Revision Anterior Cruciate Ligament Reconstruction Using a Unique Bioabsorbable Interference Screw for Malpositioned Tunnels

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Abstract

Revision anterior cruciate ligament (ACL) reconstruction surgery has become increasingly common. The number of primary ACL reconstructions increases each year, and athletes are often able to return to cutting and pivoting sports. Most failed ACL reconstructions result from technical errors, commonly malpositioned tunnels. Correcting such tunnels in revision surgery requires understanding anatomy, preoperative planning, and often multiple methods of addressing bony defects. Multiple options have been described for handling these bony deficiencies, many of which are technically difficult and time-consuming to correct.

We describe a simple technique for addressing a bony defect during revision ACL reconstruction using a unique bioabsorbable interference screw comprised of an osteoconductive bioceramic β-tricalcium phosphate and poly(lactide-co-glycolide). Unique properties of this screw provide significant structural support for drilling revision tunnels through a portion of the screw or next to the screw, which allows for uncompromised tunnel placement.

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The number of primary anterior cruciate ligament (ACL) reconstructions has been rising dramatically and currently exceeds 100,000 annually in the United States. ACL reconstruction is a largely successful surgery with long-term functional stability and patient satisfaction approaching 90%. Still, a significant number of patients develop functional instability after reconstruction. An estimated 3000 to 10,000 patients are candidates for revision ACL surgery annually.[1] Consequently, ACL revision surgery has also become increasingly common and is likely to increase as the number of primary reconstructions multiplies each year.

The importance of correct, anatomical tunnel placement during ACL reconstruction cannot be overemphasized, particularly in revision surgery. This requires placement of revision tunnels at the appropriate anatomical tibial and femoral sites, regardless of considerations of previous tunnel placement.[2,3] Correcting malpositioned tunnels can be technically demanding and requires preoperative planning and sound intraoperative judgment. Many approaches for dealing with bony defects resulting from incorrectly positioned tunnels have been described.

In this article, we describe our use of a unique bioabsorbable interference screw (Milagro™; DePuy Mitek, Raynham, Mass) for managing a bony defect resulting from malpositioned tunnels in ACL revision surgery.

> "...we believe [this method] to be useful on the femoral and tibial sides for uncompromised placement of revision ACL grafts and secure graft fixation and for providing scaffolding for bony ingrowth."

Surgical Technique

After a thorough history is obtained, a physical examination is performed, and a diagnosis of failed ACL reconstruction is made, the patient should be counseled regarding options for surgical and nonsurgical treatment. Once revision ACL reconstruction is planned, preoperative evaluation should include obtaining anteroposterior, lateral, and Merchant radiographs to assess tunnel size and position. Plain radiographs showing bony defects should be compared with previous radiographs and with current magnetic resonance images

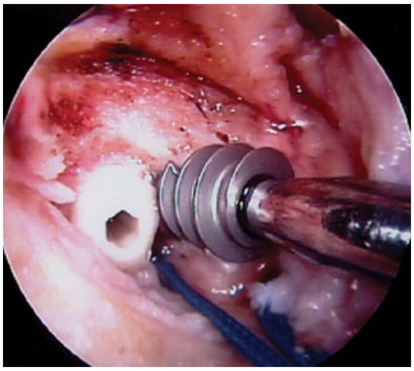

Figure 1. Insertion of a metallic interference screw after defect filling with a 10×23-mm bioabsorbable interference screw (Milagro™; DePuy Mitek, Raynham, Mass).

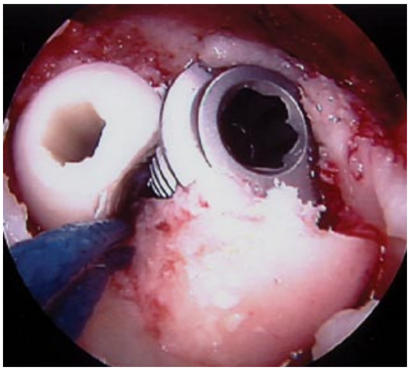

Figure 2. Final fixation of the anterior cruciate ligament graft in the tibial tunnel. Note the partially reamed adjacent bioabsorbable interference screw.

before surgery. Patients should be counseled regarding use of allograft bone, ACL graft options, and the possibility of staged reconstruction with bone grafting.

After adequate anesthesia is provided, the patient is routinely examined under anesthesia, and the examination findings documented. We begin our operative procedure with the patient in supine position on the operating table with a tourniquet on the thigh. After the extremity is prepared and draped in sterile fashion, we perform a routine diagnostic arthroscopy. Once the diagnosis of ACL deficiency is confirmed, we remove any ACL tissue that remains attached to either the femoral or tibial attachments. The notchplasty is then completed in a standard fashion ensuring adequate visualization of the over-the-top position.

If a bone–patellar tendon–bone (BPTB) autograft is used, then a midline incision is made, and an L-shaped flap of periosteum is elevated medial to the tibial tubercle. We then insert a tibial tunnel guide and reference off the anterior aspect of the posterior cruciate ligament and the anterior horn of the lateral meniscus. The guide pin is then drilled into the joint visualizing the entry position on the tibial plateau. If the guide wire can be passed into an appropriate anatomical location without contacting previous fixation, sequential reaming starting with a 6- or 7-mm reamer can begin over the guide wire. If new tunnel placement is possible without interference from previous hardware, the hardware should be left in place. If the reamer contacts a previously used interference screw, sequential reaming over the guide wire can help define the location of the hardware quickly without removing excess tibial bone. The hole can be progressively reamed until the interference screw is unroofed. Interference screws should be removed carefully after ensuring that the screw head is free of all soft tissue and that the screwdriver is fully seated. Once the screw is localized and removed, a final assessment of previous tunnel position and osteolysis is made. If initial guide wire placement is not anatomical because of deflection from the interference screw, repositioning of the wire should proceed with attention to anatomical placement of the tunnel without regard to the previous tunnel.

A Milagro bioabsorbable interference screw sized to match the residual hole created by the previous interference screw and any soft tissue is placed in the defect. Once the screw is seated, a 7-mm reamer is passed over the guide wire and advanced slowly as a portion of the screw is reamed. Sequential reaming over the guide wire is then performed to 10 mm. A standard BPTB or hamstring autograft is then harvested and prepared. If use of an Achilles, BPTB, or tibialis anterior allograft is planned, the graft should be thawed and prepared on the back table during the initial portion of this procedure. The graft can then be passed in usual fashion and secured with a metal or bioabsorb-

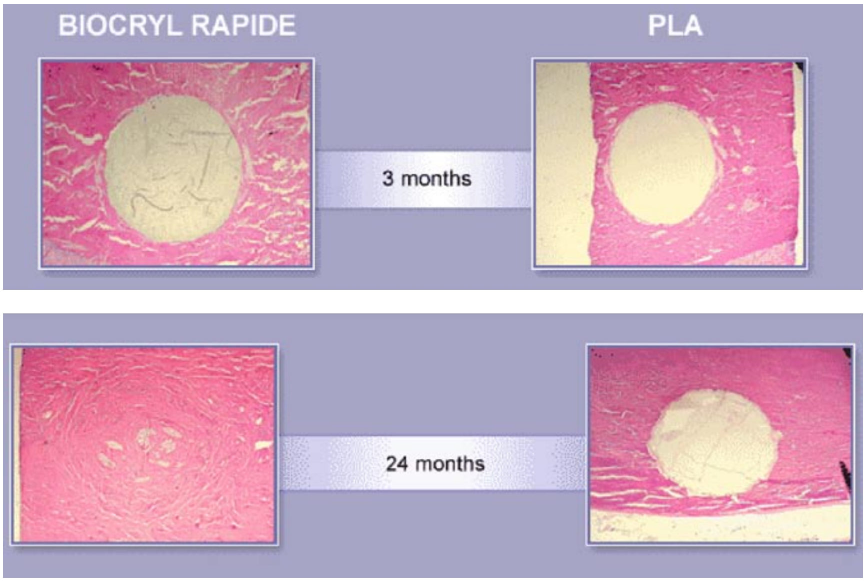

Figure 3. The images depict in vivo polylactic acid (PLA) and Biocryl Rapide test rods implanted in cortical bone of beagles. By 24 months, almost the entire cross-section of the Biocryl Rapide test rods had been absorbed and replaced by either normal bone or bone with fibrous tissue or adipose tissue. During the same period, in comparison, the poly-l-lactic acid cross-sections showed only minimal absorption.

able screw adjacent to the partially reamed Milagro screw (Figures 1, 2). A similar procedure can be performed with this screw for malpositioned femoral tunnels. We strongly emphasize reaming with slow advancement under high revolutions per minute in order to avoid tunnel deviation, particularly on the femoral side, where posterior wall blowout is a particular problem.

ily available and can be used to fill deficiencies resulting from previous graft tunnels or osteolysis. Composite screws provide sufficient structural support to allow reaming of new tunnels through or next to the screws. Other investigators have described using bioabsorbable screws to manage tunnel malposition. In the past, we were concerned about osteolysis or persistent bony defects with

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Discussion

There are many methods for managing bony deficiencies and malpositioned tunnels in revision ACL reconstruction. In some cases of gross tunnel malposition, a new tunnel can be drilled without removing any hardware. In many cases, new tunnels cannot be drilled without overlapping or breaking into a previous tunnel. Large defects often require staged procedures, with the initial procedure consisting of graft removal, tunnel curettage, and bone grafting; the second stage, performed after bony incorporation of the tunnel, consists of revision ACL reconstruction. Staged bone grafts have been recommended for defects as small as 10 mm in diameter.[1,4-6] Graduated tunnel dilators, oversized interference screws, enlarged bony grafts, allograft bone plugs, and stacked interference screws have all been described as potential solutions to a single-stage procedure for revision ACL reconstruction.[6,7] These techniques can be time-consuming and technically demanding, and most require use of allograft bone, which has the potential inherent risks, albeit small, of disease transmission.

In this article, we describe our use of a bioabsorbable, bioceramic interference screw in addressing bony defects during revision ACL reconstruction. This screw is read-

this technique. However, the unique osteoconductive properties of the Milagro screw have led to our using it in managing bony deficiencies in revision ACL surgery. We believe that use of this screw is effective and efficient in addressing bony defects encountered in revision ACL procedures. Other bioabsorbable screws, such as the Sterling® interference screw (Regeneration Technologies, Alachua, Fla), the Bio-Core™ interference screw (Biomet, Warsaw, Ind), and the Bilok® interference screw (ArthroCare, Sunnyvale, Calif), may be used in similar applications. Most of our experience, however, has involved the Milagro screw.

This screw is the first implant made of Biocryl Rapide (DePuy Mitek, Raynham, Mass), a second-generation composite of 30% osteoconductive β-tricalcium phosphate and 70% accelerated resorbing poly(lactide-co-glycolide). Animal studies have shown material absorption and bone replacement to be accelerated with this composite versus a pure polylactic acid (PLA) material. Biocryl Rapide has demonstrated evidence of complete absorption and enhanced bone growth in place of the implant over time in biopsy specimens (Figure 3). The same histologic sections of the 24- and 36-month images of this material, viewed under polarized light, show newly formed bone cells aligned in patterns similar to native bone (Figure 4).[8] The advantage of a screw made of this composite is that not only can bony defects be filled temporarily with a stable implant, but also it is reasonable to expect that the implant will remodel into new bone over time. Robinson and colleagues[9] found that use of a PLA/hydroxyapatite screw in ACL reconstruction reduced postoperative tunnel widening and tunnel wall sclerosis compared with use of PLA-only screws—an indication of improved incorporation of a composite screw. Use of the Milagro screw, made of a similar composite, may reduce concerns about residual bony defects in future ACL revision surgery.

The cost of the Milagro screw (~$300) and of other osteoconductive screws (standard PLA or metallic interference screw, $70-$150) must also be

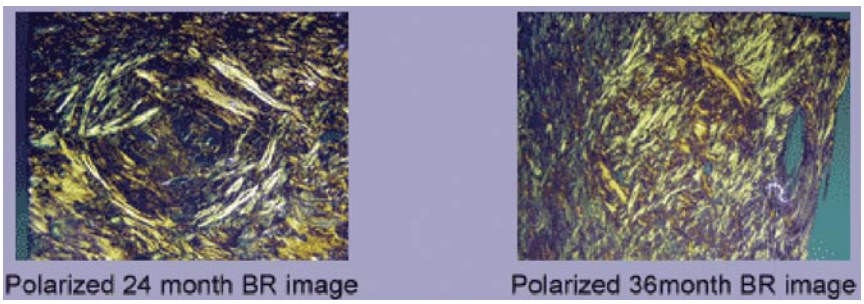

Figure 4. The images depict Biocryl Rapide (BR) test rods examined under polarized light 24 and 36 months after implantation. Note the similarity of new bone formed relative to native bone.

considered. However, when weighed against the costs of 2-stage ACL reconstruction, failed revision, autograft harvest, or processed allograft bone, the extra screw cost may be justifiable.

The Milagro screw is available in a large range of sizes—diameters of 7, 8, 9, 10, 11, and 12 mm and lengths of 23, 30, and 35 mm—which ensures a screw for multiple graft types in primary and revision procedures. We have adopted this screw for revision ACL surgery because it can be used to address bony defects of different sizes. This method has been useful in managing malpositioned tunnels and tunnel osteolysis, and we believe it to be useful on the femoral and tibial sides for uncompromised placement of revision ACL grafts and secure graft fixation and for providing scaffolding for bony ingrowth.

Caveats

Use of this bioabsorbable screw has potential complications—such as aseptic synovitis and localized swelling in the soft tissues overlying the tibial tunnel entrance mimicking infection—and surgeons should be aware of them. These reactions, though uncommon, may require additional surgical treatment (ie, irrigation and débridement).

Conclusions

As the number of revision ACL reconstructions increases, techniques addressing management of bony deficiencies caused by tunnel malposition and osteolysis must evolve. The simple technique presented here uses a bioabsorbable bioceramic composite screw to reconstitute bone stock and allow anatomical tunnel placement. We have used this technique in femoral and tibial tunnel malpositioning and osteolysis in revision ACL procedures. Use of this screw as an aid in placing revision ACL grafts should be considered one of many options in revision ACL reconstructions.

Authors' Disclosure Statement

Dr. Herbenick reports no actual or potential conflict of interest in relation to this article.

Dr. Gambardella wishes to note that he is paid consultant for DePuy Mitek, Inc., and participates in DePuy Mitek's Speaker Program.

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