



An unique unilateral tendon variation of the extensor digitorum longus muscle

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Abstract

Purpose The double tendon of extensor digitorum longus (EDL) muscle was observed on the left leg of a 80-year-old male cadaver.

Methods A male cadaver 80 years old was subjected to routine anatomical dissection for research and teaching purposes.

Results The main tendon of the EDL muscle started just at the end of the muscle belly. However, the accessory tendon started at the tendinous end of the muscle as a continuation of the muscle. The main and accessory tendons split into two more slips after passing through the same tunnel below the extensor retinaculum. There was also difference on ending of the tendon slips of EDL muscle. The main tendon divided into two tendinous slips on the dorsum of the foot attached to the second and third toes. The accessory tendon divided into two tendinous slips on the dorsum of the foot attached to the fourth and the fifth toes.

Conclusion Knowledge of the tendons and anatomical differences of this muscle is important for surgeons in interventional procedures involving the dorsum of the foot.

Keywords Anatomy · Cadaver · Extensor digitorum longus muscle · Tendon · Variations

Introduction

The extensor digitorum longus (EDL) muscle, which is part of the anterior crucial region is a feather-like and unipennate muscle that exists superficially in the extensor compartment of the lower leg. The EDL common tendon after passing

below the extensor retinaculum in the dorsal of the ankle divides into four tendons [12].

EDL muscle receives the nerve supply from the deep fibular nerve and the blood supply from the anterior tibial artery and the fibular artery. Primarily, EDL muscle extends medial four digits at the metacarpophalangeal joints and at the interphalangeal joints. Secondly acts to dorsiflexion of the foot [3, 12].

The tendonization of the EDL muscle usually starts from in lower one-third of the leg then the tendon of EDL divides into four slips and each slip attach to the dorsal digital expansions of the lateral four digits [3, 12]. This muscle varies considerably in the modes of origin and the arrangement of its various tendons. Many variations of EDL have been reported in studies such as second, fourth and fifth slips of the EDL muscle's tendon, difference in number of muscle bellies, presence of tendinous slips that join other muscles, and unilateral absence of an EDL muscle [1, 6, 9–11].

An unusual pattern in the tendons of EDL is reported and its clinical and surgical importance is discussed.

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Case presentation

We encountered double tendon of EDL muscle during routine educational dissection in African American male cadaver at the age of 80. Our study was carried out on cadavers fixed in 5% formalin. Dissection incision lines were: a transverse incision connecting the inner and outer condyles of the femur, a transverse incision between the malleoli, and a vertical incision connecting the midpoints of these incisions from the knee to the ankle. We exposed muscles and tendons after the skin, fascia and superficial veins of the leg. After dissecting the lower leg and the tendons of EDL muscle carefully, we took photographs of this rare variation. For metric measurements a digital caliper was used.

The variation that we observe was unilateral and it was in the left leg. The EDL muscle belly arose from the lateral condyle of the tibia, the interosseous membrane and the medial surface of the fibula. The EDL muscle belly width was measured 1.26 cm. There was double tendon on EDL muscle. The EDL divided into double tendons 18.09 cm below its origin point. The main tendon of the EDL muscle (width: 0.57 cm) started just at the end of the muscle belly. However, the accessory tendon of EDL muscle (width: 0.35 cm) started at the tendinous end of the muscle as a continuation of the muscle (Fig. 1). Tendon widths were

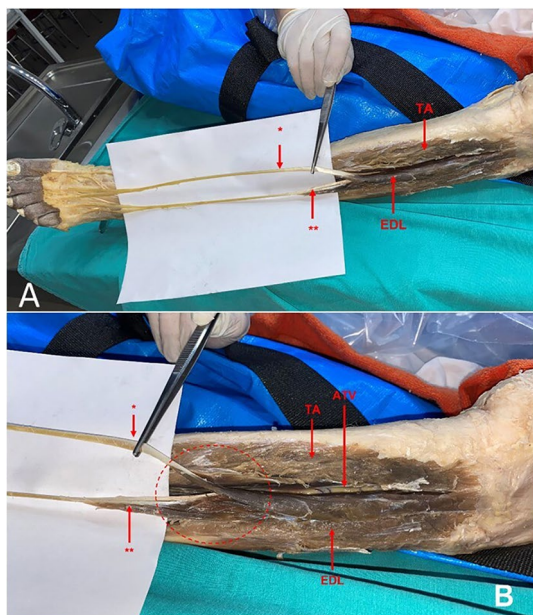


Fig. 1 **A** Dissection of the left leg and dorsum of the foot showing the double tendon of the EDL muscle. The starting point of main and accessory tendons of EDL, in the upper part of the leg. **B** Closer view of the tendon originating point of EDL muscle. (TA tibialis anterior muscle, ATV anterior tibial vein, EDL extensor digitorum longus muscle, * the main tendon of EDL muscle, ** the accessory tendon of EDL muscle)

measured at the musculotendinous junction. The main tendon has begun higher than the accessory tendon. The distance between beginning of the both tendons was 4.21 cm. The distance between the main and accessory tendons with the adjacent tibialis anterior tendon was 7.67 and 3.4 cm, respectively.

These two tendons below the extensor retinaculum were on the same tunnel. After passing below the extensor retinaculum, the main tendon and the accessory tendon were divided into two more slips. There was also difference on ending of the tendon slips of EDL muscle. The main tendon of EDL muscle divided into two tendinous slips on the dorsum of the foot attached to the second and third toes. As the main tendon, also the accessory tendon of EDL muscle divided into two tendinous slips on the dorsum of the foot attached to the fourth and the fifth toes (Fig. 2). The distance between the beginning of the 2nd and 3rd slips with the 4th and 5th slips was measured as 2.53 cm. The length of each tendon to the second, third, fourth and little toes was measured as 36.1, 35.3, 30.2 and 28.4 cm, respectively. This is the unique unilateral tendon variation of the EDL muscle. The insertion of all tendinous slips of the EDL muscle to the lateral toes was found out to be normal. Trace and structure of the tibialis anterior, extensor hallucis longus, and extensor digitorum brevis tendons were normal in the anterior compartment of the left leg.

Discussion

The descriptive and precise anatomy of the anterior compartment of the leg has been studied since 1832 [5, 8, 13]. Variations in EDL relate to the origin and arrangement

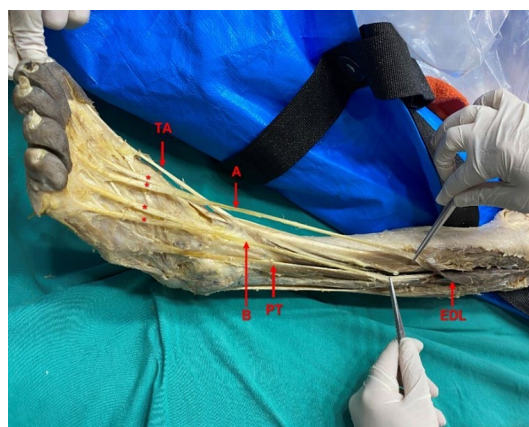


Fig. 2 A view of the tendon slips positions of the EDL muscle and the main and accessory tendon of EDL (TA: tibialis anterior muscle, EDL: extensor digitorum longus muscle, PT peroneus tertius muscle, A main tendon of EDL muscle, B accessory tendon of EDL muscle, * Tendon slips of EDL muscle)

of its various tendons. They may be extra slips may arise from one or more tendons to their corresponding metatarsal bones and to the extensor muscles. The slip of the fifth toe may contribute to extensor hallucis longus or extensor hallucis brevis [2, 5, 13].

The double tendon of EDL muscle was observed the left leg in our study. The main tendon divided into two tendinous slips on the dorsum of the foot attached to the second and third toes. The accessory tendon of this muscle divided into two tendinous slips on the dorsum of the foot attached to the fourth and the fifth toes.

Some studies have been reported that EDL muscle can show variation as giving extra slips to the base of proximal phalanx of second digit, first interosseous muscle and the fifth metatarsal bone [6, 7, 10]. The tendons of the EDL start from a common tendon and then divide into four, although some studies have been reported that the absence of the tendons of EDL muscle [1, 9, 10]. Sakuma et al. [10] found that the tendon slip of the fourth toe was absent while the other toes have a slip of the EDL muscle. Abhinitha et al. [1] found that the main tendon of EDL divides into three slips inserted to the second, third and the fourth toes and the fourth slip was absent. In addition, it has a connecting slip to the tendon of peroneus tertius. In Newton's [9] case, the EDL muscle and tendons was totally absent in the right leg. However, in the left leg the second, third and fourth slips were absent. In the left leg, the main tendon of EDL muscle progressed as a slip which inserted to fifth toe (Table 1).

The tendons of the EDL are independent of each other, but Bakırcı et al. [2] reported that a tendinous connection in the EDL tendons reminiscent of the connexus intertendinous in the hand. This tendinous junction was located between the first and second tendons. In addition, third tendon turns into two separate tendons just distal to the initial part, and these two tendons extend distally without

separating from each other and end together in the third finger [2] (Table 1).

Harşa et al. [6] detected bilateral extra tendon slips. The left EDL muscle tendon was separated into 5 slips, not 4. Slip 5 attached to the joint capsule of the 5th metatarsophalangeal joint and the accessory tendon slip separates from this tendon adheres on the dorsal left foot. An accessory tendon slip detached from slip 4 and attached to the articular capsule of the 5th metatarsophalangeal joint in the right foot [6] (Table 1). Autograft tendon or extra slips taken from long toe extensors such as EDL are used in reconstructive surgery not only of the foot but also of the hand [4, 14]. Our accessory tendon may be important as a potential graft for foot and ankle surgery.

Banerje et al. [3] reported that splitting into two tendons at the level of the leg on EDL muscle. These tendons united together again at the level of the ankle and created a common tendon that divided into four slips (Table 1). In Banerje et al.'s [3] case, the EDL muscle was divided into two tendons at leg level, as in ours. But these two tendons did not unite subsequently in our study.

Jetti et al. [7] have reported a higher division of the EDL muscle. This long tendon was between the tibialis anterior and EDL in the upper part of the leg. In this report, the tendon of EDL muscle divided into two tendinous slips for the second and the third toes. The main tendinous slip divided into two and attached the fourth and the fifth toes as in our report (Table 1). Similar to Jetti et al. [7], the main tendon of the EDL muscle appeared as a large tendon higher than the accessory tendon in the present study. Contrary to Jetti et al. [7], the main tendon is divided into two tendinous slips for the second and the third toes.

Schettler et al. [11] also detected a double tendon in the EDL muscle as in our case. EDL muscle on the right leg divided into two distinct muscle masses and double tendon. The lateral muscle provided a tendon to the index finger. The medial muscle provided tendons to the third and fourth

Table 1 Some reported tendon variation of EDL muscle

Studies	Gender	Age	Type of variation
Abhinitha et al	F	55	Fourth slip absence
Sakuma et al	F	73	Extra slips + slip of the fourth toe absence
Newton	M	Unknown	All EDL tendons absence (right leg) + second, third and fourth slips absence (left leg)
Bakırcı et al	M	Unknown	Intertendinous
Harşa et al	M	Unknown	Extra slips
Banerje et al	M	62	Double tendon
Jetti et al	M	55	Higher division + extra slips
Schettler et al	M	73	Double tendon + slip of the third toe absence
Present study	M	80	Double tendon (main and accessory tendon)

F Female, M Male

digits. Schettler et al. [11] reported a total of 3 tendon slips. There was no tendon slip of the third toe (Table 1). But in our case, there was only one muscle belly and the main tendon of EDL muscle divided into two tendinous slips on the dorsum of the foot attached to the second and third toes. The accessory tendon of EDL muscle divided into two tendinous slips to the fourth and the fifth toes. Therefore, a total of 4 tendon slips were detected.

Conclusion

The tendons of EDL have numerous variations. Knowledge and identification of these variations is an advantage for orthopedic and plastic surgery surgeons. EDL muscle variations can affect the precise movements of the ankle and toes. The presence of two tendons in place of one can be a cause of compression below the extensor retinaculum. If the accessory tendon is compressed, the extension of the 4th and 5th toes, if the main tendon is compressed, the extension of the 2nd and 3rd toes may be restricted. Therefore, dorsiflexion of the foot may be restricted and gait phases may be affected especially initial contact, midstance, swing. In addition, all tendon slips are potential graft sources for replacement of damaged tendons.

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Data availability Please contact author for data requests (Burcu Kamaşak—email address: brc1608@hotmail.com).

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study was conducted on cadaver; it is among the studies that do not require ethics committee approval. The cadaver belonged to the Department of Anatomy, Faculty of Medicine, Kırşehir Ahi Evran University. This study was reviewed and deemed exempt by our Kırşehir Ahi Evran University Faculty of Medicine Ethical Committee.

Consent to participate Not applicable.

Consent to publish Not applicable.

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