Technical Note

How to Test the Anterolateral Ligament With Ultrasound

Etienne Cavaignac, M.D., Gregoire Laumond, M.D., Nicolas Reina, M.D., Karine Wytrykowski, M.D., Jérôme Murgier, M.D., Marie Faruch, M.D., Ph.D., and Philippe Chiron, M.D., Ph.D.

Abstract: Ultrasonography (US) is a nonirradiating, low-cost, real-time imaging modality that has very good spatial resolution. US can be used to view the anterolateral ligament (ALL) and injuries to the ALL. Several authors have sought to analyze the anterolateral aspect of the knee using US with varying luck. All of them analyzed the ALL statically only. The goal of this Technical Note is to describe in detail the technique that we use to analyze the anterolateral aspect of the knee in patients with an anterior cruciate ligament tear. We use a simple technique that starts by locating the tibial end of the ALL. The lateral inferior genicular artery is a reliable landmark in this context. The analysis is dynamic in addition to being static. To determine if the ALL is injured, we look for a lack of tension on the ALL when the knee is internally rotated and for a Segond fracture. We believe that it is essential to start evaluating the ALL by its tibial end. US analysis of the ALL forms the basis for developing an appropriate "à la carte" treatment for the patient's injury.

Anterolateral structures and particularly the anterolateral ligament (ALL) help control the knee's rotational stability.[1] This ligament structure originates at a point posterior to the lateral epicondyle and attaches distally at a point mid-way between Gerdy's tubercle and the fibular head. It is a restraint to internal rotation of the knee; thus damage to this structure compromises the knee's rotational stability.[1] We need to provide an "à la carte" treatment of the knee's injuries for optimal patient care. This optimal care requires an accurate diagnosis.

Ultrasonography (US) is a nonirradiating, low-cost, real-time imaging modality that has very good spatial resolution. The ALL can be identified using US. ALL injuries can also be identified with US.[2] However, the protocol we used to identify the ALL differs from the others reported.[2-4] The various articles describing the US analysis of the anterolateral portion of the knee use a static analysis method.[3,5] However, one of the advantages of US over other imaging modalities is that a dynamic analysis is also possible.

In our practice, US supplements magnetic resonance imaging (MRI), it does not replace it. We use MRI to diagnose anterior cruciate ligament injuries. US allows us to specifically assess the ALL and test it dynamically. A US is performed in every patient with an anterior cruciate ligament tear.

The goal of this Technical Note is to describe in detail the protocol that we use to identify the ALL and to determine whether this structure is injured using a static and dynamic analysis.

Ultrasound Technique

Our US protocol was the following[6]: exploration of the ALL was performed with a high-frequency probe (Aplio 500 Toshiba, 14 MHz probe; Toshiba, Tokyo, Japan), with the patient supine, the knee flexed (90°), and the foot internally rotated, a position that places tension on the ALL (Video 1). We perform US in the operating suite, once the patient has been anesthetized and set up for surgery (Fig 1). The ALL was analyzed on a coronal slice in its major axis. This ligament's small cross-section makes it difficult to analyze it in the axial plane. The US technique consists of locating the iliotibial band (ITB) at its insertion on Gerdy's tubercle, and then translating the probe posteriorly to locate the tibial

From the Department of Orthopedic Surgery and Trauma, Hôpital Pierre Paul Riquet (E.C., G.L., N.R., K.W., J.M., P.C.); and Department of Radiology, CHU Toulouse (M.F.), Toulouse, France.

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Address correspondence to Etienne Cavaignac, M.D., Department of Orthopedic Surgery, Hôpital Pierre Paul Riquet, CHU Toulouse, Rue Jean Dausset, 3105 Toulouse, France. E-mail: cavaignac.etienne@gmail.com

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Fig 1. Ultrasound is performed in the operating theatre. The patient is anesthetized and set up for surgery. The surgical assistant holds the foot to internally rotate the knee to test the anterolateral ligament.

insertion of the ALL. A 20° counter-clockwise rotation (for a right knee) of the probe brings the ALL's major axis into view (Table 1). This allows us to follow the ALL proximally to its insertion on the femur. The lateral inferior genicular artery (LIGA) serves as an important landmark because the ALL and LIGA are closely related.[7] Blood flow in the LIGA can be seen in Doppler mode (Fig 2).

Once the ALL has been identified, we carry out dynamic testing. The surgical assistant internally rotates the knee by holding the patient's foot. If the ALL is intact, increased tension on this structure will be clearly visible. This does not occur if the ALL is injured. We place particular attention on the real-time analysis of the LIGA. In a patient with an intact ALL, this rotation stops the blood flow to the LIGA, which is visible in B-mode and Doppler mode. Lastly, we have observed bone damage at the ALL's tibial insertion

Table 1. Tips and Tricks for Identifying the Anterolateral Ligament (ALL) With Ultrasound Imaging

(1) Begin on the tibial side
(2) Identify Gerdy's tubercle and the iliotibial band
(3) Posterior translation of the probe to the ALL's tibial insertion
(4) Rotation probe toward the long axis (clockwise for the right knee and counter-clockwise for the left knee)
(5) Locate the lateral inferior genicular artery under the ALL to confirm the level ± Doppler

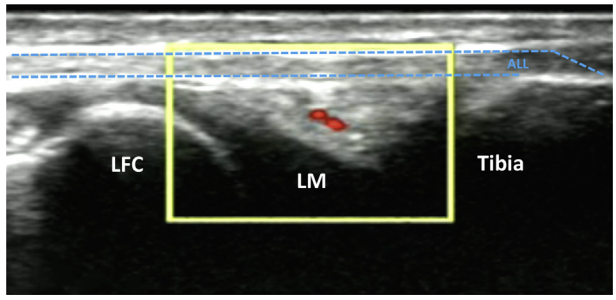

Fig 2. Doppler ultrasonography is used to view the blood flow in the lateral inferior genicular artery, which is in red here. This structure is located between the anterolateral ligament and the lateral meniscus (LM). For this right knee, distal is to the right and proximal is to the left. (LFC, lateral femoral condyle.)

(ultrasonographic Segond lesion) in approximately 50% of cases that, in most cases, is not visible on radiographs or MRI (Table 2).[1]

Discussion

We chose to locate the ALL's tibial insertion first and then to follow it to its femoral origin for several reasons. First, the position of the ALL's tibial insertion is universally accepted, but the position of the femoral origin is still debated. Second, the femoral origin is fan-shaped, making it difficult to define the insertion exactly, and it has common fibers with the lateral collateral ligament (LCL). Third, the subcutaneous tissues are thinner over Gerdy's tubercle than over the femoral condyle, making ultrasonographic visualization easier.

The US method used by Capo et al.[3] is based on locating the LCL and then its origin, before this structure is used to locate the ALL's femoral origin. These 2 ligaments are oriented differently: the LCL is angled downward and backward, whereas the ALL is angled downward and forward. Performing a clockwise rotation from the LCL to locate the ALL appears to be technically more difficult than performing a posterior translation from the ITB, as described by our team. These differences in the US protocols could explain the differences reported in the 2 studies.

Yoshida et al.[2] have described their US technique, which starts by identifying the mid-substance of the

Table 2. Findings Suggestive of an Anterolateral Ligament (ALL) Injury

Finding	Dynamic or Static Analysis
Ultrasonography (US) Segond lesion	Static
No tension on the ALL	Dynamic
No interruption of lateral inferior genicular artery blood flow	Dynamic

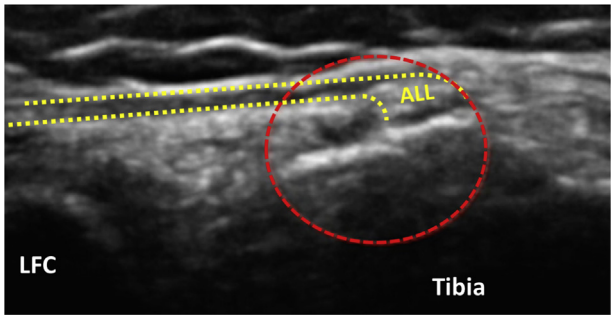

Fig 3. Ultrasound image of a right knee with an anterolateral ligament (ALL) injury at its tibial insertion. There is cortical damage (red circle), but the bone fragment is not detached. This appears to be bony avulsion. (LFC, lateral femoral condyle.)

ALL by locating the ITB and the short head of the biceps femoris. Their analysis is solely static and focused on the appearance of the anterolateral structures. They propose a 4-level classification. They do not specify the number of Segond lesions found. Their analysis uses 2 planes in space with axial and longitudinal views. In our experience, the axial view is not useful. We prefer to use the longitudinal view and a dynamic analysis.

By starting the analysis at the ALL's tibial insertion, we find an ultrasonographic Segond lesion in 50% of cases, which most of the time was not visible on plain radiographs or MRI.[1] The spatial resolution of US is better than that of other imaging modalities, which makes it possible to diagnose bone damage, even if the avulsion is small.[8] However, this is not a true Segond fracture in all cases, that is, avulsion of a complete piece of bone; instead we often see cortical damage over the ALL's distal insertion (Fig 3). In our previous publication, we grouped these 2 types of injuries under the term "ultrasonographic Segond fractures," which does not always correspond to a true fracture.[1]

The dynamic US analysis provides a functional analysis of the ALL. When the knee is internally rotated, an intact ALL will be visibly placed under tension, whereas an injured ALL will not. On the other hand, when the ALL is intact, internally rotating the knee will compress the LIGA and interrupt its blood flow. This can be measured with Doppler US (Video 1). In our opinion, this interruption of the blood flow is a more objective criterion than solely the appearance of tension in the ALL.

Table 3. Advantages and Disadvantages of Ultrasonography (US) Relative to Magnetic Resonance Imaging (MRI) and Radiograph for Evaluating the Anterolateral Ligament (ALL)

	Radiograph	MRI	US
Dynamic testing	Impossible	Impossible	Possible
Cost	+	+++	++
Spatial resolution	+	++	+++

As proposed by Yoshida et al.,[2] we make an indication for anterolateral tenodesis based on the appearance of the anterolateral structures on US. For us, the dynamic appearance is crucial—if the ALL is not placed under tension when the knee is internally rotated, we perform anterolateral tenodesis.

US is a nonirradiating, low-cost, real-time imaging modality that has very good spatial resolution (Table 3). It can reliably identify the ALL[1,6,7] and identify ALL injuries through a static and dynamic analysis of this structure.

References

1. Cavaignac E, Faruch M, Wytrykowski K, et al. Ultrasonographic evaluation of anterolateral ligament injuries: Correlation with magnetic resonance imaging and pivot-shift testing. *Arthroscopy* 2017;33:1384-1390.
2. Yoshida M, Herbst E, Albers M, Musahl V, Fu FH, Onishi K. The anterolateral complex in anterior cruciate ligament deficient knees demonstrate sonographic abnormalities on high-resolution sonography. *Knee Surg Sports Traumatol Arthrosc* 2017;25:1024-1029.
3. Capo J, Kaplan DJ, Fralinger DJ, et al. Ultrasonographic visualization and assessment of the anterolateral ligament [published online June 25, 2016]. *Knee Surg Sports Traumatol Arthrosc*. doi:10.1007/s00167-016-4215-x.
4. Cianca J, John J, Pandit S, Chiou-Tan FY. Musculoskeletal ultrasound imaging of the recently described anterolateral ligament of the knee. *Am J Phys Med Rehabil* 2014;93:186.
5. Klos B, Scholtes M, Konijnenberg S. High prevalence of all complex Segond avulsion using ultrasound imaging. *Knee Surg Sports Traumatol Arthrosc* 2017;25:1331-1338.
6. Cavaignac E, Wytrykowski K, Reina N, et al. Ultrasonographic identification of the anterolateral ligament of the knee. *Arthroscopy* 2016;32:120-126.
7. Claes S, Vereecke E, Maes M, Victor J, Verdonk P, Bellemans J. Anatomy of the anterolateral ligament of the knee. *J Anat* 2013;223:321-328.
8. Nazarian LN. The top 10 reasons musculoskeletal sonography is an important complementary or alternative technique to MRI. *AJR Am J Roentgenol* 2008;190:1621-1626.