Prevalence of Fibularis Tertius: Insights from a Surface Anatomical Study

Shrestha S, Mansur DI, Shrestha P, Maskey S, Shrestha M, Kunwar A, Poudel B, Dahal P, Gautam B

Departmnet of Anatomy

Kathmandu University School of Medical Sciences,

Dhulikhel, Kavre, Nepal.

Corresponding Author

Sheprala Shrestha

Departmnet of Anatomy

Kathmandu University School of Medical Sciences,

Dhulikhel, Kavre, Nepal.

E-mail: cpralastha@gmail.com

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ABSTRACT

Background

The fibularis tertius muscle, a variant muscle in the crural compartment of the leg, is thought to have evolved in humans in response to the development of bipedalism. Acting as both an ankle dorsiflexor and foot everter, it plays a crucial role in enabling efficient terrestrial locomotion, especially in mid-foot biomechanical stabilization. The origin and insertion of this muscle have been reported to exhibit significant variation.

Objective

The aim is to determine the prevalence of this muscle by conducting a surface anatomical examination of the foot among pre-clinical sciences students at Kathmandu University School of Medical Sciences.

Method

Each participant's fibularis tertius muscle (FTM) was assessed on both feet using a standardized surface palpation technique based on protocols that Tixa and Kendall had validated. To ensure accuracy, each foot was subjected to two separate evaluations by qualified evaluators that lasted 120 seconds each. During dorsiflexion and eversion, muscles were identified using sequential palpation techniques. Visibility was categorized into three graded responses (G1–G3) according to muscle activation. SPSS version 23 was used to analyze the data. While the Chi-square test evaluated sex-based associations, with statistical significance set at $p < 0.05$, descriptive statistics summarized prevalence.

Result

A total of 226 students (54.42% males, 45.58% females; mean age 20.8 ± 1.88 years) participated in the study. The fibularis tertius muscle had a prevalence of 95.58%, with a similar gender distribution. It was bilateral in 187 participants and unilateral in 29, mostly on the right foot. Multivariable logistic regression revealed no significant association between fibularis tertius presence and body mass index, with both crude and adjusted odds ratios (0.83 and 0.89, respectively) and p-values exceeding 0.05.

Conclusion

The fibularis tertius muscle is essential for ankle stability, reducing injury risk and aiding recovery during high-impact activities. Its absence increases instability and recurrent sprains. Understanding the anatomy of fibularis tertius muscle is crucial for surgical planning, tendon repair, and rehabilitation, influencing diagnosis, treatment, and injury prevention.

KEY WORDS

Anatomy, Bilateral traits, Fibularis tertius, Muscle anatomy, Prevalence, Unilateral traits

INTRODUCTION

Fibularis Tertius muscle (FTM) typically known as Peroneus Tertius, a unipennate muscle of the anterior (crural) compartment of the leg region.[1] This muscle may be a component of or considered as a fifth tendon of extensor digitorum longus (EDL).[2]

From an evolutionary perspective, the origins of the muscle remain a continuing area of investigation; while comparative anatomy reveals its absence in hominoid apes such as chimpanzees and gorillas, suggesting a relatively recent evolution in primate history.[3]

Originating from the lower one-fourth of the medial surface of the fibular shaft, the tendon of this muscle passes beneath the superior extensor retinaculum and through the stem of the inferior extensor retinaculum and inserts into the dorsal surface of the base of the fifth metatarsal bone.[4] Its insertion pattern has been reported with great variation and has an essential factor in Jones fractures.[5-7]

The FTM is innervated by the deep fibular nerve (DFN), contributes to neuromuscular control and helps protect against talofibular ligament injuries, in so doing it improves the efficiency and economy of human locomotion.[8]

Its action in combination with EDL and tibialis anterior (TA) muscles serves a noteworthy functional and evolutionary purpose in bipedal movement in humans.[9] It contributes to midfoot stability and separates the toes from the ground, dorsiflexion, and eversion of the foot, aiding in ankle dorsiflexion as well.[10]

The presence of the FTM can vary among humans, and its morphology can differ greatly between the right and left foot. In some cases, it may have a similar bulk to the EDL muscle, while in others; it may be reduced to a rudimentary structure.[3]

Plastic and orthopedic surgeons frequently utilize this muscle during various procedures such as tendoplasty, tendon transfer, or resection surgeries on the foot. Additionally, its muscle flap and tendon are valuable for transposition to address ankle joint laxity and can also be employed in transplantation surgeries to treat foot drop.[11]

The FTM is critically understudied in Nepal, with hardly any data on its prevalence, morphological variations, or clinical implications within this population. Given the potential regional and ethnic anatomical differences, as well as Nepal's unique terrain influencing functional adaptations, this gap represents a significant limitation in both evolutionary and clinical research. Addressing this void is essential for advancing anatomical science, refining surgical practices, and enhancing the understanding of foot biomechanics in Nepalese contexts.

METHODS

This was a quantitative observational descriptive cross-sectional study conducted to identify the fibularis tertius muscle using standardized clinical palpation techniques.

The study was conducted in the Department of Anatomy at Kathmandu University School of Medical Sciences located at Chaukot, Kavrepalanchok, Nepal over a period of five months, from May to September 2024.

III. Sample size and sampling method:

The sample size is calculated as below:[12]

$n = Z^2 \times p \times (1-p) / e^2$

$= (1.96)^2 \times (0.50) \times (1-0.50) / (0.04)^2$

$= 601$

Where,

n= minimum required sample size for infinite population

Z= Z-score corresponding to the desired confidence level (1.96 for 95% CI)

p= past prevalence taken as 50% for maximum sample size

e= margin of error, 4%

The sample size was adjusted for finite population by using the formula,

$no = (nN) / [N + (n-1)]$

$= (601 \times 300) / [300 + (601-1)]$

$= 201$

Where,

no= adjusted sample size for finite population

N= total number of Preclinical sciences medical students = (300)

Taking a 10% non-response rate, the optimal sample size = 221.

A total of 226 adult subjects were recruited using a convenience sampling method. Both feet of each participant were examined.

Each foot was examined twice by two evaluators, with each assessment lasting approximately two minutes. Subjects were seated with their knees flexed at approximately 110°, while the evaluators squatted in front and stabilized the ankle joint during palpation.

The following standardized palpation steps were performed:

1. The last tendon of the extensor digitorum longus (EDL) was palpated from the little toe toward the inferior extensor retinaculum.

2. Subjects then performed dorsiflexion and eversion of the foot, allowing for the visualization of the extensor digitorum brevis (EDB) muscle bulge.

3. A groove was palpated between the EDL tendon and the EDB bulge to locate the tendon of the FTM.

Muscle visibility was classified using a three-grade system:

G1: Visible without muscle activation [Fig. 1]

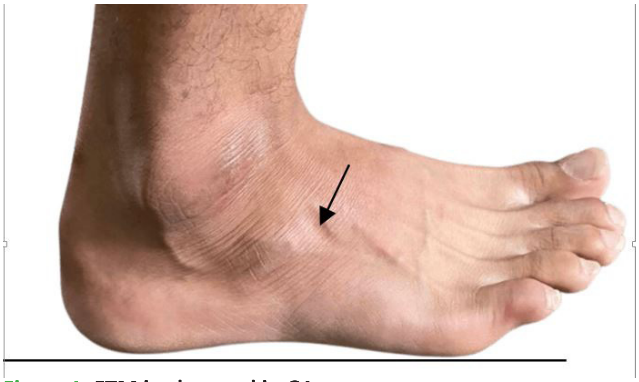

Figure 1. FTM is observed in G1

G2: Visible with dorsiflexion and eversion [Fig. 2]

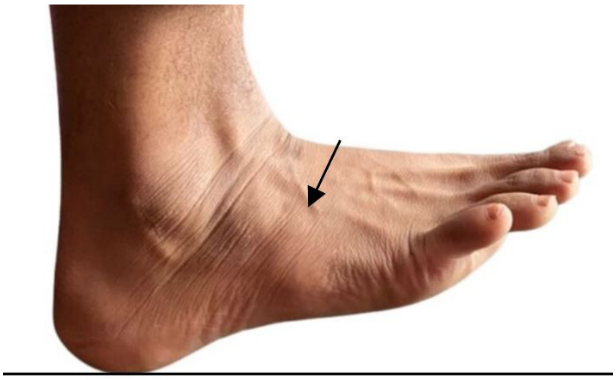

Figure 2. FTM is observed in G2

G3: Visible only with dorsiflexion and eversion against resistance [Fig. 3]

Figure 3. FTM is observed in G3

The study was approved by the Institutional Ethics Committee of KUSMS (Approval No. 159/24). Written informed consent was obtained from all participants.

Inclusion criteria were medical students attending Preclinical sciences, Kathmandu School of Medical Sciences, Chaukot, Kavrepalanchok, Nepal; age above 18 years without any known musculoskeletal or neurological conditions affecting the lower limbs. Participants with a history of lower limb trauma, surgery, congenital deformities, or acute injuries were excluded.

The examination protocol adhered to established methodologies described by Tixa and Kendall et al., which were pilot-tested for reliability and accuracy before implementation.[13,14]

All data were analyzed using the Statistical Package for Social Sciences (SPSS) version 23. Descriptive statistics were used to summarize the prevalence and visibility grades of the FTM. The Chi-square test was applied to determine the association between sex and FTM visibility. Additionally, multivariable logistic regression analysis was conducted to identify independent predictors of FTM presence, with adjustments made for sex and body mass index (BMI). A p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 226 students participated in the study, of whom 123 were male and 103 female. All participants provided informed consent. The mean age of the sample was 20.8 ± 1.88 years [Table 1].

The fibularis tertius muscle (FTM) was present in 216 participants, resulting in an overall prevalence of 95.58%. Among those with FTM, 54.63% were male and 45.37% were female [Table 1]. Bilateral FTM was observed in 187 individuals, while 29 participants exhibited unilateral FTM. Specifically, 7.08% had unilateral FTM on the right side, and 5.57% on the left. Males showed a higher prevalence of both bilateral (54.55%) and unilateral (55.17%) FTM compared to females (45.46% and 44.83%, respectively) [Table 3].

The distribution of FTM subtypes (G1, G2, G3) by foot side and sex revealed male predominance across all categories. For the right foot: G1 had 66.67% males and 33.33%

Table 1. Distribution and prevalence of fibularis tertius muscle (FTM) across sex.

FTM Status	Total (226)	Female (103)	Male (123)	Total Prevalence (%)	Female Prevalence (%)	Male Prevalence (%)	p-value*
Presence	216	98 (45.37%)	118 (54.63%)	95.58%	95.15%	95.93%	1.0
Absence	10	5 (50%)	5 (50%)	4.42%	4.85%	4.07%	
Total	226	103	123				

Note: *p-value based on Chi-square test for association between sex and presence of FTM.

Table 2. Binary Logistic Regression Results for Presence of Fibularis Tertius Muscle (FTM) by Sex.

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Sex (Male vs Female*)	0.83	0.23 to 2.95	1.00
Note: Logistic regression model with FTM presence as the dependent variable. *Reference group: Female.			

females; G2 had 52.33% males and 47.67% females; G3 showed 71.43% males and 28.57% females. For the left foot: G1 was exclusively male (100%); G2 included 56.61% males and 43.39% females; G3 had 54.55% males and 45.45% females [Table 4].

A Chi-square test was used to evaluate the association between sex and the presence of FTM. The difference in FTM prevalence between males (95.93%) and females (95.15%) was not statistically significant (p = 1.0) [Table 1].

A multivariable logistic regression was conducted to assess the association between the presence of FTM and the variables sex and BMI. In this analyses, females were used as the reference group for the sex variable. The results showed that, after adjusting for BMI, males had lower odds of having FTM compared to females (adjusted OR = 0.89; 95% CI: 0.25-3.25), but this association was not statistically significant (p = 0.86) [Table 2]. Similarly, for each unit increase in BMI, the odds of having FTM decreased slightly (adjusted OR = 0.86; 95% CI: 0.73–1.02), though this also did not reach statistical significance (p = 0.09). These findings indicate that neither sex nor BMI was significantly associated with FTM presence in the multivariable logistic regression model [Table 5].

Table 3. Distribution and prevalence of fibularis tertius muscle by type of presentation among study participants across sex.

FTM Existence	Frequency	Percentage (%)	Cumulative Frequency (%)	Male (Unilateral FTM)	Male (Bilateral FTM)	Female (Unilateral FTM)	Female (Bilateral FTM)
Absent	10	4.42	4.42	-	-	-	-
Unilateral - Right	16	7.09	11.50	16 (55.17%)	-	13 (44.43%)	-
Unilateral - Left	13	5.75	17.26	-	-	-	-
Bilateral	187	82.74	100	102 (54.55%)	102 (54.55%)	85 (45.46%)	85 (45.46%)
Total	**226**	**100**		**29**	**187**	**29**	**187**

Table 4. Distribution of fibularis tertius muscle by sex, side (right/left), and visibility grades (G1, G2, G3, Absent)

Foot	Sex		G1	G2	G3	Absent
Right	Male	123	2 (66.67%)	101 (52.33%)	5 (71.43%)	15 (65.22%)
	Female	103	1 (33.33%)	92 (47.67%)	2 (28.57%)	8 (34.78%)
Left	Male	123	1 (100%)	107 (56.61%)	6 (54.55%)	9(36%)
	Female	103	0 (0%)	82 (43.39%)	5 (45.45%)	16 (64%)
Total		**452**	**4**	**382**	**18**	**48**

Table 5. Association between Fibularis Tertius Muscle Presence and Sex & BMI Using Multivariable Logistic Regression

FTM	Adjusted Odds ratio	95% Confidence Interval	p-value
SEX (Male vs. Female*)	0.89	0.25-3.25	0.86
BMI	0.86	0.73- 1.02	0.09

Note: *Multivariable logistic regression model adjusted for sex and BMI. Female was used as the reference group for sex. BMI was treated as a continuous variable.

DISCUSSIONS

The fibularis tertius muscle is a fascinating and often overlooked part of our anatomy, but its presence varies dramatically across different populations and study methods. In our study in Nepal, we found that 95.58% of people had FTM based on surface anatomy, which is strikingly high. However, the lack of statistical significance (P value of 1.0) suggests that while it is common, it does not appear in every individual [Table 5].

Studies from places like Bolivia, Thailand, Brazil, and United Kingdom show even higher prevalence rates (up to 100%), mainly because they rely on cadaveric dissection, which allows for a much more precise identification of FTM.[15-18] But not all studies report such high numbers. As, in France, it was found in 90.9% of cases, whereas in Sri Lanka, India and Poland the rates were slightly lower, ranging from 89.55% to 83.16%.[19-22]

Table 6. Comparative prevalence of fibularis tertius muscle across different populations and study types.

Author	Year	Population	Sample	Study Type	FTM Prevalence (%)	p-value
Our Study	2024	Nepal	226	Surface Anatomy	95.58	1.0
Larico et al.[15]	2005	Bolivia	46	Cadaveric Study	100	0.0004
Kunnika et al.[16]	2004	Thailand	247	Cadaveric Study	95.55	0.0001
Marin et al.[17]	2006	Brazil	32	Cadaveric Study	93.8	0.0001
Rourke et al.[18]	2007	UK	41	Cadaveric Study	92.7	0.0001
Bertelli et al.[19]	1991	France	457	Cadaveric Study	90.9	0.0748
Kosgallana et al.[20]	2021	Sri Lanka	44	Cadaveric Study	89.55	-
Jhadav et al.[21]	2015	India	100	Cadaveric Study	87	0.0001
Domagata et al.[22]	2006	Poland	193	Cadaveric Study	83.16	0.0001
Witvrouw et al.[23]	2006	Belgium	200	Surface Anatomy	81.5	0.0001
Palomo-Lopez et al.[24]	2019	Spain	481	Surface Anatomy	38.2	0.786
Abdel et al.[25]	2018	Tunisia	198	Surface Anatomy	67.7	-
Ashaolu et al.[26]	2013	Nigeria	100	Surface Anatomy	63	-
Sirasanagandla et al.[27]	2021	Oman	222	Surface Anatomy	59.9	-
Potu et al.[28]	2016	India	195	Surface Anatomy	52.05	-
Abdel et al.[25]	2018	Egypt	250	Surface Anatomy	52.8	-
Ramirez et al.[29]	2010	Chile	168	Surface Anatomy	49.11	0.011
Abdel et al.[25]	2018	Bahrain	439	Surface Anatomy	42	-
Abdel et al.[25]	2018	Kuwait	153	Surface Anatomy	41.2	-
Abdel et al.[25]	2018	Saudi Ara-bia	208	Surface Anatomy	38.5	-

The prevalence of the FTM in surface anatomy studies reveals a fascinating range from a high of 81.5% in Belgium to as low as 38.2% in Spain.[23,24] The big drop from 52.05% to 67.7% across different populations indicating FTM might be less visible in some areas, but still widespread.[25-28] In regions like Chile and few Arab countries, the prevalence falls below 50% suggests that FTM might be harder to detect using just surface anatomy.[25,29] While the FTM is generally common; its wide variability not only highlights the diversity in anatomical presentation but also raises intriguing questions about the influence of genetic, regional, and methodological factors on the detection of FTM. Such differences emphasize the need for further exploration to better understand the underlying reasons for these variations.

The present study provides key insights into the anatomical distribution of FTM among participants. Bilateral FTM presence, observed in 82.74% of cases, is consistent with earlier studies conducted in diverse populations. Previous researchers reported similar rates of bilateral FTM prevalence, ranging from 80% to 85%.[16,17] This high frequency underscores the strong genetic and developmental basis of FTM, as bilateral symmetry in muscles is linked to the expression of HOX genes, which regulate limb morphogenesis during embryogenesis.[15,18]

Unilateral FTM was more frequent on the right side (7.08%) compared to the left (5.75%), indicating a tendency toward lateral dominance. This pattern aligns with findings from Joshi et al. and Ramirez et al., which identified asymmetry in FTM distribution.[21,29] Lateral dominance is a well-recognized phenomenon in human anatomy and may be influenced by neural innervations patterns or biomechanical factors associated with preferential limb use.[18,30] Right-sided dominance in particular has been hypothesized to result from evolutionary pressures favoring enhanced function or strength on the dominant side.[29]

The absence of FTM, observed in 4.42% of participants, is consistent with previous reports that suggest this is a relatively rare anatomical variation. Studies by Potu et al. and Abdel Halim et al. and have documented similar findings, attributing the absence of FTM to genetic variability or developmental disruptions.[28,31] Furthermore, Jadhav et al. and Domagata et al. emphasize that environmental factors during growth and development may also contribute to the variability in FTM prevalence.[23,24]

The findings of this study align with prior research, reinforcing the high prevalence of bilateral FTM and its developmental significance. The presence of unilateral and absent FTM, although less common, highlights the variability in human musculoskeletal anatomy. These results provide a foundation for future studies exploring the functional and clinical implications of FTM variations, particularly in relation to biomechanics and evolution.

There was a marginally greater occurrence of FTM among males (54.63%) in contrast to females (45.37%), indicating that sex might be a contributing factor in its development, possibly as a result of hormonal or genetic influences.

Nevertheless, most of the current literature does not explore sex-based differences, which restricts the ability to draw direct comparisons. This shortcoming underscores a significant path for future research aimed at examining the impacts of sex-specific factors on the prevalence and formation of the FTM.

Methodological impact on findings

Variations in FTM prevalence across studies highlight the influence of methodological differences, with surface anatomy offering significant advantages over cadaveric dissection. While dissection provides detailed visualization, it relies on preserved specimens that may not reflect functional anatomy. In contrast, surface anatomy assesses living populations, enhancing clinical relevance. Our research found a prevalence rate of 95.58%, surpassing several cadaveric studies, including Marin et al. in Brazil at 93.8% and Rourke et al. in the UK at 92.7%, supporting the validity of our surface anatomy approach.[17,18]

Several studies on surface anatomy have reported lower prevalence rates, such as those by Salem et al. in Tunisia (67.7%) and Ramírez et al. in Chile (49.11%).[25,29] Our results challenge the belief that cadaveric dissection represents a more effective method. Surface anatomy is non-invasive, readily accessible, and more effective in assessing anatomical variations within living populations. Our results underscore its reliability, revealing prevalence rates that are comparable to or even surpass those found in cadaveric studies, while also delivering practical and clinically relevant insights.

Implications of findings

This research highlights the widespread prevalence of the fibularis tertius muscle (FTM) across various populations, with many bilateral cases suggesting a strong genetic basis. The right-sided predominance in unilateral cases aligns with common lateral asymmetry in human anatomy, indicating genetic factors influence FTM distribution. The slight male predominance hints at potential sex-linked variations, necessitating further study. While FTM appears to be a common anatomical feature, regional genetics, research methods, and demographics may impact its distribution. Future research should explore the genetic, environmental, and functional factors affecting FTM distribution and their implications for mobility and injury susceptibility.

This research has some limitations. The results may not apply to a wider population because of the specific group studied, and focusing on surface anatomy might have missed finer anatomical differences. Also, the study did not include detailed information on ethnicity and genetics, which could help explain the factors affecting FTM prevalence. Age-related changes and the reasons behind lateral dominance were not fully explored, and there could have been some bias in measuring the traits observed.

CONCLUSION

The FTM is crucial for ankle stability, preventing injuries, and aiding recovery, particularly in high-impact activities. Variations such as unilateral absence can increase vulnerability to ankle instability and chronic sprains. Knowledge of FTM's anatomy is important for surgical planning, especially for tendon repairs and reconstructions, as well as in rehabilitation to improve recovery outcomes. Understanding the functional role and variations of FTM is a key in clinical practice, as it influences diagnosis, treatment strategies, and injury prevention.

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