Allogenous Bone Grafting Technique for Staged Revision Anterior Cruciate Ligament Surgery

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Background: Tunnel widening, slightly malplaced former tunnels or bone loss due to hardware removal might prevent a 1-stage anterior cruciate ligament (ACL) revision procedure due to tunnel convergence or challenging graft fixation. A range of graft sources and bone grafting techniques are described—all with their strengths and limitations. Common autograft techniques come with substantial donor site morbidity that might hinder postoperative rehabilitation.

Indications: Graft tunnel issues might prompt the need for structural grafts and a 2-stage ACL revision approach. The use of the current dowel allograft technique gives a flexible approach where 1 or several cylindrical grafts can be placed in prepared sockets for reliable bony ingrowth.

Technique Description: Using femoral head allografts and cannulated coring reamers, multiple bone dowels (up to 6) can give a flexible and adaptable bone grafting situation. The intra-articular tunnels are dilated, and dowels are produced to allow a press-fit fixation that facilitates good bone healing. Removal of sclerotic bone and microfracture is key to allow optimal bone-to-bone healing. Use of cannulas inserted through the arthroscopic portals and tamps plug advancement will give a reliable graft deployment without dowel breakage.

Results: The current authors have used this uniform technique for 119 patients since 2014. All cases displayed good bony healing at 5 months after surgery on computed tomography and radiographs, and 115 out of 119 went on to have a stage 2 revision ACL surgery at 6 months spacing from the bone grafting. The most common reason for not going through the second-stage revision was improvement of symptoms due to graft removal and bone grafting during the first surgery.

Discussion/Conclusion: The current allograft dowel bone grafting allows for a flexible bone grafting in cases where a 1-step ACL revision procedure is not feasible. Reliable bony ingrowth is seen in the current cohort allowing the final step of ACL revision at 6 months spacing from bone grafting.

Patient Consent Disclosure Statement: The author(s) attests that consent has been obtained from any patient(s) appearing in this publication. If the individual may be identifiable, the author(s) has included a statement of release or other written form of approval from the patient(s) with this submission for publication.

Keywords: revision surgery; anterior cruciate ligament; bone grafting; staged revision surgery; surgical technique; knee

VIDEO TRANSCRIPT

In this video, we will present an allogenous bone grafting technique for staged revision anterior cruciate ligament (ACL) surgery—using cannulated coring reamers to make bone dowels.

None of the authors have disclosures relevant to the current video presentation.

During this video, we will provide the rationale for using the current technique and display how to position the patient during surgery. Further, preparation and use of allogenous bone dowels will be presented. Some potential complications will be presented, along with the postoperative management after using this technique. The radiograph on the right shows a posterior placed tibial tunnel with some tunnel widening in both the tibial and

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femoral tunnels. This is a typical case where a staged procedure would be a safe treatment option.

Residual instability after ACL reconstruction is reported in up to 10% of cases.[2] If such failed ACL reconstructions do not improve with nonoperative management, there might be a need for revision surgery. Concomitant injuries such as meniscal tears or ligament tears might further prompt the need for repeat ACL surgery.[3] The current computed tomographic (CT) scan, showing a superior view of the tibial joint surface, displays how a tibial tunnel is displaced into the medial chamber, which is seen as unappropriated for reuse and in risk of tunnel confluence of any new tunnels reamed.

Prior surgery often complicates revision surgery. In cases of excessive tunnel widening, bone loss due to hardware removal or slight malplacement of former tunnels, there might be a risk of tunnel confluence and/or issues with graft fixation.[4] This often necessitates a staged revision where bone grafting is first performed. The need for bone grafting is also dependent on whether a soft tissue or bone block graft is planned for the ACL revision reconstruction. Our reamer system allows dowels up to 14 mm thickness. Manual preparation of the graft or use of chips will be required in larger tunnels. The current CT scan illustrates a tibial tunnel widening measuring more than 14 mm that will compromise any new tibial tunnel.

In another case, the tibial tunnel is far anteriorly placed leading to impingement and failure of the graft. Placing a new tibial tunnel posteriorly would most likely lead to insufficient graft fixation due to tunnel confluence with breakthrough into the old tunnel.

We recommend a thorough preoperative workup, with radiological measures including 3-D CT scans to check tunnel placement and potential tunnel widening. A magnetic resonance imaging (MRI) is crucial for cartilage and meniscal status, and to check concomitant ligamentous injuries. A thorough medical history should always be sought, including prior surgical records and information on implants used in prior reconstructions. All patients should also have time zero blood sampling done before a graft can be received.

In the operating room, the patient is positioned supine on the operating table with a tourniquet placed on the thigh. The contralateral leg is secured, and a lateral post is used to allow valgus opening during knee arthroscopy. Two footrests are used to secure the knee between 90° of flexion and maximal flexion for femoral tunnel access where a prior anteromedial (AM) portal technique has been used.

At arthroscopy, intra-articular screws are found and removed to reveal the tunnels to be grafted. Successive reaming up to a sufficient diameter allowing removal of residue graft material and sclerotic bone is then performed, and then the walls of the tunnel are microfractured to allow good healing of the donor bone. Further, the length of that tunnel is measured. The femoral tunnel is now ready to receive bone. At the tibial side, a guidewire is placed, and successive reaming is performed to remove debris. Sclerotic bone calls for more reaming and microfracturing to allow the bone graft to heal. Fresh frozen femoral heads are preferred grafts. We also need a drill and several sizes of coring reamers, a malleolar clamp, a bone cutter, and antibiotics to soak the graft. A 2.4-mm hole is predrilled, and a tamp is inserted. The cannulated coring reamer enters into the tamp, making it easy to release the graft after drilling. One femoral head can make 6 or more dowels.

The ends should be trimmed for easy entry, and several dowels can be combined to get the appropriate length for bone grafting. To deploy dowels, we need several sizes of tamps and corresponding cannulas. Cannulated tamps are particularly useful. For femoral bone grafting, the accessory anteromedial portal is used and a cannula is placed to allow easy bone entrance. The tamp is then used to control the dowel into its graft tunnel, here seen through the scope. Final adjustments are performed to check if the graft sits well. At the tibial side, the graft is tapped into the level of the tibial plateau.

There are several potential complications to this procedure. Reaming of the tunnels can lead to bone necrosis but this can easily be prevented by water cooling.[6] Breakage of the dowels inside the joint can be avoided by using a cannula. Dowels should be properly sized in order to allow entry but should not be undersized as stability for healing might be compromised.[1]

The technique can be used in combination with biologics such as bone marrow aspirate concentrate (BMAC) or platelet-rich plasma (PRP) by soaking the dowel to potentially increase healing. However, it is not in routine use at our clinic.

Postoperative radiographs are obtained for further reference. Nonsteroidal anti-inflammatory drugs (NSAIDs) are avoided postoperative due to possible interference with graft healing.[5] Patients are allowed partial weightbearing for 2 to 4 weeks; full ACL prehab is resumed after 6 weeks. The CT scans or radiographs are performed 5 months postoperatively to ensure proper healing. Further, most patients move on to secondary ligament reconstruction at 6 months after the bone grafting procedure.

Prior to secondary reconstruction, patients are recommended to avoid pivoting sports but can participate in activities of daily living as tolerated. Brace is only considered if a “high-risk” activity is unavoidable or in cases of severe, recurrent instability.

At our institution, we have treated 119 patients since 2014 with this method, constituting approximately 50% of all ACL revision surgeries. In our experience there have not been any healing issues related to the bone grafting incorporation; however, 4 out of 119 did not proceed to secondary stabilization, due to satisfactory improvement after graft removal and bone grafting on its own.

Finally, these are our references. Thank you for listening.

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REFERENCES

1. Büyükdoğan K, Laidlaw MS, Kew ME, Miller MD. Allograft bone dowels show better incorporation in femoral versus tibial tunnels in 2-stage revision anterior cruciate ligament reconstruction: a computed tomography-based analysis. *Arthroscopy*. 2021;37(6):1920-1928. doi:10.1016/j.arthro.2021.01.066
2. Crawford SN, Waterman BR, Lubowitz JH. Long-term failure of anterior cruciate ligament reconstruction. *Arthroscopy*. 2013;29(9):1566-1571. doi:10.1016/j.arthro.2013.04.014
3. Erickson BJ, Cvetanovich G, Waliullah K, et al. Two-stage revision anterior cruciate ligament reconstruction. *Orthopedics*. 2016;39(3):e456-e464. doi:10.3928/01477447-20160324-01
4. Group M, DeFroda SF, Owens BD, et al. Descriptive characteristics and outcomes of patients undergoing revision anterior cruciate ligament reconstruction with and without tunnel bone grafting. *Am J Sports Med*. 2022;50(9):2397-2409. doi:10.1177/03635465221104470
5. O'Keefe RJ, Tiyapatanaputi P, Xie C, et al. COX-2 has a critical role during incorporation of structural bone allografts. *Ann N Y Acad Sci*. 2006;1068(1):532-542. doi:10.1196/annals.1346.012
6. Tei MM, Placella G, Sbaraglia M, Tiribuzi R, Georgoulis A, Cerulli G. Does manual drilling improve the healing of bone–Hamstring tendon grafts in anterior cruciate ligament reconstruction? a histological and biomechanical study in a rabbit model. *Orthop J Sports Med*. 2020;8(4):2325967120911600