ANTEROLATERAL LIGAMENT OF THE KNEE JOINT, ANATOMICAL AND RADIOLOGICAL STUDY

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ABSTRACT:

Background and objectives: Injuries to the anterior cruciate ligament is very common, and its reconstruction is one of the most common procedures in orthopaedic surgery. But there are still problems with the patients undergoing this reconstruction. So further studies of the characteristics of the anterolateral ligament (ALL) of the knee were needed.

This study aims at demonstrating the anterolateral ligament of the knee, determining its length, width at the meniscus attachments, and its origin and insertion, and to identify this ligament on magnetic resonance imaging.

Methodology: Dissection of anterolateral ligament was performed in 10 unpaired human cadaveric knees, isolating the ligament. Its length, width, and points of attachments were determined. The femoral attachment was based on its relation with the attachment of the lateral collateral ligament of the knee. The tibial attachments were based on its distance from Gerdey tubercle (GT) of the tibia.

The incidence of the ligament was determined in 20 knees by magnetic resonance imaging of patients undergoing arthroplasty.

Result: The anterolateral ligament was noted to be present in all 30 knees. In all cases it took origin near the origin of the lateral collateral ligament of the knee, and insert to the lateral meniscus and tibial plateau 5mm distal to the articular surface and posterior to Gerdey tubercle. The average length was 39.69 mm, the average width was 6.48 mm, the mean thickness was 0.50 mm, and the distance from Gerdey tubercle was 19.197 mm.

Conclusion: In conclusion the anterolateral ligament (ALL) can be detected by magnetic resonance imaging, and is consistently present in the anterolateral region of the knee, attached anterior and distal to the attachment of lateral collateral ligament. Distally it is attached to the lateral meniscus and to the proximal tibia.

KEY WORDS: Cruciat, Anterolateral, Arthroplasty.

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INTRODUCTION:

Injuries to the anterior cruciate ligament are very common, and its reconstruction is one of the most common procedures in orthopaedic surgery. But there are still problems with the patients undergoing this reconstruction.

The lateral aspect of the knee is stabilized by a complex arrangement of ligaments, tendons, and muscles. These structures provide anterolateral and posterolateral stabilization. They can be demonstrated with routine spin-echo MR imaging sequences performed in the sagittal, coronal, and axial planes. Anterolateral stabilization is provided by the capsule (capsular ligament) and iliotibial tract (1,2, 3). The capsule also contributes to anterior and posterolateral stabilization. The anterior part of the capsule is reinforced by the superior and inferior retinacula and the vastus lateralis muscle. The iliotibial tract is an extension of the fascia lata and ends at the Gerdy tubercle, which is located on the anterolateral surface of the tibia. Before this tract inserts on the tibia, some of its anterior fibers attach to the lateral retinaculum and some of its posterior fibers insert on the lateral femoral condyle (2,3–4). The lateral collateral ligament originates from the external tuberosity of the lateral femoral condyle, directly anterior to the origin of the lateral head of the gastrocnemius muscle. The biceps femoris tendon descends behind the iliotibial tract. The lateral collateral ligament and biceps femoris tendon end by inserting on the head of the fibula as a conjoined tendon (2). The function of the biceps femoris tendon, along with the popliteus muscle and the iliotibial tract, is to be a strong dynamic knee stabilizer and an external rotator of the tibia (4). The popliteus tendon arises below the lateral collateral ligament in a small sulcus on the lateral femoral condyle, passes under the lateral collateral ligament, descends into the popliteus hiatus, then passes under the arcuate ligament and becomes extraarticular before finally joining its muscle belly, which attaches to the posteromedial surface of the proximal tibia. The popliteus tendon sends attachments to the lateral meniscus (the popliteal meniscal ligament) and to the styloid process of the fibula (the popliteal fibular ligament) (5–8) . The popliteus muscle is the main lateral stabilizer of the knee and also an internal rotator of the tibia (7–10). The popliteal meniscal ligament prevents the lateral meniscus from excessive forward displacement during extension of the knee (5,6,8). The popliteal fibular ligament acts as a pulley, fixing the muscle in position during contraction (11).

In spite of successful ACL repair surgery, some patients with ACL-repaired knees continue to experience so-called 'pivot shift' where the knee 'gives way' during activity. For the last four years, orthopaedic surgeons Dr Steven Claes and Professor Dr Johan Bellemans have been conducting research into serious ACL injuries in an effort to find out why. In the past, some sporadic reports have suggested the potential existence of a ligamentous structure connecting the femur with the anterolateral tibia of the human knee (27).

In 1879, years before the discovery of X-rays, Dr. Paul Segond described a remarkably constant avulsion fracture pattern at the anterolateral proximal tibia as a result of forced internal rotation at the knee (12). This eponymous Segond fracture was reported to occur in the tibial region 'above and behind the tubercle of Gerdy'. At this anatomical location, he furthermore designated the existence of 'a pearly, resistant, fibrous band which invariably showed extreme amounts of tension during forced internal rotation (of the knee)'

MATERIALS AND METHODS

This descriptive retrospective analytical study was performed to study the anatomy of the anterolateral ligament of the knee joint. The study was conducted during the period from December 2014 to December 2015.

Ethical clearance was obtained from Ummelqura university Ethical Committee and permissions from hospital authority.

The sample size of this study was 30 individuals, from which 10 were cadavers of both sexes from ummelqura university, and 20 scans were taken from patients with osteoarthritis and with many other problems.

None of the human cadavers included in this study had a history of infection, previous surgery of the lower limbs, or other conditions that could alter the anatomy of the region. The presence and characteristics of the ALL were investigated in 10 unpaired, embalmed human cadaveric knees [8 men and 2 women; mean age at death, 70 years.

The anatomic dissection was performed in a standardized manner. We initially dissected the skin and subcutaneous tissue and then performed a tenotomy of the ligamentum patellae before its insertion.

The ITB was cut transversely 5 cm proximal to the lateral femoral epicondyle and then carefully released from its tibial attachment on Gerdy's tubercle,

With the ITB reflected, the 'superficial lamina of the capsule' was visualized and a biceps femoris tenotomy was performed at the fibular head. The tendon of the popliteus muscle (TPM) and the lateral collateral ligament (LCL) were isolated carefully to avoid reaching the attachment of the ALL in the region of the lateral epicondyle. With the exception of these ligaments, all of the other soft tissue structures were removed from the lateral condyle for clear visualization of the area. After isolation of the lateral structures, clear visualization of the capsular thickening of the anterolateral region of the knee, compatible with the ALL of the knee, was possible. After isolation and identification, the length, thickness, and width measurements were performed using a digital caliper with an accuracy of 0.01 mm (Mit500196-20; Mitutoyo, Japan). The points of attachment were also documented. The ALL femoral attachment was based on the anterior-posterior and proximal-distal distances relative to the attachment of the LCL near the lateral epicondyle. The point of tibial attachment was based on the lateral portion of the Gerdy tubercle and the most anterior portion of the fibular head, the lateral tibial plateau cartilage, and the lateral meniscus.

Twenty MRI scans on the knees of patients who underwent the examination due to clinical indications unrelated to knee ligament stability or trauma were evaluated with regard to lesions of the patellar cartilage. None of the patients presented any ligament lesions. The patients' mean age was 45 years (ranging from 30 to 60). 13 patients were male and 7 were female. The examinations were performed in a machine with a 1.5-Tesla magnetic field (Sigma HDxT, General Electric Medical Systems, Milwaukee, Wisconsin, USA), using an eight-channel knee coil (HD TR knee array). T1-weighted images were obtained in the sagittal plane (TR/TE, 400–700/9–16) and T2- weighted images with fat saturation in the axial, sagittal and coronal planes (TR/TE, 3200–4500/40–50), with slice thickness of 3mm and spacing of 0.5mm.

RESULT

CADAVERIC ANATOMIC INVESTIGATION

Results are reported as averages + standard deviations (SD). The anterolateral ligament (ALL) was clearly observed in the dissections of all 10 knees studied. The origin was noted to be on the lateral femoral condyle. In all of the ten dissected specimens the ligaments origin was just anterior and distal to the origin of the lateral collateral ligament (LCL), blending with its fibers (Fig. 1). As the structure passed distally, it was noted in each case to be closely associated with the lateral meniscus near the junction of its upper and middle thirds, and it was noted that some fibers of the structure are inserted on to the meniscus, and the other to the tibia more distal between the Gerdy tubercle and the fibular head. The tibial attachment was found to be approximately 19.197 ±4.365 mm from the Gerdey tubercle.

The measurements found for the ligament were as follows: mean length, 39.69 + 6.44 mm; mean width, 6.18 ±2.145 mm ; and mean thickness, 0.50 ±0.125 mm.

Table 1: showing the ALL origin, length, width, thickness, and distance from GT.

specimen	sex	LlR	ALL femoral origin	ALL length	ALL width at center	ALL thickness at joint line	Distance from GT
1	Male	L	Anterior and distal	37.92	05.75	0.62	14.60
2	Female	R	Anterior and distal	34.81	05.40	0.41	17.51
3	Female	L	Anterior and distal	43.65	04.66	0.40	18.64
4	Male	L	Anterior and distal	35.90	05.81	0.41	16.52
5	Male	R	Anterior and distal	40.51	06.25	0.65	18.01
6	Male	L	Anterior and distal	32.28	07.22	0.54	20.02
7	Male	R	Anterior and Distal	40.62	08.62	0.63	22.52
8	Male	L	Anterior and Distal	43.13	07.16	0.55	18.59
9	Male	L	Anterior and distal	45.16	06.64	0.40	22.23
10	Male	L	Anterior andDistal	43.53	04.33	0.60	23.33

Table 2: show the average length, width, thickness, and distance from GT with the standered deviation SD.

Average length of ALL	Average width of ALL	Average thickness	Distance from GT
39.69±6.44	6.148±2.145	0.501±0125	19.197±4.365

Fig1: showing anterolateral ligament of the knee

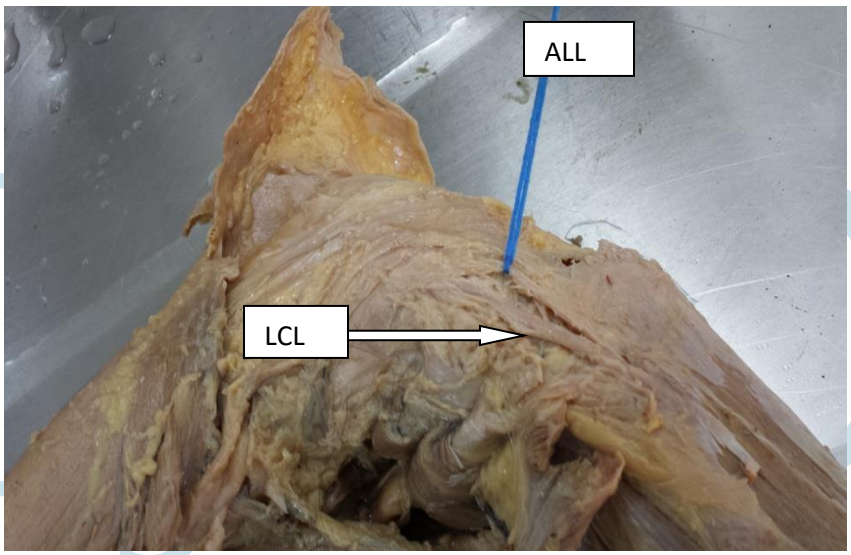


Fig2: showing the anterior and distal origin of the anterolateral ligament of the knee.

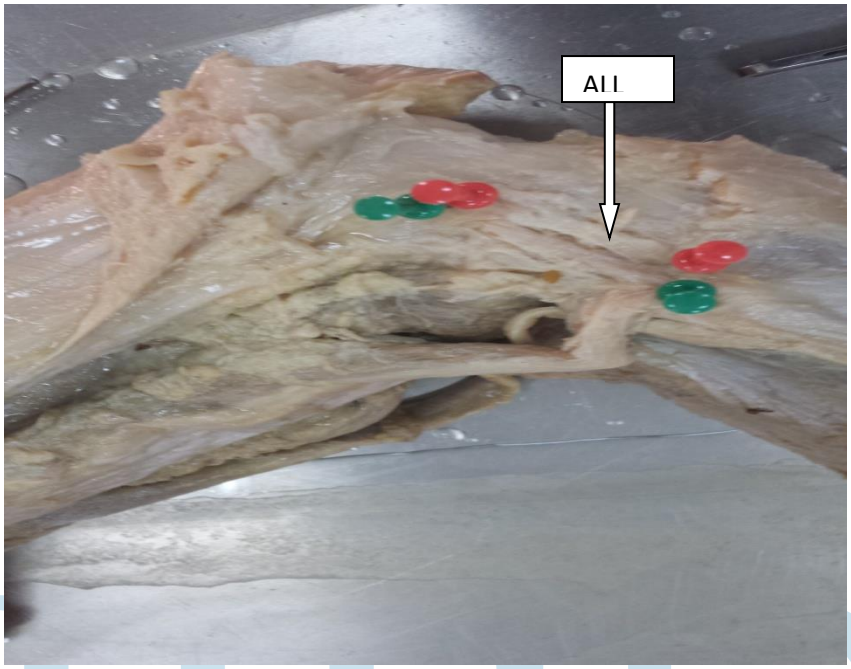
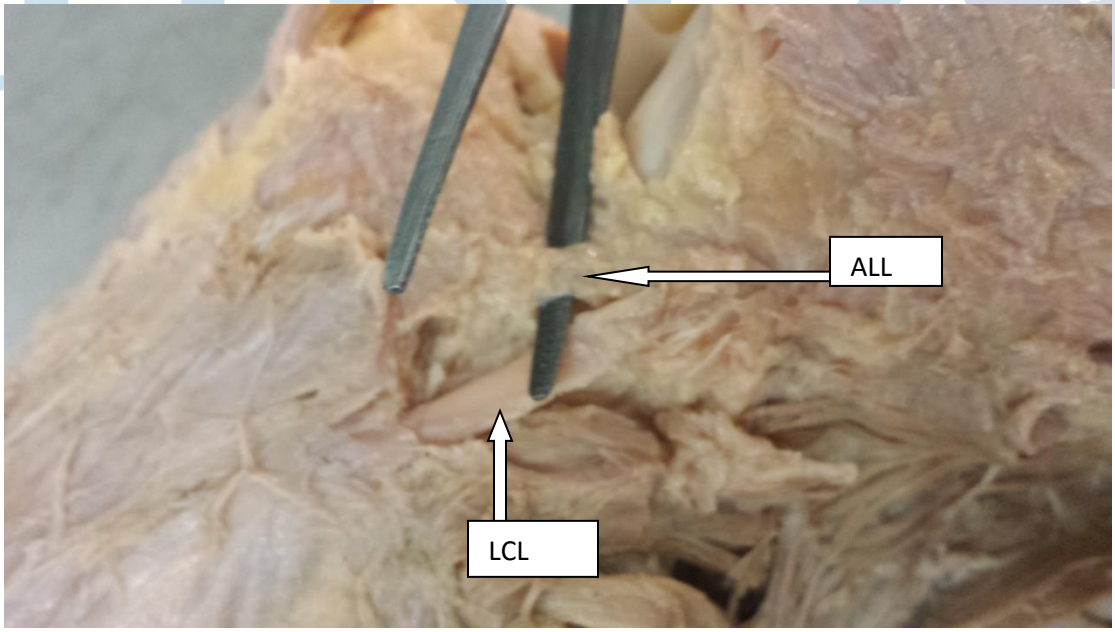


Fig3: showing the attachment of some fibers to the lateral meniscus.



RADIOLOGICAL ANALYSIS

The ALL was viewed on the knee MRI scans as a thin linear structure. It presented signal characteristics similar to those of the other ligament structures of the knee . The main plane in which the ligament was identified was the coronal plane. The femoral portion was identified as a structure with its origin close to the anterior limit of the origin of the LCL, with an inferior path that was practically vertical and superficial to the popliteal tendon. The tibial portion was best characterized immediately after the bifurcation, with a lateral and practically vertical path.

Fig 4: radiological appearance of the anterolateral ligament of the knee.

Fig 5: showing the attachment of the ligament to the lateral meniscus.

DISCUSSION

This study aims at demonstrating the anterolateral ligament of the knee, determining its length, width at the meniscus attachments, and its origin and insertion, and to identify this ligament on magnetic resonance imaging.

Although there have been sporadic reports (17,19, 21) mentioning the existence of a capsulo-ligamentous structure connecting the femur with the tibia at the (antero)lateral region of the knee joint, information on the precise anatomy and function of this entity has always been vague and confusing. The existence of a ligamentous structure between the lateral femur and tibia was first described by Paul Segond in 1897 (12) when he noted that 'a pearly, resistant, fibrous band which invariably showed extreme amounts of tension during forced internal rotation' was attached to his eponymous fracture. However, the notion of this structure was eventually forgotten, until Jack Hughston published his findings on rotatory knee instability patterns in the late 1970s (1,23). Those authors described a 'mid-third lateral capsular ligament' intimately attached to the meniscus and divided into meniscofemoral and meniscotibial portions. According to Hughston, this capsular ligament is 'strong and supported superficially by the iliotibial band' (1). It was thought to play an important role in the so-called 'anterolateral instability' (ALRI) pattern of the knee (23,26), a clinical term which has become obsolete with the advent of knee arthroscopy (and its inherent predominance in the diagnosis of intra-articular pathology) a few years later. Although the term 'mid-third lateral capsular ligament' is sporadically encountered in more recent literature (21,28,30). No further anatomical characterization, drawings or photographs have been provided, adding to the mystery surrounding this enigmatic structure. Recently, Vincent et al (17) reported their observations during total knee arthroplasty procedures, when the authors noticed 'a relatively consistent structure in the lateral knee, linking the lateral femoral condyle, the lateral meniscus, and the lateral tibial plateau' (17). The structure was named 'anterolateral ligament', a term which has previously been used by Vieira et al (16) in describing the 'capsulo-osseous' layer of the iliotibial band (ITB).

The main finding of this study is that the anterolateral ligament (ALL) can be identified as a distinct ligamentous structure at the anterolateral region of the human knee in all of the 10 specimens. This result was consistent with the finding of Helito et al (22) who stated that the ALL was clearly observed in the dissections of all 20 knees studied. Steven Claes (27) reported slightly low incidence.

The origin of the anterolateral ligament from the lateral femoral epicondyle in all the 10 dissected knees was found to be anterior and distal to the attachment of the LCL. A close relationship was noted with the proximal part of the lateral collateral ligament and not with the popliteus tendon, this was not agree with the finding of Vincent et al (17) who describe the origin of the ALL 'to be on the lateral femoral condyle, closely associated with the popliteus tendon', as in nine of 10 cases, its insertion was found 'just anterior to the popliteus tendon insertion, blending with its fibers'.

We found some fibers that connect the iliotibial tract with the anterolateral ligament. Our finding was not agree with the finding of claes et al who stated that fibers connecting the ITB with the lateral femoral condyle and the intermuscular septum do exist but originate proximal to the level of the epicondyle (the so-called 'deep layer of the iliotibial tract', or 'Kaplan's fibers') (24, 15, 20, 16), not from the tibia.

In our study, a clear bifurcation of the ligament was observed. Some fibers are inserted to the lateral meniscus. The others are inserted to the tibia, consistent with what was reported by Helito et al (22), who stated that The attachment of the ALL to the lateral meniscus periphery was identified in all

dissections. Further studies are necessary to determine the biomechanical relationship between the ALL and lateral meniscus.

In our study the tibial attachment of the ALL was also constant and slightly posterior to half the distance between the Gerdy tubercle and the fibular head. This is agree with the finding of Helito, et al (22), who reported that the the tibial attachment occurs at 38% + 11% of the way from the fibular head to the Gerdy tubercle. In our study the tibial attachment was also closer to the fibular head than the Gerdy tubercle.

CONCLUSION:

This is one of the studies that provide a detailed anatomical description of the anterolateral ligament (ALL) of the human knee. The anterolateral ligament (ALL) can be detected by magnetic resonance imaging, and is consistently present in the anterolateral region of the knee. Attached anterior and distal to the attachment of lateral collateral ligament. Distally it is attached to the lateral meniscus and to the proximal tibia. The precise anatomical knowledge of this structure delivered by this study could be highly relevant for clinical practice. However, further research is needed in this area to establish the function of the ALL and to determine its role in clinical knee injuries

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