Anterior Cruciate Ligament Reconstruction With Bone–Patellar Tendon–Bone Autograft With Concomitant Meniscal Allograft Transplantation

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Background: Primary arthroscopic-assisted anterior cruciate ligament (ACL) reconstruction using a bone–patellar tendon–bone (BTB) graft offers excellent long-term results for patients with ACL tears. When concurrent meniscal damage is present, the preferred treatment is repair of the meniscus. However, meniscectomy may be needed, which can result in insufficient meniscal function.

Indications: ACL reconstruction performed concomitantly with meniscal allograft transplantation (MAT) is indicated for patients with ACL tears and meniscal insufficiency. This procedure is typically reserved for younger, active patients, such as the 38-year-old woman in this presentation.

Technique Description: The patient was placed in the supine position. The BTB graft was harvested first using a standard medial midline incision. A posterior meniscus root tunnel was drilled, followed by drilling of the femoral tunnel for ACL reconstruction. The tibial tunnel for ACL reconstruction was subsequently created, after which tapping was performed for anterior meniscus root fixation. The meniscal allograft was secured using alternating vertical mattress inside-out sutures. Finally, the BTB graft was passed through the tibial and femoral tunnels.

Results: Outcomes following ACL reconstruction with BTB autograft and MAT are positive, with a 5-year survival between 84% and 91%. ACL reinjury and long-term development of osteoarthritis are the most common complications. In this case, the patient returned to work within 7 months and reported 0 out of 10 pain.

Discussion/Conclusion: ACL reconstruction with BTB autograft and concomitant MAT is a viable treatment option for patients with ACL tears in the context of meniscal deficiency.

Patient Consent Disclosure Statement: The author(s) attests that consent has been obtained from any patient(s) appearing in this publication. If the individual may be identifiable, the author(s) has included a statement of release or other written form of approval from the patient(s) with this submission for publication.

Keywords: ACL reconstruction; bone–patellar tendon–bone; meniscus transplant; meniscus allograft; ACLR

VIDEO TRANSCRIPT

This video demonstrates our technique for an anterior cruciate ligament (ACL) reconstruction with bone–patellar tendon–bone (BTB) autograft and concomitant medial meniscal allograft transplantation (MAT). Here are our disclosures. This is an overview of our presentation.

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BACKGROUND

The ACL is the most commonly injured knee ligament, and concurrent meniscal involvement is common, with rates ranging from 47% to greater than 65%.[2-4] When meniscal involvement is present, it is preferred to repair and preserve the meniscus if possible. However, in unrepairable cases, a partial meniscectomy will be performed, which can result in meniscal deficiency.

Primary arthroscopic-assisted ACL reconstruction using a BTB graft is considered the gold-standard surgical treatment for a ruptured ACL.[7,8] For meniscus injuries in the setting of ACL tears, an ACL reconstruction performed concomitantly with MAT offers good clinical outcomes. However, this procedure is relatively uncommon due to its technical complexity.[11] Thus, indications for this procedure are usually limited to younger patients with meniscal deficiency.[9,10] As many patients have some level of meniscal deficiency following meniscectomy, we typically wait to perform MAT until symptoms such as recurrent effusions and pain thought to be secondary to meniscal deficiency interfere with patients' physical activity goals. MAT may also be indicated if meniscal deficiency is thought to contribute to ACL instability. It is often performed in a staged fashion.

Diagnosis is made through physical examination and imaging of the knee. Diagnostic imaging may begin with plain radiographs; however, diagnosis is primarily accomplished through magnetic resonance imaging (MRI). Here is our case presentation of an ACL reconstruction with BTB autograft and MAT, which was the second part of a 2-stage revision surgery.

INDICATIONS

The patient is a 38-year-old woman with a history of left knee soft tissue allograft ACL reconstruction with subtotal meniscectomy performed elsewhere, who sought treatment after sustaining a new left knee injury 8 months prior. She reported feeling pain in her knee as she knelt down and subsequently noted feelings of instability in her knee. She was treated conservatively at an outside clinic, but her symptoms have been present since that time.

In the first case, the original ACL graft was removed. The femoral tunnel had been placed too far anteriorly, resulting in a nonanatomic graft. An insufficient medial meniscus was also noted following previous subtotal meniscectomy, and the widened large femoral and tibial tunnels were grafted with bone dowels. For this second stage, we will focus on ACL reconstruction with BTB autograft and medial meniscal transplant.

An outside MRI before the first stage surgery demonstrated ACL graft disruption with tunnel dilation and an insufficient medial meniscus. After our first stage surgery, a computed tomography (CT) scan confirmed incorporation of the bone dowels into the femoral and tibial tunnels, which allowed us to proceed with the second stage of the revision 14 weeks later.

On physical examination of the patient's left knee, full passive range of motion was noted. Some quad atrophy was present, but the knee was otherwise normal in bulk and tone. Firing of the quad and hamstring demonstrated normal strength. There was mild effusion with mild tenderness to palpation present at the medial joint line. 2B Lachman and guarded pivot-shift tests were present. The patient had a negative McMurray test and normal patellar tracking.

TECHNIQUE DESCRIPTION

To prepare for this surgery, the patient was placed in a supine position and draped in a sterile fashion. ACL instability was confirmed during examination under anesthesia prior to tourniquet with grade 1 pivot-shift and Lachman 2B tests. There was no evidence of injury to the medial collateral ligament or posterior cruciate ligament.

We performed the BTB graft harvest first. To do this, a standard medial midline incision was made overlying the medial border of the patellar tendon, extending approximately 5 to 7 cm from the distal pole of the patella to the proximal portion of the tibial tubercle. The central third of the tendon was harvested for the ACL autograft with a 10-mm by 20-mm block from the patella and a 10-mm by 25-mm block from the tibia. The ACL autograft was sized at 10 mm in width with 18 mm in length for the femur and 25 mm in length for the tibia, with a tapered appearance. Bone blocks were fashioned to fit through a 10-mm aperture. This was then drilled, prepared with sutures, and placed under tension on the back table.

Diagnostic arthroscopy confirmed that both graft tunnels had completely filled in. Evaluation of the medial and lateral joint lines confirmed medial meniscal insufficiency. This was debrided to the peripheral rim using a medial approach to prepare for transplantation. We maintained the far peripheral rim of the native meniscus to give support to the meniscal allograft.

At this point, the meniscal allograft was opened and prepared on the back table in a warm bath of saline. Our technique involved using a bone plug for the posterior root and soft tissue fixation for the anterior root. A 7-mm bone plug was prepared for the posterior meniscal root with a length of 10 mm. The anterior meniscal root attachment was cleared of soft tissues. Traction sutures were placed, and markings were applied to the graft for anterior and posterior reference. The graft was wrapped in saline-soaked gauze on the graft preparation station.

A small reverse notchplasty was performed, with flattening of the eminence to allow access to the medial compartment. The order of procedures with tunnels and fixation was the following:

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1. Drilling of the posterior meniscus root tunnel
2. Drilling of the femoral tunnel for ACL reconstruction
3. Drilling of the tibial tunnel for ACL reconstruction
4. Tapping for future PushLock (Arthrex) for anterior meniscus root fixation
5. A small posteromedial approach to guide suture management for outside-in and inside-out medial meniscus suture fixation

First, a retrograde flip cutter with an 8-mm diameter was used to create a tunnel for the posterior meniscus root and bone block to a depth of approximately 15 mm. Shuttling sutures were passed through the tunnel and docked out the anteromedial portal to facilitate later meniscus graft passage. Bone debris was evacuated using an arthroscopic shaver.

Then, in standard fashion, 10-mm tunnels were reamed for the femoral and tibial tunnels with a depth of 30 mm for the femoral tunnel and complete antegrade tunnel for the tibia. This image displays the location of the new femoral tunnel; it was placed slightly more posterior than the original. For the tibial tunnel, a guide pin was drilled into place and found to be in an acceptable position. This was then overreamed with a 10-mm reamer. A dilator was placed in the tibial tunnel to ensure easy future graft passage; this was left in the tibial tunnel to avoid conflict with the PushLock. A tap was then used to create a hole for the 2.9-mm PushLock for the future anterior soft tissue meniscus root fixation. While not gold standard for meniscus fixation, soft tissue fixation with suture anchors has been used for posterior root repair and has demonstrated superior biomechanical properties to transosseous fixation.[5] Furthermore, this approach enabled us to avoid drilling an additional transosseous tibial tunnel, which is significant given the need to drill a tibial tunnel for placement of the BTB graft.

A posteromedial approach was performed for the management of sutures. Two outside-in shuttle sutures were passed into the joint and out through the anteromedial portal. These were passed through the posterior horn of the meniscus to aid the passage of the meniscal transplant and to avoid flipping or rotating the transplant. Sutures were pulled into place using a suture lasso to facilitate future meniscal graft fixation. The suture retrieval device was passed through the body of the residual meniscus. The passing sutures were then retrieved.

We then deployed the meniscal allograft into position through the anteromedial portal and into the medial compartment under direct visualization. The meniscal allograft was positioned in anticipation of graft fixation. The posterior horn was fixated by pulling the bony attachment into the socket and fixing the sutures to the anteromedial tibia with a 4.75-mm BioComposite SwiveLock (Arthrex). Seating was obtained, and the remaining meniscal allograft was secured using 6 alternating vertical mattress inside-out sutures circumferentially on the superior and inferior surfaces. A bleeding bone bed was prepared for meniscus ingrowth. The anterior horn of the meniscal allograft was then anchored with a PushLock into the previously prepared hole on the anterior tibia. The dilator was still in the tibial tunnel, preventing any chance of the PushLock entering the tibial tunnel. Meniscus transplant was completed at this juncture, with normal restoration of meniscal volume. Stability was confirmed.

We then turned our attention to the tibial tunnel and prepared it for passing the BTB graft. The BTB graft was deployed through the prepared tibial and femoral tunnels. Following confirmation of the lack of graft-tunnel mismatch, metal interference screws were placed on both femoral and tibial sides. Final fixation was performed on the tibial side in a position of 0° of extension to prevent overconstraint of the knee. Stability of the final BTB graft was confirmed.

For the first 4 weeks after this procedure, we allowed limited toe-touch weightbearing in a hinged knee brace, with passive range of motion from 0° to 90° and ankle pumps also permitted. From weeks 4 to 6, progressive weightbearing is allowed with crutches, and range of motion is increased. Patients may stop the crutches and begin a weightbearing strengthening routine from weeks 6 to 14. From weeks 14 to 22, running on a treadmill is initiated, and athletes may include advanced sport-specific agility drills. Finally, at week 22, the athlete may return to sport as directed by a treating physician. The rehab protocol following this procedure is similar to a standard ACL recovery, with differences primarily in the early postoperative period. For example, we recommend that patients undergoing a concurrent BTB MAT procedure avoid tibial rotation until 6 weeks postoperatively. Additionally, patients who receive MAT typically remain in a brace until 6 weeks, compared to 4 weeks in patients who receive only ACL reconstruction.

RESULTS

Several complications can occur following this procedure. The first is ACL or MAT failure.[10] The risk of reinjury is greater in younger patients. A large posterior tibial slope may increase the risk of ACL retears, and the use of allograft tissue, undersized grafts, or the presence of chondral defects increases the risk for MAT failure.[12-14] Long-term development of osteoarthritis is also a possibility. Osteoarthritis development has been reported in up to 29% of cases, with meniscectomy significantly increasing this risk.[15-17]

Despite the potential for reinjury, outcomes following ACL reconstruction with BTB autograft and MAT are generally positive. The 5-year survival rate for patients undergoing this procedure is between 84% and 91%.[6,16] A systematic review by Candura et al[1] reported that 76% of patients returned to sport following combined ACL reconstruction and MAT, and Waterman et al[18] found that 78% of military members returned to their duties.

DISCUSSION/CONCLUSION

In our case, the patient was back to work at 7 months and reported 80% of normal function compared to her preinjury activity levels. Her pain was well tolerated, and she was participating in an at-home exercise regimen. She reported some stiffness with knee extension but overall good range of motion. X-rays demonstrated no evidence of tunnel widening. The patient was last seen at 9 months postoperatively, at which point she was fully active without restrictions and was instructed to follow up as needed. Thank you for your attention.

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