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ORIGINAL RESEARCH

Posterior cruciate ligament avulsion fixation: A minimally invasive retrograde fixation by a single cannulated screw

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Abstract

The optimal surgical treatment of isolated tibial avulsion fractures of the Posterior Cruciate Ligament remains controversial. The purpose of this study was to evaluate the results of an arthroscopic technique using two ordinary portals and an incision to stabilize an avulsed fragment. Five patients were treated and followed up for 4 years. The mean score measured by KT-2000 was 9.2 mm preoperatively, 4.6 mm a year (P<0.042) and 3.8 mm 4 years postoperatively (p<0.041). This study showed that fixing the PCL avulsion fractures by a cannulated screw could improve knee function and stability.

Keywords: Posterior cruciate ligament; Posterior cruciate ligament; Avulsion fracture; Arthroscopy; Knee stability

Introduction

The posterior cruciate ligament is a key element in knee stabilization. [1,2] The major role of PCL is to serve as a central axis controlling and imparting rotational stability to the knee. [3] About 20% of knee ligament injuries are linked to the PCL, which usually happen in cases resulting from high-energy trauma, such in motorcycle and car accidents. Furthermore, athletes mainly sustain the PCL injuries in contact sports.[4,5]

Unlike the anterior cruciate ligament (ACL) injuries, PCL injuries have received lesser attention in the literature. However, the emphasis on the ACL has resulted in an increased interest in the treatment of PCL injuries. One of the rare PCL injuries, which is controversially managed is the isolated PCL avulsion fractures at tibial insertion. [1,2]. The most effective technique to manage these types of PCL injuries is yet to be determined. However, it is a consensus that a displaced or unstable bony avulsion of the PCL should be anatomically reduced and rigidly fixed. [3] A displaced PCL avulsion fracture of the knee at its tibial attachment requires a surgical

treatment. [6] Various techniques for PCL avulsion surgery have been reported, such as alternatives to prevent potentially injurious exposure of the popliteal fossa. It is less controversial that displaced bony PCL avulsions need surgical repair and several open and arthroscopic techniques have been described for this purpose. One of the most common orthopedic procedures performed worldwide is arthroscopic knee surgeries.[7] One of these procedures that has been shown to have good strength and fracture stabilization is cannulated screw fixation. This procedure is considered to be less invasive, and could be performed relatively safe with low complication rates.[8] The large (3 cm or more in width) and rarely small (1.5 cm or less in width) fragments of an avulsion fracture of the PCL with multiple cannulated screws could be arthroscopically fixed.[5] Using this technique leading to achieve a bony union by 4 months following surgery. Furthermore, early and easy screw removal in this technique results in a more complete union.[6] In this study, we attempted to design a simpler, less invasive and safer arthroscopic technique to fix PCL avulsion using just a retrograde cannulated screw with anterior approach.

Materials and Methods

Five patients (all male) with the average age of 30.6 years (range from 24 to 35) were treated arthroscopically for PCL avulsion fracture during 2007 to 2010. The diagnosis was made by clinical examination and plain X-Ray and was confirmed by MRI and stressed X-Ray while knee was in 30° flexion. The demographic characteristics of all patients are shown in table 1.

Case number	Sex	Age	Side	Mechanism	Injury to surgery	Associated injury	KT2000 before surgery (MM)	Size of screw
1	Male	35	Right	MVA	2	PHMM tear	11	60mm
2	Male	32	Right	MVA	2	PHMM tear	8	55mm
3	Male	29	Left	Bike accident	3	None	10	55mm
4	Male	30	Right	MVA	2	None	9	55mm
5	Male	27	Left	MVA	3	Partial tearing of ACL & MCL	8	60mm

Table 1: Demographic Information of Patient
Abbreviations: MVA: motor vehicle accident, ACL: anterior cruciate ligament, MCL: medial collateral ligament, PHMM: Posterior horn of medial meniscus

Surgery was performed 48-72 hours after the trauma in order to confirm the normal function of the popliteal artery and vein. By patient in supine position using a tourniquet and flex the knee to 70°. The main procedure began with reversed notch plasty (limited synovial membrane shaving) and diagnostic arthroscopy. An Anterior Cruciate Ligament tibial JIG was used in order to fix the avulsed fragment. The JIG was inserted through antero medial portal and was fixed on the postero-superior part of avulsed fragment. Its location was then checked using a C-Arm system (Figure 1). Subsequently, a guide pin was drilled into the avulsed fracture that was fixed with a cannulated screw and washer (Figure 2). In this procedure, tibia's ACL JIG to the main part of bone compressed the avulsed fragment. During the whole procedure a C-arm system was used to ensure about the correct placement of the JIG and the guide tip threaded pin. Finally we fixed the avulsed fragment by cell-to-cell reduction and only one proper size retrograde 6.5 mm cannulated screw.

The knee was immobilized relatively with a soft knee immobilizer for 3 weeks with permission of at most 45-degree gentle passive motion by physiotherapist. Patients were not fully allowed to walk on the injured leg and had partial weight bearing for the first 5 weeks after the surgery by two crutches. After this period of time, patients were allowed to do daily activities, such as walking, swimming, etc. All the patients were asked to complete full weight bearing for maximum of 8 weeks period of time after the surgery day.

The patients were followed up for at least 4 years using serial radiographies and physical examination at each visit. For evaluating the knee function after a year post-operation three standard scoring scales for ligamentous injuries were used: a form provided by hospital for special knee surgery ligament rating, the Tegner activity score and the Lysholm knee scoring scale. The side-to-side instability of knee was also measured with KT-2000.

After synovectomy and diagnostic arthroscopy, our main procedure has just begun. In order to fix the avulsed fragment we used Anterior Cruciate Ligament tibial JIG. We inserted the JIG through anteromedial portal and fixed it on the postero-superior part

of avulsed fragment and checked its location by C-Arm (figure 1). Then we drilled a guide pin in avulsed fracture and fixed it with a cannulated screw and washer (figure 2).

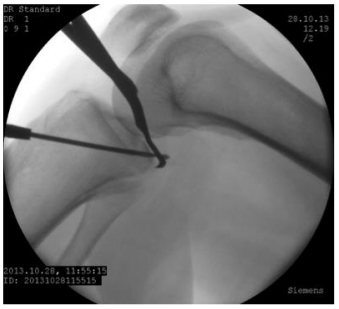

Figure 1: ACL JIG is placed on posteromedial surface of the avulsed fragment to reduce and maintain the fragment and a guide pin is inserted.

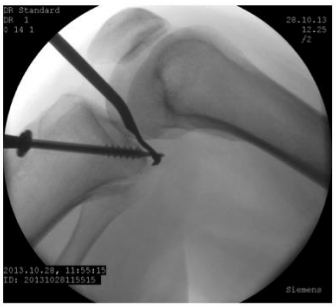

Figure 2: This image shows the placement of the cannulated screw through the avulsed fracture.

Results

Patients were followed up for at least 4 years (range from 4 to 7 years). All the patients had full range of motion a couple of weeks post-operation. Serial radiographies indicated that healing of the avulsion fractures occurred 3 months post-operation. There were no sign of mal-union and non-union in patients participated in this study.

Wilcoxon-signed rank test was used for statistical analysis. The side to side difference of knee laxity was examined using posterior drawer test by a KT-2000 (Med metric 125846890) prior to the surgery. a year post-surgery and on the last visit. The mean score, measured by a KT-2000, was 9.2 mm (ranges from 8-11 mm) before the surgery, 4.6 mm (ranges from 4-5 mm, p= 0.042) a year post-operation and 3.8 mm (ranges from 3-6 mm, p= 0.041) 4 years post-operation.

In order to evaluate the knee function, three standard scoring systems were used as mentioned above (table 2).

Case number	Follow up (year)	Tegner score		Lysholm score		HSS		KT2000	
		1 year	final	1 year	Final	1 year	final	1 year	Final
1	6	6	7	90	90	54	54	4	4
2	6	7	9	90	90	52	50	4	3
3	6	8	7	90	90	49	45	5	3
4	4	9	9	90	86	50	54	5	5
5	3	9	9	90	90	50	54	5	4

Table 2: Patient demographic outcomes.
Abbreviations: HSS: Hospital for special surgery ligament rating form

The mean score achieved using the form provided by the hospital for Special knee surgery ligament was 51 out of 58 (ranging from 49-54) a year post-operation and 51.4/58 (ranging from 50-54) 4 years post-operation. Patients' Tegner activity score was 7.8 out of 10 (ranging from 6-9) one-year post-operation and 8.2/10 (ranging from 7-9) four years post-operation. Patients' lysholm knee score was 90 out of 100 (ranging from 85-90) one year post-operation, while it was 89.2 out of 100 (ranging from 75-90) four years post-operation. No post-surgical complications, such as heterotopic ossification or calcification or septic knee arthritis, hemarthrosis, etc., occurred in this study.

Discussion

The primarily aim of this study was to, designed a simpler, less invasive and safe arthroscopic technique to fix PCL avulsion by just a retrograde cannulated screw with anterior approach. The results of this study showed that arthroscopically fixing of the fracture with a retrograde cannulated screw improves knee function and restores knee stability in pure PCL avulsion from tibial side. It has been reported that open reduction and fixation with cannulated screw is one of the excellent techniques for tibial avulsion of PCL. [2] In addition, arthroscopic knee surgery is considered minimally invasive and can be conducted relatively safely.[9]Avulsion fracture of the PCL is a rare condition, and arthroscopically assisted reattachment of the surgical fixation of the fragment is not always an easy task. However, it gets more attention due to the important role of PCL in maintaining the knee stability.[10] only a few reports describe techniques for arthroscopic fixation of avulsion of the PCL. [10,11] Little john and Geissler first reported a case with

arthroscopic repair of PCL avulsion, fixed with a cannulated screw. [12]

Most surgeons believe that surgical treatment of this injury even when the fracture is not significantly displaced is necessary as the conservative treatment alone may lead to non-union and further knee instability.[13]Surgical treatment is still a challenge for the orthopedic surgeons who try to achieve a safe and simple technique to decrease the complications, such as knee instability.[14] Many surgeons still prefer open reduction and internal fixation to treat these fractures.[15] In this procedure, surgeon should use posterior or posteromedial approach which may damage popliteal nerve and vessels which may lead to further morbidities. Another disadvantage of this technique is the impossibility of avoiding the associated injuries.[10]There are few studies available about arthroscopic treatment of these fractures. In most arthroscopic techniques, K-wire[16] and sutures are used if the size of the fracture is <15mm or when the avulsed bony part is comminuted[17,18] which may cause popliteal damage as a result of using posterior portals.[19]In addition, making bony tunnels is difficult and complicated due to the size and location of the tibial insertion of the PCL .[20] In order to fix the larger segments, surgeons usually use cannulated screws which can be used as either retrograde or antegrade.[5]This technique was first experimentally carried out by Martinez-Moreno and Blanco-Blanco on 8 cadavers in 1988.[21]

According to the literature, most of authors who used retrograde cannulated screw to treat this injury used 2 or more cannulated screws to fix the fracture.[22,23] This increases the risk of damage the body of PCL as well as crushing the avulsed segment.[24] In a study on 5 patients with PCL avulsion fracture in 2003, Shino et al used only one screw and two guide pins in 2 patients.[5] In previous studies, K-wire was used as the guide pin.[22,23]In the present study, one screw and a guide pin were used in our participating patients. In this study, complete healing was achieved about 3 months post-operation which is a month earlier than that achieved by Shino et al.[5] All other studies have reported that the healing time were between 3 to 8 months post-operation.[14]

Rehabilitation and early range of motion after surgery not only may prevent complications, such as arthrofibrosis but also facilitates bone healing. [11] It has been indicated in other studies that arthroscopic treatment itself decreases the rehabilitation time and patients can begin the range of motion earlier.[11] In the other studies, patients used knee immobilizer for 8 weeks, and weight bearing was not allowed for the first 3 weeks post-operation. Patients had partial weight bearing using crutches in the first 6th week and start full weight bearing and appropriate activities were allowed after.[11] In this study, patients followed the same rehabilitation process and gained complete weight bearing 8 weeks post-operation.

In arthroscopic techniques, replacement of the displaced segment by PCL guide is difficult[22] therefore, surgeons usually use a probe or anterior cruciate ligament guide.[22,23] Shino et al used an elbow aimer of the Acufix director drill guide instead.[5] In our study, an ACL JIG was used to reduce the fracture fragments. In order to reassure that the avulsed segment is replaced and the screw is placed in its right place a C-Arm system was used during the surgery. In this procedure, using JIG makes it possible to estimate screw's length and appropriate pathway to enter the guide pin. Therefore, there is no need to use several guide pins.

According to some MRI evaluation, 50% of patients with PCL avulsion fractures develop further plastic deformity. This complication causes further knee instability.[25] Reported side-to-side differences vary in different studies due to different fixation techniques. In the present study, the mean side-to-side difference post-operation, which was measured by KT-2000, was 3.8mm, which significantly improved ($p < 0.05$).

Using arthroscopy seems difficult and complicated. However, in the present simple technique two anterolateral and anteromedial portals were used. Appling the JIG and the guide pin makes the avulsed segment to be anatomically reduced and finally the PCL returns to its actual length. Therefore, there is no need to use several sutures and bony tunnels. Washer is frequently used for comminuted thin fragments in anterior cruciate ligament avulsion fractures.[26] Veselko et al. used washer and antegrade cannulated screw to fix PCL avulsion fractures which had encouraging results.[11] This study had some limitations: 1. Limited number of participants, which was because of the lesser incidence of

PCL avulsion fractures. 2. The technique used in this study can be only used when the size of the avulsed fragment is large enough (>15mm).

Conclusion:
As a result, this study showed that arthroscopically fixing of the fracture with a retrograde cannulated screw improves knee function and increases knee stability. Morbidity was decreased because the anterior approach and just one screw were used in this procedure.

Conflict of interest
Authors declare no conflict of interest.

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