International Journal of Research in Orthopaedics
*Jung WH et al. Int J Res Orthop. 2025 Nov;11(6):1543-1546*
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20253427

**Case Series**

# Intra-articular migration of the tibial bone plug during anterior cruciate ligament reconstruction with bone-patellar tendon-bone autograft: a case series

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**Received:** 22 August 2025
**Revised:** 06 October 2025
**Accepted:** 18 October 2025

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## ABSTRACT

Bone-patellar tendon-bone (BPTB) autografts are a preferred choice for anterior cruciate ligament (ACL) reconstruction due to their potential for reliable bone-to-bone healing. However, technical errors can lead to significant complications. This report presents a series of three cases where the tibial bone plug of a BPTB autograft migrated into the intra-articular space. Postoperative analysis identified that proximal displacement of femoral bone plug, divergence of the interference screw during femoral screw fixation was the primary cause. This led to proximal migration of the graft, increase of tension, and subsequent displacement of the tibial bone plug. These cases underscore the critical importance of meticulous surgical technique, particularly in ensuring accurate screw placement to prevent graft migration.

**Keywords:** BPTB grafts, ACL reconstruction, Tibial bone plug, Migration, Screw divergence

## INTRODUCTION

The ACL is essential for knee stability, primarily preventing anterior tibial translation and managing rotational forces. Tears of the ACL frequently lead to functional instability, especially in active individuals, often necessitating surgical intervention. ACL reconstruction utilizing a BPTB autograft is a widely accepted and effective technique, valued for its strong fixation and biological healing properties.[1]

Despite its success, the procedure is not without challenges. Complications such as graft-tunnel mismatch, improper fixation, and poor bone quality can compromise outcomes.[2] A rare but severe complication is the intra-articular migration of the tibial bone plug, which can cause pain, mechanical locking, instability, and ultimately graft failure. This report details three cases where this specific complication occurred, aiming to raise awareness and discuss its potential cause.

## CASE SERIES

For all three patients, a standardized surgical technique was employed. Patients were positioned supine, and general or regional anesthesia was administered, with a tourniquet applied to the proximal thigh to minimize intraoperative bleeding. Diagnostic arthroscopy was performed using standard anterolateral and anteromedial portals, employing a 30° arthroscope to inspect the knee joint and address meniscal or chondral lesions as needed, while the ACL remnant was debrided, preserving the femoral and tibial footprints to guide tunnel placement.

A midline incision over the anterior knee facilitated the harvesting of the BPTB autograft, excising the central third of the patellar tendon (10 mm wide) to yield a patellar bone plug of 15–20 mm and a tibial bone plug of 20–25 mm, with graft measurements recorded intraoperatively. The tibial tunnel was prepared with the knee at 90° flexion, using a tibial drill guide set at 45–55° to match the native ACL orientation, and the tibial tunnel length (TTL) was

calculated using the N+2 rule (TTL=tendon length +2 mm) to accommodate the graft. The femoral tunnel was drilled using a 7-mm offset femoral guide introduced through the tibial tunnel, positioned at the posterior notch with the knee at 80–90° flexion, matching the femoral bone plug length (20–25 mm), and the tunnel aperture was notched anterosuperiorly to facilitate graft passage.[3]

The graft was passed using a pull-through technique, fixed in the femoral tunnel with a 9-mm interference screw, and the tibial bone plug was secured with a 9-mm interference screw, supplemented by a washer screw for enhanced stability, particularly in cases of observed graft recession into the tibial tunnel after femoral fixation; graft tension was adjusted manually to ensure proper alignment and prevent migration without re-drilling. Postoperative X-rays and CT scans (sagittal and coronal views) assessed graft position and fixation integrity.

### *Case 1*

A 27-year-old male sustained a left knee twisting injury, resulting in a complete ACL tear confirmed by MRI. An ipsilateral BPTB autograft, measuring 65 mm (25 mm tendon, 20 mm femoral plug, 20 mm tibial plug), was used with a calculated TTL of 27 mm. Intraoperatively, graft recession into the tibial tunnel was noted after femoral fixation, and postoperative sagittal CT scans confirmed proximal graft migration with intra-articular displacement of the tibial bone plug as shown in Figure 1. At the six-month follow-up, the patient had a full range of motion, no instability, and an International Knee Documentation Committee (IKDC) score of 0.89; the washer screw was removed at 18 months, with an MRI confirming the graft remained intact and well-positioned.

### *Case 2*

A 49-year-old female presented with right knee instability and pain after a twisting injury, with an MRI confirming an ACL tear with mucoid degeneration. The harvested BPTB graft measured 63 mm (28 mm tendon, 15 mm patellar plug, 20 mm tibial plug), with a calculated TTL of 30 mm. Postoperative coronal and sagittal CT scans revealed proximal graft migration and intra-articular displacement of the tibial bone plug as shown in Figure 2. At the six-month follow-up, the patient's knee was stable with no functional instability, achieving an IKDC score of 0.87.

### *Case 3*

A 54-year-old male experienced left knee instability after an injury while descending stairs, with poor ACL visualization on MRI and positive Lachman and anterior drawer tests confirming the tear. The BPTB graft measured 72 mm (32 mm tendon, 20 mm femoral plug, 20 mm tibial plug), with a calculated TTL of 34 mm. Postoperative CT scans confirmed proximal graft migration with intra-articular displacement of the tibial bone plug as shown in Figure 3. At six months, the patient had a stable knee, no functional instability, and an IKDC score of 0.85.

## DICUSSION

Intra-articular migration of the tibial bone plug represents a rare yet serious complication of BPTB ACL reconstruction. Based on our analysis of three cases, we have identified a primary and preventable cause rooted in a technical error during femoral fixation. This error initiates a cascade of events, beginning with insufficient tapping of the femoral tunnel.

An improperly prepared tunnel, coupled with subsequent divergence of the interference screw, prevents the secure anchoring of the femoral bone plug. Consequently, the femoral plug migrates proximally, increasing tension along the graft.[4] This tension ultimately pulls the unsecured tibial bone plug from its tunnel, causing its displacement into the intra-articular space

While graft-tunnel length mismatch is a known challenge, In our cases, the patellar tendon length (25–32 mm) was within the normal range (22–41 mm), but overall graft length was insufficient due to intraoperative migration during femoral fixation.[5] This migration was likely exacerbated by screw divergence, rotational forces during interference screw insertion, causing proximal migration of femoral bone plug ultimately leading to intra-articular tibial bone plug displacement, as seen on CT scans (Figures 1-d, 3c, 3d).[6]

Though too early to state the use of a washer screw for supplemental tibial fixation proved effective in our cases, providing stable outcomes preventing further migration at follow-up. These patients are being closely monitored for early identification of graft failure to prevent further complications.

The management of a migrated tibial bone plug typically involves revision surgery.[7] The goals of the revision procedure are to remove the migrated bone plug, address any associated intra-articular damage, and perform a stable revision ACL reconstruction. The choice of graft for the revision surgery depends on surgeon preference and patient factors.

According to the literature preventive strategies for this type of complication include. Preoperative measurement of tendon length via MRI.[8] Accurate tunnel length calculation using the N+2 rule (TTL= tendon length+2 mm).[3] Tapping the femoral tunnel and using a straight guide wire to prevent screw divergence.[9,10]

Controlled screw insertion and proper graft tensioning to minimize migration.[6] Adjusting graft preparation or tunnel lengths as needed.[11] Supplemental fixation (washer screw) for additional stability, particularly in cases with borderline graft lengths to prevent further migration.

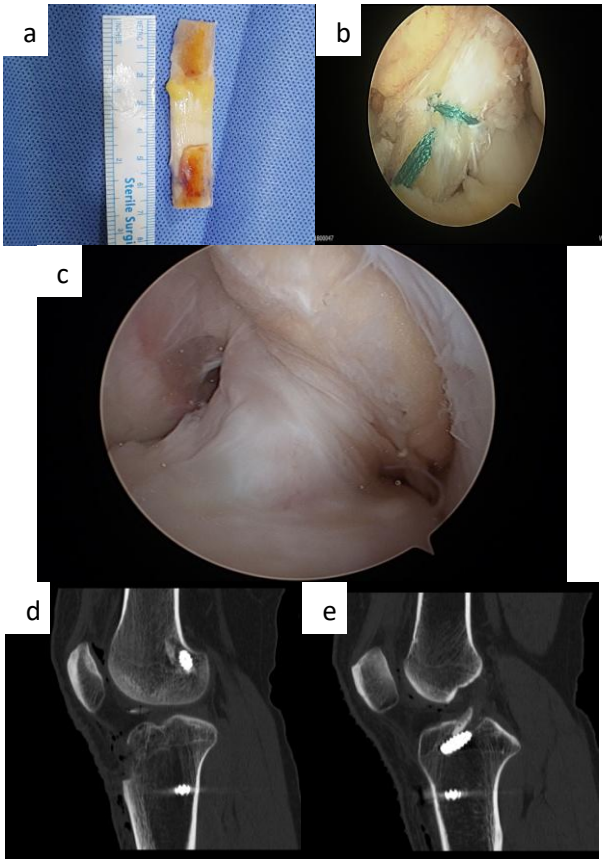


**Figure 1: (a) Intraoperative photo of short BPTB graft 65 mm. (b) Arthroscopic image showing reconstructed ACL using BPTB graft. (c) Second look arthroscopic image after 19 months post op. (d) Sagittal CT SCAN showing proximal graft migration. (e) Sagittal CT SCAN showing intraarticular bone plug migration.**

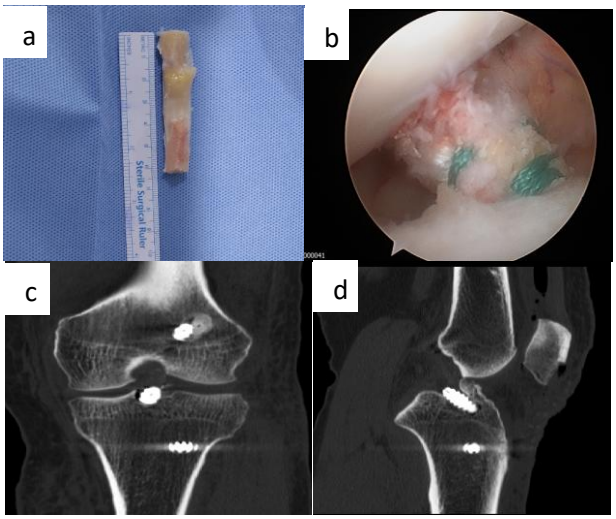


**Figure 2: (a) Intraoperative photo of short BPTB graft 63 mm. (b) Arthroscopic image showing reconstructed ACL using BPTB graft. (c) Coronal CT SCAN showing proximal graft migration. (d) Sagittal CT SCAN showing intraarticular bone plug migration.**

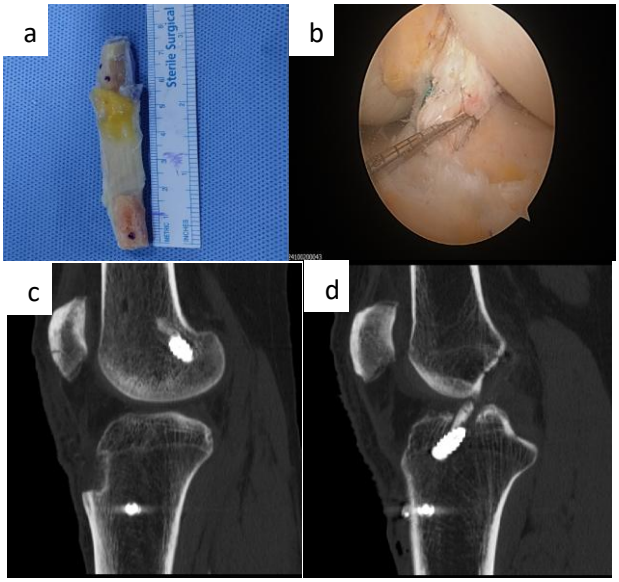


**Figure 3: (a) Intraoperative photo of short BPTB graft 72 mm. (b) Arthroscopic image showing reconstructed ACL using BPTB graft. (c) Sagittal CT scan showing proximal graft migration. (d) Sagittal CT scan showing intraarticular bone plug migration.**

## CONCLUSION

Improper femoral screw fixation is a critical and preventable cause of graft failure in BPTB ACL reconstruction. This case series demonstrates that the complication originates when a femoral interference screw deviates from its intended path, particularly within an untapped tunnel. This technical error leads to insufficient fixation, causing proximal migration of the graft and, ultimately, intra-articular displacement of the tibial bone plug. Surgeons can mitigate this risk by prioritizing meticulous surgical technique, including proper tunnel preparation and careful, coaxial screw insertion. When intraoperative migration is detected, adaptive fixation techniques, such as a supplemental washer screw, can successfully prevent further displacement and salvage the reconstruction. Despite this effective intervention, postoperative vigilance remains crucial, as revision surgery is often required to restore knee stability and function if instability persists.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: Not required*

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**Cite this article as:** Jung WH, Yadlapalli S, Kim DH, Singh MK. Intra-articular migration of the tibial bone plug during anterior cruciate ligament reconstruction with bone-patellar tendon-bone autograft: a case series. Int J Res Orthop 2025;11:1543-6.