

Assessment of the Anterolateral Ligament of the Knee by Magnetic Resonance Imaging

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Abstract

Purpose The purpose of this study was to describe the anatomy of the anterolateral ligament (ALL) of the knee by the use of 1.5 Tesla (T) magnetic resonance imaging (MRI) in a series of young patients without knee injuries.

Methods Subjects aged 18 years or older without an anterior cruciate ligament injury, as confirmed on MRI, were included. MRI examinations were all performed on 1.5 T scans. The ALL was defined as the low signal band originating from the region of the lateral epicondyle of the femur, crossing the proximal surface of the lateral collateral ligament, deep to the iliotibial band, and inserting onto the tibia between the Gerdy’s tubercle and the fibular head.

Results Twenty-six patients met the eligibility criteria and were enrolled into the study. In one patient, it was not possible to visualize the ALL. In all the other subjects, the ligament originated anterior and distal to the lateral epicondyle and inserted on the proximal tibia approximately 5 mm below the joint line and just distal to the Gerdy’s tubercle. It had an average length of 33 ± 1.2 mm, an average width of 5.5 ± 0.3 mm, and an average thickness of 2 mm.

Conclusion The ALL is a distinct structure of the anterolateral capsule that can be easily identified using 1.5 T MRI scans.

Level of Evidence This is a level IV, observational study.

Keywords

- anterolateral ligament
- anatomy
- imaging
- magnetic resonance

Introduction

The anterolateral ligament (ALL) of the knee received increasing attention in recent years because of its possible role in the pathomechanics of anterolateral rotatory stability of the knee, especially in cases of anterior cruciate ligament (ACL) reconstruction that do not achieve satisfactory results.^{1,2}

The ALL has been described by many authors^{3–6} and its insertion sites on the femur and tibia have been accurately defined in cadaver studies.^{7–12} Moreover, biomechanical properties of the ALL have been investigated in depth, reporting an ultimate failure load and stiffness of this structure to be 175 N and 20 N/mm, respectively.¹³

The prevalence of injuries to the anterolateral compartment of the knee occurring alongside an ACL injury has been implicated since 1879, when Segond⁵ described a bony avulsion of the proximal lateral tibial plateau, which henceforth has been considered pathognomonic of an ACL tear.¹⁴ Furthermore, in the milestone classification of lateral knee instabilities proposed by Hughston et al,² anterolateral instabilities were presented as a result of damage to the “mid-third of the lateral capsule ligament” often associated with an ACL tear. In a recent paper, Ferretti et al¹⁵ pointed out that lesions to the anterolateral complex are associated with acute ACL tears in 90% of cases, with an isolated lesion of the ALL (type III) detected in 21% of patients.

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The purpose of this study was to describe the anatomy of the ALL of the knee by the use of 1.5 Tesla (T) magnetic resonance imaging (MRI) in a series of young patients without knee injuries. The hypothesis of the study was that the ALL is a distinct structure of the anterolateral capsule that can be easily identified using 1.5 T MRI scans.

Methods

Ethical approval was granted for this study by the Institutional Review Board and all patients enrolled gave valid consent to participate.

Between May 2015 and May 2016, 30 patients were prospectively considered for study enrollment. Only patients aged 18 or older with one intact knee were included. Exclusion criteria were: a previous history of either ipsilateral or contralateral knee injury and/or surgery or infection and inability to undergo MRI.

Patients who came to our attention for an acute knee injury were clinically evaluated and then immediately referred for MRI of the injured knee. If the exam confirmed the clinical suspicion of an ACL injury, patients also underwent MRI of the contralateral knee and the uninjured knee was considered for the study.

The MRI examinations were all performed with 1.5-mm slice thickness in the supine position on a 1.5 T system (Aera, Espree, or Avanto; Siemens Medical Solutions, Erlangen, Germany). Parameters used during acquisition of MR scans are listed in ►Table 1.

MR scans were evaluated by an experienced musculoskeletal radiologist. A standardized approach to imaging evaluation was used. The ALL was evaluated using coronal images with the axial and sagittal planes used mainly for anatomical orientation. The ALL was defined as the low-signal band originating from the region of the lateral epicondyle of the femur, crossing the proximal surface of the lateral collateral ligament (LCL), deep to the iliotibial band (ITB), to its tibial insertion between the Gerdy's tubercle and the fibular head.

Length, width, and thickness of the ligament were calculated. Data were expressed as mean \pm standard deviation.

Results

Thirty patients were considered. Four of them were excluded because of previous knee injuries. Twenty-six patients met the eligibility criteria and were enrolled in the study. However, in

one case, it was not possible to visualize the ALL in the uninjured knee. Mean age of patients (20 males and 5 females) was 26.7 ± 7.1 years. Average body mass index was 20.6 ± 1.3 .

The ligament originated anterior and distal to the lateral epicondyle and inserted on the proximal tibia approximately 5 mm below the joint line just distal to the Gerdy's tubercle (►Fig. 1). It had an average length of 33 ± 1.2 mm, an average width of 5.5 ± 0.3 mm, and an average thickness of 2 mm.

Discussion

According to this study, the evaluation of the ALL by MRI was possible in all cases but one.

The identification of the anterolateral region of the knee is not always possible due to the adjacent structures, such as the anterolateral capsule, LCL, popliteus tendon, and ITB, which cause a partial volume effect in the region, hampering the characterization of that structure.^{16–18} MRI identified the ALL in 96% (25/26) of patients in our study.

The ALL has been analyzed by MRI by several other authors; the consensus is that the ALL is difficult to analyze along its entire length.^{16–18} Claes et al¹⁹ identified the entire ALL in 76% of cases, Helito et al¹⁸ in 71.7% of cases (89.7% for the femoral portion, 94% for the meniscal portion, and 79.4% for the tibial portion), and Taneja et al²⁰ identified the entire ALL by MRI in only 11% of cases. The challenges with identifying the ALL on MRI can be attributed to its orientation and thickness, and also to its proximity to neighboring ligament structures, which makes it difficult to analyze its proximal bone attachment. Hartigan et al²¹ reported that the ALL was visible on MRI in 100% of cases, but found poor interobserver reproducibility for the analysis of ALL injuries. Porrino et al²² examined MRI scans of 53 patients and, in contrast to other studies, were able to characterize the ALL in its entirety in all of the MRI scans. Notably, they performed their tests on a 3.0 T system.

The ALL has also been identified using ultrasonography (US), a tool that could be crucial to clinical evaluation of this structure.²³ Faruch Bilfeld et al²⁴ found that the ALL was visible in all patients using US; the tibial insertion was visible in 100% of patients and the femoral insertion in 96% of cases, but the meniscal insertion was not visible in any patient. On the contrary, the authors found that the ligament was visible with MRI in 96% of patients. Particularly, the tibial insertion was visible in 96% of patients, the femoral insertion in 40%,

Table 1 Parameters used in the MRI sequences

	Sagittal PD	Sagittal T2 FATSAT	Coronal T2 FATSAT	Coronal T1	Axial T2 FATSAT
Field of view	180 mm	180 mm	180 mm	180 mm	180 mm
Repetition time	2,800	3,950	2,950	3,110	2,940
Echo time	33	30	30	33	33
Thickness (mm)	3 mm	3 mm	3 mm	3 mm	3 mm
Spacing (mm)	20%	20%	15%	15%	20%

Abbreviations: MRI, magnetic resonance imaging; PD, proton density.

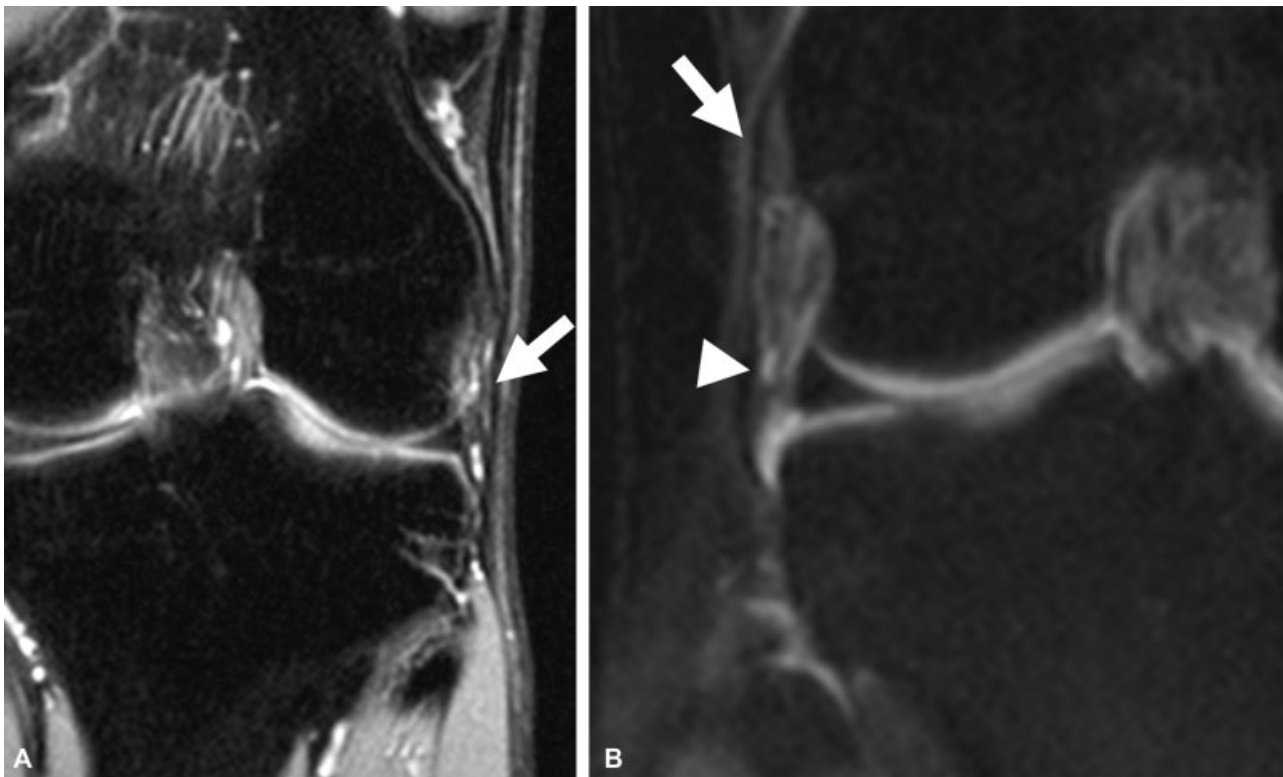


Fig. 1 (A, B) Anterolateral ligament is visible (arrows) on 1.5 T magnetic resonance imaging scans.

and the meniscal insertion in 93%. The superior ability of US to detect the ALL relative to MRI can be explained by the position in which the examination is performed. US is performed with the knee flexed and internally rotated, thus placing tension on the ALL, while MRI is performed in 10 degrees flexion and neutral rotation.

About MRI evaluation protocols in the literature, Macchi et al²⁵ obtained MRIs on a 1.5 T system acquired with a standard protocol, including turbo spin and gradient echo T1- and T2-weighted sequences. The analysis was conducted on T2-fast field echo sequence characterized by the following parameters: coronal plane, repetition time 475, echo time 13, field of view 160, and thickness 3.5 mm.

The main limitation of this study is related to the small number of patients. Moreover, neither interobserver nor intraobserver reliability were assessed.

In conclusion, the ALL is a distinct structure of the anterolateral capsule that can be identified almost in all patients evaluated (96%) using 1.5 T MRI scans.

Conflict of Interest
None declared.

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