Original Article

Anatomy of the anterolateral ligament of the knee joint and its impact on clinical practice

Elsayed Aly Mohamed Metwally, Nancy Mohamed Aly El-Sekily, Ahmad Hassan Wally[1]

Access this article online

Quick Response Code:

Website:
jecajournal.com

DOI:
10.4103/jeca.jeca_26_18

Abstract:

BACKGROUND: The anterolateral ligament (ALL) was identified as a thickening of the lateral capsule of the knee joint coming under tension with an applied internal rotation at 30° of flexion.

MATERIALS AND METHODS: In the present study, dissection of 20 lower limb specimens, 10 right and 10 left, of 10 formalin-preserved adult male cadavers was done for morphometric measurement of ALL. Nine male cases were subjected to combined anterior cruciate ligament (ACL) and ALL reconstruction; seven cases with right knee involvement and two cases with left knee involvement.

RESULTS: The ALL was clearly identified in all 20 lower limb cadaveric specimens. In all the specimens, ALL was identified along the anterolateral aspect of the extended knee, and it was in the form of a band.

CONCLUSION: Combined ALL and ACL reconstruction has better rehabilitation of the patients.

Keywords:

Anterolateral ligament, cruciate, reconstruction

Departments of Anatomy and Embryology and [1]Orthopedic Surgery, Faculty of Medicine, Alexandria University, Alexandria, Egypt

Address for correspondence:
Prof. Elsayed Aly Mohamed Metwally, Department of Anatomy, Faculty of Medicine, Alexandria University, Alexandria, Egypt.
E-mail: sayedmetwally2020@yahoo.com

Introduction

The anterolateral ligament (ALL) was identified as a thickening of the lateral capsule coming under tension with an applied internal rotation at 30° of flexion (Kennedy *et al*., 2015). The ALL of the knee passes anterodistally from an attachment proximal and posterior to the lateral femoral epicondyle (LFE) to the margin of the lateral tibial plateau, approximately midway between Gerdy's tubercle and the head of the fibula. The ligament is superficial to the lateral (fibular) collateral ligament proximally, from which it is distinct and separate from the capsule of the knee (Dodds *et al*., 2014).

The clinical importance of the ALL had been proven by some patients with possible combined anterior cruciate ligament (ACL) and ALL rupture that had residual rotational laxity following isolated ACL reconstruction (ACLR) (Helito *et al*., 2016). Biomechanical studies indicate that concurrent reconstruction of the ACL and ALL results in significantly reduced internal rotation and axial plane tibial translation compared with isolated ACLR in the presence of preoperative high-grade pivot shift (Kraeutler, 2017).

This study aims to study the anatomy of ALL and evaluation of the combined reconstruction of ALL and ACL.

Aim

This study was carried out to describe the anatomy of ALL of the knee joint and its impact on clinical practice.

How to cite this article: Metwally EA, El-Sekily NM, Wally AH. Anatomy of the anterolateral ligament of the knee joint and its impact on clinical practice. J Exp Clin Anat 2018;17(1):35-40.

Materials and Methods

The anatomical part of the study included 20 lower limb specimens 10 right and 10 left, of ten formalin preserved adult male cadavers obtained from the Anatomy Department, Faculty of Medicine, Alexandria University.

The clinical part of the study was done in the Orthopedic and Traumatology Department, Nariman Hospital, Faculty of Medicine, Alexandria University. The study included 10 male cases: seven cases with right knee involvement and three cases with left knee involvement.

Plain X-ray was done for all cases to exclude any bone fracture or bony residue inside the joint cavity. Magnetic resonance imaging (MRI) was done for all cases to assess the intra-articular structures (menisci-cruciate ligaments-ALL). Six cases were due to violent rotational knee movements during vigorous muscular exercises. Four cases were due to direct trauma to the knee.

Routine investigations were done for all cases (complete blood count, platelet test, partial thromboplastin time, and liver and kidney functions).

Written consent from all cases was taken. One of the ten cases was excluded from ALL reconstruction due to previous ACLR.

The remaining nine cases with a preoperative high-grade pivot shift were subjected to combined ACLR using quadruple hamstring graft and ALL reconstruction using iliotibial tract (ITT) graft.

ALL reconstructions were anatomical (from lateral femoral condyle to just posterior to Gerdy's tubercle).

Cadaveric part

The lateral aspect of the extended knee joint was dissected, and a rectangular skin flap was reflected to identify the underlying structures; the ITT and biceps femoris. A transverse incision in the ITT about 5 cm above the lateral femoral condyle was made and freed from its attachment to the lateral intermuscular septum (LIS) and lateral patellar retinaculum. The ITT was reflected downward toward its tibial attachment. The capsule and the lateral collateral ligament (LCL) were identified. The following parameters of the ALL were recorded:

1. Femoral attachment of ALL: Shape and diameter
2. Tibial attachment of ALL: Shape and diameter
3. Length of ALL
4. Width of ALL at knee joint line
5. Relations of ALL to LCL, inferior lateral genicular artery (ILGA), lateral meniscus (LM), popliteus, and LIS
6. Relation of ALL to a point midway between Gerdy's tubercle and fibular head.

The measures were recorded using a manual Vernier caliper [Figure 1a and b].

Clinical part

A lateral hockey-stick incision was made through the skin along the ITT and is extended distally between the lateral fibular head and Gerdy's tubercle [Figure 2].

Sharp dissection was made down to the fascia covering the ITT. Full-thickness skin flaps with subcutaneous tissue were made anteriorly and posteriorly. To avoid postoperative necrosis, the posterior skin flap should be thick with sufficient vascularity. With the aid of a spinal needle, the joint line was identified. The tibial attachment site of the ALL was identified, equidistant between the center of the Gerdy tubercle and the anterior margin of the fibular head, 9.5 mm distal to the joint line (Schon *et al*., 2016) [Figure 3].

Path was created underneath the superficial layer of the ITT using gentle blunt dissection. A proximal exit point was created slightly posterior to the proximal fibular collateral ligament attachment by making a 3-cm incision through the superficial layer of the ITT. The ALL's femoral attachment is located 4.7 mm proximal and posterior to the LCL's femoral insertion as described by (Caterine *et al*., 2015) An eyelet pin was drilled into the femur, aiming anteriorly and proximally to avoid the trochlea and a potential collision with an ACL tunnel.

Statistical analysis

Results were expressed as mean ± standard deviation. Statistical analysis was performed using Statistical Package for the Social Science version 19.0. Data were analyzed using one-way analysis of variance, and significant difference was determined using *post hoc* Turkey's test for multiple comparisons at ($P < 0.05$).

Results

Anatomical results

Shape of anterolateral ligament

The ALL was clearly identified in all 20 lower limb cadaveric specimens. In all the specimens,

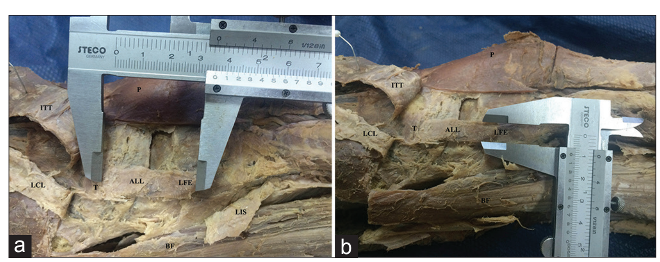

Figure 1: A photograph of lateral view of left knee showing (a) the length of ALL between its femoral and tibial attachment using a manual Vernier caliper and (b) the width of ALL. LCL - Lateral collateral ligament, LIS - Lateral intermuscular septum, LFE - Lateral femoral epicondyle, T - Anterolateral side of tibia, *P* - Patella, ITT - Iliotibial tract, BF - Biceps femoris, ALL - Anterolateral ligament

ALL was identified along the anterolateral aspect of the extended knee, and it was in the form of a band [Figures 4-9].

Femoral attachment of anterolateral ligament

ALL attachment proximally was to the lateral surface of the LFE, just anterior to the attachment of LCL with no space in between [Figures 5-7]. The area of femoral attachment was oval [Figure 9]. The longest diameter of this oval area ranged from 9 to 13 mm with a mean value of 10 ± 1 mm, while the shortest diameter ranged from 6 to 8 mm with a mean value of 7 ± 0.9 mm.

The angle between the long axis of this oval area and the long axis of femur ranged from 22° to 26° with a mean value of 21° ±2°.

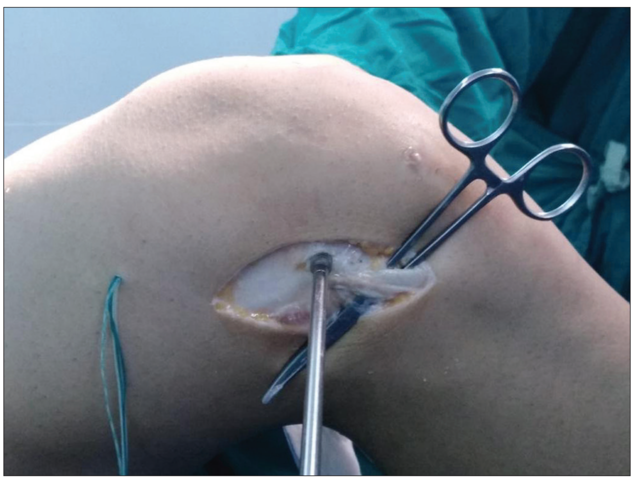

Figure 2: A photograph of lateral view of right knee showing a lateral hockey-stick incision is made through the skin along the iliotibial tract and is extended distally between the lateral fibular head and Gerdy's tubercle

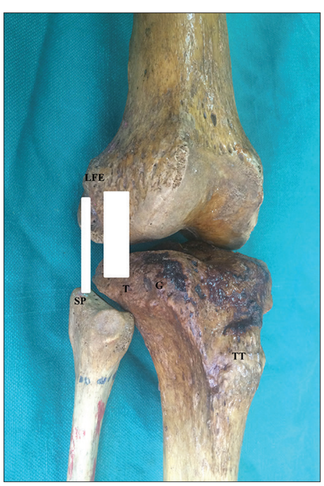

Figure 4: A photograph of lateral view of right knee skeleton showing bony attachment of ALL extending from the LFE to the T behind G. The LCL extends from LFE just behind the ALL to the SP. TT - Tibial tuberosity, LFE - Lateral femoral epicondyle, LCL - Lateral collateral ligament, T - Anterolateral side of the tibia, *P* - Patella, G - Gerdy's tubercle, SP - Styloid process, ALL - Anterolateral ligament

The angle between ALL (longitudinal axis between LFE and Gerdy's tubercle) and LCL (longitudinal axis between LFE and fibular head) ranged from 22° to 26° with a mean value of 21° ±2° [Table 1].

Tibial attachment of anterolateral ligament

Tibial attachment of ALL was just posterior to the Gerdy's Tubercle [Figures 1b, 5, and 9]. The area of tibial attachment is oval [Figure 9]. The longest diameter of this area ranged from 11 to 14 mm with a mean value of 12 ± 1 mm, while the shortest diameter ranged from 8 to 9 mm with a mean value of 8.5 ± 1.1 mm [Table 1]. The central point of this oval area lies at a distance of 5 mm from the plane of tibial tuberosity.

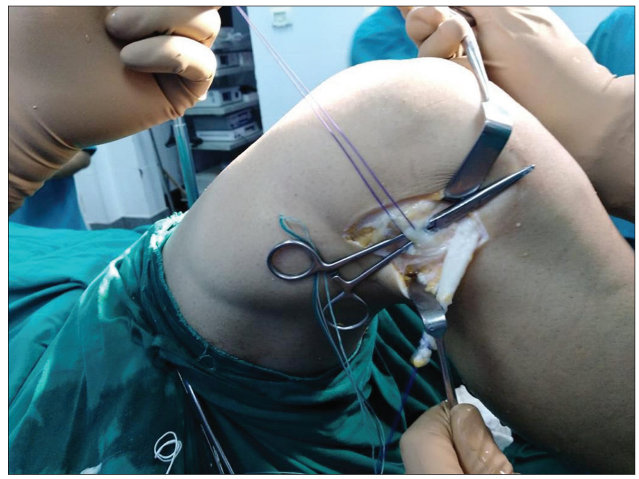

Figure 3: A photograph of lateral view of right knee showing combined anterior cruciate ligament reconstruction using quadruple hamstring graft with anterolateral ligament reconstruction using iliotibial tract graft

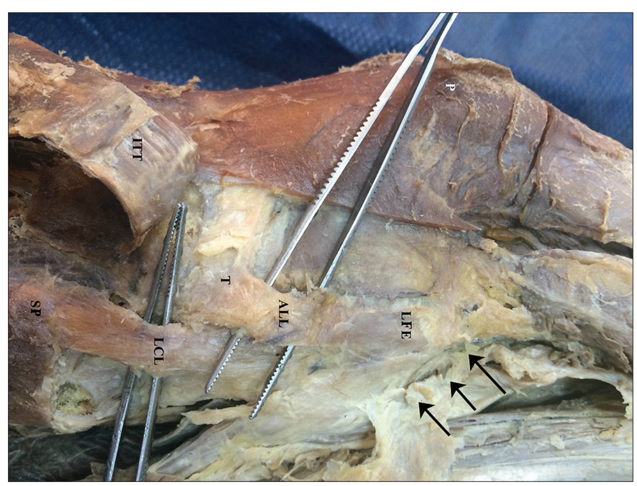

Figure 5: A photograph of lateral view of left knee showing the ALL extending from the LFE to the T. The femoral attachment of ALL is continuous upward with the lateral intermuscular septum (arrows). The proximal fibers of ALL blend with the upper fibers of LCL. The LCL is attached to the SP of fibula. Note the ITT reflected downward. *P* - Patella, ALL - Anterolateral ligament, LFE - Lateral femoral epicondyle, T - Anterolateral side of tibia, LCL - Lateral collateral ligament, SP - Styloid process, ITT - Iliotibial tract

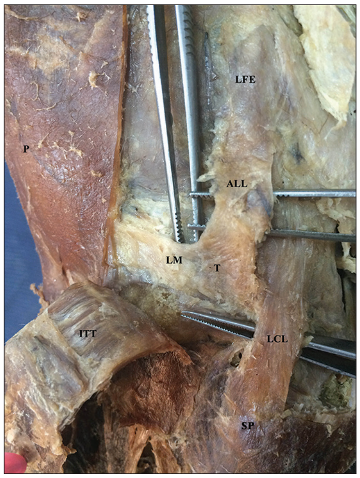

Figure 6: A photograph of lateral view of left knee showing the lower anterior fibers of the ALL extending from the LFE blending with the periphery of the LM. LCL - Lateral collateral ligament, ITT - Iliotibial tract, *P* - Patella, SP - Styloid process, T - Tibia, ALL - Anterolateral ligament, LFE - Lateral femoral epicondyle, LM - Lateral meniscus

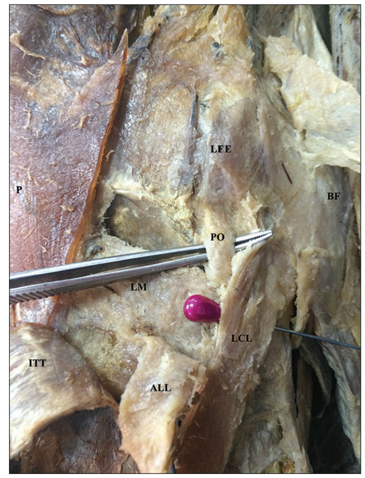

Figure 7: A photograph of lateral view of left knee showing the ALL reflected downward to show the deeply situated PO extending from below the LFE. ITT - Iliotibial tract reflected downward, LCL - Lateral collateral ligament, *P* - Patella. LM - Lateral meniscus BF - Biceps femoris, ALL - Anterolateral ligament, LFE - Lateral femoral epicondyle, PO - Popliteus tendon

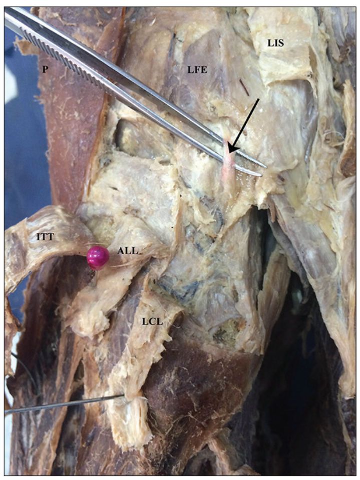

Figure 8: A photograph of lateral view of left knee showing the deep relationship of the inferior lateral genicular artery (↑) to the ALL. LIS - Lateral intermuscular septum, ITT - Iliotibial tract reflected downward, LCL - Lateral collateral ligament, *P* - Patella, LFE - Lateral femoral epicondyle, ALL - Anterolateral ligament

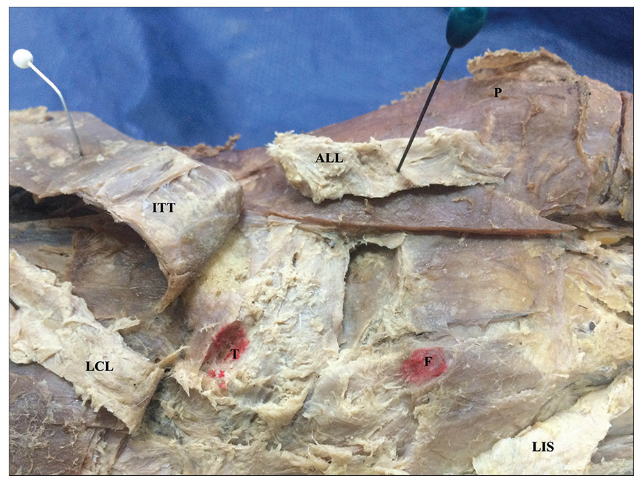

Figure 9: A photograph of lateral view of the left knee showing after detachment of ALL showing oval areas of both F and T attachments. ITT - Iliotibial tract reflected downward, LCL - Lateral collateral ligament, *P* - Patella. LFE - Lateral femoral epicondyle, ALL - Anterolateral ligament, F - Femoral, T - Tibial

The distance between the tibial attachment of ALL and the fibular head ranged from 23 to 27 mm with a mean value of 25 ± 2.5 mm [Table 1].

Length and width of anterolateral ligament

The structure was relatively flat; the width at the joint line was 1.4–6.1 mm with a mean value of 5.2 ± 1.5 mm, thickness of 0.7–2.1 mm with an average of 2 ± 1 mm, and length of 34.1–41 mm with a mean value of 37.2 ± 3.4 mm [Figure 1a and 9].

The distance between LFE and the upper edge of LM ranged from 34.1 to 41 mm with a mean value of 37.2 ± 3.4 mm. The distance between the upper edge of LM and Gerdy's tubercle ranged from 31.2 to 35 mm with a mean value of 33.2 ± 2.4 mm [Table 2].

The specimens were too rigid with minimal degree of flexion and rotation was impossible.

Relations of anterolateral ligament to anterolateral structures of the knee

The femoral attachment of ALL is continuous upwards with the LIS and related anteriorly to the distal part of ITT [Figure 1a and 5]. The proximal fibers of ALL blend with the upper fibers of LCL [Figure 5]. The lower anterior fibers of the ALL are extended from the LFE and blend with the periphery of the LM [Figure 6]. This meniscal attachment divides ALL into two parts; proximal part (meniscofemoral) and distal part (meniscotibial).

After sharply detaching the ALL from its femoral and meniscal attachments, the popliteus tendon was deeply

Table 1: Measurements of femoral and tibial attachment of anterolateral ligament in 20 lower limbs

	Range	Mean±SD
Femoral attachment of ALL		
The longest diameter (mm)	9-13	10±1
The shortest diameter (mm)	6-8	7±0.9
The angle between long axis of this oval area and long axis of femur (°)	22-26	21±2
The angle between ALL (longitudinal axis between LFE and Gerdy's tubercle) and LCL (longitudinal axis between LFE and fibular head) (°)	22-26	22±2
Tibial attachment of ALL		
The longest diameter (mm)	11-14	12±1
The shortest diameter (mm)	8-9	8.5±1.1
The distance between the tibial attachment of ALL and the fibular head (mm)	23-27	25±2.5

ALL – Antero lateral ligament, SD – Standard deviation, LCL – Lateral collateral ligament, LFE – Lateral femoral epicondyle

Table 2: Measurements of width, thickness and length of anterolateral ligament in 20 lower limbs in mm

	Range	Mean±SD
Width	1.4-6.1	5.2±1.5
Thickness	0.7-2.1	2±1
Length	34.1-41	37.2±3.4

SD – Standard deviation

situated to it blending with its superficial fibers [Figure 7]. The ILGA was found in 10% of lower limbs specimens posterior to the middle of ALL [Figure 8].

Discussion

ACL tears are one of the most common injuries among athletes. However, the ability to fully restore rotational stability with ACLR remains a challenge because up to 25% of patients may present with a residual pivot shift following surgery (Schon *et al*., 2017).

Advances in the reconstruction of the ALL are rapidly increasing because biomechanical studies have reported that the ALL is a significant contributor to internal rotational stability of the knee (Claes *et al*., 2013).

In the present study, the ALL was clearly identified along the anterolateral aspect of the extended knee as a band-shaped ligament formed of one part in 20 lower limb cadaveric specimens. Our findings were in agreement with the study of Caterine *et al*. (2015) on 19 fresh-frozen cadaveric knees. Kennedy *et al*., 2015) found that the ALL was consistently found in all knees. Claes *et al*. (2013) found that ALL was a well-defined ligamentous structure clearly separated from the capsule of the knee. Dodds *et al*. (2014) identified a consistent structure in 33 knees (83%) and they termed this the ALL of the knees.

Vincent *et al*. (2012) in their study on 10 cadaveric specimens found that the ALL was a distinct structure containing dense collagenous tissue and that it is present in all the specimens, a finding which is consistent with the present study.

The present study investigated the ALL in extended knee position, which is an obstacle for anatomic reconstruction of ALL because of the rotational laxity of the ligament. Rasmussen *et al*. (2016) found that combined anatomic ACL and ALL reconstruction further reduced rotatory laxity compared with isolated ACLR in knees with a combined ACL and ALL deficiency.

The current study revealed that ALL was attached to the lateral surface of the LFE, anterior to the attachment of LCL, and the area of femoral attachment was oval. This finding was in agreement with (Vincent *et al*., 2012) and (Claes *et al*., 2013) Both described the ALL to originate anterior to the LCL. However, Chahla *et al*. (2016) found that the femoral origin is somewhat variable in position, inserting either posterior–proximal or anterior–distal to the femoral origin of the LCL. The longest diameter of this oval area in the present study ranged from 9 to 13 mm with a mean value of 10 mm, while the shortest diameter ranged from 7 to 10 mm with a mean value of 8 mm.

Claes *et al*. (2014) in their study showed only the mean width of the femoral origin measured 8.3 ± 2.1 mm. The ALL slightly narrowed near the level of the joint line, with a mean width of 6.7 ± 3 mm. This differs from the present study that showed the ALL as a band-shaped ligament with the same width throughout its length. This may be explained that the present study was done on extended knee while Claes *et al*. (2014) studied the knee in flexed position allowing the laxity for the ligament.

Parsons *et al*. (2015) in their study of the biomechanical function of the anterolateral ligament of the knee showed that ALL on MRI had a mean length of 33.2 mm, thickness of 5.6 mm, and width of 1.9 mm. This is in agreement with the present study.

In the current research, the tibial attachment of ALL was oval and posterior to the Gerdy's Tubercle. The longest diameter of this area ranged from 11 to 14 mm with mean value of 12 mm, while the shortest diameter ranged from 8 to 9 mm with a mean value of 8.5 mm.

Pomajzl *et al.* (2015) stated that the center of the tibial insertion of ALL was on average 21.6–4.0 mm posterior to the center of Gerdy's tubercle and 23.2–5.7 mm anterior to the tip of the fibular head. The present study showed the parameters of both tibial and femoral attachment which may be of value during anatomic reconstruction of ALL.

In the current work, the femoral attachment of ALL was continuous upwards with the LIS and related anteriorly to the distal part of ITT. The proximal fibers of ALL blend with the upper fibers of LCL. The lower anterior fibers of the ALL were extending from the LFE blending with the periphery of the lateral meniscus. The meniscal attachment divided ALL into two parts; proximal part (meniscofemoral) and distal part (meniscotibial).

Analysis of the LCL, ALL, and popliteus tendon insertion on the LFE by Caterine *et al*. (2015) showed that all three attachment points had almost identical morphologies.

Because all three attachment points can be easily distinguished from each other, it provides evidence that the ALL origin is anatomically distinct compared with the surrounding LCL or popliteal origin.

In the present study, after sharply detaching the ALL from its femoral and meniscal attachments, the popliteus tendon was deeply situated to it blending with its superficial fibers; the ILGA was found in 10% of lower limb specimens posterior to the middle of ALL. The close relation of the ALL to the ILGA is very important for an orthopedic surgeon due to the blind tunneling of the tibia and fibula during ALL reconstruction. Claes *et al*. (2013) declared that a close relationship was noted with the proximal part of the LCL and not with the popliteus tendon. However, Vincent *et al*. (2012) stated that the fibers of ALL blended with the popliteus at its origin and with the lateral meniscus as it passed distally.

Conclusion

The strong point in the present study in comparison to previous studies on ALL is that it investigated the exact shape and site of both femoral and tibial attachment of ALL which may be of help during the anatomic reconstruction of ALL. On the other hand, the weak point of the present study is that the measurements of the ALL were taken in extended knee position only due to rigid specimens, so no way to know maximal tension of the graft.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Caterine S., Litchfield R., Johnson M., Chronik B., Getgood A. (2015). A cadaveric study of the anterolateral ligament: Re-introducing the lateral capsular ligament. Knee Surg Sports Traumatol Arthrosc 23 (11):3186-95.
2. Chahla J., Menge T.J., Mitchell J.J., Dean C.S., LaPrade R.F. (2016). Anterolateral ligament reconstruction technique: An anatomic-based approach. Arthrosc Tech 5 (3):453-7.
3. Claes S., Bartholomeeusen S., Bellemans J. (2014). High prevalence of anterolateral ligament abnormalities in magnetic resonance images of anterior cruciate ligament-injured knees. Acta Orthop Belg 80 (1):45-9.
4. Claes S., Vereecke E., Maes M., Victor J., Verdonk P., Bellemans J. (2013). Anatomy of the anterolateral ligament of the knee. J Anat 223 (4):321-8.
5. Dodds A.L., Halewood C., Gupte C.M., Williams A., Amis A.A. (2014). The anterolateral ligament: Anatomy, length changes and association with the Segond fracture. Bone Joint J 96-B (3):325-31.
6. Helito C.P., Bonadio M.B., Rozas J.S., Wey J.M., Pereira C.A., Cardoso T.P., Pécora J.R., Camanho G.L., Demange M.K. (2016). Biomechanical study of strength and stiffness of the knee anterolateral ligament. BMC Musculoskelet Disord 17:193.
7. Kennedy M.I., Claes S., Fuso F.A., Williams B.T., Goldsmith M.T., Turnbull T.L., Wijdicks C.A., LaPrade R.F. (2015). The anterolateral ligament: An anatomic, radiographic, and biomechanical analysis. Am J Sports Med 43 (7):1606-15.
8. Kraeutler M.J. (2017). Currents concepts of the anterolateral ligament of the knee: Anatomy, biomechanics, and reconstruction. Am J Sports Med 17:174-9.
9. Parsons E.M., Gee A.O., Spiekerman C., Cavanagh P.R. (2015). The biomechanical function of the anterolateral ligament of the knee. Am J Sports Med 43 (3):669-74.
10. Pomajzl R., Maerz T., Shams C., Guettler J., Bicos J. (2015). A review of the anterolateral ligament of the knee: Current knowledge regarding its incidence, anatomy, biomechanics, and surgical dissection. Arthroscopy 31 (3):583-91.
11. Rasmussen M.T., Nitri M., Williams B.T., Moulton S.G., Cruz R.S., Dornan G.J., Goldsmith M.T., LaPrade R.F. (2016). An *in vitro* robotic assessment of the anterolateral ligament, part 2: Anterolateral ligament reconstruction combined with anterior cruciate ligament reconstruction. Am J Sports Med 44 (3):593-601.
12. Schon J.M., Moatshe G., Brady A.W., Serra Cruz R., Chahla J., Dornan G.J. (2016). Anatomic anterolateral ligament reconstruction of the knee leads to overconstraint at any fixation angle. Am J Sports Med 44 (10):2546-56.
13. Vincent J.P., Magnussen R.A., Gezmez F., Uguen A., Jacobi M., Weppe F., Al-Saati M.F., Lustig S., Demey G., Servien E., Neyret P. (2012). The anterolateral ligament of the human knee: An anatomic and histologic study. Knee Surg Sports Traumatol Arthrosc 20:147-52.