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CASE REPORT

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Case report of a bifurcated fibular (lateral) collateral ligament: which band is the dominant one?

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Background: *The fibular collateral ligament is a permanent and extracapsular ligament of the knee joint. It is located on the lateral aspect of the knee and extends from the lateral epicondyle of the femur to the lateral surface of the head of the fibula. As one of the main knee joint ligaments it is a stabilizer of the posterolateral corner of the knee and resists varus stress. The case report displays the bifurcated variant of the fibular collateral ligament. The aim of this study is to determine which of those bands should be considered dominant.*

Materials and methods: *Classical anatomical dissection was performed on the left knee joint. The fibular collateral ligament was thoroughly cleansed around its origin, distal attachments, and course. Appropriate morphometric measurements were collected.*

Results: *A bifurcated variant of the fibular collateral ligament with inverted proportions of its two bands (main and accessory one) constitutes our findings. It originated on the lateral epicondyle of the femur. Then it divided into two bands (A1 and A2). Band A1 inserted to the head of the fibula. A bony attachment of band A2 was located on the lateral aspect of the lateral condyle of the tibia.*

Conclusions: *Although the fibular collateral ligament is a permanent structure it presents morphological variations. It is important to constantly extend morphological knowledge for all scientists concerned in anatomy.* (Folia Morphol 2021; 80, 3: 730–734)

Key words: fibular collateral ligament, lateral collateral ligament, knee, knee joint, case report

INTRODUCTION

The knee joint is considered the biggest and one of the most complex joints in the human body. It consists of various structures including many ligaments, which are divided into two main groups, *extracapsular* and *intracapsular*. It is due to these ligaments that the knee joint can maintain proper stabilisation during different movements.

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The fibular collateral ligament (FCL) is one of the main extracapsular knee joint ligaments. It is located within the lateral aspect of the knee and originates, traditionally, on the lateral epicondyle of the femur. It then runs distally and attaches to the lateral surface of the head of the fibula [3, 17, 28]. There is no connection between it and the knee joint capsule [3]. The biomechanical functions of the FCL are well known and the most important of them is to resist varus forces. Additionally, it can preclude excessive posterolateral rotation of the tibia relative to the femur [8, 10, 15].

Lesions of the FCL are not rare, especially among athletes [16]. However, isolated FCL injuries seldom occur, so clinicians have to face so-called multi-ligament knee injuries. Co-occurrence of lesions of both cruciate ligaments of the knee, anterior and posterior, and structures of the posterolateral corner of the knee, are most frequent [19]. Those in most danger of FCL rupture are sportsmen exposed to shifting strains on a fully extended knee [16]. The FCL can tear as a result of hyperextension, direct varus stress, or twisting movement when a foot is fixed on the ground and the athlete rapidly changes direction of movement [14].

Anatomical structures tend to vary and can surprise us with their morphological variations [12, 26, 27]. Such fluctuations are quite common among ligaments, muscles, and their tendons [1, 6, 7, 11, 21–25]. Although scientists know a lot about the morphology of the FCL, it can still present some new features. Therefore, a proper and accurate classification system of the FCL based on morphological variations has been created [23].

This study presents a case of the bifurcated FCL with inverted size proportions of its two bands. It is important to collect such knowledge for all scientists involved in anatomy.

CASE REPORT

The cadaver of a 71-year-old female was subjected to routine anatomical dissection at the Department of Normal and Clinical Anatomy, Medical University of Lodz, for the purposes of research and the education of medical students. The knee joint was dissected using standard techniques according to a strictly specified protocol [22, 23].

During dissection of the lateral aspect of the knee joint, a bifurcated FCL was recognised. The whole ligament was thoroughly cleansed around its origin, distal attachments, and course. It originated on the lateral epicondyle of the femur. Then the common part (band A) divided into two bands (A1 and A2). After the cleansing, it was noted that two bands differed in their proportions.

— band A1 ran towards the lateral surface of the head of the fibula and inserted at this point;
— band A2 descended anterior to A1, went under the deep fascia of leg and presented a broad bony attachment on the lateral aspect of the lateral condyle of the tibia.

There were no other morphological abnormalities (Fig. 1).

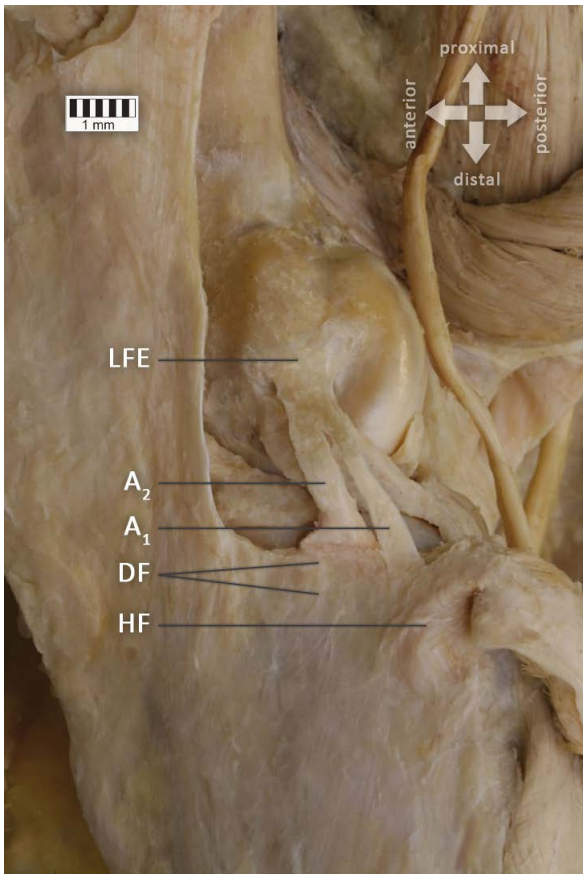

Figure 1. The presented variant of the fibular collateral ligament; a lateral view of the left knee joint; LFE — the lateral femoral epicondyle; DF — the deep fascia of leg; HF — the head of the fibula; A_1 — the main band of the fibular collateral ligament; A_2 — the accessory band of the fibular collateral ligament.

Appropriate morphometric measurements were acquired. Length and width were taken from digital photographic images and processed through MultiScanBase 18.03 (Computer Scanning System II, Warsaw, Poland), while thickness was measured with an electronic calliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan). All results are presented in Table 1.

Table 1. Measurements of the fibular collateral ligament bands

	Band	
	A1	A2
Length from the bifurcation point [mm]	24.34	18.40
Width at the bifurcation point [mm]	2.59	4.63
Width at the middle point [mm]	3.05	4.98
Width of the insertion [mm]	5.21	11.33
Thickness at the bifurcation point [mm]	0.32	0.41
Thickness at the middle point [mm]	0.34	0.40
Thickness of the insertion [mm]	0.29	0.40

DISCUSSION

Among clinicians, including orthopaedists, there is increasing interest in and hence awareness of anatomical variations. Many morphological classification systems have been published to facilitate better diagnosis and plan more advanced treatment approaches [22–24].

The fibular collateral ligament is a variable structure as demonstrated in some studies. Most of these have focused on abnormalities of its origin around the lateral epicondyle of the femur [2, 5, 13, 17, 29]. Nevertheless, some have presented morphological variations involving different numbers of FCL bands and points of distal attachments. Specifically, bifurcated and trifurcated FCLs have been recognised [3, 4, 23]. One study even presented a double FCL [23]. According to Olewnik et al. [23], there are four types of FCL (I, IIa, IIb, III, IV). Among the types that occur as multibands, we can distinguish a *main* band and one or two *accessory* band(s). The *main* band always inserts to the head of the fibula, while the *accessory* band(s) has/have two points of insertion, the deep fascia of the leg and the styloid process of the fibula. Chappell et al. [3] found all *additional* bands attached to the anterior or posterior aspect of the head of the fibula. In our study, we recognised two bands, A1 and A2. A1 inserted to the lateral surface of the head of the fibula, while A2 inserted to the lateral aspect of the tibial lateral condyle. The FCL described in this study appeared to be similar to type IIa described by Olewnik et al. [23] because of the bifurcation and the descending direction of the bands. However, there was a difference in the attachment point of the *accessory* band (A2); it presented a bony attachment, while in Olewnik et al. [23] the *accessory* band inserted to the deep fascia of the leg. On the basis of this information about the insertional points, we could consider band A1 the *main* one and band A2 an *accessory* one. The question arises whether it is appropriate reasoning in each case and whether the *main* band is always dominant. In our work, all measurements revealed (Table 1) that the band attached to the lateral aspect of the lateral condyle of the tibia (A2) was more massive than A1. This could imply that despite the atypical "non-main" insertion in such cases, the *accessory* band can be functionally dominant.

An embryological study found the mesenchymal condensation that provides rise to the FCL in 7-week-old embryos. At 9 weeks it was described as a thin but well-defined cellular band which descended from the lateral epicondyle of the femur to merge with the perichondrium of the head of the fibula. The FCL reached a structural similarity with the adult knee at 14 weeks, presenting groups of cells separated by a lot of bundles consists of collagenous fibres [9]. According to Merida-Velasco et al. [18], the FCL develops independently from the knee joint capsule in contrast to the medial collateral ligament. It is interesting whether, in the case of bifurcated variants of the FCL, both bands (*main* and *accessory*) develop simultaneously.

The FCL is a significant knee joint stabilizer. It resists varus forces at all knee flexion angles and stabilises the posterolateral corner of the knee. Moreover, it resists external rotation of the knee over the flexion span 0°–30°. Above 30° it loses tension and becomes insufficient as a stabilizer of external rotation of the knee [5, 8, 10, 15, 20]. It is possible that some kinds of multibanded FCL can provide extra stabilisation functions, but specialist biomechanical examination will be needed to establish this.

Although injuries to the FCL are less common than injuries to the medial collateral ligament, appropriate diagnosis, treatment, and rehabilitation are key to ensuring sufficient recovery and postoperative stabilisation [15, 29]. The treatment method depends on the "grade" of FCL injury, and surgical procedures include primary repair and total reconstruction. Primary repair is used in acute bony avulsions around the proximal or distal attachment of the FCL, while total reconstruction is preferable for midsubstance tears or chronic lateral knee instability after the FCL injury [19, 20]. Our findings suggest that in some surgical treatment approaches to ligaments or tendons with *accessory* bands, surgeons should be more careful and verify which band is truly dominant; this should

be given most focus in order to restore the primary and essential function.

Limitations of the study

The study has some limitations. Although the anatomical examination was thorough, this is only a case report, presenting the topic for the first time. Further anatomical, biomechanical, and imaging examinations are required to investigate the variation more deeply and create useful tips for clinicians specialising in treatment of ligaments and tendons. Nevertheless, we think it important to collect all new morphological information, and to enrich and integrate anatomical knowledge for all anatomists.

CONCLUSIONS

The fibular collateral ligament is an anatomical structure with the potential for novel, extremely rare morphological variations. Besides bifurcated, trifurcated, or double FCLs, the size proportions between the *main* and *accessory* bands can be inverted. Assembling complete anatomical knowledge, even including such rare cases, is valuable for clinicians involved in anatomy.

Ethics approval and consent to participate

The protocol of the study was accepted by Bioethics Committee of Medical University of Lodz (resolution RNN/297/17/KE). The cadavers belong to the Department of Normal and Clinical Anatomy of the Medical University of Lodz.

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