructed knees after operative fixation of tibial spine fractures.[16] Laxity, restricted motion, and persistent pain are the major complications seen.[1,12] Long-term function is more closely related to restriction of motion and pain than it is to laxity. Reduction in function after these injuries may be due to poor muscular control and requires an aggressive postoperative rehabilitation program in order to improve neuromuscular control of the limb.[25] Scarring in the anterior compartment of the knee may lead to loss of extension or flexion, requiring arthroscopic debridement and notchplasty to regain motion. Lack of full extension can also occur sometime due to the secondary displacement or from a malunion.[11] Nonunions are rarely seen.[26] Reduction and fixation with bone grafting is the treatment modality for symptomatic nonunions.

CONCLUSION

Tibial spine avulsion fractures are frequently seen by arthrosocopic surgeons. Prompt diagnosis and appropriate treatment usually lead to good results. Various treatment options exist and generally the results are good if an anatomic reduction is obtained. Arthroscopic pull through suture technique helps avoid complications like prominent hardware and extension loss.

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