Lateral Capsular Fixation: An implant-free technique to prevent meniscal allograft extrusion.

Introduction Heading

Capsulodesis in meniscal transplantation

Abstract

Although several surgical techniques have been described to perform a meniscal allograft transplantation (MAT) with good clinical results and although different methods of capsular stabilization can be found in the literature, there is no standard surgical technique to prevent a common complication in the most of series: the tendency to a radial displacement or extrusion of the transplanted menisci. We present a simple, reproducible and implant free technique to perform a lateral capsular fixation (capsulodesis) at the time of only soft-tissue fixation technique of MAT in an effort to reduce or prevent the risk of graft extrusion. Using a minimum of two 2.4mm tunnels drilled from the contralateral side of the tibia with the help of a regular tibial ACL guide, a capsular attachment to the lateral tibial plateau is obtained.

In an attempt to replace the lost meniscal tissue as well as to prevent progressive deterioration of the joint, meniscal allograft transplantation (MAT) was introduced into clinical practice[1]. Since then, several surgical techniques have been described for MAT with good short-, mid- and even long-term clinical results in cases of painful meniscectomized compartments of the knee[2].

However, most of the series found a tendency to a radial displacement or extrusion of the transplanted menisci[3]. In the same way, meniscal transplants have been shown to extrude more than normal menisci[4]. Extrusion is seen shortly after transplantation and tends to stabilize over time[5]. From a biomechanical stand point, an extruded meniscus results in decreased resistance to hoop strain. However, it hasn't been shown to have any clinical relevance. Although the final significance of extrusion is unknown, the anomalous position of those grafts causes concern among surgeons. In recent years several technical steps have been implemented to limit or prevent allograft extrusion. The aim of this study was to present a simple, reproducible and implant free technique to perform a lateral capsular fixation (capsulodesis) at the time of lateral MAT in an effort to reduce or prevent graft extrusion.

Surgical Technique

The arthroscopic lateral capsulodesis is performed in cases where a redundant capsule is observed or where extrusion of the mid-body of the lateral meniscus has been identified with magnetic resonance imaging (MRI) before MAT.

Fresh-frozen (–80ºC), non-irradiated, bone-free, non–antigen matched meniscal allografts were used in this series. Local authorized tissue banks supplied the allografts. Allograft sizing was done in accordance with the method described by Pollard et al[6].

The surgical technique is completely arthroscopic and includes only soft-tissue fixation. Routine anterolateral and anteromedial portals are performed (Video). Two 5mm bone tunnels are drilled at the anatomic sites of the lateral meniscal attachments, one at the anterior horn and the other at the posterior horn. In every case, #2 high-strength sutures (Hi-Fi ConMed, Largo, Florida) with a Krackow mattress are placed at both horns. One additional vertical mattress suture is placed at the junction between the posterior horn and the body of the meniscus. This suture will later help in introducing the graft into the joint.

Lateral Capsulodesis

A motorized arthroscopy shaver is used to remove any marginal osteophite on the lateral edge of the tibial plateau. The place where the lateral capsule is most displaced from the edge of the lateral tibial plateau is identified. In this area, a minimum of two 2.4mm tibial tunnels are performed (Fig 1). The tunnels are drilled from the anteromedial aspect of the tibia with the help of an ACL tibial guide (Pinn-ACL Guide ConMed, Largo, Florida) with a distance of 1cm between each one (Fig 2). Care should be taken to avoid tunnel collision. Using a suture passer, each tunnel is identified by a different coloured thread, leaving a small loop inside the joint to retrieve the capsulodesis suture strand (Fig 3). Then, two 19-gauge spinal needles loaded with a #1 PDS suture are used to pierce the peripheral rim of the meniscus remnant or the capsule with an outside-in technique. This shuttle suture is substituted by a high strength suture and retrieved through each tibial tunnel (Fig 4). The two limbs are then tied to each other on the anteromedial tibial cortex, bringing together the capsule to the tibial plateau (Fig 5). This step must be always performed prior to the meniscal graft introduction and fixation. A step-by- step summary of this technique is provided in Table 1

Graft Placement

Once the capsulodesis has been secured and the anterolateral portal enlarged, the posterior-horn suture is used to pull the meniscal allograft in place. The vertical stitch placed between the posterior horn and the body of the meniscus helps to accommodate the graft in the proper position by pulling the sutures from the posterolateral corner. The allograft is then fixed to the rim by combining all-inside meniscal repair implants (FasT-Fix, Smith & Nephew, Andover, Massachusetts) in the posterior horn and meniscal body and an outside-in technique in the anterior horn. Finally, the sutures placed in the anterior and posterior horns are tied together over the tibial cortex. Pearls and pitfall to performing this surgical procedure are listed in Table 2.

Rehabilitation protocol

Partial weight bearing with a knee immobilizer is allowed at 3 weeks and progressed to full weight bearing at about 6 weeks. Progressive range of motion (ROM) without exceeding 90 degrees of flexion until the 4th week is followed by unrestricted progression per tolerance. Patients may return to a normal workload by the fourth month after surgery.

Discussion

Since MAT is carried out with the hope of preventing the progression of osteoarthritis, the presence of graft extrusion is a matter of concern for the surgeon. To avoid meniscal extrusion, a simple, implant-free capsulodesis technique is presented in this report.

Several factors have been related to an extruded meniscal allograft. They are the fixation method, the type of allograft (medial or lateral), the investigated meniscal area and the graft size.

MAT fixation is crucial to preventing short and mid-term complications due to altered knee kinematics. While peripheral fixation is achieved with sutures in any of the available techniques, the fixation of meniscal horns may be achieved through either sutures or a bone plug or a bone bridge. In general, bone plugs are preferred for the medial meniscus when using bone-to-bone fixation and a bone bridge for the lateral meniscus. Some in vitro studies have demonstrated that fixation with bone plugs is better compared to graft fixation without bone plugs in terms of the restoration of the normal contact mechanics of the knee[7,8]. Nonetheless, other biomechanical in vitro studies have shown no differences in the mean pull-out strength of medial meniscus allograft between the two fixation methods[9]. Moreover, MAT without bone plugs has shown good and excellent results in terms of pain relief and clinical and functional outcomes[10,11,12]. Clinical studies comparing both fixation methods have demonstrated no differences in clinical, functional, or radiographic outcomes[13]. However, as suture-only fixation has shown a higher degree of meniscal extrusion[14], this capsulodesis technique was developed to prevent or decrease this lateral displacement.

Several technical recommendations have been made to limit or prevent allograft extrusion. Jang et al. [15] reported that reducing the graft size by 5% decreases the percentage of extrusion without any adverse outcome either clinically or radiographically. Other studies demonstrated that in the bone bridge technique, the risk of graft extrusion increases as the angle of the trough on the axial plane increases[16]. Jeon et al.[17] suggested that the excision of a peripheral osteophyte larger than 2mm in

the proximal tibial plateau was associated with less MAT extrusion. Some surgeons fix the meniscus body to the tibial plateau in an attempt to control graft extrusion. However, this manoeuvre may present the risk of limiting the normal mobility of the meniscus during knee motion.

A recent investigation showed not only that peripheral fixation in an adequate remnant meniscal rim is important to promoting healing of the graft, but also is crucial to prevent peripheral extrusion[18]. In that sense, we are currently exploring the role that a capsule fixation to the tibial plateau might play. A list of advantages and limitations of our procedure can be found on Table 3.

Although different methods of capsular stabilization have been described, the present technique based on an implant-free lateral capsulodesis seems to be a valid, reliable and easy method to prevent or decrease lateral MAT extrusion. It allows for versatility in terms of number of fixation points and locations, without a significant bone loss in the tibial plateau as the diameter of the drill holes are only 2.4mm. It does not interfere with subsequent MRI imaging (Fig 6) and adds no additional costs.

REFERENCES

1. Milachowski KA, Weismeier K, Wirth CJ. Homologous meniscus transplantation: experimental and clinical results. *Int Orthop* 1989;13:1-11.

2. Rosso F, Bisicchia S, Bonasia DE, Amendola A. Meniscal Allograft Transplantation: A Systematic Review. *Am J Sports Med* 2015;43:998-1007.

3. Samitier G, Alentorn-Geli E, Taylor DC, Rill B, Lock T, Moutzouros V, Kolowich P. Meniscal allograft transplantation. Part 1: systematic review of graft biology, graft shrinkage, graft extrusion, graft sizing, and graft fixation. *Knee Surg Sports Traumatol Arthrosc* 2015;23:310-322.

4. Verdonk P, Depaepe Y, Desmyter S, De Muynck M, Almqvist KF, Verstraete K, Verdonk R. Normal and transplanted lateral knee menisci: evaluation of extrusion using magnetic resonance imaging and ultrasound. *Knee Surg Sports Traumatol Arthrosc* 2004;12:411-419.

5. Lee DH, Kim TH, Lee SH, Kim CW, Kim JM, Bin S. Evaluation of meniscus allograft transplantation with serial magnetic resonance imaging during the first postoperative year: focus on graft extrusion. *Arthroscopy* 2008;24:1115-1121.

6. Pollard ME, Kang Q, Berg EE. Radiographic sizing for meniscal transplantation. *Arthroscopy* 1995;11:684-687.

7. Paletta GA, Manning T, Snell E, Parker R, Bergfeld J. The effect of allograft meniscal replacement on intraarticular contact area and pressures in the human knee. *Am J Sports Med* 1997;25:692.

8. Alhalki MM, Howell SM, Hull ML. How three methods for fixing a medial meniscal autograft affect tibial contact mechanics. *Am J Sports Med* 1999;27:320-328.

9. Hunt S, Kaplan K, Ishak C, Kummer FJ, Meislin R. Bone plug versus suture fixation of the posterior horn in medial meniscal allograft transplantation: a biomechanical

188 study. *Bull NYU Hosp Joint Dis* 2008;66:22-26.
189 10. Alentorn-Geli E, Seijas R, García M et al. Arthroscopic meniscal allograft
190 transplantation without bone plugs. *Knee Surg Sports Traumatol Arthrosc* 2011;19:174-
191 182.
192 11. González-Lucena G, Gelber PE, Pelfort X, Tey M, Monllau JC. Meniscal allograft
193 transplantation without bone blocks: a 5- to 8-year follow-up of 33 patients.
194 *Arthroscopy* 2010;26:1633-1640.
195 12. Verdonk PC, Demurie A, Almqvist KF, Veys EM, Verbruggen G, Verdonk R.
196 Transplantation of viable meniscal allograft. Survivorship analysis and clinical outcome
197 of one hundred cases. *J Bone Joint Surg Am* 2005;87:715-724.
198 13. Abat F, Gelber PE, Erquicia JI, Tey M, Gonzalez-Lucena G, Monllau JC.
199 Prospective comparative study between two different fixation techniques in meniscal
200 allograft transplantation. *Knee Surg Sports Traumatol Arthrosc* 2013;21:1516–22.
201 14. Abat F, Gelber PE, Erquicia JI, Pelfort X, Gonzalez-Lucena G, Monllau JC. Suture-
202 only fixation technique leads to a higher degree of extrusion than bony fixation in
203 meniscal allograft transplantation. *Am J Sports Med* 2012;40:1591-1596.
204 15. Jang SH, Kim JG, Ha JG, Shim JC. Reducing the size of the meniscal allograft
205 decreases the percentage of extrusion after meniscal allograft transplantation.
206 *Arthroscopy* 2011;27:914-22.
207 16. Dae-Hee L, Jong-Min K, Bum-Sik L, Kyung-Ah K, Seong-Il B. Greater Axial
208 Trough Obliquity Increases the Risk of Graft Extrusion in Lateral Meniscus Allograft
209 Transplantation. *Am J Sports Med* 2012;40:1597.
210 17. Jeon B, Kim JM, Kim JM, Lee CR, Kim KA, Bin SI. An osteophyte in
211 the tibial plateau is a risk factor for allograft extrusion after meniscus allograft
212 transplantation. *Am J Sports Med* 2015;43:1215-1221.

18. Matava MJ. Meniscal allograft transplantation: a systematic review. *Clin Orthop Relat Res* 2007;455:142-157.

FIGURE LEGENDS

Fig. 1: Left knee image showing (A) patient positioning on the operating table. Arthroscopic image viewed through the anterolateral portal (B) drilling the posterior horn in the tibial plateau. (LFC, lateral femoral condyle).

Arthroscopic image through the anteromedial portal (C and D) showing the 2.4mm tibial tunnel drilled from the anteromedial aspect of the tibia with the help of an ACL tibial guide

Fig. 2: Right knee, anteromedial view. Lateral capsulodesis tunnels placement using the ACL tibial guide through the anteromedial (AM) portal.

Fig. 3: Left knee, arthroscopic image through the anteromedial portal. Using a suture passer, (A) identify the tunnel leaving a small loop inside the joint (B) to retrieve the capsulodesis suture strand. Then use two 19-gauge spinal needles (C and D) loaded with nº 1 PDS suture to pierce the peripheral rim of the meniscus remnant or the capsule with an outside-in technique.

Fig. 4: Shuttle suture replaced by a high strength strand and retrieved through the tibial tunnel. Tie the two suture ends together on the anteromedial tibial cortex to secure the capsulodesis

Fig. 5: Capsular fixation suture passed through each transtibial tunnel and tied to each other on the anteromedial cortex fixing the capsule to the tibial plateau.

Fig. 6: Coronal view of MRI at 6 months postoperatively. We see the midbody position of the lateral meniscus allograft and the lateral capsulodesis tibial tunnel placement (arrows) with no extrusion of the graft.

Video Legend

0:00 – 0:04 Lateral Capsular Fixation: A reliable implant free technique to prevent meniscal allograft extrusion

0:04 – 0:11 The surgical technique was completely arthroscopic. Routine anterolateral and anteromedial portals were utilized.

0:12 – 0:21 This arthroscopic lateral capsulodesis for meniscal allograft transplantation is performed in cases where a redundant capsule is observed or where extrusion of the mid-body of the meniscus has been identified with MRI before meniscal transplantation.

0:22 – 0:29 Two 5mm bone tunnels were drilled at the anatomic sites of meniscal attachment, one at the anterior horn and the other at the posterior horn.

0:30 – 0:45 Once the place where the lateral capsule is most displaced from the edge of the lateral tibial plateau is identified, stabilization is performed using a minimum of two 2.5mm tunnels. The tunnels were drilled from the contralateral side of the tibia with the help of a regular tibial ACL guide with a distance of 1cm between those. Care should be taken to avoid tunnel collision.

0:46 – 1:05 Using a suture passer, each tunnel is identified, leaving a small loop inside the joint to retrieve the capsulodesis suture strand.

1:06 – 1:26 Then, two spinal needles loaded with a number 2 PDS suture are used to capture the peripheral rim of the meniscus with an outside-in technique or, alternatively, the capsule when the previous doesn't exist. This shuttle suture is substituted by a high strength suture and recovered through each tibial tunnel. The two limbs are tied to each other on the medial tibial cortex, fixing the capsule to the tibial plateau. This step must be always performed prior to meniscal graft introduction and fixation.

1:27 – 1:39 The anterior tunnel is drilled at the anatomic site of meniscal insertion and a shuttle suture is recovered through the anterolateral portal to pass the sutures of the anterior horn of the meniscal allograft

1:40 – 1:46 With an outside-in technique, a shuttle suture is placed in the posterolateral corner

1:47 – 1:54 Once the capsulodesis has been secured, the posterior-horn suture is used to pull the meniscal allograft in place. The additional vertical stitch helps to accommodate the graft in the right position as it pulls the graft from the posterolateral corner.

1:55 – 2:03 The allograft is then fixed to the rim by combining an all-inside technique in the posterior horn and meniscal body and an outside-in technique in the anterior horn.

2:04 – 2:13 Finally, the sutures placed in the anterior and posterior horns are tied together over the tibial cortex