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## CADAVERIC STUDY OF VARIANT FLEXOR CARPI ULNARIS MUSCLE

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### ABSTRACT

**Aim:** To study the variations in the flexor carpi ulnaris muscle.

**Materials and Methods:** 50 embalmed donated cadavers (45 males and 5 females) are dissected to study the variations in the flexor carpi ulnaris muscle in the department of Anatomy of K. J. Somaiya Medical College, Sion, Mumbai, India. 100 specimens were meticulously dissected. All the superficial flexor muscles were exposed. The humeral and ulnar heads of flexor carpi ulnaris muscle was dissected carefully. The course of ulnar artery and ulnar nerve were also dissected. The photographs of the variations were taken for proper documentation.

**Observations:** Out of 100 specimens, 28 specimens showed the additional muscle slip of the flexor carpi ulnaris muscle. The additional belly originated from the lower part of the flexor carpi ulnaris muscle and crossed the ulnar nerve, ulnar vessels and median nerve. The additional belly merged with the flexor retinaculum and the palmaris longus muscle. In two specimens the separate ulnar and humeral heads of flexor carpi ulnaris muscle was observed. The ulnar head of flexor carpi ulnaris muscle separated ulnar artery and nerve. The humeral and ulnar heads were separated from each other by ulnar nerve. The tendons of both the heads of flexor carpi ulnaris fused with each other just before their insertion. The ulnar artery comes in contact with ulnar nerve in the lower part of the forearm near the wrist where the two heads of flexor carpi ulnaris fused with each other.

**Conclusion:** The awareness of additional muscle slip of the flexor carpi ulnaris is clinically important for surgeons dealing with entrapment or compressive neuropathies, orthopaedicians operating on the fractures of radius or ulna or both and plastic surgeons who are using the flexor carpi ulnaris muscle pedicle flap to improve blood supply and soft tissue coverage at the non union site of the proximal ulna for restoration of elbow function. A lack of knowledge of such type of variations might complicate surgical repair.

**Keywords:** Flexor Carpi Ulnaris, Additional Muscle Slip, Ulnar Head, Humeral head, Ulnar Nerve, Ulnar Artery, Median Nerve, Surgeons, Entrapment, Orthopaedicians, Fractures of Radius or Ulna, Plastic Surgeons, Muscle, Pedicle Flap.

### INTRODUCTION

Flexor carpi ulnaris muscle is the most medial superficial flexor muscle of forearm. It arises by two heads, humeral and ulnar, connected by a tendinous arch. The small humeral head arises from the medial epicondyle via the common superficial flexor origin. The ulnar head has an

extensive origin from the medial margin of the olecranon process and proximal two-thirds of the posterior border of the ulna, an aponeurosis (which it shares with the extensor carpi ulnaris and flexor digitorum profundus) and from the intermuscular septum between it and the flexor digitorum superficialis. A thick tendon forms along its

anterolateral border in its distal half. The tendon is attached to the pisiform, and thence prolonged to the hamate and the fifth metacarpal bone by pisohamate and pisometacarpal ligaments. The blood is supplied to the flexor carpi ulnaris muscle by the ulnar collateral arteries, the anterior and posterior ulnar recurrent arteries, and small branches from the ulnar artery. Acting with the flexor carpi radialis, it flexes the wrist and acting with the extensor carpi ulnaris it adducts the wrist (1). The flexor carpi ulnaris muscle is innervated by the ulnar nerve having root value C<sub>7</sub>, C<sub>8</sub>, T<sub>1</sub>. The line between the medial humeral epicondyle and the pisiform, along the anterior palmar margin of the muscle, is used as a reference point for locating the ulnar neurovascular bundle (2). The ulnar artery reaches the muscle in its middle third, whereas the ulnar nerve is covered by the muscle throughout its entire course running under the tendon in the wrist region. The ulnar artery, the deeper and the larger of the two terminal branches of the brachial artery, begins a little below the bend of the elbow, and, passing obliquely downward, reaches the ulnar side of the forearm at a point about midway between the elbow and the wrist. It then runs along the ulnar border to the wrist, crosses the transverse carpal ligament on the radial side of the pisiform bone, and immediately beyond this bone divides into two branches, which enter into the formation of the superficial and deep palmar arches. Like the median nerve, the ulnar nerve has no branches in the arm, but it also supplies articular branches to the elbow joint (3). It enters the forearm between two heads of the flexor carpi ulnaris superficial to the posterior and oblique parts of the ulnar collateral ligament (1). The ulnar nerve, after descending in the forearm between the flexor digitorum profundus and the flexor carpi ulnaris muscles, pierces the deep fascia and enters the wrist through the Guyon's canal. In the distal canal, the ulnar nerve bifurcates into a superficial sensory branch and a deep motor branch, which supplies the hypothenar muscles

and then passes across the palm, distributing to other intrinsic hand muscles (2).

## MATERIALS AND METHODS

50 embalmed donated cadavers (45 males & 5 females) are dissected to study the variations in the flexor carpi ulnaris muscle in the department of Anatomy of K. J. Somaiya Medical College, Sion, Mumbai, India. 100 specimens were meticulously dissected. All the superficial flexor muscles were exposed. The humeral and ulnar heads of flexor carpi ulnaris muscle was dissected carefully. The course of ulnar artery and ulnar nerve were also dissected. The photographs of the variations were taken for proper documentation.

## OBSERVATIONS

Out of 100 specimens, 28 specimens showed the additional muscle slip of the flexor carpi ulnaris muscle. The additional belly originated from the lower part of the flexor carpi ulnaris muscle and crossed the ulnar nerve, ulnar vessels and median nerve. The additional belly merged with the flexor retinaculum and the palmaris longus muscle. In two specimens the separate ulnar and humeral heads of flexor carpi ulnaris muscle was observed. The ulnar head of flexor carpi ulnaris muscle separated ulnar artery and nerve. The humeral and ulnar heads were separated from each other by ulnar nerve. The tendons of both the heads of flexor carpi ulnaris fused with each other just before their insertion. The ulnar artery comes in contact with ulnar nerve in the lower part of the forearm near the wrist where the two heads of flexor carpi ulnaris fused with each other.

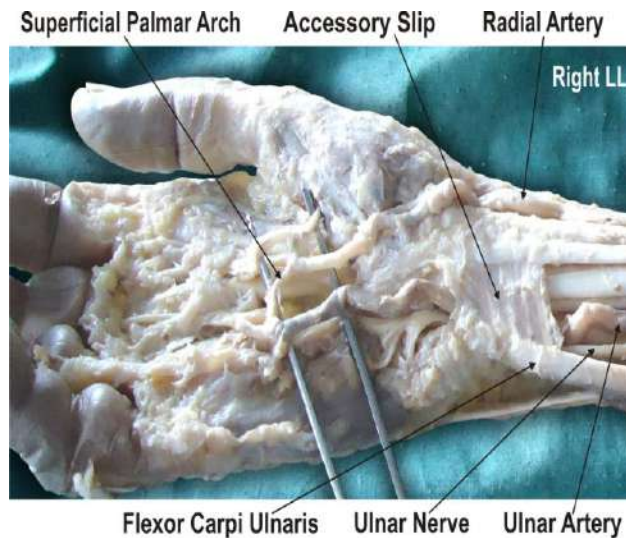


Figure - 1 : The photographic presentation of the additional belly (3 x 2 x 0.2 cm) originated from the lower part of the flexor carpi ulnaris and crossed ulnar nerve, ulnar vessels and median nerve and merged with the flexor retinaculum and palmaris longus tendon.

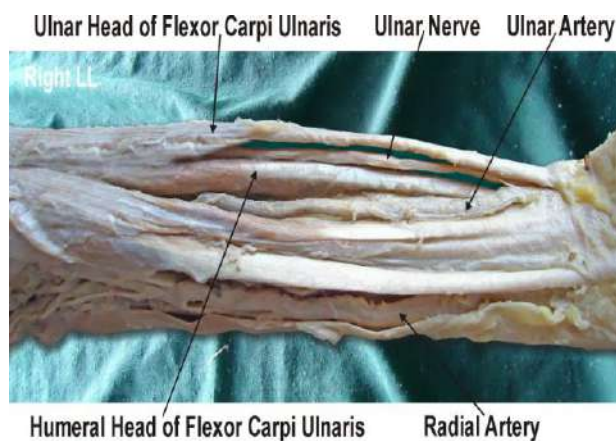


Figure - 2 : Photographic presentation of the right forearm showing separate ulnar and humeral heads of flexor carpi ulnaris muscle. The ulnar artery running in between ulnar and humeral heads of flexor carpi ulnaris muscle.

## DISCUSSION

The flexor carpi ulnaris muscle acts as an anatomical guideline for finding the neurovascular bundle i.e. ulnar nerve, ulnar artery and accompanying venae comitantes, it can be easily palpated in its distal course if the wrist is flexed

and adducted. The line between the medial humeral epicondyle and the pisiform, along the anterior palmar margin of the flexor carpi ulnaris muscle, is used as a reference point (3). Anatomical variations in musculotendinous junction of the flexor carpi ulnaris muscle were found in literature (4). The variant flexor carpi ulnaris causing ulnar nerve compression was also documented (5). A small additional slip of flexor carpi ulnaris muscle was reported in literature (6). In the present study, the separate ulnar and humeral heads of flexor carpi ulnaris muscle was observed and the ulnar head of flexor carpi ulnaris separating ulnar artery and ulnar nerve. Such type of variations seen in two specimens is not yet reported in literature. The variations of the flexor carpi ulnaris muscle is important for the radiologist in interpreting the ultrasound and the magnetic resonance images and also for the surgeons operating on the ulnar neurovascular bundle by using flexor carpi ulnaris muscle as a guideline. The ulnar nerve entrapment may occur due to the aponeurosis of the two heads of the flexor carpi ulnaris muscle leading to compression or irritation of the ulnar nerve. The surgeons should have the knowledge of an additional slip of the flexor carpi ulnaris muscle while operating on the compression or irritation of the ulnar nerve and the cubital tunnel syndrome. A test called electromyography i.e. EMG and / or nerve conduction study i.e. NCS may be done to confirm the diagnosis of the ulnar nerve entrapment and its severity. During the surgical correction on cubital tunnel syndrome the ulnar nerve is moved from its place behind the medial epicondyle to a new place in front of it. This is called an anterior transposition of the ulnar nerve. The nerve can be moved to lie under the skin and fat, on top of the muscle (subcutaneous transposition), within the muscle (intermuscular transposition) or under the muscle (submuscular transposition). Therefore the knowledge of the variations of the flexor carpi ulnaris muscle is important in cubital tunnel release operation. This knowledge is also

important for the plastic surgeons using a proximally based, pedicled flexor carpi ulnaris muscle turnover flap for the soft tissue reconstruction at the posterior elbow (7). The whole and split flexor carpi ulnaris pedicle flaps provide predictable coverage of posterior elbow soft-tissue defects (8). The flexor carpi ulnaris muscle is a useful local muscle flap in the forearm and elbow. The flexor carpi ulnaris muscle is an important palmar flexor and ulnar deviator of the wrist, and hence the action may be affected if the entire muscle is used as a local muscle flap. The flexor carpi ulnaris muscle is made up of two distinct neuromuscular compartments. This arrangement allows for splitting of the muscle and the potential use of the larger ulnar compartment as a local muscle flap while maintaining the humeral compartment to flex and adduct the hand (9). The flexor carpi ulnaris muscle pedicle flap is used to improve blood supply and soft tissue coverage at the infected nonunion site of the proximal ulna for restoration of elbow function (10). Entrapment or compressive neuropathies are important and wide spread debilitating clinical problems. They are caused frequently as the nerve passes through a fibrous tunnel, or an opening in fibrous or muscular tissue. The most common is the entrapment of the median nerve in the wrist leading to the carpal tunnel syndrome. In the present study, the accessory belly of the flexor carpi ulnaris muscle was observed in 18 upper limb specimens. The accessory belly of the flexor carpi ulnaris muscle crossed over the ulnar nerve and the median nerve. The accessory belly of the flexor carpi ulnaris muscle may compress the ulnar nerve and the median nerve which might lead to numbness and tingling in the hand. The knowledge of this variation may be clinically important because the symptoms are similar to those of the carpal tunnel syndrome (11). In the era of modern medicine due to the technical advances and interventional methods of diagnosis and treatment it is very importance to record and discuss the anatomical anomalies (12). The ulnar

tunnel is located at the proximal part of the hand lateral to the pisiform bone and to the proximal part of the carpal tunnel. The ulnar tunnel contains the ulnar nerve and artery. Compression of the ulnar nerve in this tunnel is often reported due to cysts, occupational trauma, fractures and muscle variations (13, 14). The flexor carpi ulnaris is made up of two distinct neuromuscular compartments. This arrangement allows for splitting of the muscle and the potential use of the larger ulnar compartment as a local muscle flap while maintaining the humeral compartment as an ulnar deviator and palmar flexor of the wrist (9). After multiple efforts to heal an infected nonunion of the proximal ulna, a flexor carpi ulnaris muscle pedicle flap was used to improve blood supply and soft tissue coverage at the nonunion site. It was observed that it promoted bone healing and restoration of useful elbow function (10). The course and distribution of ulnar nerve and ulnar artery can assist the surgeon in the diagnosis and effective management of the more common pain syndromes conditions associated with the ulnar aspect of the hand (13, 14). As the two heads of flexor carpi ulnaris muscles were separate the tendinous arch between them was absent. The possibility of entrapment of ulnar nerve in cubital tunnel in such cases is rare.

#### **Clinical significance**

The crossing of accessory belly of the flexor carpi ulnaris muscle over the ulnar nerve and the median nerve might compress them leading to numbness and tingling in the hand. The knowledge of this variation may be clinically important because the symptoms are similar to those of the carpal tunnel syndrome.

#### **CONCLUSION**

The awareness of the variations in the flexor carpi ulnaris is clinically important for surgeons dealing with entrapment or compressive neuropathies, orthopaedicians operating on the fractures of radius or ulna or both and plastic surgeons who are

using the flexor carpi ulnaris muscle pedicle flap to improve blood supply and soft tissue coverage at the non union site of the proximal ulna for restoration of elbow function. A lack of knowledge of such type of variations might complicate surgical repair.

### Competing Interests

The authors declare that they have no competing interests.

### Authors' contributions

SPS wrote the case report, performed the literature review & obtained the photograph for the study. SDL, UR performed the literature search, SR assisted with writing the paper. STS conceived the study and SRM helped to draft the manuscript. All authors have read and approved the final version manuscript.

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