# Anatomy of the Peroneal/Fibular Complex: Ultrasonic Findings in Asymptomatic Ankles

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## INTRODUCTION

The peroneal complex plays a pivotal role in maintaining lateral ankle stability and facilitating eversion of the foot. Flattening of the peroneus brevis (PB) tendon may be caused by pathologic processes or can be found as a normal variant.[1] Recent studies found incidence of 70-87.5% of a low-lying muscle belly (LLMB) in those with posterior-lateral ankle pain.[2,3] A LLMB is postulated to cause an overcrowding effect within the retromalleolar groove leading to subluxation and tendon damage.[4-7]

Approximately 40% of peroneal pathologies are misdiagnosed on initial evaluation, highlighting the importance of advanced imaging for a thorough evaluation of peroneal complex pathology.[8,9] MRI has been shown to be unreliable in the preoperative evaluation of surgically confirmed PB LLMB with sensitivity of 3.23% to 7.1%.[2,7] Ultrasound (US) imaging has emerged as a valuable diagnostic tool in musculoskeletal medicine as it offers a dynamic assessment of the soft tissues without ionizing radiation exposure.[10-12]

## PURPOSE

To the best of the author's knowledge, no publications have evaluated normal peroneal complex anatomy in asymptomatic subjects utilizing musculoskeletal US. Therefore, the aim is to evaluate the morphological features of asymptomatic, nonpathological peroneal complexes utilizing musculoskeletal US. Hypothesized most subjects with asymptomatic ankles would show pathologic signs, including flattening of the peroneal tendons and/or a LLMB.

## METHODS

Volunteers were scanned by a single physician trained in musculoskeletal US. Asymptomatic adults free of injury history based on a questionnaire were included. If both ankles met criteria, a bilateral exam was performed, otherwise the unaffected limb was evaluated in isolation.

A standardized US protocol with the same machines was completed for each subject. With the subject supine and their foot resting on the examination table, a general scan of the anterior tibiotalar joint was performed evaluating for effusion and synovitis. The peroneal tendons were evaluated for subluxation with the ankle moving through active range of motion. The tendons were then evaluated for tears, synovitis, and the presence of anatomic variants. The retromalleolar groove depth was measured. The peroneal tubercle was identified and described and the relationship of the peroneal tendons to the tubercle was evaluated. The peroneal tendons were identified at the level of the CFL and the height and width of each tendon were measured in the transverse plane, with a "flat" tendon described as having twice the length in one dimension. The PB muscle belly distance from the CFL was measured with the ankle placed in neutral, maximum inversion, and maximum eversion. The CFL was utilized for ease of identification and reproducibility. A positive value indicated the myotendinous junction was proximal to the CFL with a negative value distal. The location of the PB muscle belly at neutral was classified into three categories: A – Proximal to CFL, B – at the CFL, C – Distal to CFL.

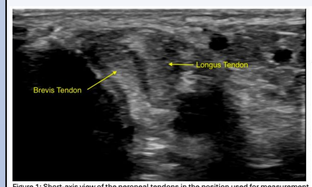

Figure 1: Short-axis view of the peroneal tendons in the position used for measurement

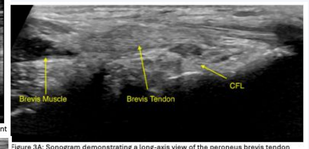

Figure 3A: Sonogram demonstrating a long-axis view of the peroneus brevis tendon and muscle in relation to a short-axis view of the calcaneal fibular ligament (CFL) with the ankle in neutral position.

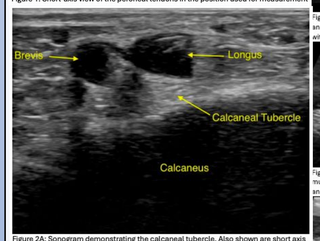

Figure 2A: Sonogram demonstrating the calcaneal tubercle. Also shown are short axis views of the peroneus brevis and longus tendons.

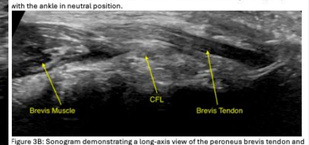

Figure 3B: Sonogram demonstrating a long-axis view of the peroneus brevis tendon and muscle in relation to a short-axis view of the calcaneal fibular ligament (CFL) with the ankle in inversion.

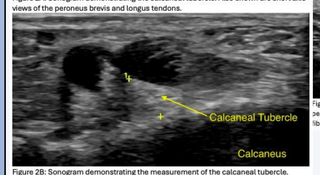

Figure 2B: Sonogram demonstrating the measurement of the calcaneal tubercle.

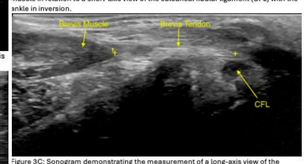

Figure 3C: Sonogram demonstrating the measurement of a long-axis view of the peroneus brevis myotendinous junction in relation to a short-axis view of the calcaneal fibular ligament (CFL) with the ankle in eversion.

## STATISTICAL ANALYSIS

Independent samples T-test were utilized for comparison of ultrasound types. If the data was categorical, a chi-square test was employed instead. Descriptive data was tallied, and a mean was calculated.

## RESULTS

The average age of the participants was 33.3 years old. 10 (33.3%) of the subjects were male and 20 (66.7%) were female. No tears or subluxations were appreciated in either the peroneus brevis or peroneus longus tendon. Of the 23 bilateral examinations, 19 of them were classified in the same category on either side.

| | | N |
|---|---|---|
| **Subjects** | | 30 (53 ankles) |
| **Limb Evaluated** | Right | 25 (47.2%) |
| | Left | 28 (52.8%) |
| **Limb Dominance** | Right | 26 (86.7%) |
| | Left | 4 (13.3%) |
| **Gender** | Male | 10 (33.3%) |
| | Female | 20 (66.7%) |
| **Anatomical Variants** | Peroneus Quartus | 2 (3.8%) |
| | Os Peroneum | 2 (3.8%) |
| **Abnormal Findings** | Ankle synovitis | 3 (5.7%) |
| | Peroneal Tenosynovitis | 3 (5.7%) |

**Table 1:** Demographic data, anatomical variants and abnormal pathological findings.

| Variable | Combined, mean | Right, mean | Left, mean | P value |
|---|---|---|---|---|
| Retromalleolar Groove Depth, mm | 5.52 ± 1.29 | 5.52 ± 1.59 | 5.51 ± 0.97 | 0.979 |
| Height of PB, mm | 5.94 ± 1.21 | 5.74 ± 0.90 | 6.13 ± 1.43 | 0.252 |
| Width of PB, mm | 2.72 ± 1.29 | 2.73 ± 1.31 | 2.71 ± 1.29 | 0.962 |
| Height of PL, mm | 6.42 ± 1.35 | 6.24 ± 1.43 | 6.58 ± 1.28 | 0.362 |
| Width of PL, mm | 3.36 ± 0.84 | 3.42 ± 0.70 | 3.31 ± 0.96 | 0.617 |
| Height of Peroneal Tubercle, mm | 2.63 ± 0.74 | 2.53 ± 0.85 | 2.73 ± 0.63 | 0.350 |

**Table 2:** Ultrasound measurements of peroneal complex structures.
Abbreviations: PB, peroneus brevis; PL, peroneus longus

| Overall, mean | Inversion, mean | Neutral, mean | Eversion, mean | Type A, ankles | Type B, ankles | Type C, ankles |
|---|---|---|---|---|---|---|
| 2.9 ± 11.17mm | -2.34 ± 4.36 mm | 1.70 ± 4.39 mm | 4.10 ± 11.17 mm | 4 (7.5%) | 30 (56.6%) | 19 (35.8%) |

**Table 3:** Distance of peroneus brevis myotendinous junction from the calcaneofibular ligament. Proposed classification in types A, B, and C with type A proximal to the CFL, type B at the level of the CFL, and type C distal to the CFL.

## ANALYSIS AND DISCUSSION

Musculoskeletal US was used to describe normal anatomic features of the peroneal complex in uninjured, asymptomatic individuals. US has been described as the study of choice for evaluating peroneal tendon injuries as it's noninvasive, inexpensive, and dynamic.[10]

Multiple anatomic variants about the lateral ankle have been described and may lead to pathological processes.[13-16] This study found a 3.8% prevalence of a peroneus quartus or an os peroneum. The low incidence of both a peroneus quartus[17-20] or os peroneum[18,21,22] compared to literature is likely secondary to a small population size.

A recent MRI study in asymptomatic subjects found the retromalleolar groove was concave in 28%, flat in 43%, and convex in 18%.[15] Lamm found the retromalleolar groove was convex in 78% of individuals who were pathologic.[14] This study found a mean retromalleolar depth of 5.52 mm with no correlation to peroneal subluxation.

On MRI, the normal contour of the PB tendon is flat or mildly crescentic at the level of the retromalleolar groove. 64.2% of asymptomatic PB tendons were described as flat. A flattened PB tendon is not necessarily pathologic.

Tenosynovitis and degenerative changes of the PL tendon may occur from a hypertrophic peroneal tubercle.[12, 23-25] Saupe et al concluded a peroneal tubercle height of >5mm is pathologic.[15] These findings agree with Saupe et al.

Multiple pathological processes have been described secondary to a PB LLMB.[12,13,23, 27-29] The location of the myotendinous junction varied in relation to the CFL, dependent on foot position. Most ankles were classified as Type B in this study. To the authors knowledge, no other classification systems describe a PB LLMB.

There are several limitations. Convenience sampling may not be representative and is prone to selection bias. A single clinician evaluated all subjects, although differences in evaluation technique were therefore eliminated, caution should be taken when generalizing results.

## REFERENCES

1. Edwards ME. The relations of the peroneal tendons the fibula, calcaneus, and cuboideum. Am J Anat 42:213–253, 1928.
2. Sharpe J, Feltner M, Carroll P, Harrington T, Walker S, Bala V, Logan D. Comparison of Preoperative MRI With Intraoperative Findings for Peroneal Tendon Pathologies. J Foot Ankle Surg. 2022 Jul-Aug;61(4):680-685. doi: 10.1053/j.jfas.2020.11.012. Epub 2021 Jun 16. PMID: 35562304.
3. Highlander P, Pearson KT, Burns P. Magnetic Resonance Imaging Analysis of Peroneal Tendon Pathology Associated With Low-Lying Peroneus Brevis Muscle Belly: A Case-Control Study. *Foot & Ankle Specialist*. 2015;8(5):347-353.
4. Hammerschlag WA, Goldner JL. Chronic peroneal tendon subluxation produced by an anomalous peroneus brevis: case report and literature review. Foot Ankle 10: 45–47, 1989Geller
5. Freccero DM, Berkowitz MJ. The relationship between tears of the peroneus brevis tendon and the distal extent of its muscle belly: an MRI study. Foot Ankle Int. 2006 Apr;27(4):236-9. PMID: 16624211.erco
6. Mimiran R, Squire C, Wassell D. Prevalence and Role of a Low-Lying Peroneus Brevis Muscle Belly in Patients With Peroneal Tendon Pathologic Features: A Potential Source of Tendon Subluxation. J Foot Ankle Surg. 2015 Sep-Oct;54(5):872-5. doi: 10.1053/j.jfas.2015.02.012. Epub 2015 May 19. PMID: 25998478; PMCID: PMC4553117.mriran
7. Dombek MF, Lamm BM, Saltrick K, et al. Peroneal tendon tears: a retrospective review. J Foot Ankle Surg 2003;42(5):250–8
8. Davda K, Malhotra K, O'Donnell P, Singh D, Cullen N. Peroneal tendon disorders. EFORT Open Rev. 2017;2:281-292vda
9. Bianchi S, Delmi M, Molini L. Ultrasound of peroneal tendons. Semin Musculoskelet Radiol. 2010 Sep;14(3):292-306.
10. Grant TH, Kelikian AS, Jereb SE, McCarthy RJ. Ultrasound diagnosis of peroneal tendon tears: A surgical correlation. J Bone Joint Surg Am. 2005 Aug;87(8):1788-94.
11. Hyer CF, Dawson JM, Philbin TM, Berlet GC, Lee TH (2005) The peroneal tubercle: description, classification, and rel- evance to peroneus longus tendon pathology. Foot Ankle Int 26:947–950
12. Wang. Normal variants and diseases of the peroneal tendons and superior peroneal retinaculum MR imaging features
13. Lamm BM, Myers DT, Dombek M, Mendicino RW, Catanzariti AR, Saltrick K. Magnetic resonance imaging and surgical correlation of peroneus brevis tears. J Foot Ankle Surg. 2004 Jan-Feb;43(1):30-6. doi: 10.1053/j.jfas.2003.11.002. PMID: 14752761.
14. Saupe N, Mengiardi B, Pfirrmann CW, Vienne P, Seifert B, Zanetti M. Anatomic variants associated with peroneal tendon disorders: MR imaging findings in volunteers with asymptomatic ankles. Radiology. 2007 Feb;242(2):509-17.
15. Tatjanovic MS, Alcala JN, Gimber LH, Rieke JD, Chilvers MM, Lell LD. High-resolution US and MR imaging of peroneal tendon injuries. Radiographics. 2015 Jan-Feb;35(1):179-99. doi: 10.1148/rg.351130062. Erratum in: Radiographics. 2015 Mar-Apr;35(2):651. doi: 10.1148/rg.352154005. PMID: 25590397.
16. Yammine K (2015) The accessory peroneal (fibular) muscles: peroneus quartus and peroneus digiti quinti. A systematic review and meta-analysis. Surg Radiol Anat 37:617–62
17. Sobel M, Pavlov H, Geppert MJ, Thompson FM, DiCarlo EF, Davis WH (1994) Painful os peroneum syndrome: a spectrum of conditions responsible for lateral foot pain. Foot Ankle Int 15:112–124.
18. Zammit J, Singh D. The peroneus quartus muscle: anatomy and clinical relevance. J Bone Joint Surg Br 2003;85:1134–1137
19. Cheung Y, Rosenberg ZS. MR imaging of the accessory muscles around the ankle. Magn Reson Imaging Clin N Am 2001;9:465–473, x. Review.
20. Sammarco GJ (1994) Peroneal tendon injuries. Orthop Clin N Am 25:135–145.
21. Mueheman C, Williams J, Barrether ML. A radiologic and histologic study of the os peroneum: prevalence, morphology, and relationship to degenerative joint disease of the foot and ankle in a cadaveric sample. Clin Anat 2009;22(6):747–754.
22. van Dijk PAD, Kerkhoffs GMMJ, Chiodo C, DiGiovanni CW. Chronic Disorders of the Peroneal Tendons: Current Concepts Review of the Literature. J Am Acad Orthop Surg. 2019 Aug 15;27(16):590-598. doi: 10.5435/JAAOS-D-18-00623. PMID: 31394550.
23. Edwards M.E.: Relations of peroneal tendons to fibula, calcaneus, and cuboideum. Am J Anat 1928; 42: pp. 213-25
24. Kijowski R, Smet AD, Mukherjee R. Magnetic resonance imaging findings in patients with peroneal tendinopathy and peroneal tenosynovitis. Skeletal Radiol 2007;36:105–14
25. Krause JO, Brodsky JW. Peroneus brevis tendon tears: pathophysiology, surgical reconstruction, and clinical results. Foot Ankle Int. 1998;19(5):271-279.
26. Freccero DM, Berkowitz MJ. The relationship between tears of the peroneus brevis tendon and the distal extent of its muscle belly: an MRI study. Foot Ankle Int. 2006 Apr;27(4):236-9. doi: 10.1177/107110070602700402. PMID: 16624211.
27. Draghi F, Bortolotto C, Draghi AG, Gitto S. Intrasheath Instability of the Peroneal Tendons: Dynamic Ultrasound Imaging. J Ultrasound Med. 2018 Dec;37(12):2753-2758. doi: 10.1002/jum.14633. Epub 2018 Apr 19. PMID: 29672895.
28. Rosier B., Mscheller P., and Gisa E.: Peroneal tendon disorders. Clin Sports Med 2015; 34 pp. 525-641