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Technical note

A mini-invasive technique for severe arthrofibrosis of the knee: A technical note

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ABSTRACT

Purpose: In this article, a mini-invasive technique is described, which consists of arthroscopic adhesiolysis and quadriceps pie-crusting lengthening basing on pre-operative sonographic examination. Sonographic diagnostic value of quadriceps tendon fibrosis is also evaluated.
Methods: Pre-operative sonographic examination was performed to make an accurate location diagnosis of quadriceps fibrosis. After arthroscopic adhesiolysis, percutaneous pie-crusting release was performed basing on preoperative sonographic examination. An 18-gauge needle was used to puncture the stiff fibrous band of the distal and lateral quadriceps tendon under maximum knee flexion. The contractural quadriceps tendon is gradually released after 60–100 needle punctures.
Results: This technique was performed in five post-traumatic stiff knees and three stiff knees after previous infection. The contractural rectus femoris tendon is average 22% thinner than contralateral parts according to sonographic measurement. Mean maximum flexion increased from 35° preoperatively to 80° after arthroscopic adhesiolysis and 120° after pie-crusting.
Conclusions: This technique is a simple, effective and mini-invasive method, allowing an immediate, aggressive rehabilitation postoperatively. Pre-operative sonographic location of quadriceps tendon fibrosis could potentially improve the efficacy and accuracy of percutaneous pie-crusting procedures.

Introduction

Arthrofibrosis, abnormal scarring of the joint, was a tough complication of fractures, joint infection and total knee arthroplasty. The treatments for arthrofibrosis include physiotherapy, aggressive pain management, manipulation under anesthesia, arthroscopic release, and open sugical release [1]. The arthroscopic approach is a less invasive approach that has been advocated for both focal, discrete lesions as well as for more global arthrofibrosis [2]. Quadriceps contracture and atrophy usually accompany arthrofibrosis since the intra-articular adhesions prevent normal range of motion and constrain the extensor mechanism [3].

Quadricepsplasty is a well-known procedure to improve extension contracture of the knee [4]. Traditional treatments such as Thompson quadricepsplasty [5], Judet quadricepsplasty [6] and their modifications [7,8] require extensive exposure and can result in recurrent adhesion, permanent extensor lag and infection. Although several modified approaches to quadricepsplasty [9–12] with limited exposure have been described, most cannot avoid transverse incisions in the quadriceps, with risk of extension lag. We have previously reported success with percutaneous approaches involving needle puncture of the quadriceps [13,14]. However, location of fibrosis in quadriceps was identified by the sense of touch in previous procedures. Sonographic examination is a precise method for diagnosis of muscle fibrosis [15] and expected to be a good preoperative evaluation method, which has been less implied in quadricepsplasty.

We describe a simple and effective technique, arthroscopic adhesiolysis combined with percutaneous quadriceps pie-crusting lengthening basing on pre-operative sonographic examination. It could provide a minimally invasive alternative to release arthrofibrosis and extension contracture of the knee.

Pre-operative examination

Patients were diagnosed with arthrofibrosis on the basis of the following criteria: reduced range of motion (maximal range of motion of <80°); an interval of more than 3 months after the last surgical or conservative intervention. X-ray examination was

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performed to exclude bony ankylosis and patella baja/infera. Arthrofibrosis could be further confirmed by Magnetic Resonance Imaging (MRI), which determine the presence of intra-articular adhesion, the capsule volume, and the presence of meniscus, cartilage and ligament injuries (Fig. 1).

Pre-operative sonographic examination was performed to make a precise diagnosis of quadriceps contracture and atrophy. The quadriceps contracture and atrophy appeared to be thinner muscle bundle with fibrosis change of strip-like high-density echo (Fig. 2). We measured the thickness of quadriceps tendon bundle, drawing a line perpendicular to the direction of the tendon by using the electronic calipers of the sonographic equipment. The fibrosis severity was identified according to the amount of muscle fibrosis and the thickness of the tendon. After comparing the medial, lateral, distal and proximal parts of fibrotic quadriceps with contralateral parts, the location of the severest fibrosis was identified and marked (Fig. 2).

Surgical technique

The operation is performed with the use of spinal anesthesia. The patient is placed supine with a tourniquet cuff placed at the base of the thigh. The preoperative range of motion of the knee is assessed under anaesthesia. The operative procedure included the arthroscopic adhesiolysis, manipulation and a mini-invasive quadricepsplasty.

The arthroscope was through the standard anteromedial and anterolateral portals. Any fibrous nodules were removed with a soft tissue shaver (Smith and Nephew) or a bipolar resection device (Smith and Nephew). The excision of adhesive bands and scar tissue is performed starting in the suprapatellar pouch. Suprapatellar pouch is kept intact to reduce postoperative swelling of the knee. Next, adhesions in the medial and lateral gutters are addressed since the adhesions often form between the capsule and the femoral condyles. The infrapatellar fat pad needs to be released from the tibia and the front of the intermeniscal ligament. Medial and lateral patellar retinacular release is also performed to address high flexion range. A gentle manipulation is carried out following lysis of adhesions, using a slight pressure on the tubercle to avoid fractures and disruptions of the extensor mechanisms. After the final intra-articular assessment, no significant adhesion must remain and the maximum range of passive motion is recorded.

Then, pie-crusting release is performed using an 18-gauge needle (Fig. 3). According to the fibrosis distribution detected by preoperative sonographic examination, the first puncture is usually located in the rectus femoris tendon about 3 cm away from the superior pole of the patella. A series of punctures are carried out from medial to lateral (10–20 punctures per level) and from distal to proximal (at 1 cm intervals). The stiff fibrous bands of the quadriceps tendon, when an assistant pushes the knee into maximum flexion, are punctured percutaneously. Needle fenestrations are directed through the skin, rectus femoris tendon or vastus lateralis tendon and then the vastus intermedius tendon. One skin penetration allows five subsequent penetrations through the quadricep tendon. Passes through the stiff fibrous band of the tendon typically meet with resistance, which would produce palpable and audible crepitations. The contractural tendon is gradually released, with the tension tendon softening after 60–100 needle punctures. The maximum range of passive motion possible is recorded.

Rehabilitation program

The rehabilitation program aims to maintain the intra-operative range of flexion and avoid recurrence of the stiffness and extension contracture. Epidural analgesia is administered for two days and followed by oral analgesics. A mobile hinged brace, adjusted to a range of 90° to 120° flexion, is fitted for one week. Maximal flexion exercises are performed on the first postoperative day. Full extension and flexion exercises without the knee brace are encouraged one week after surgery and continue until maximal knee flexion is achieved with no further improvement (Fig. 4).

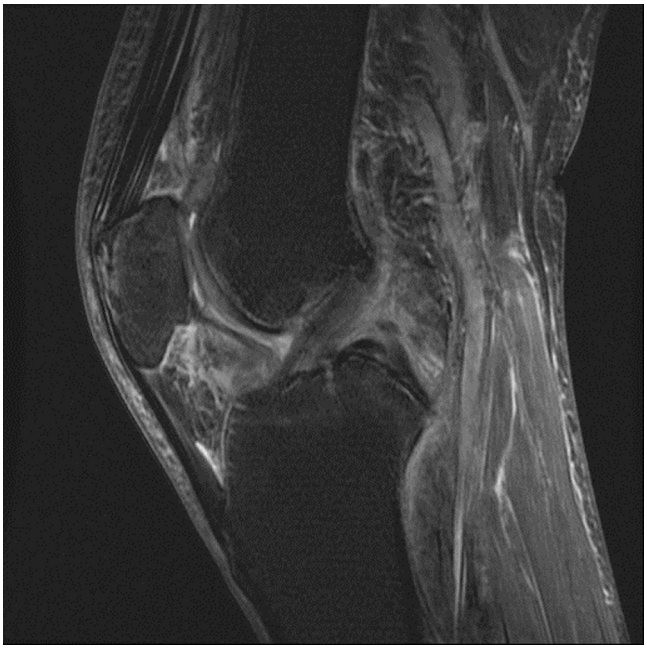

Fig. 1. Preoperative MRI shows the intra-articular adhesions, especially in suprapatellar pouch and infrapatellar fat pad. There is no meniscus, cartilage and ligament injuries. Bony ankylosis and patella baja are also excluded.

Result

This technique was performed in five post-traumatic stiff knees and three stiff knees after previous infection with mean age 53 ± 6 years. Five had fracture-related knee stiffness (femoral supracondylar fracture in two patients, patellar fracture in two and tibial plateau fracture in one). Three had knee stiffness after previous infection, two of which were due to joint puncture and another one to arthroscopic surgery. There was no flexion contracture. The mean interval between initial intervention and pie-crusting release was 6 ± 2 months.

Normal quadriceps tendon has a well-defined, linear, echogenic appearance on sonography. In patient of quadriceps contracture, large amount of fibrous changes occur in quadriceps muscle or tendon with hyperechoic appearance and muscle bundle or tendon fibers become thinner. Diseased rectus femoris tendon is average 22% thinner than contralateral parts according to sonographic measurement. Mean maximum flexion increased from 35° preoperatively to 80° after arthroscopic adhesiolysis and 120° after pie-crusting. At a mean follow-up of six months, mean maximum flexion was 110°.

Preoperative sonographic examination of quadriceps tendon fibrosis displays its surgery-related values. After accurate location of quadriceps tendon fibrosis, useless penetration is reducing. Moreover, 22% atrophy of rectus femoris tendon indicates a potential 40° range of flexion improvement. There are no other major complications, such as extensor lag, skin necrosis, deep infection, dislocation of the patella or recurrent stiffness.