Radiographic Landmarks for Identifying the Anterolateral Ligament of the Knee

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Purpose: To identify the radiographic position of the origin and insertion of the anterolateral ligament (ALL) of the knee on a lateral radiograph. **Methods:** Twelve unpaired, fresh-frozen cadaveric knees were dissected to expose the ALL. The origin and insertion of the ALL on each cadaver were then tagged using 2-mm radiopaque beads. True lateral fluoroscopic views of the knee were then obtained, and the distance from known radiographic landmarks was recorded by 2 reviewers. **Results:** The origin of the ALL was found at a distance that is 37.0 ± 9.2% of the total anterior-posterior length of the femoral condyle from the posterior edge as measured along Blumensaat's line. The insertion was located at a distance that is 56.1 ± 6.9% of the total length of the tibial plateau from the posterior edge. The origin of the ALL is 5 mm posterior to a line from the posterior femoral cortex and 9 mm distal to a line along Blumensaat's line. The insertion is 4 mm anterior to the 50% mark of the anterior-posterior width of the tibia, 14 mm distal to the articular surface. **Conclusions:** The origin and insertion of the ALL can be accurately identified using intraoperative fluoroscopy. **Clinical Relevance:** Determining radiographic parameters for the ALL will assist in developing accurate surgical techniques for ALL reconstruction.

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Although the anterolateral ligament (ALL) of the knee was initially discovered in 1879, it was dismissed as being a variant of the lateral collateral ligament (LCL).[1] However, it has recently been shown to be a definitive ligament in multiple cadaveric, radiographic, and biomechanical studies.[2-11] Claes et al.[4] described the origin of the ALL at the prominence of the lateral femoral epicondyle, with the insertion at the anterolateral tibia halfway between Gerdy's tubercle and the tip of the fibular head.

The discovery of the ALL explains the cause of the Segond fracture, as these avulsion fractures occur at the insertion of the ALL on the tibia.[5,9,11,12] A Segond fracture occurs as a concomitant injury in approximately 75% to 100% of anterior cruciate ligament (ACL) injuries; however, the exact pathomechanical contribution of this injury has not been fully elucidated. A recent biomechanical study found that the ALL is a stronger restraint to internal rotation of the knee than the ACL at knee flexion angles greater than 35°.[8] Furthermore, cadaveric studies suggest the ALL may play a role in the rotational stability of the knee because the ligament becomes taut with knee flexion and internal rotation of the tibia.[4,13,14] The rotational stabilizing role of the ALL may explain why some patients continue to have residual pivot shift instability after ACL reconstruction, possibly due to an occult ALL injury. The double-bundle ACL reconstruction was initially developed to address this rotational laxity; however, recent studies have shown that the double-bundle technique may not improve rotational stability in all patients.[15,16] This residual laxity is problematic as it may result in an increased incidence of osteoarthritic changes[17] and is a known predictor of long-term poor functional outcomes after ACL reconstruction.[18] In a recent study of patients who underwent a combined ACL and ALL reconstruction, 92% of the patients had a negative pivot shift and the remaining 8% had a grade I pivot shift at an average follow-up of

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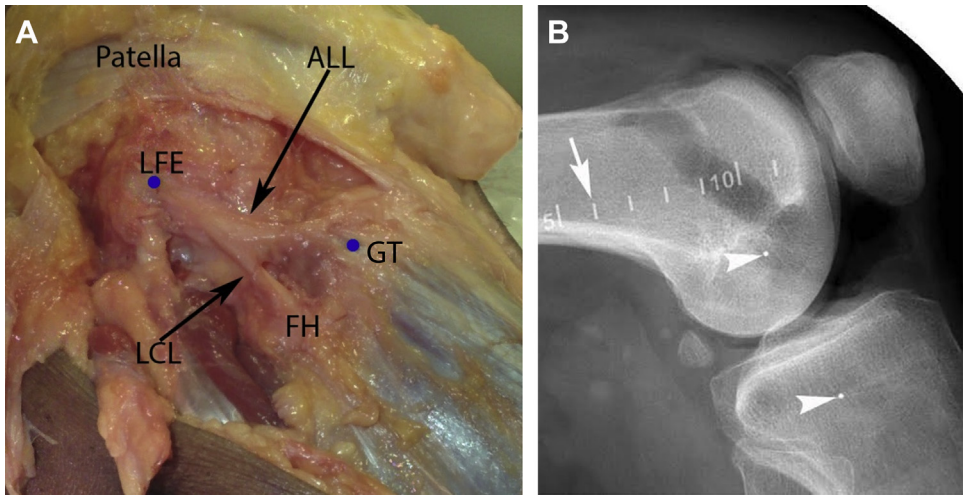

Fig 1. (A) Lateral view of the knee. The origin and insertion of the anterolateral ligament (ALL) are marked by the blue circles. Other structures identified include the lateral femoral epicondyle (LFE), lateral collateral ligament (LCL), Gerdy's tubercle (GT), fibular head (FH), and patella. Note: The iliotibial band has been resected. (B) An anterolateral view of an anatomic specimen used in our study. Arrow: radiopaque ruler. Arrowheads: radiopaque markers indicating center of the origin and insertion of the ALL. Note: An anterolateral view was chosen to better illustrate the appearance of the ligament; thus, the origin and insertion points marked in this image may not directly correlate to a true lateral radiograph.

32 months.[19] Thus, an ACL reconstruction technique that addresses the ALL may yield promising mid-term and long-term functional results.

Recent radiographic studies have been published to help identify the origin and insertion of the ALL to aid in anatomic ALL reconstruction.[7,13] Rezansoff et al.[13] and Helito et al.[7] propose using radiographic landmarks to identify the origin and insertion of the ALL for tunnel placement during ALL reconstruction; however, their descriptions of the origin and insertion of the ALL differ significantly. Currently there is no consensus about the radiographic location of the ALL as these prior studies use different landmarks to measure the ALL and give different descriptions of the ligament's origin, insertion, and orientation.

The purpose of this study was to clarify the radiographic position of the origin and insertion of the ALL of the knee on a lateral radiograph. Our study sought to provide clarity to previously published data by offering new data and comparing them with the existing findings. We hypothesized that the ALL could be consistently identified using radiographic parameters on a lateral radiograph.

Methods

Twelve unpaired, fresh-frozen cadaveric knees were used for this study (mean age: 68.3 ± 8.2). A dissection of the anterolateral aspect of each knee was performed with a minimum of 2 dissectors by reflecting the epidermis and subcutaneous tissues proximally from the fibular head and Gerdy's tubercle. Care was taken during the deep dissection to preserve the fibular collateral ligament, popliteus tendon, and anterolateral joint capsule.

After exposure of the anterolateral knee, the origin of the ALL was identified by isolating the femoral origin of the LCL and visualizing the oblique fibers of the ALL as they course anteriorly and distally from the LCL origin. The width of the origin was measured using calipers and then marked with a small nail at the bisected, proximal-most aspect of the origin (Fig 1A). With the knee internally rotated and flexed at approximately 70° to 110°, the oblique fibers of the ALL became taut in all specimens, making identification of the ligament easier.

The ALL was then followed distally to its insertion on the anterolateral tibia where the band fanned out as it was inserted into the proximal tibia. The width of the ALL insertion was measured with calipers, and the midpoint was marked at the distal-most aspect of the insertion with a small nail. Once this point was marked, the location was assessed by internally rotating the knee to ensure that the nail was placed at the midpoint of the taut fibers.

The origin and insertion of the ALL on each cadaver were then tagged using 2-mm radiopaque beads, and correct positioning of the origin and insertion were confirmed by a minimum of 4 authors. Each specimen was subsequently placed on a radiographic table, held in a lateral position with a vise clamp, and placed in full extension until the tibia was in line with the femur. A fellowship-trained, board-certified musculoskeletal radiologist used a fixed fluoroscopic system to confirm the position of the specimen and subsequently obtained a true lateral radiograph of the distal femur in the same manner as in previous studies[20,21] with overlap of the posterior aspect of the medial and