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Extensor digitorum muscle tendon to the index finger from the extensor carpi radialis brevis: a cadaveric case report

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ABSTRACT

The forearm extensor compartment is known for its wide variability in terms of muscle origin, number of tendons and their distal insertion. The index finger on its dorsal aspect is the typical place of insertion of the two tendons of the extensor digitorum (ED-index) and of the extensor indicis. Being acquainted with their anatomy is of immense importance to orthopedic surgeons in the treatment of e.g., de Quervain's syndrome.

The current report presents a rare finding of the ED-index tendon arising from the extensor carpi radialis brevis (ECRB). A routine dissection revealed their fused course from the lateral epicondyle of humerus, though separate from the extensor carpi radialis longus. The ED-index muscle belly separated from the ECRB, 119 mm distal to the lateral epicondyle. The distal insertion point of the ED-index was located radially to that of the extensor

indicis. The deep branch of the radial nerve and the recurrent interosseous artery supplied the ED-index. No other musculotendinous variations were encountered neither on the ipsilateral nor the contralateral upper limb of the cadaver.

This study presents in detail a tendon of the ED-index arising from the ECRB, a knowledge that can be applied namely in the lateral epicondylitis treatment or approach to the ulnar nerve at the level of the elbow. Extensive depiction of both the proximal and distal attachment points of the muscles, their course and dimensions is indispensable to attain the best patient outcomes and avoid iatrogenic injuries.

Key words: extensor digitorum, extensor carpi radialis brevis, anatomy, variation

INTRODUCTION

The extensor compartment of the forearm presents a rich variability. Most of these variants are asymptomatic [10, 14]. The index finger has two independent tendons: the tendon of the extensor digitorum (ED-index) with a single slip, usually, and the tendon of the extensor indicis (EI), variable in size, origin, and insertion locations, as well as in number of distal slips present. The most common variant is a single-slip of the EI tendon inserting on the ulnar side of the ED-index tendon [25].

The ED arises from the lateral epicondyle of humerus and divides into four tendons, inserting into the lateral and dorsal surface of the middle and distal phalanges of the 2nd-5th finger [13]. Most studies describe the ED to give off one tendon directly to the extensor expansion of hand of each one of the above-mentioned four digits [3]. The extensor carpi radialis brevis (ECRB) also arises from the lateral epicondyle of humerus and inserts as a flat tendon into the styloid process of metacarpal III [13, 24]. The ED and the ECRB muscles are both innervated by the radial nerve. The ECRB's function is mainly to extend the wrist, whereas the ED extends the proximal interphalangeal joints, the wrist, and the elbow.

Becoming thoroughly acquainted with the extensor tendons' variants may be helpful for hand surgeons in planning tendon graft surgery [3, 25] and allowing them to

successfully perform tenosynovectomy for the treatment of de Quervain's syndrome [3, 19]. The detailed anatomical knowledge of the extensor tendons is a determining factor in preserving healthy tendons during orthopedic procedures, hence accounts for good patient outcomes and improves their quality of life [3, 5].

The current case study refers to a rare origin of the ED-index tendon from the ECRB. The report offers a detailed depiction of the topography of this aberrant muscle in its clinical context and discusses its embryological significance.

CASE REPORT

During a routine dissection of a 66-year-old male formalin fixed cadaver (performed by JAW and SP), a variant origin of the ED-index tendon from the ECRB was noted on the left upper extremity. Having removed both the superficial fat and connective tissues, digital documentation was performed prior to measurement taking using a digital caliper (Lux tools, China), and further exploration of the subsequent vascular and neural supply. The obtained values were averaged from three subsequent measurements.

The described variation involved a common origin of the musculotendinous ED-index from the ECRB. The proximal attachment site was at the lateral epicondyle of humerus. The ED-index muscle belly and tendon separated from the ECRB, 119 mm distal to the outermost palpable point of the lateral epicondyle. The separated muscle belly measured 70 mm in length and 12 mm in width (at its widest part located midlength). The musculotendinous portion had a length of 179 mm (from the point of separation to the extensor retinaculum of wrist). The ED-index tendon coursed near the other tendons of the ED and inserted into the radial side of the tendon of the extensor indicis. The ED-index passed beneath the extensor retinaculum of wrist in the typical manner. The tendon width at the proximal entry point underneath the extensor retinaculum was approximately 2 mm and its further course was not altered (Figure 1).

No aberrations were found in terms of the neurovascular structures supplying the variation. The ED-index was supplied by the deep branch of the radial nerve and the recurrent interosseous artery. No variations were found regarding the ED muscle and tendons to the middle, ring, and little fingers at the ipsilateral extremity. Their origin and

insertion points were typical. The EI muscle also had a typical course and inserted into the ulnar side of the ED-index. No musculotendinous variants were found at the contralateral upper limb of the cadaver.

DISCUSSION

A variation in the extensor compartment of the forearm is not an uncommon finding. The ED-index occurs in 99.8% of cases, and in the vast majority arises from a single proximal attachment of the ED [24]. Notwithstanding, to the best knowledge of the authors the prevalence of ED-index and ECRB variants is casuistic and has not been analyzed in larger study samples. Henceforth, it is crucial for the researchers worldwide to continuously identify and record them to facilitate surgical procedures on the forearm.

Embryology

The muscles of the upper limb are identifiable by the seventh week of gestation. Among them, superficial and proximal muscles differentiate before the deeper and distal ones, respectively [2]. Diogo et al. [8] reported that the ED can be distinguished in the fetus of 12.0 mm. The ED and the extensor carpi ulnaris are the first muscles of the forearm to develop during ontogeny in the human. According to Straus et al. [21], the mammalian innovation, when it comes to evolution, includes a widespread migration of the superficial marginal muscles and the complete transformation of the extensor carpi intermedius into the ED. Henceforth, it is thought to be related to more potential aberrances encountered in that region. The ED is divided into more muscle bellies in humans and that tendency is a differentiating factor between them and the three great apes *(chimpanzee, gorilla, and orangutan)* [21].

A more severe form of disruption in migration of the mesoderm cells in the distal upper limb than simple misalignment of muscles may e.g., be symbrachydactyly. Mesoderm germ layer gives rise not only to the musculature, but also vasculature, cartilage and bones. Nonetheless, in case of symbrachydactyly the ectoderm derivatives tend to appear normal [20]. Bavinck and Weaver [4] hypothesized that interruption to the vascular supply can play a part in certain conditions, namely Poland syndrome. A study by Simet et al. [20] has found a variant distal insertion point of the extensor indicis muscle onto the

1st metacarpal in a patient with symbrachydactyly, working as an accessory extensor pollicis longus. However, similarly to the current study, the authors have not found any visible aberrances in the vasculature of the upper limb, hence possibly pointing to the disruption in the mesoderm migration and division as the embryologic mechanism responsible for the encountered variants.

ED-index and ECRB variants in the literature

An aberrant ED-index was described by Kim et al. [13]. Similarly to the present study, it originated from the ECRB muscle and inserted into the index finger. The ED arose from the lateral epicondyle of humerus and was divided into three musculotendinous bellies. There was no index finger tendon of the ED muscle [13].

The ED has many variants. Nayak et al. [15] reported it to have five distinct tendon slips, instead of the typical four. It resulted from a tendon split that inserted into both the ring and little fingers. Arora et al. [3] found both the ED and ECRB to be aberrant. The ECRB had an accessory belly inserting into the dorsal digital expansion of the index finger and the ED was divided into three (lateral, intermediate, and medial) musculotendinous bellies [3].

Musculotendinous variant connections to the index finger are frequently described in the literature. Vaida et al. [23] reported an EI, originating from the ECRB and replacing the tendon of the ED-index. The other muscle was the extensor indicis and medii communis split to three tendons, two of which attached to the index finger and one to the middle digit. Casanova-Martinez et al. [6] described an accessory tendon located between the tendons of the ED-index and the extensor pollicis longus muscle, which arose from an independent muscle, being a part of the EI.

The ECRB can also give rise to anomalous muscles. West et al. [24], in their sample of 82 cadaveric forearms, found 7 cases (8.53%) with additional wrist extensors (4 extensor carpi radialis intermedius and 3 accessory extensor carpi radialis). The extensor carpi radialis intermedius originated from the ECRB lateral and medial part in four and one forearms, respectively. Anomalies of the radial wrist extensors were described by Albright et al. [1], as well. The interconnections between the ECRB and the extensor carpi radialis longus were found in 61 out of 173 forearms (35.3%). The tendons

arose from the ECRB in 21% of the cases. Such muscular linkage between the extensor carpi radialis brevis and longus was reported by Gümüşalan et al. [11]. Furthermore, they described an accessory muscle emerging from the ECRB medial side and inserting to the base of the second metacarpal bone.

Clinical significance

Meticulous knowledge of the distribution pattern of the ED and ECRB tendons is crucial in a wide range of surgical procedures. The ED may play an important role in the lateral epicondylitis (known also as “the tennis elbow”), as indicated by Fairbank and Corlett [9]. The authors suggest that the ED is a main factor in the Maudsley’s test, which is positive in painful patients while resisting the extension of the middle finger, in a fully extended elbow. In such tendinopathy, a proximal disinsertion of the common extensor tendon is carried out [7]. During the procedure, the origins of both the tendons of ECRB and ED need to be located, so any possible variants in that area could have an impact on the treatment result.

Location of the ECRB tendon is also important in the dorsoradial approach to the wrist, used for corrective osteotomies [17]. Another landmark is the tendon of the extensor carpi radialis longus. The dissection is performed distally to these two tendons, and proximally between the ECRB and ED. Incision between those muscles is also made to treat elbow stiffness [18].

Tendon of the ECRB can be harvested for an autograft [22]. Multiple variations in the extensor forearm region may also influence the results of tenosynovectomy performed for the treatment of de Quervain’s syndrome. The procedure, in case of coexisting variants, may not be successful in terms of reducing the inflammation and relieving pain [3, 19]. However, it is worth remembering that the extensor digitorum brevis muscle can be found in the proximity of the index finger extensor tendons and might e.g., be mistaken for dorsal ganglion tenosynovitis [16]. Henceforth, it is worth bearing that variation in mind in the differential diagnosis.

Limitations and future directions of research

The main limitation of the current case description is the lack of medical history of the patient. Thus, no possibility existed to associate the cadaveric finding with clinical

significance. The authors can only conclude that due to the location of the musculotendinous variant, away from the neurovascular structures, its presence was asymptomatic, although no medical record was available to reinforce this point of view. However, case reports describing rare findings such as the present one, are the first step for future studies based on larger samples. Lastly, it is worth remembering that the widely acclaimed “anatomical norm” is rather an approximation, as many reported variants are not pathological in nature, but rather pose a higher risk of iatrogenic complications during surgical interventions if one is not aware of their presence [26].

CONCLUSIONS

This report presents a rare musculotendinous variant formed by the common origin of the ED-index tendon from the ECRB in a formalin-fixed cadaver. Being thoroughly acquainted with the possible variants in the forearm extensor compartment is of dire importance to the orthopedic surgeons performing procedures in the elbow region, namely for the tennis elbow or whilst approaching the ulnar nerve in its humeral grove. Undoubtedly, there is still a need to correlate the detected finding with its potential clinical presentation in vivo, utilizing larger study samples.

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Conflict of interest: None declared

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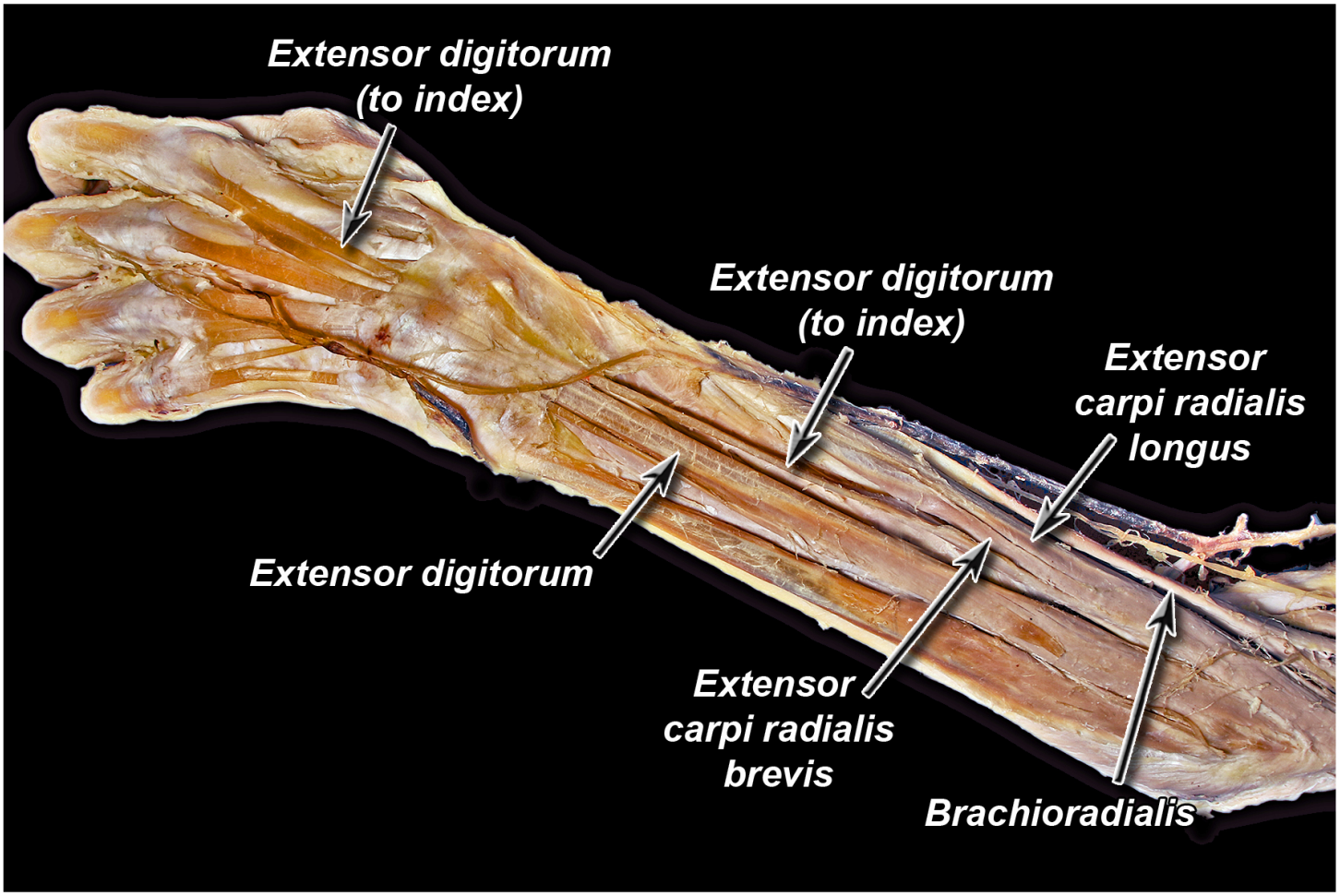
Figure 1. The posterior view of the left forearm and dorsum of hand.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