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Operative Techniques in
Orthopaedics

Intraoperative Landmarks for Tunnel Placement in Anatomical Anterior Cruciate Ligament Reconstruction

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Anatomical anterior cruciate ligament reconstruction, which stabilizes the knee without a loss of motion, requires graft placement within anterior cruciate ligament attachment-area tunnels. Intraoperatively identifiable arthroscopic landmarks for the femoral attachment area include the resident's ridge, proximal cartilage margin, and posterior cartilage margin. In turn, tibial landmarks include the anterior ridge or Parson's knob, intercondylar eminence, medial intercondylar ridge, and anterior horn of the lateral meniscus.
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Principles of Anatomical Anterior Cruciate Ligament Reconstruction

Emphasis should be placed on the following issues during anatomical anterior cruciate ligament (ACL) reconstruction:

(1) The native ACL should be mimicked as closely as possible during ACL reconstruction to stabilize the knee without a loss in motion.
(2) The direct insertion areas should be exactly identified for correct tunnel placement. The native ACL has direct ligament insertion types and fibrocartilage layers to the femur and tibia. In turn, synovial-fibrous tissues or indirect fibers attached near the direct insertion sites have little mechanical functions in stabilizing the knee.
(3) Tunnel apertures should be created inside attachment areas to ensure placement within thicker cortex areas, thus making the apertures more robust.[1]
(4) Grafts should not cover the entire attachment area, as autogenous tendon grafts present greater mechanical properties than native ACL, and these become hypertrophic after implantation.[2]

Anatomical Landmarks on 3-Dimensional Computerized Tomography

ACL Femoral Attachment Area

Iwahashi et al[3] histologically demonstrated that the direct femoral ligament insertion site is a crescent-shaped fovea located at the superior-posterior margin of the lateral intercondylar notch wall. Furthermore, the area of this site was obtained using a 3-dimensional computerized tomographic image reconstruction of oblique-axial computerized tomography sections. These images led to the identification of various landmarks for the crescent-shaped femoral insertion area, including the resident's ridge (anterior), proximal cartilage margin (superior), and posterior cartilage margin (posterior) (Fig. 1).

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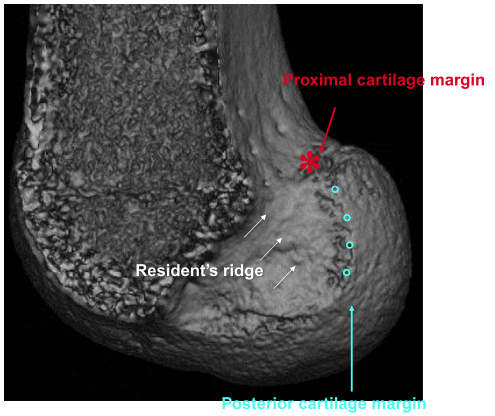

Figure 1 ACL femoral attachment area of the right knee is shown on 3D CT. The following are the 3 landmarks to identify the area: the resident's ridge, proximal cartilage margin, and posterior cartilage margin. (Color version of figure is available online.).

ACL Tibial Attachment Area

Berg[4] identified Parson's knob (tuberculum intercondylare tertium) as the anterior border of the tibial insertion, a site termed the "anterior ridge of the tibia" by Tensho et al.[5] Purnell et al[6] showed that the medial intercondylar ridge could be used as a bony landmark for the medial border of the tibial insertion. Adding to this, Siebold et al[7] clarified the tibial insertion relationship between the ACL and the anterior horn of the lateral meniscus. In total, 4 landmarks have been identified for the tibial attachment area, including the anterior ridge (anterior), the intercondylar eminence (posterior), the medial intercondylar ridge (medial), and the anterior horn of the lateral meniscus (lateral) (Fig. 2).

Intraoperative Landmarks

Operative Setup

To arthroscopically identify the femoral attachment area or the resident's ridge through the anteromedial portal, we recommend maintaining the distal thigh horizontal using a leg holder with the calf hung down (Fig. 3).

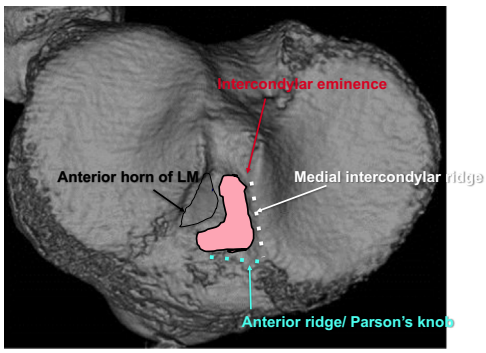

Figure 2 ACL tibial attachment area of the right knee is shown by 3D CT. The following are the 4 landmarks to identify the area: the anterior ridge, anteriorly; the intercondylar eminence, posteriorly; the medial intercondylar ridge, medially; the anterior horn of the lateral meniscus, laterally. LM, lateral meniscus. (Color version of figure is available online.).

Figure 3 Recommended operative setup. Keeping the distal thigh horizontal using a leg holder with the calf hung down. (Color version of figure is available online.).

Femoral Attachment Area

By viewing the posterior third of the lateral notch wall via the anteromedial portal with a 45° oblique arthroscope, the fibrous tissues of the intercondylar notch can be thoroughly removed, including the ACL stump. For removal, a radiofrequency device and small curette should be used through the far anteromedial portal, which should be created 2-2.5 cm posterior to the anteromedial portal and just above the medial meniscus.[8] Mechanical shavers should be used only to roughly excise the fibrous tissue, and care should be taken to preserve the subtle undulation of the bony surface around the attachment area. After cleaning, the crescent-shaped attachment area can be clearly delineated by the resident's ridge (anterior), proximal cartilage margin (superior), and posterior cartilage margin (posterior; Fig. 4).

Even if the resident's ridge cannot be clearly identified, the other landmarks (ie, proximal and posterior cartilage margins) could be used to approximate the attachment area. This approximation is possible as the long axis of the area, or ridge, is placed at a 31° angle to the distal femoral axis.[9]

Tibial Attachment Area

By viewing down the ACL tibial remnant and attachment area via the anteromedial portal with a 45° oblique arthroscope, the ACL stump can be cut to 3-5 mm in length with a shaver. By viewing the anterior and medial margins of residual ACL fibers, as well as the anterior horn of the lateral meniscus, the C-shaped ACL tibial attachment area can be delineated (Fig. 5). We recommend taking plain lateral radiographs to verify a centralized location of the guide-pin tip (Fig. 6).