Simplifying Anterior Cruciate Ligament Graft Bone Plug Reconstructions: The "U" Trough Technique

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Abstract: This Technical Note discusses an anterior cruciate ligament graft preparation technique to simplify and ease graft visualization, insertion, and fixation. Our technique incorporates a 2-mm central trough in the bone plug of the graft to improve one's ability to efficiently identify and orient the anterior cruciate ligament graft during insertion, and ensure correct screw placement and fixation.

Several anterior cruciate ligament (ACL) graft variables influence outcomes and patient satisfaction. Many of these variables are typically decided on before the ACL reconstruction, such as the patient and surgeon preference for graft source and type. Although several factors play a role in deciding which graft is ultimately chosen, the preferences and recommendations of the surgeon outweigh other factors and these decisions are typically met with favorable results.[1] Although those preferences often refer to graft type and source, graft preparation also plays an important role during the reconstruction and is typically influenced by the preference of the surgeon as well. The importance of this preparation has led to several studies investigating components of graft preparation such as the size, shape, and how to fixate the grafts.[2-5]

For grafts incorporating bone plugs, an important aspect of this preparation is fitting the bone plug so that it slides easily and fits tightly within the femoral or tibial tunnels.[3] We sought a way to shorten the time required to pass a graft through the knee, while simultaneously simplifying the process of graft fixation. Here we present a technique of creating a central trough in the superior aspect of the bone plug that does not greatly affect the graft characteristics, while serving a multipurpose role including guiding the correct orientation of the graft before insertion into a bone tunnel, providing a "ledge" for a probe to manipulate to achieve optimal graft orientation before insertion into the bone tunnel, and finally serving as a framework for guidewire insertion before interference screw placement, bypassing the guidewire dilation step and improving intraoperative efficiency.

Surgical Technique

Surgical Indication

The trough technique can be applied to ACL grafts incorporating a bony segment on either of their attachment points, such as Achilles allografts and bone–patellar tendon–bone grafts. These bony segments serve as fixation points inside the femoral and/or tibial tunnels for the ACL graft.

Graft Harvest

Grafts incorporating the bone plug can be harvested from the patella tendon as both ends of the tendon have bony segments, from the patella and tibia. In addition, quadriceps autografts incorporating bone segments can have the trough incorporated into the bone segment taken from the patella. Lastly, any allografts using bone segments on either end, such as Achilles allografts, may have the trough incorporated (Video 1).

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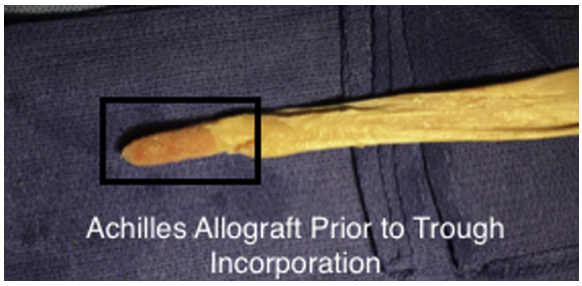

Fig 1. The Achilles allograft after preparation, before incorporation of the "U" trough. Typically, the bone segment preparation is completed once it has been fitted to the dimensions of the femoral tunnel using a rongeur. The box is depicted to illustrate the stage in which the trough is being incorporated.

Graft Preparation

The bony portion of the graft is prepared in a traditional fashion. Once the graft is appropriately sized and confirmed, a 7″ (18-cm) slightly curved bone rongeur (Arthrex, Naples, FL) is used to create a 2-mm trough (Figs 1-4) on the central superior aspect of the bony

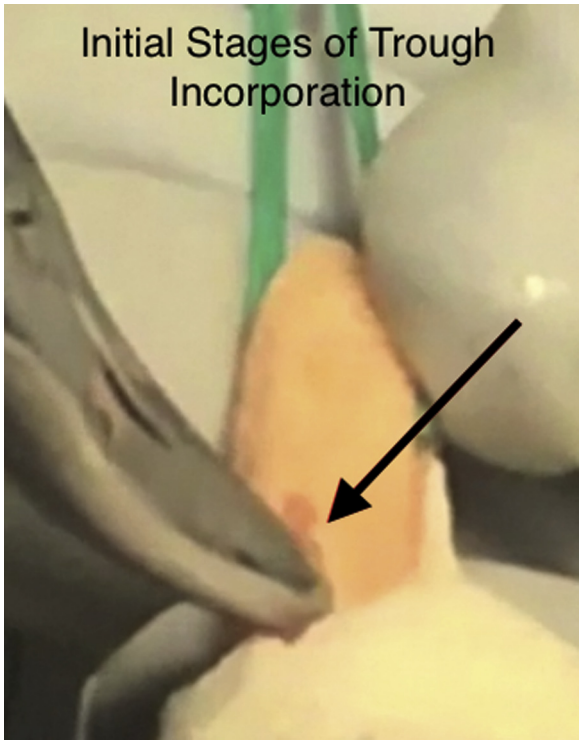

Fig 2. The initial stages of incorporating the trough. Using a rongeur angled perpendicular to the bone plug to ensure the trough is shaped as a "U." This prevents guidewire slippage and sharper ledges that function as lever points during graft manipulation. Remove 1 to 2 mm of bone in depth and 1 to 2 mm in width starting at one end of the bone segment. The trough should be centered on the bone plug. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

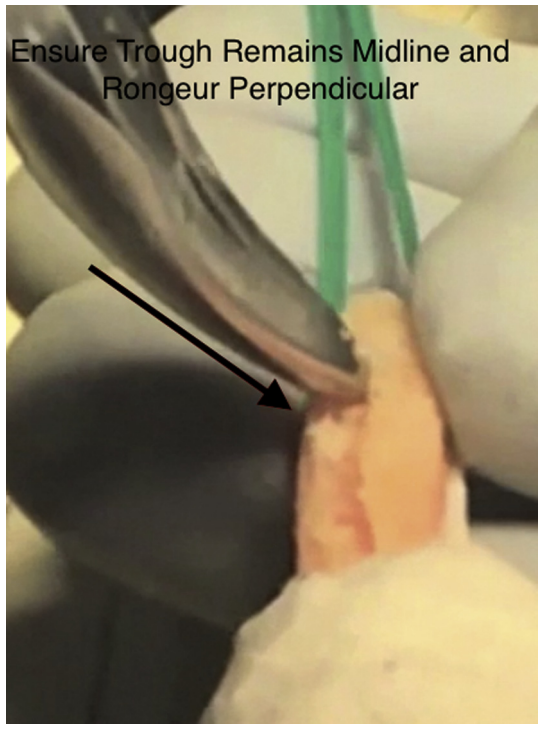

Fig 3. Continue removing 1 to 2 mm in depth and 1 to 2 mm in width of bone from the bone segment, moving in a midline direction toward the other end of the bone plug. Ensure that the rongeur remains angled perpendicular to ascertain consistency in the shape of the trough. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

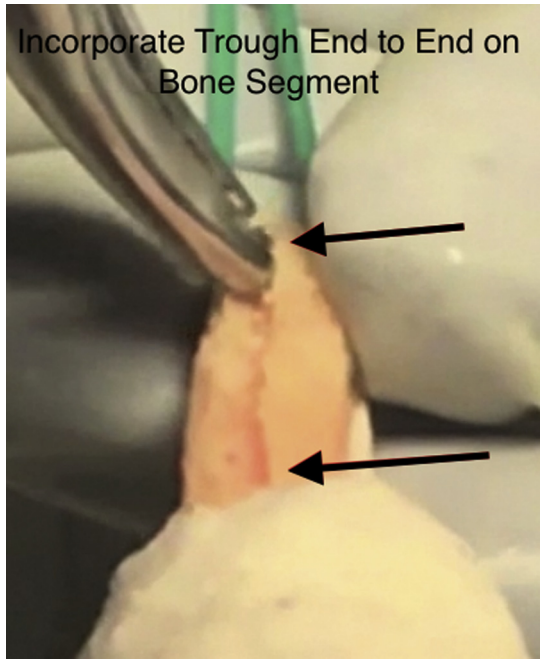

Fig 4. The trough is completed once the trough is extended to the other end of the bone segment in a midline fashion. The arrows are depicted to illustrate the stage in which the trough is being incorporated.

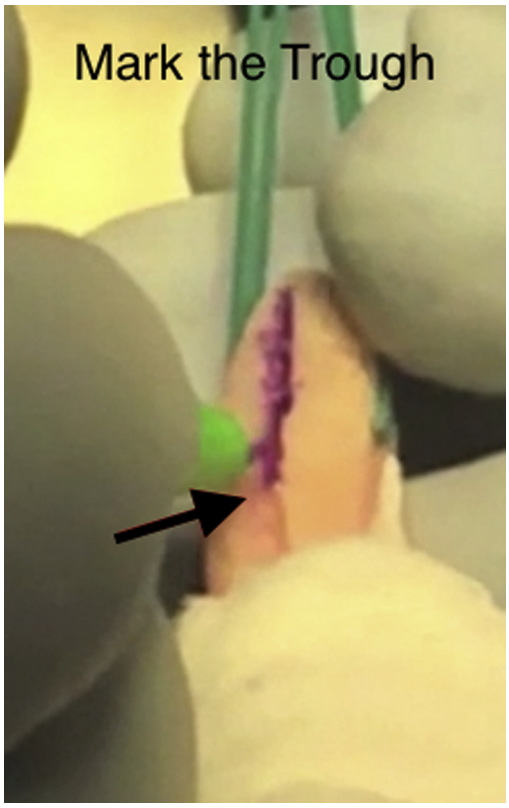

Fig 5. After completion of the "U" trough, a marking pen is used to aid in visualization of the trough once it is inserted arthroscopically. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

portion of the graft. The trough is then marked with a surgical pen (Figs 5 and 6).

Graft Manipulation and Insertion

After being passed into the knee joint, the bone segment of the trough can be manipulated by using the trough as a ledge for probing (Arthrex) into correct position to ultimately be passed into the femoral tunnel (Fig 7). Once probed into position, the trough again serves the function of acting as a lever to help manipulate the bone segment into the tunnel (Fig 8).

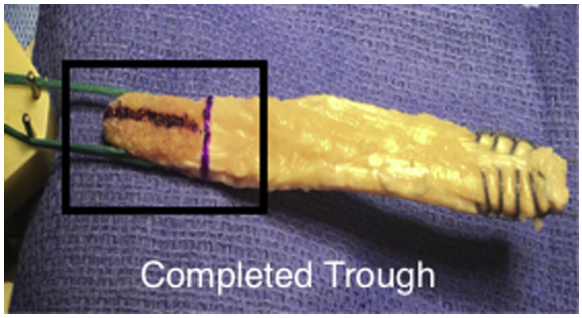

Fig 6. The graft incorporating the "U" trough and marked with a surgical pen for visualization. The graft is now ready to be inserted into the knee joint for completion of the anterior cruciate ligament reconstruction. The box is depicted to illustrate the stage in which the trough is being incorporated.

Fig 7. Arthroscopic images showing the "ledge" of the trough serving as a level for probing and orientating the graft into position. The patient is in the supine position with the right knee in hyperflexion. The arthroscope is placed through the inferiolateral portal with a light source directed in the 9 o'clock direction. The graft has been inserted via the tibial tunnel and is ready to be guided into the femoral tunnel. The probe is placed through the inferiomedial portal to assist with this process. The trough helps guide the graft for insertion into the femoral tunnel. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

Graft Fixation

After the bone segment is passed into the femoral tunnel, the incorporated trough acts as a guide for placement of the guidewire (Arthrex). The guidewire slides easily in between the bone segment and the femur by way of the trough, which also prevents the guidewire from slipping out of position (Fig 9). Once the guidewire is placed, interference screws are passed through the secured guidewire, allowing for easier fixation of the screw (Arthrex).

Fig 8. Arthroscopic images showing the graft being inserted into the femoral tunnel. The patient remains in the supine position with the right knee in hyperflexion. The arthroscope remains placed through the inferiolateral portal with a light source directed in the 9 o'clock direction. The probe remains placed through the inferiomedial portal and has been advanced to insert the graft into the femoral tunnel. The trough serves as an anchor for the probe to ease the process of inserting the graft into the femoral tunnel. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

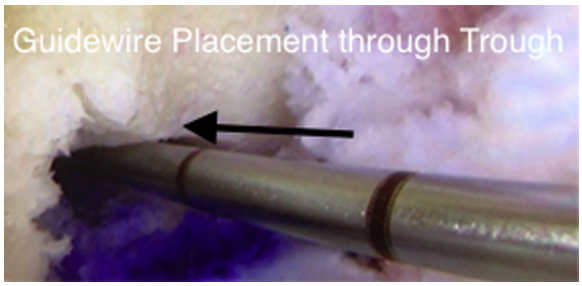

Fig 9. Arthroscopic images showing the placement of the guidewire. In this image, the patient remains in the supine position with the right knee in hyperflexion. The arthroscope remains placed through the inferiolateral portal with a light source directed in the 9 o'clock direction. The guide pin is placed through the inferiomedial portal and into the trough previously created to help for interference screw fixation. The trough improves the introduction and placement of the guidewire for femoral fixation. The arrow is depicted to illustrate the stage in which the trough is being incorporated.

Discussion

This Technical Note discusses a technique of manipulating the bone plug of ACL grafts by clipping a trough through its side, followed by marking the trough for visualization. The trough can be incorporated quickly during graft preparation while the surgeon is performing the diagnostic arthroscopy and tunnel preparation without increasing overall operative time. Ultimately, making the trough during graft preparation shortens the overall time of the surgery by simplifying later steps involving ACL graft insertion and fixation.

The first function of the trough is to help visualize the correct position of the graft within the knee joint. The "ledges" of the trough then function as a lever point to help rotate the graft into optimal orientation to guide later interference screw fixation. Once probed into position, the trough serves as a guide for the guidewire to direct interference screw fixation of the bone plug into the femur. Incorporating the trough during graft preparation eliminates the need to dilate a space for the guidewire during final screw insertion and fixation of the bone plug in the femoral tunnel. This step bypasses the notchplasty typically required to fit the guidewire in between the femur and bone plug, essentially removing a step during the reconstruction. This technique improves efficiency in the operating room, saving time during ACL reconstruction.

Unfortunately, the technique can only be applied to grafts incorporating bony segments. In general, the most graft types do not include a bony segment, limiting the applicability of the technique. However, for ACL reconstructions using ACL grafts with bone segments (bone–patella tendon–bone plugs, quadriceps tendon with bone plug, and allografts with bone plugs), the technique can be easily taught and incorporated into practice (Table 1). Another pitfall of the technique is weakening of the integrity of the bone plug, which may cause bone plug fracture (Table 2). However, this complication has yet to be seen, likely due to the compressive forces after the placement and fixation of the interference screw.

For further evaluation, the results of this technique need to be confirmed by clinical studies.

Table 1. Advantages and Disadvantages

Advantages
• Can be incorporated quickly during ACL graft preparation
• Helps with visualization of the proper orientation of the ACL graft arthroscopically
• The "ledges" of the trough function as a lever point to help rotate the graft into optimal orientation
• Acts as a guide during the placement of the guidewire for the final fixation of the bone plug into the femoral tunnel
Disadvantages
• Can only be applied to ACL grafts with bony segments at its attachment points

ACL, anterior cruciate ligament.

Table 2. Pearls and Pitfalls

Pearls
• Use a narrow rongeur when incorporating the trough, angled perpendicular to the bone segment
• When removing bone with the rongeur, ensure that no more than 2 mm in depth and 1-2 mm in width of bone is removed
• Ensure that the trough is placed midline into the bone segment without deviation from end to end
Pitfalls
• May weaken the integrity of the bone plug

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