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Clinical Implications of Novel Variants of the Fibularis (Peroneus) Quartus Muscle Inserting onto the Cuboid Bone: Peroneocuboideus and Peroneocalcaneocuboideus

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Abstract

Two variants of the fibularis (peroneus) quartus muscle were identified and photographed in the legs of a 70-year-old white male cadaver. A rare peroneocuboideus (fibulocuboideus) muscle (as described by Chudzinski) and a novel peroneocalcaneocuboideus (fibulocalcaneocuboideus) muscle was found in the right and left leg, respectively. The latter muscle has not been previously reported and was termed “peroneocalcaneocuboideus” on the basis of its origin and insertions. Also, the distal attachment of both muscles inserted onto the distal lip of the peroneal sulcus of the cuboid bone, which differs from the historical data. The insertion of the peroneocuboideus muscle was previously described as being at the tuberosity of the cuboid bone or, simply, the lateral surface of the cuboid. Therefore, the present case study provides the first gross anatomic photographs of these variant leg muscles along their entire length, identifies a novel fibularis quartus variant, and describes a new insertion site for the peroneocuboideus muscle. Throughout our report, the historical data are reviewed to list the prevalence and describe the clinical implications of the fibularis quartus muscle and its variants. The presence of variant fibularis quartus muscles has been known to cause lateral ankle pain and stenosis, ankle instability, fibular tenosynovitis, subluxation of the fibular (peroneal) tendons, and longitudinal splitting of the fibularis brevis tendon in radiologic and case studies. Therefore, surgeons, radiologists, and clinicians should be aware of these variant muscles when considering various diagnoses, interpreting radiographs, and pursuing surgical intervention to relieve lateral ankle pathologic features.

Keywords

anatomy; calcaneus; cuboid; fibula; peroneal; leg; ankle; surgery; hindfoot

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Level of Clinical Evidence: 5

The fibularis (peroneus) quartus muscle, the most common variant muscle of the foot or ankle, is located in the lateral leg compartment (1). It predominantly arises from the lower third of the fibula, fibularis brevis muscle, and/or fibularis longus muscle. However, its distal insertion has shown great variability, most often inserting onto the lateral surface of the calcaneus on the retrotrochlear eminence (2). Believed to be an evolutionary acquisition for bipedal gait, the fibularis quartus muscle is unique to humans, assisting with eversion of the lateral border of the foot, pronation of the foot against the walking surface, and lateral stabilization of the ankle (3–5).

The fibularis quartus muscle was first described by Otto in 1816 (2) and has since been termed the *peroneus sextus*, *peroneus calcaneus externus*, *peroneocuboidian*, *peroneus accessorius*, *peroneus medius* (6), and *peroneus muscle of the tarsus* (3). Anatomists, surgeons, and radiologists have discovered slight variations in the distal insertion of the fibularis quartus, resulting in both increased and ambiguous nomenclature (7–10). The reported points of insertion include (from proximally to distally): retrotrochlear eminence of the calcaneus, the fibular (peroneal) trochlea of the calcaneus, tendons of the fibularis longus and brevis muscles, the cuboid, and the fifth metatarsal (9,11–13). In 1923, Hecker (3) classified the fibularis quartus variants into 3 categories according to the insertion onto the calcaneus (peroneocalcaneus externum), cuboid (peroneocuboideus), or tendon of fibularis longus (peroneoperoneolongus). However, the peroneoperoneolongus muscle is now referred to as the peroneus accessorius (9,14,15). Other fibularis quartus variants include the peroneus digiti minimi, which inserts onto the fifth metatarsal (9) and the peroneotalocalcaneus muscle (16). With so many variations of the fibularis quartus muscle, 2 studies attempted to resolve the nomenclature issues by suggesting that the fibularis quartus muscle inserts onto the lateral aspect of the calcaneus and the variants of the muscle have other distal attachments (9,13,17,18).

The prevalence of the fibularis quartus muscle and its variants has shown much disparity through the years, potentially owing to the confusion in the nomenclature (19). In 1868, Wood (7) reported a prevalence of 2.9% for the 70 limbs he studied; however, recent studies have identified the fibularis quartus muscle in approximately 21.8% of limbs during cadaveric dissection and magnetic resonance imaging and ultrasound studies (5,9,20). The prevalence of the fibularis quartus muscle in previous studies (3,5,7,9,10,11,13,16,20–27) is summarized in Table 1. Three research groups have reported a greater incidence of the fibularis quartus and its variants in males (9,11,20). However, other studies have reported no gender disparities in the prevalence of the fibularis quartus muscle (13,19,27).

During 277 cadaveric leg dissections performed at the West Virginia University School of Medicine, several different variant leg muscles were identified, including 58 fibularis quartus muscles, for a prevalence of 20.9% (28,29). Most of these fibularis quartus muscles inserted onto the lateral surface of the calcaneus, primarily onto the retrotrochlear eminence. However, 2 rare fibularis quartus variants were observed bilaterally on 1 cadaver.

Case Report (Cadaveric)

During routine dissection of the lateral leg compartment in a 70-year-old white male cadaver, variant fibularis quartus muscles were identified bilaterally. The left fibularis quartus muscle originated from the muscle belly of the fibularis brevis, the lower third of the fibula, and the posterior intermuscular septum. It paralleled the course of the fibularis longus and brevis muscles in the leg and then traveled posterior to the lateral malleolus. At this location, the muscle became tendinous, and the proximal aspect of the insertion at the retrotrochlear eminence of the calcaneus became apparent. The tendon of the variant muscle continued anteriorly with the tendons of the fibularis longus and brevis and then diverged to insert onto the cuboid bone at the distal lip of the peroneal sulcus, which contains the fibularis longus tendon (Fig.). The measurements of this variant fibularis quartus muscle were determined with a digital caliber (Table 2). Using the 1990 nomenclature system developed by Sobel et al (9), we named this variant muscle the *peroneocalcaneocuboideus* (fibulocalcaneocuboideus) *muscle*.

In the right leg, the other variant muscle possessed the same proximal attachments, course, and insertion onto the distal lip of the peroneal sulcus of the cuboid bone as the peroneocalcaneocuboideus muscle. However, the attachment to the calcaneus was not apparent in the right leg of the cadaver, although it might have been damaged during the initial student dissection of the leg (Fig). The measurements of this variant fibularis quartus muscle are also listed in Table 2. Because of the lack of insertion onto the calcaneus, this variant was classified as a peroneocuboideus (fibulocuboideus) muscle.

Discussion

In 277 cadaveric lower limb dissections, the present study identified 58 fibularis quartus muscles. Most of these supernumerary muscles were classified as fibulocalcaneus externum muscles, inserting onto the retrotrochlear eminence on the lateral aspect of the calcaneus. However, 2 rare variants were also identified, the peroneocuboideus (fibulocuboideus) and the novel peroneocalcaneocuboideus (fibulocalcaneocuboideus) muscles (Fig). The peroneocuboideus variant was originally described by Theophile H. Chudzinski in 1875 (30,31); it is extremely rare, with an estimated prevalence of 0.50%, because 3 peroneocuboideus muscles have been identified (11,13,31) in 600 leg dissections (5,9–11,13,31). In the present study, we identified 2 fibularis quartus variants inserting onto the cuboid bone in 277 leg dissections. The published data have identified the distal attachment of the peroneocuboideus muscle as inserting onto the tuberosity of the cuboid bone (27,32) or, simply, the lateral surface of the cuboid (31). However, both fibularis quartus variants identified in our study inserted onto the distal lip of the peroneal sulcus of the cuboid bone, a novel insertion site and more distal than previously reported. Therefore, the our case study presents the first gross anatomic photographs of these fibularis quartus variants, reports the existence of a novel fibularis quartus muscle variant (the peroneocalcaneocuboideus muscle), and identifies a new insertion site for the peroneocuboideus muscles.

Variants of the fibularis quartus muscle can predispose individuals to specific ankle pathologic entities, although most have been identified in asymptomatic individuals (10,33).

Historically, White et al (14) were the first to show that the presence of the fibularis quartus muscle can elicit foot and ankle pain due to the stretching and subsequent ischemia caused by irritation of the peroneal tendon sheaths. Since their study, the fibularis quartus has been shown to cause lateral ankle pain, ankle instability, fibular tenosynovitis, subluxation of the fibular (peroneal) tendons, and longitudinal splitting of the fibularis brevis tendon in radiologic and case studies (13,15,19,31,34,35). Fibular tenosynovitis, longitudinal splitting of fibular tendons, and, even, entrapment or attrition of the fibular tendons has been directly associated with hypertrophy of the retrotrochlear eminence and fibular (peroneal) trochlea of the calcaneus, as a result of the distal insertion of the peroneocalcaneus (fibulocalcaneus) externum muscle (1,12,13,18,36–38). If problems persist in a patient, surgical ablation of the fibularis quartus muscle often resolves the symptoms (15,19,31,34), although fasciotomy (35) or special treatment with orthoses (4) has also been reported. When excised, the fibularis quartus can be attractive for reconstructive surgery (16). It has already been successfully used in reconstruction of the superior fibular retinaculum to treat anterior subluxation of the fibular tendons (39).

The fibularis quartus muscle can also cause lateral ankle stenosis or predispose individuals to peroneal tendon tears when its muscle belly is low lying and invades the retromalleolar groove, effectively reducing the space available for the tendons of the fibularis longus and fibularis brevis muscles (1,11,31,40). Specifically, a second 1990 study by Sobel et al (41) showed that the relative risk of fibularis brevis attrition was doubled when a fibularis quartus muscle was present. Furthermore, in patients with a fibularis quartus muscle, insults such as a longitudinal tear of the fibularis brevis muscle or even common ankle twisting injuries can cause lateral ankle stenosis through congestive synovial proliferation in the retromalleolar lateral fibular sheath (19,31,42). Additionally, the presence of the fibularis digiti minimi variant of the fibularis quartus muscle, which inserts at the base of the fifth metatarsal, can have a detrimental effect on patients who also experience a Jones' fracture (a transverse fracture of the proximal diaphysis of the fifth metatarsal) by imposing stress on the fractured area, hindering the healing process (1,43). During clinical imaging of the retromalleolar region, the presence of 3 tendinous structures in the region typically only has 2 differential diagnoses: a longitudinal split tear of the fibularis brevis or the presence of a supernumerary fibularis quartus muscle (20,25,44). Hence, it is important that clinicians have knowledge of the possible presence of a fibularis quartus muscle to avoid confusing it with pathologic features associated with the fibularis brevis or soft tissue tumors during magnetic resonance imaging or ultrasonography (10,11,25,33,45–47).

Many of the ankle pathologic entities reported in published studies would apply to the rare peroneocuboideus muscle (as described by Chudzinski) (30,31) and novel peroneocalcaneocuboideus muscle identified in the present case study. Both variant muscles originate from the muscle belly of the fibularis brevis, lower third of the fibula, and posterior intermuscular septum and travel deep to the superior fibular retinaculum. Their proximity to the fibularis brevis and longus tendons in this fibro-osseous tunnel could act as a space-occupying mass, causing entrapment or attrition of the fibular tendons, lateral ankle stenosis, fibular tenosynovitis, or, even, longitudinal splitting of fibular tendons, especially after inversion ankle sprains (1,12,13,18,25,36–38). The tendons of these variant muscles ran deep (medial) to the fibularis longus tendon to insert onto the distal lip of the peroneal sulcus

of the cuboid bone, which could potentially irritate, reduce the space for, and hinder the mechanical functions of the fibularis longus tendon, residing in and traversing this sulcus during its course (48). Moreover, the proximal insertion of the peroneocalcaneocuboideus muscle onto the retrotrochlear eminence of the calcaneus was evident in the left hindfoot, but it might have been damaged by the initial student dissection on the right side. Surgeons, clinicians, and radiologists should be aware of these variant fibularis quartus muscles and their possible etiology in ankle pathologic features. It is also important to not confuse the rare peroneocuboideus muscle and novel peroneocalcaneocuboideus muscle with ankle masses or longitudinal tears of the fibularis brevis on magnetic resonance imaging scans or ultrasound studies (10,11,25,33,45–47). Finally, in patients with post-traumatic chronic ankle pain, instability, or strength deficits that do not improve with rehabilitation, the possible presence of a fibularis quartus muscle should be included in the differential diagnosis (33).

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Fig.
(*Left*) Novel peroneocalcaneocuboideus (fibulocalcaneocuboideus) muscle. Note, intermediate insertion to retrotrochlear eminence of the calcaneus. (*Right*) Rare peroneocuboideus (fibulocuboideus) muscle (of Chudzinski). Its attachment to the calcaneus might have been damaged during the initial student dissection.

Table 1

Prevalence of fibularis quartus muscle in previous cadaveric, magnetic resonance imaging, and ultrasound studies

Study	Method	Limbs (n)	Fibularis Quartus (n)	Prevalence (%)
Wood (21), 1866	Cadaveric	32	5	15.6
Wood (7), 1868	Cadaveric	70	2	2.9
Pozzi (22), 1872	Cadaveric	28	4	14.3
Gruber (23), 1879	Cadaveric	982	118	12.0
Hecker (3), 1923	Cadaveric	63	10	15.9
Sobel et al (9), 1990	Cadaveric	124	27	21.8
Chaney et al (24), 1996	Cadaveric	269	8	3.0
Cheung et al (11), 1997	MRI	136	14	10.3
Rosenberg et al (25), 1997	MRI	31	2	6.5
Chepuri et al (20), 2001	Ultrasound/MRI	32	7	21.9
Borne et al (26), 2002	MRI	63	7	11.1
Zammit and Singh (13), 2003	Cadaveric/MRI	182	12	6.6
Saupe et al (10), 2007	MRI	65	11	16.9
Tubbs et al (16), 2008	Cadaveric	89	1	1.1
Athavale et al (5), 2012	Cadaveric	92	20	21.7
Nascimento et al (27), 2012	MRI	211	16	7.6
Our study	Cadaveric	277	58	20.9
Total		2746	322	11.7

Abbreviation: MRI, magnetic resonance imaging.

Table 2

Measurements of fibularis quartus variants identified in present study

Variable	Left Leg: Fibulocalcaneocuboideus (cm)	Right Leg: Fibulocuboideus (cm)
Total muscle length	20.97	19.55
Muscle belly length	13.17	12.83
Tendon length	7.80	6.72
Muscle belly width	0.846	0.82
Length of attachment to intermuscular septum	9.525	8.90
Width of fascial connection to calcaneus	1.72	Potentially lost during student dissection