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Journal of Arthroscopic Surgery and Sports Medicine

Article in Press

*Original Article*

# Peroneal tendon anatomy in the retromalleolar region of the ankle: A new radiological classification

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## ABSTRACT

**Objectives:** Lateral ankle pain can be caused by a variety of pathologies, including those involving the peroneal tendons. The spatial arrangement of the peroneal tendons within the trimalleolar groove remains underexplored in the literature. The objective of this study is to propose a new classification to describe and categorize the spatial relationship between the peroneal longus and peroneus brevis (PB) tendons in the retromalleolar groove.

**Materials and Methods:** A retrospective analysis of the ankle joint anatomy on magnetic resonance imaging was conducted on 100 consecutive patients undergoing foot and ankle imaging. A musculoskeletal radiologist and orthopedic surgeon meticulously evaluated the spatial relationship between the PB and peroneus longus (PL) tendons in the axial plane and subsequently categorized them as follows: Type 1: PB tendon is deep to PL tendon. Type 2: PB tendon is <50% medial to PL tendon. Type 3: PB tendon is more than 50% medial to PL tendon Type 4: PB tendon adjacent to PL tendon. Descriptive statistics were performed on the cohort and intraclass correlation for interobserver reliability.

**Results:** In our study, the most common variant seen was type 1 (40% of cases), followed by type 2. There was good intraobserver reliability with an intraclass correlation of 0.8.

**Conclusion:** Our study successfully introduces a novel classification system that effectively delineates and categorizes the spatial relationship between the PB and PL tendons within the retromalleolar groove. This may be of clinical value during tendon repair and reconstruction.

**Keywords:** Ankle joint, Magnetic resonance imaging, Pain, Peroneal tendons, Retromalleolar groove, Retrospective studies

## INTRODUCTION

Peroneal tendon tears and pathologies are common, and there has been a growing recognition of this condition over the past few decades. Peroneal tendon pathology or injury can be categorized into tendinopathy, tears, subluxation, and dislocation. They may also be linked to systemic conditions such as rheumatoid arthritis, psoriasis, diabetes, and hypothyroidism, as well as local steroid injections.[1,2]

Patients commonly present with anterolateral, lateral, and posterolateral ankle pain that gets worse with activity that can be associated with a "popping" or "snapping" sensation. Frequently, patients may present with no history of trauma.[3]

When discussing peroneal tendon injury and lateral ankle pain, it is important to be fully acquainted with the anatomy of the lateral ankle. In our study, we propose a classification that delineates the spatial relationship between the peroneus longus (PL) and peroneus brevis (PB) tendons in the retromalleolar region, structured as follows:

Chapala, Arnav, David Beale, Botchu, Reddy, Rajesh, Iyengar, Kapil Shirodkar, Stuart (CADBRIKS) anatomical classification of peroneal tendons

Type 1: PB is deep to PL tendon

Type 2: PB is <50% medial to PL tendon

Type 3: PB tendon is more than 50% medial to PL tendon

Type 4: PB tendon adjacent to PL tendon.

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**Received:** 25 January 2025 **Accepted:** 03 March 2025 **EPub Ahead of Print:** 29 April 2025 **Published:** XXXXXX **DOI:** 10.25259/JASSM_8_2025

### Applied anatomy at the ankle

The peroneal tendons are located on the lateral side of the leg and consist of the PB and PL muscle and tendon and the peroneal tendon sheath.

The PB muscle originates from the lower two-thirds of the lateral fibula and adjacent intermuscular septa, with its tendon attaching to the base of the fifth metatarsal bone. The PL muscle arises from the lateral condyle of the tibia, the head and upper two-thirds of the lateral fibula, the intermuscular septa, and adjacent fascia. The PL tendon then inserts on the plantar-lateral surface of the plantar aspects of the first and second metatarsal bases and the medial cuneiform bone.

In the distal third of the fibula, the lateral border undergoes a posterior twist, allowing the peroneal tendons to continue their course behind the lateral malleolus. At the lower aspect of the lateral malleolus, a sulcus known as the retromalleolar groove is created. Both the peroneal tendons share a common peroneal synovial sheath in retromalleolar groove, allowing for smooth gliding of tendons. Stabilization of the peroneal tendons at the level of the retromalleolar groove is provided by the superior peroneal retinaculum (SPR) and the calcaneofibular ligament. The SPR forms the posterolateral margin of the retromalleolar groove and consists of a fibrous band that originates from the posterior ridge of the distal fibula. It inserts onto the lateral wall of the calcaneus after coursing posteriorly and inferiorly, thus playing a crucial role in maintaining the position and function of the peroneal tendons.[1,4]

### Biomechanical relevance/implications

The evertors of the foot (peroneals) are responsible for 3.7% of plantar flexion power and 87% of eversion power. From a structural point of view, the PL stabilizes and locks the first metatarsal against cuneiform.[5] The peroneal tendons also aid the windlass mechanism by augmenting the dorsiflexion of the first metatarsophalangeal joint and play a vital role in stabilizing it.[6] Kokubo *et al.* investigated the impact of the posterior tibialis and PL on the medial longitudinal arch stiffness, concluding that the influence of PL is much less than the posterior tibialis. However, the study revealed that the PL plays a role in the positioning of the first ray when subjected to weight-bearing loads.[7]

The PL and PB tendons glide parallel to each other and facilitate load transfer both eccentrically and concentrically. The presence of stenoses within the tendon sheaths, anatomical variants, loading (frictional and tensile) across the peroneal tubercle, and the presence of other anatomical variants can contribute to the development of tendinopathies.[4,5]

## MATERIALS AND METHODS

Following the approval of the local hospital's ethics committee (HLC, 2024), a retrospective analysis of a search of our Radiology Information System and Picture Archiving and Communication System was performed to evaluate ankle anatomy. It was conducted involving 100 consecutive ankle magnetic resonance imaging (MRI) scans. These images were obtained using the advanced Siemens 3T Vida (Erlangen, Germany). Proton density fat-suppressed (PDFS) axial images were obtained with a TR-2690, TE 36, and a slice thickness of 3 mm. Patient demographics and radiological findings were recorded.

### Inclusion and exclusion criteria

Individuals over the age of 40 years, along with those who had tumors or those who had a history of surgery, were excluded from the study. MRIs with movement artifacts were also excluded.

### Image analysis

PDFS axial images were analyzed at the level of retromalleolar groove by a fellowship-trained musculoskeletal radiologist with over 10 years of experience and an orthopedic surgeon with over 20 years of experience. A detailed assessment of the spatial relationship between the PL and PB was performed and was independently graded. The spatial relationship of PL and PB was analyzed with the proposed classification [Figures 1 and 2].

### Statistical analysis

All data were collected and documented in MS Excel Sheet. Descriptive statistics were performed on the cohort, and an intraclass correlation coefficient (ICC) analysis was performed to evaluate interobserver reliability. The ICC is a value between 0 and 1, where values below 0.5 indicate poor reliability, between 0.5 and 0.75 moderate reliability, between 0.75 and 0.9 good reliability, and any value above 0.9 indicates excellent reliability.

## RESULTS

Among the 100 patients included in our study, there were 66 males and 34 females. Fifty-eight right-sided ankles and 42 left-sided ankles were examined. The range of ages included in our study was 8–40 years of age, with a mean age of 23.98 years.

Among the 100 case studies, 40 cases were categorized as type 1, indicating a prominent representation within the study population. In addition, 31 cases were categorized as type 2, 18 cases as type 3, and 11 cases as type 11 [Table 1]. There was good interobserver reliability with an intraclass correlation of 0.8.

## DISCUSSION

Our CADBRIKS classification on the spatial relation of the peroneal tendon at the level of retromalleolar groove can aid in identifying individuals at risk for peroneal tendon pathologies and facilitate the development of tailored management strategies. Such a standardized anatomical approach to imaging can significantly influence the planning of surgical management and guide various surgeries.

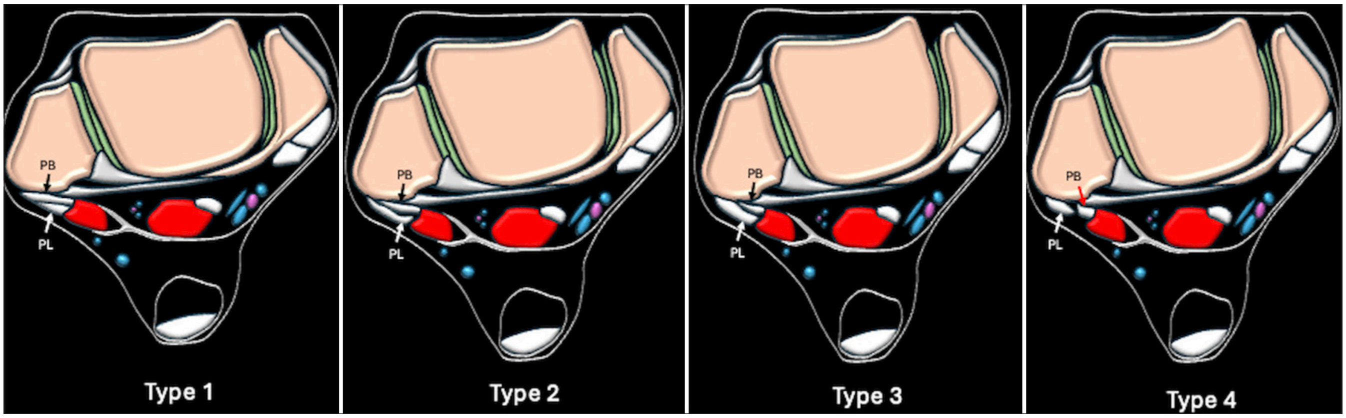


**Figure 1:** Schematics of different types of spatial relationship of peroneal tendons [peroneus longus (PL) and peroneus brevis (PB)] at the level of retromalleolar groove (Type 1-4).

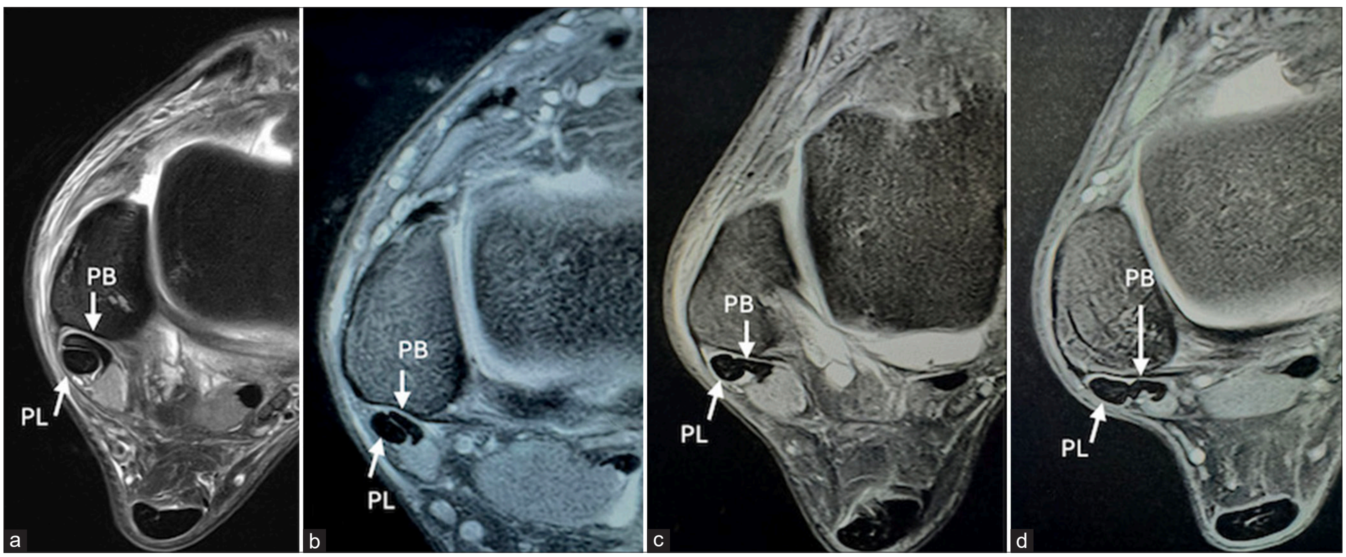


**Figure 2:** Proton density fat-suppressed axial at the level of retromalleolar groove of various types of spatial relationship of peroneal tendons [peroneus longus (PL) and peroneus brevis (PB)] (a) Type 1, (b) Type 2, (c) Type 3, and (d) Type 4.

**Table 1:** Number of patients in each type of spatial relation between the peroneal tendons at retromalleolar groove according to CADBRIKS classification.

| Type of peroneal tendon relationship | Number of patients |
|---|---|
| Type 1 | 40 |
| Type 2 | 31 |
| Type 3 | 18 |
| Type 4 | 11 |

CADBRIKS: Chapala, Arnav, David Beale, Botchu, Reddy, Rajesh, Iyengar, Kapil Shirodkar, Stuart.

Although most pathological conditions of the peroneal tendon are due to acute trauma or chronic overuse, a small proportion of foot–ankle anatomical variations have been suggested to be predisposing factors for peroneal tendon injuries. The presence of shallow or irregular retromalleolar groove, hypertrophied peroneal tubercle, crowding from a low-lying PB muscle, the presence of a peroneus quartus muscle, and os peroneum can further increase the risk for tendon pathologies.[4,8]

Peroneal tenosynovitis is thought to arise from heightened stress on anatomical pulleys such as the peroneal tubercle, the retromalleolar groove, and the cuboid's undersurface, with ankle inversion injuries and fractures of the lateral malleolus or calcaneus also contributing.[2,7]

Peroneal tears can result as a result of acute trauma or chronic degeneration. Tendons immediately posterior to the lateral malleolus can be more prone to degenerative tearing.[2]

Tendon tears are also seen in cases of foot malalignment. Cavovarus malalignment leads to lateral foot overload, frequently contributing to peroneal tendon tears. Planovalgus malalignment resulting in a narrowing of the inframalleolar space increases the risk of peroneal tendonitis and subsequent tendon tears.[3]

In the retromalleolar region, the PB tendon is more prone to tears as it is subjected to compression between the PL against the retromalleolar groove.[1,9] Our classification, describing the spatial relationship between the peroneal tendons, can help identify high-risk individuals, although this was not analyzed in the current study.

MRI is highly sensitive in identifying fixed subluxation or dislocation of peroneal tendons but may not identify transient subluxation or dislocation that occurs only during loading or dorsiflexion of the ankle.[10] Anatomical classification based on the spatial relationship of tendons may allow for effective comparison between prior and current MRI studies, providing a valuable framework to rule out subluxation of peroneal tendons.

### Limitation of the study

Our study is a retrospective study and analyzed the relationship of peroneal tendons in normal patients. We did not correlate this with pathologies and we intend to do this in the future.

## CONCLUSION

We recommend that this classification system should be adopted by other radiologists and healthcare professionals in the assessment of ankle MRIs. By standardizing the approach in evaluating peroneal tendons, we can foster greater consistency in the diagnosis of pathology as well as tailor specific management strategies.

**Author contributions:** SRP and RB: Conception and design, or acquisition of data, or analysis and interpretation of data; SRP, SC, KPI, RB: Design, or acquisition of data, or analysis and interpretation of data; SRP, SC, AG, KS, KPI, SM, DB, RB: Drafting the article or revising it critically for important intellectual content, and final approval of the version to be published.

**Ethical approval:** The research/study was approved by the Institutional Review Board at HLC, number 2024, dated May 2024.

**Declaration of patient consent:** Patient's consent not required as patient identity is not disclosed or compromised.

**Financial support and sponsorship:** Nil.

**Conflicts of interest:** There are no conflicts of interest.

**Use of artificial intelligence (AI)-assisted technology for manuscript preparation:** The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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**How to cite this article:** Pellakuru SR, Chapala S, Gupta A, Shirodkar K, Iyengar KP, Metcalfe S, *et al*. Peroneal tendon anatomy in the retromalleolar region of the ankle: A new radiological classification. J Arthrosc Surg Sports Med. doi: 10.25259/JASSM_8_2025