Case Report
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Separated muscle belly of the flexor digitorum brevis for the fifth toe: a case report

Hyun Jin Park[1,*], Jae Wook Baeg[2,*], Mi-Sun Hur[1]
[1]Department of Anatomy, Daegu Catholic University School of Medicine, Daegu, [2]Department of Anesthesia and Pain Medicine, Kyungpook National University Hospital, Daegu, Korea

Abstract: This case report describes a variation of the flexor digitorum brevis (FDB) with a separated muscle belly and tendon at the fifth toe. The narrow tendon and muscle belly for the fifth toe arose from the intermuscular septum between the FDB and abductor digiti minimi adjacent to the arising fibers of the FDB, separating from its other fibers. The tendon and muscle belly for the fifth toe became wider at the base of the metatarsal bones and narrower as it coursed toward the toes in a fusiform shape. The tendon and muscle belly for the fifth toe became thin at the midfoot and coursed just beneath the flexor digitorum longus tendon and entered the digital tendinous sheath. FDB variations including that described herein should be considered when performing various surgical procedures and evaluating the biomechanics of the foot.

Key words: Flexor digitorum brevis, Fifth toe, Muscle belly, Tendon, Variation

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Introduction

Human feet have evolved to facilitate bipedal locomotion and hence have lost the opposable digit that grasped branches in favor of a longitudinal arch that stiffens the foot and aids in the bipedal gait [1]. The little toe is less functional than the little finger and has no opposable digit in humans, resulting in the muscles acting on the little toe undergoing evolutionary changes [2].

The flexor digitorum brevis (FDB) is a foot muscle undergoing phylogenetic degeneration [3]. The FDB is the intrinsic digital flexor and is the most superficially located of the plantar muscles, lying in the midplantar region beneath the plantar fascia [4]. It extends from the medial process of the calcaneal tuberosity to the lateral four toes and assists in maintaining the concavity of the foot. The FDB flexes the lateral four toes at the proximal interphalangeal joint, with equal effect in any position of the ankle joint [4].

Variations have been found in 63% of limbs with an FDB. These variations most often occurred in the slips to the fourth and fifth digits and were relatively uncommon in the more-medial ones. The most commonly described variation has been the absence of the muscle belly and tendon for the fifth toe [5]. Yammine [3] found that the prevalence of the FDB tendon for the fifth toe ranged widely in previous studies, from 0% to 93.3%.

Despite the absence rate of FDB appearing to be increasing, its actions have been closely related to foot control and longitudinal arch support. The FDB is a powerful supporter of the longitudinal foot arches [4]. FDB paralysis results in foot-arch distortion [6]. It is a highly specialized muscle that helps to control the changing posture of the foot [7]. The three largest plantar intrinsic foot muscles (the FDB, abductor hallucis, and quadratus plantae) are activated to dynamically support the longitudinal arch during locomotion so as to control foot posture and longitudinal arch stiffness, and

Corresponding author:
Mi-Sun Hur
Department of Anatomy, Daegu Catholic University School of Medicine, Daegu 42472, Korea
E-mail: mshur@cu.ac.kr

*These authors contributed equally to this work.

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they may provide a buttressing effect during foot loading [8]. Smith et al. [9] also demonstrated that the FDB utilizes its tendinous tissues to enhance power output during arch recoil when mechanical energy is produced at the foot, and also to buffer the power input into its muscle fascicles while the foot dissipates energy.

Variations in the FDB may be clinically important for surgical planning and foot surgery including FDB flap transfer and biomechanical evaluations [10-12]. This case report describes a variation of the FDB with a separated muscle belly and tendon at the fifth toe.

Case Report

The routine dissection of the cadaver of a Korean male who was 54 years old at the time of death revealed that the FDB had a separated muscle belly and tendon at the fifth toe in the left foot (Fig. 1). The FDB arose as the muscle fibers from the medial process of the calcaneal tuberosity, from the deep surface of the plantar aponeurosis, and from the intermuscular septa adjacent to the abductor hallucis and abductor digiti minimi. The narrow tendon and muscle belly for the fifth toe arose from the intermuscular septum between the FDB and abductor digiti minimi adjacent to the arising fibers of the FDB, separating from the other fibers. The tendon and muscle belly for the fifth toe became wider at the base of the metatarsal bones and narrower as it coursed toward the toes in a fusiform shape. The tendon and muscle belly of the fifth toe became a thin tendon at the midfoot and coursed just beneath the flexor digitorum longus tendon and entered the digital tendinous sheath. The other FDB fibers were divided into three tendons for the second, third, and fourth toes, and coursed beneath the flexor digitorum longus tendons.

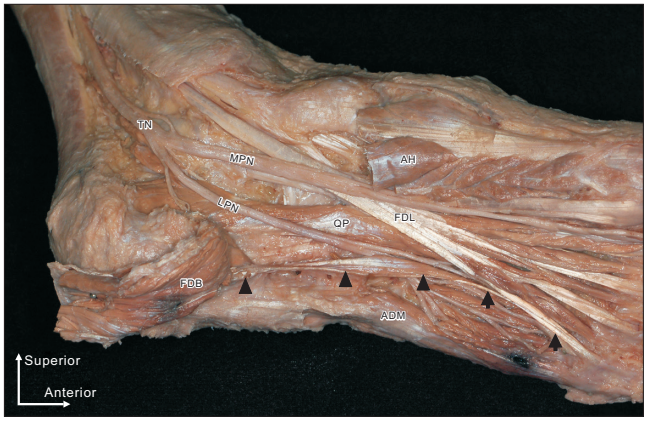

Fig. 1. Separated muscle belly (arrowheads) and tendon (arrows) of the FDB for the fifth toe. The narrow tendon and muscle belly for the fifth toe arose from the intermuscular septum between the FDB and ADM adjacent to the arising fibers of the FDB, separating from its other fibers. The tendon and muscle belly for the fifth toe became wider at the base of the metatarsal bones and narrower as it coursed toward the toes in a fusiform shape. The tendon and muscle belly for the fifth toe became thin at the midfoot and coursed just beneath the flexor digitorum longus tendon and entered the digital tendinous sheath. The other FDB fibers were cut at the digital tendinous sheath of the toes and were reflected posteriorly. FDB, flexor digitorum brevis; ADM, abductor digiti minimi; AH, abductor hallucis; FDL, flexor digitorum longus; LPN, lateral plantar nerve; MPN, medial plantar nerve; TN, tibial nerve; QP, quadratus plantae.

Discussion

The FDB muscle fibers in the sole of the foot are generally divided into four tendons for each of the four lateral toes [4]. The muscle belly and tendon of the FDB for the fifth toe was separated and distinctive in the present study. It may therefore help to move the fifth toe more independently, to support the lateral longitudinal arch, and to stabilize the foot and stiffen the metatarsophalangeal joints during locomotion.

Several studies have found a separated muscle belly in the FDB for the fifth toe. Yalçin and Ozan [11] found that a separated muscle belly for the fifth toe was very thin and originated from the intermuscular septum as a flat fascia under the FDB. An independent FDB to the fifth toe may also arise from the tibialis posterior muscle [5]. The separated muscle belly and tendon of the FDB for the fifth toe were distinct and originated from the intermuscular septum in the present study, thereby demonstrating slightly different features.

Previous studies have found that the muscle belly and tendon of the FDB for the fifth toe were often absent or very small. Yalçin and Ozan [11] found that the muscle belly and tendon for the fifth toe were totally absent in 18% or very small in 36%. Quiñones-Rodriguez et al. [13] found that the FDB tendon for the fifth toe was absent in 26.7%. Ilayperuma [14] found it to be absent in 71.9%, in which it was bilaterally absent. Bernhard et al. [12] found it to be absent in 48%, and it was notably small in 26%. That study also found that there was a tendency for females to have fewer and smaller tendons for the fifth toe when the tendon of the FDB was present, and demonstrated that males are more likely to have a fourth tendon. Stimec et al. [15] found an additional muscular slip of the flexor digitorum longus muscle to the fifth toe that did

not have a musculotendinous portion of the FDB in the same toe, and replaced that of the fifth toe. Lobo et al. [2] found that the tendon for the fifth toe was missing in all 60 soles, and the authors suggested that the action of the FDB can be compensated by other long flexors of the foot, probably due to a gradual reduction in the usage of the little toe during the evolution of a bipedal posture.

FDB variations have several clinical implications. Musculocutaneous flap transfer of the FDB can be used to reconstruct the heel pad [2, 10, 11]. The possibility of a separated muscle belly and tendon of the FDB for the fifth toe should therefore be considered when performing FDB flap transfer. In cases when the tendon of the FDB for the fifth toe is absent, this may also alter the biomechanics of the fifth toe and its force vector due to the difference in number of tendons [12]. FDB variations including that described herein should therefore be considered when performing various surgical procedures and evaluating the biomechanics of the foot.

ORCID

Hyun Jin Park: https://orcid.org/0000-0001-5639-6540
Jae Wook Baeg: https://orcid.org/0009-0000-5136-8794
Mi-Sun Hur: https://orcid.org/0000-0002-1482-1657

Author Contributions

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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References

1. Farris DJ, Kelly LA, Cresswell AG, Lichtwark GA. The functional importance of human foot muscles for bipedal locomotion. Proc Natl Acad Sci U S A 2019;116:1645-50.
2. Lobo SW, Menezes RG, Mamata S, Baral P, Hunnargi SA, Kanchan T, Bodhe AV, Bhat NB. Phylogenetic variation in flexor digitorum brevis: a Nepalese cadaveric study. Nepal Med Coll J 2008;10:230-2.
3. Yammine K. The fourth slip of the flexor digitorum brevis muscle of the human foot. A systematic review and meta-analysis. Ital J Anat Embryol 2015;120:59-70.
4. Standring S. Gray's anatomy: the anatomical basis of clinical practice. 42nd ed. Elsevier; 2020.
5. Tubbs RS, Shoja MM, Loukas M. Bergman's comprehensive encyclopedia of human anatomic variation. Wiley-Blackwell; 2016.
6. Rosse C, Gaddum-Rosse P. Hollinshead's textbook of anatomy. 5th ed. Lippincott-Raven; 1997.
7. Grogono BJ, Jowsey J. Flexor accessoreus longus: an unusual muscle anomaly. J Bone Joint Surg Br 1965;47:118-9.
8. Kelly LA, Cresswell AG, Racinais S, Whiteley R, Lichtwark G. Intrinsic foot muscles have the capacity to control deformation of the longitudinal arch. J R Soc Interface 2014;11:20131188.
9. Smith RE, Lichtwark GA, Kelly LA. Flexor digitorum brevis utilizes elastic strain energy to contribute to both work generation and energy absorption at the foot. J Exp Biol 2022;225:jeb243792.
10. Ikuta Y, Murakami T, Yoshioka K, Tsuge K. Reconstruction of the heel pad by flexor digitorum brevis musculocutaneous flap transfer. Plast Reconstr Surg 1984;74:86-96.
11. Yalçin B, Ozan H. Some variations of the musculus flexor digitorum brevis. Anat Sci Int 2005;80:189-92.
12. Bernhard A, Miller J, Keeler J, Siesel K, Bridges E. Absence of the fourth tendon of the flexor digitorum brevis muscle: a cadaveric study. Foot Ankle Spec 2013;6:286-9.
13. Quiñones-Rodriguez JI, Mantilla-Rosa C, Rodríguez F, Villamil CI, Fernández J, González-Solá M, Torres-Toro C, Rosario MG. A missing flexor digitorum brevis tendon and its relationship to sex and ancestry: evaluation in Hispanic population. Anatomia 2022;1:210-6.
14. Ilayperuma I. On the variations of the muscle flexor digitorum brevis: anatomical insight. Int J Morphol 2012;30:337-40.
15. Stimec BV, Dash J, Assal M, Stern R, Fasel JHD. Additional muscular slip of the flexor digitorum longus muscle to the fifth toe. Surg Radiol Anat 2018;40:533-5.