Injury, Int. J. Care Injured 44 (2013) 1028–1032

Contents lists available at SciVerse ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Novel arthroscopic fixation method for anterior cruciate ligament tibial avulsion fracture with accompanying detachment of the anterior horn of the lateral meniscus: Three-point suture fixation

Ki-Mo Jang [a], Ji-Hoon Bae [b], Jae Gyoon Kim [c], Joon Ho Wang [a,*]

[a] Department of Orthopaedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50 Ilwon-Dong, Kangnam-Gu, Seoul 135-710, South Korea
[b] Department of Orthopedic Surgery, Korea University College of Medicine, Ansan Hospital, Ansan Si, Gyeonggi Do, South Korea
[c] Department of Orthopedic Surgery, Korea University College of Medicine, Guro Hospital, Seoul, South Korea

ARTICLE INFO

Article history:
Accepted 6 December 2012

Keywords:
Anterior cruciate ligament
Tibial avulsion fracture
Lateral meniscus anterior horn
Three-point suture fixation

SUMMARY

Purpose: The purpose of this study is to present and evaluate a new arthroscopic technique using three-point suture fixation for anterior cruciate ligament (ACL) tibial avulsion fracture with accompanying detachment of the anterior horn of the lateral meniscus.
Methods: Eleven patients with a diagnosis of ACL tibial avulsion fracture underwent arthroscopic suture fixation from January 2007 to December 2009. Out of the 11 patients, six had cases of ACL tibial avulsion fractures (four were type III and two were type IV) with accompanying detachment of the anterior horn of the lateral meniscus and were treated using three-point suture fixation. The patients were followed up and evaluated according to Lysholm scores, International Knee Documentation Committee (IKDC) subjective scores, Tegner activity level scales, anterior drawer testing and KT-2000 arthrometer testing.
Results: All patients were followed up for more than 2 years (range 25–40 months). The fracture fragments were united at a mean of 10.3 weeks (range 8–13). All patients were negative for the Lachman test and the anterior drawer test and had <3 mm side-to-side difference with the KT-2000 arthrometer. The postoperative mean Lysholm score improved to 98 (range 96–100, $P < 0.05$). The postoperative mean IKDC subjective score was 93.3 (range 91–98, $P < 0.05$). The median Tegner score improved from 2.5 (range 2–3) to 8.5 (range 8–9) postoperatively ($P < 0.05$). The type of avulsion fracture (III or IV) did not significantly impact clinical results (Lysholm score, IKDC score, Tegner activity level, $P > 0.05$).
Conclusion: ACL avulsion fractures with accompanying detachment of the anterior horn of the lateral meniscus should be treated as another type of ACL avulsion fracture. Arthroscopic treatment using the three-point suture fixation technique is effective for this type of ACL avulsion fracture and can restore the function and stability of the knee joint.

Anterior cruciate ligament (ACL) tibial avulsion fractures are relatively uncommon injuries with an incidence of approximately 3 per 100,000/year (only 1–5% of ACL injuries in adults). Currently, the preferred treatments for these fractures are arthroscopy-assisted techniques.[1,2]

Meyers and McKeever first developed a system for classifying ACL avulsion tibial fractures.[3,4] Type I fractures are minimally displaced fractures, type II fractures show elevation of the anterior half or third with the posterior half remaining on the tibia and type III fractures are completely displaced fractures. Later, Zaricznyj modified this classification and suggested that comminuted avulsion fractures should be classified as a type IV fracture.[5] Most surgical treatments have been performed according to this modified Meyers and McKeever classification. However, this classification does not take into account associated soft-tissue structures around the fracture fragment. In fact, in many cases of ACL tibial avulsion fractures, avulsed fragments are frequently associated with not only ACL fibres but also detachment of the anterior horn of the lateral meniscus. The approach that should be taken in the treatment of this type of ACL avulsion fracture can be unclear as there is no specific classification and treatment method.

The lateral meniscus has an integral role in normal knee joint mechanics. It is responsible for load bearing, energy absorption, lubrication of the articular cartilage and joint stability.[6,7] If any tears or detachment of the meniscus occur, the structure's hoop tension capability can be irreversibly disrupted. Thus, detachment of the anterior horn of the lateral meniscus should be treated with the goal of normal joint mechanics and function. However, there

* Corresponding author. Tel.: +82 2 3410 3507; fax: +82 2 3410 0061.
E-mail address: mdwang88@gmail.com (J.H. Wang).

0020–1383/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.injury.2012.12.008

have been no reports on specific treatments for the detachment of the anterior horn of the lateral meniscus associated with ACL tibial avulsion fractures.

This study retrospectively reviewed and evaluated six patients treated with arthroscopic three-point suture fixation for ACL tibial avulsion fractures with detachment of the anterior horn of the lateral meniscus. The purpose of the present study is to present this novel arthroscopic suture fixation method and to assess its efficacy. We hypothesise that arthroscopic three-point suture fixation may produce satisfactory clinical outcomes.

Materials and methods

From January 2007 to December 2009, 11 patients diagnosed with ACL tibial avulsion fracture were treated using arthroscopic suture fixation. Of the 11 patients, six patients (54.5%) were diagnosed as having ACL tibial avulsion fracture with detachment of the anterior horn of the lateral meniscus and underwent arthroscopic suture fixation using the three-point fixation method. The other five patients, who did not have detachment of the anterior horn, were treated using traditional two-point pull-out suture fixation. The inclusion criteria for the study were a displaced ACL avulsion fracture (Meyer and McKeever type III and Zaricznyj type IV) with detachment of the anterior horn of the lateral meniscus and anterior knee instability of grade II or higher (Fig. 1). Patients who completed the minimum 2-year follow-up were included in the final analysis. The six patients were all males and all had acute fractures. The mean age of patients at surgery was 30 years (range 14–49). Two patients incurred fractures in their second decade. All patients were assessed by preoperative magnetic resonance imaging (MRI) to confirm a detached anterior horn of the lateral meniscus (Fig. 2). Anterior instability was determined by the anterior drawer test and the Lachman test. We did not use the KT-2000 arthrometer (MEDmetric Corp, San Diego, CA, USA) preoperatively in order to avoid further displacement of the fracture fragments.

Four of the injuries were sports-related (three skiing accidents and one soccer injury) and two were a result of traffic accidents. Two of the six patients had combined injuries (one had a grade II medial collateral ligament injury and the other had a medial meniscus radial tear). Conservative treatment was applied after operation for the MCL injuries and partial meniscectomy was performed for the meniscus tear.

Fig. 1. Preoperative anteroposterior (AP) and lateral (LAT) radiographs of type III acute ACL tibial avulsion fracture (Case 6).

All patients were followed up beginning at postoperative 2 weeks and every 4 weeks until union was observed. Clinical outcomes were assessed using Lysholm knee scores, Tegner activity level scales, International Knee Documentation Committee (IKDC) subjective scores, the anterior drawer test and the KT-2000 arthrometer. Antero-posterior and lateral plain radiographs were used to evaluate healing of fracture. Fracture union was defined as the lack of a visible fracture line on the radiographs.

Surgical technique

All surgical procedures were performed by a single orthopaedic surgeon (W.J.H.). Spinal or general anaesthesia was administered to the patient. Standard knee arthroscopy was performed with anterolateral (AL) and anteromedial (AM) portals using a 30°, 4.0-mm arthroscope (Linvatec, Largo, FL, USA). The joint was fully examined. Any concomitant meniscal pathology that required attention was corrected before the status of the ACL was assessed. The knee was then flexed to 45–60°, and the anterior knee compartment was debrided. In all patients, we used an additional lateral mid-patellar portal for a wider and better view of the intercondylar tibial eminence. From the perspective of the lateral mid-patellar portal, removal of any haematomas, fracture debris or interposed tissues was performed using a motorised shaver through the AM and AL portals. In cases of transverse intermeniscal ligament interposition, we used a probe to pull the ligament anteriorly to reduce the displaced fragment. If the intermeniscal ligament prevented reduction and could not be mobilised effectively, the ligament was resected. A superiorly displaced fragment of the anterior tibial eminence was found in the intercondylar notch. In cases with a detached anterior horn of the lateral meniscus, the ACL and the anterior horn of the lateral meniscus were attached to the fragment. The avulsed osseous fragment involved the insertion sites of both the ACL and the anterior horn of the lateral meniscus (Fig. 3(a)). After debridement of the blood clot around the avulsed osseous fragment, we were able to reduce the fragment anatomically while maintaining the posterior drawer.

Before suture placement, a 2-cm vertical incision was created at approximately 3 cm distal to the joint line with the mid-portion between the tibial tuberosity and the medial edge of tibia. The periosteum was also elevated to expose the bone surface. Using an ACL tibial drill guide, three separate 2.7-mm tibial tunnels were drilled obliquely from the proximal AM tibia towards the crater of the fracture site. The positioning of the drilled holes at the ACL avulsion crater was critical to the stabilisation of the reduced fracture fragment and the anterior horn of the lateral meniscus. The holes were guided to be placed in a triangular formation in the marginal area of the ACL avulsion crater (Fig. 4). One hole was placed medially (medial hole) and the other two holes were placed laterally (AL hole and posterolateral hole) (Fig. 3(b)). Then, viewing from the lateral mid-patellar portal, crescent and straight suture hooks (Linvatec, Largo, FL, USA) loaded with No. 0 PDS (Ethicon, Sommerville, NJ, USA) were introduced. Typically, two sutures were introduced by a crescent suture hook through the accessory AM portal, while the other two sutures were introduced by a straight suture hook through the standard AM portal. The suture hook pierced the ACL bundle just above the superior border of the avulsed fragment, securing the entire thickness. The PDS was then advanced out through the hook, and, using a suture retriever (Linvatec, Largo, FL, USA), the end of the PDS was brought out to the AL portal. Both ends of the PDS were gathered with a haemostat for later identification. Three additional sutures were passed through the ACL fibre parallel to the previous sutures. A wire loop was then advanced through each