An unusual accessory soleus muscle with its clinical implications

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SUMMARY

Anomalous, supernumerary or accessory muscles in the flexor compartment of the leg are reported in the medical literature. The accessory soleus muscle is one of the variations found in this region, with the incidence ranging from 0.7-5.5%. The presence of an accessory muscle in the posterior compartment is of clinical significance, as it can be mistaken for a tumor during the clinical examination, or it can lead to the compression of surrounding neurovascular structures. During routine dissection of a cadaver, an accessory muscle was found in the medial aspect of the middle portion of the posterior compartment of the left leg. It originated with two heads from the middle portion of the soleus muscle and got inserted onto the medial surface of the calcaneum. The muscle was unilateral and was supplied by the tibial nerve. Evidence about these accessory muscles and their location and attachments are useful in making a proper diagnosis and management.

Key words: Anatomic variation – Soleus muscle – Nerve entrapment – Tarsal tunnel syndrome – Soft tissue tumor

INTRODUCTION

The flexor or posterior compartment of the leg consists of superficial and deep layers of muscles. They are supplied by the tibial nerve and they act as plantar flexors of foot at ankle, invertor of the foot and plantar flexors of toes. The superficial layer is formed by two heads of the gastrocnemius, plantaris and soleus muscle. All three superficial muscles get inserted into the calcaneum bone and they help in the plantar flexion of the foot at the ankle joint. The underlying deep layer of muscles includes popliteus, flexor digitorum longus (FDL), flexor hallucis longus (FHL) and tibialis posterior (TP). The FDL, FHL and TP form long cord-like tendons inferiorly and are arranged from medial to lateral as TP, FDL and FHL under the flexor retinaculum (Standring, 2008). Supernumerary or accessory muscles in the flexor compartment of the leg are reported in the medical literature (Paul et al., 2008). Accessory soleus muscle (ASM) is one such variation, which was first reported by Cruveilhier in 1843. The incidence of ASM ranges from 0.7-5.5% (Mihovil et al., 2020). We present an unusual muscle in the posterior compartment of the leg supplied by the tibial nerve.

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CASE REPORT

During routine dissection of a formalin fixed, 81-year-old female cadaver, an accessory muscle was found unilaterally in the medial and middle portion of the posterior compartment of the left leg. It had tendinous origin with two heads from the middle portion of the anterior surface of the soleus muscle, and got inserted onto the medial surface of the calcaneus as a tendon. The lateral slip of origin was measuring 5.2 cm long and the medial slip was 4.9 cm long; the length of the muscle belly was 9.2 cm, the length of the tendon of insertion was 3.8 cm, width and thickness at the bulkiest part of the muscle belly was 3.6 cm and 0.9 cm respectively. The muscle was supplied by a branch of the tibial nerve (Fig. 1 and Fig. 2). The surrounding neuro-vascular structures appeared to be normal. Origin and insertion of the soleus muscle was found to be normal.

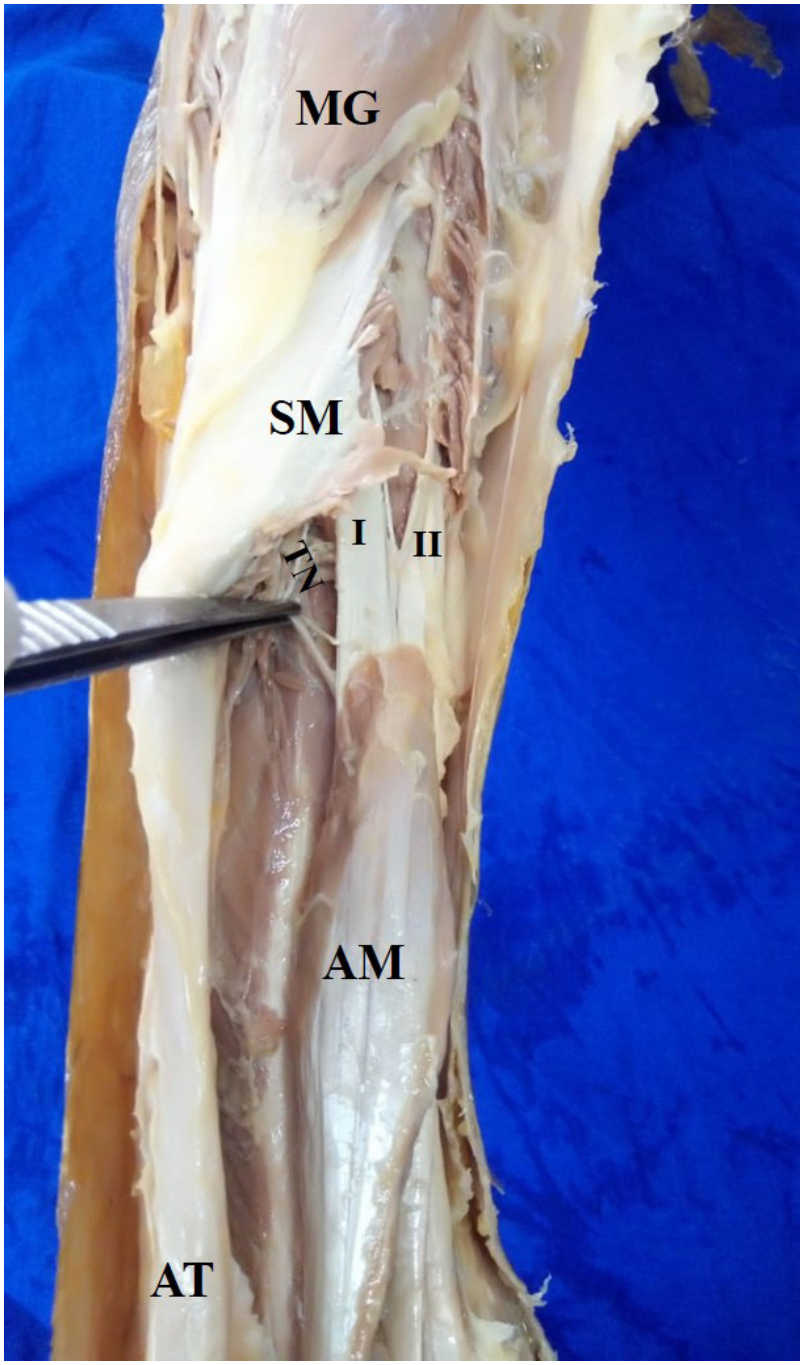

Fig. 1.- Right lower limb of a cadaver showing accessory muscle. (Origin of Soleus is partially divided to show the two heads of origin of AM). AM- Accessory muscle, AT- Achilles tendon, SM- Soleus muscle, MG- Medial head of Gastrocnemius, I- Lateral head of accessory soleus, II- Medial head of accessory soleus taking origin from anterior surface of soleus, TN- Branch of tibial nerve.

DISCUSSION

The presence of anatomical variation in the posterior compartment muscles is of clinical significance, as it may be mistaken for a soft tissue tumor during the clinical examination, or it may lead to the compression of surrounding neurovascular structures and cause painful syndromes like tarsal tunnel syndrome (Carrington et al., 2016). The ASM is one such muscle, which was first described by Cruveilhier in 1843. Its incidence ranges from 0.7% to 5.5%. It may be present bilaterally in 15% of cases, and it is twice as common in men compared to women (Brodie et al., 1997). The ASM may arise from the anterior surface of the soleus or from the fibula and soleal line of the tibia (Brodie et al., 1997; Lorentzon and Wirell, 1987). On the basis of the insertion of ASM, it can be classified into 5 types. It may get inserted to the Achilles tendon, to the upper surface of the calcaneus by fleshy muscle fibres, upper surface of the calcaneus by a tendon,

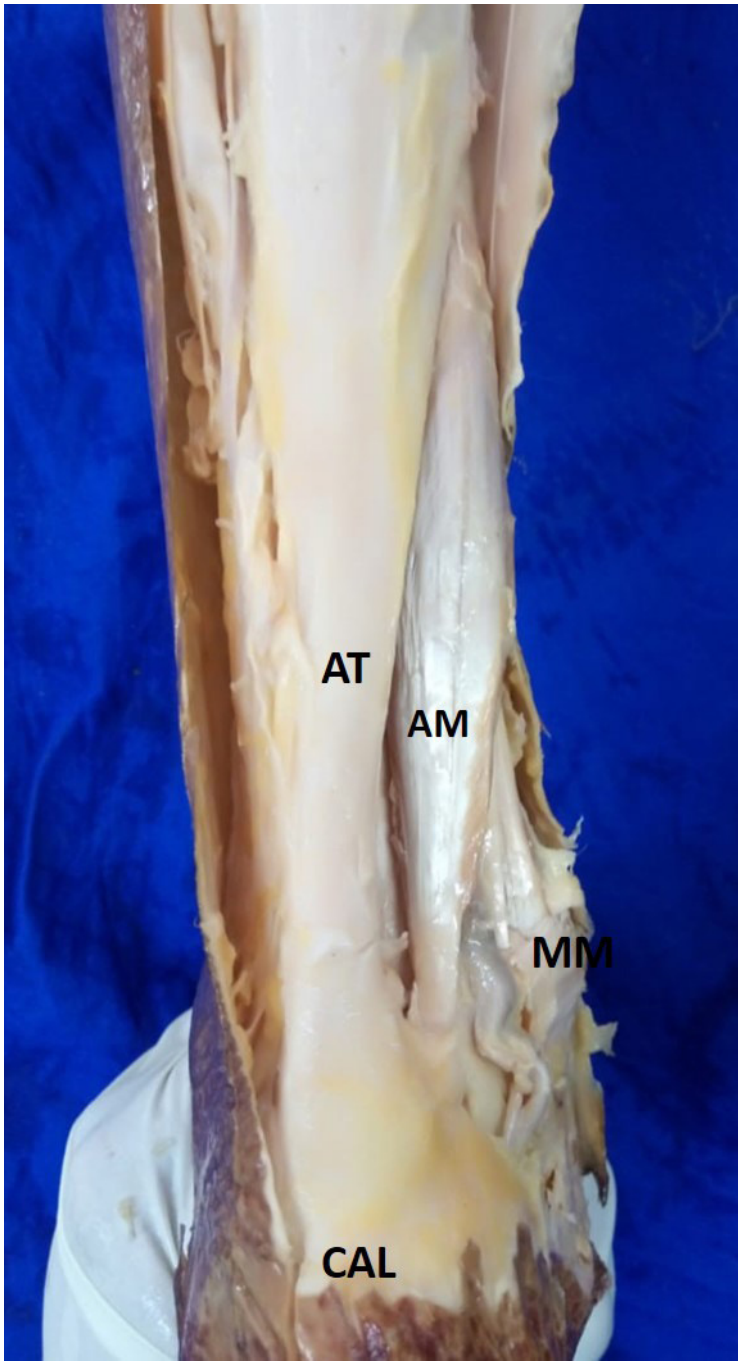

Fig. 2.- Right lower limb of a cadaver showing insertion of accessory muscle. AM- Accessory muscle, AT- Achilles tendon, SM- Soleus muscle, MM- Medial malleolus, CAL- Calcaneus.

medial surface of the calcaneus by fleshy muscle fibre or medial surface of calcaneus by a tendon (Lorentzon and Wirell, 1987; Yu et al., 1994). Like any other accessory muscles, they are also usually asymptomatic and can be identified incidentally during radiological investigations. Identifying these accessory muscles and defining their position, attachment and neuro-vascular supply is useful for making an appropriate diagnosis, as well as planning the surgical approach and procedures (Dunn, 1965). The authors describe an accessory muscle, with the origin from the anterior surface of the soleus with two fascicles and with insertion in the posterior tuberosity of the calcaneus, medial to the Achilles tendon, which we consider as ASM. This variation corresponds to type 5 of ASM by Yu et al. (1994). A branch of the tibial nerve was supplying the ASM in our case, which is similar to the report by Sekiya et al. (1994), Christodoulou et al. (2004) and Yildirim et al. (2011). Some researchers have described this variant muscle as accessory plantaris muscle. This muscle takes origin from the fascia of the soleus, due to its caudal migration from the femoral origin (Mayer et al., 2013). Embryological aspects state that lower limbs develop from the mesoderm at the end of fourth week of development as outpocketings from the ventrolateral body wall, which corresponds to stage 13 of Carneggie (O'Rahilly et al., 1981). Abnormal migration and rearrangement of muscles may lead to variations (Hamilton et al., 1978).

Olewnik et al. (2021) have classified the soleus muscle according to its fiber morphology into four types. Type 1- Bipennate muscle, with the fascicles attached to both sides of central tendon, Type 2- Unnipennate, with fascicles running at an acute angle from one side of the tendon, Type 3- Multipennate, in which fascicles are attached to many tendons within the muscle and Type 4- Non pennate lacking any central tendon. The muscle we found was similar to type 4 of Olewnik et al. (2021).

Common presentation of ASM is posteromedial ankle swelling which may become painful during physical activity (Kendi et al., 2004). Sometimes it may present as painless swelling and rarely it may be associated with club foot deformity (Brodie et al., 1997). Even though ASM is congenital, the symptoms are usually seen in 2nd or 3rd decade of life. Increasing muscle mass and more physical activity during this age may be the reason for symptoms (Mayer et al., 2013). Mihovil et al. (2020) have reported a rare case of ASM with symptom of pain at the ankle without swelling.

Nayak and Shetty (2019) have noticed an anatomical variation of two accessory muscle bellies in the flexor compartment of the leg. One belly was connected between FHL and TP whereas another belly was taking origin from the connective tissue around the posterior tibial artery and was inserted into the lateral border of the tibia. The muscles were crossing the posterior tibial artery. They have also opined that these muscles can compress the posterior tibial vessels. The ASM can cause nerve entrapment at the tarsal tunnel leading to many conditions like painful legs, moving toes syndrome (Pla et al., 1996). Accessory soleus in athletes with ankle pain may confuse the orthopedicians to differentiate from the exertion pain (Randell et al., 2019).

According to Cheung (2017), identifying such accessory muscles can be difficult for radiologists during the evaluation as they follow the path of other normal flexor muscles. As suggested by Kendi et al. (2004), absence of Kager's fat in the plain radiograph may be highly suggestive of ASM. Even though ultrasound and CT scan may be useful in the diagnosis, definitive diagnosis can be done only with magnetic resonance imaging (Mihovil et al., 2020).

In patients with chronic Achilles tendon rupture, treatment is challenging for surgeons. Usually, semitendinosus and gracilis will be used to graft the tendon (Bakowski et al., 2020). Pre-operative evaluation for any accessory muscles in the lower limb may be beneficial in such patients, as these accessory muscle tendons can be used as a graft material for the repair of the injured tendon.

CONCLUSION

We present an accessory muscle in the posterior compartment of the leg supplied by the tibial nerve. Many times, accessory muscles will be unnoticed when they are asymptomatic. Evidence

about these accessory muscles and their location and attachments is useful in making a clinical and radiological diagnosis. Sometimes the presence of this type of anatomical variation is of clinical significance, as it may be mistaken for a soft tissue tumor during the clinical examination, or it may lead to the compression of surrounding neurovascular structures.

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REFERENCES

BĄKOWSKI P, CIEMNIEWSKA-GORZELA K, TALAŚKA K, GÓRECKI J, WOJTKOWIAK D, KERKHOFFS GMMJ, PIONTEK T (2020) Minimally invasive reconstruction technique for chronic Achilles tendon tears allows rapid return to walking and leads to good functional recovery. *Knee Surg Sports Traumatol Arthrosc*, 28(1): 305-311.

BRODIE JT, DORMANS JP, GREGG JR, DAVIDSON RS (1997) Accessory soleus muscle. A report of 4 cases and review of literature. *Clin. Orthop Relat. Res,* 337: 180-186.

CARRINGTON SC, STONE P, KRUSE D (2016) Accessory soleus: a case report of exertional compartment and tarsal tunnel syndrome associated with an accessory soleus muscle. *J Foot Ankle Surg*, 55(5): 1076-1078.

CHEUNG Y (2017) Normal variants: accessory muscles about the ankle. *Magn Reson Imaging Clin N Am*, 25(1): 11-26.

CHRISTODOULOU A, TERZIDIS I, NATSIS K, GIGIS I, POURNARAS J (2004). Soleus accessorius, an anomalous muscle in a young athlete: case report and analysis of the literature. *Br J Sports Med,* 38(6): e38.

DUNN AW (1965) Anomalous muscles simulating soft-tissue tumors in the lower extremities: report of three cases. *J Bone Joint Surg Am*, 47: 1397-1400.

HAMILTON WJ, BOYD JD, MOSSMAN HW (1978) Cardiovascular system. In: Hamilton WJ, Mossman HW (eds). *Human Embryology*, 4th ed. Williams Wilkins, Philadelphia, pp 271-290.

KENDI TK, ERAKAR A, OKTAY O, YILDIZ HY, SAGLIK Y (2004) Accessory soleus muscle. *J Am Podiatr Med Assoc,* 94: 587-589.

LORENTZON R, WIRELL S (1987) Anatomic variations of the accessory soleus muscle. *Acta Radiol*, 28: 627-629.

MAYER WP, BAPTISTA JDS, AZEREDO RA, MUSSO F (2013) Accessory soleus muscle: a case report and clinical applicability. *Autops Case Rep*, 3(3): 5-9.

MIHOVIL P, IGOR K, DAMJAN D, MARIO J, IVAN B (2020) Accessory soleus muscle: Two case reports with a completely different presentation caused by the same entity. *Case reports in Orthopaedics*, Article ID 8851920. 1-7. https://doi.org/10.1155/2020/8851920

NAYAK SB, SHETTY SD (2019) Two accessory muscles of leg: potential source of entrapment of posterior tibial vessels. *Surg Radiol Anat,* 41(1): 97-99.

OLEWNIK L, ZIELINSKA N, PAULSEN F, PODGORSKI M, HALADAJ R, KARAUDA P, POLGUJ M (2020) A proposal for a new classification of soleus muscle morphology. *Ann Anat,* 232: 151584.

O'RAHILLY R, BOSSY J, MÜLLER F (1981) Introduction to the study of embryonic stages in man. *Bull Assoc Anat (Nancy)*, 65(189): 141-236.

PAUL AS, ALI MN, ROBERT RB, ROSY J, OTTO C, LAWRENCE MW (2008) Accessory muscles: anatomy, symptoms and radiological evaluation. *RadioGraphics*, 28(2): 481-499.

PLA ME, DILLINGHAM TR, SPELLMAN NT, COLON E, JABBARI B (1996) Painful legs and moving toes associates with tarsal tunnel syndrome and accessory soleus muscle. *Mov Disord,* 11(1): 82-86.

RANDELL M, MARSLAND D, JENKINS O, FORSTER B (2019) Minimally invasive tendon release for symptomatic accessory soleus muscle in an athlete: a case report. *J Foot Ankle Surg*, 58(4): 644-646.

SEKIYA S, KUMAKI K, YAMADA TK, HORIGUCHI M (1994) Nerve supply to the accessory soleus muscle. *Acta Anat (Basel),* 149(2): 121-127.

STANDRING S (2008) *Gray's Anatomy. The Anatomical Basis of Clinical Practice*. 40th ed. Churchill-Livingstone, London, pp 1420-1424.

YILDIRIM FB, SARIKCIOGLU L, NAKAJIMA K (2011) The co-existence of the gastrocnemius tertius and accessory soleus muscles. *J Korean Med Sci*, 26(10): 1378-1381.

YU JS, RESNICK D (1994) MR imaging of the accessory soleus muscle appearance in six patients and a review of the literature. *Skeletal Radiol*, 23: 525-528.