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# **Infrequent disposition of the first metacarpal artery related to anastomoses of the superficial and deep systems of the hand**

Infrequent disposition of the first metacarpal artery

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## **Abstract**

There is an infrequent disposition of the first metacarpal artery which results in an anastomosis with the common palmar digital artery of the second space, forming an anastomotic system between the deep radial system and the superficial ulnar system. The radial system in turn, through the first dorsal interosseous artery, anastomoses with a collateral of the common palmar digital artery of the second space, ending as the ulnar palmar digital artery of the thumb and establishing a second anastomotic system. A third anastomosis is established in one case, between the common palmar digital artery of the fourth space and the fourth metacarpal artery. To this may be added the classic anastomosis between the superficial branch of the ulnar artery and the deep branch of the radial artery, i.e. the deep palmar arch.

**Key words: first metacarpal artery, superficial palmar arch, deep palmar arch, anastomosis**

## **INTRODUCTION**

In the course of an investigation into the morphology of the superficial palmar arch (SPA), we found an infrequent disposition of the first palmar metacarpal artery (1PMA), which is considered primordial in the circulation of the thumb to the point that it is called the princeps pollicis artery. We believe that doctors surgeons must be familiar with the arterial disposition of this finger for the purposes of surgery and reconstruction procedures.

## **MATERIAL AND METHOD**

The specimens were 28 fresh upper limbs undistinguished by sex, mean age 65 years. The specimens were injected manually, through axillary artery, with elastomeric material (natural latex) (Meister©), using 10 mL syringes. Chemically, this elastomeric material is defined as a polymer of methylbutadiene or isoprene (C<sub>5</sub>H<sub>8</sub>), whose degree of polymerization is 2500 to 4500. It is white in color, and was colored red with an acrylic paint (chemically, vinyl acetate) (Arcel©). Subsequently, the specimens were immersed in a 10% formalin fixative liquid container for 30 days, at room temperature. The upper limbs were dissected using appropriate instruments and stereoscopic microscopes 2x.

## **RESULTS**

The findings reported were found in 3 cases, i.e. 10.7%, of the total sample.

Common characteristics were observed between cases 1 and 2. The superficial palmar arches (SPA) of cases 1 and 2 may be considered of the incomplete type (Figs. 1a, 2a): the 1PMA originates in the deep palmar arch (DPA), close to the passage of the radial artery (RA) through the first dorsal interosseous muscle (1DIOM) (Figs. 1c, 2c). From this origin, the artery lies between the first dorsal interosseous muscle (1DIOM) and the adductor pollicis (AdP), emerging below its distal border, hidden by the flexor tendons of the index finger. At the point of emergence, it emits the radial artery of the index (Figs. 1a,b and 2a,b), which is seen emerging outside the flexor tendons of this finger. Located at first outside the flexor tendons, the 1PMA passes below them close to

the metacarpophalangeal joint, and subsequently courses inside the flexor tendons (Figs. 1a,b and 2a,b) in the second interdigital space, where it anastomoses with the common palmar digital artery of the second space (CPDA2S) (Figs. 1a,b and 2a,b). It courses posterior of the palmar digital nerves of the index finger. Before it passes through the 1DIOM ring, the RA emits the first dorsal interosseous artery (1DIOA) (Fig. 1c and 2c), which anastomoses with a branch of the SPA at the edge of the first commissure. It continues its course parallel to the medial border of the thumb to become the ulnar palmar artery of the thumb (UPAT) (Fig. 1c and 2c). In case 1, shortly after its origin, the CPDA2S emits a branch which courses to proximal and divides into two branches (Fig.1 a): one distal, parallel to the medial border of the thumb, which anastomoses with the 1DIOA when it reaches the border of the first joint; and one proximal which ends up as the radial palmar artery of the thumb. Case 2 is similar (Fig. 2a), but it is the branch that anastomoses with the dorsal system that emits the radial palmar artery of the thumb. In case 1 (Fig. 1a), other arterial variations were observed: the origin of a common trunk for the common palmar digital artery of the fifth finger and the common palmar digital artery of the fourth space (CPDA4S), which has to pass below the extensor tendons and the common palmar digital nerve of this space, to arrive at the same point, receiving a fourth palmar metacarpal artery (4PMA) with which it anastomoses; and the presence of a highly developed second dorsal interosseous artery (2DIOA) located over the second dorsal interosseous muscle, which passes under the extensor tendons of the index and the juntura tendinum between this and the middle finger, and ends by joining the CPDA2S at the point where it divides into the medial and radial proper palmar digital artery of the index and middle fingers (Fig. 1d).

Case 3 presents a complete SPA (Fig. 3a), with the thumb receiving blood supply from the ulnar proper palmar digital artery of the thumb and from radial proper palmar digital artery of the thumb, originating in the common palmar digital artery of the first space. The RA does not give origin to a 1DIOA. The 1PMA originates from the DPA and presents the same course and disposition as in the above cases (Fig. 3b,c). It also presents an arterial variation in the form of a DPA between the RA and a distal deep ulnar artery (Fig. 2c). The proximal deep ulnar artery turns over the DPA and a small anastomosis can be seen between the first and second metacarpal arteries (Fig. 3c).

## DISCUSSION

Although our purpose is not to discuss the origins of the arteries of the thumb, in order to compare our findings we will say that the 1PMA has been considered the principal source of irrigation of the thumb, which is why it has been called princeps pollis [15, 21]. Other authors argue that it should not be so called, as its contribution to the vascularisation of the thumb is inconstant [10, 15, 16, 18], or because its contribution is provided from other sources: 1DIOA [1-3, 9, 13, 15, 16, 18]; or SPA [1, 11, 15, 17]. Other authors again consider that the 1PMA and the princeps pollis are different [8, 19]. A similar disposition to our findings appears in illustration by Dujarier [9], who calls the 1PMA as the arterial trunk of the index and – citing Farabeuf – considers this a habitual disposition, an opinion shared by Delorme [8]. Patil [13] refers to a case, which we understand to be the same as those described here, in which a 1PMA is located in the second palmar space with termination as in our findings, but with the radial artery of the index passing under the tendons and nerves destined for the index, because the 1PMA is located in a medial position relative to these structures, while in our specimens it passes to radial. A similar disposition to ours is mentioned by Hashem [12], without indicating which metacarpal artery is substituted. Occasionally a second palmar metacarpal artery (2PMA) can supply a common palmar digital artery of the second space [2], forming another anastomosis between elements of the DPA and the SPA [3, 4]. Coleman and Anson [7] say that the most developed artery destined for thumb should be called 1PMA.

Our cases confirm that it is not correct to call 1PMA as “princeps pollis”, because it does not contribute to the vascularization of the thumb in any of them: in two cases this is provided by 1DIOA which ends up as ulnar proper palmar digital artery of the thumb. In case 1 the radial proper palmar digital artery of the thumb originates from the branch which has originated in the CPDA2S, and in case 2 from the distal branch from the same origin, anastomosing with the dorsal system. In case 3, both radial proper palmar digital artery of the index come from the SPA.

In all cases, the 1PMA (Fig. 1a) presents an anastomosis which differs from the classic configuration between the deep radial and the superficial ulnar systems via an

indirect anastomosis between two collateral branches of those systems, the CPDA2S and the 1PMA, in the second digital space, although it originates in the first space. The same occurs in other cases of anastomosis between the radial and ulnar systems, most frequently originating in the SPA and the 1DIOA [1, 2, 15, 18]. Anastomoses between the SPA and the 1PMA or princeps pollicis were mentioned by Browning [6], but none of these cases are similar to our findings. In all the cases investigated, the 1PMA supplies the radial artery of the index [15, 16, 18]. We do not think it appropriate, even in cases like this, to call it the arterial trunk of the index as Dujarier does [9], although it could be justified in case 2, since the volume of the 1MP is greater than that of the common palmar digital artery (CPDA), which appears to be anastomosed with the 1PMA and not the other way round. The volume of the ulnar proper palmar digital artery of the thumb supplied by the 1DIOA is dominant, coinciding with other findings [15, 18]; this justifies preference for its use in implants and revascularization [19]. In 2 of our findings, the RA was the principal source of irrigation of the thumb [1].

In specimen 1, simultaneous arterial variations were observed, such as presence of the common trunk of origin of the common palmar digital arteries for the fifth and fourth spaces, similar to that reported by Singh [14] and Hasham [12]; however these authors identified a different course of the common trunk, as well as an anastomosis of the common palmar digital artery of the fourth finger with a 4PMA, and a 2DIOA. This anastomosis reinforced the circulation of the second interdigital space instead of supplying it [3], giving rise to another indirect anastomosis between the SPA and DPA.

We agree with Rodríguez-Niedenführ [19], who considered that the arteries develop from shoots, initially capillary plexuses, and that they become differentiated from proximal to distal. In this process, some become definitive blood vessels, while others disappear or present incomplete development.

Although the incidence of modifications in arterial disposition is low, occlusions of the RA due to cannulation or trauma (Mozersky cited by Parks [18]) may have consequences such as ischaemia or acute vascular insufficiency of the thumb. We believe that caution must be exercised in surgical approaches to the radial side of the hand, where arterial variations are more frequent [4, 5], for example in aponeurotic retractions, lesions of the flexor tendons of the index, ~~and~~ in primary or secondary repairs. There is also a risk in the pollicisation of the index finger [12]. In some cases,

the use of a Doppler ultrasound scan or angiography needs to be considered to ensure that the surgery is well planned.

## CONCLUSIONS

We confirm the presence of anastomotic circuits between the superficial and deep systems of the hand, apart from the classic anastomosis between the SPA and DPA, occurring between their collateral arteries: 1PMA and CPDA2S, 1DIOA and SPA, 4PMA with CDPA4S, 2DIOA and proper palmar digital artery of the second interdigital space, in addition to those reported between the 2PMA and the common palmar digital artery. Their presence may explain why many serious hand injuries have a favourable evolution, including injuries to the thumb where the circulation is not restricted to a single artery. Considering the frequency of arterial modifications in the radial side of the hand, their possible presence must be taken in mind when carrying out both invasive and non-invasive procedures.

**Ethical considerations:** We complied with all the protocols and requirements established by the Government of the City of Buenos Aires, Argentina ("Protocol for the treatment of dead bodies, dead births, segments and anatomical parts in GCBA hospitals. Government of the City of Buenos Aires, Argentina, 2014").

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**FIGURE 1. a. View of the palmar side of the hand. 1.** ulnar artery; **2.** common trunk for the common palmar digital artery of the fifth finger and the common palmar digital artery of the fourth space; **3.** common palmar digital artery of the third space; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar

digital artery of the second space; **6.** distal anastomotic branch of the first dorsal interosseous artery; **7.** proximal branch of the first dorsal interosseous artery; **8.** ulnar proper palmar digital artery of the index; **9.** radial artery of the index; **10.** Anastomotic branch between first palmar metacarpal artery and common palmar digital artery of the second space (white arrow); **11.** common palmar digital artery of the fourth space (black arrow); **FT.** flexor tendons; **L.** lumbrical muscle; **AdP.** adductor pollicis muscle. **b.**

**Enlarged visualization of palmar side of the hand on the first and second interosseous space.** White arrow: first palmar metacarpal artery; Black arrow: anastomosis between second dorsal interosseous artery and common palmar digital artery of the second space; **3.** common palmar digital artery of the third space; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar digital artery of the second space; **6.** distal anastomotic branch of the first dorsal interosseous artery; **7.** proximal branch of the first dorsal interosseous artery; **8.** ulnar proper palmar digital artery of the index; **9.** radial artery of the index; **10.** Anastomotic branch between first palmar metacarpal artery and common palmar digital artery of the second space (white arrow); **FT.** flexor tendons; **AdP.** adductor pollicis muscle. **c. View of the dorsal side of the hand.** **12.** radial artery; **13.** first dorsal interosseous artery (white arrow: anastomosis with medial branch of common palmar digital artery of the second space); **8.** ulnar proper palmar digital artery of the index; **14.** first palmar metacarpal artery. **IDIAM:** first dorsal interosseous muscle (reclined and sectioned at the level of the interosseous ring); **AdP:** m. adductor pollicis; **EPB:** m. extensor pollicis brevis; **EPL:** m. extensor pollicis longus. **d. View of the dorsal side of the hand, from the first interosseous space, with recline of the first dorsal interosseous muscle.** **15.** second dorsal interosseous artery; **16.** proper palmar digital arteries; **IET:** index extensor tendons; **JT:** junctura tendinae.

**FIGURE 2. a. View of the palmar side of the hand.** **1.** ulnar artery; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar digital artery of the second space; **6.** distal anastomotic branch of the first dorsal interosseous artery; **8.** ulnar proper palmar digital artery of the thumb; **9.** radial artery of the index; **14.** first palmar metacarpal artery; **17.** radial proper palmar digital artery of the thumb; **AdP:** m. adductor pollicis; **IET:** index flexor tendons. **b. Enlarged visualization of palmar side**

**of the hand. 4.** common palmar digital artery of the second space; **9.** radial artery of the index; **14.** first palmar metacarpal artery; **18.** superficial palmar arch; **AdP:** m. aductor pollicis; **dbUN:** deep branch of the ulnar nerve; **IFT:** index flexor tendons. **c. View of the dorsal and palmar side of the hand, from the first interosseous space, with recline of the first dorsal interosseous muscle. 8.** ulnar proper palmar digital artery of the thumb; **9.** radial artery of the index; **13.** first dorsal interosseous artery; **14.** first palmar metacarpal artery; **19.** deep palmar arch; **AdP:** m. aductor pollicis; **EPB:** m. extensor pollicis brevis; **EPL:** m. extensor pollicis longus; **1DIOM:** first dorsal interosseous muscle; **White arrow:** anastomosis between distal branch of the common palmar digital artery of the second space with the first dorsal interosseous artery.

**FIGURE 3. a. View of the palmar side of the hand. 1.** ulnar artery; **2.** common trunk for the common palmar digital artery of the fifth finger and the common palmar digital artery of the fourth space; **3.** common palmar digital artery of the third space; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar digital artery of the second space; **8.** ulnar proper palmar digital artery of the thumb; **17.** radial proper palmar digital artery of the thumb; **20.** common palmar digital artery of the first space. **b. Enlarged visualization of palmar side of the hand, with recline of the index flexor tendon, and visualization of m. aductor pollicis. 1.** ulnar artery; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar digital artery of the second space; **7.** proximal branch of the first dorsal interosseous artery; **9.** radial artery of the index; **14.** first palmar metacarpal artery; **20.** common palmar digital artery of the first space; **AdP:** m. aductor pollicis; **IFT:** index flexor tendons; **Black arrow:** anastomosis with common palmar digital artery of the second space. **c. View of the palmar side of the hand, with recline of the thumb. 1.** ulnar artery; **2.** common trunk for the common palmar digital artery of the fifth finger and the common palmar digital artery of the fourth space; **3.** common palmar digital artery of the third space; **4.** common palmar digital artery of the second space; **5.** Branch of the common palmar digital artery of the second space; **9.** radial artery of the index; **12.** radial artery; **14.** first palmar metacarpal artery; **19.** deep palmar arch; **20.** common palmar digital artery of the first space; **White arrow:** anastomosis between first palmar

metacarpal artery and second palmar metacarpal artery; **Green arrow:** anastomosis between deep branch of ulnar artery and deep palmar arch; **ppDN5:** proper palmar digital nerve of fifth digit; **dbUN:** deep branch of the ulnar nerve; **FT:** flexor tendons; **AdP:** m. adductor pollicis; **1DIOM:** first dorsal interosseous muscle.





