



Surgical Techniques of ACL Reconstruction, A. AM Portal Technique

Dong Jin Ryu and Joon Ho Wang

Abstract

By increasingly recognized importance of femoral tunnel position on restoration of native knee kinematics, use of the anteromedial portal (AMP) for establishment of the femoral tunnel is growing interest. The AMP technique is meant to allow for more anatomic femoral tunnel position. To perform easily, appropriate portal formation is the key to the AMP technique. To avoid crowding and jamming of instrument through the AM and additional anteromedial (AAM) portal, it is recommended to make the portals at least 1.5 cm space. The bony anatomy of the lateral femoral condyle is helpful in locating the boundaries of native ACL. Femoral tunnel would be made by using flexible guide and with hyperflexed knee position. Slightly medial positioned tibial tunnel in the native ACL footprint can reduce the risk of graft impingement. After graft passage, the endobutton CL is flipped on the lateral femoral cortex. Before final securing, the position of button should be checked under C-arm fluoroscopy. Finally, the tibial side of graft is secured with bio-absorbable interference screw in full extension with tibiofemoral reduction force.

Despite there are the technical challenges associated with AMP technique, complications can be avoided with understanding of the potential pitfalls and technical principles.

Keywords

AM portal technique · Anatomic reconstruction · Flexible guide · Complication

Introduction

Femoral tunnel creation during anterior cruciate ligament (ACL) reconstruction has been performed through the previously reamed tibial tunnel. The transtibial (TT) technique, which can lead to the creation of a non-anatomic aperture with vertical femoral tunnel position [1, 2]. By increasingly recognized importance of femoral tunnel position on restoration of native knee kinematics, use of the anteromedial portal (AMP) for establishment of the femoral tunnel is growing clinical and research interest. The AMP technique is meant to allow for more anatomic, lower placement of the femoral tunnel and better re-creation of the native origins of the anteromedial (AM) and posterolateral (PL) bundles on the femoral condyle [3, 4]. The AMP enables the surgeon to visualize and position the femoral tunnel independently of

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the tibial tunnel. However, some studies [5–7] have devaluated the technical challenges and steep learning curve associated with application of the AMP technique. Complications that have been described include poor visualization during reaming, crowding of instrument, short femoral tunnel, posterior wall breakage, iatrogenic chondral damage of medial femoral condyle (MFC), acute graft-tunnel bending angle [8–14]. Despite the risk of above problems, the AMP technique has continued to grow in popularity, and we believe that it would become a standard technique for performing ACL reconstruction.

Here, we describe our approach for ACL reconstruction using AMP technique with a single bundle auto-hamstring graft and suspensory device (EndoButton CL, Smith and Nephew, Andover, Massachusetts) and some technical tips related to avoidance of complications.

Re-physical Exam Under Anesthesia and Position

Following induction of anesthesia, re-physical exam performed for range of motion and ligamentous stability with the Lachman, pivot shift, and anterior and posterior drawer tests and varus and valgus stability at 0 and 30 degrees of flexion. A tourniquet is placed high on the thigh, and the patient is positioned for lithotomy on the operating table. Following the setting of position, check the availability of the hyperflexed knee (Fig. 1). After applying arthroscopic surgical draping, the tourniquet is inflated after the limb is exsanguinated.

Portal Formation

As with other arthroscopic procedures, proper portal formation is the key of the AMP technique. Well-positioned portal will provide good visibility and ease of operation of the instrument, but incorrect positioning can make surgery difficult. For anatomic ACL reconstruction using AMP technique, it has advantages to form portal that allows easy viewing of anatomical landmarks. To view easily, superior and medial

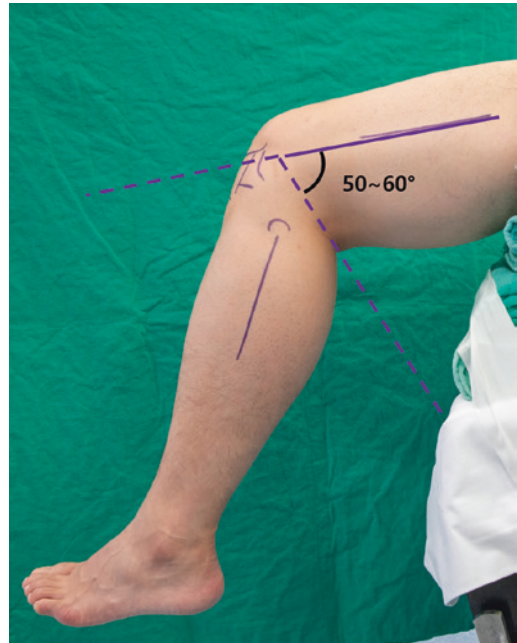


Fig. 1 A tourniquet is placed high on the thigh, and the patient is positioned to lithotomy on the operating table. Following the setting of position, check the availability of the hyperflexed knee

located AL portal formation is recommended (Fig. 2a). A high AL portal is important to avoid poor visualization [5, 15]. With the knee flexed 30 degrees, the AL portal is formed first using No. 11 blade and straight hemostat, just lateral to the patellar tendon and superior to the inferior pole of the patella to avoid the infrapatellar fat pad [15]. This high AL portal could facilitate viewing tibial footprint.

The AM portal is formed under direct visualization using 18G-spinal needle. The AM portal is formed along the medial border of patellar tendon and upper articular line of medial meniscus, taking care not to injure the intermeniscal ligament. Following the formation of AM portal, the shaver is introduced and debride some of the fat pad and ligamentum mucosum to facilitate visualization. During AMP technique, the AM portal is used for viewing portal. The additional anteromedial (AAM) portal is formed at the level of the joint line, medial to the AM portal with transverse incision. To avoid crowding and jamming of instrument through the AM

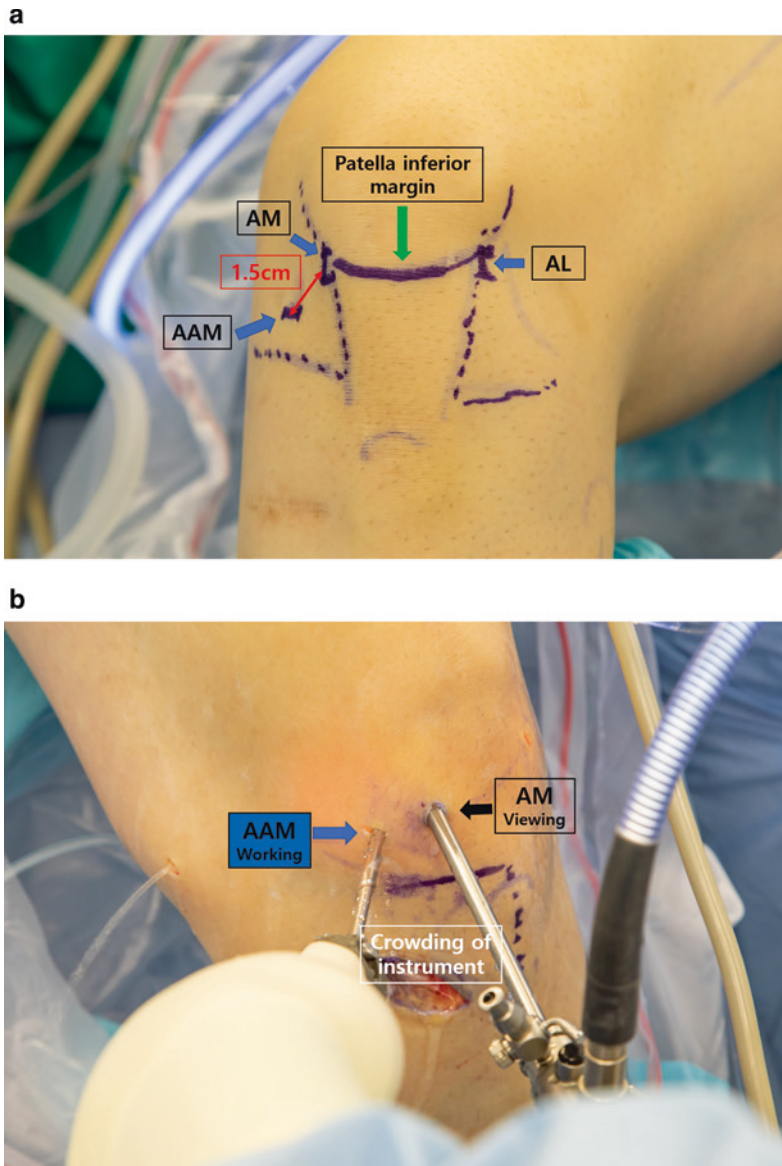


Fig. 2 **a** Superior and medial located AL portal is recommended. The AM portal is formed along the medial border of patellar tendon and upper articular line of medial meniscus. The additional anteromedial (AAM) portal is formed at the level of the joint line, medial to the AM portal with transverse incision. To avoid crowding and jamming of instrument through the AM and AAM portal, it is recommended to make the portals at least 1.5 cm space. **b** During AMP technique, the AAM portal is used for working portal

and AAM portal, it is recommended to make the portals at least 1.5 cm space (Fig. 2a). The 18G-spinal needle should pass safely above the medial meniscus and reach the center of the femoral ACL footprint with enough space. It can allow safe for using instruments without damage

to the medial femoral condyle (MFC) as femoral tunnel drilling. After AAM portal formation, the shaver is reintroduced and debride fat pad more to facilitate the passage and manipulation of the instrument. During AMP technique, the AAM portal is used for working portal (Fig. 2b).

Auto-hamstring Tendon Harvest and Graft Preparation

Mark at distal 5 cm from the knee joint line and 2 cm medial from the Patella tendon center. After palpating Semitendinosus and Gracilis tendon as you can, make a 4–5 cm sized oblique-transverse incision along the skin crease. Oblique-transverse incision can reduce the risk of injury infrapatellar branch of the saphenous nerve [16]. Following re-palpation of Gracilis and Semitendinosus tendon, lifting the sartorial fascia with forcep and dissecting to proximal portion. In this process, it is often attached with Gracilis and sartorial fascia, pre-detach them carefully using metzenbaum. Until both of the Gracilis and Semitendinosus tendons are clearly and separately identified, neither tendon should be harvested.

The Gracilis tendon, being more proximal and having acute angle, can be hooked out of the subsartorial space with a right-angled forcep and is harvested first (Fig. 3a). Although Gracilis rarely has any significant vinculi, identify and detach all of its vinculi using finger and metzenbaum before the harvest [17]. The tendon stripper applied to the tendon should be passed beyond the proximal tibia and the graft is amputated from its muscular attachment at this length.

After the harvest of the Gracilis tendon, the semitendinosus tendon is thus exposed and care to identify all of its vinculi to prevent short harvest of the tendon (Fig. 3b). The vinculi pass

distally and medially from the body of the tendon toward the medial gastrocnemius [18]. The vinculi can be hooked and pulled out of the wound or divided distal to the tendon. Following the confirmation of all of the vinculi dissected, the tendon stripper is applied. After insertion of negative pressure drain to prevent hematoma formation at graft site, sartorial fascia would be repaired by absorbable suture No 2-0.

Muscle and fat tissue are cleanly removed from the graft tendons. After folded twice the graft, check the diameter and length of the graft. No. 5 non-absorbable whipstitch leading sutures applied to tibial insertion side and then whipstitched using a no. 2 Vicryl absorbable suture over a length of 40 mm to form a four-stranded bundle [17]. No. 1 Vicryl is then used to suture 10 mm of tendon on the looped femoral end, which is then measured diameter finally. A surgical pen is used to mark the position (femoral tunnel length) from the end of the graft. And additional mark is made at distal 7 mm from the previous marking which indicates the degree of the pass during the graft passing. The graft is left wrapped in saline-soaked gauze until it is passed through the joint (Fig. 4).

Femoral Tunnel Preparation

When forming a femoral tunnel, the viewing portal uses an AM portal and the working portal uses an AAM portal. Without for femoral

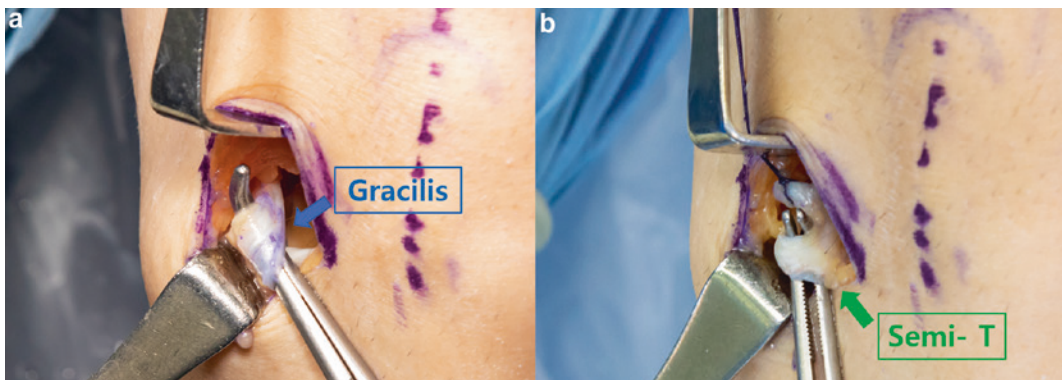


Fig. 3 **a** The Gracilis tendon, being more proximal and having acute angle, can be hooked out of the subsartorial space with a right-angled forcep and is harvested first. **b** After the harvest of the Gracilis tendon, the semitendinosus tendon is thus exposed



Fig. 4 Final preparation of auto gracilis and semitendinosus tendon

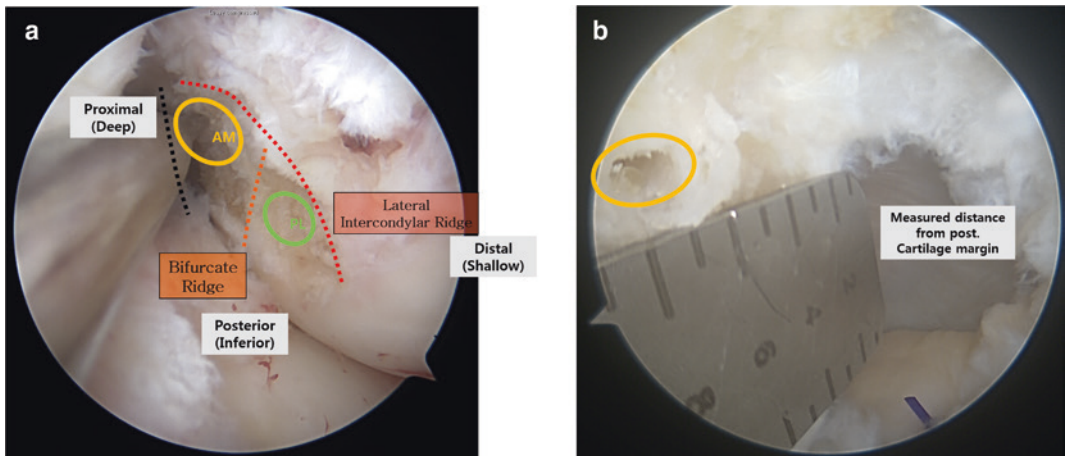


Fig. 5 **a** The anatomical footprint of femur (left side knee) viewing from AM portal. **b** For single bundle reconstruction, the center point located at 3 mm inferior to roof, 7 or 8 mm from posterior cartilage margin (view from AM portal, right side knee)

tunnel formation, the knee maintains 90 degrees flexion during preparation. It's critical to see the anatomic ACL femoral side attachment correctly, using a radiofrequency thermal device to carefully remove any remaining tissue. The bony anatomy of the lateral femoral condyle is helpful in locating the boundaries of native ACL (Anterior: lateral intercondylar ridge, Posterior: inferior cartilage margin of lateral femoral condyle, Proximal: posterior cartilage

margin, Distal: distal cartilage margin) (Fig. 5a). Lateral bifurcate ridge is a landmark to distinguish between AM bundle and PL bundle attachment. After identifying footprints, the length and width of the ACL insertion sites are measured with arthroscopic metal ruler. In our experience, the length of ACL footprint measures from 22 to 24 mm from posterior cartilage margin to anterior margin. For single bundle reconstruction, the center point located at 3 mm inferior to roof,

7 or 8 mm from posterior cartilage margin. After confirming the position, footprint marking made using 45-degree angled microfracture awl.

Recheck the marked point again with a metal ruler if it is correctly positioned (Fig. 5b). Next, a flexible guide (Clancy 42 degrees guide (Fig. 6) [19], and guide pin are engaged just a little to fix the point through the AAM portal to the marked center of point. Then, the knee must be hyperflexed to 120 degrees to allow the trajectory of the guidewire directly into the center of the femoral footprint (Fig. 7) [14, 20, 21]. Alternatively, flexible guide pins and reamers have been introduced in an effort to avoid the need for hyperflexion, minimize articular cartilage damage on the MFC, and allow the length of the femoral tunnel to be maximized via a more proximally directed orientation [22]. Following with the knee in hyperflexion (flexible guide: 120 degrees flexion, rigid guide: 135 degrees flexion), the guide pin is advanced through the lateral femoral cortex and the skin. The length of the femoral tunnel is measured through indirect method. The ideal tunnel length is 30–40 mm, and enough length (8 mm) can be left to allow the button to flip.

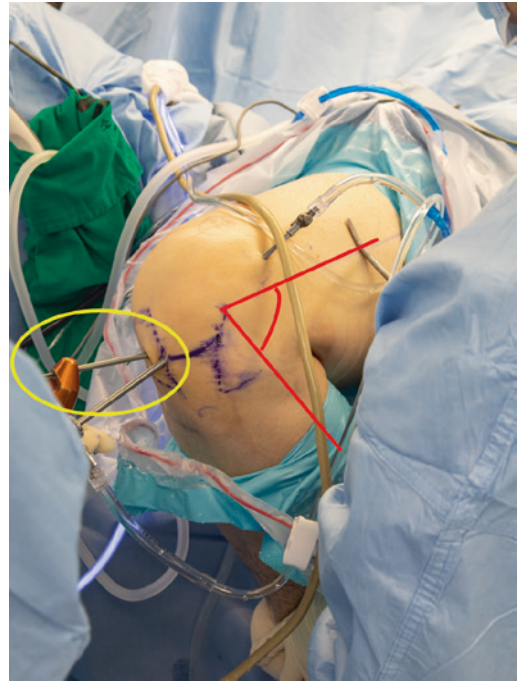


Fig. 7 The knee must be flexed to 120 degrees to allow the trajectory of the guidewire directly into the center of the femoral footprint. This position should be maintained during the formation of the femur tunnel

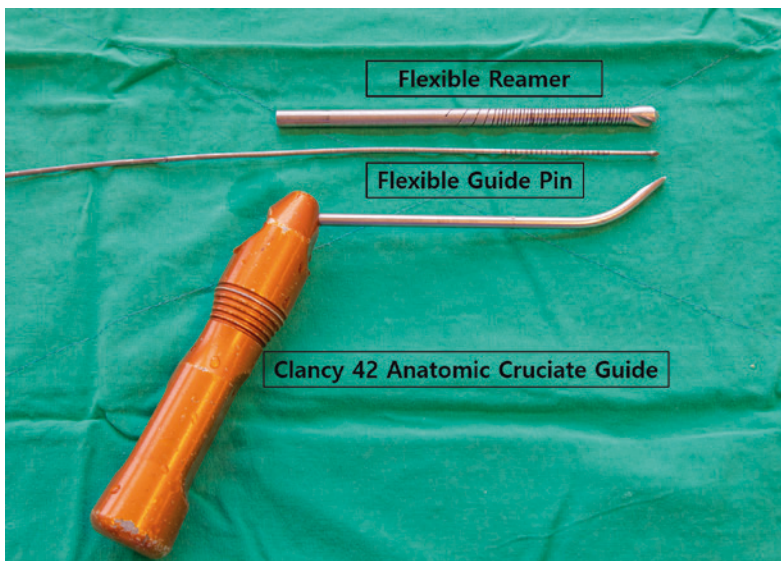


Fig. 6 Flexible guide (Clancy 42 degrees anatomic cruciate guide), flexible guide pin, and flexible reamer set

Provided the angle of knee flexion is maintained, the reamer is then advanced to the appropriate depth taking care to avoid damage to the MFC cartilage by the edges of the reamer. When reaming, use the irrigation tube to remove bone debris while keep the sight. When removing the reamer, pull it out by hand at near around the entrance of the tunnel to reduce the risk of MFC cartilage injury. When using a Sentinel[®] rigid reamer, should be careful during introducing or removing so that the arrow towards lateral side [14].

Following the tunnel reaming, the endobutton reamer advanced to the lateral femoral cortex. After the guide pin and endobutton reamer unit is removed, check tunnel position and the adequacy of the posterior wall (Fig. 8). Measure the tunnel length directly again using arthroscopic depth. The shaver is introduced to the femoral

tunnel area and debride bony debris with the knee 90 degrees flexion.

Tibial Tunnel Preparation

With AL portal viewing, the tibial footprint is measured. The tibial footprint is located between 6 and 7 mm posterior of the ACL ridge and 5 mm lateral from the medial tibial spine. This places the tibial aperture medial in the native ACL footprint (Fig. 9). It can reduce the risk of graft impingement [23]. Furthermore, this medial placement of tibial tunnel creates an obliquity in the coronal plane and reported better rotatory instability [24]. We prefer to preserve the soft tissues around tibial footprint to promote graft incorporation and tibial tunnel widening. After marking the tibial footprint

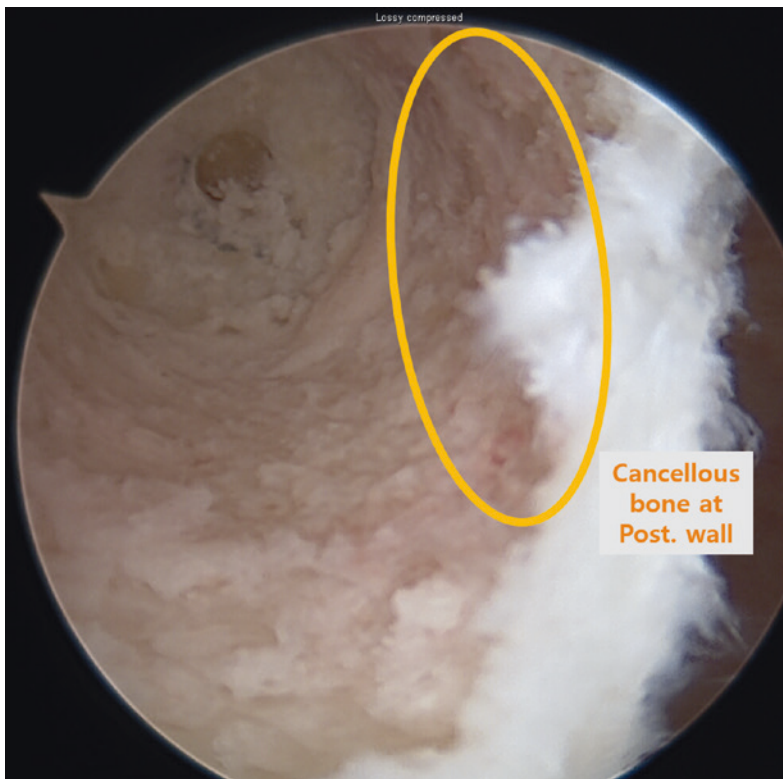


Fig. 8 Check tunnel position and the adequacy of the posterior wall. If you see a cancellous bone fragment (yellow circle) on the posterior wall, it can be judged that there is no blow out fracture has occurred. (viewing from AM portal, right side knee)

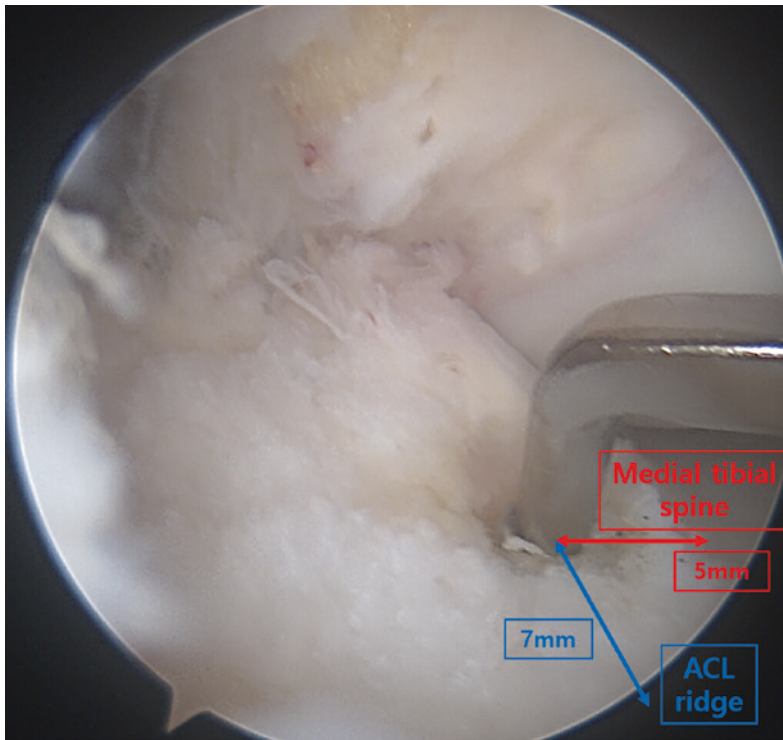


Fig. 9 The tibial footprint is located between 6 and 7 mm posterior of the ACL ridge and 5 mm lateral from the medial tibial spine. (viewing from AL portal, right side knee)

using microfracture awl, the ACL tibial guide zig is introduced through AAM portal. The ACL tibial guide usually set to 50 or 55 degree for single bundle reconstruction.

If auto-hamstring tendon were harvested, the same incision is used for tibial tunnel. If not, 2 cm longitudinal incision is made from the entry marking point. In general, the Pes anserinus superior border is set as the starting point, which can secure a tibial tunnel length of about 30–40 mm. Then, the guide pin is advanced while checking the progress axis. After the guide pin is appropriately positioned, the knee is taken to full extension slowly to ensure whether there would be no graft impingement. A notchplasty is performed only if there is a risk of anterior impingement during flexion and extension motion.

Following standard tibial tunnel reaming, the shaver is introduced to tibial tunnel and debride the bony debris. After the preparation of both side tunnel, a beath pin with a looped suture attached is passed through the AAM portal first, then the knee in the same degree of hyperflexion that was

used during femoral tunnel formation (flexible reamer: 120 degrees, rigid reamer: 135 degrees). Following the pin is passed through the skin of the anterolateral thigh, looped suture is pulled through a tibia tunnel using a suture retriever.

Graft Passage and Fixation

Following the femoral side graft anchored to the loop, the beath pin and suture loop retrieved to anterolateral side of thigh. The graft is passed through the femoral tunnel with arthroscopic guide, and the endobutton CL is flipped on the lateral femoral cortex. After flipping the button, pull the graft end of the tibia towards the distal side to check if it is correctly positioned. With holding tension on the distal end of graft, the knee is fully extended to confirm that there is no impingement. The knee is cycled 20 times while still holding tension on the distal end of graft. We finally confirm the position of button under C-arm fluoroscopy. The tibial side of graft is

secured with bio-absorbable interference screw in full extension with tibiofemoral reduction force. After a Lachman test is performed to confirm stability. Arthroscopic exam is again performed to check graft position, tension and the knee is examined through full range of motion (Fig. 10). Finally, additional fixation is applied using cortical screw and washer at 1.5 cm inferior of tibial tunnel. The wounds are copiously irrigated especially for tibial tunnel area and closed. The knee is then compressed by elastic bandage and applied cylinder splint in knee extension position.

Discussion

The AMP technique allows the femoral and tibial tunnels to be made independently. It has advantages of allowing more anatomic placement of the graft within the native ACL footprints comparing with TT procedure. It remains to be seen whether the acute angle formed at the

graft entrance to the femoral creates a “killer turn” that can lead to long-term graft damage. Despite the technical challenges associated with its use, complications can be avoided with understanding of the potential pitfalls and technical principles. Critical to success with AMP techniques are (1) appropriate AAM portal placement, (2) introduction and advancement of instruments into the joint and notch under arthroscopic visualization, (3) understanding of native footprint anatomy, (4) experience with appropriate flexion and hyperflexion angles of the knee, (5) appropriate graft and tunnel length [25].

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Fig. 10 Finally, arthroscopic exam is performed again to check graft position, tension. (viewing from AM portal, right side knee)

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