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Case Report

Anatomical variations detected in the arterial arches of the palm: A case report

Laxman Khanal[1*], Saroj Kumar Yadav[2]

Author's Affiliations

[1]Additional professor, Department of Human anatomy, BP Koirala Institute of Health Sciences, Dharan

[2]Assistant professor, Department of Human anatomy, BP Koirala Institute of Health Sciences, Dharan

Correspondence to:

Dr. Laxman Khanal

Department of Human Anatomy, BPKIHS, Dharan

Email: laxman.khanal.bpkihs@gmail.com

ABSTRACT

Background and objectives: The vascular anatomy of the hand, particularly the superficial palmar arch (SPA) and deep palmar arch (DPA), presents complex and variable patterns crucial for microsurgical interventions.

Presentation of case: We encountered a unique case during routine cadaveric dissection, an incomplete SPA in a male cadaver. The left upper extremity revealed atypical branching of the ulnar artery (UA), where the superficial branch lacked the typical connection to the radial artery, deviating from conventional SPA anatomy. The medial branch of UA served as a common trunk, supplying the common palmar digital artery and the digiti minimi artery. Additionally, origin of first common palmar digital artery from palmar metacarpal artery (branch of radial artery) instead from ulnar artery itself further distinguished this case.

Discussion: Incomplete SPA due to absence of connection between ulnar artery and superficial branch of radial artery is also reported by other studies with prevalence ranging from 3.6 % to 21.7%. Knowledge of this type of variation is significant for hand surgeries involving harvesting of the radial artery to prevent dangerous complications like ischemia and gangrene.

Conclusion: Understanding anatomical variations in hand vasculature is pivotal for surgical procedures. This case highlights the importance of thorough anatomical knowledge in clinical practice and surgical planning.

Key words: Anatomical variation, Deep palmar arch, Superficial palmar arch

INTRODUCTION

The intricate vascular patterns of the palm in the form of superficial palmar arch (SPA) and deep palmar arch (DPA) present some of the challenging and fascinating areas of hand anatomy. With advances in microsurgical functional hand reconstruction, vascular

anatomy of hand has emerged as an extremely important area [1]. Contribution to both these arterial arches is provided by two branches of brachial artery, i.e. radial and ulnar artery.

The superficial palmar arch is an anastomotic vascular structure found in the palmar (volar) compartment of the hand. Its main source is the superficial branch of ulnar artery (SUA), with a smaller contribution from the superficial branch of radial artery (SRA). In some cases, the radialis indicis, or the princeps pollicis arteries participate in this anastomosis instead of the radial artery. The SPA is classified as incomplete when there is no visible anastomosis to other contributing arteries. The main function of the superficial palmar arch is to provide blood supply to the phalanges, metacarpophalangeal and inte rphalangeal joints of digits 2-4 [2].

The SPA normally lies superficially to the long flexor tendons and lumbricals, and beneath the palmaris brevis, as well as the palmar aponeurosis. It provides the three common palmar digital arteries (CPDA) and a fourth digital artery that supplies the ulnar half of the 5th finger, the so-called Digiti Minimi Artery (DMA) [3]. There have been many reported patterns of SPA formation. The first described classification, and one of the most frequently used, is the classification of Coleman and Anson [4]. According to this classification, the classical formation pattern of the SPA, with equal contributions from the SUA and SRA, is Type A. Type B SPA refers to an arch formed solely by the SUA, Type C to a mediano-ulnar SPA, Type D to a radio-mediano-ulnar SPA, and Type E SPA to an arch initiated by the SUA and finished by an enlarged arterial branch from the deep palmar arch.

Ottone et al classified the non- arch or Incomplete SPA, prevalence of which was 42% into two categories: dominant ulnar subtype (29%) in which the ulnar artery is dominantly responsible for the formation of the superficial palmar arterial system; and co-dominant subtype (13%) in which there is the presence of two arteries, which supply two totally independent areas [5].

Most often the DPA is formed by anastomosis of the deep palmar branch of the ulnar artery to the dorsal radial artery, which branches off the radial artery near the wrist and passes dorsally on the hand before passing through the first or second metacarpal space [6]. The three palmar metacarpal arteries extend distally from the convexity of the deep palmar arch on the interossei of the second to fourth spaces, and they join the common digital branches of the superficial arch at the digital clefts. They supply nutrient branches to the medial four metacarpals [2].

Anatomical variation of SPA is found to be higher as compared to the variation in DPA [2]. The SPA is more variable, with variable contributions from the ulnar, radial and even persistent median arteries [4,7,8].

CASE REPORT

After proper skin incision and dissection of flexor retinaculum of right side, palmar aponeurosis and deep fascia covering the thenar and hypothenar muscles, we encountered an incomplete type of SPA in the left upper extremity of a formalin-fixed adult male cadaver during routine dissection for the purpose of practical session for MBBS students. The history of the individual and the cause of death was not known. Cadaver was embalmed by concentrated salt technique to make it soft, also called as soft cadaver. The meticulous dissection of hand region was

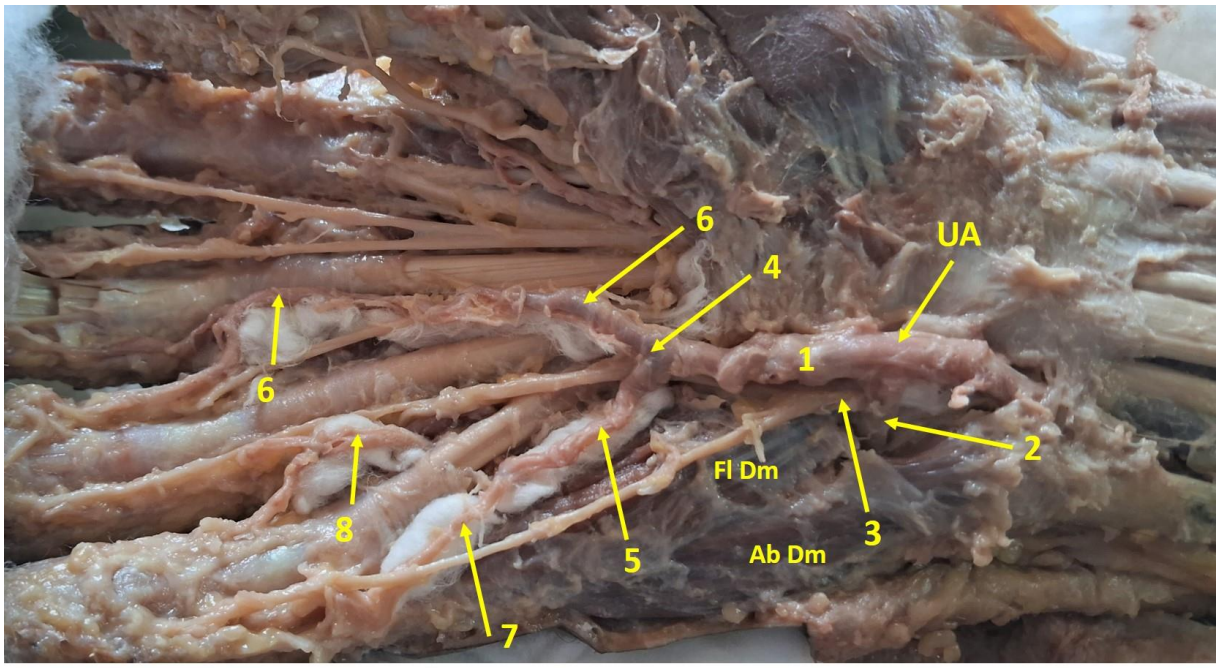

Figure 1: superficial dissection of palm after removal of skin, palmaris brevis muscle and palmar aponeurosis *(UA: ulnar artery; 1: superficial branch of UA; 2: deep branch of UA; 3: ulnar nerve; 4: bifurcation of superficial branch of UA into two branches (medial common trunk (5) and second common palmar digital branch (6); 7: proper digital branch for little finger (digiti minimi artery); 8: common palmar digital branch for little and ring finger (3rd CPD artery); Fl Dm: Flexor Digiti Minimi muscle; Ab Dm: Abductor Digiti Minimi muscle)*

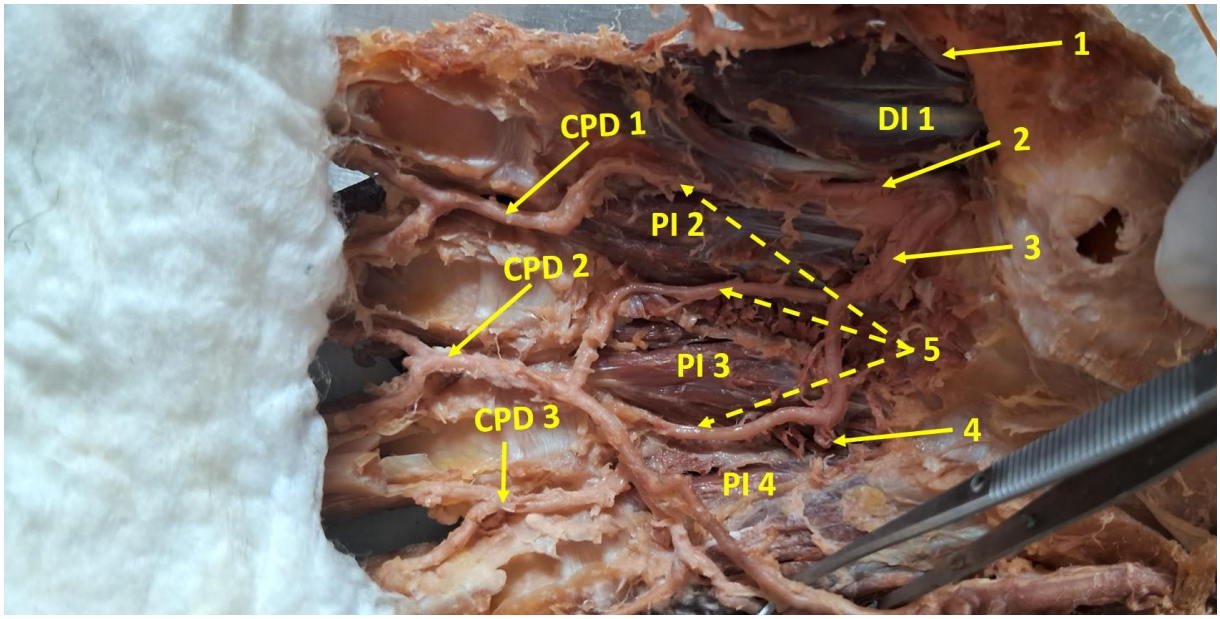

Figure 2: Deep dissection of palm after removal of all flexor tendons, branches of nerves, thenal group of muscle and lumbrical muscles *(PI 2,3,4: 2nd, 3rd and 4th palmar interossei muscles; **CPD 1-3**: first, second and third common palmar digital artery; **1**: principal pollicis artery from radial artery; **2**: first common palmar digital artery; **4**: point of connection of deep branches of radial and ulnar artery; **5**: three palmar metacarpal arteries; **DI 1**: first dorsal interosseous muscle)*

carried out according to the instructions by Cunningham's Manual of Practical Anatomy (vol. 1, 15th edition). The dissections took place during the year 2024.

Ulnar artery (UA) was found to be entering into palm deep to volar carpal ligament and superficial to flexor retinaculum. Immediately it gave off smaller deep branch that passed deep to abductor digiti minimi and flexor digiti minimi. After giving off the deep branch, UA continued as a larger superficial branch, which after a short course, divided into two branches. First one, medial branch passed medial to the long flexor tendons (LFT) of digiti minimi (little finger) and the second, after crossing the LFT of little and ring finger, runs between the LFT of ring and middle finger (figure 1).

Medial branch of UA (common trunk for common palmar digital and digiti minimi artery) first gave off one common palmar digital branch (3rd CPD artery) that passed deep to the LFT of little finger, then between the tendon of little and ring finger, and finally divided into two proper digital arteries (PDA) between the little and ring fingers. After giving off this 3rd CPD artery, medial common trunk of UA continued as digiti minimi artery and coursed toward the ulnar aspect of little finger (figure 1).

The superficial branch of UA after giving the medial common trunk, further continued as 2nd CPD artery and divided into two PDA between the ring and middle finger. There was no connection of this superficial branch of UA to the superficial branch of radial artery as expected in normal anatomy of superficial palmar arch. Similarly, there was also lack of origin of first CPD artery from superficial arch as expected in usual cases (figure 1).

Further course of radial artery was also explored after dissecting out the superficial nerves, Long flexor tendons, lumbrical muscles and two heads of adductor pollicis brevis. Radial artery was found to be passing first dorsally at wrist region and enters into the palm region between the first and second metacarpal bone piercing the dorsal interossei muscle. Principal Pollicis artery, three palmar metacarpal arteries (PMA) and lateral part of deep palmar arch were the contribution made by the radial artery. Unlike the usual anatomical trend, first PMA continued toward the web between index and middle digit (similar to the CPD artery) and divides into digital branches. Here the role of SPA was replaced by the radial artery (figure 2).

DISCUSSION

It's interesting to note that the typical formation of the Superficial Palmar Arch (SPA), which usually involves the fusion of the superficial palmar branches of the radial and ulnar arteries, isn't consistently the most common morphology observed. In this particular case, an incomplete SPA was observed due to the absence of a connection between the ulnar artery and the superficial branch of the radial artery. Similar instances of incomplete SPA have been documented in many studies with variable extent: Ikeda et al (1988) reported it in 3.6%; Loukas, Holdman, and Holdman (2005) reported it in 10% of their cases; Patnaik, Kalsey, and Singla (2002), and Al-turk and Metcalf (1984) observed it in 16% of cases, while Coleman and Anson (1961) noted it in 21.47% of cases [4,6,9-11].

In our study, due to incomplete SPA, only two CPD arteries were arising from the ulnar artery contributing medial two and half digits only. The digital arteries for radial side of

middle finger and ulnar side of index finger were found to be arising from the branch from the radial artery while forming the DPA. Similarly it was observed that radial side of index finger and thumb were supplied by branch from the radial artery only. This case showed the dominance of DPA in arterial supply for part of middle and index finger. Previous study done among 86 dissection hands by Ottone NE et al had reported 4 such cases (4.7%) in which ulnar artery contributed for blood supply only for medial two and half digits as reported in this case [5]. In contrast to this case, Ruengsakulrach, Eizenberg, Fahrer et al. (2001) reported that, in 66% of the hands, all the fingers were supplied by the SPA showing the predominance of the superficial arch over the deep arch in supplying the thumb and index finger [12].

The axis artery from the seventh cervical segment extends into the upper limb as the anterior interosseous artery. It travels along the ventral axis to the palm, forming a deep capillary network. As this network diminishes, the median artery extends further and joins the superficial palmar capillary plexus, which gives rise to the finger arteries. Eventually, the median artery regresses, replaced by the radial artery (RA) and ulnar artery (UA). The RA connects first with the deep palmar arch, followed by the UA joining the superficial palmar arch [13].

Embryologically, variations in hand blood vessels arise from persisting vessels that should vanish, disappearing vessels that should persist, incomplete vessel development, and abnormal merging or absorption of usually separate elements. These mechanisms can explain differences in superficial palmar arch formation [3]. A comparative analysis of hand artery anatomy in primates indicates that several variations seen in the human hand reflect either the persistence or resurgence of primitive patterns. These variations can be understood through the principles of embryological parallelism and the idea that ontogeny recapitulates phylogeny. Rodriguez-Niedenfuhr et al. (2001) noted that by the 21st stage of embryo development, the radial artery reaches its fully differentiated state [8]. Consequently, it is postulated that arterial variations impacting the radial artery's distal path must have occurred prior to the 21st gestational stage of the fetus.

In this case, there was no connection of this superficial branch of UA to the superficial branch of radial artery as expected in normal anatomy of superficial palmar arch. In such cases, harvesting the radial grafts can lead to dangerous complications like ischemia and gangrene.

CONCLUSION

Surgical methods require an understanding of the anatomical differences in the hand vasculature. This case report emphasizes how crucial in-depth anatomical knowledge is for both clinical practice and surgical planning.

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