Accessory Flexor Carpi Ulnaris and Bilaterally Variant Vascular Anatomy of Upper Limb: An Unusual Presentation

Abstract
We report a rare combination of variations in the upper limb of a human cadaver. Accessory flexor carpi ulnaris with absent palmaris longus was observed in the left forearm during routine dissection of a male cadaver. Variant vascular pattern was observed bilaterally. Brachial artery bifurcated at a higher level. Ulnar artery gave rise to persistent median artery (PMA) which pierced the median nerve and accompanied it deep into flexor retinaculum to terminate as two common palmar digital arteries. Superficial palmar arch was not formed as the PMA did not anastomose with either the radial or ulnar artery. Radial artery was small and deep palmar arch was mainly contributed by the deep branch of ulnar artery. Awareness of these coexistent variations in the forearm and hand is anatomically as well as clinically important in reconstructive hand surgeries.

Keywords: Accessory flexor carpi ulnaris, deep palmar arch, persistent median artery, superficial palmar arch

Introduction
We report an unusual combination of accessory flexor carpi ulnaris (FCU) and absent palmaris longus (PL) in the left forearm, with variant vascular pattern on both sides. Persistent median artery (PMA) terminated as common palmar digital arteries without forming superficial palmar arch (SPA). Furthermore, deep palmar arch was mainly formed by ulnar artery. Accessory FCU is a rare presentation with few reported cases.[1] Niumsawatt et al., in their review article, reported the incidence of FCU anomalies as 0.02% and 2%, respectively, in two different studies.[1] Coexisting variations in the forearm and hand are clinically important in reconstructive surgeries.

Case Report
During the dissection class for undergraduates, we observed multiple variations involving the muscles and arteries, in the upper limb of a 61-year-old male cadaver. In the left forearm, we came across an accessory FCU, with absent PL [Figure 1]. This accessory muscle was supplied by ulnar nerve and presented with a separate belly that originated from the medial epicondyle of humerus, passed downward on the radial side of FCU proper and its tendon was inserted into the flexor retinaculum and hook of hamate. We observed an interesting vascular pattern bilaterally. The brachial artery bifurcated at the interepicondylar level into ulnar and radial artery. In the cubital fossa, the ulnar artery trifurcated into the PMA, a common interosseous artery and a third branch which continued as the ulnar artery into the forearm [Figure 2]. In the upper third of the forearm, the PMA pierced the median nerve from posterior to anterior and accompanied it into the carpal tunnel. In the palm, PMA gave rise to two common palmar digital arteries, supplying the lateral 2½ digits, whereas superficial branch of the ulnar artery supplied the medial 2½ digits. PMA did not anastomose with radial or ulnar artery to form the SPA [Figure 3]. Deep palmar arch was mainly fed by deep branch of the ulnar artery; the radial artery was smaller and did not give rise to princeps pollicis.

Discussion
The presence of accessory muscles can be explained by the embryogenesis of muscle. Myogenic precursor cells from somites migrate to the limb buds. Differentiated myogenic cells, guided by the connective tissue framework, coalesce to form two
principal dorsal and ventral muscle masses that undergo a sequence of divisions and subdivisions to form the limb muscles.\[2,3\] Some of the muscle primordia disappear by apoptosis. Thus, the definitive form of the muscle depends on the migration, fusion, displacement, and apoptosis of muscle primordia.\[3\]

Variants of FCU are clinically important as they cause ulnar nerve compression.\[4\] Niumsawatt et al.\[1\] came across a single case of accessory FCU in 500 forearms examined. They proposed a new classification identifying all the variations of FCU: aberrant origin, aberrant insertion, aberrant size or number of bellies, anomalous conjoined FCU, accessory FCU, and aberrant innervations. FCU is clinically important as it may be used as local flap, free flap, in tendon transfer, and also explored during decompression in ulnar nerve palsy.\[1\]

PL is a slender, fusiform muscle in the forearm and is often absent unilaterally or bilaterally.\[2\] Prevalence of absence of PL varies with different ethnic groups. Caucasian population (Hispanic - 14.9% and non-Hispanic - 13.1%) had a greater prevalence than the African-Americans (4.5%) and Asians (2.9%).\[3\] The overall prevalence of absent PL (unilateral - 3.3%, bilateral - 1.2%) in Chinese population is 4.6%, which is quite low when compared to the Caucasian population.\[4\] As PL is an ideal donor for tendon transfer, this statistically significant lower prevalence in Asians could be valuable information in treating tendon injury.\[5\]

O’Sullivan and Mitchell found a significant association between the absent PL and variant SPA in 47% of cases.\[7\] Another study found no association, as only 1 of the 15 cadavers with absent PL had an incomplete palmar arch.\[6\] In the present variation, PL was absent unilaterally, but SPA was not formed on both the sides.

Median artery is a branch of anterior interosseous artery, the axial artery of the forearm, and it accompanies the median nerve to end in the superficial palmar plexus. As the SPA is being formed, the median artery regresses to become a small vessel.\[5\] About a third of the SPA are completed by the median artery or radialis indicis or a branch of princeps pollicis.\[3\] PMA's vary in their origin and may arise from ulnar, caudal angle between ulnar and its common interosseous trunk, common or anterior interosseous arteries, and it has been associated with carpal tunnel syndrome, pronator teres syndrome, and anterior interosseous nerve syndrome.\[8\]

PMA is of two types: antebrachial and palmar. In the antebrachial type, PMA is slender and terminates above the wrist, and in the palmar type, it is long, reaches the palm, and terminates by forming a complete or incomplete arch.\[8\] Rodríguez-Niedenführ et al. reported the palmar type of PMA in 20% of cases with no statistical difference between male and female cadavers, which terminated by joining SPA or forming common digital arteries in 35% and 65% of cases, respectively.\[8\] In 41% of the cases, the median nerve was pierced by the PMA from posterior to anterior.\[8\] A few cases of SPA giving rise to princeps pollicis and radialis indicis arteries have been reported.\[9\] In the present report, the first common palmar digital artery from PMA bifurcated to the ulnar side of the thumb and radial side of the index finger which were the main blood supply for the first two digits and could be considered as the princeps pollicis and radialis indicis, respectively. Deep palmar arch may be smaller than usual, but its absence or replacement by
the ulnar artery is rare.[10] In the present case, deep arch was mainly contributed by the ulnar artery, and the radial artery was thin. Thus, inadvertent damage to the PMA might result in ischemia of the hand.

**Conclusion**

Coexistence of multiple variations in the forearm muscles and the vascular pattern of the hand are of utmost importance both anatomically as well as clinically and may be anticipated to prevent complications during reconstructive surgical procedures.

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**Conflicts of interest**

There are no conflicts of interest.

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