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HYBRID BONE-GRAFTING TECHNIQUE FOR STAGED REVISION ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Published outcomes of this procedure can be found at: *Orthopedics*. 2016 May 1;39(3):e456-64, *J Orthop Surg (Hong Kong)*. May-Aug 2019;27(2), and *Am J Sports Med*. 2017 Jul; 45(8):1790-8.

Investigation performed at the Division of Sports Medicine and Shoulder Surgery, Department of Orthopaedic Surgery, David Geffen School of Medicine at UCLA, Los Angeles, California

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Abstract

Background: Although most patients who undergo anterior cruciate ligament (ACL) reconstruction achieve long-term functional stability and symptom relief, graft rupture rates range from 2% to 10%^{1,2}. A small subset of these patients require a 2-stage revision ACL reconstruction because of tunnel osteolysis or tunnel malposition that will interfere with the planned revision tunnel placement³. In the present article, we describe the hybrid use of arthroscopically delivered injectable allograft matrix in the femur and pre-shaped bone dowels in the tibia for the treatment of lower-extremity bone deficiencies.

Description: After induction of anesthesia, approximately 60 cc of bone marrow aspirate is harvested from the anterior iliac crest with use of sterile techniques and is processed to obtain bone marrow aspirate concentrate. Routine diagnostic knee arthroscopy is performed via the standard anterolateral and anteromedial portals. Any additional intra-articular pathology is addressed, followed by excision of the remnant graft material, removal of existing femoral hardware as needed, and exposure of the existing bone tunnels. The femoral tunnel is debrided arthroscopically, removing all soft-tissue remnants. The existing tibial tunnel is exposed via the previous anteromedial tibial incision when possible. Again, any existing tibial hardware is removed. The tibial tunnel is then prepared with use of a combination of sequential reaming and dilation. A shaver and curets are utilized to debride the sclerotic walls of the tunnel and remove the remnant graft material. A cannulated allograft bone dowel is then impacted into place over a guidewire, ensuring that the graft is not proud within the joint space. An injectable bone allograft matrix composite is prepared by manually mixing 5 mL of StimuBlast demineralized bone matrix (Arthrex) and 5 mL of FlexiGraft cortical fibers (Arthrex), along with the previously obtained bone marrow aspirate concentrate. Under dry arthroscopy, this bone graft is delivered into the femoral tunnel via a cannula with use of the anteromedial portal. Finally, a Freer elevator is used to contour the graft at the aperture of the tunnel. Graft osteointegration is mandatory prior to proceeding with the second stage of the procedure. Typically, a minimum 3-month follow-up is necessary to confirm adequate graft incorporation on computed tomography.

Disclosure: The Disclosure of Potential Conflicts of Interest forms are provided with the online version of the article (<http://links.lww.com/JBJSST/A349>).

Alternatives: As an alternative to the 2-stage procedure, previous studies have suggested the use of a single-stage revision utilizing cylindrical allografts or multiple “stacked screws.”⁴⁻⁶ In addition, a number of bone allograft and autograft options have been described. Autologous bone graft can be harvested from the ipsilateral iliac crest or proximal aspect of the tibia with use of a variety of techniques⁷⁻¹⁰. Allograft bone options include cancellous bone chips and commercially available bone matrices or dowels¹¹⁻¹⁴. Finally, another viable option is calcium phosphate bone graft substitutes¹⁵. There is a paucity of high-quality studies comparing available bone graft materials for revision ACL reconstruction; thus, no consensus exists regarding the optimal choice¹⁶.

Rationale: A 2-stage approach is typically indicated for cases that demonstrate tunnel enlargement (>12 mm) that would compromise graft fixation or non-anatomic tunnel placement that will interfere with placement of the revision tibial tunnel³. The aim of the first stage is to re-establish adequate bone stock to optimize future tunnel placement and healing of the ACL graft during the second stage. We believe that this 2-stage approach is a reliable and safe method of treating enlarged, irregularly shaped bone tunnel defects while minimizing the risk of complications. Furthermore, the use of allograft material avoids the donor-site morbidity and volume limitations associated with the use of autograft bone. In the case of the femoral tunnel, the injectable bone graft composite has the advantage of being easily delivered arthroscopically while completely filling irregularly shaped tunnels. The use of bone marrow aspirate concentrate may improve the rate of graft healing as well as a hydrating substance to reduce viscosity and facilitate the flow of the bone graft material through the cannula^{16,17}. For the tibia, especially in cases of lengthy tibial bone deficiencies, allograft bone dowels are commercially available off-the-shelf in a variety of different lengths and diameters to allow for adequate fill of bone defects.

Expected Outcomes: It is well known that outcomes following revision ACL reconstruction are inferior to those following primary ACL reconstruction, with a number of variables, beyond those associated with the surgical technique, influencing clinical outcomes¹⁸. Few studies have reported on the results of 2-stage revision ACL reconstruction with use of allograft bone; however, a high rate of allograft bone integration and improved bone quality at the time of revision ACL reconstruction have been reported¹³. Moreover, Mitchell et al. reported no differences in either subjective outcomes or failure rates between the 1-stage and 2-stage revision ACL reconstruction groups¹¹.

Important Tips:

- Utilize computed tomography for preoperative assessment and measurement of the extent of osteolysis.
- If possible, obtain the operative report for the index ACL procedure in order to identify any preexisting hardware and to obtain any instrumentation that may be needed to facilitate hardware removal.
- Multiple bone dowel sizes are available off the shelf.
- A 70° arthroscope can aid in visualization of the entire tibial and femoral tunnel.
- Although the bone graft matrix can be injected while the joint is filled with irrigation fluid, we find it easier to administer the graft under dry arthroscopic conditions.
- Place the scope inside the tibial tunnel to confirm appropriate removal of soft tissue and hardware. Circumferential native cancellous bone should be visualized.
- It is acceptable to retain previous hardware if it does not interfere with the new tunnel placement.
- Utilize prior incisions to access the tibial tunnel.
- Do not underestimate the amount of bone graft needed for each tunnel.
- Avoid excessive force during impaction of the dowels.

Acronyms and Abbreviations:

ACLR = Anterior cruciate ligament reconstruction

BMAC = Bone marrow aspirate concentrate

MRI = Magnetic resonance imaging

CT = Computed tomography
 BTB = Bone-patellar tendon-bone
 DVT = Deep vein thrombosis
 ROM = Range of motion

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