

ABNORMAL ATTACHMENTS BETWEEN A PLANTAR APONEUROSIS AND CALCANEUS

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Abstract

Background and aims. *The plantar aponeurosis or fascia is a thick fascial seal located on the lower surface of the sole. It consists of three parts central, lateral, and medial. The central portion is the thickest. It is narrow behind and wider in front. The central portion has two strong vertical intermuscular septa which are directed upward into the foot. The lateral and medial portions are thinner. The medial portion is thinnest. The lateral portion is thin in front and thick behind. The main function of the plantar fascia is to support the longitudinal arch of the foot.*

In May 2013 during a routine dissection in the section hall of the Department of Anatomy and Histology in Medical University – Sofia, Bulgaria we came across a very interesting variation of the plantar aponeurosis.

Materials and methods. *For the present morphological study tissues from a human corpse material were used. This unusual anatomical variation was photographed using a Nikon Coolpix 995 camera with a 3.34 Megapixels.*

Results. *We found some fibrous strands which started from the proximal portion of the plantar aponeurosis on the left foot. The fibrous strands resembled the tentacles of an octopus and started from the proximal portion of the aponeurosis. Two of fibrous strands were directed laterally to adipose tissue and one was directed medially and backward. The first lateral fibrous strand was divided into several fascicles. We found very few data in literature about the varieties of the plantar fascia.*

Conclusion. *It is very important to consider the occurrence of above mentioned variations in the plantar aponeurosis when surgical procedures are performed on the sole.*

Keywords: plantar aponeurosis, plantar muscles, variations, plantar fasciitis, surgery.

Introduction

The function of the plantar aponeurosis from the biomechanical point of view is to maintain the longitudinal arch of the foot, it supports the compactness of the rotating movements of the step, limits the metatarsal motility and modifies the elastic properties of foot [1,4,7]. Anatomically, the plantar aponeurosis (plantar fascia) consists of pearly white glistening fibers, disposed, for the most part, longitudinally. It is divided into central, lateral, and medial portions [11].

In clinical aspect, some diseases influence the

plantar area, as well as the plantar fascia. For example, Dupuytren’s disease contracture is a benign proliferative disease of the connective tissue. It is characterized by an abnormal fibroblast proliferation and matrix deposition affecting the palmar or plantar fascia [13]. Moreover, the plantar fascia inflammation is at the top of foot disorders in America, and it runs along the sole from the bottom of the heel bone [14].

The central portion is the thickest portion. It is narrow behind, where it is attached to the medial process of the tuberosity of the calcaneus, posterior to the origin of the Flexor digitorum brevis. The lateral and medial portions are thinner. The central portion becomes broader and thinner in front. Then it divides near the heads of the metatarsal bones into five processes. Each of these processes consists

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of two layers, superficial and deep. The superficial layer is inserted into the skin of the transverse groove and this way it separates the toes from the sole. On the other hand, the deeper layer divides into two slips. Every one of them embraces the side of the Flexor tendons of the toes, and blend with the sheaths of the tendons. Connecting with the transverse metatarsal ligament, they form a series of arches through which the tendons of the short and long Flexors pass to the toes. The central portion has two strong vertical intermuscular septa which are directed upward into the foot. These septa separate the intermediate group of muscles from the lateral and medial plantar groups of muscles. The upper surface of the plantar aponeurosis gives origin behind to the Flexor digitorum brevis.

The thin medial portion covers the lower surface of the Abductor hallucis. It is attached behind to the lacinate ligament, and is continuous around the side of the foot with the dorsal fascia. Laterally the medial portion continues in the central portion of the plantar aponeurosis.

The lateral portion is thin in front and thick behind. It covers the under surface of the Abductor digiti quinti. It forms here a strong band between the lateral process of the tuberosity of the calcaneus and the base of the fifth metatarsal bone [11]. Medially the lateral portion is continuous with the central portion and laterally with the dorsal fascia.

The main function of the plantar fascia is to support of longitudinal arch of the foot when the foot bears weight. It is important to mention that failure of the plantar fascia (i.e. in plantar fasciitis) most often occurs at the proximal attachment to the calcaneus, which is consistent with the usual location of symptoms. In case of rupture of the plantar fascia or its surgical release the longitudinal arch of the foot collapses and as a result the arch stiffness decreases.

During gait the plantar fascia has a dynamic function. For example the plantar fascia continuously elongates during the contact phase of gait and has a main role in the normal mechanical function of the foot [11].

As seen from the literature, it is clear that the plantar fascia has a number of roles. The main role is to support arch of the foot and thus contribute to the “windlass mechanism”. Therefore the aim of the present study is to describe our findings about the variation of the anatomy of human foot, which can be in relation with some disorders and disease complications.

Materials and methods

For the present morphological study tissues from a human corpse material were used. In May 2013 during routine dissection in the section hall of the Department of Anatomy and Histology in Medical University – Sofia we came across a very interesting variation of the plantar aponeurosis. We found some fibrous strands starting from the proximal portion of the aponeurosis.

The observations are in accordance with the ethical principles applying by the Sofia’s Medical University. All

legislative requirements to protect human rights have been observed as well. This unusual anatomical variation was photographed using a Nikon Coolpix 995 camera with a 3.34 Megapixels.

Results and discussion

At the time of dissection of the lower limb the following variation regarding plantar aponeurosis was found (Figure 1, and Figure 2):

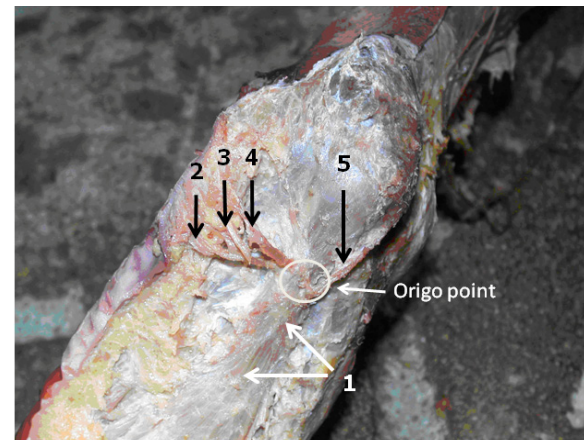


Figure 1. Condition of the lower limb in the early stages of dissection. Normal position (1) of the plantar aponeurosis (white arrow) from the point of capture (origo point) to calcaneus and targeting of three additional fibers directed laterally (black arrows 1, 2, 3). Branch of the plantar aponeurosis (5), oriented in the direction mediodorsal (black arrow 5) and fastened dorsally to calcaneus.



Figure 2. Condition of the lower limb in a later stage of the dissection. Stage of fixation of fascial fibers after removal of the underlying adipose tissue (arrows 1 and 2). Lacking grip for bone fragment.

It is interesting to mention that these fibrous strands existed only on the left foot. This variation was not present on the right foot (data not shown).

On the left foot some fibrous strands are clearly

visible (Figure 1). They resemble the tentacles of an octopus (arrows 2, 3, 4, and 5) and start from the proximal portion (origo point) of the aponeurosis. On the Figure 2 two of fibrous strands can be seen, directed laterally to the adipose tissue and one directed medially and backwards. The first lateral fibrous strand is divided into several fascicles (arrows 1, and 2).

There are data showing some differences in the varieties of the plantar fascia. The central, or major, component of the plantar aponeurosis is the largest, thickest, and strongest. It is triangular and divides into five bands at the midmetatarsal level. Proximal to the metatarsal heads, each longitudinally oriented band divides into a deep tract (*lacertus aponeuroticus profundus*) and a superficial tract (*lacertus aponeuroticus superficialis*) [5]. The deep band of the plantar aponeurosis is a variable structure formed by fibers from both the medial and lateral portions of the plantar aponeurosis. This band courses directly to the plantar ligament of the fourth metatarsophalangeal joint. The function of the deep band of the plantar aponeurosis is unknown, although the anatomical arrangement may make it important in stabilizing the fourth ray of the foot during locomotion [3].

According to Bojsen-Moller et al. (2006) [2], an area proximal to the heads of the metatarsals the retinacula cutis developed into a series of transverse bands, in which the deep fibres of the plantar aponeurosis form ten sagittal septa connected to the deep transverse metatarsal ligament and through this the proximal phalanges of the toes.

On the other hand the plantar aponeurosis consists of the tibial and fibular parts. The form of the fibular part markedly varies according to individuals. The top portion of the medial fiber bundle, if it exists, is the origin of a part of the transverse head of the adductor pollicis muscle and the flexor digiti minimi brevis muscle in some cases [6]. Concerning the medial septum, [12] it has been reported to be very incomplete and to be absent both posteriorly, where structures pass from the calcanean canal to the plantar region, and also anteriorly, where the flexors and the adductor of the great toe pass from the central to the medial plantar space. It was reported as having its deep attachments the medial cuneiform and navicular bones and the tendon of *tibialis posterior*, and the medial plantar nerve and vessels normally pass medially behind the large orifice which transmits the muscles.

Although complete at its origin from the medial margin, it soon divides into three bands (proximal, middle and distal) and the intervals between them are utilized by structures passing from the central to the medial compartment of the foot. Each band divides into medial and lateral divisions which diverge widely as they gain their deep attachments, and the intervals created are also utilized for the passage of certain structures. The tendon of *flexor hallucis longus* passes between the divisions of the distal band, and they retain it in apposition with the lateral head of the *flexor hallucis brevis*. The middle band is the

strongest; it is intimately related to the origin of the *flexor hallucis brevis*, and the 'metatarsal extension' of *tibialis posterior* passes between its divisions [10].

The most extensive studies of the plantar aponeurosis were carried out by Loth [8] in his book in 1908 and afterward in 1931 [9]. The structure of plantar aponeurosis and its function were clearly described, but we have never found in the literature fibrous strands like our finding.

Conclusion

Our observations in this work show that these fibrous strands are part of the unusual and variable superficial tract, or, more probably, the fibrous strands are the product of plantar fasciitis. Regardless of their origin the presence of these fibrous strands must be taken into consideration not only when performing surgery, but also in the prophylaxis and therapy of pain in arthritis patients, or for the people with Dupuytren's contracture. It is very important to consider the occurrence of the above mentioned variations in the plantar aponeurosis when surgical procedures are performed on the sole.

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