

Unilateral Extra Muscle in the Sole of the Foot: A Case Report and Its Embryological Review

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Abstract

Presence of accessory muscles in upper or lower extremities is not uncommon. Variations may be in the form of presence of accessory or duplicate muscles or tendons, absence of muscle or tendon. We report a very rare variation, which is not described previously. During routine dissection of cadavers for teaching medical undergraduates at ESIC Medical College, Sanathnagar, we observed an extra small muscle in-between the first and the second layer of the sole of the left foot, with a small belly arising from inter-muscular septa on the medial side of the foot. It was innervated by medial plantar nerve. Muscle belly was running superficial to flexor digitorum longus tendon and flexor digitorum accessorius from medial to lateral side and formed a tendon which was running medial to and in close contact with the tendon of flexor digitorum longus for little toe, to be inserted along with it at the base of distal phalanx of the little toe. The knowledge of these anatomical variations of foot muscle architecture is utmost importance to orthopedic surgeons, radiologist and podiatrist in analysis of foot function, biomechanical modeling of the foot and prosthesis designing. In painful and disabling conditions of foot during differential diagnosis of the presence of accessory muscles of the foot should be kept in mind. On other hand additional muscle slip can be used as replacement flaps in cases of tendon rupture or dysfunction.

Keywords: Accessory Muscle; Flexor Digitorum Longus; Sole; Variation.

Introduction

Variations in the intrinsic muscles of sole are relatively uncommon. There are 18 intrinsic and 4 extrinsic tendons in the sole of foot. These muscles are subjected to variations which are usually encountered during surgery or cadaveric dissections. Variations may be in the form of presence of accessory or duplicate tendons, and absence of a muscle or tendon. Muscle development occurs in the embryo through the formation of myoblasts, which undergo extensive proliferation to form terminally differentiated, postmitotic myocytes. Striated muscle development involves both prenatal and post natal events: primary myogenesis (occurs during the

stage of the embryo) and secondary myogenesis (occurs during the stage of the fetus) lay down the muscular system, and satellite cells act in muscle growth postnatally and in response to exercise or muscle damage [1]. Any deviation from normal development leads to variations of the muscle.

The intrinsic muscles, i.e. those contained entirely within the foot, follow the primitive limb pattern of plantar flexors and dorsal extensors. The plantar muscles in the foot can be divided into medial, lateral and intermediate groups. The medial and lateral groups consist of the intrinsic muscles of the hallux and minimus, respectively, and the central or intermediate group includes the lumbricals, interossei and short digital flexors. It is customary to group the muscles in four layers, because this is the order in which they are encountered during dissection. However, in clinical practice and in terms of function, the former grouping is often more useful [2]. First layer includes abductor hallucis (ABH), abductor digiti minimi (ADM) and flexor digitorum brevis (FDB). The second layer consists of flexor digitorum accessorius (FDBac) and four lumbrical muscles. The tendons of flexor hallucis longus (FHL) and flexor digitorum longus (FDL) run

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Received | 23.10.2018, Accepted | 14.11.2018

in the same plane as the muscles of the second layer [3]. Here, we report unilateral presence of an extra small muscle in between the muscles of first and second layer of the sole, which has never been reported yet.

Case Report

During routine dissection of cadavers for teaching medical undergraduates at ESIC medical college, sanathnagar, we observed an extra small muscle in the second layer of the sole of the left foot of a middle aged male cadaver. Dissection steps were followed as per Cunningham's Manual of Practical Anatomy [4]. In this we reflected skin and superficial fascia of the sole from heel to the root of the middle toe. We removed the fat in the superficial fascia to get the planter aponeurosis (PA) and digital nerves and vessels. Planter aponeurosis was cut 2-3 cms proximal to the heel and reflected distally towards the toes to find the flexor digitorum brevis (FDB) muscle. Deep fascia of the abductor muscles of hallux and little toe was removed. Digital nerves were traced proximally to reach medial and lateral planter nerves. FDB was cut in the middle and reflected proximally avoiding injury to the planter nerves.

After reflecting FDB, we observed a muscle with small belly arising from inter-muscular septa or deep fascia (DF) on the medial side of the foot [Figure 1]. Muscle belly was running superficial to flexor digitorum longus (FDL) tendon and flexor digitorum accessorius (FDAc) muscle from medial to lateral side and formed a tendon which was running medial to and in close contact with the tendon of FDL for little

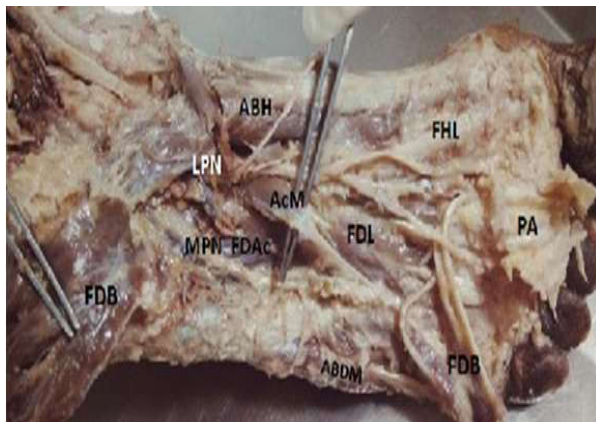


Fig. 1: Sole of left foot showing an Accessory Muscle (AcM), ABH: Abductor Hallucis, FDB: Flexor digitorum Brevis, ABDM: Abductor digiti minimi, FHL: Flexor Hallucis Longus, FDL: Flexor Digitorum Longus, FDL: Flexor digitorum accessories, PA: Planter Aponeurosis, LPN: Lateral Planter Nerve, MPN: Medial Planter Nerve

toe [Fig. 2,3], to be inserted along with it at the base of distal phalanx of the little toe. This small muscle is present in between the muscles of first and second layer. This new muscle was innervated by medial planter nerve (MPN), without any other changes in the patterns of neurovascular branching in this region. This variation is quite unusual. In literature we did not find the similar kind of variation. In right sole however, there was no such variation observed.

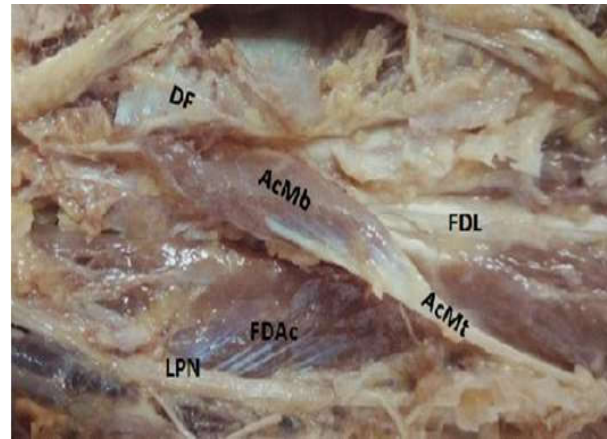


Fig. 2: Sole of left foot showing an Accessory Muscle with a small belly (AcMb) and a tendon (AcMt). DF: Deep Fascia, FDL: Flexor digitorum longus, FDL: Flexor digitorum accessorius, LPN: Lateral Planter Nerve

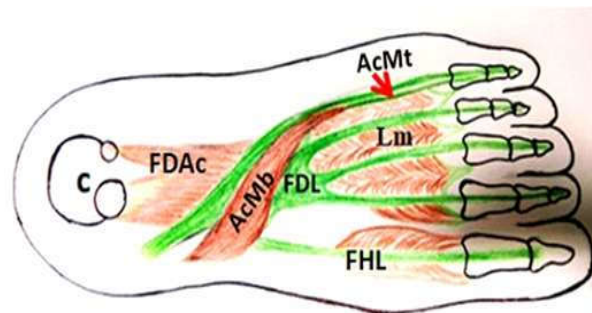


Fig. 3: Diagrammatic representation of sole of left foot showing an Accessory Muscle with a small belly (AcMb) and a tendon (Red arrow, AcMt) inserting along with the tendon of Flexor Digitorum Longus (FDL) for fifth digit, FDL: Flexor digitorum accessories

Discussion

Human foot has evolved from primarily a grasping organ which was essential for efficient arboreal locomotion and over the course developed to have an elaborate plantar aponeurosis, strong plantar ligaments, longitudinal arches an enlarged muscles flexor accessories, an adducted (non opposable) hallux, a remodeled calcaneocuboid joint, a long tarsus and shortened toes (II to V) [5].

It serves a dual role in bi-pedal locomotion performing as mobile structure and also as a rigid lever. The foot muscles play an important role in positioning of the forces on the foot in both posture and locomotion [6].

Accessory muscles are commonly overlooked at imaging evaluation [7]. Although they are typically asymptomatic and encountered as incidental findings, accessory muscles have been implicated as a potential source of clinical symptoms. Such symptoms are usually due to mass effect of the supernumerary muscle, with the patient presenting with either a palpable swelling or secondary compression of adjacent structures such as nerves, vessels, or tendons [8].

As found in literature, accessory muscles like abductor ossis metatarsi quarta muscle and opponens digiti minimi muscle can strengthen the parent muscle and used in replacement flaps in tendon injuries [9] and also have anthropological importance. Flexor digitorum profundus subjected to variety of variation absence of digitations to little toe [10] or supernumerary slip [11]. There is usually communication between FHL & FDL muscle. Flexor digitorum accessorius might be absent and adductor hallucis, transverse head might be missing [12]. We reported the presence of an extra muscle in the second layer of the sole of the left foot. This appears to be additional slip could be remnant of some of the muscles which were involved during process of movement from quadrupedal to bipedal locomotion

Conclusion

The anatomical knowledge of variations of foot muscle is very important to orthopedic surgeons, radiologists and podiatrists for analysing foot function, biomechanical modeling of the foot and prosthesis designing. In painful and disabling conditions of foot during differential diagnosis of the presence of accessory muscles of the foot should be kept in mind. On other hand additional muscle slip can be used as replacement flaps in cases of tendon rupture or dysfunction. Furthermore, accessory muscles may result in compression neuropathies, especially in relation to the anatomical tunnels. Careful evaluation of fibro-osseous tunnels for an accessory muscle may help identify such a muscle as a causative factor, which can easily be overlooked unless accessory muscles are specifically sought out during the review process.

Acknowledgement

We would like to thank students of first year MBBS of our institute for helping in the dissection. I am really thankful to the Dean of our institute and the head of the department for their continuous encouragement and guidance.

There is no funding source concerning this manuscript. The authors do not have any conflict of interest concerning this manuscript.

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