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Anatomical Transtibial Single-Bundle Anterior Cruciate Ligament Reconstruction

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In the era of isometric anterior cruciate ligament (ACL) reconstruction, the transtibial technique was routinely performed. During the transition from isometric ACL reconstruction to anatomical ACL reconstruction [1], the possibility of anatomical ACL reconstruction through the tibial tunnel was explored. Some studies have shown that anatomical ACL reconstruction can be performed through a shallow tibial tunnel [2, 3], but other studies have suggested that anatomic ACL reconstruction through tibial tunnels is impossible or difficult [4–7].

However, in our clinical practice, we have found that if the angulation of the tibial tunnel to the sagittal plane and the tibial axis are properly controlled during the creation of the tibial tunnel, an anatomical femoral tunnel can be created [8]. Thus, we present this anatomical transtibial single-bundle ACL reconstruction technique, which is indicated for any complete ACL tear recommended for surgery in skeletally mature patients.

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Basic Concepts

How to Locate the Tibial Tunnel During Anatomical Single-Bundle ACL Reconstruction?

On the tibial side, the ACL is inserted to the anterior part of the intercondylar area, mainly at the anterolateral slope of the medial tibial eminence, with a posterior border at the tip of the medial tibial eminence and an anterior border at the anterior edge of the intercondylar area. The ACL tibial insertion is in a C-shaped configuration, with high fibril density at the anterior edge of the footprint and low density at the posterior part of the footprint. Theoretically, we should put a larger part of the graft at the anterior side of the footprint. However, anterior placement of the graft may result in breakage of the anterior wall of the tibial tunnel. Thus, in an anterior-to-posterior direction, locating the tibial tunnel at the middle of the ACL footprint is reasonable and a guidance in our clinical practice.

Locating the tibial tunnel with lateral view fluoroscopy of the tibia may help to get the right position. However, it is impractical to use fluoroscopy routinely during ACL reconstruction. Without fluoroscopy, there is still no feasible way to locate the anterior and posterior edge of the proximal tibia and get the right percentage during operation. Thus, finding an anatomic landmark under arthroscopic view as a reference point may be more feasible.

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One consensus of locating the ACL tibial tunnel arthroscopically is to use the PCL as a landmark and locate the center of the ACL 14 mm anterior to the PCL. However, the PCL is a structure passing obliquely in the intercondylar notch, which means the distance of its anterior edge to the ACL footprint changes, and it may be unreliable to use the anterior edge of the PCL as a reference point. Furthermore, the number 14 mm may be too larger for a small knee and too small for a large knee.

Locating the ACL tibial tunnel with reference landmark on the tibial side may get reproducible results. Under arthroscopic view, the only referable bony landmarks are the two tibial eminences. Because the tip of the medial tibial eminence is always not obvious, we use the tip of the lateral tibial eminence as a reference point to locate the posterior border of the ACL tibial footprint.

As for the anterior border of the ACL tibial footprint, there is no bony landmark to be used as a reference point when the lateral meniscus and the transverse knee ligament exist. The transverse knee ligament cannot be used as a reference structure because it goes obliquely, from anteromedial to posterolateral side. Thus, we use the anterior edge of the lateral meniscus as a reference point to locate the anterior border of the ACL footprint. When the anterior edge of the lateral meniscus does not exist, we use the anterior edge of the intercondylar region as the anterior border of the ACL footprint (Fig. 16.1a).

In a medial-to-lateral direction, it is supposed to locate the tibial tunnel at a point of 54% on a transverse tibial scale. However, this tunnel locating method rely on fluoroscopy and calculation, which is impractical. We locate the tibial tunnel on the midline of the lateral slope of the medial tibial eminence. As for the bony landmark for this location, the ridge of the medial tibial eminence is there. What we need to do is to find the bottom of the lateral slope (Fig. 16.1b). The right location in medial to lateral direction of the tibial tunnel is to prevent breakage of the medial slope of the medial tibial eminence, which may result in impingement between the graft and the medial femoral condyle, and too lateral placement, which may result in impingement between the lateral femoral condyle and the graft.

However, although the anterior, posterior, medial, and lateral border of the ACL footprint can be defined arthroscopically, the real coronal and sagittal planes of the proximal tibia cannot be precisely defined arthroscopically. Thus, locating the ACL tibial tunnel through the crossing of the two lines in the sagittal and the coronal planes, respectively, may be just an ideal and can only be realized with a robot in the future. Deviation, although not so large, always exists during locating the tibial tunnel.

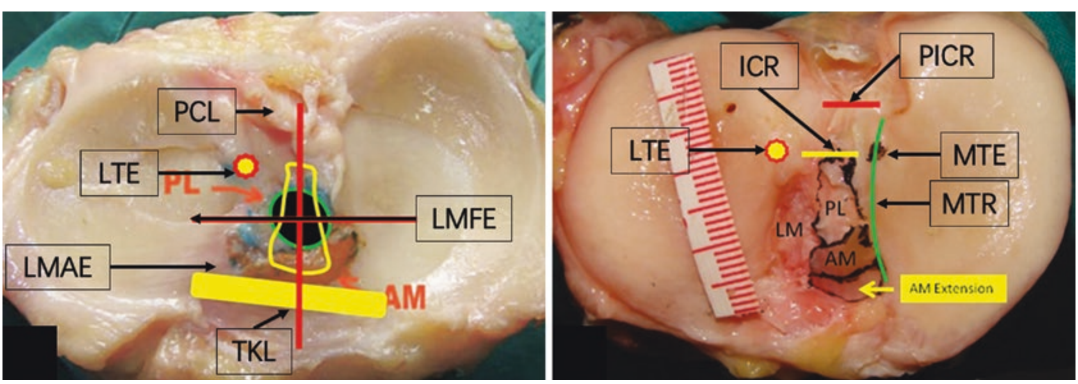

Fig. 16.1 The potential bony and soft tissue landmarks used to locate the ACL tibial tunnel in specimen with (**a**) and without (**b**) meniscus. *TKL* the transverse knee ligament, *LMAE* the anterior edge of the lateral meniscus, *LMFE* the free edge of the anterior horn of the lateral meniscus, *PCL* the posterior cruciate ligament, *MTE* the medial tibial eminence, *LTE* the lateral tibial eminence, *MTR* the medial tibial ridge, *ICR* intercondylar ridge, *PICR* posterior intercondylar ridge

How to Locate the Femoral Tunnel During Anatomical Single-Bundle ACL Reconstruction?

On the femoral side, the ACL is inserted to the lateral wall of the intercondylar notch, with a proximal border at the posterior border of the posterior outlet of the femoral notch and a distal border at the posterodistal cartilage edge of the lateral wall of the femoral notch. The ACL femoral insertion is in an oval or crescent shape, with the anterior border outlined by the extension of the intercondylar ridge, and the posterior border outlined by the posterior cartilage edge. Regarding the fibril allocation within the footprint, high fibril density at the anterior edge of the footprint and low density at the posterior part of the footprint exist.

There have been several methods reported to locate the ACL femoral tunnel. The first method to locate the ACL femoral tunnel is to locate the bifurcating ridge and use it as a reference. On the lateral wall of the femoral notch, the extension of the intercondylar ridge is first defined. Then the bifurcating ridge, which is described as the outline of the separation of the AM and PL bundles, is found. The center of the ACL femoral tunnel is then located on the bifurcating ridge. This is an idealized but impractical method of femoral tunnel location, first because the intercondylar and the bifurcating ridges do not constantly exist, and secondly because without thorough removal of the ACL stump, these two ridges are just the results of imagination. Furthermore, the two ridges may be erased during femoral notch plasty. Anyway, this method is still valuable clinically because we can get a low and relatively distal location of the femoral tunnel when we keep the bifurcating ridge in mind (Fig. 16.2a).

The second one is using fluoroscopy during operation to set the center of the femoral tunnel at a desired point on the meshed area on the lateral view of the lateral femoral condyle. The rectangle is formed by the anterior and posterior ends of the Blumensaat line and the posterodistal edge of the lateral femoral condyle. This method is impractical because we must rely on fluoroscopy routinely during operation. This method also cannot be applied arthroscopically because we cannot put the rectangle into one arthroscopic view (Fig. 16.2b).

Watanabe mid-lateral wall locating method is practical clinically. The proximal end of the cartilage edge on the lateral wall of the femoral notch is first defined as a proximal reference point, a line parallel to the femoral axis is drawn

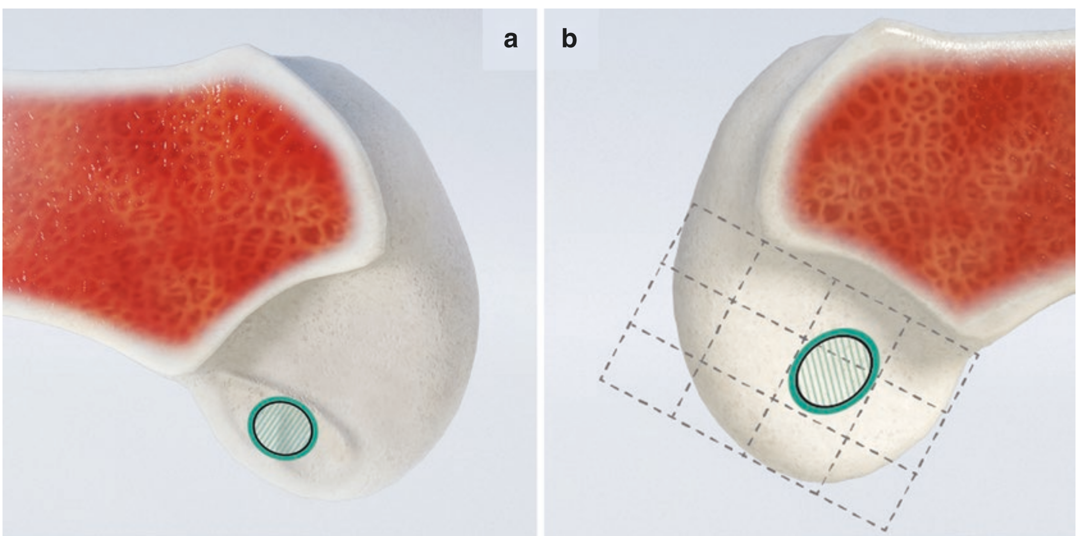

Fig. 16.2 Locating the ACL femoral tunnel with the lateral intercondylar ridge and lateral bifurcating ridge as references (**a**) and via the meshing method (**b**)

from the proximal reference point distally. The crossing point of this line and the distal cartilage edge is defined as the distal reference point. The femoral tunnel is located at the site, at the middle of the two reference points. Deviation exists because it is difficult to define the femoral axis under arthroscopic view (Fig. 16.3a).

In the current technique, we use the low and high reference points and to locate the femoral tunnel. The high reference point (HRP), namely, the over-the-top (OTT) point, is defined as the midpoint between the 12 o'clock point on the posterior outlet of the femoral notch and the posterior end of the cartilage edge on the lateral wall of the femoral notch. The low reference point (LRP) is located at the most posterior site on the lateral wall of the femoral notch. The posterolateral bundle point (PLP) is first defined as a point 5 mm anterior to the LRP. The midpoint between the PLP and the OTT is defined as the anteromedial bundle point (AMP). And the center of the ACL femoral tunnel is located at the midpoint between the AMP and PLB or is at the first one fourth from the PLP on the line segment connecting the OTT point and the PLP. In patients with relatively normal body figure, we usually set the center of the femoral tunnel 5 mm proximal to the PLP on the line connecting the PLP and the OTT.

In the current femoral tunnel locating technique, when the proximal reference point is set at 3 o'clock position (left knee), the OTT position is located at 1:30 position. Because the shape of the cartilage edge of the lateral wall of the femoral notch varies and the long axis of the femur is difficult to define arthroscopically, deviation exists in defining the LRP, namely the lowest point of the cartilage edge. Furthermore, following femoral notch plasty, a large part of the native cartilage edge disappears, which make the definition of the LRP impossible. We prefer to locate the femoral tunnel before femoral notch plasty (Fig. 16.3b). In the current technique, defining the posterior end of the cartilage edge of the lateral wall and the femoral axis are essential to locate the LRP and the OTT.

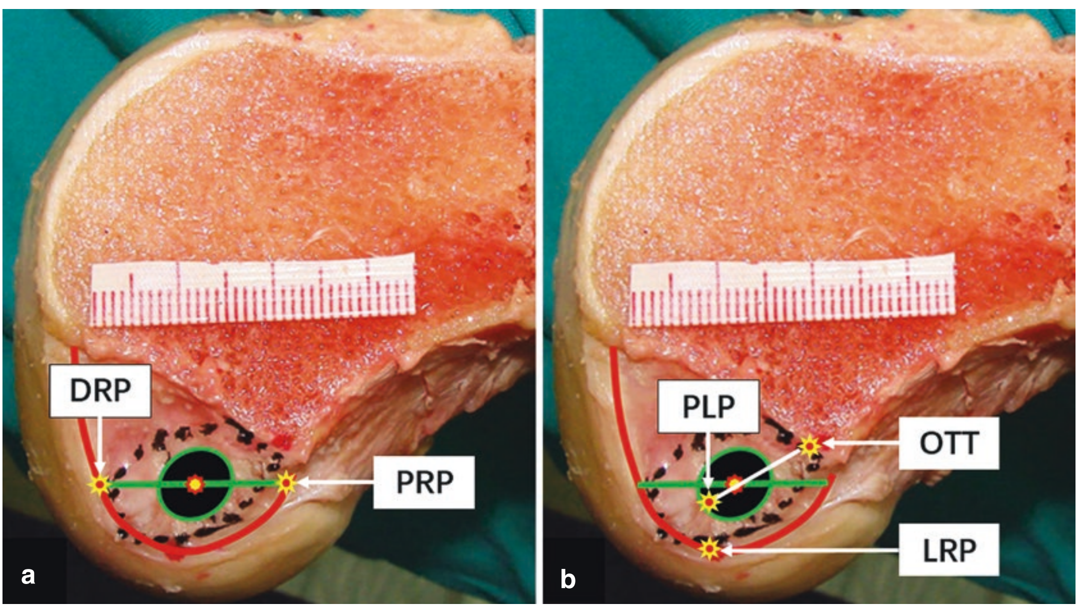

Fig. 16.3 Locating the femoral tunnel with Watanabe mid-lateral-wall locating method (**a**) and Zhao three-reference-points locating method (**b**). In Watanabe method, the femoral tunnel is in the middle of the proximal and distal reference points. In Zhao's method, the femoral tunnel is located on the line segment connecting the OTT and the PLP point at the first one fourth from the PLB point. *PRP* proximal reference point, *DRP* distal reference point, *OTT* over the top point, *LRP* low reference point, *PLP* posterolateral bundle point

Surgical Techniques of Anatomical Transtibial Single-Bundle Anterior Cruciate Ligament Reconstruction

The procedure is performed in the supine position. A post is placed at the lateral side of the thigh to provide support when the knee is flexed (Table 16.1).

Table 16.1 Step-by-step procedures of the anatomical transtibial single-bundle ACL reconstruction

1. The ST and GT are harvested. A seven-stranded graft is made from these two tendons. The graft is mounted on a set of cortical fixation device with an adjustable loop
2. The femoral tunnel is located at the center of the ACL footprint and marked with a radiofrequency probe. The location is at a point 5 mm anterior and 5 mm proximal to the lowest point of the lateral wall of the femoral notch
3. The tibial tunnel is created, with its inner orifice located in the middle of the ACL tibial footprint, with the tunnel plane angulating the sagittal plane at approximately 40° and the tunnel angulating the tibial axis at approximately 50° in the tunnel plane, with a projection point on the femur within 5 mm distance to the desired location of the center of the femoral tunnel
4. The K wire within the tibial tunnel is adjusted to the marked point of the femoral tunnel and drilled in. The femoral tunnel is created
5. The length of the femoral tunnel is measured. The length of the proximal graft complex is adjusted and set at a length 7 mm longer than the length of the femoral tunnel
6. The graft is pulled into the femoral tunnel. The button is flipped. Proximal suspension fixation is completed by shortening the adjustable loop and setting the button in the cortical fixation device on the outer orifice of the femoral tunnel
7. Interference screw fixation is first performed on the tibial side
8. A trans-anterior tibial ridge tunnel is created. A cortical suspension fixation device with an adjustable loop is pulled though the medial to the lateral side and set the cortical button on the lateral orifice of the tunnel
9. The sutures from the distal graft end are tied at the adjustable loop

ACL anterior cruciate ligament, *ST* semitendinosus tendon, *GT* gracilis tendon

Graft Preparation

The semitendinosus tendon (ST) and gracilis tendon (GT) are harvested to prepare a seven-stranded graft. The graft is composed of four strands of ST and three strands of GT, with a mean length of 7 cm and a usual width of 8–10 mm. A cortical fixation device with an adjustable loop is used for proximal fixation, in which case the graft tendons are hung on the loop during graft preparation (Fig. 16.4).

On the proximal end of the graft a mark is made by suture the tendons together with a colored absorbable suture at a site with a distance to the graft end equal to the desired graft length in the femoral tunnel. The adjustable loop and the graft that will be put into the femoral tunnel is called proximal graft complex. The length of the proximal graft complex should be 7 mm longer than the length of the femoral tunnel.

Locating the Tibial Tunnel

The inner orifice of the tibial tunnel is located in the middle of the tibial footprint of the ACL. The tibial tunnel is located with a medial-to-lateral transverse line and an anterior-to-posterior longi-

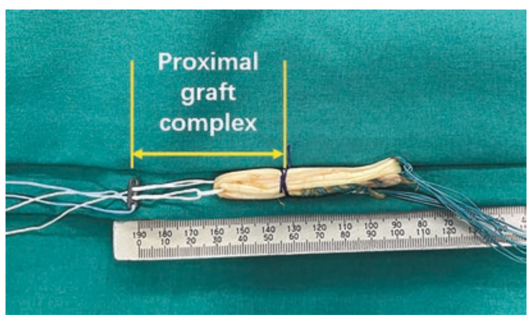

Fig. 16.4 Graft preparation and proximal graft complex. An eight-stranded graft is made from the semitendinosus tendon and gracilis tendon. Proximal graft complex includes the cortical suspension fixation device and the graft part to be put into the femoral tunnel

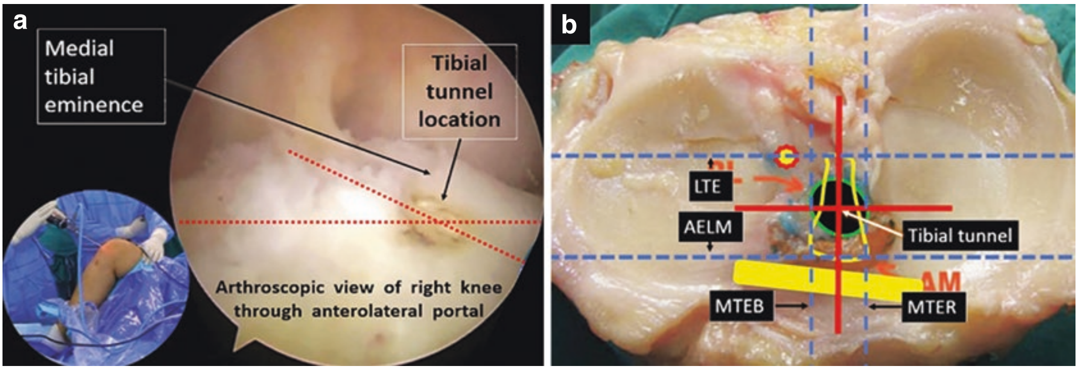

Fig. 16.5 Intraoperative photo and specimen illustrations of locating the tibial tunnel. (**a**) Arthroscopic view of right knee in supine position through the anterolateral portal. The inner orifice of the tibial tunnel is located at the midpoint of the ACL tibial footprint, with the crossing point of two lines passing through the lateral slope of the medial tibial eminence and the free edge of the anterior horn of the lateral meniscus as reference. (**b**) The tibial tunnel is located at the intersection of the midline between the two transverse lines passing through the lateral tibial eminence and the anterior edge of the anterior horn of the lateral meniscus and the midline between two longitudinal lines passing through the ridge of the medial tibial eminence and the base of its medial slope. *LTE* lateral tibial eminence, *AELM* anterior edge of the anterior horn of the lateral meniscus, *MTEB* base of the medial tibial eminence, *MTER* ridge of the medial tibial eminence. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

tudinal line when there is no ligament remnant on the tibial side. The transverse line crosses the middle of the tip of the lateral tibial eminence and the anterior edge of the anterior horn of the lateral meniscus. The longitudinal line crosses the middle of the lateral slope of the medial tibial eminence. The intersection of the two lines is defined as the location of the tibial tunnel (Fig. 16.5).

Locating the Femoral Tunnel

The knee is flexed at 90°. The femoral tunnel is located in the center of the ACL footprint and is marked with an RF probe. When there is no residual ligament in the footprint for tunnel positioning, two reference points, namely the low reference point (LRP) and the high reference point (HRP), are defined first. LRP is located at the lowest point of the lateral wall of the femoral notch and HRP is located at the OTT point. The point 5 mm in front of the LRP is called the posterolateral bundle point (PLP). On the line connecting the HRP and the PLP, a point at the first one fourth from the PLP on the line segment or 5 mm proximal to the PLP in normal-figured patients is defined as the footprint center (Fig. 16.6).

Creating the Tibial Tunnel

A 5-mm offset point-to-hole tibial tunnel locating device (Aesculap, Tuttlingen, Germany) is inserted into the joint through the anteromedial portal. The hook of the device is placed at the correct site, and the space position of the tunnel targeting component of the device is adjusted to create a tibial tunnel in a plane (tibial tunnel plane) which angulates the sagittal plane at an angle of 40°. In the tibial tunnel plane, the tibial tunnel is at an angle of 50° to the tibial axis (Fig. 16.7).

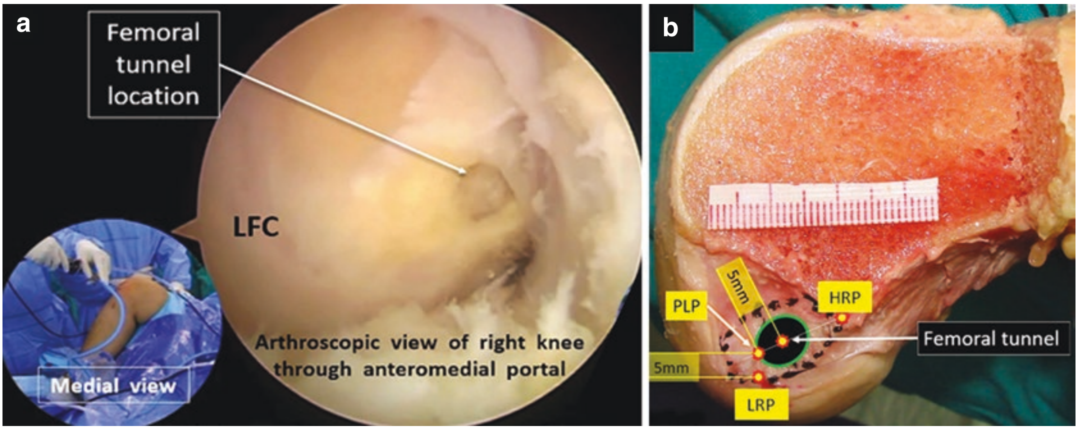

Fig. 16.6 Intraoperative and illustration of location of the femoral tunnel. (**a**) Arthroscopic view of right knee in supine position through the anteromedial portal. The femoral tunnel is located at the midpoint of the ACL femoral footprint. (**b**) The femoral tunnel is located at a point between the PLP and HRP, with approximately 5 mm to the PLP. *HRP* high reference point, namely the over-the-top point, *LRP* low reference point, namely the lowest point of the lateral wall of the femoral notch, *PLP* a point 5 mm anterior to the LRP. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

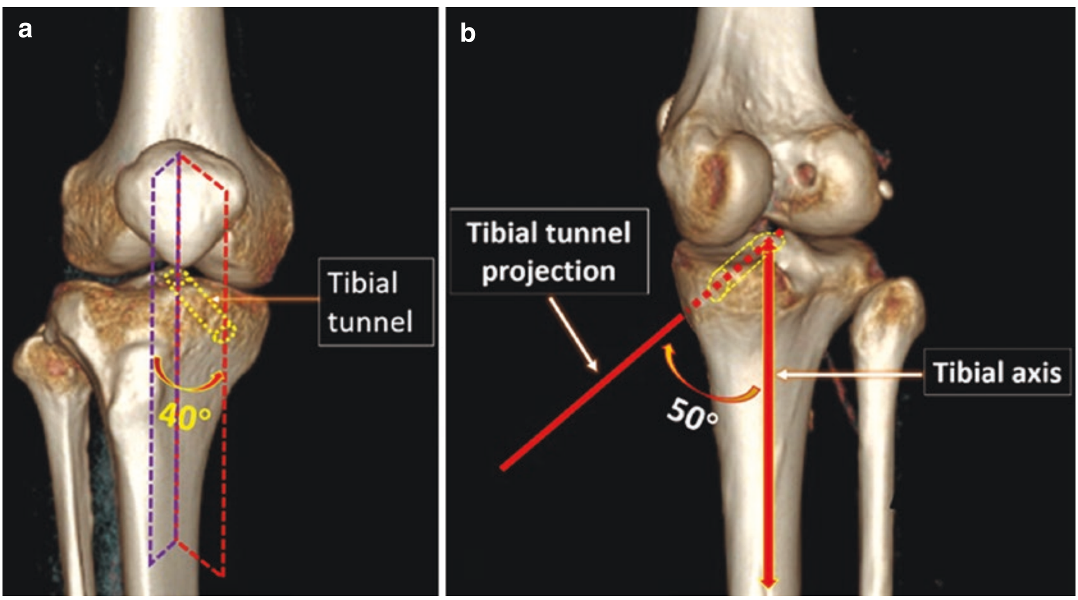

Fig. 16.7 Angulation of the tibial tunnel to the sagittal plane (**a**) and the tibial axis (**b**). (Right knee). The tibial tunnel is created on a plane (tibial tunnel plane) with a 40° angulation to the sagittal plane. On the tibial tunnel plane, the tibial tunnel should be angulated to the tibial axis at 50°. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

A K wire is drilled through the tibia to the femur to ensure that it can reach a point on the lateral wall of the femoral notch, which is within 5 mm from the center of the femoral tunnel (Fig. 16.8a). Micro-adjustment may be needed through multiple tries. The K wire is over drilled to create the expected size of the tibial tunnel.

Creating the Femoral Tunnel

The direction of K wire in the tibia tunnel is adjusted to reach the marked point of femoral tunnel (Fig. 16.8b). The K wire is first drilled through the femur (Fig. 16.9a). The K wire is then over-drilled to create a femoral socket of desired size (typically 8–10 mm) and length (typically 25–30 mm) (Figs. 16.9b and 16.10). The K wire is over drilled with a 4.5-mm cannulated drill all through the femur. The length of the femoral tunnel is measured, and the length of the adjustable loop is adjusted to obtain a desired length of the proximal graft complex, which should be 7 mm longer than the length of the femoral tunnel.

Graft Placement and Proximal Fixation

The traction sutures, flipping sutures, and the loop-shortening sutures are pulled through the tibial and the femoral tunnels. Then the graft is

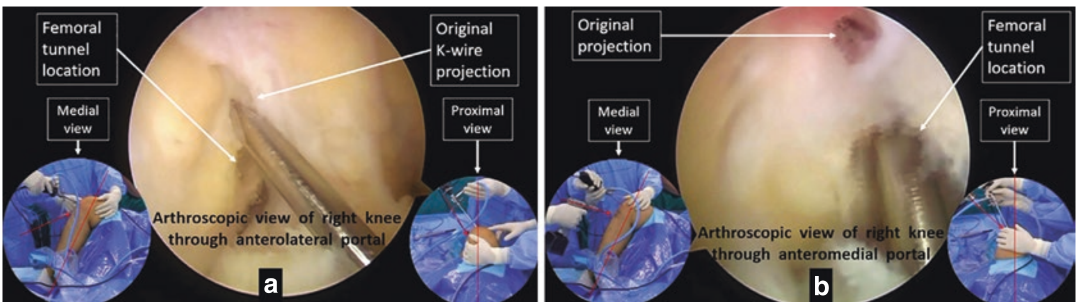

Fig. 16.8 Locating the femoral tunnel through the tibial tunnel. (Arthroscopic view of right knee in supine position through the anteromedial portal). (**a**) Desired projection of the tibial tunnel. The projecting point of the tibial tunnel on the lateral wall of the intercondylar notch is located within 5 mm distance to the marked point of the femoral tunnel. (**b**) Adjusting the K wire through the tibial tunnel to pointing to the location of the femoral tunnel. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

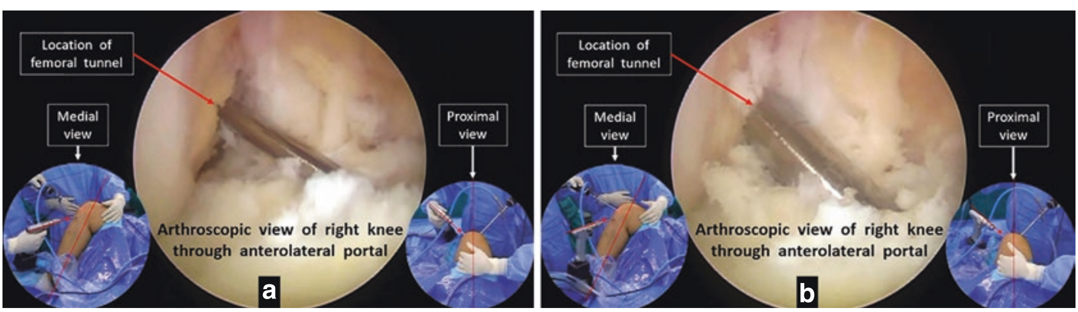

Fig. 16.9 Creating the femoral tunnel through the tibial tunnel. (Arthroscopic view of right knee in supine position through the anterolateral portal). (**a**) Drilling the K wire into the femoral location through the tibial tunnel. (**b**) Creating the femoral tunnel through the tibial tunnel with corresponding drills. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

pulled through the tibial tunnel into the femoral tunnel till the graft enters the femoral tunnel with desired length, usually reaches the tunnel end, during which the cortical fixation button is pulled out of the femoral tunnel (Fig. 16.11). The button is flipped. The adjustable loop is shortened to set the cortical fixation button on the outer orifice of the femoral tunnel.

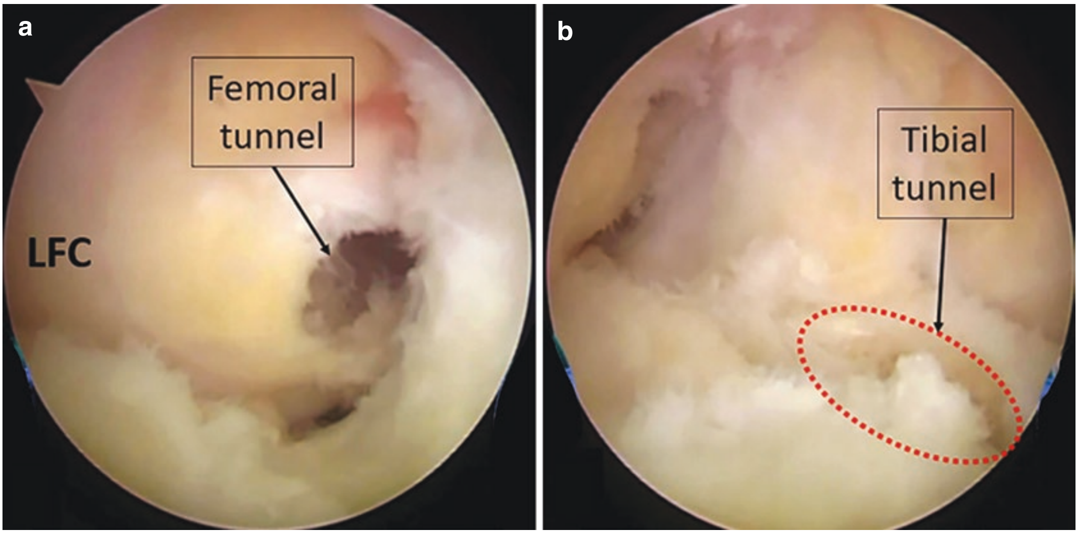

Fig. 16.10 The inner orifices of the created tibial and femoral tunnels. (**a**) Arthroscopic view of right knee through the anterolateral portal. (**b**) Arthroscopic view of right knee in supine position through the anteromedial portal). *LFC* lateral femoral condyle. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

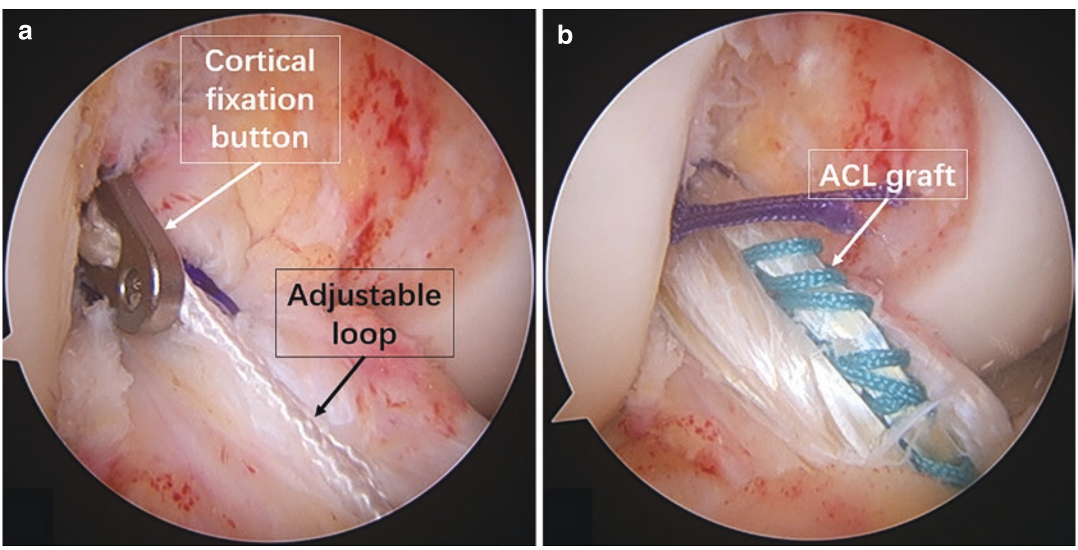

Fig. 16.11 Placement of the graft into the femoral tunnel through the tibial tunnel. (Arthroscopic view of right knee in supine position through the anterolateral portal). (**a**) The proximal fixation sutures are pulled into the femoral tunnel. (**b**) The graft is pulled into the femoral tunnel

Graft Fixation on the Tibial Side

The knee is placed in full extension. Femoral notch impingement is first excluded. Interference screw fixation is performed on the tibial side to set the screw at the inner orifice of the tibial tunnel (Fig. 16.12).

A 2-mm incision is made approximately 1 cm lateral to the anterior tibial ridge and distal to the transverse plane on which the outer orifice of the tibial tunnel lies. A 4.0-mm tunnel across the tibial ridge is created. A set of cortical fixation device with an adjustable loop is pulled from the medial to the lateral side of the tunnel. Half of sutures from the graft ends are passed through the adjustable loop. The cortical fixation button is pulled across the transverse tibial tunnel and flipped over the lateral orifice. The adjustable loop is shortened to desired length. The suture limbs through the adjustable loop and the corresponding suture limbs are tied to secure the graft (Fig. 16.13). The adjustable loop is shortened to the final tensioning of the graft.

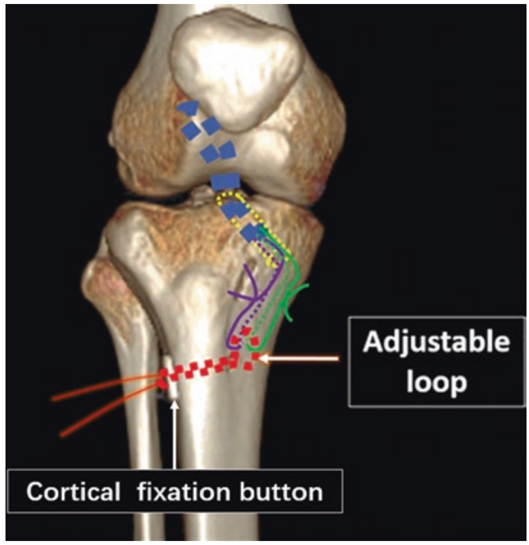

Fig. 16.13 Distal fixation of the graft. (Right knee). The graft is fixed distally at an adjustable loop set through a transtibial ridge tunnel. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

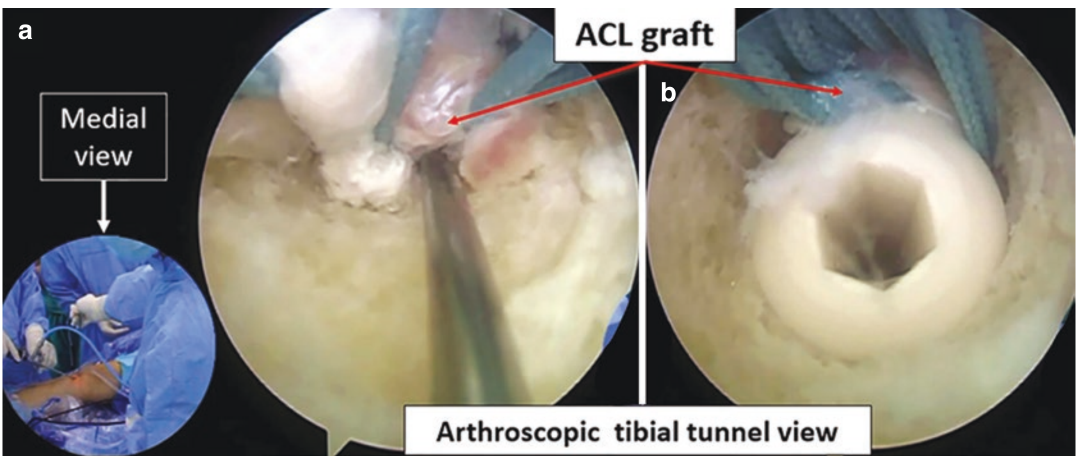

Fig. 16.12 Interference screw fixation of the graft on the tibial side. The crew is place at the posterior side of the graft to the inner orifice of the tibial tunnel. (Arthroscopic view of right knee in supine position through the tibial tunnel). The mean graft length in the tibial tunnel is 25 mm. (**a**) The guide wire is placed at the posterior side of the graft. (**b**) The interference screw is placed to the inner orifice. Due the that the graft length in the tibial tunnel is approximately 25 mm and the length of the screw is 23 mm, it can be inferred the screw is set at the inner orifice of the tibial tunnel when the screw end is abreast the graft end. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

Comments on Current Technique

The characteristic of this technical description is that it provides a simple and practical technique for ACL reconstruction through the tibial tunnel. This technology provides accurate positioning and fabrication of the femoral tunnel. The key step in this technique is to elevate the tibial tunnel positioning device to create a shallow tibial tunnel at a 40° angle with the sagittal plane and a 50° angle with the tibial axis. The projection of the tibial tunnel to be created can be evaluated by drilling the K wire into the joint near the femur. When K wire has a smaller angle with the tibial axis and deviates too far from the expected femoral position, the tibial tunnel positioning device needs to be adjusted (Table 16.2).

Table 16.2 Pearls and pitfalls of anatomical transtibial single-bundle ACL reconstruction

1. Enough graft size is needed to ensure final graft strength. Thus, a graft size ≥8 mm is the best choice. When a seven-stranded ST-GT is still not large enough, we recommend using the anterior half of the peroneus longus tendon as a supplement
2. During creation of the tibial tunnel, elevation of the tibial-aiming device to create a shallow tibial tunnel is the most critical step. Drilling the K wire into the joint can help evaluate the projection of the tibial tunnel
3. Locate the inner orifice of the tibial tunnel at the lateral slope of the medial tibial eminence. Otherwise, it will result in breakage of the medial slope of the medial tibial eminence and impingement between the graft and the medial femoral condyle
4. When the lateral tibial eminence is too high, remove it to prevent its inferior impingement to the graft
5. Keep the tibial remnant to get tunnel sealing effect
6. The length of the proximal graft complex should be set precisely according to the length of the femoral tunnel. Too long a proximal graft complex will result in engaging of the cortical button with the soft tissue overlies the outer orifice of the femoral tunnel
7. The graft is fixed in full extension of the knee to prevent extension limitation
8. The interference screw should be placed at the posterior side of the graft to prevent intra-articular extrusion

ACL anterior cruciate ligament, *ST* semitendinosus tendon, *GT* gracilis tendon

Usually, the protruding K wire can get close to the mark but not exactly to the point on the femur. However, when the distance between the projection point of the tibial tunnel and the marked point of the femoral tunnel is within 5 mm, the positioning of the femoral tunnel at the correct point through the 8- to 10-mm-wide tibial tunnel is not a problem, because the direction of the K wire in the tibial tunnel can be adjusted to a wide range (Fig. 16.14).

This special technique of tibial tunnel creation results in a shallow tibial tunnel with a length of 35–40 mm and an outer orifice 15–20 mm below the medial tibial plateau. Because the length of graft that would be placed in the tibial tunnel is 25–30 mm, the tibial tunnel can accommodate the graft without tendon extrusion.

The main problem with this technique is the breaking potential of the anterior wall of the tibial tunnel during the creation of a shallow tibial tunnel. In our clinical practice, we find that it

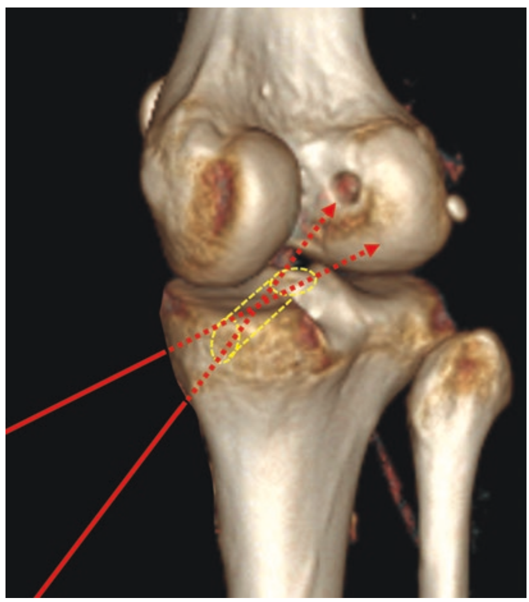

Fig. 16.14 Change of direction of the femoral tunnel-aiming device within the tibial tunnel. (Reproduced with permission from Zhao J. Anatomical Single-Bundle Transtibial Anterior Cruciate Ligament Reconstruction. Arthrosc Tech. 2020;9(9):e1275–e1282)

rarely occurs in the proper control of the position and spatial direction of the tibial tunnel. In a few cases, even the anterior wall breaks due to abnormally large tunnel or its angulation with the tibial axis, it rarely caused a fixation problem because we rely on suspension fixation on the tibial side. The advantages and disadvantages of this technique are listed in Table 16.3.

Table 16.3 Advantages and disadvantages of anatomical single-bundle transtibial ACL reconstruction

Advantages
1. No high-degree flexion of the knee is needed during femoral tunnel creation, and a better view and proper location of the femoral tunnel can be expected
2. The creation of an extremely short femoral tunnel can be avoided
3. The outer orifice of the femoral tunnel is away from the lateral femoral epicondyle and iliotibial band irritation is prevented
4. The hypertrophied lateral tibial eminence is removed during tibial and femoral tunnel creation and inferior impingement of it to the graft can be prevented
Disadvantages
1. Multiple try to adjust the projection of the tibial tunnel to close to the location of the femoral tunnel is needed
2. A relatively short tibial tunnel is fabricated, which may result in graft–tunnel length mismatch
3. A long oval inner orifice of the tibial formed is formed which may result in more exposure of the graft in the joint, especially when the tibial remnant is removed
4. When an interference screw is used, screw protrusion into the joint occurs easily when it is placed and the anterior side of the graft

Postscript The technique description in this chapter is modified from an Elsevier source [8] (https://www.arthroscopytechniques.org/) with permission.

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