

Phylogenetic Variation of Muscle Flexor Digitorum Brevis- Rare Variation on the Right Foot.

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ABSTRACT

Background: Flexor digitorum brevis is an intrinsic muscle of the sole of the foot that lies superior to the central part of planter apponurosis and inferior to the tendons of flexor digitorum longus. This flat spindle shaped muscle arise from the medial process of tuber calcanei, proximal part of planter apponurosis, inter muscular septa and adjacent fascial layers. The muscle fiber conver anteriorly forming four tendons one each for the four lateral toes at the bases of proximal phalanges each tendon splits into two slips around the tendon of flexor digitorum longus, reunites into a chiasma, divides again to insert into margins of intermediate phalanges of lateral four toes. **Methods:** This study was carried out by routine dissection classes for undergraduate medical students classes from July 2010 to January 2014 in the department of anatomy, Teerthanker Mahaveer medical college Moradabad; department of anatomy, Rama medical college Kanpur; Department of Anatomy, Hamdard Institute of Medical Science & Research, Jamia Hamdard New Delhi. Total no. of 80 cadavers (48 male and 32 female) all the cadavers were been preserved in 10% of formalin and age ranged between 45 to 67 years. **Results:** Summarising the result indicates out of 80 cadavers 25% were having none anatomical variation, 46% of cadavers had bilateral absence of tendon for fifth toe of flexor digitorum brevis while 18% of cadavers having variation on the left foot and rare 9% of cadavers were represented having variation on the right foot while the left foot was anatomically normal. **Conclusion:** Variation of flexor digitorum brevis may occur as phylogenetical changes due to minimal use of little toe in evolved bipedal posture.

Keywords: Flexor digitorum brevis, musculocutaneous flap, phylogenetic variation, anatomical variation, heal pad.

INTRODUCTION

Flexor digitorum brevis, musculocutaneous flap, phylogenetic variation, anatomical variation, heal pad.

Flexor digitorum brevis are an intrinsic muscle of the sole of the foot that lies superior to the central part of planter apponurosis and inferior to the tendons of flexor digitorum longus. This flat spindle shaped muscle arises from the medial process of tuber calcanei, proximal part of planter apponurosis; inter muscular septa and adjacent fascial layers. The muscle fiber conver anteriorly forming four tendons one each of the four lateral toes at the bases of proximal phalanges each tendon splits into two slips around the tendon of flexor digitorum longus, reunites into a chiasma, divides again to insert into margins of intermediate phalanges of lateral four toes.^[1] The tendon of flexor digitorum brevis enters fibrous digital tunnel on the planter aspect of the digits where they are surrounded by digital synovial sheath.

These fibrous digital tunnels or sheaths hold the flexi or digitorum brevis tendons to the bony plane and prevents them from bowing when the toes are flexed.^[2-5] Flexor digitorum brevis is innervated by the major sensory nerve in the sole of the foot, medial planter nerve, and a branch of the tibial nerve and vascularised by medial and lateral planter arteries, planter metatarsal arteries and planter digital arteries.^[6] Flexor digitorum brevis functions in flexion of the four lateral toes at the proximal interphalangeal and metatarsophalangeal joints, regardless of the positions of the ankle joints.^[3-7] Along with other muscles of the foot, it reinforces the longitudinal arch of the foot.^[8,9] Paralysis of flexor digitorum brevis results in distortion of arches of the foot.^[10] Variety of anatomical variations of flexor digitorum brevis that differed from classical descriptions given in anatomy text has been reported. Variation in this muscle occurs in 63% of feet.^[11] Some of its reported anomalies have been manifested as the absence of the tendon to little toe^[2,4,5,10,11, 12] presence of deep head arising from the flexor digitorum longus which either joins the main muscle or proceeding as a separate tendon to the little toe.^[13] It is present but ends in fascia, failing to reach the toe, it arises separately fibular band of planterapponurosis and presence of supernumary slips.^[14]

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Clinically flexor digitorum brevis musculocutaneous flap is used in the reconstruction of the heel pad and flexor digitorum brevis tendon transfer is used in correction of flexible claw and hammer toe deformity. Therefore deep knowledge of anatomical variation of this muscle will facilitate prospective diagnosis as well as surgical procedures of feet.

MATERIALS AND METHODS

This study was carried out by routine dissection classes for undergraduate medical student’s classes from July 2010 to January 2014 in the department of anatomy, Teerthanker Mahaveer medical college Moradabad; department of anatomy, Rama medical college Kanpur; Department of Anatomy, Hamdard Institute of Medical Science & Research, Jamia Hamdard New Delhi. Total no. of 80 cadavers (48 male and 32 female), all the cadavers were been preserved in 10% of formalin and age ranged between 45 to 67 years. All the 160 feet of 80 cadavers were dissected under instructions given in cunningham’s manual of practical anatomy i.e. longitudinal incision was made on the sole of foot extending from heel to toes, planter skin, subcutaneous fascia and planter apourosis of foot have been dissected carefully to exposed flexor digitorum brevis. Present study did not include any specific issue that needed to be approved by concerned institutional ethical committee.

RESULTS

Out of 160 feet of 80 cadavers 42 feet of 21 cadavers represented none variations, 74 feet of 37 cadavers shown bilateral absence of fourth tendon of flexor digitorum brevis to fifth toe. While 30 feet of 15 cadavers shown absence of fourth tendon to fifth toe on left limb. As comparing to text available from most of the sources the variation commonly found on the left foot while in the present study we found a rare variation on the right while the left foot remain normal with its anatomical structures. The present study representing the rare variation i.e. on the 14 feet of 7 cadavers we found that on the right foot of these 7 cadavers the tendon to fifth toe is coming from an individual belly originating from tendon of flexor digitorum longus muscle and adjacent apourosis and additionally it is giving a small belly & its tendon is joining the tendon of flexor digitorum breves to the fourth toe. Summarising the result indicates out of 80 cadavers 25% were having none anatomical variation, 46% of cadavers had bilateral absence of tendon for fifth toe of flexor digitorum breves while 18% of cadavers having variation on the left foot and rare 9% of cadavers were

represented having variation on the right foot while the left foot was anatomically normal.

Table 1: Showing the frequency of variation with their percentage.

Anatomical variation		
Cadavers	Normal	Percentage
80	21	26%
	Bilateral	Percentage
	37	46%
	Left side	Percentage
	15	18%
	Right side	Percentage
	7	9%

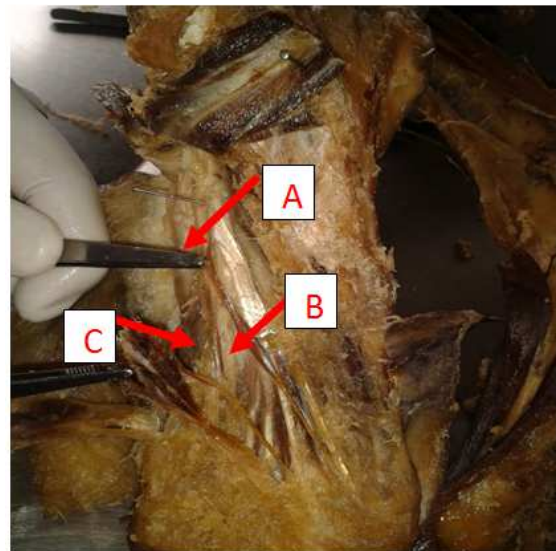


Figure 1: Showing individual belly (A) its division (B) to 5 toe and (C) slip to tendon of FDB to 4 toe.

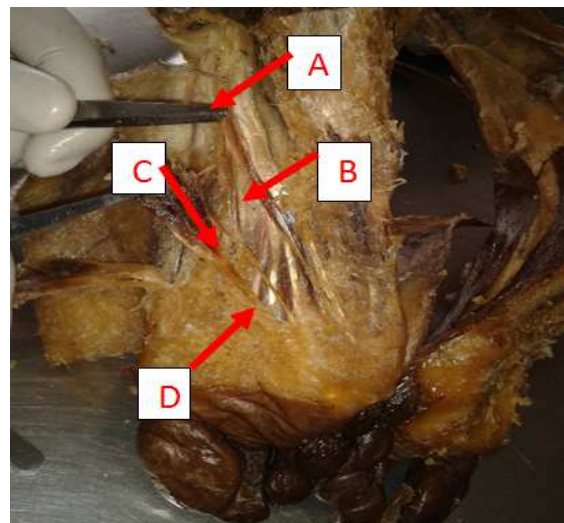


Figure 2: Showing individual belly (A) its division (B) to 5 toe and (C) the junction of FDB tendon for 4 toe and slip from (A) and (D) to tendon of FDB to 4 toe.

DISCUSSION

Variation is a fundamental factor. Evolution is not possible had there been no variation in different organs and their structure. Present study documents valuable new data on the anatomical variation of the muscle flexor digitorum brevis especially on the right foot in contrast with the left foot. Although wide variety of anatomical variation such as the absence of flexor digitorum brevis tendon to the fifth toe was stated as the commonest variation.^[1,2,4,5,10,15] It is interesting to note, that the incidence of absence of flexor digitorum brevis slip to the little toe was reported as 63%^[1] 21%^[3], 18%^[16] and 100%^[10]

During evaluation, as brachiation is not used for locomotion, degenerative changes have occurred in the muscle. Therefore, in man muscle is often absent unilaterally or bilaterally and incidence of agenesis is gradually increasing in different races and populations.^[4] The usage of fifth toe in human is minimal when compared to the little finger. Further, it has no opposition action in humans.^[17] Thinking along these lines, it has been speculated, that muscles acting on the little toe are undergoing evolutionary changes^[10] this is further supported by the results obtained from an electromyographic investigation of foot muscles that reports, three toe flexor muscle (flexor digitorum longus, flexor digitorum brevis, flexor accessorius) act together to re-assist extension of the toes during the stance phase of locomotion. Despite the large flexor accessorius muscle in human, neither it nor the flexor digitorum brevis were preferentially recruited over the flexor digitorum longus for any normal posture or locomotion.^[18] From the clinical point of view, knowledge about anatomical variation of flexor digitorum brevis has several implications. Claw toe deformity is characterised by dorsiflexion of proximal and distal interphalangeal joint^[19] flexor digitorum longus tendon transfer is considered as the gold standard and transfer of the flexor digitorum brevis as an alternative method to treat such deformities.^[20] In the correction of claw or hammer toe deformities, especially in the second, third and fourth toes, flexor digitorum brevis tendon has been successfully transferred to the dorsum of proximal phalanx.^[10] Furthermore, results obtained from study that compared the biomechanical outcome of these two methods by means of finite element simulation have shown that, flexor digitorum brevis tendon transfer resulted in a uniform distribution of stress along the entire toe. These results confirm that the flexor digitorum tendon transfer as an effective treatment option for patient with claw toe deformity.^[21]

CONCLUSION

In the present study flexor digitorum brevis gave only three tendons to second, third, fourth toe in the majority of the cases while only in seven cadavers and specially on the right foot flexor digitorum brevis gave three tendons to second, third, fourth toe while a separate muscle belly originating from tendon of flexor digitorum longus and adjacent aponeurosis giving a minor belly which joins the tendon of flexor digitorum brevis to fourth toe and rest of the belly converted into a tendon and gets inserted into fifth toe while the structure of the left foot of these cadavers showing none anatomical variation. By the review of other literature, we concluded that such variation may occur as phylogenetic changes due to minimal use of little toe in evolved bipedal posture. It is clear that sound knowledge about anatomical variation of flexor digitorum brevis facilitates the outcome of surgical as well as diagnostic imaging techniques such as computed tomography or magnetic resonance imaging of foot.

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