

# Anterior Cruciate Ligament Reconstruction Utilizing Bone-Patellar Tendon-Bone Autograft: Pearls and Pitfalls of Graft Harvest

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**Summary:** Precise graft harvesting techniques are critical in performing successful anterior cruciate ligament reconstruction. Our experience has led us to believe that improper graft harvest makes the procedure more difficult and may impact the result. The purpose of this manuscript is to discuss the "pearls" and "pitfalls" pertinent to patellar tendon harvesting for ACL reconstruction. **Key Words:** ACL Reconstruction—Graft harvest—Technique.

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Graft harvest is an integral part of anterior cruciate ligament reconstruction. The goal is to obtain a satisfactory graft while minimizing donor site morbidity. In the process of obtaining an adequate graft, numerous technical challenges are encountered. The ability to overcome these challenges can be facilitated with the knowledge of a few important surgical pearls. Awareness of potential complications and an understanding of how to avoid them help to ensure that an acceptable graft is obtained. Intraoperative complications during the harvesting of a bone-patella tendon-bone (BPTB) graft may include inadequate tendon or bone plug size, patella fracture, extensor mechanism disruption, chondral damage, thermal necrosis, and graft contamination.<sup>3,5,7</sup>

**PEARL:** A accurately sized and well-prepared graft makes the operation much easier

Careful surgical technique with attention to detail is essential for successful graft harvest. Adequate exposure is essential. The patellar tendon should be completely visualized from its proximal to distal insertions. This can usually be accomplished with an 8 cm incision paralleling the

medial edge of the patellar tendon from the distal pole of the patella to just below the tibial tubercle. If the skin about the knee is mobile, a slightly smaller, more cosmetic incision may be used with retraction of the skin proximally and distally during bone plug harvest. Keeping the incision just medial of midline enables the surgeon to create the tibial tunnel through the same incision (Fig. 1).<sup>9</sup>

**PITFALL:** Small transverse incisions, although more cosmetic, may compromise graft harvest

The distal width of the patellar tendon should be measured and documented in the operative record. The distal width is used for measurement because the patellar tendon usually narrows gradually from proximal to distal. This ensures that both the harvested portion and remaining portions of the tendon will be adequate. If the patellar tendon is narrow (ie, <30 mm), a smaller central third (<10 mm) should be considered. In rare cases, an alternative graft choice may be needed if the patella or patellar tendon size is too small. The surgeon should always evaluate the patella tendon size preoperatively, and if there is concern about its girth, consent should be obtained for the possibility of an alternative graft.

**PEARL:** Always palpate the tendon width preoperatively to assess for adequate tendon tissue

The knee should be placed in flexion while the central distal pole of the patella and the center of the patellar

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**FIG. 1.** Photograph of a typical skin incision from distal pole of patella to tibial tubercle along medial border of patellar tendon.

tendon insertion are marked with a sterile marking pen. Placing the knee in flexion keeps tension on the fibers and aids in achieving a straight longitudinal cut. Make a nick in the paratenon overlying the patellar tendon and separate this layer from the tendon with a metzenbaum scissor (Fig. 2). A curved three-eighths inch osteotome is approximately 10 mm wide and may be used as a cutting template to identify the central third of the tendon to be harvested (Fig. 3). If the knee is kept in extension, there is laxity in the tendon that may lead to inaccurate or inadvertent crosscuts in the tendon. While making the longitudinal cuts, the surgeon should maintain visualization of the distal orientation of the tendon to avoid cutting across the longitudinal fibers of the tendon or converging or diverging distally. An Army-Navy retractor can be placed in the distal pole of the skin incision to



**FIG. 2.** Photograph showing the paratenon dissection off the tendon using Metzenbaum scissors.



**FIG. 3.** Photograph showing the three-eighths inch osteotome being used as a cutting template for a 10 mm wide graft.

avoid inadvertent extension of the operative incision when outlining the tibial bone block with the scalpel. Once the tendo-osseous junction is identified, the distal tendon incision should be extended an additional 2.5 cm overlying the tibial tubercle. This process is then repeated at the proper width to obtain a 10 mm wide graft. The scalpel is also used to make the crosscut on the bone plug to create a plug that is approximately 2.5 cm long.

**PEARL:** Obtain the graft with the leg in flexion to maintain tension on the tendon fibers

**PITFALL:** Double bladed scalpels can cut across tendon fibers as the tendon tapers distally

The standard size for the tibial and patellar bone plugs is 10 mm wide and 25 mm long. A number 238 oscillating saw blade is used for the bone cuts. The surgeon should begin on the tibial tubercle side. It is technically easier and prevents blood from dripping down into the surgical wound, which may occur if the patellar bone plug is created first. Cooling the saw blade with irrigation solution helps prevent possible thermal necrosis of bone or skin. Angling the oscillating saw 45 degrees toward the center of the tibial tubercle creates a bone plug in the shape of an equilateral triangle. This beveled cut maximizes the remaining bone stock in the tibial tubercle beneath the tendon, which will minimize the chance of patellar tendon avulsion. The distal crosscut should be made with the saw blade held at a 45-degree angle oblique to the cortex. The corner of the blade is used to prevent extension into the bone beyond the longitudinal cuts.

**PEARL:** The width of the number 238 saw blade is approximately 10 mm, allowing the surgeon the

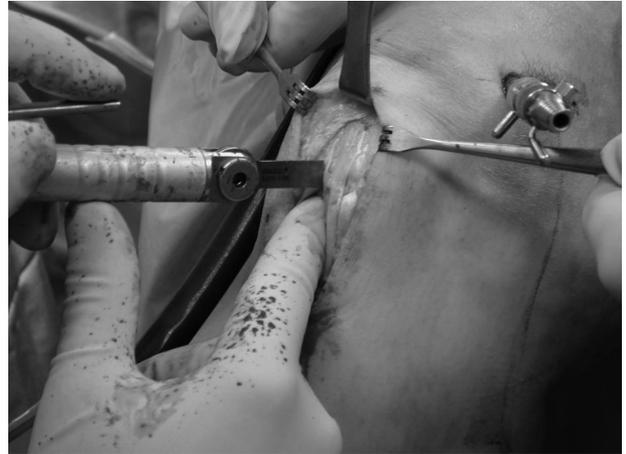


**FIG. 4.** Photograph showing the method used to safely complete the corner cuts of the bone plug by placing saw longitudinally in the previously made vertical cuts.

estimate the depth of the cuts

Once the cuts for the tibial bone block are completed, leave the bone plug in place and turn attention to the patellar bone cuts. The patellar bone plug should be in the profile of a trapezoid with a depth of 6 to 8 mm.<sup>1,6-9</sup> This helps to avoid penetration into the articular surface and subsequent chondral damage. Harvesting the patellar bone plug has been shown to create a stress riser and increase the risk of patellar fracture.<sup>4,10</sup> Beveling the cuts helps to reduce the likelihood of this occurring.<sup>6</sup> The longitudinal cuts and proximal crosscut are made using the same technique as for the tibia. The corner cuts can be completed by placing the blade in the longitudinal cuts, at the appropriate depth, in a parallel fashion and advancing to the apex of the corner (Fig. 4). Should the patella fracture intraoperatively, it will most likely be longitudinal in nature. Longitudinal fractures may be repaired using lag screws or K-wires.<sup>3,4</sup> Although placing the leg in extension for cutting the bone blocks is a common technique, which allows for a smaller skin incision, we routinely keep the leg flexed to make our bone cuts to keep tension on the tendon.

When making the tibial and patellar cuts on the right side from the surgeon's perspective, the saw should be held in the right hand while the thumb of the left hand stabilizes the saw and the index finger of the left hand protects the graft by opening the axilla between the graft and remaining patellar tendon. When making the cuts on the left side, the left hand should hold the saw while the right thumb stabilizes the saw and the right index finger opens the axilla for protection (Fig. 5).<sup>9</sup> Performing the cuts in this manner allows full visualization of the saw



**FIG. 5.** Photograph demonstrating the technique for holding the saw for maximal control and visualization while exposing the bone-tendon junction.

blade and bone throughout the procedure. It also prevents errant cutting angles, such as making too sagittal of a cut on the surgeon's nondominant side if the dominant hand is holding the saw. The cortex is outlined first with the saw, and the surgeon should then proceed from proximal to distal on the tibia and distal to proximal on the patella. The saw should be moved with the same technique as a cast saw, feeling a sense of give as it enters cancellous bone.

**PEARL:** Switching hands on the saw allows for improved visualization of the bone cuts

After all of the bone cuts have been completed, a one-half inch or one-quarter inch curved osteotome is used to gently raise the tibial bone plug from its bed (Fig. 6). Aggressive use or levering of the osteotome may result in splintering of the bone plug. An assistant may place a finger on the central portion of the tendon to maintain control of the graft and prevent the graft from falling. Should splintering of the bone plug occur such that the bone plug is not useable, a Krackow suture may be placed in the tendon to allow the graft to be secured using either soft tissue interference fixation or tying it around a screw and post on the tibia. Soft tissue fixation methods such as the Endobutton device (Acufex, Inc., Norwood, MA) or cross-pin fixation (Rigidfix, Mitek-Products, Westwood, MA) may also be used. If enough bone remains on the graft, the bone plug can be augmented by "piggy-backing" bone obtained from a coring reamer onto the bone plug and attaching the two with suture through drill holes.<sup>5</sup> Undersizing the femoral tunnel is another option to match the small bone plug, and to allow for interference fixation.



**FIG. 6.** Photograph showing the osteotome being used gently to elevate the bone plug.

**PITFALL:** Aggressive levering of the bone plug in the patella may lead to patella fracture

Once completely released from its bed, the tibial bone plug is held with a laparotomy sponge and gently elevated. At this point, the fat pad and other soft tissue attachments are dissected from the patellar tendon with Metzenbaum scissors. The fat pad should be left behind because it will serve to prevent excessive fluid extrusion secondary to water pressure from the arthroscopic portion of the procedure. In addition, cutting into the fat pad may increase bleeding. Once the fat pad has been removed from the graft, the patellar bone plug is gently elevated from its bed in the same manner as the tibia.

**PITFALL:** Avulsion of the fat pad rather than careful dissection may result in a rent and excessive fluid extravasation throughout the remainder of the case

Once the graft is obtained, it should be transported by the surgeon to the back table for preparation. It should not be handed off to any other member of the surgical team. After this procedure reduces the likelihood of the graft being misplaced or dropped on the floor. From the time that the graft is harvested until it is placed back in the knee, the location of the graft should be clearly communicated with the entire surgical team. Because the graft may be placed in a moist sponge or in a basin at times during preparation, its container should be clearly marked. This will avoid the possibility of the graft being inadvertently passed off the sterile field by the scrub staff.

**PITFALL:** Passing the graft between members of the surgical team increases the possibility of drop-

ping the graft

**PEARL:** The surgeon who harvested the graft should always walk the graft to the back table him or her self

Should the graft somehow become contaminated, there are a limited number of salvage options available. These include sterilization of the graft, harvest of a similar graft from the contralateral side, an alternative graft from the ipsilateral or contralateral knee, or use of an allograft if available.<sup>7</sup> Studies of sterilization of contaminated graft specimens have found chlorhexidine to be the most effective agent.<sup>11</sup> One technique found a 100% disinfection rate in a controlled in vivo rabbit model. This consisted of a 30-minute soak in 4% chlorhexidine gluconate followed by a 30-minute soak in triple antibiotic solution and a brief rinse in sterile normal saline. It is important to wash the graft and remove all of the chlorhexidine before introducing it into the knee. This is done to prevent chlorhexidine-induced chondrolysis of articular cartilage.<sup>12</sup>

Graft harvest during ACL reconstruction with bone-patellar tendon-bone autograft is fraught with possible complications. Potential pitfalls can be avoided if the surgeon is aware of when these complications may occur and understands how to avoid them. Proper surgical technique and close attention to detail also limit the possibility of adverse events occurring. The pearls and pitfalls discussed here should help facilitate graft harvest and minimize complications.

#### TABLE OF KEY PEARLS

- Use distal width of tendon for measurement
- Use an 8-cm incision just medial of midline so it can be used for tibial tunnel
- Obtain adequate exposure with complete visualization of patellar tendon
- Flex knee to put tension on tendon fibers and ensure straight longitudinal cuts
- Place Army-Navy retractor in distal incision to protect skin during outlining of tibial bone block with scalpel
- Standard bone plug size of 10 mm wide × 25 mm long
- No. 238 oscillating blade for bone cuts
- Tibial bone cuts first
- 30 degree angle tibial cuts to create equilateral triangle
- 45 degree angle patellar cuts to create trapezoid
- 45 degree oblique angle for cross cuts
- Finish corner cuts with blade parallel in previous longitudinal cuts

- Hold saw in right hand for cuts on right, in left hand for cuts on left
- Stabilize saw with opposite thumb
- Index finger in axilla of tendon incision for protection
- Avoid overaggressive levering of bone plugs when elevating with osteotome
- Dissect tendon from fat pad after all bone cuts are completed
- Surgeon personally transports graft to back table for preparation
- Place graft in clearly marked container
- All surgical staff must know location of graft at all times

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