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Original Article

Prevalence of ankle accessory muscles: a cross-sectional study

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Abstract

Objective: Determine the prevalence of accessory muscles around the ankle of patients with ankle pain using magnetic resonance imaging (MRI) and evaluate its correlation with other foot and ankle disorders. In addition, better understand the association with accessory muscle and types of pain, mechanical due to compression forces around ankle structures or neuropathic due to mass effect around the tarsal tunnel.

Methods: The MRIs obtained from 2007 to 2017 were retrospectively studied and analyzed by a radiologist specializing in foot and ankle pathologies. A total of 9,600 scans were studied after ankle pain; 31 scans had at least one accessory muscle.

Results: The prevalence of symptomatic accessory muscle was 0.32% (31 feet). It was found due to mechanical pain in 45.2% of cases. It was considered an incidental finding in 32.3%. Tarsal syndrome was the main clinical presentation in 19.4%, and 16% had other causes of mechanical disorders: 10% with peroneal tendinitis, 3% with Achilles tendinopathy, and 3% with plantar fasciitis. The prevalence of accessory muscles was 35% of the flexor digitorum, 32% of the peroneus quartus, 19% of the fibulocalcaneus internus, 13% of the accessory soleus, and 6% of the tibiocalcaneus internus.

Conclusion: Although rare, accessory muscles can contribute to ankle pain with various presentations that confound clinical diagnosis or even appear as incidental on MRI and should be considered in the management of ankle pain.

Level of Evidence III; Therapeutic Studies; Retrospective Cohort Study.

Keywords: Ankle joint; Magnetic resonance imaging; Muscle, skeletal; Tendons.

Introduction

Accessory supernumerary muscle can be found on magnetic resonance imaging (MRI) by accident while investigating pain around the foot and ankle[1-3]. Accessory muscles such as peroneus quartus (PQ), peroneus digiti quinti (PQUI), flexor digitorum accessory (FDA), fibulocalcaneus internus (FCI), tibiocalcaneus internus (TCI) and accessory soleus (AS) are frequently underappreciated and often misdiagnosed[1-4]. Few case series studies demonstrated accessory muscles as causative agents in chronic lateral ankle pain; however, its true population prevalence is unknown[5].

Chronic lateral ankle pain is a common complaint in daily practice. It could be related to various soft tissue and osseous abnormalities, like trauma, fracture sequelae, ankle instability, repetitive trauma, and vascular or neurological disorders[1-3]. However, the presence of accessory muscle itself could cause persistent swelling, mechanical pain, or neuropathic disorders even after all conservative treatments[3,6,7]. Pain could result from a mass effect on the tarsal tunnel performing compression forces around the tibial nerve, and symptoms would only be resolved after surgical exploration and resection of accessory muscles[1,4,5,8,9].

Study performed at the Amelia Lins Hospital, Belo Horizonte, MG, Brazil.

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Magnetic resonance imaging is frequently necessary to elucidate internal derangement of foot and ankle joints, assessing tendons disarrangements, accessory muscle, soft tissue tears, and nerves and osseous structures[6,7,10]. Previous case series MRI studies demonstrated a 10.6% presence of accessory peroneal tendons[3,6,7]. However, there is a lack of populational studies in the literature associating the presence of accessory muscles and types of ankle pain. In addition, there is no information about which spectrum of symptoms would be more frequently associated with the presence of accessory muscle around the ankle: mechanical or neuropathic disorders[1,6,7,11,12].

The objective of this cross-sectional study was to determine the prevalence of accessory muscles around the ankle of patients with ankle pain using MRI and evaluate its correlation with other foot and ankle disorders. As a secondary objective, establish an association with accessory muscle and types of pain, mechanical due to compression forces around ankle structures or neuropathic due to mass effect around the tarsal tunnel.

Methods

The MRIs obtained from 2007 to 2017 at the Amelia Lins Hospital were retrospectively studied and analyzed by an experienced radiologist specializing in foot and ankle pathologies. This study was approved by the institution's Ethical Committee Board under the number 2698273, and informed consent was obtained. A total of 9,600 sequential patients were included due to pain around the ankle, and 31 exams had at least one accessory muscle: PQ, FDA, FCI, TCI, and AS. Selected exams were confirmed with a second blinded to clinical and radiological findings, also by an experienced radiologist specializing in foot and ankle. All data were then compared with the patient's medical records searching for an association of mechanical or neuropathic symptoms, primary diagnostic hypothesis for ankle pain, gender, age at the time of the exam, and outcome.

Magnetic resonance imaging

T1- and T2-weighted sagittal and axial images were obtained using a 1.5 Tesla Siemens MRI scanner. The repetition and echo times for the T1- and T2-weighted images were 518 msec and 11 msec, and 3,470 msec and 79 msec, respectively. The repetition and echo times for the sagittal T1-weighted fat suppression images were 2,430 msec and 34 msec; coronal T2-weighted fat suppression images were 3,290 msec and 90 msec. The other acquisition parameters were field of view, 100 × 160 mm; matrix size, 182 × 384; and slice thickness, 3 mm.

Statistical methods

All analyses were conducted using Statistical Package for the Social Science (IBM Corp., Armonk, New York, USA) statistics software. Statistical analyses were performed to determine the frequencies of appearance of accessory muscles and the correlation between each accessory muscle and clinical symptoms.

Fischer's exact test was used to compare accessory muscle findings and clinical symptoms. In addition, ANOVA was performed to identify the relationship between variables.

The significance level for all statistical tests was set at p = 0.05, power analysis of 80%, and confidence interval of 95% for all relative frequencies.

Results

The prevalence of symptomatic accessory muscle was 0.32% (31 feet) of all symptomatic ankles submitted to ankle MRI from 2007 to 2017 (9,600 exams) with a 95% confidence interval.

In this study, 41% were male (12 cases), and 59% were female (17 cases). There were two cases with bilateral findings. Age distribution was 3% (1 case) of individuals under 18 years old, 45% (13 cases) between 19 and 40 years old, 45% (13 cases) between 41 and 65 years old, and 7% (2 cases) above 65 years old. This demonstrates a 90% prevalence of young adults.

Clinical presentation comparison showed that 45.2% had accessory muscle associated with mechanical ankle pain,16.1% were found as incidents after a traumatic event, 19.4% had tarsal syndrome as the main clinical presentation, and 16% of cases were found with other mechanical symptoms not anatomically related with accessory muscles: 10% had fibular tendinitis, 3% had Achilles tendinopathy, and 3% had plantar fasciitis (Figures 1, 2, and 3).

Prevalence of accessory muscles in this study was 35% for FDA, 32% for PQ, 19% for FCI, 13% for AS, and 6% for TCI (Figure 4).

There was no statistical significance between accessory muscles and tarsal tunnel syndrome as the main clinical

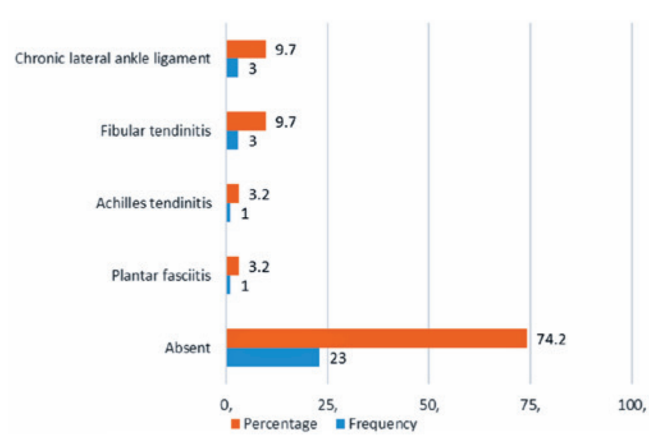

Figure 1. Presence of accessory muscle around the ankle on MRI and each clinical foot and ankle disorder presentation before the exam: chronic lateral ankle ligament, fibular tendinitis, Achilles tendinitis, plantar fasciitis, and absence were considered when ankle pain was not associated with any other foot and ankle disorder on MRI.

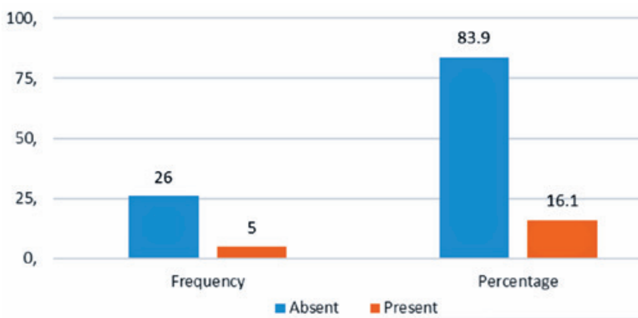

Figure 2. Frequency of incidental accessory muscle around the ankle findings.

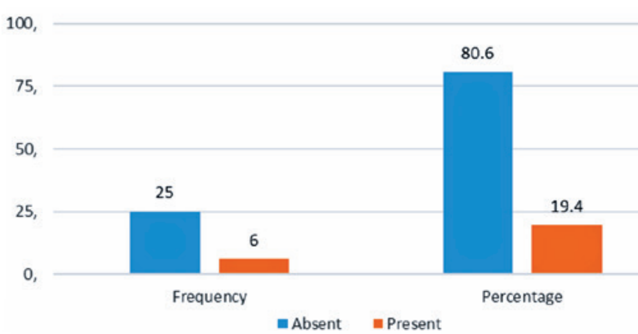

Figure 3. Frequency of tarsal syndrome and presence of accessory muscle around the foot and ankle using MRI.

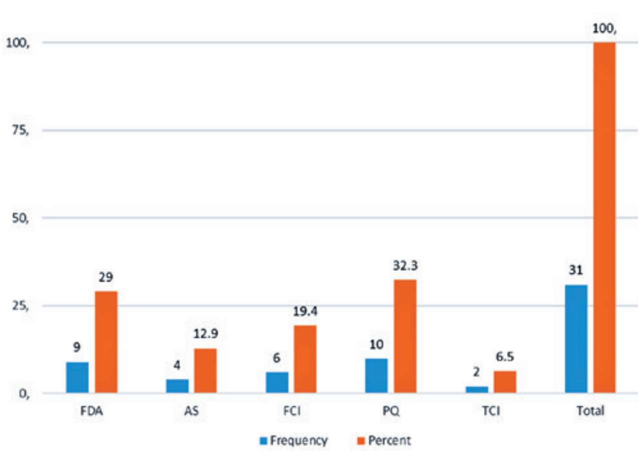

Figure 4. The relative frequency of each accessory muscle around the foot and ankle was found using MRI.

* FDA: Flexor digitorum accessory, AS: Accessory soleus, FCI: Fibulocalcaneus internus, PQ: Peroneus quartus,TCI: Tibiocalcaneus internus.

presentation ($p = 0.389$). There was no statistical significance between accessory muscle findings and trauma onset ($p = 0.499$). There was no statistical significance between accessory muscle and clinical mechanical presentation ($p = 0.499$) (Tables 1 and 2).

Discussion

Ankle pain is a frequent debilitating complaint in general practice caused by several etiologies, like ligament injury, mechanical ankle instability, peroneal tendon lesion, sinus tarsi syndrome, tarsal syndrome, or the presence of accessory muscle around the ankle[4,7,9,13].

Few case reports have described accessory muscle as the main causative agent of ankle pain[4,10,14].

In this study, the prevalence of young adults was 90%, corroborating previous studies, and 45.2% of cases presented accessory muscle and had mechanical chronic ankle pain as the main clinical presentation[11,15-17]. The most frequent symptomatic accessory muscle was FLD (35%), followed by PQ (32%), FCI (19%), AS (13%), and TCI (6%), with no statistically significant difference between them ($p > 0.05$). According to studies by Yammine[17] and Choudhary and McNally[8], PQ would be the most common accessory muscle around the ankle, located medial or posterior to peroneus brevis or longus tendons with an incidence in literature based on cadaveric studies varying from 6.6 to 21.7%. In contrast, this study encountered FDL as the most prevalent accessory muscle around the ankle, present in 35 % of cases, followed by PQ in 32%.

Neuropathic pain around the ankle with concomitant tarsal syndrome was found in 19.4% of cases. Considering anatomical proximity to the tibial nerve, only TCI played an important role in nerve compression on tarsal tunnel, as the surgical treatment record confirmed, and it conforms with literature[18].

Pain unrelated to the presence of accessory muscle or after a trauma event was considered an incident at MRI. Incidents at MRI with other causes of mechanical pain were found in 16%, 10% due to fibular tendinitis, 3% to Achilles tendinopathy, and 3% had plantar fasciitis. Trauma event was the main reason for MRI and had accessory muscles as incidents in 16.1%. Frequencies of accessory muscles found as incidents were 6% of FLD (2 cases), 9% PQ (3 cases), and 3% of SA (1 case)

Despite their rare appearance, accessory muscles can be associated with ankle pain with various presentations that confound clinical diagnosis and need to be considered to treat better the spectrum of conditions causing ankle pain. This is in agreement with several studies[1,5,8,11,14].

This study intended to analyze epidemiologic data about the prevalence of accessory muscle appearing in all patients submitted to MRI after any ankle complaint from 2007 to 2017 and its correlation with the clinical presentation at the time of the exam. The presence of mechanical ankle pain, tarsal syndrome, or incident asymptomatic found after trauma or even association with other mechanical pathologies around

Table 1. Crosstabulation between each accessory muscle found in MRI and clinical presentation at the time of the exam.

Accessory muscle		Clinical findings				Total
		Tarsal tunnel syndrome	Trauma	Other ankle pathologies	Accessory muscle	
Flexor digitorum accessory	Count	1	3	1	4	9
	% within m_accessory	11.10%	33.30%	11.10%	44.40%	100%
	% within diagnose	25%	60%	20%	23.50%	29%
Accessory soleo	Count	1	0	0	3	4
	% within m_accessory	25%	0%	0%	75%	100%
	% within diagnose	25%	0%	0%	17.60%	12.90%
Fibulocalcaneus internus	Count	2	0	2	2	6
	% within m_accessory	33.30%	0%	33.30%	33.30%	100%
	% within diagnose	50%	0%	40%	11.80%	19.40%
Peroneus quartus	Count	0	1	1	8	10
	% within m_accessory	0%	10%	10%	80%	100%
	% within diagnose	0%	20%	20%	47.10%	32.30%
Tibiocalcaneus internus	Count	0	1	1	0	2
	% within m_accessory	0%	50%	50%	0%	100%
	% within diagnose	0%	20%	20%	0%	6.50%
Total	Count	4	5	5	17	31
	% within m_accessory	12.90%	16.10%	16.10%	54.80%	100%
	% within diagnose	100%	100%	100%	100%	100%

Table 2. Analysis of variance (ANOVA) of tarsal tunnel syndrome, previous trauma event, other mechanical causes of foot and ankle disorders, and presence of accessory muscles around the ankle using MRI.

		Sum of squares	Df	Mean square	F	Sig.
Tarsal Tunnel syndrome	Between Groups	0.124	1	0.124	0.765	0.389
	Within Groups	4.714	29	0.163		
	Total	4.839	30			
Trauma	Between Groups	0.055	1	0.055	0.468	0.499
	Within Groups	3.429	29	0.118		
	Total	3.484	30			
Other foot and ankle pathology	Between Groups	0.055	1	0.055	0.468	0.499
	Within Groups	3.429	29	0.118		
	Total	3.484	30			
Accessory muscle	Between Groups	0.677	1	0.677	2.806	0.105
	Within Groups	7	29	0.241		
	Total	7.677	30			

the foot and ankle compared to accessory muscle findings. One limitation of this study is that only symptomatic patients were submitted to MRI, and other causes of mechanical disorders, anatomically distant from accessory muscle encountered, could still interfere with clinical diagnosis. Only 31 feet presented accessory muscle and mostly in young adults. One possibility is that young adults had symptomatic ankles and performed more MRIs than children and older adults in this sample. The overall prevalence in the population could be greater than found in this study because people born with accessory muscles could be asymptomatic and not perform MRIs.

Conclusion

This study of 9,600 subjects with symptomatic ankle disorders presents epidemiological data about the populational prevalence of accessory muscles around the ankle in patients with ankle pain and its correlation with clinical presentation. Although rare, accessory muscles can contribute to ankle pain with various presentations that confound clinical diagnosis or even appear as incidental on MRI and should be considered when in the management of ankle pain.

Authors' contributions: Each author contributed individually and significantly to the development of this article: SIK *(https://orcid.org/0000-0002-9079-6940) and JPFM *(https://orcid.org/0009-0002-8424-9980) Conceived and planned the activities that led to the study, approved the final version; GDH *(https://orcid.org/0000-0002-1830-450X) and RNR *(https://orcid.org/0000-0003-4163-7721) and AAL *(https://orcid.org/0000-0001-8010-8975) Interpreted the results of the study, participated in the review process and approved the final version; AFB *(https://orcid.org/0000-0001-9751-9738) and LRP *(https://orcid.org/0009-0007-8305-7158) and CMM *(https://orcid.org/0000-0003-2469-0424) Data collection and approved the final version. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID) iD.

References

1. Al-Himdani S, Talbot C, Kurdy N, Pillai A. Accessory muscles around the foot and ankle presenting as chronic undiagnosed pain. An illustrative case report and review of the literature. Foot (Edinb). 2013;23(4):154-61.
2. Athavale SA, Gupta V, Kotgirwar S, Singh V. The peroneus quartus muscle: clinical correlation with evolutionary importance. Anat Sci Int. 2012;87(2):106-10.
3. Bilgili MG, Kaynak G, Botanlioğlu H, Basaran SH, Ercin E, Baca E, et al. Peroneus quartus: prevalance and clinical importance. Arch Orthop Trauma Surg. 2014;134(4):481-7.
4. Ersoz E, Tokgoz N, Kaptan AY, Ozturk AM, Ucar M. Anatomical variations related to pathological conditions of the peroneal tendon: evaluation of ankle MRI with a 3D SPACE sequence in symptomatic patients. Skeletal Radiol. 2019;48(8):1221-31.
5. Yammine K. The accessory peroneal (fibular) muscles: peroneus quartus and peroneus digiti quinti. A systematic review and meta-analysis. Surg Radiol Anat. 2015;37(6):617-27.
6. Cheung YY, Rosenberg ZS, Ramsinghani R, Beltran J, Jahss MH. Peroneus quartus muscle: MR imaging features. Radiology. 1997;202(3):745-50.
7. Cheung Y. Normal Variants: Accessory muscles about the ankle. Magn Reson Imaging Clin N Am. 2017;25(1):11-26.
8. Choudhary S, McNally E. Review of common and unusual causes of lateral ankle pain. Skeletal Radiol. 2011;40(11):1399-413.
9. Buschmann WR. Congenital variations of the peroneus quartus muscle: an anatomical study by Sobel et al. Foot Ankle. 1991;11(5):342.
10. Fabrizio PA. Unusual fibularis (peroneus) muscle. Surg Radiol Anat. 2015;37(8):997–9.
11. Galli MM, Protzman NM, Mandelker EM, Malhotra AD, Schwartz E, Brigido SA. An examination of anatomic variants and incidental peroneal tendon pathologic features: a comprehensive MRI review of asymptomatic lateral ankles. J Foot Ankle Surg. 2015; 54(2):164-72.
12. Hur MS, Won HS, Chung IH. A new morphological classification for the fibularis quartus muscle. Surg Radiol Anat. 2014;37(1):27–32.
13. Lotito G, Pruvost J, Collado H, Coudreuse JM, Bensoussan L, Curvale G, et al. Peroneus quartus and functional ankle instability. Ann Phys Rehabil Med. 2011;54(5):282-92.
14. Opdam KT, van Dijk PA, Stufkens SA, van Dijk CN. The peroneus quartus muscle in a locking phenomenon of the ankle: A case report. J Foot Ankle Surg. 2017;56(1):108-11.
15. Park HJ, Cha SD, Kim HS, Chung ST, Park NH, Yoo JH, et al. Reliability of MRI findings of peroneal tendinopathy in patients with lateral chronic ankle instability. Clin Orthop Surg. 2010;2(4):237-43.
16. Trono M, Tueche S, Quintart C, Libotte M, Baillon J. Peroneus quartus muscle: a case report and review of the literature. Foot Ankle Int. 1999;20(10):659-62.
17. Chang SH, Matsumoto T, Okajima K, Naito M, Hirose J, Tanaka S. Heterotopic ossification of the peroneus longus tendon in the retromalleolar portion with the peroneus quartus muscle: A case report. Case Rep Orthop. 2018;2018:7978369.
18. Sammarco GJ, Conti SF. Tarsal tunnel syndrome caused by an anomalous muscle. J Bone Joint Surg Am. 1994;76(9):1308-14.