
Author
Humberto Ferreira Arquez,
Professor Human Morphology, Medicine Program, University of Pamplona; Morphology Laboratory Coordinator, University of Pamplona.

Address for Correspondence
Humberto Ferreira Arquez,
University of Pamplona, Laboratory of Morphology,
Kilometer 1, Via Bucaramanga,
Norte de Santander, Colombia, S America
E-mail: humfear@unipamplona.edu.co

Citation

Abstract: Forearm and dorsum of the hand region of 13 cadavers were dissected to investigate the anatomy of the extensor tendons. In the left hand double tendon to the middle, triple tendon to the ring finger, a single tendon to the little finger or digiti minimi. The extensor digiti minimi has double tendon. In the right hand triple tendon to the middle finger, triple tendons to the ring finger, a double tendon to the little finger. The extensor digiti minimi has double tendon. The little finger receives four tendons. In the left and right hand the extensor digitorum there was a single tendon to the index. The dorsal of the left hand and right showed juncturae tendinum type 2, between the extensors tendons in the 3rd. intermetacarpal space; type 3, between the extensors tendons in the 4th intermetacarpal space. Anatomical variations may be beneficial for hand surgeons performing graft operations.

Key Words: Extensor digitorum, extensor indicis, Extensor digiti minimi, Juncturae tendinum, Anatomical variation.

Introduction:
Usually the dorsal surface of the hand is devoid of muscle bellies, it only contains the tendons of the extensor muscles of the hand. Between the dorsal carpal ligament and the carpal bones six compartments are formed for the passage of tendons. Found on the dorsum of the hand are the tendons of the extensor pollicis longus, extensor digitorum, extensor indicis (extensor indicis proprius), and the extensor digiti minimi. The synergistic contraction of the extensor musculature along with the long flexors is indispensable for an efficient grip on different objects in daily life. The thumb works independently due to its own abductors and extensors. Rest of the four digits has a common extensor, the extensor digitorum muscle (ED). The index finger and the little fingers have additional extensors of their own. Variant arrangement of extensor musculature of hand has clinical importance and also alters the kinematics of the hand.

The ED is one of the superficial muscles of the posterior aspect of the forearm. It originates from the common extensor origin, i.e. lateral epicondylole of the humerus, the adjacent intermuscular septa and antebrachial fascia. It expands into a rounded belly in the middle of forearm and passes distally in a common synovial sheath with the tendon of extensor indicis, through a tunnel beneath the extensor retinaculum. These tendons diverge on the dorsum of the hand into four tendons for medial four digits, and each of these contribute to form the dorsal digital expansion over the corresponding metacarpo-phalangeal joint. This muscle provides extension of interphalangeal, metacarpophalangeal and wrist joints. The extensor indicis (EI) muscle belongs to the deep muscles of the forearm. This muscle takes origin from posterior ulnar surface and from the interosseous membrane. The tendon of Extensor Indecis usually joins the ulnar side of the tendon of Extensor digitorum for the index finger. This muscle helps in extension of index finger and wrist. Both these extensors pass through the same fourth compartment of extensor retinaculum within a common synovial sheath.

The abductor pollicis longus (APL) originates from the radius, interosseous membrane and ulna on the dorsum of the forearm. Its tendon travels with the extensor pollicis brevis in the first dorsal compartment. Its primary insertion is into the radial side of the base of the first metacarpal bone. The juncturae tendinum (JT) have certain clinical applications. They prevent independent extension of the digits since they bridge the tendons and thereby mask tendon lacerations. They also can be used for proper identification of the tendons of the hand and have been used in repair of the dorsal aponeurosis. The arrangement of the human extensor muscles of the forearm, wrist and hand vary greatly and those of the extensor indicis and extensor digiti minimi are well described.
Awareness of the anatomy and variations of the extensor tendons on the dorsum of the hand is necessary not only for the anatomist but also for surgeons. A knowledge of these tendons helps when assessing the traumatized or diseased hand and when considering tendons for repair or transfer. Suturing of an injured extensor tendon on the dorsum of the hand or fingers usually gives good results, unlike the results frequently obtained when flexor tendons are sutured.

The objective of the present study was to investigate the anatomy of the extensor tendons of the fingers, explore their juncturae tendinum. In this paper, a variant in the little finger which receives four tendons, 2 of extensor digitii minimi and 2 of extensor digitum, these variations described is unique, has not been reported.

Materials and Methods

A total of 13 cadavers of both sexes (12 men and 1 women) with different age group were used for the study. Upper limb region (26 sides) of the cadavers were carefully dissected as per the standard dissection procedure in the Morphology Laboratory at the University of Pamplona. After reflection of the skin and superficial fascia on the back of the forearm and hand, the extensor retinaculum was divided longitudinally to fully expose the tendons and the intertendinous connections present between them. Tendons were defined as independent or easily divisible bands originating from a muscle. A tendon was considered single, double and triple based on the number of separable tendons originating from the muscle at the myotendinous junction. The juncturae tendinum (JT) were defined as short bands of connective tissue between a tendon and an adjacent tendon. The juncturae were classified into 3 types according to Von Schroeder et al. The topographic details were examined and the variations were recorded and photographed. The history of the individual and the cause of death are not known.

Results

In all specimens, the abductor pollicis longus (APL) originates from the radius, interosseous membrane and ulna on the dorsum of the forearm. It tendon was attached into the radial side of the base of the first metacarpal bone.

In all specimens, the extensor pollicis longus (EPL) existed with a single tendon. The EPL tendon was attached to extensor expansion of thumb at level of base of proximal phalanx.

In all specimens, the extensor pollicis brevis (EPB) existed with a single tendon, it was attached distally to the base of the proximal phalanx of the thumb.

In all specimens, the extensor indicis (EI) was a single tendon with a single insertion, attaching to the dorsal digital expansion ulnar to the extensor digitorum to the index tendon.

In 92.31% of the specimens, the extensor digitii minimi (EDM) was found as a single tendon proximal to the extensor retinaculum, inserted into the extensor expansion to the little finger.

In 61.55 % of the cases the extensor digitorum (ED) split into four tendons, the ED to the index finger, to the middle finger, to the ringer finger, to the little finger.

In 1 right and 1 left (7.69%) of the cases the ED to the index finger it originated as 2 tendons and inserted as a single tendon before reaching the metacarpophalangeal joint and to be inserted into the extensor expansion of the index finger.

In 1 left (3.845%) of the cases, the extensor digitorum (ED) to the middle finger it originated as 2 tendons and inserted as a single tendon into the dorsal digital expansion of middle finger. In 1 right (3.845%) of the cases, the extensor digitorum to the middle finger, the tendon divided into 2 slips but the bursa slips reunited before insertion.

In 1 left (3.845%) of the hands the extensor digitorum to the ring finger it inserted as double tendon. In 1 right (3.845%) it inserted as triple tendons. These tendons were inserted separately to the extensor expansion of the ringer finger by intertendinous connections.

In 1 right and 1 left (7.69%) of the cases the ED to the little finger existed with a single tendon of dissected limbs, it was inserted into extensor expansion of the little finger.

Juncturae tendinum (JT) were observed in the 2nd, 3rd and 4th intermetacarpal space (IMS). In the 2nd IMS, Type 1 was most common (65%), followed by Type 2 (25%). The JT was absent in 6% of hands. In the 3rd IMS, Type 2 was most common (45%), followed by Type 3 (16%) and Type 1 (7.69%) and Type 3r (6.69%). In the 4th IMS, the JT was thicker, and present between the extensor digitorum to the ringer finger and extensor digitii minimi. At level to the ED to the little finger was associated with JT such as Type 2 (44%), Type 3y (28%), Type 3r (16%) and Type 1 (3.84%).

Anatomic variations were found in the right and left side of the dorsum of the hand (7.69%), a male cadaver of 75 years of age:

Left hand:

In the left forearm the extensor digitii minimi (EDM) muscle originates to level lateral epicondyle of the humerus, passing inferiorly to the extensor retinaculum (ER) ends in double tendons that inserts into the extensor expansion of the 5th finger. The extensor digitorum (ED) muscle originates to level lateral epicondyle of the humerus and continued downwards, passing inferiorly to the extensor retinaculum (ER) to split into individual tendons for each of the finger. There was a single tendon to the index, double tendon to the middle, triple tendon to the ring finger, a single tenon to the little finger. The dorsum of the hand showing juncturae tendineum type 2, between ED 3, ED 4 in the 3rd. intermetacarpal space of a left hand; juncturae tendineum type 3 between ED 6, ED 7 in the 4th intermetacarpal space of a left hand. The extensor digitii minimi has double tendon. The little finger receives three tendons. Figure 1.
The tendon of the ED may exhibit multiple variations in terms of number. Even the standard textbooks of anatomy mention that the tendon of extensor digitorum may be doubled or even tripled in any of the digits and such a variation has been reported to be more common in the index or the middle finger. (6,7) Hence, even a double tendon to any of the digits may be taken as usual finding. There are even reports of double or triple tendons to the long fingers, single or double tendons to the little finger and occasionally double tendons to the little finger. (5) A concurrent anomaly of the three slips to the extensor digiti minimi and a separate tendon of ED to the little finger have been reported. (8) A past study had also reported the ED muscle with a single tendon to the index and middle finger with an absence of any tendon to the ring finger. (9) Interestingly, another study by one of the authors had detected a double tendon to the ring and the little fingers and three tendons to the ring finger. (10-12) In specimens studied by Abdel-Hamid et al. (2013) where extensor digitorum to the little finger was absent, extensor digiti minimi gave 2 to 3 tendons to the little finger to replace its absence. (13) This was supported by Dass et al. (2011) who suggested that in case of absent extensor digitorum to the little finger or presence of a common tendon dividing for both ring and little fingers, the extensor digiti minimi compensated by giving 2 or 3 tendons to the little finger. (14) A single tendon of extensor digiti minimi was found in all specimens examined by Von Schroeder et al. (1995) who classified the juncturae tendinum (JT) of the extensor tendons into three types: Type I, Type II, and Type III. Type I consist of filamentous regions within the intertendinous fascia; Type II consists of much thicker and well-defined connecting bands; and Type III consist of tendon slips from the extensor tendons and were subclassified into «y» or «r» subtypes, depending on shape. (20) Hirai et al. (2001) in their series of 548 cadaveric hand dissections found that the most common pattern of intertendinous connections were classified into Type I in the second intermetacarpal space, into Type III-r in the third metacarpal space, and into type III-y in the fourth intermetacarpal space. (16) The functional importance of these juncturae could be to strengthen the frail tendons of the extensor mechanism of the fingers, at the cost of some loss of independence of the 4th finger. (5, 21-24) According with Gövs et al. (2011) who described the 4th intermetacarpal spaces to contain the thickest type of Juncturae Tendinum (JT). This type can be used for repairing lacerated or torn tendons, this suggestion was supported by the histological similarity between type 3 Juncturae Tendinum and tendons. (17) Anatomical knowledge of extensor tendons is important for successful tenosynovectomy in the treatment of De Quervian’s disease. Tenosynovitis of the extensor tendons occurs in 30% of patients with rheumatoid arthritis; rupture of the tendons is more common in the extensor tendon of fourth and fifth digits. The selection of appropriate tendon slip for transfer to restore hand function must be aided by the understanding of anatomical variations of the wrist extensors. Knowledge of these anatomical variations of hand musculature is vital for reconstructive surgeons while attempting tendon transfer in trauma cases. (2)

**Conclusion:**  
Presence of these types of variant tendons on the dorsum of the hand in persons who are involved in sports such as, golf, cricket, tennis, weight lifting were the excessive wrist movement is involved, may show some symptoms. Anatomical knowledge of the anatomy, prevalence and variations of the extensor tendons on the dorsum of the hand
and the intertendinous connections between them is necessary when considering tendons for repair or transfer, it can help to prevent diagnostic errors, help in planning tendon graft surgeries and may check any inadvertent injury during hand surgery.

**Conflict Of Interest:** None

**Acknowledgements:**
The author thanks the University of Pamplona for research support and/or financial support and Erasmo Meoz University Hospital for the donation of cadavers identified, unclaimed by any family, or persons responsible for their care, process subject to compliance with the legal regulations in force in the Republic of Colombia.

**References**