

## VARIATIONS IN MUSCLES OF EXTENSOR COMPARTMENT OF FOREARM AND HAND

Satishkumar Sukhanand Porwal<sup>1</sup>, Varsha Prabhakar Rao Dahiphale<sup>2</sup>, Yashwant Ramkrishnarao Kulkarni<sup>3</sup>

Received : 09/03/2025  
 Received in revised form : 03/05/2025  
 Accepted : 22/05/2025

**Keywords:**  
*Extensor digitorum, extensor digiti minimi, forearm.*

Corresponding Author:  
**Dr. Satishkumar Sukhanand Porwal,**  
 Email: satish.porwal@gmail.com

DOI: 10.47009/jamp.2025.7.3.104

Source of Support: Nil,  
 Conflict of Interest: None declared

*Int J Acad Med Pharm*  
 2025; 7 (3); 551-554



<sup>1</sup>Associate Professor, Department of Anatomy, Chhatrapati Sambhaji Maharaj Government Medical College and hospital, Satara, India.

<sup>2</sup>Associate Professor, Department of Anatomy, Swami Ramanand Teerth Rural Government Medical College Ambajogai, India.

<sup>3</sup>Professor and Head, Department of Anatomy, Chhatrapati Sambhaji Maharaj Government Medical College and hospital, Satara, India.

## ABSTRACT

**Background:** Humans have got unique feature of ‘opposing thumb’ in their hand than that of apes and chimpanzees. It helps very well in gripping and skilful motor activities. All the movements of fingers are brought about by actions of various muscles on various joints of forearm and hand. The present study was carried out over 44 cadavers (88 upper limbs) to know variations in attachments of muscles of extensor compartment of forearm. **Materials and Methods:** Total 88 upper limbs from 44 adult cadavers were dissected. The dissection was carried out as per Cunningham’s manual of practical anatomy. The variations encountered during dissection were photographed and labeled. **Result:** Out of 88 upper limbs (44 adult cadavers) studied 09 upper limbs showed variations in attachment of extensor muscles of forearm and hand. **Conclusion:** Clinicians should have knowledge of such variations for diagnosis and treatment of unusual cases.

## INTRODUCTION

Any species on earth struggles for its survival and continuity. For survival, it adapts/evolves itself both structurally and behaviourally for food searching and eating. For continuity it undergoes reproduction. For reproduction it adapts/evolves itself for mating.

Anatomical reconstruction of the hand during human evolution is linked with tool behaviour. The unique feature of human hand can be viewed as adaptation for throwing & clubbing.<sup>[1]</sup>

Chimpanze hand have long curved fingers and short thumb. Human hand have short finger and long thumb for precision and power grip. It is related with tool behaviour. Accordingly the muscles required for the movement of these fingers could change their mass, orientation and attachment.<sup>[1]</sup>

Darwin (1871) believed that use of hand held weapons from an upright posture may have enabled hominoid to defend, hunt and fight enemies. In human evolution it changed from quadrupedal to bipedal behaviour.<sup>[2]</sup> Its four limbs classified as upper limb and lower limb. For picking up food and keeping in mouth the movements like supination and pronation developed. Also for activities like throwing, gripping fingers of hand developed and evolved. Finger motion is a balance of flexor muscles and intrinsic and extensor muscles.<sup>[3]</sup>

In today’s human thumb can be opposed to all fingers. It helps very well in gripping, skilful motor activities etc. All the movements of fingers are brought about by action of muscles on various joints of forearm and hand. These muscles can change their attachment, morphology as per the action needed.

A dozen muscles occupy the extensor compartment. At the upper part are anconeus (superficial) and supinator (deep). From the lateral part of the humerus arise three muscles that pass along the radial side (brachioradialis, and extensors carpi radialis longus and brevis), and three that pass along the posterior surface of the forearm (extensors digitorum, digiti minimi and carpi ulnaris). At the lower end of the forearm these two groups are separated by three muscles that emerge from deeply in between them and go to the thumb (abductor pollicis longus and extensors pollicis longus and brevis). Finally, one muscle for the forefinger runs deeply to reach the back of the hand (extensor indicis).<sup>[4]</sup>

All of the above muscles pass through various compartments of extensor retinaculum except anconeus, brachioradialis and supinator. These muscles are responsible for carrying out the movement of wrist and fingers of hand.

Knowledge of attachments of muscles of back of forearm is essential to the surgeons during repair of injured/crushed upper limb.

In the present study 88 upper limbs (44 cadavers) in the various medical colleges of Maharashtra were studied. Variations of attachments of extensor compartment muscles of forearm were observed.

## MATERIALS AND METHODS

A total 88 upper limbs (44 formalin embalmed adult cadavers) from the various medical colleges of Maharashtra were studied. The extensor compartment of forearm and hand of 88 upper limbs were dissected. The dissection was carried out as per Cunningham's manual of practical anatomy. The observed variations were photographed and labelled.<sup>[5]</sup>

## RESULTS

Out of 88 upper limbs (44 adult cadavers) studied 09 upper limbs showed variations in attachment of extensor muscles of forearm and hand.

### CASE 1

Extensor compartment of right forearm showed the common belly for extensor carpi radialis brevis and part of extensor digitorum for index finger approximately 2cm distal to the common extensor origin. The common belly divided into two parts, out of which one part showed the normal attachment as that of extensor carpi radialis brevis and the other part showed its distal attachment on the posterior surface of base of middle phalanx of index finger. The extensor digitorum divided into two parts, out of which one part showed its distal attachment on the posterior surface of base of middle phalanx of middle finger and the other part showed its distal attachment on the posterior surface of base of middle phalanx of ring finger. The part of extensor digitorum for little finger was absent. Other muscles of extensor compartment of Forearm showed the normal attachments. The left upper limb was normal.



**Figure 1:** Abbreviations- ECU- Extensor carpi ulnaris, ED- Extensor digitorum, ECRL- Extensor carpi radialis longus, BR- Brachioradialis

### CASE 2

Extensor compartment of right forearm showed extensor digitorum divided into four tendons. First tendon showed its distal attachment on the posterior surface of base of middle phalanx of index finger, second tendon showed its distal attachment on the posterior surface of base of middle phalanx of middle finger, third and fourth tendon fused at the level of metacarpo-phalangeal joint and showed its distal attachment on the posterior surface of base of middle phalanx of ring finger. The part of extensor digitorum for little finger was absent. Other muscles of extensor compartment of Forearm showed the normal attachments. Left upper limb was normal.

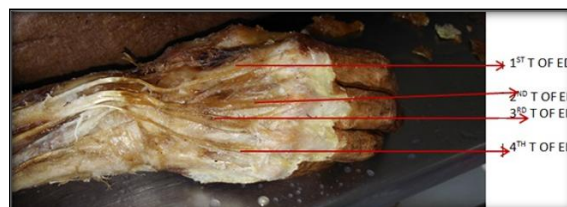


**Figure 2:** Abbreviations- T- Tendon, ED- Extensor digitorum

### CASE 3

Extensor compartment of right and left forearm and hand showed the same variation.

Extensor digitorum muscle originated from lateral epicondyle of humerus (common extensor origin), distally it is divided into four tendons first and second tendon showed its distal attachment on the posterior surface of base of middle phalanx of index and middle finger respectively. Third tendon divided into two slips, one showed its distal attachment on the posterior surface of base of middle phalanx of middle finger and other on the posterior surface of base of middle phalanx of ring finger. Fourth tendon also divided into two slips one showed its distal attachment on the posterior surface of base of middle phalanx of ring finger and other on the posterior surface of base of middle phalanx of little finger. Other muscles of extensor compartment of Forearm showed the normal attachments.



**Figure 3:** Abbreviations- T- Tendon, ED- Extensor digitorum

### CASE 4

Extensor compartment of right forearm and hand showed that extensor digitorum originated from lateral epicondyle of humerus (common extensor origin), distally it is divided into three tendons which distally attached to the posterior surface of base of middle phalanx of index, middle and ring finger

respectively. Tendon of extensor digitorum for little finger was absent.

Other muscles of extensor compartment of Forearm showed the normal attachments. Left upper limb was normal.



**Figure 4: Abbreviations- T- Tendon, ED- Extensor digitorum**

#### CASE 5

Extensor compartment of right and left forearm and hand showed the same variation.

Extensor digitorum originated from lateral epicondyle of humerus (common extensor origin) later it is divided into five bellies. Tendons from these bellies showed their distal attachments as:

First tendon- the posterior surface of base of middle phalanx of index finger

Second tendon - the posterior surface of base of middle phalanx of middle finger

Third and fourth tendon- the posterior surface of base of middle phalanx of ring finger.

Fifth tendon- the posterior surface of base of middle phalanx of little finger.



**Figure 5: Abbreviations- T- Tendon, ED- Extensor digitorum**

#### CASE 6

Extensor compartment of right forearm and hand showed that extensor digitorum originated from lateral epicondyle of humerus (common extensor origin), distally it is divided into three tendons which distally attached to the posterior surface of base of middle phalanx of middle, ring and little finger respectively. Tendon of extensor digitorum for index finger was absent.

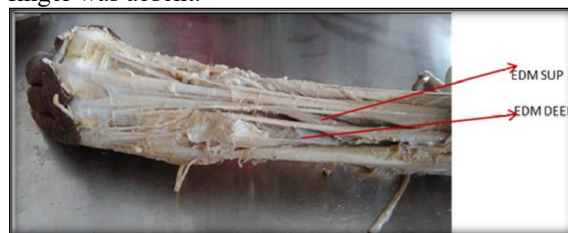
Other muscles of extensor compartment of Forearm showed the normal attachments. Left upper limb was normal.



**Figure 6: Abbreviations- T- Tendon, ED- Extensor digitorum**

#### CASE 7

Extensor compartment of left forearm and hand showed that extensor digiti minimi originated from lateral epicondyle of humerus (common extensor origin), distally it is divided into two parts superficial and deep. The superficial part bifurcated at the level of distal margin of extensor retinaculum and distally showed attachment to the posterior surface of base of middle phalanx of ring and little finger respectively. Deep part bifurcated at the level of distal margin of extensor retinaculum and distally showed attachment to the posterior surface of base of middle phalanx of little finger. Tendon of extensor digitorum for little finger was absent.



**Figure 7: Abbreviations- EDM- Extensor digiti minimi**

## DISCUSSION

The muscles present in the extensor compartment of forearm and hand mainly carry out the movements of wrist and fingers. The variations in the attachments of extensor muscles of forearm and hand are common. Sometimes they are symptomatic. But most of the times they are asymptomatic and detected as accidental finding during radiological investigations, surgery and cadaveric dissections.

Von Schroeder HP and Botte MJ(1995) studied 43 adult hands. The variants reported were a double EIP tendon; a double or triple EDC-long tendon; a single or triple EDC-ring tendon; and a single or double EDC-small tendon.<sup>[6]</sup>

Baker J and Gonzalez(2008) reported a case of painful snapping wrist due to an anomalous extensor indicis proprius. In this case the variant observed on MRI was enlarged extensor indicis proprius with majority of the muscle belly at the level of the extensor retinaculum.<sup>[7]</sup>

KOCABIYIK et al. (2009) found that In the right forearm extensor digitorum muscle was having a tripled tendon for third finger and doubled tendon for the ring finger. Also in the left forearm was having the tripled tendon of abductor pollicis longus inserting each tendon separately at the base of first metacarpal.<sup>[8]</sup>

Das P et al.(2011) studied 100 upper limbs of adult south Indian cadavers from Department of Anatomy of Kasturba Medical College, Mangalore. The variants found in their study were as:

In 98% of the specimens, the EIP was a single tendon with a single insertion.

1. whereas in two right upper limbs there were two EIP tendons with two insertions.



2. In 77% of the specimens the EDC distally had tendons to the middle three fingers (EDC index, EDC longus and EDC ring).
3. The EDC small was present in only 34% of samples.
4. The EDM showed normal anatomy in only 20%.<sup>[9]</sup>

Abdel-Hamid A. G., El-Beshbishy R.A. I.H. A. Abdel Aal (2013) carried out a study over 95 upper limbs of adult cadavers from King Abdulaziz University, Jeddah, Saudi Arabia. The variations reported were as:

1. Duplicated extensor pollicis longus tendon Extensor pollicis tendon was attached to the distal phalanx through extensor expansion
2. Duplicated extensor pollicis brevis
3. Extensor digitorum tendons varying no.3 to 7
4. Double tendon of extensor digitorum for index finger
5. 2 or 3 tendons of extensor digitorum for middle finger
6. 2 or 4 tendons of extensor digitorum for ring finger
7. Absence of tendon of extensor digitorum for little finger
8. Doubled and Tripled tendon of extensor digiti minimi.<sup>[10]</sup>

Yaşar K. Y. et al.(2017) observed a case during routine dissection at department of Anatomy, Gazi university Turkey. It was observed that extensor carpi radialis brevis was having an accessory head. This accessory muscle head was attached distally to dorsal surface of proximal phalanx of index finger. They also found that extensor digitorum was divided into three tendons which distributed as one tendon each for middle, ring and little finger. The tendon of extensor digitorum for index finger was absent.

Extensor digitorum can extend any or all of the joints over which it passes that is wrist, metacarpophalangeal, proximal and distal inter-phalangeal (via extensor expansion of digits) joint. When acting on metacarpophalangeal joint, extensor digitorum muscle tends to spread the digits apart, an action that is due principally to different axes of the individual joints imposed by the transverse arch of the hand. This is a trick movement used by the patients with interosseus muscle paralysis. Function of the intertendinous connections is not clear but they may affect the independent extension of digits.<sup>[12]</sup>

Extensor digiti minimi can extend any of the joint of little finger or contribute to wrist extension. It permits the extension of the little finger independently.<sup>[12]</sup>

Extensor carpi ulnaris together with the extensor carpi radialis longus and extensor carpi radialis brevis, it acts synergistically with digital flexors to extend and to fix the wrist when objects are being gripped or when the fist is clenched. This observation shows that it is impossible to grip strongly unless the wrist is extended.<sup>[12]</sup>

Abductor pollicis longus - carries out the abduction of wrist joint. When acting with abductor pollicis brevis it aids the abduction of thumb. When acting with pollicial extensors extends the thumb at first carpometacarpal joint. It stabilizes the trapezium on which the first metacarpal moves. As the thumb is brought into action abductor pollicis longus and abductor pollicis brevis stabilize the trapezium for precision and power grip.<sup>[12]</sup>

After analysing the actions of extensor muscles of forearm and hand it is clear that actions of these muscles are very much important for day today activities which require holding and moving the objects precisely and powerfully. Hence knowledge of variants of these muscles is very much necessary to clinicians while dealing with the patients with complaints of difficulty, pain or restricted movements of forearm and hand.

In the present study 88 upper limbs were studied for variations in the muscles of extensor compartment of forearm and hand. 9(10.22%) upper limbs showed the variations in the attachments of extensor muscles of forearm and hand. Out of these 5 cadavers showed unilateral variation (4 right and 01 left) and 2 cadavers showed bilateral variations.

## CONCLUSION

Surgeons should be aware of variations of extensor muscles present in forearm and hand to prevent iatrogenic complications during surgeries of forearm and hand. Clinicians should have knowledge of such variations for diagnosis and treatment of unusual cases.

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