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CASE REPORT

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A previously unknown variant of the calcaneofibular ligament

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The lateral ankle joint is composed of 3 ligaments: the anterior talofibular ligament (ATFL), the posterior talofibular ligament (PTFL) and the calcaneofibular ligament (CFL). The ATFL and CFL demonstrate morphological variation, especially regarding their shape and number of bands. During standard anatomical dissection, an unusual type of triple CFL was observed: the CFL was composed of 2 bands originating on the lateral malleolus, and the presence of a lateral talocalcaneal ligament (LTC) originating on the talus bone. The insertion point of each band was located on the calcaneal bone. An understanding of these anatomical patterns allows a clearer view of ankle joint biomechanics, and improved planning and performance of surgical treatment. (Folia Morphol 2025; 84, 1: 276–280)

Keywords: ankle joint, anatomical variations, calcaneofibular ligament, lateral talocalcaneal ligament

INTRODUCTION

The ankle joint ligament can be divided into 3 subgroups based on its anatomical position: lateral ligaments, medial ligaments, and ligaments of the tibiofibular syndesmosis [15]. These demonstrate considerable anatomical variation [6, 10, 11, 15, 17, 20, 21, 26, 39]. The medial side of the ankle joint is created by the deltoid ligament and the lateral side by the lateral collateral ligament complex (LCL). The LCL consists of the anterior talofibular ligament (ATFL), posterior talofibular ligament (PTFL), and calcaneofibular ligament (CFL) [14].

Calcaneofibular ligament fibres course posteroinferiorly from the tip of the lateral malleolus onto the lateral surface of the calcaneal bone. Being bi-articular, the CFL bridges both the talocrural joint and subtalar joint. The primary role of the CFL is to prevent inversion in the neutral or dorsiflexed position and restrain subtalar inversion; it also limits talar tilt within the ankle mortise [41].

All anatomical structures, including muscles or ligaments, exhibit anatomical variation [24, 33–35]. The variations of ligaments may concern the location of the attachments, their morphology, and the occurrence of additional bands [27–29]. There are several classifications based on CFL morphology [6, 14, 20, 30]. The most recent classifications were proposed by Ruzik et al. [31, 32].

The most common injury in the locomotor system is ankle joint sprain, which mostly occurs as result of supination with extreme inversion and plantar flexion at the ankle joint. Although the most commonly injured ligament is the AFL, up to 20% of ankle sprains also include CFL damage [2, 10].

This study presents a case report of a double CFL accompanied by the presence of a lateral talocalcaneal ligament (LTC). An awareness of the morphological variability of CFL may be beneficial for anatomists, radiologists, or orthopaedic surgeons.

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CASE REPORT

A male cadaver, 70 years old at death, was subjected to routine anatomical dissection for teaching and research purposes. The cadaver had been donated to the Department of Anatomical Dissection and Donation, Medical University of Lodz. The lateral side of the foot was dissected using standard techniques as described previously.

Dissection of the ankle joint began with the removal of the skin of the lateral compartment of the leg. Following this, the subcutaneous tissue and fascia were carefully removed to reveal the fibularis brevis and fibularis longus tendons. The tendons were then removed to display the CFL. After the dissection, a double-banded CFL with the presence of the lateral talocalcaneal ligament (LTC) was identified. (Figs. 1, 2).

Measurements were taken using an electronic caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan). The measurements were obtained twice by 2 researchers. The results are given in Table 1.

Figure 1. Case report of double calcaneofibular ligament with lateral talocalcaneal ligament. CFL — calcaneofibular ligament; LTC — lateral talocalcaneal ligament.

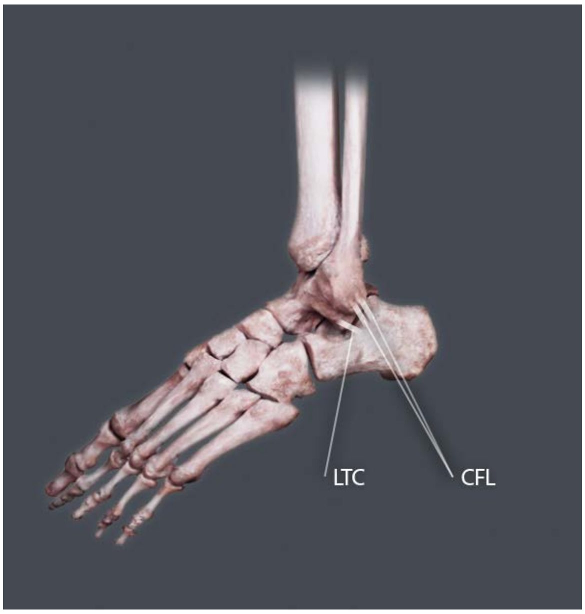

Figure 2. Schematic drawing of double calcaneofibular ligament with lateral talocalcaneal ligament. CFL — calcaneofibular ligament; LTC — lateral talocalcaneal ligament.

DISCUSSION

To understand the complexity of CFL variations, it is necessary to consider the embryology of the ankle joint. Foot and ankle development begins in the fourth week of foetal life. At that time, the lower limb buds are visible in external rotation. Starting from the eighth week, the rotation decreases, and the feet are set in a near neutral position in the eleventh week. In the tenth week of foetal life, joint cavities with synovial linings begin to appear, followed by the development of ATFL, PTFL, and CFL [22, 23]. The former is created by the thickening of the joint capsule. The PTFL and CFL arise from a thickening of loose tissue distant from the ankle joint, following which, the CFL fibres elongate, forming the shape of a ligament [22, 23]. A study by Ruzik et al. [32] on human foetuses found the shape of the ligament to be determined from the onset of development; as such, any potential division into a double-banded CFL or the creation of an additional ligament, such as the LTC, must take place at this early stage.

The CFL runs along the lateral side of the ankle joint and is almost completely covered by the fibularis longus and fibularis brevis tendons. The ligament originates on the anterior part of the lateral malleolus and inserts onto the small tubercle at the posterior aspect of the lateral calcaneus [14].

Table 1. Morphometric measurements of the presented case report of double CFL with presence of LTC.

	Main band	Second band	LTC
Origin	Lateral malleolus	Lateral malleolus	Talus bone
Insertion	Lateral surface of calcaneal bone	Lateral surface of calcaneal bone	Lateral surface of calcaneal bone
Length	24.77	23.92	26.89
Width at proximal attachment point	2.82	2.40	2.16
Thickness at proximal attachment point	1.56	1.50	1.51
Width in the centre	2.80	2.44	2.10
Thickness in the centre	1.56	1.44	1.51
Width at distal attachment point	2.86	2.48	1.78
Thickness at distal attachment point	1.52	1.51	1.44

CFL — calcaneofibular ligament; LTC — lateral talocalcaneal ligament.

Like other ligaments of the ankle joint, the CFL is characterised by high morphological variability. In a study based on 39 lower limbs, Burks et al. [6] describe the CFL as a band-shaped ligament; however, they did not note any anatomical variations and only mentioned the LTC without considering its frequency. Trouilloud et al. [37] presented a threefold classification of the CFL based on the presence of the LTC; however, they did not describe the morphology of main band of the CFL. Wiersma et al. [40] were among the first to describe the morphological variations of the CFL, reporting a cord-like structure (66%) and a fan shape (34%). Kitsoulis et al. [20] proposed a CFL classification based on band number, i.e. 1, 2, or 3 bands, but did not consider any attachments; the study does not include any photographic documentation of the specified morphological types.

Pereira et al. [30] described 4 types of CFL based on 47 lower limbs: Type 1 (21 out of 47 cases) is a band-shaped ligament; Type 2 is a Y-type CFL; Type 3 is a V-shaped CFL; and Type 4 includes an associated lateral talocalcaneal ligament. More recent studies by Ruzik et al. [31, 32] based on human foetuses and adult human cadavers divided Type 2 and Type 4 into subtypes with detailed types of origin: for Type 2 (Y-shaped), subtype 2a included both origins located on the lateral malleolus while subtype 2b included origins located on the lateral malleolus and the talus bone. In addition, Type 4, i.e. with additional bands, was divided into 3 subtypes: Type 4a, with the additional band originating on the lateral malleolus, Type 4b originating on the talus bone, and Type 4c, with 2 additional bands, as in the present study. Each subtype included a main band originating on the lateral malleolus, with the proximal attachments located on the lateral malleolus. Of all the subtypes, only Type 4b accommodates the lateral talocalcaneal ligament. The prevalence of LTC is reported from 42% to 66% [19]. However, the presented case represents as a new subtype because it is the first example in which an LTC coexists with a double CFL [31, 32].

The most common injury to the system is ankle sprain occurring during inversion and supination of a plantar-flexed foot. The main stabiliser of the ankle joint, which prevents this type of injury, are the lateral ankle ligaments [12, 26]. Most sprains affect the ATFL; however, the CFL is also ruptured in 20% of cases. While rest, ice, compression, and elevation therapy can achieve excellent results, the patient may develop chronic ankle instability (CAI) [3, 4, 38]. CAI is initially treated conservatively with rehabilitation; however, if symptoms last longer than 6 months, surgical treatment should be considered [9, 18, 36].

While surgical treatment of ankle instability was originally based on non-anatomical techniques, Brostrom [5] developed the first anatomical technique, which was modified by Gould et al. [16]. Many surgical techniques have been developed for the anatomical reconstruction of ankle ligaments based on the principles described by Brostrom and Gouland [1, 7, 8, 13, 25]. Surgical CAI treatment should be accompanied by detailed diagnostic imaging to assess whether the ATFL is isolated or whether there is a concomitant CFL injury. If both ligaments are ruptured, they must be reconstructed to avoid recurrence. Because both open and arthroscopic techniques are used to reconstruct the ligaments, an understanding of the anatomical variants presented herein is needed to ensure optimal treatment results [1, 7, 8, 13, 25].

CONCLUSIONS

An unusual CFL ligament characterised by the co-occurrence of a double CFL and the presence of a LTC was identified. The described case is significant for anatomists, orthopaedic surgeons, and radiologists because its findings can be used to support the correct diagnosis and treatment.

ARTICLE INFORMATION AND DECLARATIONS

Ethics statement

The study protocol was accepted by the Bioethics Committee of the Medical University of Lodz (resolution RNN/242/22/KE). The cadavers were the property of the Department of Anatomical Dissection and Donation, Medical University of Lodz. Informed consent was obtained from all participants before they died.

Author contributions

Kacper Ruzik — data collection and analysis and manuscript writing. **Anna Czech** — data collection and analysis. **Marek Drobniewski** — data analysis and manuscript editing. **Andrzej Borowski** — numerous consultations, observations, and suggestions related to the paper. **Łukasz Olewnik** — data analysis and manuscript editing, data analysis and manuscript writing. All authors have read and approved the manuscript.

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Conflict of interest

The authors declare that they have no competing interests.

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