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Topographic and Anatomical Features of Anterolateral Ligament of the Knee

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Abstract

Purpose of the study: to investigate the occurrence, severity and topographic features of anterolateral ligament (ALL) in the vien of stabilizing procedures on the knee.

Materials and Methods: the study included 60 samples of lower extremities obtained from 30 unfixed corpses of people who died at the age from 69 to 99 years. Topographic and anatomical study was performed with knee flexion at 90° with internal rotation of lower extremity using basic surgical instruments set and precision preparation instruments set. When the ligament was identified, relationship with the lateral meniscus body was evaluated, relationship with peroneal collateral ligament (mainly by connective fibers) and the presence of lateral lower knee vessels (artery and veins) were evaluated. Also, the place of ligament attachment on lateral epicondyle of femur and lateral condyle of tibia were measured.

Results: the incidence of ALL in studied age group is 56.6 percent. ALL was observed in both knee joints in 100% of cases. In women ALL was observed in 66.7% (24 joints out of 36), in men — 41.6% (10 joints out of 24). The average length of the ALL was 38.5±4.4 mm. The average width at the level of joint gap — 4.45±0.85 mm.

The location of the attachment to the lateral epicondyle of the femur was represented in three anatomical variants: posterior and proximal to the lateral collateral ligament — 64.7%, anterior to the lateral collateral ligament — 23.5%, in the place of attachment of popliteal muscle tendon or next to it — 11.8%. The place of attachment on lateral condyle of the tibia is typical — approximately in the middle of the line from fibula head to Gerdy tubercle.

Conclusion. Based on the authors' findings and findings of foreign studies the optimal area for proximal channel formation is the posterior position and proximal to place of lateral collateral ligament beginning. Also, the anatomical regularity of lateral lower knee vessels is obtained, that allows to preserve one of the main blood supply sources of anterolateral area of the knee joint.

Keywords: anterolateral ligament of the knee joint, anterior cruciate ligament.

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Background

Anterolateral ligament (ALL) is known since it was found in 1879 by Paul Segond [1]. Being studied during many years by anatomists and researchers it was given different names and reckoned among the anatomical structures of anterolateral compartment of the knee joint: iliotibial band, lateral collateral ligament, joint capsule [2–9]. An established name “anterolateral ligament” is mentioned in works of J.P. Vincent and S. Claes [10, 11]. During more than 130 years this anatomical structure was in the shade and apparently it’s role was either unobvious or underestimated. For this reason the ALL was not restored during surgical procedures for ACL rupture until 2013. The validity of ALL for reconstructive surgery has risen after further research studies demonstrated ALL contribution into knee rotational stability [12–16]. However, the data of topography and anatomical studies of anterolateral ligament is controversial and definitely insufficient [17] and require further research of this anatomical structure.

Purpose of the study — to investigate frequency of occurrence and features of anterolateral ligament topography in the context of stabilizing procedures on the knee joint.

Material and Methods

The study included 60 specimen of lower extremities obtained from 30 unfixed corpses of people who died at the age from 69 to 99 years. Only knee joints without any visual damage and signs of prior surgeries were included in the present study.

Exclusion criteria were tumors, liver or kidney diseases with marked hypoproteinemic edemas, overweight (more than 120 kg) for reasons of pronounced subcutaneous fat layer.

A conventional specimen preparation of 30 paired knee joints was performed for study purposes. Prior to that the authors performed the dissection of 10 paired knee joints in order to determine the optimal dissection technique and to evaluate relations of ALL with surrounding anatomical structures.

Topographic and anatomical study was performed with knee flexion of 90° with internal rotation of lower extremity using a set of basic surgical instruments and precision preparation instruments.

Dissection technique. The authors made U-shape skin incision starting 6–8 cm proximal to lateral femoral epicondyle, incision apex was located on the lateral border of patella and continued anteriorly and downwards at 2 cm distally to Gerdy’s tubercle. Then subcutaneous fat was detached, then superficial femur fascia was dissected. Forceps or surgical scissors were placed under iliotibial band (ITB) 5–6 cm proximally to lateral epicondyle and perpendicular to ITB, then ITB was dissected over the instrument. ITB was dissected with scalpel along the lateral border of patella up to Gerdy’s tubercle, along the inferior border ITB was dissected from femoral biceps muscle up to Gerdy’s tubercle. After that the dissected part of ITB was taken by forceps and carefully detached from joint capsule. At the same time part of osteo-capsular layer of ITB remained in close cohesion with joint capsule.

After separation of the capsule the authors evaluated anterolateral aspect of the joint in maximum internal rotation of tibia. Availability of anterolateral ligament was assessed visually, macroscopically. During ALL contouring it was isolated by precision preparing using set of special instruments and it’s relations with adjacent anatomical structures were assessed: with the lateral meniscus body, relation with lateral collateral ligament (mainly by connective fibers) and the presence of lateral inferior knee vessels (artery and veins), ALL attachment site on lateral femoral epicondyle and on lateral tibial condyle.

After identification of ALL it was fixed by traction sutures and by using digital caliper the authors measured ligament length, width at attachment to lateral femoral epicondyle, width at articular gap and at attachment to lateral tibial condyle. Origin and attachment sites of lateral collateral ligament and ALL were marked by drawing pins and then photographed (Nikon D5000). Measurement data was put into the table with ALL description, morphological data and data on individual anatomical specimen for further statistical analysis.

Results

30 paired extremities were used for cadaveric study (60 specimen), where in 17 research pairs (34 specimen) the authors observed anterolateral ligament. It should be noted that in all cases the ALL was present in both knee joints. Microscopically ALL represents a low-tensile directional band of firm texture and whitish pearlescent color under focal light. Mean age of deceased where ALL was observed was 81 years (69<81<99). ALL was observed in 12 women (67.7%) and 5 men (41.7%).

Average length of ALL was 38.5±4.4 mm, average width at the level of articular gap — 4.45±0.85 mm. In 100% of cases where ALL was observed the authors reported links of ALL with lateral inferior knee vessels (LIKV), the lateral meniscus body (LM) and lateral collateral ligament (LCL) by connective fibers and intersection.

Key properties of observed ALL are presented in table.

Table

Parameters of anterolateral ligament

No.	Age, years	Gender	Femoral attachment	Ligament length, mm	Width at level of articular gap, mm
1	75	Female	Posterior and proximal to LCL	28	5
2	87	Female	Anterior to LCL	23	5
3	90	Female	Posterior and proximal to LCL	41	4
4	85	Female	Posterior and proximal to LCL	40	5
5	99	Female	Posterior and proximal to LCL	55	4.5
6	85	Female	Posterior and proximal to LCL	45	7
7	79	Female	Posterior and proximal to LCL	43	4
8	78	Male	At site of popliteal tendon attachment	41	5
9	85	Female	Posterior and proximal to LCL	43	5
10	81	Male	Anterior to LCL	34	4
11	74	Male	At site of popliteal tendon attachment	39	3.5
12	94	Male	Posterior and proximal to LCL	40	4
13	91	Female	Anterior to LCL	31	4
14	70	Female	Posterior and proximal to LCL	29	3.5
15	69	Male	Anterior to LCL	42	4
16	92	Female	Posterior and proximal to LCL	41	4
17	89	Female	Posterior and proximal to LCL	39	4

LCL — lateral collateral ligament; LM — lateral meniscus; LIKV — lateral inferior knee vessels.

Attachment to lateral femoral epicondyle. The attachment site was represented in several anatomical variants. The most frequent variant was attachment posteriorly and proximally to attachment of lateral collateral ligament on lateral femoral epicondyle — 64.7% (22 out of 34 specimen). It should be noted that such variant is the most frequent according to the data of other researchers [11, 12, 18–20]. Authors believe that such ALL attachment site is the optimal and easier reproducible during surgical repair which can be seen on specimen image (Fig. 1).

Next frequent in occurrence is the attachment of ALL anteriorly to origin of lateral collateral ligament (23.5% cases or 8 out of 34 specimen) (Fig. 2).

ALL was attached at attachment of popliteal tendon or next to it in 11.8% of cases (4 out of 34 specimen) (Fig. 3).

In other 43.4% of cases (26 out of 60 specimen) ALL was not detected during precision preparation (Fig. 4).

Attachment on the lateral tibial condyle. ALL attachment on lateral tibial condyle was always rather typical — approximately at the middle of the line from fibula head to Gerdy's tubercle. In all cases when ligament was detected with knee flexed of 30°, 60°, 90° and with internal rotation of the tibia ALL fibers tightened which confirms contribution of this anatomical structure into the rotational stability of the knee joint.

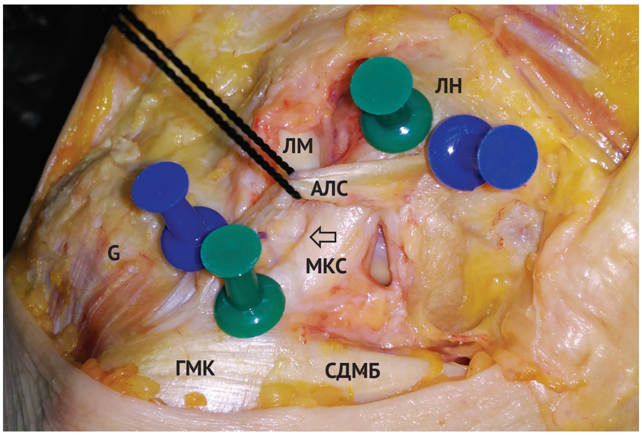

Fig. 1. ALL attachment to lateral femoral condyle posteriorly and proximally to the basis of lateral collateral ligament:
АЛС — anterolateral ligament;
МКС — lateral collateral ligament;
ГМК — fibular head;
G — Gerdy tubercle;
СДМБ — femoral biceps tendon;
ЛН — lateral epicondyle;
ЛМ — lateral condyle.
Arrow marks relation to lateral meniscus body and vessels

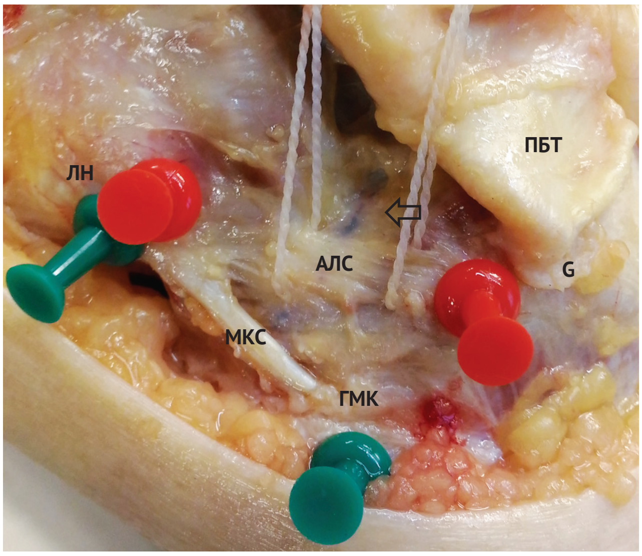

Fig. 2. Attachment site of anterolateral ligament to lateral femoral condyle anteriorly to the basis of lateral collateral ligament:
АЛС — anterolateral ligament;
МКС — lateral collateral ligament;
ГМК — fibula head;
ПБТ — iliotibial tract;
G — Gerdy tubercle;
ЛН — lateral epicondyle.
Arrow marks lateral inferior knee vessels (arteria and veins)

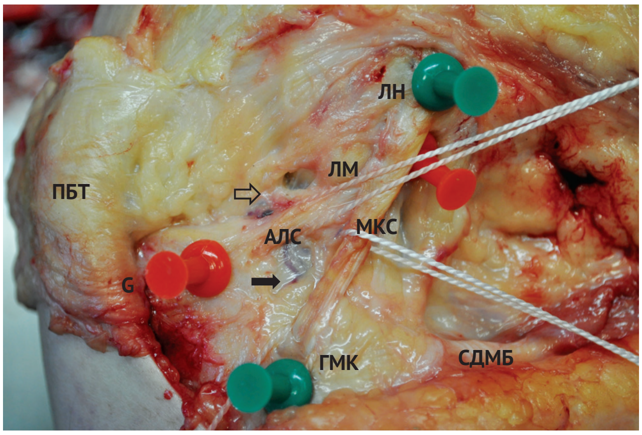

Fig. 3. ALL attachment to lateral femoral condyle at the site of hamstring attachment or next to it:
АЛС — anterolateral ligament;
МКС — lateral collateral ligament;
ГМК — fibula head;
G — Gerdy tubercle;
СДМБ — femoral biceps tendon;
ПБТ — iliotibial tract;
ЛМ — lateral condyle;
ЛН — lateral epicondyle.
Black arrow marks lateral inferior knee vessels;
White arrow demonstrates relation to lateral meniscus

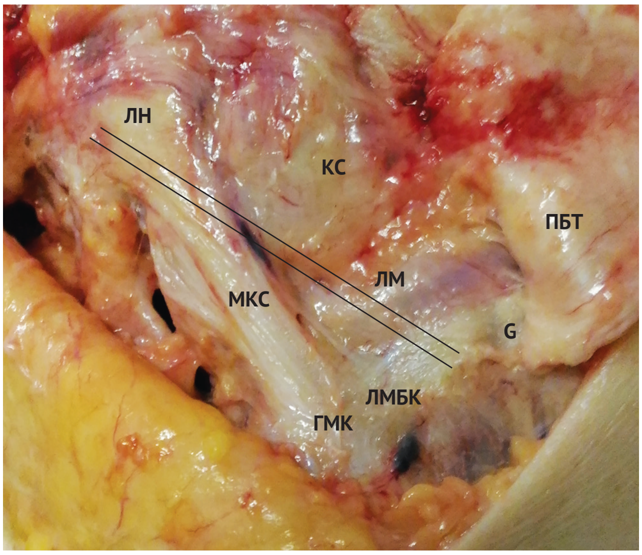

Fig. 4. Absence of anterolateral ligament:
МКС — lateral collateral ligament;
ГМК — fibula head;
G — Gerdy tubercle;
КС — joint capsule;
ПБТ — iliotibial tract;
ЛМ — lateral meniscus;
ЛМБК — lateral tibial condyle;
ЛН — lateral epicondyle.
Parallel line mark assumed position of absent ALL

Discussion

After ACL grafting in postoperative period a certain extent of micro-instability in the knee joint is reported especially rotational instability verified by Lachmann and pivot-shift tests [21, 22]. For this reasons it's considered that repair or reconstruction of this structure will allow to decrease figures of above tests and to increase rotational stability of the joint. It's important for patients with high sports activity especially with rotational load on the knee (football, rugby, basketball, combat sports, etc) [12, 23–25]. On this basis the increase of rotational stability of the knee will probably help to decrease a risk of secondary ACL graft damage and rupture of contralateral ACL [12, 26].

Frequency of ALL occurrence in the studied age group (69–99 years) was 56.6% (34 out of 60 studied specimen). Based on the fact that age of persons with identified ligament was varying from 69 to 99 and that the major part of the study group consisted of women allows the authors to suggest that in young people engaged in sports especially with high rotational load such ligament properties as width, thickness and overall evidence can be superior.

Currently anterolateral ligament is actively studied and there is new data on anatomy, clinical diagnosis and surgical technique for restoration of this structure. The present research demonstrates and confirms the results of other anatomical studies stating that ALL anatomy and passage are variable and individual. ALL femoral attachment can have several variants but the ligament function of passive support to rotational stability of the knee joint remains the same [12–16, 27].

ALL anatomy is variable and individual but as the present and other research non the less demonstrates the attachment to lateral epicondyle has several key variants which serve as reference for repair or reconstruction of anterolateral ligament [11, 12, 18–20, 28–30].

The optimal site for proximal tunnel formation is the area of lateral femoral epicondyle located posteriorly and proximally to the origin of lateral collateral ligament. Formation of bone tunnel at this site has certain advantages such as sparing treatment of adjacent anatomical structures (lateral collateral ligament, gastrocnemius lateral head tendon), simplified identification of rotation point for tunnel formation. Undoubtedly, the key for successful surgery is isometric location of ligament, meaning such graft passage where ligament will remain evenly taut at various angles of knee flexion. To create such conditions an intraoperative search is required to find a rotation point on lateral femoral epicondyle which will depend on anthropometric data of patient.

We should give consideration to positioning of lateral inferior knee vessels in relation to ALL, lateral meniscus and lateral collateral ligament, while in all cases where anterolateral ligament was identified there was a tight link and certain topography consistency of localization of above anatomical structures. Being a branch of popliteal artery the lateral inferior knee artery in anterolateral aspect of the joint is located under lateral collateral ligament. Further the artery emerges at the interval between lateral collateral ligament and anterolateral ligament, then passes under the ALL, along the body and anterior horn of the lateral meniscus towards inferior pole of patella (artery passage is parallel to lateral meniscus, or can have oblique ascending direction when passing from underneath the ALL). There the artery forms anastomosis with other vessels of the knee joint that constitute the arterial network of the patella. Considering the above we should bear in mind that lateral inferior knee vessels have the major role for perfusion of anterolateral aspect of the knee joint and preservation of those vessels will certainly have a positive effect on reparative process in postoperative period.

The data received during the present topography and anatomical research contribute to understanding the role of this structure and in the future can be useful for improvement of surgical technique. The decrease of internal tibia rotation will probably decrease the risk of damage to ACL graft in patients with high functional demands. Still further research should be aimed at studying of ALL parameters of younger people and in conditions of various physical or sports load. Then we would be able to make own corresponding conclusions on frequency of occurrence and evidence of ALL in people of different age and with different physical activity which might be of great practical importance. Also we should continue study of biomechanics, clinical aspects, diagnostic methods, surgical technique and late treatment outcomes to gain understanding on ALL's role for stabilization of knee joint and requirements for its restoration in case of injury.

References

1. Segond P. Recherches cliniques et experimentales sur les epanchements sanguins du genou par entorse. *Progres Medical.* 1879;7:297-299, 319-321, 340-341.
2. Campos J.C., Chung C.B., Lektrakul N., Pedowitz R., Trudell D., Yu J., Resnick D. Pathogenesis of the Segond fracture: anatomic and MR imaging evidence of an iliotibial tract or anterior oblique band avulsion. *Radiology*. 2001;219(2):381-386. DOI: 10.1148/radiology.219.2.r01ma23381.
3. Terry G.C., Hughston J.C., Norwood L.A. The anatomy of the iliopatellar band and iliotibial tract. *Am J Sports Med.* 1986;14(1):39-45. DOI: 10.1177/036354658601400108.
4. Dietz G.W., Wilcox D.M., Montgomery J.B. Segond tibial condyle fracture: lateral capsular ligament avulsion. Radiol. 1986;159(2):467-469. DOI: 10.1148/radiology.159.2.3961179.
5. Johnson L.L. Lateral capsular ligament complex: anatomical and surgical considerations. *Am J Sports Med.* 1979;7(3):156-160. DOI: 10.1177/036354657900700302.
6. Hughston J.C., Andrews A.R., Cross M.J., Moschi A. Classification of knee ligament instabilities: Part I. The medial compartment and cruciate ligaments. *J Bone Joint Surg Am.* 1976;58(2):159-172.
7. Hughston J.C., Andrews J.R., Cross M.J., Moschi A. Classification of knee ligament instabilities: Part II. The lateral compartment. *J Bone Joint Surg Am.* 1976;58(2):173-179.
8. LaPrade R.F., Gilbert T.J., Bollom T.S., Wentorf F., Chaljub G. The magnetic resonance imaging appearance of individual structures of the posterolateral knee: a prospective study of normal knees and knees with surgically verified grade III injuries. *Am J Sports Med.* 2000;28(2):191-199. DOI: 10.1177/03635465000280020901.
9. Goldman A.B., Pavlov H., Rubenstein D. The Segond fracture of the proximal tibia: a small avulsion that reflects major ligamentous damage. *AJR Am J Roentgenol.* 1988;151(6):1163-1167. DOI: 10.2214/ajr.151.6.1163.
10. 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. The anterolateral ligament of the human knee: an anatomic and histological study. *Knee Surg Sports Traumatol Arthrosc.* 2012;20(1):147-152. DOI: 10.1007/s00167-011-1580-3.

11. Claes S., Vereecke E., Maes M., Victor J., Verdonk P., Bellemans J. Anatomy of the anterolateral ligament of the knee. *J Anat.* 2013;223(4):321-328. DOI: 10.1111/joa.12087.

12. Sonnery-Cottet B., Daggett M., Fayard J-M., Ferretti A., Helito C.P., Lind M., Monaco E., Castro de Pádua V.B., Thaunat M., Wilson A., Zaffagnini S., Zijl J., Claes S. Anterolateral Ligament Expert Group consensus paper on the management of internal rotation and instability of the anterior cruciate ligament – deficient knee. *J Orthop Traumatol.* 2017;18(2):91-106. DOI: 10.1007/s10195-017-0449-8.

13. Rasmussen M.T., Nitri M., Williams B.T., Moulton S.G., Cruz R.S., Dornan G.J., Goldsmith M.T., LaPrade R.F. An in vitro robotic assessment of the anterolateral ligament, part 1: secondary role of the anterolateral ligament in the setting of an anterior cruciate ligament injury. *Am J Sports Med.* 2016;44(3):585-592. DOI: 10.1177/0363546515618387.

14. Sonnery-Cottet B., Barbosa N.C., Tuteja S., Daggett M., Kajetanek C., Thaunat M. Minimally invasive anterolateral ligament reconstruction in the setting of anterior cruciate ligament injury. *Arthrosc Tech.* 2016;5(1):e211-e215. DOI: 10.1016/j.eats.2015.11.005.

15. Kennedy M.I., Claes S., Fuso F.A., Williams B.T., Goldsmith M.T., Turnbull T.L., Wijdicks C.A., LaPrade R.F. The anterolateral ligament: an anatomic, radiographic, and biomechanical analysis. *Am J Sports Med.* 2015;43(7):1606-1615. DOI: 10.1177/0363546515578253.

16. Parsons E.M., Gee A.O., Spiekerman C., Cavanagh P.R. The biomechanical function of the anterolateral ligament of the knee. *Am J Sports Med.* 2015;43(3):669-674. DOI: 10.1177/0363546514562751.

17. Potu B.K., Salem A.H., Abu-Hijleh M.F. Morphology of anterolateral ligament of the knee: a cadaveric observation with clinical insight. *Adv Med.* 2016; 2016:9182863. DOI:10.1155/2016/9182863.

18. Daggett M., Ockuly A.C., Cullen M., Busch K., Lutz C., Imbert P., Sonnery-Cottet B. Femoral origin of the anterolateral ligament: an anatomic analysis. *Arthroscopy*. 2016;32(5):835-841. DOI: 10.1016/j.arthro.2015.10.006.

19. Dodds A.L., Halewood C., Gupte C.M., Williams A., Amis A.A. The anterolateral ligament: Anatomy, length changes and association with the Segond fracture. *Bone Jnt J.* 2014. 96-B(3):325-331. DOI: 10.1302/0301-620x.96b3.33033.

20. Lutz C., Sonnery-Cottet B., Niglis L., Freychet B., Clavert P., Imbert P. Behavior of the anterolateral structures of the knee during internal rotation. *Orthop Traumatol Surg Res.* 2015;101(5):523-528. DOI: 10.1016/j.otsr.2015.04.007.

21. Xie X., Liu X., Chen Z., Yu Y., Peng S., Li Q. A meta-analysis of bone-patellar tendon-bone autograft versus four-strand hamstring tendon autograft for anterior cruciate ligament reconstruction. *Knee*. 2015;22(2):100-110. DOI: 10.1016/j.knee.2014.11.014.

22. Mohtadi N.G., Chan D.S., Dainty K.N., Whelan D.B. Patellar tendon versus hamstring tendon autograft for anterior cruciate ligament rupture in adults. *Cochrane Database Syst Rev.* 2011;(9):CD005960. DOI: 10.1002/14651858.CD005960.pub2.

23. Andernord D., Desai N., Bjornsson H., Ylander M., Karlsson J., Samuelsson K. Patient predictors of early revision surgery after anterior cruciate ligament reconstruction: a cohort study of 16,930 patients with 2-year follow-up. *Am J Sports Med.* 2015;43(1):121-127. DOI: 10.1177/0363546514552788.

24. Bourke H.E., Salmon L.J., Waller A., Patterson V., Pinczewski L.A. Survival of the anterior cruciate ligament graft and the contralateral ACL at a minimum of 15 years. *Am J Sports Med.* 2012;40(9):1985-1992. DOI: 10.1177/0363546512454414.

25. Pujol N., Blanchi M.P., Chambat P. The incidence of anterior cruciate ligament injuries among competitive Alpine skiers: a 25-year investigation. *Am J Sports Med.* 2007;35(7):1070-1074. DOI: 10.1177/0363546507301083.

26. Oshima T., Nakase J., Numata H., Takata Y., Tsuchiya H. Ultrasonography imaging of the anterolateral ligament using real-time virtual sonography. *Knee.* 2016;23(2):198-202. DOI: 10.1016/j.knee.2015.10.002.

27. Roessler P.P., Schuttler K.F., Heyse T.J., Wirtz D.C., Efe T. The anterolateral ligament (ALL) and its role in rotational extra-articular stability of the knee joint: a review of anatomy and surgical concepts. *Arch Orthop Trauma Surg.* 2016;136(3):305-313. DOI: 10.1007/s00402-015-2395-3.

28. Helito C.P., Demange M.K., Bonadio M.B., Tirico L.E., Gobbi R.G., Pecora J.R., Camanho G.L. Radiographic landmarks for locating the femoral origin and tibial insertion of the knee anterolateral ligament. *Am J Sports Med.* 2014;42(10):2356-2362. DOI: 10.1177/0363546514543770.

29. Caterine S., Litchfield R., Johnson M., Chronik B., Getgood A. A cadaveric study of the anterolateral ligament: re-introducing the lateral capsular ligament. *Knee Surg Sports Traumatol Arthrosc.* 2015;23(11):3186-3195. DOI: 10.1007/s00167-014-3117-z.

30. Helito C.P., Demange M.K., Bonadio M.B., Tirico L.E., Gobbi R.G., Pecora J.R., Camanho G.L. Anatomy and histology of the knee anterolateral ligament. *Orthop J Sports Med.* 2013;1(7):2325967113513546. DOI: 10.1177/2325967113513546.

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