Revision Anterior Cruciate Ligament Reconstruction With Bone–Patellar Tendon–Bone Allograft and Extra-Articular Iliotibial Band Tenodesis

Randy Mascarenhas, MD, Mark O. McConkey, MD, FRCSC, Brian Forsythe, MD, and Christopher D. Harner, MD

Abstract

Revision anterior cruciate ligament (ACL) reconstruction is a technically demanding procedure with outcomes that generally fail to reach those seen with primary ACL reconstruction. With most index procedures using autograft tissue, it is not uncommon for allograft tissue to be required for revision ACL reconstruction. Compared with autografts, allografts take longer to incorporate and lead to more episodes of instability.

In this article, we describe ipsilateral iliotibial band tenodesis performed to augment use of bone–patellar tendon–bone allograft in revision ACL reconstruction. This technique adds rotational stability to protect the allograft tissue while it incorporates.

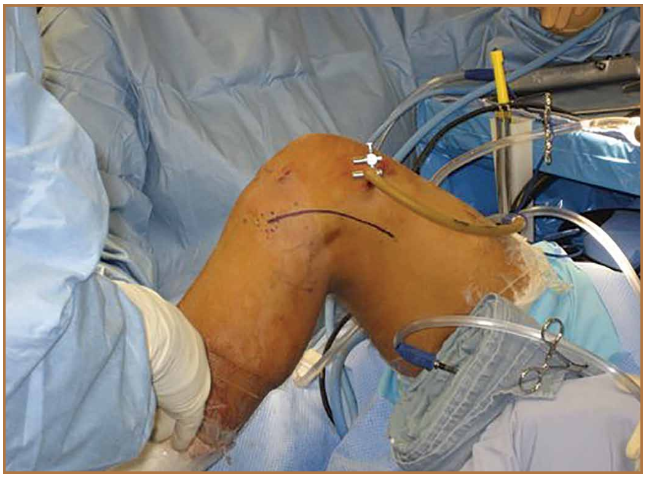
Primary anterior cruciate ligament (ACL) reconstruction has satisfactory outcomes in 75% to 97% of patients.[1-3] Despite this high success rate, the number of revision ACL reconstructions has risen[4] and is likely underreported.[5] Recurrent instability occurs if the reconstructed ligament fails to provide adequate anterior and rotational knee stability. Causes of graft failure include repeat trauma, early return to high-demand activity, poor operative technique (including poor graft placement), failure to address concomitant pathology, and perioperative complications (eg, infection, stiffness).[4] In addition, most patients who have revision ACL reconstruction received autograft tissue in the initial surgery, and allograft is thus not uncommon in revision ACL surgery. Allograft tissue has longer incorporation times[6] and increased incidence of recurrent postoperative instability when compared with autograft tissue.[7] Extra-articular tenodesis may thus be used to provide additional stability to the revision allograft tissue while it incorporates.

In this article, we describe our use of an extra-articular iliotibial band (ITB) tenodesis as an augmentative procedure in patients undergoing revision ACL reconstruction with bone–patellar tendon–bone (BPTB) allograft.

Surgical Technique

After induction of anesthesia and careful positioning, the patient is prepared and draped in the usual sterile fashion. Standard anteromedial, anterolateral, and superolateral outflow portals are established, and diagnostic arthroscopy is performed to inspect the cruciate ligaments, menisci, and articular cartilage (**Figure 1**). Peripheral meniscal tears should be repaired (**Figure 2**), and central or inner tears should be débrided to a stable rim. If meniscal repair is performed, sutures should be tied at the end of the case. Unstable articular cartilage defects should also be débrided. An 8- to 12-cm lateral hockey-stick incision is then made from the Gerdy tubercle to

Figure 1. With knee flexed to 90°, curvilinear (hockey stick) incision is made beginning at Gerdy tubercle and extending proximally along posterior border of iliotibial band. Note placement of arthroscopic superolateral outflow portal.



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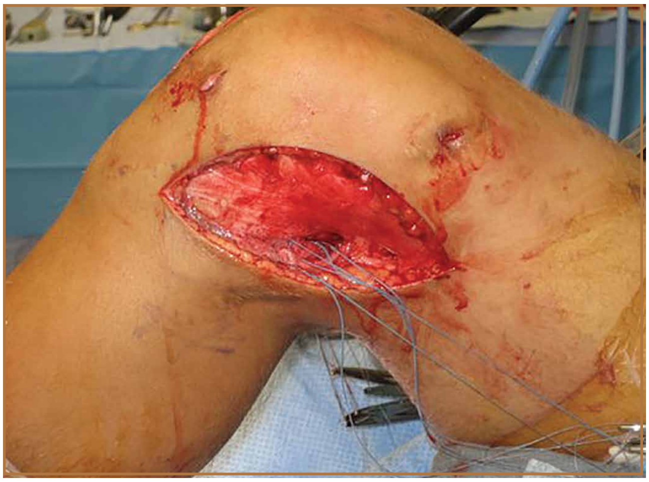

Figure 2. Posterolateral meniscal repair was performed concomitantly. Note placement of inside-out sutures within triangle formed by posterior border of iliotibial band, lateral head of gastrocnemius, and short head of biceps femoris.

Figure 3. Bone–patellar tendon–bone allograft is prepared with 2 drill holes and threaded with Ti-Cron suture (Covidien, New Haven, Connecticut) to facilitate graft passage.

the inferior edge of the lateral femoral epicondyle in preparation for the ITB tenodesis (**Figure 1**). The lateral collateral ligament (LCL), the lateral head of the gastrocnemius, and the ITB are identified. The peroneal nerve should be significantly distal to the working field.

Remnants of the previous ACL graft are débrided, and, if necessary, a modified notchplasty is performed. A position for the new femoral tunnel is located and is confirmed with intraoperative fluoroscopy. This tunnel is established with compaction drill bits and dilated to the appropriate diameter through the anteromedial portal with the knee in 120° of flexion.

BPTB allograft is prepared first by cutting its central third to the desired diameter (**Figure 3**). The bone-plug ends are prepared with compaction pliers. Two 2.0-mm drill holes are made in each of the allograft bone plugs, and a No. 5 Ti-Cron suture (Covidien, New Haven, Connecticut) is placed through each of the holes. We typically use 2 sutures on each bone plug.

A tibial tunnel is then established with an ACL drill guide under arthroscopic visualization and intraoperative fluoroscopy for confirmation of correct pin placement. We use Kirschner wires (with parallel pin guides as needed), compaction drills, and dilators to create a well-positioned tunnel of the appropriate diameter. The allograft is then passed through the tibia and femur in retrograde fashion. We secure the femoral side with an AO (Arbeitsgemeinschaft für Osteosynthesefragen) 4.5-mm bicortical screw and washer. Our tibial fixation is secured after the ITB tenodesis. The knee is then cycled a dozen times.

In preparation for the ITB tenodesis, we lengthen our previously made incision by about 4 cm proximally along the posterior aspect of the ITB. The central portion of the ITB is then outlined at the Gerdy tubercle and split with a No. 10 blade. This generally leaves an approximately 12- to 14-mm strip of ITB centrally (**Figure 4**). This portion should be gently lifted from the underlying tissue attachments distally at the insertion on the Gerdy tubercle. The interval between the LCL and

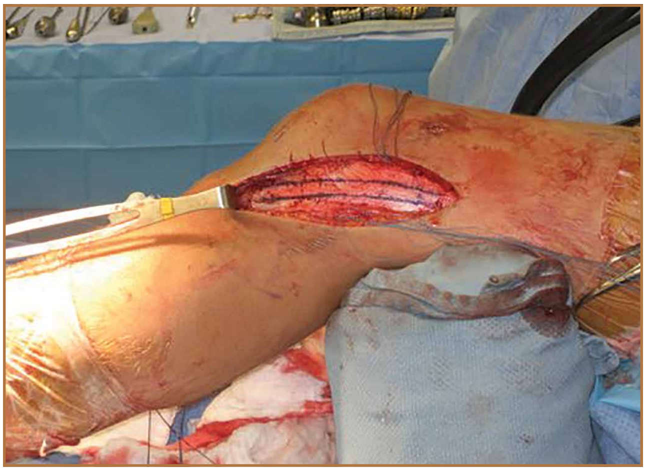

Figure 4. Central third of iliotibial band is outlined, beginning at Gerdy tubercle and extending proximally. Total length should be between 16 and 20 cm; width, about 1 cm.

lateral capsule of the knee is identified, and a No. 2 Ti-Cron whip-stitch is thrown through the free end of the ITB graft (**Figure 5**). The anterior aspect of the femoral tunnel is at the distal aspect of the lateral femoral condyle, and the posterior aspect is at the juncture of the proximal LCL and the lateral head of the gastrocnemius. The cortices of these landmarks should be perforated with a drill, and a curved instrument should be used to create a bone tunnel at this location (**Figure 6**). The tibial tunnel is just posterior and distal to the Gerdy tubercle and should be created in similar fashion. The graft is then passed underneath the LCL (**Figure 7**), through the proximal tunnel that has been created on the lateral femoral condyle, and then back down through the LCL and back onto itself after exiting the tibial tunnel (**Figure 8**). With the knee at 30° of flexion, the ITB graft is tensioned and sutured down to intact ITB fascia just proximal to the tibial tunnel orifice (**Figure 9**).

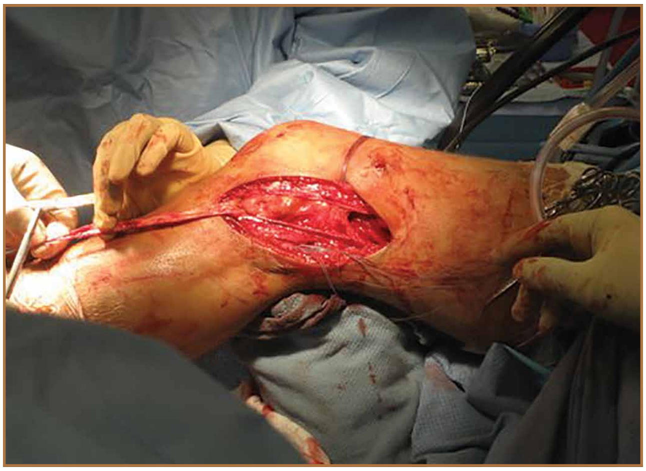

Figure 5. Central third of iliotibial band is sharply dissected. Distal insertion is left intact. Proximal end is whip-stitched with No. 2 Ti-Cron suture.

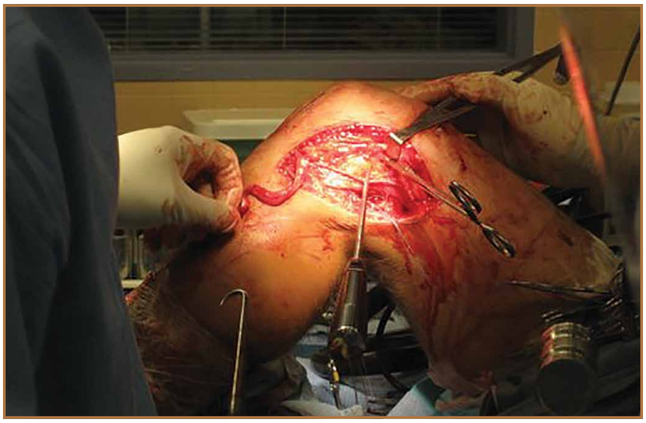

Figure 6. Lateral collateral ligament is identified while placing varus stress on knee joint. Iliotibial band strip is placed deep to lateral collateral ligament as it is passed in both distal-to-proximal and proximal-to-distal directions. Reconstruction is entirely extra-articular.

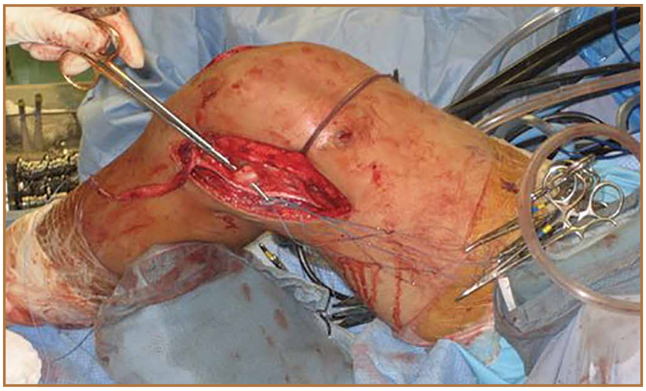

Figure 7. Clamp is placed on distal aspect of lateral intermuscular septum on lateral femoral condyle, marking anterior or proximal end of femoral tunnel. Posterior or distal aspect of tunnel is placed at juncture of proximal lateral collateral ligament anteriorly and lateral head of gastrocnemius posteriorly. Drill is used to perforate anterior and posterior tunnel cortical orifices. Curved hemostat or Kelly clamp is used to complete tunnel. Tibial tunnel entry point is just posterior to Gerdy tubercle. Tunnel should be several millimeters in diameter and exit just distal to tubercle.

Figure 8. Two shuttling sutures are placed beneath lateral collateral ligament (LCL), and another is placed through femoral tunnel, to allow graft passage in figure-8 fashion: Fascial strip is carefully passed beneath LCL, then from posterior to anterior through femoral tunnel and once again beneath LCL from proximal to distal. Whip-stitched fascial strip is then passed through tibial tunnel proximal to distal.

We check knee range of motion (ROM) and then perform a Lachman test to assess changes in knee stability. The pivot shift examination is omitted to avoid placing excessive stress on the tenodesis. The tibial side of the patellar tendon allograft is then tensioned and secured over an AO 4.5-mm bicortical screw with washer with the knee in full extension. The screw is then tightened at 30° of knee flexion.

The ITB fascia is closed to the lateral femoral epicondyle with a running heavy suture, and all incisions are then irrigated and closed (**Figures 10, 11**). Standard sterile surgical dressing, Cryo/Cuff (Aircast, Vista, California), and brace are applied with the knee locked at 20°. Patients are generally discharged home the same day and followed up in clinic 1 week after surgery.

Complications

The peroneal nerve must be identified and protected during the open lateral procedure. In addition, the need for the extra lateral incision poses a slightly higher risk for infection compared with the traditional arthroscopic revision ACL procedure. Last, the additional tunnels required for the tenodesis can increase the theoretical potential for distal femur fracture and ACL graft fixation failure on the femoral side.

Postoperative Management

The operative knee is kept in extension in a brace locked at 20° for week 1 after surgery. Isometric quadriceps exercises are started immediately after surgery. Flexion to 90° is allowed starting week 2 after surgery, when the patient begins super-

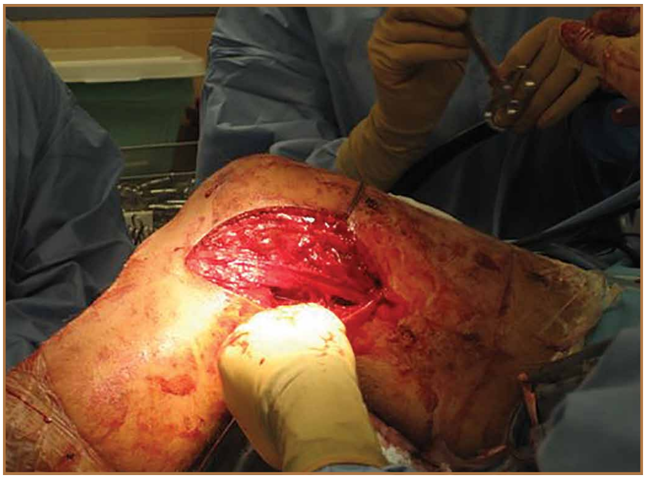

Figure 9. With knee in 30° of flexion and foot in neutral rotation, tension is applied to graft exiting distal tibial tunnel. Rerouted iliotibial band fascia is then sutured to intact iliotibial band fascia with several mattress sutures just proximal to tibial tunnel orifice.

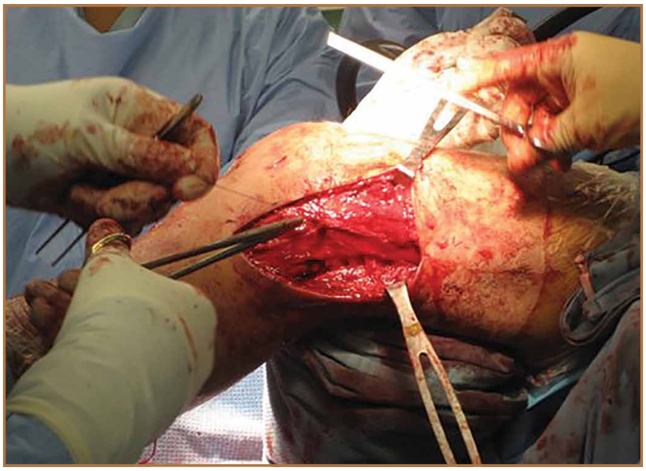

Figure 10. Proximal to joint line, outer thirds of iliotibial band fascia are closed with absorbable suture. Lateral retinacular tissue may require release to prevent lateral subluxation of patella.

vised active/passive flexion and progressive ROM exercises. In most cases, full ROM should be achieved by 6 to 8 weeks after surgery. Patients are progressed in their weight-bearing status by about 25% of their body weight per week, and use of crutches should be discontinued by week 4 after surgery. The brace should be discontinued by week 6 after surgery, when use of stationary bicycle and closed chain exercises begin. The patient may begin jogging when the operative leg regains 80% of contralateral quadriceps strength via Cybex strength testing. Functional drills begin in month 6, but patients should be counseled against returning to sport any earlier than 9 months after surgery.

Discussion

Achieving a successful outcome in revision ACL surgery (vs primary ACL surgery) is a significant challenge. Any of numerous factors can make the revision surgery more challenging, including existing poorly placed tunnels, tunnel expansion, lack of ideal graft choice, loss of secondary stabilizers, and deviations of the weight-bearing axis. Therefore, outcomes of revision surgery tend to be more moderate than outcomes of primary procedures.[4,8-12]

Revision ACL reconstruction techniques are varied and can involve use of autograft or allograft tissue as well as extra-articular augmentation techniques. Diamantopoulos and colleagues[8] reported the outcomes of revision ACL reconstruction using bone–tendon–bone, hamstring, or quadriceps autografts in 107 patients. The majority of patients had improved outcome measures (mean Lysholm score improved from 51.5 to 88.5) and side-to-side laxity measurements. However, only 36.4% returned to preinjury activity level. Similarly, Noyes and Barber-Westin[9] reported the outcomes of revision ACL reconstruction using quadriceps tendon–patellar bone autograft in 21 patients. Although there was significant improvement in terms of symptoms and activity level, 4 of the 21 knees were

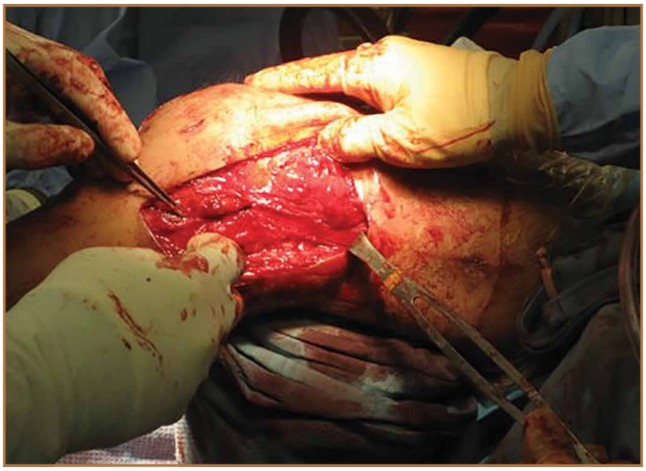

Figure 11. Iliotibial band interval is closed proximal to lateral joint line, and forceps indicates fixation point of distal aspect of extra-articular tenodesis.

graded abnormal or severely abnormal on the IKDC (International Knee Documentation Committee) ligament rating. In a systematic review, pooled results of revision ACL reconstructions reiterated the above results.[10] Eight hundred sixty-three patients from 21 studies were included in the analysis, which found significantly worse subjective outcomes than for primary procedures and a dramatically higher failure rate for the re-reconstructed ACL.

Several authors have directly compared primary cohorts with revision cohorts. Ahn and colleagues[11] compared the outcomes of 59 revision ACL reconstructions with those of 117 primary reconstructions at a single institution. Although statistical comparison of stability between primary and revision ACL reconstructions showed no difference, revision reconstructions fared more poorly in terms of quality of life and return to activity compared with primary reconstructions. In a large cohort study of the Danish registry, revisions were found to have worse subjective outcomes than primary reconstructions as well.[12] The study also found that the rerupture risk was significantly higher (relative risk, 2.05) when allograft was used.

Given the inferior results of revision surgery, our technique is recommended to augment the stability of reconstructed knees in the setting of revision ACL reconstruction. Adding the extra-articular procedure may augment the revised graft and protect it from excessive stress.[13] A cadaver study compared double-bundle ACL reconstruction with single-bundle hamstring reconstruction plus extra-articular lateral tenodesis and found improved internal rotation control at 30° of flexion in the latter.[14] Using contralateral 4-strand hamstring autograft in combination with an extra-articular lateral augment can have encouraging outcomes. Ferretti and colleagues[15] reported an average Lysholm score of 95 in 12 patients who underwent this revision procedure and good anterior-to-posterior stability in 11 of the 12 patients. Trojani and colleagues[16] reported on a cohort of 163 patients who underwent ACL revision surgery over a 10-year period. The authors found that 80% of patients with a lateral extra-articular tenodesis performed to augment their revision reconstruction had a negative pivot shift at long-term follow-up—versus only 63% of patients who underwent isolated revision ACL reconstruction. This finding was statistically significant, but the authors did not find any differences in IKDC scores between groups. These results support the initial biomechanical findings of Engebretsen and colleagues,[17] who found that adding a lateral tenodesis decreased the forces on the reconstructed graft by 15%.

Conclusion

This technique allows for protection of the intra-articular allograft ligament reconstruction with improved rotational control that may potentially allow for improved subjective outcomes and protect against graft failure. Given the common pitfalls with stability in revision ACL surgery with allograft, this lateral extra-articular procedure can be an important structural augmentation in this challenging clinical issue in knee surgery.

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