

Anterolateral Ligament (ALL) — Myth or Reality?

Mihai Roman¹, Octav Russu², Radu Prejbeanu³, Adrian Todor⁴, Vlad Predescu⁵, Bogdan Codorean⁵, Tiberiu Bătagă², Radu Fleaca¹

¹“Victor Papilian” Faculty of Medicine, “Lucian Blaga” University, Sibiu, Romania

² University of Medicine and Pharmacy, Tîrgu Mureş, Romania

³ “Victor Babeş” University of Medicine and Pharmacy, Timişoara, Romania

⁴ “Iuliu Haţieganu” University of Medicine and Pharmacy, Cluj-Napoca, Romania

⁵ “Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania

CORRESPONDENCE

Mihai Roman

Str. Lucian Blaga nr. 2A
550169 Sibiu, Romania
Tel: +40 269 212 320
E-mail: mihaidanroman@yahoo.com

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Octav Russu • Str. Gheorghe Marinescu nr. 38,
540139 Tîrgu Mureş, Romania. Tel: +40 265 215 551.
E-mail: octav@genunchi.ro

Radu Prejbeanu • P-ța Eftimie Murgu nr. 2, 300041
Timişoara, Romania. Tel: +40 256 204 400. E-mail:
raduprejbeanu@gmail.com

Adrian Todor • Str. Emil Isac nr. 13, 400023 Cluj-
Napoca, Romania. Tel: +40 264 406 843. E-mail: adi.
todor@yahoo.com

Vlad Predescu • B-dul Eroii Sanitari nr. 8, 050474
Bucureşti, Romania. Tel: +40 213 180 719. E-mail:
vladpredescu001@gmail.com

Bogdan Codorean • B-dul Eroii Sanitari nr. 8, 050474
Bucureşti, Romania. Tel: +40 213 180 719. E-mail:
dr.codorean@traumatologie-sportiva.ro

Tiberiu Bătagă • Str. Gheorghe Marinescu nr. 38,
540139 Tîrgu Mureş, Romania. E-mail: tbataga@
gmail.com

Radu Fleaca • Str. Lucian Blaga nr. 2A, 550169 Sibiu,
Romania. Tel: +40 269 212 320. E-mail: r_eaca@
yahoo.com

ABSTRACT

Although the anterolateral ligament (ALL) was described a long time ago, recent research shows a lot of interest regarding this structure. There is a high variability concerning its anatomy, especially its capsular/extracapsular situation and insertion sites. There is also some controversy about its ligamentous structure. It seems that it has a biomechanical role in restricting anterior tibial translation and internal rotation. The ALL complex seems to have a clinical significance, and a relationship with the pivot shift has been described. Although there are promising results recently, the surgical techniques of ALL reconstruction, in addition to anterior cruciate ligament reconstruction, have to be further investigated. A precise indication algorithm and patient selection criteria need to be established.

Keywords: anterolateral ligament (ALL), anterolateral complex, anterior cruciate ligament (ACL), ACL reconstruction

INTRODUCTION

The anterolateral ligament (ALL) has been recently brought into attention after the paper of Claes received considerable public and media attention.¹ A large debate regarding the ligament's anatomical landmarks, histology, functional role, best method of surgical reconstruction, and even its actual existence was generated. Although a final verdict was not yet achieved, this research enhanced our knowledge to the benefit of our patients.

However, this structure is far from new. Segond first described it in 1879, as a reinforcement of the lateral joint capsule by fibers of the iliotibial band, and the avulsion fracture of the tibial plateau was named the “Segond fracture”.² Then, in 1948, Last named it “short lateral ligament”.³ In 1976, Jack Hughston⁴ described the anterolateral structures and the middle third of the lateral capsular ligament, and in 1982 Werner Muller⁵ identified it as the lateral femorotibial ligamentous

attachment. In 1986, Terry showed that there is a “capsulo-osseous layer” of the iliotibial band, while LaPrade described it as a “mid-third lateral capsular ligament” and included it in the so-called “anterolateral complex”.^{6,7} Finally, Vieira named this structure as we know it today – “anterolateral ligament”.⁸

Anterior cruciate ligament (ACL) surgical techniques have evolved during the years, but residual pivot shift remains a concerning issue. Therefore, more interest was addressed to the anterolateral peripheral structures. In the last years there was a large amount of research regarding the ALL; however, no definitive consensus regarding this structure has been achieved.^{1,9–14}

VARIABILITY

Due the conflicting results that were published, some confusion is still present. The ALL seems to have a certain variability that occurs in at 33–97% of the human population.^{1,4,15,16} Whether the ALL is absent from a specimen or has simply been obliterated or overlooked can be due to the multiple dissection techniques.¹⁷ The impact of an ALL absence, even if only unilateral, needs to be investigated in clinical and imaging studies to finally clarify its importance.¹⁸

CAPSULAR VERSUS EXTRACAPSULAR

There are studies that identify the ALL as a capsular structure with attachments to the lateral meniscus.^{1,19} In contrast, other studies support the idea that it is an extra-capsular structure originating from the iliotibial tract, with no relation to the meniscus.¹⁰

The iliotibial tract consists of an 8 cm wide collagen structure, which originates from the iliac crest and iliac spine. At knee level, fibers from the iliotibial tract reach the patella (retinaculum), while others reach the septum intermusculare. The distal insertion is on Gerdy’s tubercle. There are three layers: superficial, deep, and capsulo-osseous.¹² The deep layer consists of fibers that reach the intermuscular septum at 6 cm proximal to the lateral epicondyle and anchor the iliotibial tract on the femur (Kaplan fibers).²⁰

The capsulo-osseous layer consists of the fibers that originate cranially and posterior of the lateral epicondyle and insert on the tibia, posterior from the Gerdy’s tubercle. These fibers correspond to the so-called ALL.²¹

Regarding the relationship to the lateral collateral ligament (LCL), the ALL is described as being superficial to the LCL.²² Many ALL reconstruction techniques have used a graft passing deep to the LCL, which could explain

the over-tightening and the sub-optimal results seen with these methods.²³ Other researchers consider that the ALL and the deep capsulo-osseous fibers of the iliotibial tract are in fact one and the same structure.²¹

The Anterolateral Ligament Expert Group concluded in a recent paper that there is a consensus that the ALL is a triangular, anterolateral structure found deep to the iliotibial band, admitting that there is a lot of debate concerning the exact specifications of the ligament.²⁴

LENGTH, THICKNESS, WIDTH

There is also a variability regarding the length of this structure, from 37 to 59 mm.^{10,19} The width seems to be less than 10 mm.^{1,16,22,23} The thickness also presents great variability – from 0.87 mm to 2–3 mm.^{15,23} This variability depends on the dissection technique. The structures are difficult to be separated.²³

INSERTION

There is some controversy regarding the femoral and tibial insertions of the ALL. Claes and Bellemans (2013) found that the ALL originates at the lateral epicondyle of the femur, near the origin of the LCL, crosses the joint, attaches to the lateral meniscus, and inserts at the anterolateral aspect of the proximal tibia between the Gerdy’s tubercle and the fibular head.¹ Following this article, many authors performed anatomical studies, trying to define exactly the macro- and microscopic landmarks of this structure.

Vincent *et al.* (2012) reported the origin to be the lateral femoral condyle.¹⁵ Other authors reported slightly different insertion points. The different results can be related to the anatomical differences of the specimens, but also on the preparation methods. However, the majority of researchers conclude that the femoral insertion point lies posterior from the lateral epicondyle, and the tibial insertion is located just posterior to the mid-point of Gerdy’s tubercle and fibular head.^{9,14,23}

The ongoing controversy that surrounds this structure reveals the difficulty of understanding the peripheral anatomy. It is not always possible to clearly define these structures, that is why one can discuss about complexes (posterolateral, anterolateral, posteromedial, anteromedial) rather than well-defined single units.^{5,21,26}

Although most studies show that the anatomy and topography of the ALL seems to be highly variable, they also underline that it is consistent within certain limits.¹⁸

Thus, it is a reality that this structure exists. But is it truly a ligament or, similarly to the glenohumeral ligaments of

the shoulder, just a thickening of the capsule that is part of an anterolateral complex?¹³

HISTOLOGY

Histological analysis from certain studies revealed characteristics of ligamentous tissue, and immunohistochemistry identified a network of peripheral nerves, suggesting a proprioceptive function of the ALL.^{26,27} Guenther *et al.* stated that, histologically, the collagenous structure of the ALL is significantly different from the LCL, thus questioning the ligamentous origin of the ALL. Parts of the anterolateral capsule are organized into individual bundles, most likely a combination of multiple thickenings of the capsule, and not a homogenous ligamentous entity such as the ACL or LCL.^{22,28} Thus, although there are some similarities between the ALL's structure and ligaments, it seems that the ALL does not fulfill the necessary criteria to be called a ligament.

FUNCTION

Internal rotational stability of the tibia is mainly restricted by the ACL, but other anatomical structures (the anterolateral complex, or the posterior horn of the meniscus) also act as secondary stabilizers.^{29,30}

Regarding the function of the ALL, Terry *et al.* suggested that the anterolateral structures may play a role as a rotational knee stabilizer.³¹ The ALL fibers seem to stabilize the internal rotation of the knee and the anterior translation of the lateral tibia plateau, extra-articular, together with the ACL, which is the most important intra-articular contributor to rotatory knee stability.^{1,32-35}

Drews *et al.* concluded that the ALL is supporting the ACL against internal tibial loads to a minor degree, and that there is no apparent relationship between the ALL and the pivot shift. Therefore, ALL reconstruction cannot be recommended at the moment without further biomechanical investigations.³⁶ From a biomechanical point of view, internal rotation of the knee is better controlled by a lateral extra-articular structure compared to the centrally located ACL because of a longer lever arm.^{37,38}

Cadaveric studies showed that starting with 30 degrees of flexion, the deep capsulo-osseous fibers of the iliotibial tract play an important role regarding the rotational stability of the knee, while the ALL is just of secondary importance.¹² Other studies showed that sectioning of the ALL in addition to the ACL, in cadaver specimens, enhanced the pivot shift significantly.¹ Monaco *et al.* suggested that the anterolateral structures play even a larger role than the

posterolateral bundle of the ACL in controlling rotational stability.³⁹

Despite the extensive research on the ALL, there is no consensus regarding its structure and biomechanical function. It seems that the ALL is a stabilizer against internal tibial rotation, particularly at flexion angles greater 30 degrees, and rupture of this structure/complex may be involved in the pathogenesis of a high-grade pivot shift.⁴⁰

The consensus of the ALL Expert Group stated that the mean load to failure is around 180 N, the mean stiffness is 31 N/mm, and the ALL acts as a restraint for the internal rotation of the tibia and affects the pivot shift in the ACL-deficient knee.²⁴

THE SEGOND FRACTURE

Segond described the avulsion fracture of the tibial plateau as the "Segond fracture" back in 1879.² This is considered a pathognomonic radiographic feature for an ACL injury.⁴¹ The anatomic structure responsible for the Segond fracture is not yet defined, although the suggestions include the anterolateral capsule, the anterior oblique band of the fibular collateral ligament, the iliotibial band, the short head of the biceps femoris, and the ALL.^{10,41,42}

There is some evidence that the load of the ALL and anterolateral complex increases during ACL injury, and these structures might be responsible for the Segond fracture. Therefore, while evaluating the injured knee, one should closely evaluate the anterolateral structures as well.^{1,25,43,44}

CLINICAL AND SURGICAL SIGNIFICANCE

Before modern ACL reconstruction techniques were developed, isolated lateral extra-articular procedures were used as the standard surgical techniques in patients with ACL insufficiency. These procedures were non-anatomic, reproduced the biomechanics poorly, and resulted in residual instability and over-constraint of the lateral compartment (with secondary osteoarthritis), thus being abandoned.^{40,45}

Isolated ACL ruptures do not produce an increased pivot shift, but additional disruption of the anterolateral structures generates a high-grade pivot shift.^{39,46} In the last years, several anterolateral stabilizing techniques were described in order to address this issue.

The exact indication remains uncertain, because there is no study that fully proved that anatomic ALL reconstruction, in addition to the ACL reconstruction, adds real benefits. It seems that there is only a theoretical advantage related to the ALL reconstruction.⁴⁷

Although there are a large number of studies and many debates regarding this topic, the majority of experts accept some potential indications for ALL reconstruction, based on the severity of injury: patients with high-grade pivot shifts, selected revision cases, and some high-level pivoting sports. More studies are needed to establish adequate treatment algorithms based on the individual anatomy of the patient.⁴⁸⁻⁵¹

CONCLUSION

In our opinion, the key points in understanding the ALL structure include defining its anatomical attachment sites on the femur, tibia, and lateral meniscus and its precise role in knee biomechanics; evaluation of its histological composition, as well as the consequences of its insufficiency. Also, it is important to make a precise diagnosis (clinical, radiological – MRI, US), to study the natural healing potential of the ALL, the exact operative indications, and the best surgical reconstruction technique.

CONFLICT OF INTEREST

Nothing to declare.

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