Anatomy of the fibularis tertius muscle – a cadaveric study

Dariusz Jan Krawiec[1,2], Michał Szlęzak[2,3], Kamil Luboński[2,3], Kacper Warakomski[1,3], Grzegorz Bajor[4], Michał Kuszewski[1]

[1] Department of Biomedical Sciences and Physical Medicine, Institute of Physiotherapy and Health Sciences, Academy of Physical Education, Katowice, Poland

[2] Fizjosport Medical Center, Katowice, Poland

[3] NOMPT, Association of Neurophysiological and Orthopedic Manual Therapists, Poland

[4] Department of Human Anatomy, Faculty of Medical Science, Medical University in Katowice, Katowice, Poland

Correspondence to: Dariusz Jan Krawiec, email: darek.krawiec1997@wp.pl

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Abstract

Background: According to anatomical studies conducted on cadavers, the fibularis tertius muscle (FTM) is frequently or consistently present in the population. Some authors claim that the fibularis tertius muscle is present at up to level of 81.5-100%.

Aims: The main objective of the study is to present the anatomy of the FTM by investigating the frequency of occurrence of the FTM and measuring the length of the tendon and belly of this muscle, and revealing possible clinical and academic implications of the relative position of these structures and their anatomical variability based on the cadaveric studies performed on the cadavers unfixed with formalin.

Material and methods: This study included 24 lower extremities from 12 frozen (but not fixed with formalin) cadavers.

Results: In the performed anatomical section, FTM was present in 24 out of the 24 lower extremities – it was present on both right and left lower limbs in each of examined 12 cadavers (100%). The mean overall length of the FTM was 180.3mm, the mean length of the muscle belly was 112.1mm, and the mean length of the tendon was 68.2mm.

Conclusion: In the conducted study, FTM was present on every examined lower extremity. The variability of the muscle's morphological features seems to be worth investigating in future studies due to the interesting features found during preparation.

Key words

measurements, anatomy, fibularis tertius muscle, cadaveric study.

Introduction

Classically, the fibularis (peroneus) tertius muscle (FTM) is the most superficially located muscle in the anterior compartment of the lower extremity. The origin of this muscle is the lateral condyle of the tibia, 1/2 or 1/3 of the distal fibula, 1/2 or 1/3 of the interosseous membrane of the shin and the anterior intermuscular septum, the inner surface of the fascia of the shin [1].

The fibers of this muscle run vertically downwards, passing into a tendon, which is located under the upper and then under the inferior extensor retinaculum; lateral to the extensor digitorum longus muscle in the same canal; and attaches to the dorsal side of the base of the V and/or IV metatarsal bones [1-2].

The FTM, on its path, passes through the superior and inferior extensor retinaculum of the ankle joint. The superior and inferior extensor retinaculum are located distally in the anterior compartment of the lower leg and foot. The superior extensor retinaculum of the ankle joint attaches laterally to the lower edge of the fibula and runs medially from the anterior to the anterior edge of the tibia and medial malleolus. The inferior extensor retinaculum is a complex structure formed of 3 - in the case of a Y-shaped structure - or 4 strands of fibers - in the case of an X-shaped structure [3].

The inferior extensor retinaculum of the ankle joint begins on the superior surface of the calcaneus on the lateral side and runs medially, splitting into branches: the superior medial oblique and inferior medial oblique, which attach respectively to: the anterior surface of the medial malleolus and the medial edge of the foot at the level of the cuneiform joint [3].

The superior and inferior extensor retinaculum of the ankle joint are responsible for supporting the tendons of the muscles that straighten (dorsiflexion) the foot. This protects the tendons of the muscles passing through the retinaculum canals: the tibialis anterior muscle, the extensor digitorum longus muscle, the extensor hallucis longus muscle, and the fibularis tertius muscle before subluxation, or what is known as the 'bowstring tightening mechanism' [4].

The FTM is the only one of the fibular muscles that does not perform plantar flexion of the foot but does perform dorsiflexion, collaborating in this function with the tibialis anterior, extensor digitorum longus, and extensor hallucis longus muscles. The FTM also performs foot eversion, working with the fibular muscles - longus and brevis; functionally, the activity of this muscle translates into movement in the phase of transferring the foot over the ground during gait [2, 5-8].

According to anatomical research carried out on cadavers, the FTM is a muscle that is frequently or consistently present in the population, as some authors even report a rate of 81.5%-100% [5-12]. The anatomy and biomechanics of the FTM and the inferior extensor retinaculum of the ankle joint can be important not only for academic reasons but also for clinical purposes. The FTM is used in tendoplasty, tendon grafting, and resection surgery of the foot [12] and also as a reference point in the anterolateral ankle during arthroscopy [13-14]. In addition, the brevis fibula muscle and the FTM tendon attach to the V metatarsal bone; this can imply torsional forces in the areas where Jones fractures and stress fractures occur [14-15].

Aims

The main objective was to investigate the basic morphological characteristics of the FTM muscle, such as the overall length, length of the belly, and tendon. An additional aim was to investigate the prevalence of FTM in the research material.

Materials and methods

A cadaveric examination was carried out by dissecting the anterior and lateral aspects of the lower leg and foot, together with the inferior extensor retinaculum and the muscles passing through this retinaculum. The study was designed to provide an accurate anatomical picture of the forefoot and lateral shin and foot region and to trace the course of the FTM, along with the measurement of selected morphological features of the muscle.

The research material consisted of 24 lower limbs from 12 cadavers frozen and unfixed in formalin (2 from each cadaver). The cadavers were provided by the Conscious Donation Program of the Silesian Medical University in Katowice. The cadaver study was approved by the Bioethics Committee of the Silesian Medical University in Katowice under the number: KNW/0022/KBI/135/17.

In order to dissect the muscles of the anterior and lateral parts of the lower leg and foot, together with the inferior extensor retinaculum of the ankle joint, the cadaver was placed in the supine position, and each of the lower limbs examined in the supination position, and then the skin together with the subcutaneous adipose tissue was removed from both lower limbs of each cadaver and removed completely starting from the tibia plateau and the head of the fibula longitudinally in a caudal direction up to the level of the metatarsophalangeal joints (**Figure 1**).

Figure 1. Anterolateral forefoot and ankle joint with exposed Y-shaped inferior extensor retinaculum of the ankle joint.

Notes: Posted with permission from the Medical University in Katowice, Poland.

Abbreviations: tFTM – tendon of the fibularis tertius muscle, bFTM – belly of the fibularis tertius muscle), S – stem of the inferior extensor retinaculum), OSL – oblique superomedial limb of the inferior extensor retinaculum, OIL – oblique inferomedial limb of the inferior extensor retinaculum.

Most of the preparation process was carried out 'bluntly' - with the fingers; only in the final phase was the fascia cut away so as not to damage the FTM and the extensor retinaculum of the superior and inferior ankle on the path of this muscle, which were also exposed, followed by the subsequent procedures:

1. In the lower limbs, where FTM was present, it was exposed at the level of the inferior extensor retinaculum of the ankle joint.
2. The following FTM measurements were taken using an electronic digital caliper with an accuracy of 1mm, one end of the caliper marking where the measurement started was applied respectively to: a) the proximal attachment of the FTM, and the caliper was extended lengthwise in line with the direction of the muscle fibers to the distal attachment - in this way the total length of the FTM was measured twice, b) the proximal attachment of the FTM and the caliper was extended longitudinally in line with the direction of the muscle fibers to the transition of these fibers into the tendon - in this way the length of the belly was measured twice, c) the transition of the muscle fibers into the FTM tendon and the caliper was extended along the tendon to the distal attachment of this muscle - in this way the length of the tendon was measured twice.
3. Calculations were made: the mean of each pair was extracted from the measurements taken, and from such obtained results, the average was calculated for: the total length of the FTM, the belly length of the FTM, the tendon length of the FTM, and the standard deviation.

Results

In the performed autopsy, the FTM was detected in 24 out of 24 lower extremities – it was present in the right and left lower limb in each of the 12 examined cadavers (100%). The following results presented in **Tables 1-3** were obtained from the FTM tendon and belly length measurements:

Table 1. Results of measured features of FTM in all cadavers.

Serial number	**Total muscle length** [mm]	**Muscle belly length** [mm]	**Tendon length** [mm]
1R	186	106	80
1L	191	110	81
2R	193	124	69
2L	195	128	67
3R	172	98	74
3L	167	95	72
4R	209	147	62
4L	206	142	64
5R	158	87	71
5L	160	87	73
6R	199	134	65

6L	200	137	63
7R	179	120	59
7L	177	116	61
8R	185	93	92
8L	178	91	87
9R	202	140	62
9L	201	137	64
10R	173	106	67
10L	172	109	63
11R	190	121	69
11L	177	114	63
12R	127	72	55
12L	130	77	53
Average	180.3	112.1	68.2

Abbreviations: R – right, L – left.

Table 2. Average scores of measured features of a right-sided FTM.

Feature	**Total muscle length** [mm]	**Muscle belly length** [mm]	**Tendon length** [mm]
Average	181.1	112.3	68.8

Table 3. Average scores of measured features of a left-sided FTM.

Feature	**Total muscle length** [mm]	**Muscle belly length** [mm]	**Tendon length** [mm]
Average	179.5	111.9	67.6

Discussion

Previous publications put the prevalence of the FTM as high as 81.5%-100% [5-12], which is similar to the results of our paper (100%). Differences in the prevalence of the FTM between publications may be due to the type of population studied (race) and the sample size [7,13]. The prevalence of the FTM in the lower limbs in research conducted on the selected populations: English 38 out of 40 (95%) [5], Belgian 163 out of 200 (81.5%) [6], Polish 91 out of 106 (85.8%) [7], British 77 out of 82 (93.9%) [8], Turkish 42 out of 44 (95.45%) [9], and Asian 197 out of 220 (89.55%) [10]. Interestingly, 2 studies were conducted on the Indian population, where the prevalence of the FTM was 100% in both cases: 60 out of 60 [11] and 66 out of 66 [12]. The present examination was conducted on a Polish population, where the FTM was present in 24 out of 24 lower limbs (100%). This may be due to the sample size, as studies performed on smaller study material (n < 100) [5, 8-9, 11-12] have a higher prevalence of the FTM when compared to research conducted on a larger sample (n > 100) [6-7, 10]. In research involving the Indian population [11-12], the prevalence of the FTM was the same as in the current investigation on the Polish population (100%), also conducted with a smaller group (n < 100) (**Table 4**).

In the publication by Olewnik [7], a different division of the average belly and tendon lengths of the FTM was adopted from other publications. The author of the publication separated the average lengths for each of the different types of initial attachments, where type III meant that there was no independent muscle belly, but the tendon diverged from the extensor digitorum longus muscle. Therefore, the table does not include the mean muscle belly length for the type III initial attachment. The differences in the results of the average lengths of the belly and the FTM tendon may be due to the different types of initial attachments present in the examined material. However, according to Olewnik [7], the FTM origin of a distal 1/2 of the fibula is referred to as type I, while type II refers to muscles attached to the distal 1/3 of the fibula.

In the following publication, the results are similar to those reported by Olewnik [7] for type II origin. This may suggest that in the following study, most cadavers had a type II initial attachment. However, this was not the focus of the current research and was not identified at the time of the investigation. In contrast to Ercikti et al. [9], it was decided to include the collected results

Table 4. Comparison of the average belly and tendon length of the FTM in selected studies.

Publication	Olewnik 2019 [7]	Rourke et al. 2007 [8]	Ercikti et al. 2016 [9]	Verma Seema 2015 [11]	Our study
Average muscle belly length [mm]	Type I PP 106.3 ± 22.5 mm	106.4 ± 32.3 mm	-	210 mm	112.1 ± 21.5 mm
	Type II PP 111.6 ± 18.5 mm				
Average tendon length [mm]	Type I PP 77.5 ± 13.11 mm	69.6 ± 16.5 mm	Right 62.2 ± 8.65 mm	60 mm	68.2 ± 9.4 mm
	Type II PP 72.8 ± 17.2 mm		Left 57.7 ± 10.8 mm		
	Type III 54.5 ± 6.95 mm				

without distinguishing between the right and left lower limb due to the lack of a significant difference in the length of the FTM tendon and belly between the individual lower limbs; this makes it impossible to compare the results of this publication to others. The mean belly length of the FTM in the publication by Verma et al. [11] differs significantly from the other findings. This may be due to the fact that the authors of the publication took the distal end of the belly as the distal end of the longest muscle fiber rather than the FTM muscle-tendon transition or the belly-tendon transition, as in other publications.

Conclusions

In the following examined research materials, FTM was consistently present. The subject of variation in morphological features of the FTM seems worth pursuing in future studies due to interesting correlations revealed during preparation, such as the presence of a muscle belly under the inferior extensor retinaculum, the occurrence of the FTM on both sides, and a constant or high incidence in the population.

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