Abstract

Background: The present study documents valuable new data on the anatomical variations of the *musculus flexor digitorum brevis* in an adult Colombian population, this muscle and in particular its fourth slip, has a significant clinical and surgical importance. The fourth slip is undergoing a phylogenetic degeneration. The purpose of this study is to conduct an evidenced on the prevalence of the *musculus flexor digitorum brevis* and its variants in humans.

Methods and Findings: A total of 17 cadavers with different age groups were used for this study, 34 feet of 15 male and 2 females embalmed adults cadavers in the laboratory of Morphology of the University of Pamplona. All feet (n= 34) were studied serially during the years 2013-2016. Of the 34 feet examined, in 32 (94.12%) the muscle conformed to the classical descriptions given in anatomical textbooks showed 4 bellies. In the remaining 2 feet (5.88%) the muscle divided into three parts which ended in slender tendons to the second, third and fourth toes.

Conclusions: The knowledge of the anatomical variations in relation to the demographic characteristics of patients would be of importance for diagnostic imaging and foot surgery.

Introduction

The *musculus flexor digitorum brevis* (FDB) lies immediately deep to the central part of the plantar aponeurosis. It takes origin from the central part of the plantar aponeurosis, medial tubercle of calcaneal tuberosity and from the medial and lateral intermuscular septa. The FDB divides into four tendons for the lateral four toes. Each tendon is divided into two slips at the base of their proximal phalanges, to
allow the *flexor digitorum longus* (FDL) tendons, and finally attaches to both sides of the shaft of the middle phalanx [1, 2].

The most common variations of FDB are: absence of tendon to the little toe, the tendon arising as a separate muscle, FDB having a deep head originating from the *flexor digitorum longus* which either joins the main muscle or proceeds as a separate tendon to the little toe, and presence of supernumerary slips [3]. Compared to birds, reptiles and other eutherian mammals only human primates have evolved complete habitual erect posture, and with this evolution, the architecture of the foot has become unique in humans as compared to the lower animals and we are further witnessing more changes [4]. Compared to the little finger, the function of the little toe is minimal and has no opposition action in humans. Hence, the muscles acting on the little toe are undergoing evolutionary changes [5].

*Flexor digitorum brevis* is innervated by the major sensory nerve in the sole of the foot, medial plantar nerve, a branch of the tibial nerve and vascularized by medial and lateral planter arteries, plantar metatarsal arteries and plantar digital arteries. *Flexor digitorum brevis* function in flexion of the four lateral toes at the proximal inter-phalangeal and metatarso-phalangeal joints, regardless of the position of the ankle joint. Along with other muscles of the foot, it reinforces the longitudinal arch of the foot. Paralysis of the *flexor digitorum brevis* (FDB) results in distortion of the arches of the foot. Variations of FDB are important clinically because FDB musculocutaneous flap is used in the reconstruction of the heel pad [6]. The purpose of this anatomical study is to provide more data on the incidence and morphological features of *musculus flexor digitorum brevis*.

### Results

Of the 34 feet examined, in 32 (94.12%) the muscle conformed to the classical descriptions given in anatomical textbooks showed 4 bellies. The muscle was shown to arise from the medial process of tuber calcanei, *plantar aponeurosis* and intermuscular septa of adjacent muscles. It divided into four parts which ended in slender tendons to the second, third, fourth and fifth toes.

In the remaining 2 feet (5.88%), the FDB differed from the standard description in the distal attachment. The anatomical variations described were found during routine dissection conducted in one male cadaver of 75 years old: Fourth tendon of the FDB was absent bilaterally. In the right and left feet...
the *musculus flexor digitorum brevis* (FDB) arose from the medial process of tuber calcanei, plantar aponeurosis and intermuscular septa of adjacent muscles. The muscle divided into three parts which ended in slender tendons to the second, third and fourth toes *(Figure 1 and 2).* The tendons passed through the fibrous flexor sheath of the toes and split into two parts which curved along the sides of the long flexor tendon, rejoined and were attached to the plantar surface of base of middle phalanx. The fifth toe did not receive any tendon from FDB.

Supernumerary tendons were absent in all the cadavers.

**Discussions**

Although a wide variety of anatomical variations such as, absence of *flexor digitorum brevis* slip to a given toe, presence of supernumerary slips or its replacement by a slip from the long flexor tendon or flexor accessorius have been reported [4, 7]. The absence of *flexor digitorum brevis* tendon slip to the
fifth toe was stated as the commonest anatomical variation of this muscle [5, 7-12]. In contrast with the findings in the present study, it is interesting to note, that the incidence of absence of flexor digitorum brevis slip to the little toe was reported as 21% [4], 100% [5], 63% [7], 18% [10] among different study populations.

The present study documents valuable new data on the anatomical variations of the musculus flexor digitorum brevis, reports that FDB slip to the little toe was absent in 5.88% of the study subjects, a result that further highlights the anatomical variations of flexor digitorum brevis. Such anatomical variations, remind us to appreciate the crucial concept that anatomical diversity and variation is a canon of living organisms. However, it is not clear whether these variations represent a functional adaptation of the reference populations.

The FDB is related to toe deformities such as the congenital curly toe [12] and hammer toes. Transfer of the FDB to the proximal interphalangeal joint has been found effective in the prevention of floating toes after Weil osteotomy [13] and in toe ulcers of claw- or hammer-toes in diabetic patients [14]. FDB transfer to the interosseous and lumbrical muscles has been effectively used in treating dynamic claw toe deformity [15]. Transposition of the flexor digitorum brevis tendon has been described for flexible hammer toes [11, 16-18].

A rotational transfer of a musculocutaneous island flap comprising of the FDB is considered as one of the best procedures currently available for covering and reconstructing the weight-bearing area of the heel [6, 19-22]. In addition, distal plantar area of the foot has been successfully reconstructed using a FDB flap based on reverse-flow lateral plantar artery pedicle [23]. This has important implications as it is difficult to resurface skin defects of the sole because of its unique anatomy.

**Conclusion**

A sound knowledge about muscle architecture of foot may facilitate the outcome of surgical as well assist the orthopedist in design of prosthesis and analysis of foot function, in procedures such as tendon transfer and anatomists in understanding the evolutionary changes affecting foot. Reporting of such anatomical variations could also facilitate to radiologist in diagnostic imaging of foot.

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**Competing interests**

None.

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**References**


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