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A case Report on Accessory Slip of Flexor Carpi Ulnaris Muscle Associated with Variant Superficial Palmar Arch

KEYWORDS: Flexor Carpi Ulnaris, Additional Muscle Slip, Incomplete Superficial Palmar Arch, Ulnar Nerve, Ulnar Artery, Median Nerve, Reconstructive Hand Surgeries, Surgeons, Entrapment, Orthopaedicians, Fractures of Radius or Ulna, Plastic Surgeons, Pedicle Flap.

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ABSTRACT *During routine dissection, of the right upper limb of a 70 years old donated embalmed male cadaver in the Department of Anatomy, K.J. Somaiya Medical College, Sion, Mumbai, India, we observed an additional muscle slip of flexor carpi ulnaris with incomplete superficial palmar arch. The additional belly originated from the lower part of the flexor carpi ulnaris muscle and crossed ulnar nerve, ulnar vessels and median nerve. The additional belly merged with the flexor retinaculum. The superficial palmar arch was formed alone by the ulnar artery on medial side but there was no contribution from the radial artery on the lateral side. The pattern of nerves and vessels in the forearm was normal. The variation was unilateral and the left upper limb was normal. The photographs of the additional muscle slip of flexor carpi ulnaris with incomplete superficial palmar arch were taken for proper documentation. The awareness of additional muscle slip of 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. The knowledge of variations of vascular pattern of hand gained more importance in microsurgical techniques, reconstructive hand surgeries, preoperative screening of radial artery harvesting for myocardial revascularization and also in arterial interventions that include radial artery cannulation and radial artery forearm 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 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 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_7, C_8, T_1. 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. 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 flexor carpi ulnaris superficial to the posterior and obligue parts of the ulnar collateral ligament (1).The ulnar nerve, after descending in the forearm between the flexor digitorum profundus and 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). The superficial palmar arch is an arterial arcade and a dominant vascular structure of the palm. It is localized just deep to palmar aponeurosis and is superficial to digital branches of the median nerve, long flexor tendons of the forearm and lumbricals of the palm (3). The arch is formed by superficial terminal branch of the ulnar artery and can be completed on lateral side by superficial palmar branch of the radial artery or the princeps pollicis artery or the radialis indicis artery or the median artery which accompanies the median nerve (4). The anastomoses between the radial and the ulnar arteries through superficial and deep palmar arches in the palm play a significant role through collateral circulation in the diseases of the palm. Knowledge of the frequency of anatomical variations of the arterial pattern of the hand is crucial for safe and successful hand surgeries (5).

Case Report:

During routine dissection, of the right upper limb of a 70 years old donated embalmed male cadaver in the Department of Anatomy, K.J. Somaiya Medical College, Sion, Mumbai, India, we observed an additional muscle slip of flexor carpi ulnaris muscle associated with incomplete superficial palmar arch. The additional belly originated from the lower part of the flexor carpi ulnaris muscle and crossed ulnar nerve, ulnar vessels and median nerve. The additional belly merged with the flexor retinaculum. The superficial palmar arch was formed alone by the ulnar artery on medial side but there was no contribution from the radial artery on the lateral side. The pattern of nerves and vessels in the forearm was normal. The variation was unilateral and the left upper limb was normal. The photographs of the additional muscle slip of flexor carpi ulnaris with incomplete superficial palmar arch were taken for proper documentation.

Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

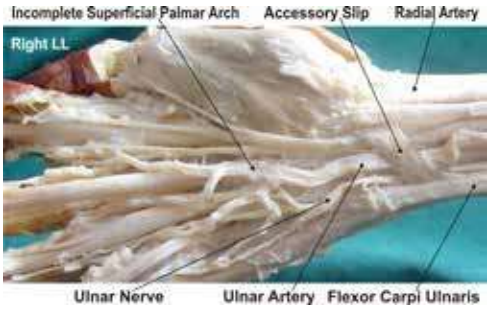

Figure : The photographic presentation of an additional muscle slip from the flexor carpi ulnaris muscle in the lower part of the anterior compartment of the forearm associated with incomplete superficial palmar arch.

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 (6). Anatomical variations in musculotendinous junction of the flexor carpi ulnaris muscle were found in literature (7). The variant flexor carpi ulnaris causing ulnar nerve compression was also documented (8). An additional slip of flexor carpi ulnaris muscle was reported by previous research workers (9). But the presence of an additional muscle slip of flexor carpi ulnaris muscle associated with anomalous high division of dorsal branch of ulnar nerve was 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 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 but 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 (10). The whole and split flexor carpi ulnaris pedicle flaps provide predictable coverage of posterior elbow soft-tissue defects (11). 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 (12). 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 (13). 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 case, 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 (14). The knowledge of course and distribution of ulnar nerve can assist the anaesthetist in pain management therapies. 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 (15). 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 (16, 17). The superficial palmar arch is a direct continuation of the ulnar artery (18). It gives four palmar digital arteries, the medial most supplies the medial side of little finger and is termed as the proper palmar digital artery. The other three are common palmar digital arteries which pass to the medial three interdigital clefts (19). There is a report of superficial palmar branch of the radial artery terminating in the thenar muscles without any contribution to the superficial palmar arch (20). It is extremely difficult to establish a type, due to the large number of variations in the superficial palmar arch (21). Gellman et al. classified the superficial palmar arch into two categories as complete and incomplete. In complete arch there will be an anastomosis between vessels constituting it. There will be an absence of a communication or anastomosis between the vessels constituting an incomplete arch. In the present case the ulnar artery does not anastomose with the radial artery or the median artery and hence the superficial palmar arch was incomplete type. This classification is simple and understandable for many anatomists and researchers and is currently in use (22). Adachi has described 3 types of superficial palmar arch (23). Type A : Ulnar type - in which contribution by radial artery is absent or minimal, Type B : Radioulnar type - in which arch is formed by the superficial palmar branch of radial artery and the larger ulnar artery, Type C : Mediano ulnar type - in which arch is formed by the median artery and the larger ulnar artery. The superficial palmar arch observed in the present case is Adachi's Type A : Ulnar type. Huber (24) classified the superficial palmar arch into 2 types. Type 1 in which additional branches from the forearm participate in the formation of the arch or replace the radial in its composition. Type 2 in which there is no true arch, the arteries which should participate in its formation and in some cases the additional ones also, failing to anastomose and each giving rise independently to a certain number of digital branches in a somewhat fan like manner. The superficial palmar arch seen in the present case is Huber's Type 1. Coleman and Anson (25) elaborated more on superficial palmar arch and reclassified it as follows : Group I : Complete arch. It can be further divided into five types :- Type A : The classical radio ulnar arch is formed by superficial palmar branch of radial artery and the larger ulnar artery. Type B : This arch is formed entirely by ulnar artery. Type C : Mediano ulnar arch is composed of ulnar artery and an enlarged median artery. Type D : Radio-median-ulnar arch in which 3 vessels enter into the formation of arch. Type E : It consists of a well formed arch initiated by ulnar artery and completed by a large sized vessel derived from deep arch. The latter vessel comes to superficial level at the base of the thenar eminence of join the ulnar artery. Group II : Incomplete arch : When the contributing arteries to the superficial arch do not anastomose or when the ulnar artery fails to reach the thumb and index finger, the arch is incomplete. It can be further divided into 4 types. Type A : Both superficial palmar branch of radial artery and ulnar artery take part in supplying palm and fingers but in doing so, fail to anastomose. Type B : Only the ulnar artery

Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

forms superficial palmar arch. The arch is incomplete in the sense that the ulnar artery does not take part in the supply of thumb and index finger. Type C : Superficial vessels receive contributions from both median and ulnar arteries but without anastomosis. Type D : Radial, median and ulnar artery all give origin to superficial vessels but do not anastomose. The superficial palmar arch seen in the present case is Coleman and Anson's Type B. Since the superficial palmar arch is the main source of arterial supply to the palm, the details about its possible variations is important for the hand surgeons. The knowledge is important while performing the superficial dissections and to the radiologists while performing the angiographic procedures. The morphology of arterial arches of hand is important for microvascular surgeons as well as orthopaedicians (26). The clamping of radial artery is contraindicated in cases of deficient collateral flow through the ulnar artery, as it can lead to ischemia and gangrene of the fingers (27). The patients should be screened before harvesting the radial artery to confirm the presence of a viable collateral circulation in the hand (28). It is mandatory to conduct the investigations like Allen test, angiography and colour doppler studies of the hand before starting any invasive procedures including the vascular surgeries. The knowledge about these variant arches is essential for the safe and successful outcome of the hand surgeries. The recent advances in microsurgical techniques for the reconstruction of hand and upper extremity after trauma and congenital deformities have necessitated better understanding of the vascular patterns of the vessels. The doppler and angiographic studies allow visualization of vessels of the hand, but do not accurately assess the small connecting vessels (29, 30, 31, 32). The hand surgeon needs to refer to the existence and healthy functioning of the arch before surgical procedures such as, arterial repairs, vascular graft applications. The radial artery contributes greatly to the circulation of the hand but in many cases it can be removed as a non-essential vessel, with adequate circulation being provided by the remaining ulnar and in some cases, persistent median artery (33).

Clinical significance:
The anatomical variation described here has practical implications, since 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. The variation in the flexor carpi ulnaris muscle should be kept in mind by the 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. The knowledge of variations of vascular patterns of hand gained more importance in microsurgical techniques, reconstructive hand surgeries, preoperative screening of radial artery harvesting for myocardial revascularization and also in arterial interventions that include radial artery cannulation and radial artery forearm flap.

Conclusion:
The awareness of additional muscle slip of 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. Recent advances in the microsurgical techniques for reconstructive hand surgeries have necessitated the understanding of variant arterial arches, the comprehensive knowledge of which is important for the surgical interventions and successful outcome. Scientific improvement can be achieved by thorough knowledge of anatomical variations.

Competing interests:
The author declare that he has no competing interests.

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Volume : 3 | Issue : 2 | February 2013 | ISSN - 2249-555X

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