

Technical Note

Anterior Cruciate Ligament Revision: Double-Bundle Augmentation of Primary Vertical Graft

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Abstract: A variety of factors contribute to the failure of primary anterior cruciate ligament (ACL) reconstruction; most commonly, it is technical error related to tunnel placement. Recently, the increasing popularity of the all-endoscopic ACL reconstruction and concern about graft impingement may have led to more posterior placement of the tibial tunnel by surgeons. Working through a tibial tunnel placed too posterior makes it more difficult to recognize the correct starting position on the femur, and more likely to start the femoral tunnel in a central 12 o'clock position. The combination of subtle posterior placement of the tibial tunnel and central placement of the femoral tunnel results in a graft that is malpositioned in both the sagittal and coronal planes—a “vertical graft.” We present a novel method of ACL revision surgery applicable to a specific subset of ACL revision patients with an intact “vertical graft” and instability that is rotational more than translational. In these patients, a double-bundle revision ACL augmentation technique can be used, leaving the original graft in place. A new tibial tunnel is placed anterior to the original and a new femoral tunnel lateral to the original. Reconstruction is performed with allograft and the combined ACL construct provides robust translational and rotational stability to the tibiofemoral joint. **Key Words:** Anterior cruciate ligament—Reconstruction—Revision—Double bundle.

Over 100,000 anterior cruciate ligament (ACL) injuries occur in the United States each year¹ and roughly 60,000 to 75,000 ACL reconstructions are performed annually.² Although the outcomes are generally good for up to 75% to 90% of cases,³ some patients do have unsatisfactory outcomes, with failures occurring at a rate of 10% to 20%.⁴⁻⁶ The number of potential ACL revisions in the United States is

estimated at 3,000 to 10,000 a year.⁷ The cause and presentation of failed ACL reconstruction varies,^{8,9} with technical error considered the most common cause of failure.¹⁰ The most common technical error in ACL reconstruction is misplaced tunnels, most often the femoral tunnel.^{9,10} A variety of surgical techniques for revising ACL reconstruction have been described in the literature, although the reported results have generally been inferior to primary ACL reconstruction.^{5,11,15} The purpose of this article is to present a novel technique for revision ACL surgery that may be useful in a specific subset of patients.

The increasing number of failed ACL reconstructions over the last decade may be related to 2 emerging issues: the concern about possible graft impingement^{12,13} and the all-endoscopic technique for ACL reconstruction.^{14,16} These 2 issues may have led to a more posterior placement of the tibial tunnel by surgeons, which tends to result in a more vertical graft in the sagittal plane. Working through a tibial tunnel placed too posterior makes it more difficult to recog-

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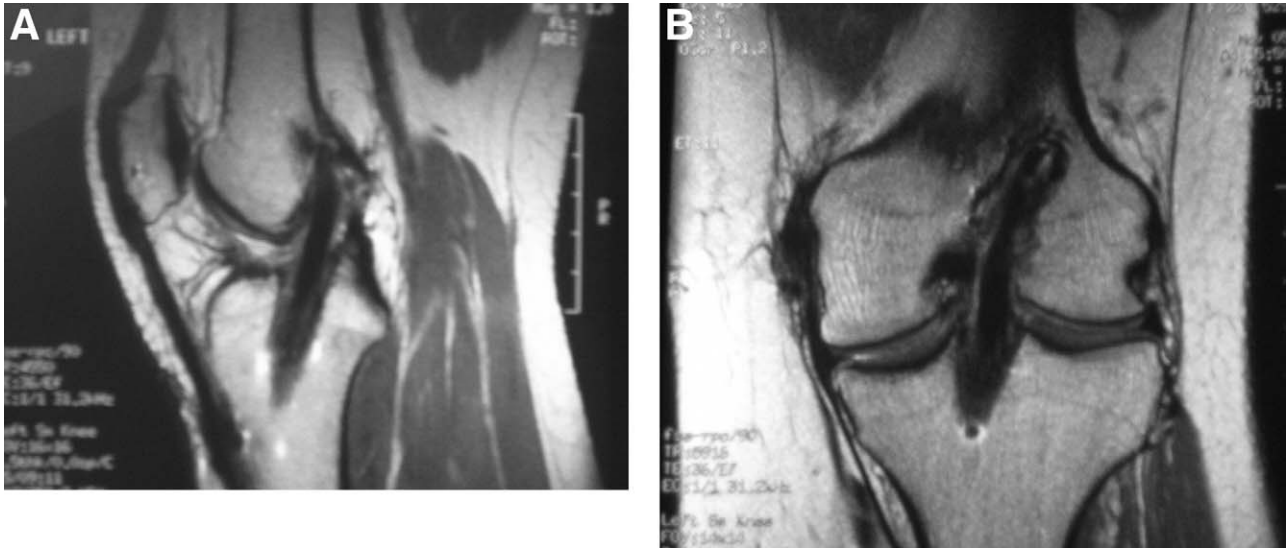


FIGURE 1. (A) Sagittal and (B) coronal magnetic resonance imaging cuts of one of our patients with a primary vertical graft who was subsequently treated with a double-bundle revision graft.

nize the correct starting position on the femur, and more likely to start the femoral tunnel in a central or 12 o'clock position. The combination of subtle posterior placement of the tibial tunnel and central placement of the femoral tunnel results in a graft that is malpositioned in both the sagittal and coronal planes—a “vertical graft” (Fig 1). The clinical result of a vertical graft is rotational instability.

In this case, there are 2 possible solutions. The first and more traditional route is to remove the primary graft and replace it with a new graft. With this approach, there may be a problem with the tibial tunnel if graft removal leaves a large tibial defect. Such a defect must be grafted before redrilling a new tibial tunnel in a more anatomic anterior position.¹⁷ It is important to recognize that the true vertical graft is malpositioned in 2 planes and that only changing the location of the femoral tunnel while reusing the previous position of the tibial tunnel does not completely correct the problem.

We propose that if the existing vertical graft appears intact and well-integrated on magnetic resonance imaging, surgeons should consider a “double-bundle” revision whereby the original reconstructed ACL graft is left in place and a second additional graft reconstruction is performed. By placing a new tibial tunnel anterior to the original and the new femoral tunnel lateral to the original, the combined graft will be correctly positioned and restore stability to the knee. The patients who may benefit most from this tech-

nique are those with an intact primary vertical graft and rotational instability more than translational instability.

SURGICAL TECHNIQUE

The surgical technique involves standard knee arthroscopy with treatment of any concomitant intra-articular pathology as indicated. With regard to treating the ACL, the decision to use the double-bundle technique is made intra-operatively. If the original graft appears to be intact with good tissue quality and tunnel fixation, then the double-bundle revision may be considered. Typically the tibial tunnel will be too posterior and the femoral tunnel will be too central in the notch. The original graft is left in place and the new revision graft is added.

Allograft is usually selected for the reconstruction, specifically Achilles tendon allograft in the patients presented here, although one could use bone–patellar tendon–bone or hamstring autograft if these had not been used for the previous reconstruction(s). Both the 2-incision and 1-incision techniques have been used with this approach and may be used based on surgeon experience and preference. Regardless of the incision(s) used, the guiding principles are the same.

For the tibia, the new tunnel is typically anterior and may be slightly medial to the original graft (Fig 2A). Care should be taken to preserve the anterior wall, so the tunnel diameter may need to be downsized to 8 or

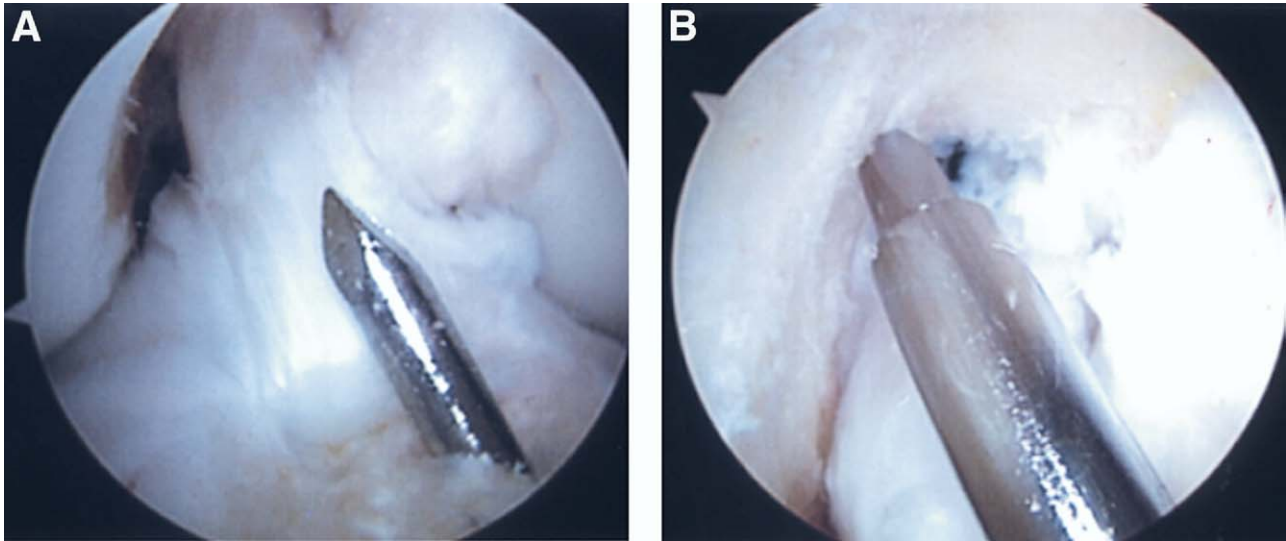


FIGURE 2. (A) Intraoperative arthroscopic image of the guide pin exiting the tibia anterior to the original graft during double-bundle revision. (B) Intraoperative arthroscopic image identifying the location of the new femoral tunnel lateral to the original graft during double-bundle revision.

9 mm as opposed to 10 or 11 mm. If it is necessary to use the smaller tunnel, the bone plugs and tendon must be carefully sized on the back table to fit the smaller tunnel.

In the femur, the new tunnel will be more lateral to the original location (Fig 2B). Depending on the fixation used for the original graft, the original interference screw may need to be removed. The resulting defect can be filled with a slightly smaller bioabsorbable screw. This allows sufficient room to drill the new tunnel and pass the graft without leaving a large defect that puts graft fixation at risk. The screw surface facing the graft should be smoothed with the shaver and/or rasp to minimize the chance for trauma to the graft (Fig 3).

Graft preparation, passage, and fixation are otherwise similar to previously described techniques for ACL reconstruction. When completed, the new graft is anterior and lateral to the original graft (Fig 4). Careful inspection is necessary to confirm that there is no impingement of the new graft on the notch or the original graft. Fixation of the tibial side often benefits from augmentation, particularly for soft tissue if using hamstring tendons or Achilles allograft. In the patients presented here, the InterFix system has been used in conjunction with a staple to fix the tendinous portion of the graft to the tibia. Postoperatively, the patient is placed in a Bledsoe brace and allowed toe-touch weight bearing unless otherwise indicated by treatment of concomitant pathology.

DISCUSSION

Revision of failed ACL surgery is becoming more common.⁶ Some patients, particularly those with a vertical graft and rotational instability more than translational instability, may benefit from augmentation of their initial ACL graft with a second ACL graft

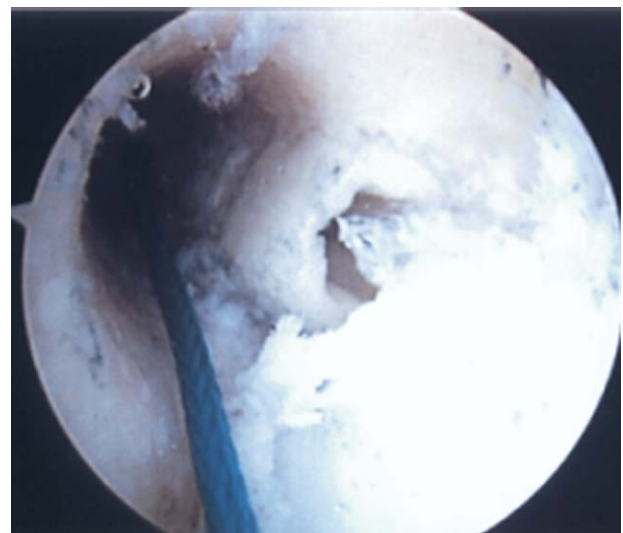


FIGURE 3. The original metal interference screw in the femur has been removed and replaced by a bioabsorbable screw. The edge of the bioabsorbable screw facing the new femoral tunnel has been smoothed with a rasp to minimize the chance of damaging the new graft.

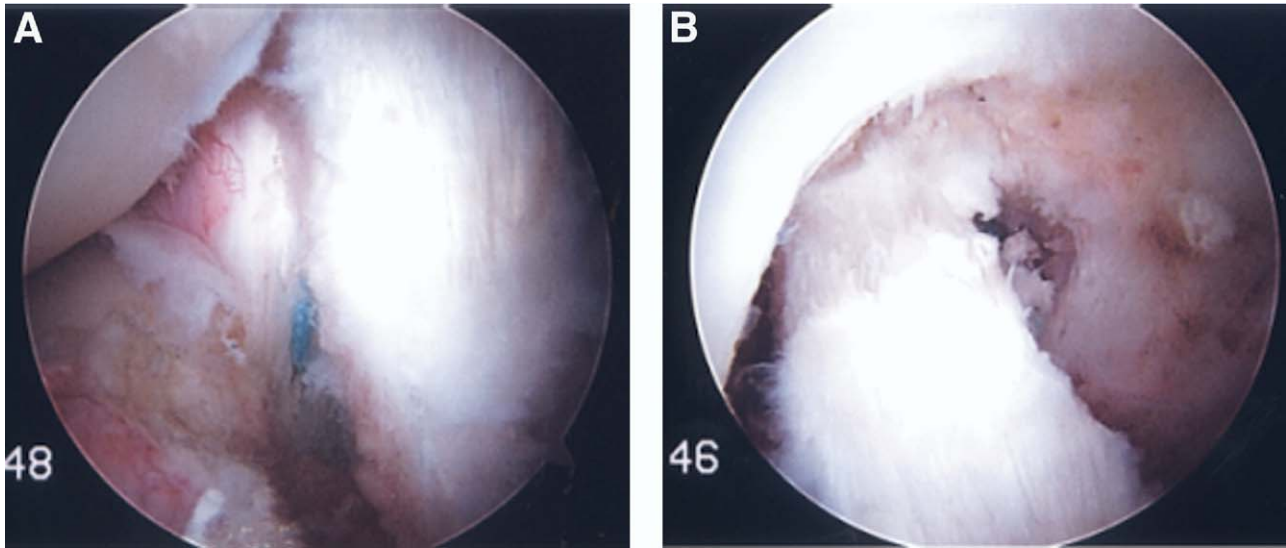


FIGURE 4. After the new graft has been placed, it is (A) anterior to the primary graft on the tibia and (B) lateral to the primary graft on the femur.

anterior to the first. If the initial graft is intact with good proximal and distal fixation, adding a second graft is a reasonable alternative to removing the primary graft and placing a new graft in isolation. In theory, the resulting ACL could be stronger and provide greater stability than an isolated revision graft.

The double-bundle concept has been explored as an option for primary reconstruction for many years. Although early studies suggested potential advantages and disadvantages of the double-bundle reconstruction,^{18,19} more recent studies suggest more favorable results with double-bundle primary ACL reconstruction.^{20,21}

The technique presented here provides augmentation to a previously reconstructed and otherwise intact ACL graft in a symptomatic patient. Typically, the graft is vertical and the recurrent instability is more rotational than translational. While this technique could be considered in all patients with this presentation, the decision to use this technique can only be made intra-operatively, once the presence of an intact graft with good femoral and tibial fixation has been confirmed.

Once the decision has been made to go forward with this technique, the most significant decision is the choice of graft. The patients presented here have all received Achilles tendon allografts. Obviously, the use of allograft tendon minimizes morbidity and may be necessary if autograft hamstring or bone–patellar tendon–bone is not available in a given patient. The

potential disadvantages of using allograft include the high cost, limited availability, and the risk of infection and disease transmission.²²

Regardless of the graft source, potential pitfalls with this technique include insufficient anterior wall on the tibial tunnel, graft impingement, and difficulty with future revision surgery. Although this technique has been used successfully on 3 patients, a larger series with more patients is necessary to better define the results from this approach.

In conclusion, this technique offers a reasonable approach to revision ACL surgery in the properly indicated patients. An important unknown is how the role of this technique may evolve in conjunction with the evolution of the double-bundle primary ACL reconstruction.

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