

Proximal Tibia Biplanar Anterior and Lateral Closing Wedge Osteotomy with Concomitant Revision Anterior Cruciate Ligament Reconstruction: A Case Report

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ABSTRACT

This report documents a unique, successful strategy to manage a failed anterior cruciate ligament reconstruction (ACLR) in the setting of coronal and sagittal plane malalignment. The patient is a 38-year-old man with a history of a failed ACLR who presented with recurrent knee instability. Imaging revealed a posterior tibial slope (PTS) of 17° complicated by a varus malalignment of 10°. A single-stage anterior and lateral closing wedge tibial osteotomy (biplanar) with simultaneous revision anterior cruciate ligament reconstruction was performed. Final radiographic evaluation revealed that the tibial osteotomy healed with correction of coronal alignment to a physiologic 3° varus and a PTS of 7°. The patient returned to an active lifestyle without limitations.

Keywords: Anterior Cruciate Ligament; Orthopaedics; Osteotomy

INTRODUCTION

The combination of clinically significant varus and posterior tibial slope (PTS) malalignment presents a difficult scenario in the presence of a failed anterior cruciate ligament (ACL) graft and recurrent knee instability. Excessive PTS and varus malalignment have both been shown to increase the forces placed on the ACL, thereby increasing the potential for graft failure, which makes surgical correction and graft protection necessary in properly indicated patients.^{1,2}

Biplanar tibial osteotomies and their impact on posterior tibial slope and varus alignment of the knee have been previously researched and documented.^{3,4} However, correction in both planes, along with a simultaneous or staged ACL reconstruction, is a newer treatment option. A literature search identified only a handful of articles published within the past three years, none of which used the same technique used for this patient.⁵⁻⁸

Additional considerations in the setting of a revision ACL reconstruction (rACLR) include the evaluation of non-bony structures to mitigate factors that may contribute to postoperative knee instability. Medial and

lateral meniscus tears, improper tunnel placement and size, and other soft-tissue deficiencies are among the many factors that can affect the success of a rACLR.⁹⁻¹¹

This case report discusses the authors' experience with a patient who returned to their pre-injury level of athletics following a biplanar anterior and lateral closing wedge high tibial osteotomy (Bi-PlanarClosingWedge HTO or bpcwHTO) for slope and varus correction, along with a simultaneous rACLR using autograft quadriceps tendon.

The patient was informed that information about this case would be submitted for publication and they provided consent.

CASE REPORT

The patient is a 38-year-old man with a history of a left knee ACL tear and reconstruction with medial meniscectomy seven years prior. Three years before presentation, he reinjured the knee while playing tennis, resulting in a rupture of the left ACL graft. Preoperative physical examination revealed a positive Lachman with soft endpoint, positive pivot shift with clunk, negative posterior drawer, and negative varus

and valgus stress testing at both 0° and 30°. The patient rated his pain at a 7 out of 10 on the Numeric Pain Rating Scale (NPRS). Imaging confirmed a 17° PTS, 10° varus deformity, 6.66 millimeters of anterior tibial subluxation, complete ACL graft rupture, and progression of medial compartment arthritis compared to imaging performed seven years prior (Figures 1A-1D).

A paper template developed by the surgical team, including senior authors LN and RCS, illustrated an asymmetrical osteotomy wedge needed for concomitant varus and slope correction (Figures 2A & 2B). The Fujisawa Point was identified and used for coronal alignment correction due to its documented use for patients with medial compartment degeneration and ligamentous instability.^{12,13}

The lateral bpcwHTO was performed using two infra-tubercular tibial cuts to reduce the risk of fibular nerve

palsy. An asymmetrical biplanar tibial osteotomy was performed and required for correction in two planes, along with a fibular osteotomy to allow for reduction (Figures 3A & 3B). Final fixation of the tibial osteotomy was achieved with a TOMOFIX® (Synthes, USA) plate (Figure 4). An ipsilateral quadriceps tendon autograft with bone plug soaked in vancomycin was selected as the graft choice, given the prior bone tendon bone autograft harvest.^{14,15} Graft placement used the previously drilled graft tunnels, which were in an acceptable position.

Postoperative instructions included weight bearing as tolerated immediately following the surgery. At two months postoperative, radiographs demonstrated secure fixation with PTS corrected to 7° and varus neutralized to 3° (Figures 6A & 6B). The patient

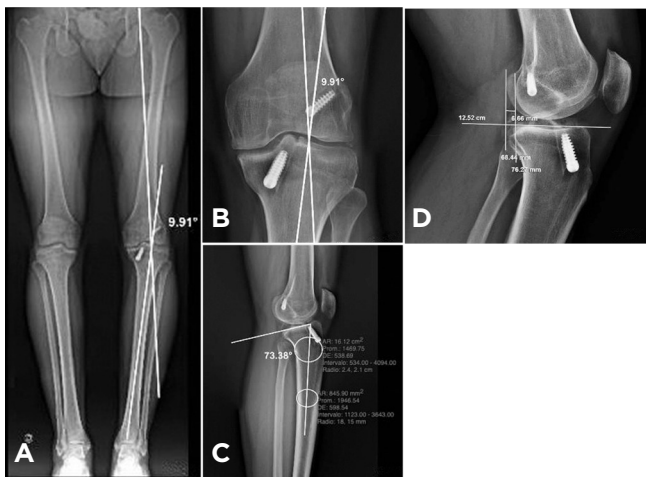


Figure 1. A) Preoperative weight bearing full-length radiograph demonstrates varus deformity of nearly 10° with hardware from the primary ACLR; B) Anteroposterior radiograph of the knee shows varus alignment and mild medial joint space narrowing with intact hardware from prior bone tendon bone autograft ACL reconstruction; C) Preoperative lateral weight bearing radiograph of the left knee displaying a PTS of nearly 17°; D) Preoperative anterior tibial subluxation (ATS) measured 6.66 millimeters on lateral radiographs.

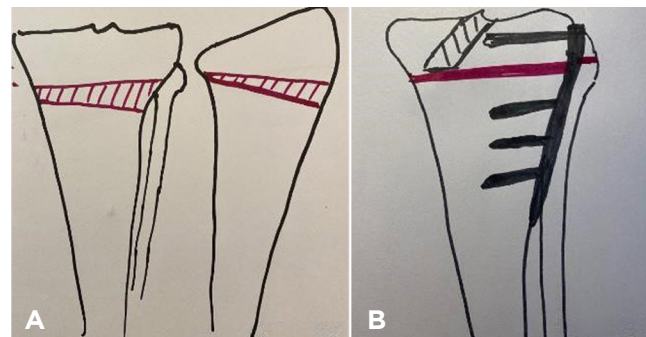


Figure 2. Preoperative paper template demonstrating the asymmetrical bony cut via a bpcwHTO followed by plate fixation and tunnel positioning for placement of rACL with quadriceps autograft.



Figure 3. Placement of two osteotomies demonstrating the two-cut technique for a bpcwHTO with radiographic imaging confirming placement and subsequent bone wedge removal with remaining flat opposing surfaces.



Figure 4. Placement of two osteotomies demonstrating the two-cut technique for a bpcwHTO with radiographic imaging confirming placement and subsequent bone wedge removal with remaining flat opposing surfaces.



Figure 5. Lateral radiograph with the knee in extension taken immediately following the procedure demonstrates a correction of the ATS from 6.66 millimeters to 1.59 millimeters.



Figure 6. A) Full-length weight bearing radiograph; B) lateral radiograph showing final fixation at two months post operation. Postoperative PTS was corrected from $\sim 17^\circ$ to $\sim 7^\circ$. Postoperative coronal alignment improved from a varus measurement of $\sim 10^\circ$ to $\sim 3^\circ$.

completed six months of physical therapy before slowly transitioning back to tennis. At three years postoperative, the patient had a NPRS score of 0, an International Knee Documentation Committee score of 86.2, Lysholm knee score of 94, and returned to brace-free tennis without limitations or instability.

DISCUSSION

This case illustrates the successful use of a biplanar anterior and lateral closing wedge osteotomy to reduce PTS and correct varus deformity with a simultaneous rACLR. There are limited surgical technique descriptions in the literature to guide biplanar osteotomies in the setting of ACL rupture.^{3,6,12} Indications for osteotomies after failed ACLR include both varus and posterior slope corrections when there is more than 10° of varus deformity with simultaneous medial degeneration and 12° of posterior slope.^{1,16,17} Large varus deformities greater than or equal to 10° substantially increase forces across the ACL, and when this deformity is isolated in the setting of a failed ACLR, coronal correction is indicated.¹⁸ Similarly, current literature indicates that a PTS greater than 12° increases the risk of graft failure in a reconstructed ACL.¹⁹⁻²³ The authors considered additional surgical techniques and focused on identifying the properly indicated patient, as both factors contribute to a positive outcome.

Müller et al³ highlight a different approach to address the same pathology in the form of a biplanar medial

opening wedge high tibial osteotomy (mowHTO). The described technique corrected varus deformity and PTS in patients with symptomatic medial osteoarthritis and biplanar deformity. When rACLR was indicated, it was recommended to wait six months following the osteotomy and perform the procedure in a staged fashion to allow for bone consolidation. Müller et al³ concluded that while a biplanar mowHTO is useful for addressing complex anatomy, as presented in this case, further research is needed to evaluate the long-term efficacy of this procedure. In the authors' experience, mowHTO is a useful procedure, but due to the potential complication of increasing the already large PTS of 17° seen in this patient, the bpcwHTO used in this case was a better fit for the patient's pathology.

Price et al⁵ discussed a similar biplanar mowHTO approach for the correction of coronal and sagittal plane malalignment. The patient was a 38-year-old woman with a history of polytrauma who presented with an ACL rupture, varus deformity, and increased PTS. The biplanar osteotomy was performed first to correct the slope and varus malalignment, followed by staged ACLR 23 months later.⁵ In the bpcwHTO approach used in this case, the authors avoided increasing the PTS with an opening wedge osteotomy and avoided potential non-union complications, allowing for immediate weight bearing and, most importantly, avoiding the need for a staged approach and the associated social pressures.

In a biomechanical cadaver study, Imhoff et al¹ indicated that the goal of achieving a perpendicular tibial plateau in the setting of an ACLR led to the greatest reduction in stress on the ACL (33.0% reduction in graft force at 200N and 58.0% at 400N) and a significant reduction in anterior tibial translation compared to native alignment. This research supports biplanar correction in the setting of a previous ACL graft failure, as seen in this case.

Biplanar high tibial osteotomy procedures have been shown to be effective in correcting PTS and varus malalignment. Literature searches demonstrate that although proximal tibial biplanar corrections are a newer technique, they show promise at effectively decreasing stress on native and reconstructed ACLs. This case documents a novel approach to correcting both varus and PTS in the setting of a simultaneous rACLR with a three-year follow-up and a good outcome. Further studies are needed to determine the efficacy of different surgical techniques for the treatment of coronal and sagittal plane malalignment during simultaneous rACLR. However, in the presence of ACL failure and significant varus and PTS, this appears to be a useful approach for patient care.

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