An Accessory Peroneocalcaneus Internus Muscle with MRI and US Correlation

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ABSTRACT

The peroneocalcaneus internus (PCI) is a rare accessory muscle of the medial ankle with typical MRI anatomic features allowing differentiation from the more common accessory flexor digitorum longus muscle. To our knowledge, there have been no previously published sonographic images of the peroneocalcaneus internus. A PCI is typically an incidental, asymptomatic finding, but knowledge of the entity may avoid confusion when initially encountered by diagnostic ultrasound. We review the anatomic imaging features which allow for a confident imaging diagnosis and the clinical relevance of this anomaly.

CASE REPORT

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A 68-year-old gentleman presented for diagnostic imaging of acute on chronic right ankle pain. He reported multiple injuries to the ankle in the past with the most recent injury occurring while playing tennis a few months prior to his imaging presentation. An MRI (GE Signa 3T - Milwaukee, WI) demonstrated advanced degenerative arthritis of the tibiotalar joint thought to represent the etiology of pain. Incidentally noted, was an accessory muscle located between the flexor hallucis longus (FHL) and the peroneus brevis (PB) muscles (Figure 1). The muscle originated along the medial aspect of the lower third of the fibular diaphysis and became tendinous approximately 2-3 cm above the tibiotalar joint. The tendon passed along the undersurface of the sustentaculum tali with the FHL tendon and inserted onto a calcaneal tubercle just distal to the sustentaculum tali (Figure 2). An ultrasound (Toshiba Aplio XG, 12 (7-14) MHz linear array tranducer; Toshiba America Medical Systems, Inc., Tustin, CA) of the medial ankle at the level of the tibiotalar joint also demonstrated the accessory muscle and tendon (Figure 3). However, it was extremely difficult to accurately identify and depict the tendon insertion upon the calcaneal tubercle just distal to the sustentaculum tali due to its relatively deep position and shadowing caused by the sustentaculum tali. Contralateral imaging was not performed and it is uncertain if the patient had bilateral PCI muscles.

The patient was diagnosed with functional ankle instability and mild degenerative joint disease. He was treated conservatively with an ankle strength and stability program, an ankle sleeve, and icing after activities.

DISCUSSION

The peroneocalcaneus internus (PCI) muscle is a rare accessory muscle of the medial ankle and is thought to represent an asymptomatic finding [1-3]. In a series by Mellado et al., one PCI was identified in 100 ankle magnetic resonance imaging (MRI) examinations of asymptomatic patients [3]. They also identified 4 patients with PCI muscles and 3 of the patients had them bilaterally [3]. The PCI originates from the fibula distal to the origin of the flexor hallicus longus muscle, but there may be interdigitation of the PCI and FHL muscles proximally [3]. The interdigitation of the fibers could be confused with a normal variant FHL with two tendon slips that merge distally [3]. The PCI lies at the posterior and lateral aspect of the FHL. The PCI tendon passes through the tarsal tunnel and inserts on a calcaneal tubercle after passing beneath the sustentaculum tali [2-4]. The anatomy and MRI appearance of the PCI muscle has been described in the literature [3, 5, 6]. However, to our knowledge, the ultrasound (US) appearance of this accessory

muscle has not been published. Our purpose in presenting the sonographic appearance of this accessory PCI muscle is to raise awareness of this entity and the limitation of ultrasound in making a confident diagnosis as it may be the first line imaging study. As with many other anatomic variants, it is critical to obtain an accurate diagnosis to avoid possible injury if surgery is contemplated in that region.

The normal structures of the medial ankle from anterior to posterior include the tibialis posterior (TP), flexor digitorum longus (FDL), tibial neurovascular bundle, and flexor hallucis longus (FHL). Although the PCI is a rare entity, it is important to be aware of the characteristic imaging and clinical features of a PCI in order to differentiate it from the FHL and an accessory flexor digitorum longus (AFDL). Both accessory muscles are located in the medial ankle with different clinical presentations and subtle imaging differences.

The FHL is an important landmark used during posterior hindfoot arthroscopy [6]. Just distal to the level of the tibiotalar joint, the FHL tendon becomes the medial safe boundary for arthroscopy. At this level, the tibial neurovascular bundle is situated in a more superficial and posteromedial location to the FHL (Figure 4). This allows for safe instrumentation anteriorly and laterally to the FHL tendon. If a PCI is present, it may be mistaken for the FHL altering the approach. The tibial neurovascular bundle is situated in a more anteromedial location with respect to the PCI than the FHL (Figure 4) and the altered path could damage the tibial neurovascular bundle [6]. Phisitkul and Amendola depicted this false pathway in the scenario of accessing an osteochondral lesion of the posteromedial tibial dome via arthroscopy, which is re-created in Figure 4, and the potential for injury to the tibial neurovascular bundle [6].

AFDL, PCI, accessory soleus, and tibiocalcaneus internus represent the described accessory muscles of the medial ankle[4]. The AFDL is the most common medial accessory muscle and is seen in 6% of asymptomatic individuals [7]. It has been described to cause tarsal tunnel syndrome related to mass effect upon the tibial neurovascular bundle [4, 7-9]. There has been only one case report of symptomatic bilateral PCI muscles that were surgically resected with subsequent resolution of symptoms [5]. In that case report, the pain was thought to be secondary to posterior impingement rather than tibial neurovascular compression as seen with a symptomatic AFDL [5]. An additional case report described tarsal tunnel syndrome with both an AFDL and PCI identified on MRI. This patient was treated non-operatively [10]. The AFDL may either be superficial or deep to the tibial neurovascular bundle within the tarsal tunnel [1, 8, 9]. The AFDL should be distinguishable from the PCI and FHL based on location, as it should be in a more medial location. However, in some cases this may be difficult to assess. Knowledge of the insertion of these two accessory muscles is a key distinguishing feature [3, 4, 7]. The PCI originates along the medial aspect of the lower third of the fibular diaphysis and extends along the posterior and lateral aspect of the FHL (Figure 3b). The PCI is reported to insert on a calcaneal tubercle immediately after passing beneath the sustentaculum tali [2-4]. Lambert et al. clarified this anatomical insertion when the accessory muscle was identified in a cadaver. They report the insertion is "into the inferior surface of the medial calcaneus distal to the coronoid fossa, a small depression between the anterior tuberosity and the anterior apex of the sustentaculum tali." [11] The AFDL muscle has a variable origin from the tibia, fibula, or the muscles of the deep posterior compartment of the leg [11] while the tendon has a muscular insertion on either the flexor digitorum longus or the quadratus plantae and not to the calcaneus [2-4, 7]. Unfortunately, as encountered with our case, the accurate identification of the PCI insertion with ultrasound is difficult due to its relative deep location and shadowing from the sustentaculum tali which is likely the same situation that would be encountered with identifying the AFDL insertion.

The PCI is a rare medial accessory ankle muscle, typically thought to represent an incidental finding. Knowledge of this muscle is important to help differentiate it from the FHL in cases where hindfoot arthroscopy may be considered and from an AFDL which tends to present more frequently with tarsal tunnel syndrome. The PCI tendon insertion is a key distinguishing feature which is difficult to evaluate on ultrasound due to the technical limitations of ultrasound in this location. Therefore, MRI should be considered for essential evaluation.

TEACHING POINT

The peroneocalcaneus internus muscle is a rare accessory muscle of the medial ankle. MRI can confidently differentiate the peroneocalcaneus internus from the more common accessory flexor digitorum longus muscle. With increasing use of ultrasound in the diagnosis of musculoskeletal pathology, it is important to understand the limitations of ultrasound in accurate characterization of medial ankle accessory muscles and the potential implications of the failure of identification.

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FIGURES

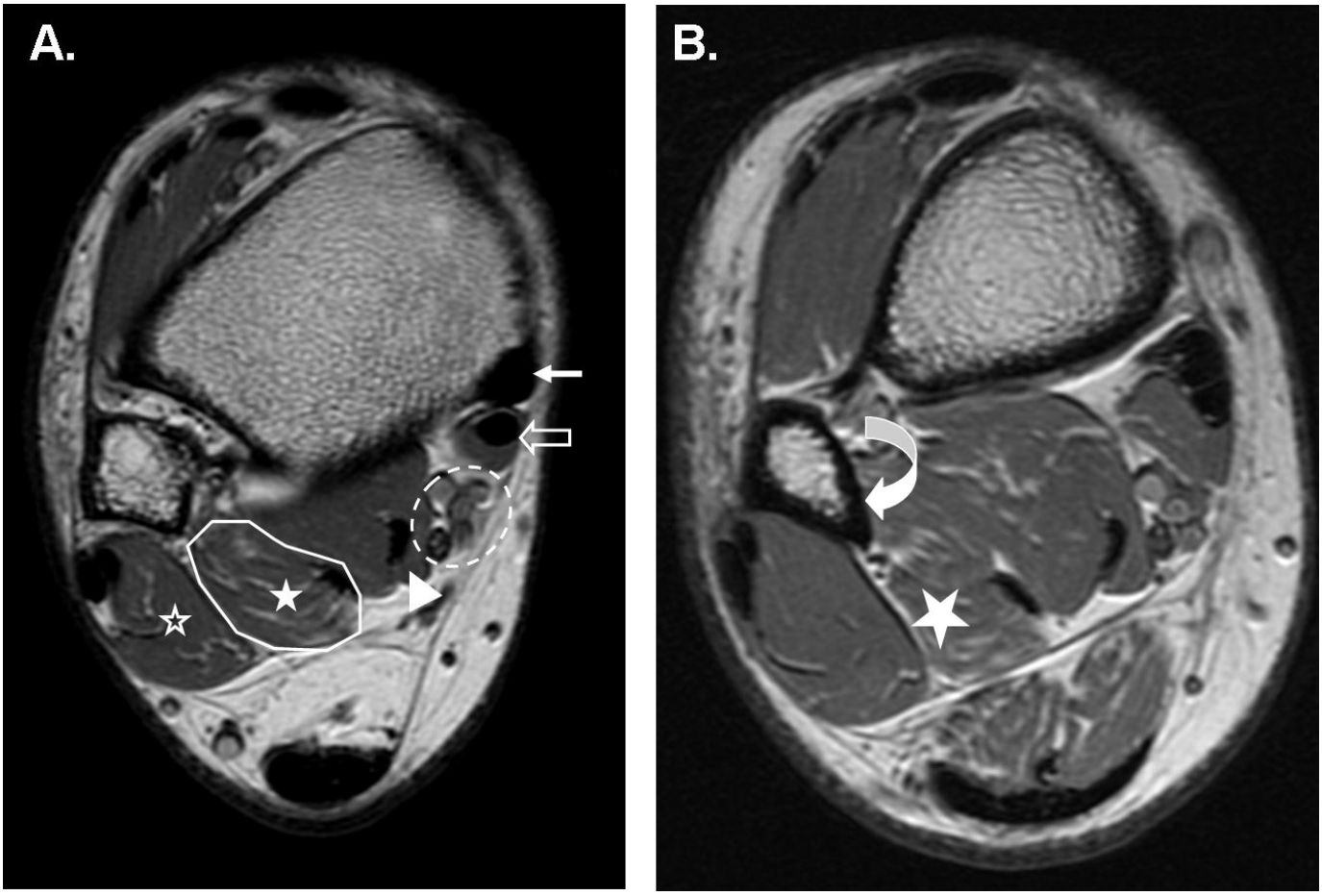

Figure 1: 68-year-old male with ankle pain and an accessory peroneocalcaneus internus muscle. A.Axial non-contrast proton density MR image of the right ankle near the level of the syndesmosis (3T GE clinical scanner, GE Healthcare, WI, USA; TR=3707, TE= 29, ETL=8, matrix 384x256, FOV=14cm, slice thickness/spacing=4/0mm). The accessory muscle and tendon is outlined in white with the muscle portion marked with a white star. This accessory muscle is situated between the flexor hallucis longus muscle (arrowhead) and the peroneus brevis muscle (open star). Tibialis posterior tendon (white arrow). Flexor digitorum longus tendon (open arrow). Tibial neurovascular bundle (outlined dashed oval). B. A more proximal non-contrast axial proton density MR image from the same sequence again demonstrates the accessory peroneocalcaneus internus muscle (star). The curved arrow highlights a portion of the muscular origin of the peroneocalcaneus internus from the medial margin of the distal fibula.

Figure 2 (left): 68-year-old male with ankle pain and an accessory peroneocalcaneus internus muscle. Coronal, non-contrast, proton density MRI of the right ankle (3T GE clinical scanner, GE Healthcare, WI, USATR=4946, TE= 29, ETL=8, matrix 384x256, FOV=14cm, slice thickness/spacing=3/0mm). The accessory peroneocalcaneus internus tendon inserts (arrow) upon a calcaneal tubercle immediately distal to the sustentaculum tali.

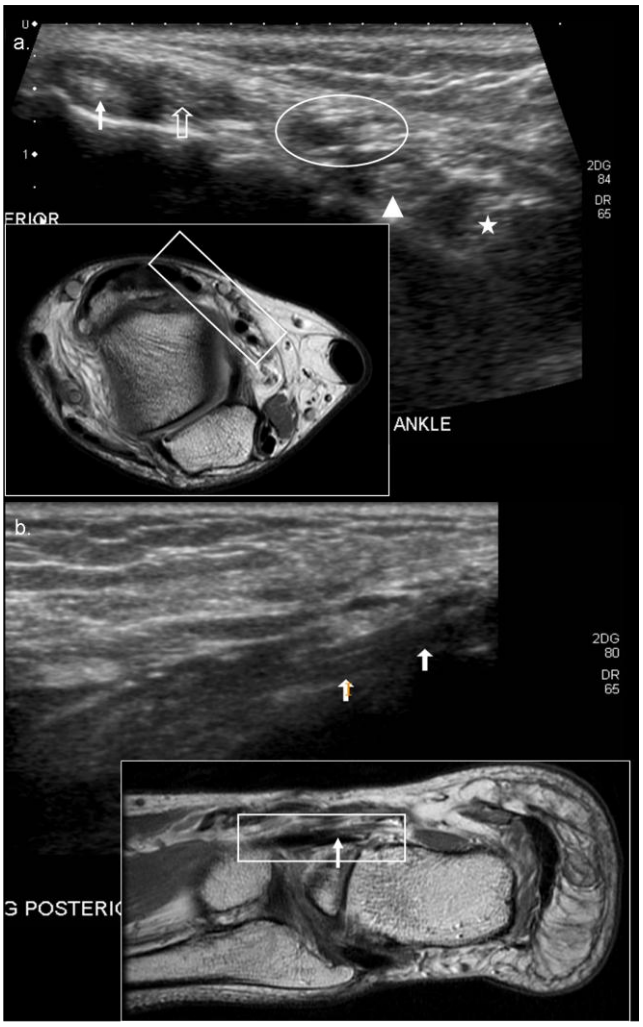

Figure 3 (right): 68-year-old male with ankle pain and an accessory peroneocalcaneus internus muscle. A. The inset image is a rotated, non-contrast, axial, proton density FSE MR image (3T GE clinical scanner, GE Healthcare, WI, USA; TR=3707, TE= 29, ETL=8, matrix 384x256, FOV=14cm, slice thickness/spacing=4/0mm). The white rectangle on the inset MR image demonstrates the field of view and orientation of the provided ultrasound image (Toshiba Aplio XG, 12 (7-14) MHz linear array tranducer; Toshiba America Medical Systems, Inc., Tustin, CA). Tibialis posterior tendon (white arrow). Flexor digitorum longus tendon (open arrow). Tibial neurovascular bundle (outlined white oval). Flexor hallucis longus tendon (arrowhead). Accessory muscle tendon (star). B. Longitudinal ultrasound of the medial right ankle at the level of the tibiotalar joint. The inset image is a rotated, non-contrast, coronal proton density FSE MR image (3T GE clinical scanner, GE Healthcare, WI, USA; TR=4946, TE= 29, ETL=8, matrix 384x256, FOV=14cm, slice thickness/spacing=3/0mm). The white rectangle on the inset MRI demonstrates the field of view and orientation of the provided ultrasound image outlining the location of the ultrasound image (Toshiba Aplio XG, 12 (7-14) MHz linear array tranducer; Toshiba America Medical Systems, Inc., Tustin, CA). The accessory muscle tendon of the medial ankle (arrows) is seen posterior and lateral to the flexor hallucis longus tendon (arrowhead).

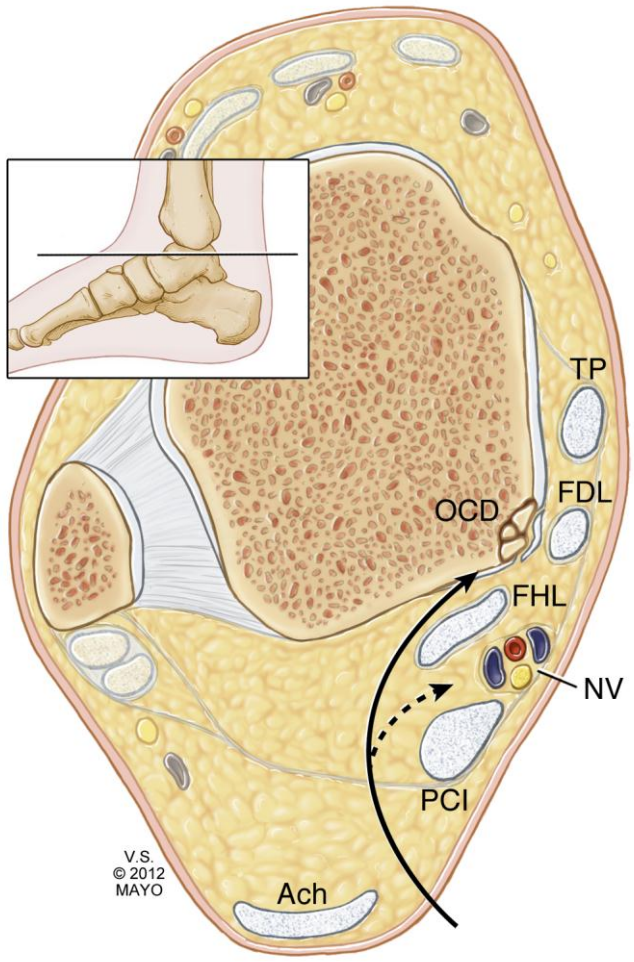

Figure 4 (left): Artist representation the potential pitfall of posteromedial ankle portal placement in hindfoot arthroscopy for treatment of a talar dome osteochondral defect (OCD) in patients with an accessory peroneocalcaneus internus muscle as described by Phisitkul and Amendola [6]. The flexor hallicus longus (FHL) tendon is the medial margin of safety when accessing the medial talar dome by arthroscopy (solid path) in patients without an accessory muscle. An accessory peroneocalcaneus internus (PCI) may falsely depict the anatomy and result in an altered approach (dashed path) potentially leading to damage of the neurovascular bundle. (TP= tibialis posterior, FDL= flexor digitorum longus, NV=neurovascular bundle, Ach= Achilles tendon,). (By permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

Etiology	Congenital
Incidence	1 in 100 in an asymptomatic population. Three of four patients in the patient population had bilateral PCI muscles [3].
Gender ratio	Unknown
Age predilection	None
Risk factors	Unknown
Treatment	None, although a symptomatic case has been reported which was treated surgically [5].
Prognosis	The entity is typically thought to be asymptomatic. It is important to differentiate a PCI from the more common AFDL which is more likely to be symptomatic.
Findings on imaging	Originates along the medial aspect of the lower third of the fibular diaphysis and extends along the posterior and lateral aspect of the FHL. The PCI inserts on a calcaneal tubercle immediately after passing beneath the sustentaculum tali

Table 1: Summary table for accessory peroneocalcaneus internus muscle

	MRI	US
Normal flexor hallucis longus	• Origin from the posterior aspect of the mid and distal fibula • Passes along the plantar margin of the medial tubercle of the talus • Passes dorsal to the flexor digitorum tendon at the master knot of Henry • Inserts on the great toe distal phalanx	• The most laterally located of the normal posteromedial ankle tendons • When imaged from a medial approach, the tendon will be lateral and adjacent to the tibial neurovascular bundle
Peroneocalcaneus internus	• Originates along the medial aspect of the lower third of the fibular diaphysis • Located posterior and lateral to the FHL • Inserts on the calcaneal tubercle after passing beneath the sustentaculum tali*	• Medial ankle accessory muscle and tendon • Typically a small muscle and tendon • Calcaneal insertion is difficult to evaluate secondary to acoustic shadowing from the sustentaculum tali
Accessory flexor digitorum longus	• Variable origin including tibia, fibula, and muscles of the posterior compartment. [11] • More medially located than the PCI • Passes through the tarsal tunnel • Inserts on the flexor digitorum longus or the quadratus plantae*	• Medial ankle accessory muscle and tendon • May identify the accessory muscle in the tarsal tunnel

Table 2: Differential table - Imaging features of a normal flexor hallicus longus, accessory peroneocalcaneus internus, and accessory flexor digitorum longus.

ABBREVIATIONS

Ach = Achilles tendon
AFDL = accessory flexor digitorum longus
FDL = flexor digitorum longus
FHL =flexor hallicus longus
MRI = magnetic resonance imaging
NV = neurovascular bundle
OCD = osteochondral defect
PB = peroneus brevis
PCI = peroneocalcaneus internus
TP = tibialis posterior
US = ultrasound

KEYWORDS

PCI; peroneocalcaneus internus; peronaeocalcaneus internus; false flexor hallicus longus; false FHL; accessory muscle