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The Functional and Surgical Anatomy of the Anterior Cruciate Ligament

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Recent literature has improved our knowledge of the anatomy of the anterior cruciate ligament (ACL). In the setting of an ACL tear, the goal should be to reconstruct the function of the ACL to allow the athlete to return to full unrestricted activity. To accomplish this, anatomic reconstructions must be performed. Thus, the surgeon must be familiar with the arthroscopic anatomy of the ACL and the anatomy of the ACL footprint so that reconstructions can recreate the native ACL anatomy. Because ACL function is directly related to its anatomy, a better understanding of the anatomy of the ACL may help the surgeon to achieve an anatomic reconstruction and improve clinical outcomes. This manuscript will review the neurovascular and gross anatomy, the functional anatomy, the surgical landmarks, and footprint anatomy, as well as the radiographic anatomy of the ACL.
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The anterior cruciate ligament (ACL) is essential to knee kinematics for cutting and pivoting maneuvers. The function of the ACL is directly related to its anatomy. ACL tears are common among athletes and are functionally disabling knee injuries. Knees with incompetent ACLs have a greater likelihood of recurrent instability events that can lead to meniscal tears and cartilage injury. Although no direct correlation between ACL deficiency and the development of osteoarthritis has been confirmed, studies have shown that knee instability has a higher likelihood of causing meniscal tears and that those with meniscal deficient knees are more likely to develop osteoarthritis.

The goals of ACL reconstruction are simple: to restore joint stability and kinematics of the injured knee to preinjury levels. Prior reconstruction techniques aimed to place the ligament in an isometric location, which was determined to be relatively vertical in both the sagittal and coronal planes.[1] In this location, the graft has little resistance to rotational forces and is in a nonanatomic location, which may lead to impingement on normal structures such as the intercondylar notch or the posterior cruciate ligament (PCL). Recent anatomical dissections and biomechanical studies have demonstrated that recreating the normal anatomy eliminates these concerns and have spurned a recent modification in the procedures of ACL reconstruction surgery.[2-9] More accurate anatomical reconstructions of this ligament may restore a knee to its normal kinematics, decrease the possible risk for osteoarthritis, and improve patient outcomes; however, these have not been conclusively proven in the literature.

Although most sports medicine surgeons would agree that an anatomic ACL reconstruction is required for elimination of abnormal knee biomechanics, controversy continues as to where exactly the normal ACL anatomy lies, how many bundles make up the ACL, how many bundles of the torn ACL need to be reconstructed, and which techniques best reconstruct the ligament in an anatomical location. Regardless of the number of bundles or the technique used when reconstructing the ACL, anatomic reconstruction is dependent on surgeon understanding the ACL anatomy, osseous topography, and functional relationships. This review will explore the functional anatomy of the ACL and provide surgeons an anatomical basis for determining the most efficient method to recreate the anatomy using intraoperative landmarks during ACL reconstruction.

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Vascular Anatomy

The main vascular supply to the ligament is from the middle geniculate artery, with contributions from the inferior medial and lateral geniculate artery through the anterior fat pad. On physical exam, many ACL ruptures will present with a large hemarthrosis, which may be attributed to its extrasynovial location as well as the blood supply of the ACL. Furthermore, two layers of synovium that originate from the posterior intercondylar area of the knee envelop both ligaments.

Neural Anatomy

The ACL is thought to provide some proprioceptive feedback to the brain, which may aid in injury prevention. Afferent proprioceptive fibers arise from the posterior branch of the posterior tibial nerve that provides the afferent arc for postural changes during motion and ligament deformation. Studies have shown that Golgi tendon organs and Golgi-like tendon receptors near the ligaments insertions account for majority of the small number of mechanoreceptors playing a role in knee restraint and proprioception.[10,11]

Gross Structure

The ACL is composed of multiple collagen fascicles wrapped in a sheath that connects the femur and tibia through a fibrocartilaginous bone–tendon interface. The ACL is an intracapsular yet extrasynovial ligament whose origin begins at the fossa of the medial surface of intercondylar notch of the lateral femoral condyle (LFC) and inserts medial to the intertubercular ridge between the medial and lateral tibial spines[12-14] (Fig. 1). The ACL attaches through incorporation of collagen fibers of the ligament within the mineralized bone, a series of regions that are seen as a flexible ligamentous tissue transitions to bone through a fibrocartilaginous zone.[13,15] This method of tendon insertion has been termed direct insertion.

The size, shape, and strength of the ACL are important when determining optimal grafts used for reconstruction of the ligament. The average length has been measured at 38 mm and width to be 11 mm. The width is not uniform as the midsubstance of the ACL is a smaller diameter than its femoral and tibial endpoints. The intact ACL has an ultimate tensile load of 2160 N with a stiffness of 242 N/mm over a cross sectional area of 44 mm.[12] Common grafts used for ACL reconstruction include patellar/hamstring autograft and increasingly used allograft tissue.[3] Surgical planning and decision-making for tunnel placement may need to be adjusted depending on graft selected (Table 1).[16,17] The goal of graft selection is to select a graft that will provide sufficient strength and biomechanical properties to fill the majority of the ACL footprint, to allow early rehabilitation, and to achieve secure fixation to the femur and tibia. Beyond the type of reconstruction, graft selection must also consider patient activity level, age, comorbidities, and personal expectations of both patient and clinician.

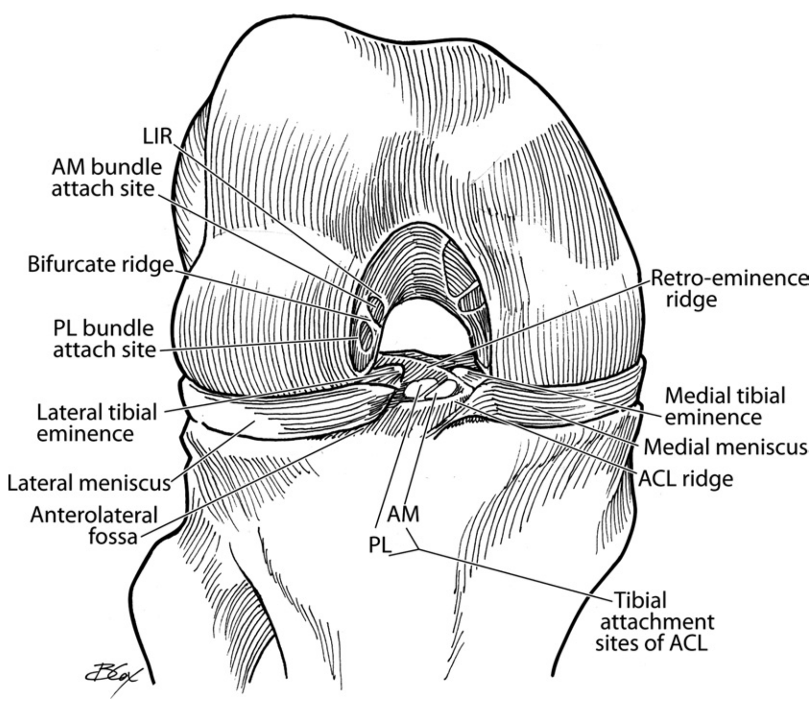

Figure 1 Notch view of a right knee. Here, the ACL femoral and tibial insertions are shown as they relate to various bony and soft tissue landmarks. The bundles of the ACL are named based on their tibial attachment relationship. With the knee in flexion as depicted, the bundles actually cross with the posterolateral bundle (PL) crossing behind the anteromedial bundle (AM). The landmarks shown in this diagram can aid the surgeon in identifying the correct location of the anatomic insertions.

Table 1 Size and Strength of Common ACL Grafts

Tissue	Ultimate Tensile Load (N)	Stiffness (N/mm)	Cross-Sectional Area (mm²)
Intact ACL[18]	2160	242	44
Bone–patellar tendon–bone (10 mm)[19]	2977	620	35
Quadrupled hamstring[20]	4090	776	53
Quadriceps tendon (10 mm)[21,22]	2352	463	62
Patellar tendon allograft[23]	1403	224	
Achilles allograft[24,25]	1189	741[3]	105
1 Tibialis anterior allograft[23]	3012	343	

Functional Anatomy

The ACL is vital to the kinematics and biomechanics of the knee joint, serving as the primary restraint to anterior tibial translation and a secondary stabilizer to valgus and varus stress in full extension. Beyond translation, it limits coupled internal rotation that may be evaluated through commonly applied physical examination testing, such as the pivot shift and the flexion–rotation drawer tests. The tensile properties and viscoelastic nature of the ACL affects its spatial orientation, as flexion and extension may change the relative position of the cruciate ligaments. The elastic nature and stiffness of the ligament controls the ability to limit tibiofemoral motion, and ligament stiffness dictates the necessary force to resist an applied load.

Two functional bundles have been dissected using cadaveric studies and corroborated with radiographic studies and intraoperative findings. The anteromedial (AM) and posterolateral (PL) bundles are referenced according to their relative attachment positions on the tibial surface. The PL bundle fibers originate distal to the femoral origin of the AM bundle and insert on the PL aspect of the ACL tibial insertion (Fig. 2).

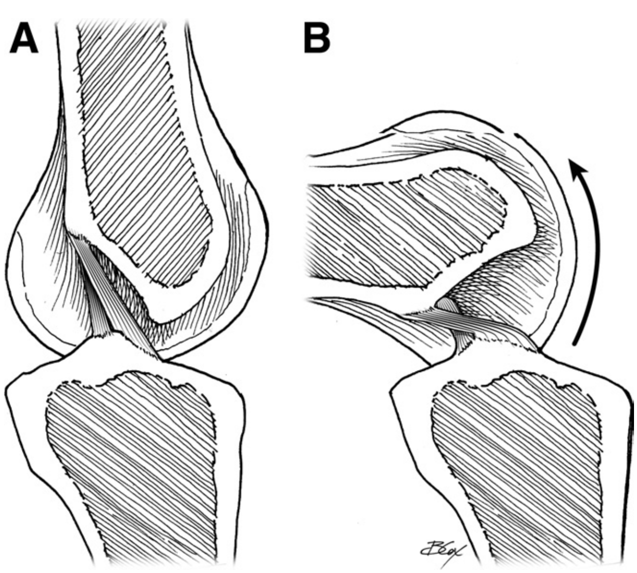

Figure 2 Figure 2 is a sagittal image of the ACL bundles demonstrating the crossing of the bundles as the knee is brought from extension to flexion. (A) Demonstrates the parallel relationship of the two bundles in extension. (B) Demonstrates the bundles crossing as the knee is flexed.

Kinematics and motion of the knee are affected by the bundle insertional anatomy.[3,9] The AM bundle tightens at ≥60 degrees of flexion, whereas the PL bundle is lax in flexion and tight in extension and with both in internal and external rotation. The bundles are parallel in the sagittal plane with full extension; however, with knee flexion, the PL bundle femoral insertion moves anterior, and the bundles cross.

The PL bundle has been shown to have a critical role in providing both translational and rotational stability to the knee. Biomechanical evidence has supported a lateralized single bundle tunnel to establish rotational stability by incorporating more of the anatomic PL femoral footprint.[3,9,26] Double bundle reconstruction of the ACL focuses on recreating the entire footprint of the AM and PL bundles with 2 grafts placed anatomically to reduce the occurrence of persistent positive pivot shift tests and to improve the results of the Lachman test.[3]

Although there is little controversy that 2 functional bundles exist, debate continues on the necessity of both bundles being reconstructed and if differential tensioning is needed when securing the grafts. Traditional reconstruction techniques that solely reconstructed the AM bundle have produced well over 90% good to excellent results.[27] Proponents for the double bundle reconstruction report instability and a marked failure to correct rotational deficiencies after single bundle ACL reconstruction.[28,29] However, many of these studies have been performed comparing the double bundle technique to a nonanatomic ACL reconstruction using traditional methods. Anatomic ACL reconstruction using a single bundle has also been shown to improve rotational restraint compared with nonanatomic reconstruction[30,31]; however, some recent studies are reporting the double bundle technique has statistically significantly improved biomechanics when compared even with anatomic single bundle reconstructions.[8,9] Furthermore, with the length of the femoral attachment site noted to be between 14 and 23 mm, single bundle ACL reconstruction may not be able to reconstitute native anatomy proportions.[4] Although cited cadaveric biomechanical studies quantitatively show that double bundle reconstruction may restore rotational instability greater than single bundle,[32,33] there is a lack of definitive consensus whether either method has an advantage over the other in the clinical setting. It is noteworthy that in physically larger patients, double bundle reconstruction may be advantageous by simply providing additional collagen over a larger footprint vs one that can be reconstructed using a single tunnel.

Surgical Landmarks and Footprint Anatomy

The femoral attachment has been characterized with varying morphologies ranging from circular,[34] semicircular,[35] or oval.[36,37] Distally, the ACL inserts onto the tibia in the anterior intercondylar area in an oval to triangular pattern. This intercondylar area covers a mean area of 136-150 mm,[13,34] and is defined by the fossa in front of and lateral to the anterior tibial spine. Anteriorly, the insertion fans out to become twice the bulk width of the ACL. The tibial attachment is also highly variable, as the ACL may pass beneath the transverse meniscal ligament and few fascicles may blend with the anterior lateral meniscus attachment. The medial tibial eminence and intermeniscal ligament are fixed points that may help guide correct tunnel placement, whereas the anterior root of the lateral meniscus may vary in its relationship with the ACL tibial insertion.[38] The femoral intercondylar notch has much less variation, with the lateral intercondylar ridge present in over 90% of specimens.[39]

Poorly positioned, often vertically oriented, tunnels are a common reason for failure of an ACL reconstruction. A primary cause of graft failure may be attributed to technical error, as graft impingement from inadequate notchplasty and improper tunnel placement may lead to overtensioning of the graft.[1,2,17,40] A vertical orientation may lead to persistent instability and patient discomfort from even minor loss of rotational stability. Knee flexion angle should be considered during femoral tunnel placement, as it will alter the arthroscopic landscape with excessive flexion leading to erroneous anterior tunnel placement and hyperextension causing posterior cortex violation. Regions of attachment vary by patient but basic locations should be referenced with common soft tissue and osseous landmarks for reproducible and consistent reconstruction.

The femoral attachment has been characterized with various classification systems, such as the clock face,[41] quadrant or grids,[42] and measurements referencing the posterior articular cartilage. The intercondylar fossa is one boundary that helps evaluate the native ACL and to guide placement of drill tunnels.[40,43] The intercondylar notch is wider posteriorly and converges as one moves anteriorly. This morphology has been described as the shape of a "Gothic arch," and the roof of the fossa is commonly referred to as "Blumensaat's line" when seen on conventional lateral knee radiographs. Abnormal notch morphology (notch width and roof angle) may play a role in graft impingement, leading to abnormal motion or graft failure.[44] This may negatively affect nonanatomic ACL reconstructions, as placing the graft low along the wall of the lateral femoral notch is unlikely to result in notch impingement. However, anatomic reconstructions typically will not need a notchplasty as the ACL footprint lies entirely on the wall of the LFC and remains clear of the roof of the intercondylar notch. The ACL femoral attachments can be more readily delineated with the lateral intercondylar ridge, and roughly perpendicular to this, the lateral bifurcate ridge of the femur.[37] The lateral intercondylar ridge, commonly referred to as the "resident's ridge,"[45] marks the femoral ACL origin anteriorly with few, if any, ACL fibers anterior to this ridge (Fig. 3). The lateral bifurcate ridge serves as a divider distinguishing the femoral footprints of the AM and PL bundles.[2,45] An additional reference position is the tibial retroeminence ridge (RER), which represents the posterior interspinous ridge anterior to the PCL.

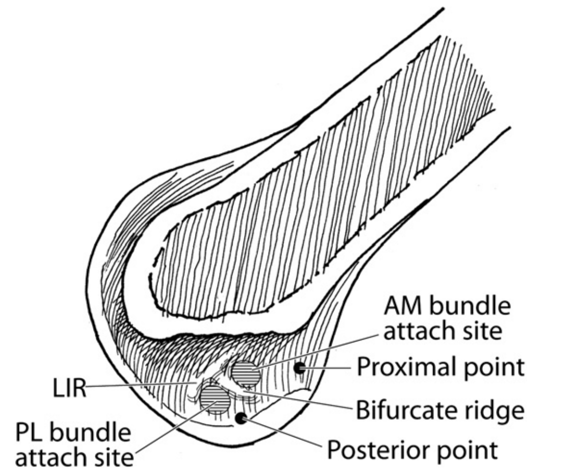

Figure 3 Figure 3 are 2 more detailed anatomical images outlining the bony landmarks and their association with the femoral insertions of the AM and PL bundles of the ACL.

The diameter of the femoral insertion varies between 13 and 18.4 mm in the proximal–distal direction and 6.8-9.5 mm anterior–posterior, making it vital for proper reference points to be established.[40] Reliable landmarks on the femoral attachment sites include the remnant tissue from the torn ACL and anatomical landmarks, including the lateral intercondylar ridge and lateral bifurcate ridge.[2,6,40,46] Arthroscopically, the lateral bifurcate ridge may be difficult to identify; however, the lateral intercondylar ridge is easily identified with clearance of soft tissue attachments.[6] Edwards et al[47] determined that the AM tunnel at 11 o'clock consistently was close to the posterior edge of the notch with the AM center 5 mm shallow from the posterior edge of notch parallel to the axis of the femur, whereas the PL tunnel was at the 10 o'clock position 9 ± 2 mm from posterior outlet. Arthroscopic landmarks as the lateral intercondylar ridge has been noted to be 18.0 mm long, whereas the bifurcate ridge length is estimated to be 11.6 mm with the PL bundle attached distal and posterior to the AM bundle.[6] Ziegler et al,[6] on cadaveric specimens, determined the ACL attachment center to be 6.1 posterior to the lateral intercondylar ridge and 1.7 mm proximal to the bifurcate ridge, with the distance from the distal cartilage margin to be proximally 14.7 and 8.5 mm anterior. The AM and PL bundle attachments were also examined as they were, respectively, 7.1 and 3.6 mm posterior to the lateral intercondylar ridge, 4.8 mm and 5.2 proximal to the bifurcate ridge, 18.6 and 10.7 proximal to the distal cartilage margin, and 11.7 and 5.7 mm anterodistal to the proximal point. Takahashi et al[48] confirmed the distance between femoral insertions of the centers of the AM and PL bundles and the posterior margin of the LFC to average 7.6 and 7.0 mm,

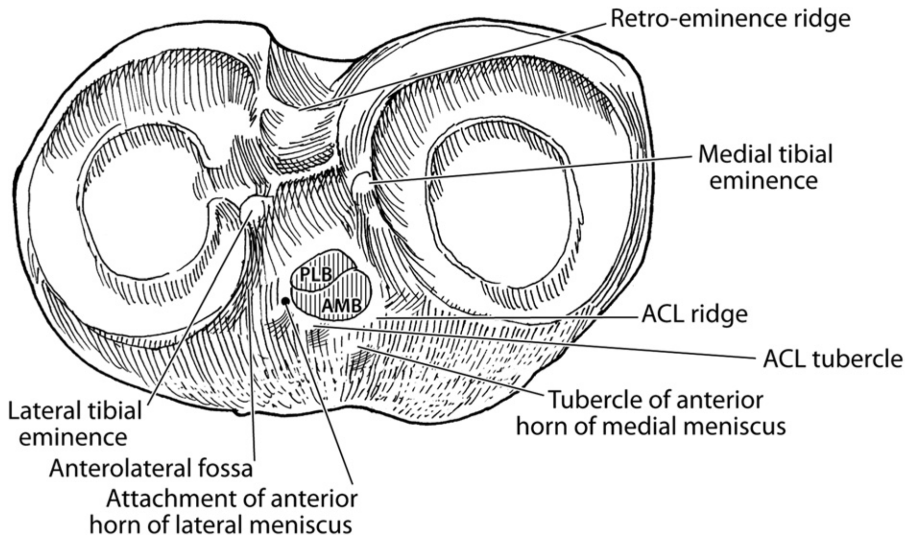

Figure 4 Figure 4 is an axial drawing of the tibia outlining the tibial insertions of the AM and PL bundles in relation to the bony anatomy of the tibial plateau.

respectively. Siebold et al[37] emphasized the difficulty in separating the bundles and regarded the natural ACL stump as possibly the most accurate anatomic landmark. A larger footprint may aid in AM/PL tunnel placement, as the femoral center angles of the AM and PL bundles were heavily affected by femoral shaft axis, as the footprint of the AM and PL bundle made up 52% and 48% of the ACL insertion area, respectively. Colombet[46] measured ACL femoral and tibial attachment of AM and PL bundle in 7 cadaveric knees and determined the reference position as the RER as an important landmark to measure to posterior ACL attachment. This group found a distance between the AM and PL centers of 8.4 ± 0.6 mm, with the AM bundle an average of 17.8 ± 1.7 mm anterior to the RER.

Tibial insertional anatomy is commonly referenced from the anterior portion of the PCL, with standardized aiming guides designed to reference roughly 7 mm anterior to the PCL. Recent anatomical studies have found the tibial insertion to be located much more anterior than this and in a similar fashion uses additional soft tissue and bony landmarks. The tibial insertion fans out to become twice the bulk width of the ACL, and its anterior border has been defined at approximately 22 mm from the anterior cortex of the tibia and 15 mm from the anterior edge of the articular surface. The broad insertions of the 2 bundles of the ACL are anterior to and between the medial and lateral tibial spines. Proper recognition and ability to define the boundaries of the tibial footprints of the AM and PL bundles are a key step in creating a proper tibial tunnel, as graft diameters may be smaller than overall insertion site.[12]

Although the anterior root of the lateral meniscus may vary in its relationship with the ACL tibial insertion, the medial tibial eminence and intermeniscal ligament are points that may help guide correct tunnel placement.[38] Other tibial landmarks include the RER ridge, the lateral tibial eminence, the medial and lateral tibial plateau articular cartilage borders, the ACL ridge, the ACL tubercle, and the anterolateral fossa. Soft tissue landmarks include the AM and posteromedial attachments of the anterior horn of the lateral meniscus and the posterior horn of the lateral meniscus.

The AP diameter of ACL tibial insertion was measured 17.6 ± 2.1 mm similar to historical measurements,[13] whereas the medial to lateral diameter was 12.7 ± 2.8 mm.[46] Tibial insertion area has been averaged to 114 mm^2 and varies in size from 67 to 259 mm^2 and also affected by gender of patient.[49] AM and PL bundle area also differed with the area being 67 and 52 mm^2, respectively, with the centers separated by an average of 5 mm. Siebold[49] clarified anatomic variability in establishing tibial tunnels, and recommended arthroscopic landmarks, such as the ACL stump, rim of the medial and lateral tibial condyles, and the posterior horn of the lateral meniscus (Fig. 4). A "tibial square model" was suggested to provide a relative boundary for the prospective area of the tibial bone tunnels.[49] Studies have shown the center of the ACL attachment to be 19 mm anterior to the RER ridge. Others have measured the center of the ACL attachment at 15 ± 2 mm (11-18 mm) from the RER at 36% of the depth of the tibia while each bundle anterior to the RER was 10 ± 1 mm for the PL/17 ± 2 mm AM bundle. The PL bundle was 4 ± 1 mm lateral to the medial tibial spine and the AM bundle was 5 ± 1 mm lateral.[50] Zantop[12] quantified the centers of the AM bundle to be 2.8 mm posterior and 5.2 mm medial to the anterior insertion of the lateral meniscus with the center of the PL bundle being 11.2 and 4.1 mm to the respective landmarks. With regard to the posterior footprint, the PCL notch provides additional perspective, as its anterior extent defines the posterior boundaries of the tibial ACL insertion.

In the cases of acute ACL tears, the ACL anatomy will be preserved and can be used to help guide anatomic placement of the bone tunnels. However, chronic disruptions or revision cases force the surgeon to rely on anatomic relationships of other bony and soft tissue structures to identify the correct locations to perform an anatomic ACL reconstruction. As stated, osseous landmarks are critical for the surgeon, as they provide intraoperative orientation and guides for tunnel placement.

Special considerations must be discussed as they relate to the transtibial approach of anatomic ACL reconstruction. Although some authors would argue that anatomic ACL reconstruction is not possible using the transtibial method, there is good evidence that this can be achieved when a bone–patellar tendon–bone graft is used, owing to the relatively larger bone tunnels and the maneuverability this affords. To create footprint with lateralized transtibial drilled single femoral tunnel, the TT must be oriented 60 degrees from the proximal tibia joint surface in the coronal plane. This orientation has been demonstrated to reproducibly allow for placement of a lateralized femoral tunnel placement between the 10 and 11 o'clock position using a transtibial drilled technique.[17]

Radiographic Anatomy

Radiographic landmarks have been defined so that intraoperative radiographs can be used to verify correct location of bone tunnels. Postoperative radiographs or magnetic resonance imagings) MRIs can be used to evaluate tunnel location and attempt to improve tunnel locations in subsequent reconstructions. Understanding these locations can also be used when attempting to understand why a graft failed during preoperative assessment before ACL revisions. The use of intact ACL location and angles on radiographs and MRIs can be used in the research setting as well.

There currently are several methods used in the literature for identification of the native ACL and bone tunnels on the femur. Bernard and Hertel[42] described a quadrant method (Fig. 5) with the anterior to posterior coordinate measured along Blumensaat's line and the intercondylar height measured from a line tangential to the most inferior articular cartilage if looking at the knee flexed 90 degrees on a lateral radiograph. Using this method on cadaveric specimens, Zantop et al[12] determined the PL bundle was located an average of 29.3% anterior to the posterior-most aspect of Blumensaat's line and 53.6% of the intercondylar height measured superior to inferior with the knee in 90 degrees of flexion. The AM bundle was located 18.5% anterior to the posterior aspect of Blumensaat's line and at 22.3% of the intercondylar height measured from Blumensaat's line. Lorenz et al, using the same coordinate system, found the native ACL footprint on cadaveric specimens at 21% on the A to P axis and 22% along the superior/inferior axis for the AM bundle and 27% and 45% for the respective coordinates of the PL bundle with the knee at 90 degrees of flexion. Using a method in which the distance along Blumensaat's line was used, Bernard and colleagues[42] found that the center was 26.4% ± 2.6% and the center of the PL bundle was 32.3% ± 3.9% the length of Blumensaat's line. A recent systematic review of femoral insertional anatomy located the center of the AM bundle at 29.5% of the total distance from the posterior edge of a line drawn parallel to the femoral anatomic axis from the proximal articular cartilage margin to the distal articular margin. The PL bundle was located at 50% along this same line. Both bundles averaged 2.5 mm anterior to the posterior border of the articular cartilage; however, because of the curvature of the femoral condyle, the AM bundle sits slightly more proximal along the wall with the knee bent at 90 degrees of flexion.

Zantop et al[4] measured the tibial insertions of the PL and AM bundle using the method described by Staubli and Rauschning. Zantop et al found the center of the PL and AM bundles at 44% and 30% from the anterior aspect of the tibial plateau, respectively. Using computed tomography scans of cadaveric specimens, Lorenz et al[51] measured the center of the AM and PL bundles at 41% and 52% from the anterior aspect of the tibial plateau. Using MRI to evaluate the native ACL, Ahn et al[52] found the center of the tibial insertion to be located at 37% from the anterior aspect of the tibial plateau. Another study by Frank et al demonstrated native tibial insertion of the ACL stretched from 28% to 63% along an anterior to posterior line as measured from the anterior aspect of the tibial plateau. The average center of the insertion was 46%, but interestingly, the insertion encompassed an average of 36% of the total anterior to posterior depth of the tibial plateau. In the coronal plane, Ahn et al[52] located the tibial insertion at 46% from the medial articular margin. Lorenz et al,[53] using computed tomography scans in cadaveric specimens demonstrated a coronal plane location of the AM and PL bundles at 48% and 50% from the medial tibial plateau.

Several authors have used a "sum score" to report radiographic obliquity.[53,54] This score adds the location of the femoral tunnel as measured from the posterior cortex along Blumensaat's line as a percentage of the entire length of this line and the location of the tibial location as measured from the anterior cortex along a line from anterior to posterior along the tibial plateau on the lateral radiograph. The authors found that a more stable graft was seen when this value was between 61 and 66 and that grafts with a sum score >66 were less stable and more vertical.

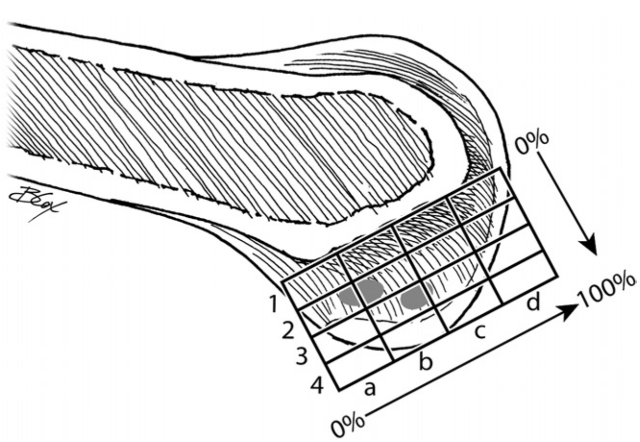

Figure 5 Figure 5 demonstrates the quadrant method of evaluating tunnel location. The location of the AM and PL bundles are marked. This location should be recreated with the ACL graft tunnels either using a double bundle technique or using the central point between these marks for an anatomic single bundle reconstruction.

Several studies have measured intact ACLs on MRI and have reported intact sagittal ACL angles, defined as the angle between the ACL fibers and a line perpendicular to the long axis of the tibia, of 50 and 60 degrees.[52,55] Bowers et al also measured native ACL obliquity, finding an average sagittal angle of 53.5 degrees with reproduction of this value using the AM femoral drilling technique (sagittal angle = 52.2 degrees). The native ACL in the coronal plane is much more vertical, which is consistent with the fact that the intercondylar notch is narrow and does not allow for significant amount of obliquity in this plane. Bowers et al found the average native coronal plane obliquity to be 76.1 degrees, whereas Ahn et al[52] demonstrated a more oblique native ACL with a coronal angle of 66 degrees.

There is enough anatomic variability that it is difficult to assign a normal value to these measurements. However, it appears that the native ACL typically has a sagittal angle of 50-60 degrees, and a coronal obliquity between 66 and 76 degrees. As in several other aspects of orthopedics, there is enough anatomic variability that a "safe zone" of 10 degrees off these averages is likely to produce excellent results; however, in general, the surgeon should aim to reconstruct the anatomy of the individual patient and not conform to the average location of the tunnels. Therefore, using the native footprints is ideal when available.

Conclusions

Although there are still many controversies surrounding ACL reconstruction, anatomical and biomechanical studies have clearly demonstrated the superiority of an anatomic ACL reconstruction. Regardless of the methods used to achieve this, the studies have clearly demonstrated the importance of placing the aperture of the bone tunnels at the anatomic insertions of the intact ACL. Arthroscopic landmarks should be used to define these locations, and intraoperative radiographs can be obtained if the surgeon is unsure of proper location or if the anatomy is distorted. Anatomic reconstructions conceptually should allow for better restoration of the normal function of the ACL, and this has been shown in biomechanical studies. Despite controversies surrounding surgical indications, graft type and fixation methods, femoral tunnel drilling technique, and number of bundles, there is little controversy that anatomic ACL reconstruction should be the goal of any contemporary ACL reconstruction.

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