A Novel Arthroscopic Fixation Technique versus Open Posteromedial Fixation

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Abstract

Purpose: The purpose of this study was to compare the results of Posteromedial (PM) open reduction internal fixation versus arthroscopic reduction and adjustable loop fixation of displaced Posterior Cruciate Ligament (PCL) tibial avulsion fractures, regarding healing, degree of posterior stability, Range of Motion (ROM), level of activity, complications and diagnosis of associated injuries.

Hypothesis: Arthroscopic fixation of posterior cruciate ligament tibial avulsion would have similar results to open reduction internal fixation in terms of stability however is a less invasive technique.

Methods: All patients with acute displaced PCL tibial avulsion fractures presented to our institute between 2009 and 2014 were included in the study. 12 patients were managed by arthroscopic reduction and fixation with a double button adjustable loop, (arthroscopic group AG). 17 patients were managed by open reduction and internal fixation with screw and washer through a posteromedial approach. The mean follow-up period was 32 ± 6 months. The operative time, time for healing and 3 different knee scores were compared between both groups.

Results: All patients were available at the final follow up. The healing in both groups was obtained at 3 month with no nonunion. There were no neurovascular complications reported in all patients of both groups. All patients of AG achieved full flexion at 2 month with the ability to pray on ground however the full flexion was achieved only by 14 patients (82.3%) of OG. Associated injuries were found in 10 out of 12 (83.3%) patients in the AG in the form of 5 medial meniscal tears, 4 avulsion of the tibial ACL, one avulsion of the ACL together with the anterior horn lateral meniscus. All associated lesions were managed by repair during arthroscopic procedure.

Conclusions: Both open and arthroscopic treatment for displaced tibial posterior cruciate ligament (PCL) avulsion fractures give good results in term of range of motion and knee stability, however the arthroscopy has the advantage of diagnosis and treatment of associated injuries in the knee.

Level of Evidence: Level III, prospective comparative study.

Keywords: PCL; Tibial avulsion; Arthroscopic

Introduction

PCL tibial avulsion fracture is not a rare injury especially with increased incidence of motorcycle injuries [1]. While non-displaced fractures could be treated with conservative management, in displaced fractures with posterior knee instability many (more than grade II) authors recommend fixation [2,3].

Open reduction and internal fixation is considered a gold standard treatment for such injuries with good results reported [4]. On the other hand much less reports about arthroscopic fixation with no published prospective comparative studies between both open and arthroscopic techniques. The open techniques which requires a direct posterior or modified posteromedial approach has the benefit of direct access with good stable fixation of the fragment however it carries the risk of neurovascular injury also big posterior incision with the risk of stiffness and increased pain postoperatively.

Arthroscopic techniques are less invasive; more precise reduction of the fragment as well as ability to manage comminuted posterior tibial avulsion being attached to the PCL fibers [5].
disadvantages of arthroscopic techniques include technical difficulty and learning curve, less rigid fixation. However, the most important merit of the arthroscopic technique is the ability to diagnose and manage associated intraarticular injuries simultaneously.

Our hypothesis was that the arthroscopic reduction and fixation of displaced posterior tibial spine avulsion with our novel fixation method would lead better results than the open technique especially in the terms of knee stability and range of motion. The other very important point was the ability of the arthroscopic technique to diagnose and manage associated intraarticular pathology in the same time.

Methods

The approval of the institutional review board in our university was obtained for this study. The nature of injury and both methods of management were discussed in details with all the patients and, all patients gave a written consent to participate in this research.

Patients

Patients with acute displaced posterior cruciate ligament tibial avulsion presented to our institute in the period between January 2009 and October 2014 were included in this study. The exclusion criteria included non-displaced fragment, low-grade knee instability, associated long bone fractures and, associated vascular injury.

Clinical assessment

In the emergency department general assessment, local clinical examination to diagnose associated ligament injuries was done and detailed history of the mode of trauma was documented. Vascular injury was rolled out in all cases. Radiological assessment was done in the form of anteroposterior and lateral radiographs and CT to study the fractured fragment and any commination. MRI was not done to all cases only cases with suspected associated injuries or cases that were referred to our center with an MRI, as our previous protocol of management for theses cases did not include an MRI [6].

Operative treatment

The patients were selected randomly according to date of admission to our institute. Patients whom were admitted during duty of the first author were assigned for arthroscopic surgery while, patients admitted during duty of the third author were assigned to open surgery.

Arthroscopic group: After spinal anesthesia the leg is draped in the standard fashion with the use of tourniquet. Arthroscopic examination of the knee is done using an anterolateral and anteromedial portals. Associated injuries if present is documented and managed in the same time. Through the posterior trans-septal approach [7] with posteromedial and posterolateral portals the posterior tibial avulsion of the posterior cruciate ligament is exposed and the fracture site is freshened with the shaver. Using the PCL tibial guide introduced through the anteromedial portal the fragment is reduced in place and fixed with K wire drilled through the anteromedial tibia through out the fragment. Then another guide wire is passed through the fragment and the substance of the PCL this guide wire is over drilled with a 4.5 drill after which an AC Tight Robe is passed through the 4.5 drill tunnel. The button is then flipped under vision over the fragment and the fibers of the PCL. Tightening of the AC tight robe is done from outside on the tibial side while applying anterior drawer force and knee flexed to 60 degrees to compress the fragment. After which the posterior stability of the knee is checked (Figure 1, 2).
Open group: After spinal anesthesia the leg is draped in the standard fashion with the use of tourniquet. The patient in supine position a posteromedial knee approach [8] was opened and the interval between the medial head of gastrocnemius and semimembranosus was developed. The posterior fragment was exposed after opening the posterior capsule of the knee and fixed with one or two partial serrated 4.5 cancellous screws and a washer. The wound was closed in layers over a drain for 24 hours.

Both groups were immobilized in knee brace for 2 weeks. After which gradual increase in the range of motion of the knee was allowed. Partial weight bearing is started after one month.

Assessment and Statistical analysis

Immediate postoperative X-ray and CT were done to confirm the reduction and position of the screws and or the tight robe. The progress of healing was followed by X-rays done at one and half month and three month and, at the final follow up. Lysholm score, Tegner score and, IKDC subjective and objective score were used to assess the knee function of the patient.

Paired Student’s t tests were used to compare preoperative and postoperative, IKDC subjective [9] and Lysholm and Tegner scores [10]. All statistical analyses were performed using SPSS software version 12 (SPSS Inc., Chicago, IL, USA). A P value of <0.05 was considered statistically significant.

Results

At the end of the study we had 29 patients all were males. 12 patients were in the AG and 17 were in the OG. Demographic data of the patients is presented in Table 1 and 2. There was no statistically significant difference between both groups in age, time between injury and surgery or knee instability.

Operative time

The mean operative time was 42.23 ± 4.5 min for the OG and 37.4 ± 4.2 min for the AG there was no statistically
significant difference between operative times of both groups.

**Bony Union**

Cases in both groups achieved full union with no cases of non or delayed union. The mean time for healing was 6.7 ± 0.6 weeks for the open group and 7.1 ± 0.7 weeks for the arthroscopic group.

**Range of motion**

The mean range of flexion at the final follow up was 127.64 degrees ± 9.03 for the open group and 137.916 ± 3.342 for the arthroscopic group. A statistically significant difference in the range of flexion was found p<0.03. The arthroscopic group patients had full knee flexion by 2 month and were able to pray on ground with deep flexion with weight bearing at three and half month after surgery. On the other hand complete knee flexion was obtained only in 14 out of 17 patients in the open group with 3 patients having limited knee flexion to 110 degrees. Other 4 patients in the open group were able to have full passive knee flexion but were not able to pray on ground in the deep-seated position.

**Symptoms and return to activity**

The IKDC subjective scores, Lysholm score, Tegner activity score showed statistically significant difference between the preoperative values and the final follow up. However there was no statistically significant difference between both groups (Table 3).

**Associated injuries**

Arthroscopy group had associated injuries diagnosed in 10 out of 12 patients. 7 patients had medial meniscal tear three tears required meniscal repair one fast fix and two out in repairs and other were treated with partial meniscectomy. 1 patient had partial tear of the ACL and, 1 patient had tibial avulsion of ACL treated by Anchor repair. 2 patients had ulcer medial femoral condyle has done drilling. Table No 3 show all the associated injuries found (Figure 3).

**IKDC and Stress X-ray**

The IKDC score was D for 13 patients in the open group and 9 patients in the arthroscopic group. At the end of follow up IKDC score was A for 70.6% of patients in OG (12 out of 17) and 91.7% of patients in AG (11 out of 12). And was B for 29.4 % and 8.3% of patients in OG and AG respectively. The mean side-to-side difference on stress x-ray [11] improved from 14.64 ± 0.46, 15.16 ± 0.27 preoperatively to 2 ± 0.24 and, 2.08 ± 0.25 for the OG and AG respectively. There was a statistically significant difference between the preoperative and final follow up and no difference between both groups (Table 4).

**Complications**

There were no vascular related complications in both groups either perioperative or postoperative. No wound related complications were reported during the study.
period. 3 patients in the arthroscopic group had injury of the sensory branch of the saphenous nerve while making the posteromedial portal; they had sensory loss on the anteromedial aspect of the leg with persistent numbness for 7 month postoperatively.

Discussion

In this study both groups had satisfactory results by the end of follow up with complete union of the fragment within 7 weeks with no statistical significant difference. Both groups had showed a statistically significant improvement in the postoperative Lysholm and IKDC compared to the preoperative scores with no significant difference between the groups. The most important point was that 83% of the patients in the arthroscopic group had associated lesions; this high incidence of associated pathology could be missed in the open group. Since the corner stone for the diagnosis for the PCL tibial avulsion is the plain X-ray and CT scans to study fragment size and comminution and, MRI is not done for all cases leaving a big chance for missing associated injuries with open management of PCL tibial avulsion. In a recent study by D Sabat et al found associated injuries in 11 out of 20 patients done arthroscopic fixation for PCL avulsion [12]. Other study by Szu-Yuan Chen et al found associated injuries in 23% of 36 patients [13].

Open approach which is considered by many as the standard treatment for PCL tibial avulsion[4] could be done through, a posterior approach, modified posterior approach,
and posteromedial approach, and modified posteromedial approach have been described. The posteromedial approach through the interval between the medial gastrocnemius and semimembranosus tendons has the advantage of protecting the neuro-vascular bundle lateral to the medial head of gastrocnemius and easy access to the back of the knee to fix the fragment however it is difficult to obtain adequate exposure of the lateral base of the PCL tibial avulsion and capsule, and there is difficulty in placement of the screw perpendicular to the fracture plane with the PM approach specially in obese patients.

The main disadvantages of open approach are the need for a big incision with possible scarring and stiffness especially in flexion as well as the difficulty to manage obese patients. Also with open fixation with anterograde screw can’t be used for comminuted fragments or when the fragment size is small as well as the need for hardware removal latter on. The arthroscopic approach on the other hand is minimal invasive and can be done for obese patients without increased risk as well as it allows an accurate reduction and strong fixation and also, can manage associated injuries in the same time. The main disadvantages are the learning curve and the possibility of compartment syndrome; this was avoided in our study by using fluid inflow without pump.

The first arthroscopic assisted reduction and percutaneous fixation was done experimentally in 1988 [14]. The first clinical report on percutaneous screw fixation under arthroscopic control was done 1995 [15] thereafter; arthroscopic techniques arthroscopic techniques for PCL bony avulsion fixation have been described that differ in the number of posterior portals used, the implant used for fixation, and the number of tibial tunnels.

Arthroscopic fixation of the PCL tibial bony avulsion could be done with the use of one or two posteromedial portals [16,17] or, through a posterolateral and posteromedial portals with posterior trans septal approach [18]. In our study we used the trans septal approach because of the very good visibility of the fragment that allows for accurate reduction and assessment of the reduction through the posterioromedial and posterolateral views. The one or two posteromedial approach had a limited view and the working portal is so close to the viewing portal leading to some difficulty.

For fragment fixation many options were published retrograde cannulated screws, tension-band wires, K-wires, anchors, Mersilene tape (Ethicon) with a suture disk, sutures, an EndoButton (Smith & Nephew) and a double spiked plate, and TightRope devices (Arthrex) [19] have been used. The main advantage of the double button TightRope is the uniform distribution of loads all over the construct and the easy application the strong fixation. In biomechanical study by Christoph Domnick [20] et al comparing four methods of PCL tibial avulsion fixation showed that a double button fixation had the least elongation with comparable stiffness and strength to anterograde screws. Eggers et al. [21] evaluated the initial fixation strength of 4 different fixation techniques for tibial eminence fractures the biomechanical data suggested that under cyclic loading conditions, suture fixation of tibial eminence fractures provides more fixation strength than screw fixation.

More recently, Horas et al. [22] and Wajsfisz et al [23] proposed new methods using transtibial shuttle techniques with encouraging results. Both groups concluded that the all-inside suspensory devices assessed presented easy-to-handle techniques that offered homogeneous distribution of pressure to the avulsion side and could be extended to fragments of any size.

Our study showed very good results with the use of double button fixation and posterior trans-septal approach. First the posteromedial and posterolateral portals give a good exposure of the fragment allowing for accurate reduction and assessment of fragmentation. The double button fixation is very easy to use with no suture management problems as well as uniform distribution of loads through the entire construct. The disadvantage of this fixation is the small size of the posterior button that could be needed to compress over the fibers of the PCL in case of fragmented fracture also, the use of the 4.5 drill for the passage of the button should be positioned with caution in the center of the fragment to avoid fracture.

The main advantage of strong fixation is the ability to adopt an accelerated rehabilitation protocol to avoid postoperative stiffness. Although previous reports recommended cast immobilization after fixation of displaced PCL avulsion fractures [24], and this could explain the associated high incidence of stiffness. In our study both groups had very good range of motion by 3 month with the arthroscopic group showing better results of deep knee flexion allowing them to pray on ground without discomfort.

We did not report any vascular related complications in both groups. The most common complication in our study was the injury of the superficial branch of the saphenous nerve with lost sensation over the anterior aspect of the leg and it occurred in 3 out of 12 patients in the arthroscopic group.

The limitation of this study was the small number of the patients but this could be justified by the uncommon incidence of the injury. The second limitation was that the first author operated the arthroscopic group while the third authoroperated the open group, which may lead to selection bias. However other surgeon that was not involved in the surgery did the final assessment.

Conclusion

Both the open and arthroscopic approach lead to good results for treatment of PCL tibial avulsion. The arthroscopic approach had the benefit of diagnosis and management of associated injuries as well as a less invasive treatment especially in obese patients. We recommend the use of MRI for accurate diagnosis of associated injury especially with open approach.

References


