Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-009-0874-1

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A new surgical technique for arthroscopic repair of the meniscus root tear

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Received: 18 November 2008 / Accepted: 30 June 2009

Abstract Injury of the meniscal root can lead to meniscal extrusion and loss of normal hoop stress distribution by the meniscus. This has been shown to result in an excessive tibiofemoral contact pressures and has been associated with development of arthritis in the affected compartment of the knee. Repair of meniscal root avulsion has been shown to restore the normal contact stresses, and several techniques for such repair have been described. We report an all-arthroscopic technique that allows anatomic reattachment of the avulsed meniscal root, applicable to both the medial or lateral menisci. Our technique utilizes a novel retrograde reaming device to create a small intraosseous socket at the meniscal tibial attachment, and may be particularly useful for repairing meniscal root avulsions in knees with multi-ligamentous injuries.

Keywords Meniscus root · Meniscus avulsion · Meniscus repair · FlipCutter

Introduction

The primary function of the meniscus is load transmission across the knee joint. The deleterious clinical effects of the loss of meniscal function have been well documented [8, 10, 11, 16]. Recently, attention has been directed at evaluating injuries of the meniscal root. The root serves as the anchor point for the meniscus. Injury of the root can lead to meniscal extrusion [7, 18, 19], and disrupts the normal hoop stress distribution by the meniscus. This has been shown to be associated with progression of arthritic disease in the involved compartment [5, 14, 22].

Cadaveric studies have shown that meniscal root injury alters the mechanics of load distribution, producing values that approach those associated with complete meniscal excision [3]. Further, repair of root injury has been shown to restore the normal contact stresses on the tibial plateau [3, 4, 21].

Current options for meniscal root repair include repair into transosseous bone tunnels, trans-osseous suture passage for surface fixation, and suture anchor fixation [1, 2, 6, 15, 20, 23]. Biomechanical evaluation and clinical follow-up reports of these techniques are currently lacking.

We present a description of a new variation on a pull-out suture technique for meniscal root repair (we describe this technique for a medial meniscus injury, but a similar technique can be used to repair lateral meniscal roots tear as well). Our technique reattaches the meniscal root to the tibia via a small intraosseous socket created with a novel retrograde reaming device. Creation of this socket removes only minimal amount of tibial bone, which is especially useful in situations when meniscal root repair is performed concomitantly with cruciate ligament reconstructions that require drilling of transosseous tunnels. The anatomic reattachment of the meniscal root avulsion should allow restoration of meniscal function and therefore result in normal or near-normal tibiofemoral contact stresses.

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Published online: 19 August 2009

Surgical technique

The patient is positioned supine on the operating table. We prefer to use a non-sterile thigh tourniquet and a lateral post at the level of the mid-thigh (instead of an arthroscopic leg holder). Prior to prepping and draping, access to the postero-medial accessory portal must be ensured. Standard anterolateral and anteromedial portals are used to perform diagnostic arthroscopy, and meniscal root injury is identified (Fig. 1). Then we prefer to perform a small notchplasty on the ipsilateral femoral condyle in order to improve access to and visualization of the torn meniscal root and the root insertion footprint, as well as to improve access for instrumentation. For the medial root repair, we perform this notchplasty at the posterior–inferior aspect of the medial femoral condyle directly overlying the medial meniscal root, and limit removal of bone to no more than 5 mm in the lateral to medial direction. This allows for easier handling and suturing of the meniscal root during subsequent repair. In knees with intact cruciate ligaments care should be taken to minimize disruption to the ligament origin while performing the notchplasty.

The arthroscope is advanced into the posterior aspect of the notch and an accessory postero-medial portal is established with spinal needle localization. Although this portal is not absolutely mandatory for completion of the root repair, it is particularly helpful for visualization of and suture passage through the medial meniscal root, which, due to its posterior location, may be difficult to visualize and instrument using anterior portals only. We prefer to maintain control of this portal with a 5 mm arthroscopic cannula. The meniscal root footprint is then identified on the posterior tibia and remnants of the root attachment are debrided with a motorized shaver. The medial meniscal root is located anterior and slightly medial to the PCL tibial insertion [13]. The lateral meniscal root is located lateral to the PCL tibial insertion and further anterior than the medial meniscal root.

The posterior horn of the affected meniscus is grasped with an arthroscopic grasper and the tension required to bring the root to its footprint is assessed. Based on the amount of the excursion of the affected posterior horn, the root insertion site may have to be medialized (for the medial meniscus) or lateralized (for the lateral meniscus) in order to minimize excessive tension on the meniscal body and the repair. Once the bed is prepared, the underside of the meniscal root and the local capsule are abraded to improve the healing surfaces.

Fig. 1 Arthroscopic view of the completely avulsed posterior root of the medial meniscus (left knee)

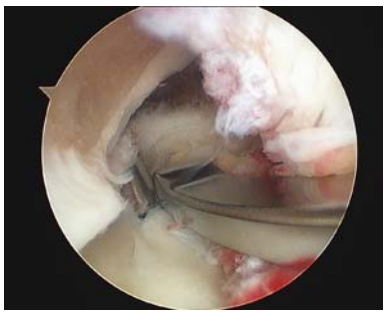

Fig. 2 The FlipCutter tip-aiming guide is inserted through the anterolateral portal and placed onto the medial meniscal root insertion site. The FlipCutter is then advanced through the guide into the knee joint

The tip-aiming guide for the retrograde reaming device (FlipCutter™, Arthrex Inc., Naples, FL, USA) is inserted and positioned on the meniscal root insertion site. The guide is placed through whichever of the anterior portals (medial or lateral) allows its tip to accurately and securely rest on the affected meniscal root footprint. The FlipCutter is then inserted in the external portion of the guide and drilled through the proximal tibia, entering the knee joint at the location of the guide-tip (Fig. 2). This may be performed percutaneously, through an incision used for cruciate ligament reconstruction (on the anteromedial tibia), or through a separate small incision.

Once the proper position of the reaming device is confirmed, the tip is flipped and locked (Fig. 3). A 10-mm deep tunnel is then reamed; diameter of the tunnel is determined by the size of the FlipCutter chosen and is not of paramount importance. We prefer to use an 8 mm or 9 mm device, as this size socket allows adequate mobility of the subsequently used instruments. The FlipCutter is

Fig. 3 The aiming guide is removed and the tip of the FlipCutter is flipped (using an arthroscopic probe) and locked in preparation for retrograde reaming

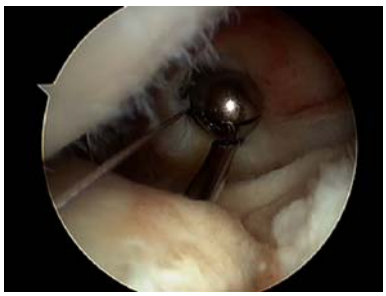

Fig. 4 A straight cannulated suture-passing device (Micro Suture-Lasso™, Arthrex, Naples, FL, USA) is used to penetrate the meniscal root and shuttle the flexible wire loop out through the posteromedial portal using an arthroscopic grasper. This allows for suture shuttling through the avulsed meniscal root and creation of a mattress-type repair

then again switched to the forward-pointing position, locked, and removed. The aiming guide should be held in place against the proximal tibia to maintain the location of the bone tunnel, which can be hard to find because of its small size (3.5 mm), especially if drilled percutaneously. A thin plastic rod or a metal pin is then inserted through the guide into the joint to maintain position of the tunnel. At this time the FlipCutter aiming guide can be removed.

The meniscal root is grasped and held over the socket, and a small straight sharp cannulated suture-passing device is then inserted through the tibial tunnel into the joint, penetrating the meniscal root (Fig. 4). This should be done approximately 2–3 mm from the edge of the root tear. Capturing the posterior horn further from the edge may create excessive tension on the meniscal body, while placing the sutures too close to the edge may result in suture cut-out and loss of fixation. A wire loop is advanced through the cannulated suture-passer (and thus through the meniscal root) and withdrawn through the postero-medial portal. A #2 nonabsorbable braided suture is placed through the loop and shuttled through the meniscal root out of the tibial tunnel (Fig. 5). The process is repeated to shuttle the second end of the nonabsorbable suture through the root, thus creating a mattress-type repair. The sutures are then tensioned, which will deliver the meniscal root

Fig. 5 Both suture loops of the mattress-type repair are tensioned, which pulls the avulsed meniscal root over the socket created at its the insertion site

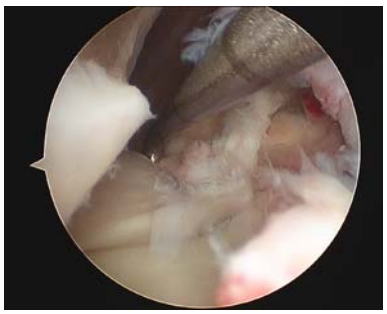

Fig. 6 After the sutures are tension and tied over a bioabsorbable button on the proximal tibia, the meniscal root insertion site is restored and firmly secured

into or just over the repair socket. While applying tension to the sutures the posterior horn is probed to ensure adequacy of the repair and the sutures are then tied over a button or post on the tibial surface. If a button is used, tying sutures with a sliding knot allows the surgeon to maintain tension on the repair while the knot is being tied. The meniscal root is then probed again to ensure that the repair is secure (Fig. 6). If there are additional areas of tearing in the meniscus, further repair or partial meniscectomy are performed, based on surgeon's discretion. Reconstruction of the cruciate ligaments, if necessary, should be performed after the repair of the meniscal root, to allow easier visualization and more working space for the meniscal repair when performed first.

Postoperatively the patient is placed in a hinged knee brace and discharged from the hospital on the day of the surgery. Non-weight bearing range-of-motion exercises are started on postoperative day 1 with a flexion limit of 90° for 4 weeks. For ambulation, we allow immediate weight bearing as tolerated in the brace locked in extension for 4 weeks, followed by 2 weeks of weight bearing in the unlocked brace with a flexion stop at 90°.

Electrical stimulation of the quadriceps, and isometric quadriceps and hamstring strengthening is begun in the first postoperative week. At 6 weeks postoperative, short arc closed chain kinetics are begun (e.g. mini-squats, exercise bicycle). Straight line jogging is started at 10–12 weeks. Lateral cutting is started at 12–14 weeks. Full return to sport is allowed at 14–16 weeks.

Discussion

The primary meniscal function of protecting articular cartilage of the knee from excessive loading is accomplished by the distribution of hoop stresses by the circumferentially arranged collagen fibers of the meniscal body. Loss of meniscal volume has been shown to adversely affect the articular surface by decreasing contact area and by

increasing contact stresses and the elastic modulus [4, 9, 12, 17]. Not surprisingly total meniscectomy has been shown to be associated with high rates of development of osteoarthritis of the involved compartment [8, 10, 11].

The first clinical report of a meniscal root tear was published in 1991 [22]. Subsequent case series of patients with this injury found an association of the root tears with meniscal extrusion and subsequent loss of articular cartilage in the affected compartment [7, 14, 18, 19]. A recent cadaveric study found that peak tibiofemoral contact pressures in knees with medial meniscal root avulsions were increased by 25% in the medial compartment and by 13% in the lateral compartment, and that repairing the meniscal root tear restored these values to "within normal conditions" [3]. The authors of that study repaired the meniscal root with an open technique, using transtibial tunnels, similar to the technique described by Ahn et al. [2]. Other repair techniques have also been reported, some of them partially open and other all-arthroscopic [1, 2, 6, 15, 20, 23].

We describe an all-arthroscopic technique for repair of the meniscal root tears, applicable for both the medial and lateral menisci. This technique utilizes a new retrograde reaming device that allows creation of short, small-diameter tibial tunnels on the articular side only, thus limiting potential stress-risers due to tunnel holes on the cortex of the proximal tibia. We feel that this is particularly useful in cases where reconstruction of multiple ligaments of the knee is required, allowing the surgeon to arthroscopically repair and reconstruct all injured structures, with minimal drilling of the proximal tibia and minimizing the potential of tunnel convergence or intersection. Furthermore, ability to repair the root of the meniscus over a bone tunnel should encourage healing of the repair.

In conclusion, this report describes an all-arthroscopic technique for repair of the medial or lateral meniscal root tears. The technique can be used in isolated injuries of the meniscus or in cases with ligamentous injury requiring repair or reconstruction. The technique is minimally-invasive, bone-sparing and should allow restoration of normal meniscal architecture and function.

Conflict of interest statement None of the authors have any financial or other conflicts of interest relating to the information presented in this manuscript.

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