



Case Report

Bilateral Agenesis of the Extensor Carpi Ulnaris Muscle of a 70 Year-Old White Male Donor

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Abstract

Agenesis of one of the superficial forearm extensor muscles is rare and therefore, equally rarely reported in the anatomical literature. During routine anatomical dissection of sixty-three human donors in the 2020-2021 first-year medical gross anatomy course and 2021 graduate nursing advanced anatomy course at the Uniformed Services University of the Health Sciences, we discovered bilateral agenesis of the extensor carpi ulnaris muscle in a 70 year-old White Male donor. Knowledge of agenesis of the extensor carpi ulnaris muscle is important for orthopedic surgeons, hand surgeons, as well as anatomical instructors. Awareness of the failure of this muscle to develop during embryonic growth is significant since the extensor carpi ulnaris muscle is widely used in tendon transfer surgeries in cases of ulnar or median nerve palsy for restoring function and balance to the wrist and hand. The extensor carpi ulnaris tendon is an important structure that contributes to the dynamic stability of the wrist therefore its absence may contribute to wrist instability with the lack of support to the distal radioulnar joint.

Keywords: Bilateral agenesis of the extensor carpi ulnaris muscle; Extensor carpi ulnaris muscle; Forearm muscle anatomical variations

Introduction

The Extensor Carpi Ulnaris (ECU) muscle generally originates from the lateral epicondyle of the humerus, from the dorsal border of the ulna and from the deep fascia of the humerus. It generally inserts onto the prominent tubercle at the medial aspect of the base of the fifth metacarpal bone [1]. The ECU muscle plays a key role not only in active wrist extension movements and ulnar deviation, but also in providing stability to the ulnar aspect of the wrist [2]. The ECU muscle provides a variable contribution to wrist flexion and extension dependent on forearm position [2].

Agenesis of the ECU muscle is rare (0.55%) and bilateral agenesis is extremely rare (Figures 1a and 1b) [3-5]. Other more common anatomical variations involving the ECU muscle include the duplication of the muscle belly, partial attachment of its tendon to the base of the third or fourth metacarpal bone, an additional tendon replacing an absent extensor digiti minimi, providing origin from its tendon to the abductor digiti minimi, sending a slip to be inserted into the septum in the posterior annular ligament, sending an anomalous tendon slip to the tendinous extensor aponeurosis of the fifth finger (ulnaris quinti), or sending a tendinous extension from the ECU tendon to the fascia of the hypothenar eminence [1,3,6-14]. Anatomical variations involving the ECU muscle can facilitate dislocation and tendinopathy of the ECU muscle. These variations can cause functional impairment of the wrist and fifth

hand digit or disruption of the distal radioulnar joint, causing wrist instability [9,15].

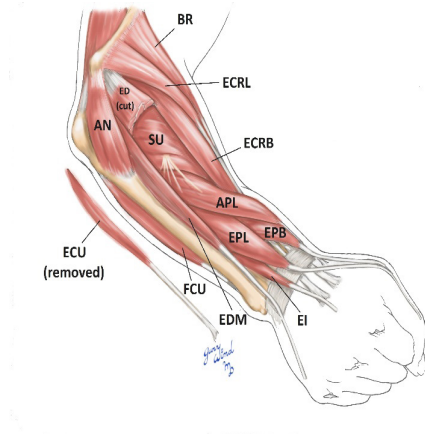


Figure 1a: Schematic of a right forearm with agenesis of the extensor carpi ulnaris muscle (the absent extensor carpi ulnaris muscle is pictured to the side of the arm) and the following forearm muscles highlighted: AN: Anconeus, APL: Abductor Pollicis Longus Muscle, BR: Brachioradialis Muscle, ECRB: Extensor Carpi Radialis Brevis Muscle, ECRL: Extensor Carpi Radialis Longus Muscle, ECU: Extensor Carpi Ulnaris Muscle, ED: Extensor Digitorum Muscle, EI: Extensor Indicis Muscle, EDM: Extensor Digiti Minimi Muscle, EPB: Extensor Pollicis Brevis Muscle, EPL: Extensor Pollicis Longus Muscle, FCU: Flexor Carpi Ulnaris Muscle, SU: Supinator.

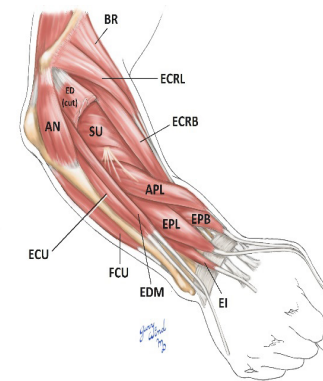


Figure 1b: Schematic of a right forearm with the extensor carpi ulnaris muscle present for teaching and comparison purposes and the following forearm muscles highlighted: AN: Anconeus, APL: Abductor Pollicis Longus Muscle, BR: Brachioradialis Muscle, ECRB: Extensor Carpi Radialis Brevis Muscle, ECRL: Extensor Carpi Radialis Longus Muscle, ECU: Extensor Carpi Ulnaris Muscle, ED: Extensor Digitorum Muscle, EI: Extensor Indicis Muscle, EDM: Extensor Digiti Minimi Muscle, EPB: Extensor Pollicis Brevis Muscle, EPL: Extensor Pollicis Longus Muscle, FCU: Flexor Carpi Ulnaris Muscle, SU: Supinator.

Hand and orthopedic surgeons should be knowledgeable of ECU muscle variations, particularly when dealing with tendon transfer in cases of ulnar or median nerve palsy, as well as treating dorsoulnar wrist and hand ailments [9-11,14,16,17].

Case Description

During routine anatomical dissection of sixty-three human cadaveric donors in the 2020-2021 first-year medical gross anatomy course and 2021 graduate nursing advanced anatomy course at the Uniformed Services University of the Health Sciences, we found bilateral agenesis of the extensor carpi ulnaris muscle in a 70 year-old White Male donor with a cause of death of pneumonia (Figures 2, 3a, and 3b).



Figure 2: Facilitated display highlighting the following left forearm muscles: APL: Abductor Pollicis Longus Muscle, BR: Brachioradialis Muscle, ECRB: Extensor Carpi Radialis Brevis Muscle, ECRL: Extensor Carpi Radialis Longus Muscle, ED: Extensor Digitorum Muscle, EI: Extensor Indicis Muscle, EDM: Extensor Digiti Minimi Muscle, EPB: Extensor Pollicis Brevis Muscle, EPL: Extensor Pollicis Longus Muscle, FCU: Flexor Carpi Ulnaris Muscle.

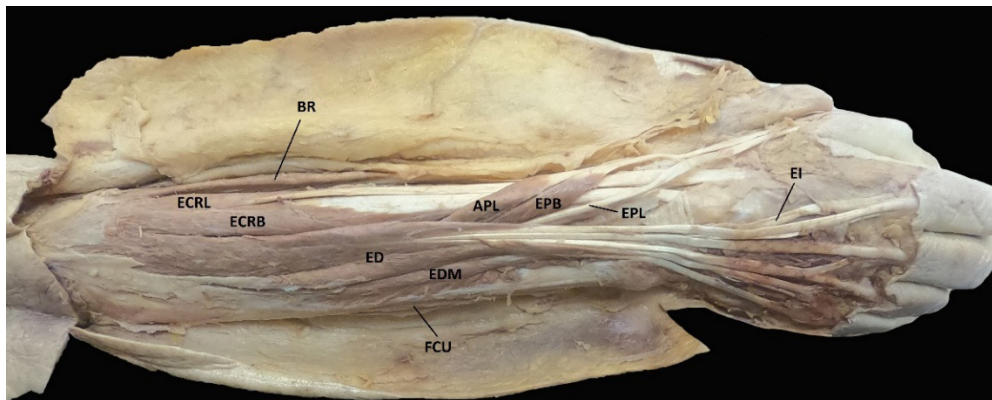


Figure 3a: Facilitated display highlighting the following right forearm muscles: APL: Abductor Pollicis Longus Muscle, BR: Brachioradialis Muscle, ECRB: Extensor Carpi Radialis Brevis Muscle, ECRL: Extensor Carpi Radialis Longus Muscle, ED: Extensor Digitorum Muscle, EI: Extensor Indicis Muscle, EDM: Extensor Digiti Minimi Muscle, EPB: Extensor Pollicis Brevis Muscle, EPL: Extensor Pollicis Longus Muscle, FCU: Flexor Carpi Ulnaris Muscle.

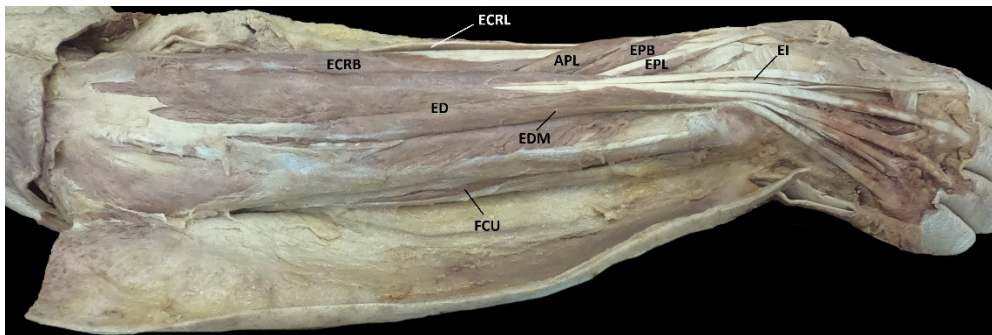


Figure 3b: Facilitated display highlighting the following right forearm muscles: APL: Abductor Pollicis Longus Muscle, ECRB: Extensor Carpi Radialis Brevis Muscle, ECRL: Extensor Carpi Radialis Longus Muscle, ED: Extensor Digitorum Muscle, EI: Extensor Indicis Muscle, EDM: Extensor Digiti Minimi Muscle, EPB: Extensor Pollicis Brevis Muscle, EPL: Extensor Pollicis Longus Muscle, FCU: Flexor Carpi Ulnaris Muscle.

Discussion

Forearm Extensor Compartment Anatomical Variations

Some of the reported forearm extensor muscle variations are the brachioradialis tendon dividing into two to three slips, accessory brachioradialis (brachioradialis brevis) muscle, abductor manus muscle, trigastric extensor carpi radialis longus, extensor carpi radialis intermedius, and the extensor carpi radialis accessorius muscle. There are also splitting radial carpal extensors into two to three slips, additional slip of the extensor digitorum to the thumb, double belly of the extensor digiti minimi muscle, an ulnar slip of the extensor digiti minimi muscle going to the fifth metacarpal bone, ulnaris digiti minimi muscle, extensive cleavage of the tendon and belly of abductor pollicis longus muscle, and doubling of the extensor pollicis longus muscle. In addition, there are an additional extensor between extensor indicis and extensor pollicis longus muscles, abductor pollicis tertius muscle, double

tendons of extensor indicis muscle, extensor brevis manus muscle and the extensor digiti medii proprius muscle [14,18]. The presence of additional muscles and tendons is common among the extensors of the forearm and can be misleading for clinicians and surgeons. Knowledge of such anatomical variations is key when diagnosing dorsal hand masses and planning tendon transfers [9-11,14,16,17].

Anatomical variations associated with the ECU muscle include the duplication of the muscle belly, partial attachment of its tendon to the base of the third or fourth metacarpal bone, an additional tendon replacing an absent extensor digiti minimi, providing origin from its tendon to the abductor digiti minimi, sending a slip to be inserted into the septum in the posterior annular ligament, sending an anomalous tendon slip to the tendinous extensor aponeurosis of the fifth finger (ulnaris quinti), or sending a tendinous extension from the ECU tendon to the fascia of the hypothenar eminence [1,3,6-14]. Agenesis of the ECU muscle is

rare (0.55%). Anatomical variations involving the ECU muscle can facilitate dislocation and tendinopathy of the ECU muscle and can also cause functional impairment of the wrist and fifth hand digit [9].

Agenesis of the Extensor Carpi Ulnaris Muscle and Other Forearm Muscles

Gloobe and Liberty (1973) cites the only other case found in the literature referencing bilateral agenesis of the ECU muscle [5]. The absence of one of the superficial extensor muscles in general is also very rare [4]. Parson and Robinson (1898) reported on the absence of deep forearm extensor muscles, finding the lack of the extensor pollicis brevis muscle in eight out of 126 limbs (6.3%), and of the extensor pollicis longus in two out of 131 limbs (1.5%) [19]. Cauldwell, et al. (1943) found no incidence of absence of the extensor indicis muscle, although in 3% of the series the tendon was markedly reduced in size [20].

With regards to agenesis of flexor forearm muscles, Adachi (1909) reported the absence of the Palmaris Longus (PL) muscle in 3.4% of arms among the Japanese [5,21]. Nakano (1923) found PL muscle agenesis in only 2.2% of the Chinese population [5,22]. Reimann et al. (1944) stated that the most common variation of the PL muscle is its absence, which may be either uni- or bilateral, finding it absent in 12.8% of their 1,600 cases [23]. Tejaswi and Shilpashree (2014) reported on the prevalence in the Indian population as varying between 6-27.44% [24]. Genetic research completed by Thompson et al. in 1921 found that the absence of the PL muscle is a Mendelian characteristic [25]. Dwight (1887) reported the absence of the flexor carpi radialis muscle in one case [26]. Yammine and Erić (2018) reported in their literature review of agenesis for the Flexor Digitorum Superficialis (FDS) muscle tendon of the fifth digit that there was a significant discrepancy between clinical and cadaveric frequencies [27]. The weighted “clinical” frequency of functional absence of the FDS muscle tendon of the fifth digit (FDS-5) was 7.45%, while prevalence of the common type was 37.5%. The weighted “cadaveric” prevalence of FDS-5 was 2.5% while tendon absence in the hands was 0% [27]. Tejaswi and Shilpashree (2014) also reported on the agenesis of FDS-5 finding none of the subjects showed agenesis of FDS-5 [24]. In 14 subjects (5.2%), however, the function of FDS-5 was dependent on FDS to the fourth digit [24].

Clinical Significance

The ECU muscle tendon, along with its fibroosseous tendon, are important structures that contribute to the dynamic stability of the wrist therefore their absence may contribute to wrist instability with the lack of support to the distal radioulnar joint [15,28,29]. The ECU muscle is a major component of the Triangular Fibrocartilage Complex (TFCC) and provides ulnocarpal stability, radioulnar stability (DRUJ), and cushioning of the radiocarpal joint. The

ECU, in particular its subsheath, provide a significant degree of support to the TFCC as a whole as it is a longitudinal structure that crosses the wrist joint and connects the ulna with the carpal bones. TFCC pathology comes in two forms, degenerative and traumatic. Traumatic TFCC tears often need to be stabilized through either repair to the ulna or to stabilizing soft tissue structures (i.e. the ECU muscle). Ulnar sided wrist pain is common and can often be attributed to TFCC pathology. As a result, agenesis of the ECU and its subsheath (a major component of the TFCC) should be an important consideration in treating ulnar sided wrist pain.

Knowledge of ECU muscle agenesis, as well as other ECU and forearm muscle anatomical variation is incredibly important for orthopedic and hand surgeons performing tendon transfers in cases of ulnar or median nerve palsy, as well as treating dorsoulnar wrist and hand ailments [5,9-11,14,16,17]. Other anatomical variations involving the ECU muscle can also facilitate dislocation and tendinopathy of the ECU muscle [9].

Conclusions

Agenesis of the ECU muscle is infrequently encountered and bilateral agenesis is extremely rare. Knowledge of ECU muscle agenesis, as well as other ECU and forearm muscle anatomical variations, is incredibly important for orthopedic and hand surgeons performing tendon transfers in cases of ulnar or median nerve palsy, as well as treating dorsoulnar wrist and hand ailments. Other anatomical variations involving the ECU muscle can facilitate dislocation and tendinopathy of the ECU muscle. Anatomical variations of the ECU muscle, including agenesis, can cause functional impairment of the wrist and fifth hand digit, disruption of, or lack of support to the distal radioulnar joint, causing wrist instability. In particular, the ECU muscle is a major component of the TFCC and provides ulnocarpal stability, DRUJ, and cushioning of the radiocarpal joint.

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