

MORPHOLOGICAL VARIANTS AND THEIR CLINICAL SIGNIFICANCE OF SUPERFICIAL PALMAR ARCH IN HAND SURGERIES

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ABSTRACT

Background: Superficial palmar arch is the dominant vascular structure in palm formed by the anastomosis between superficial branch of ulnar and superficial palmar branch of radial arteries.

Purpose of the study: To know the different anatomic patterns in the formation of superficial palmar arch in humans and their clinical implications.

Materials and Methods: The study included 50 hands from human cadavers from Department of Anatomy, Mysore Medical College & Research Institute, Mysore and Sree Narayana Institute of Medical Sciences, Ernakulum. The specimens were fixed with 10% formalin solution and morphology of superficial palmar arch was observed for different patterns.

Results: In the above study, different variants of superficial palmar arch were observed. 88% of specimens were of complete and 12% were incomplete type of arch. The different morphological variants were grouped according to the classification provided by Coleman and Anson in 1961. 42% of specimens belonged to type-A variety in the formation of superficial palmar arch, 26% to type-B, 4% to type-C, 6% to type-D, 10% were of complete arch- (not in the classification), 4% to type-F, 6% (rare variety) and 2% to type-H variety.

Conclusion: The present study revealed details about different patterns of vascular anastomosis which helps in knowing the importance of arches in cases of reconstructive hand surgeries, preoperative screening of radial artery harvesting for myocardial revascularisation and arterial interventions that include radial artery cannulation and radial artery arm flap. Lack of knowledge of different patterns might complicate reconstructive hand surgeries.

KEY WORDS: Superficial palmar arch, Variations, Radial artery, Ulnar artery, Median artery.

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INTRODUCTION

The anastomosis between radial and ulnar arteries in the palm plays a significant role in blood supply to structures in the palm through collateral circulation. The superficial palmar arch is a dominant vascular structure in the palm. The

superficial branch of ulnar artery on entering the palm curves laterally deep to the palmar aponeurosis and superficial to the long flexor tendons anastomoses with superficial palmar branch of radial artery to complete the arch [1]. The arterial arch ensures suitable blood

supply to entire territory of the hand, thus maintaining the integrity of hand. Superficial palmar arch gives four palmar digital arteries; the medial most supplies medial side of the little finger and is called proper palmar digital artery. The other three are common palmar digital arteries which supply medial three interdigital clefts. The radial side of index finger and thumb are supplied by *radialis indicis* and *princeps pollicis* arteries respectively which are branches of radial artery [2]. The superficial arteries of the hand form different well-defined patterns of anastomosis. About one-third of superficial palmar arch is formed completely by ulnar artery and further third is completed by the superficial palmar branch of radial artery and a third either by *arteria radialis indicis* or *princeps pollicis* or median artery. Knowledge of the frequency of anatomical variants of arterial pattern in the hand is crucial for safe and successful hand surgeries. As superficial palmar arch is main vascular structure of the palm, the familiarity about the possible variants is especially important for the surgeons dealing with reconstructive hand surgeries (congenital malformations, post traumatic deformities or general procedures) and those concerned with restoration of the functional anatomy of the hand.

MATERIALS AND METHODS

The present study included 50 human cadaver hands (25 right and 25 left). 24 hands were from Department of Anatomy, Mysore medical college & research institute, Mysore and 26 from Department of Anatomy, Sree narayana institute of medical sciences, Ernakulum. The specimens were fixed with 10% formalin solution. Exclusion criteria included the cadavers which exhibited previous trauma to the upper limb, fractures before death, any kind of surgical procedures in the hand and pathologies. The dissection of the hands was done according to the Cunningham's manual of practical anatomy [3]. The course and branches of the radial and ulnar arteries from the lower one-third of forearm and hand was meticulously dissected to observe the morphological variants of superficial palmar arch and photographs were taken whenever necessary for documentation.

RESULTS

Among the careful and meticulous dissection of 50 hands, we came across different patterns of anastomosis in forming the superficial palmar arch which were grouped according to the classification given by Coleman and Anson in 1961 [4]. The complete arch was observed in 88% and 12% for incomplete arch. 42% of superficial palmar arch (24 hands, R-13, L-11) was classical radio-ulnar type of complete arch, where superficial branch of ulnar artery completes the arch by anastomosing with superficial palmar branch of radial artery. 26% of arch (13 hands, R-7, L-6) was formed entirely by ulnar artery (In figure-1, ulnar artery gives two common trunks which divide later into common palmar digital branches, the *arteria radialis indicis* and *arteria princeps pollicis* were given from superficial palmar arch). 4% of arch (2 hands, R-1, L-1) was ulnar- median type, where ulnar and median arteries anastomose to complete the arch. Median artery was a branch from anterior interosseous artery. The *arteria radialis indicis* and *arteria princeps pollicis* were also branches from superficial palmar arch. 6% (3 hands, R-1, L-2) arch was ulnar-radio-median type, where ulnar, radial and median arteries anastomosed to form the superficial palmar complete arch. Median artery was a branch from anterior interosseous artery. 10% (5 hands, R-2, L-3) arch was rare radioulnar type, where ulnar artery anastomosed with superficial palmar branch of radial artery similar to classic type but the superficial palmar branch of radial artery passed superficial to thenar group of muscles and the *arteria radialis indicis* and *arteria princeps pollicis* were branches of this arch (Fig.no-2). 4% (2 hands, R-2) arch was incomplete (ulnar-radial type), where ulnar artery supplied medial three and half fingers and superficial palmar branch of radial artery passed superficial to thenar muscles to supply lateral one and half fingers (Fig.no-3). 6% (3 hands, R-1, L-2) arch was formed only by ulnar artery without anastomosis and supplied all the digits (Fig.no-4). 2% (1 hand, R-1) arch was incomplete (ulnar-median type), where the superficial branch of ulnar artery supplied medial two and half fingers and the lateral two and half fingers were supplied

by median artery which was arising from anterior interosseous artery in forearm. The radial artery did not take part in formation of superficial palmar arch.

Fig. 1: Complete superficial palmar arch formed by ulnar artery alone; UA- ulnar artery, SP br RA- Superficial palmar branch of radial artery, SPA- superficial palmar arch, CPDA- Common palmar digital arteries.

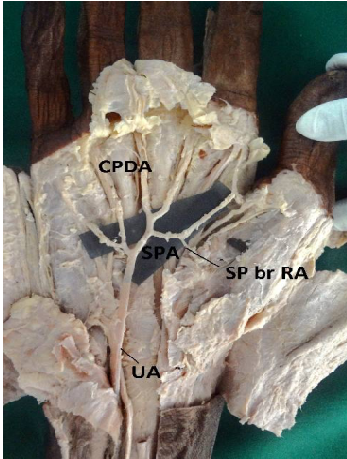


Fig. 2: Complete superficial palmar arch formed by radial and ulnar artery (rare variety); UA- ulnar artery, SP br RA- Superficial palmar branch of radial artery, ARI- arteria radialis indicis, APP- Arteria princeps pollicis, CPDA- Common palmar digital arteries.

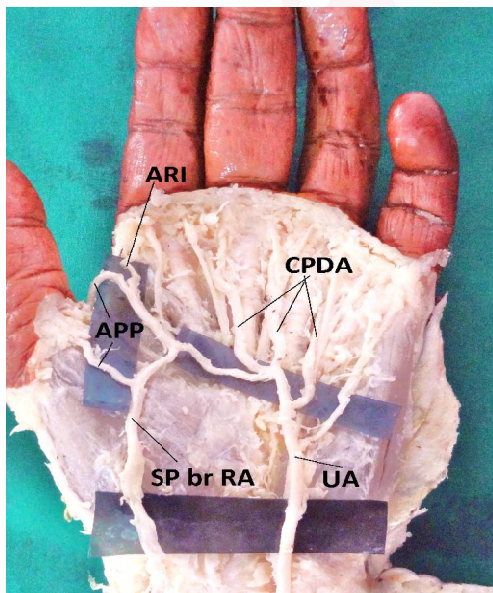


Fig. 3: Incomplete superficial palmar arch formed by radial and ulnar artery; UA- ulnar artery, SP br RA- Superficial palmar branch of radial artery, ARI- arteria radialis indicis, APP- Arteria princeps pollicis.

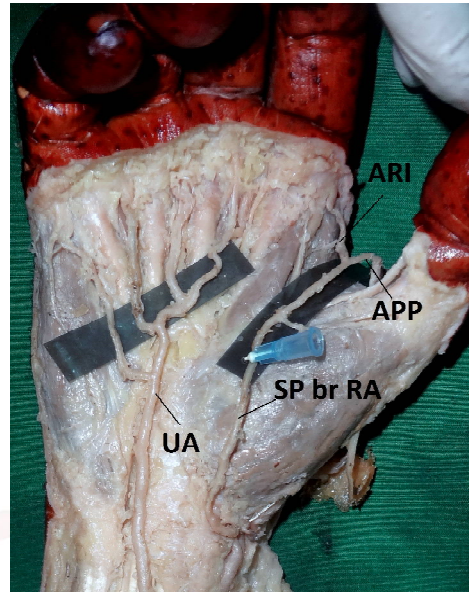


Fig. 4: Incomplete superficial palmar arch formed by ulnar artery alone which even supplies thumb and lateral side of index finger; UA- ulnar artery, SPA- Superficial palmar arch, ARI- arteria radialis indicis, APP- Arteria princeps pollicis.

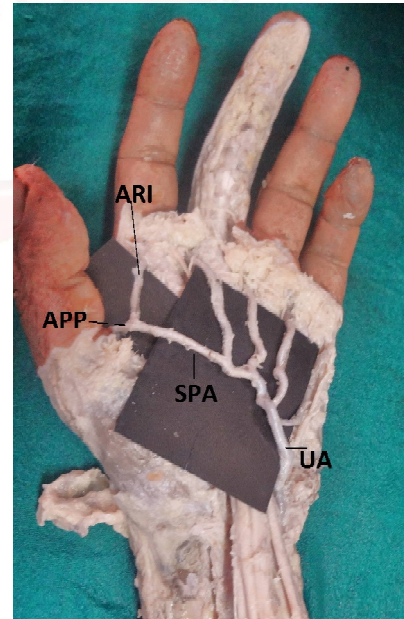
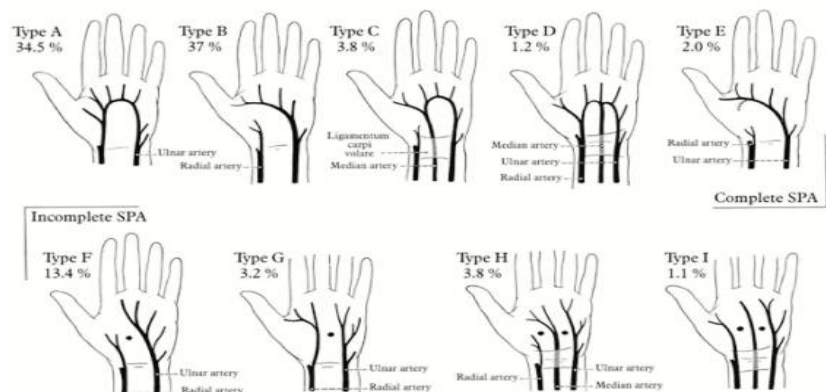


Fig. 5: Depicting the sketches of different patterns of superficial palmar arches.



DISCUSSION

Coleman and Anson in 1961 observed the complete form of arch in 78.5% and incomplete form in 21.5% out of 650 hands used for study. As per the classification provided by Coleman & Anson (Figure- 5), there are two groups in formation of superficial palmar arch [4, 5, 6]. **Group-1: Complete arch (78.5%) divided into five subtypes.** **Type A:** Classical type which is formed by the radio ulnar arch (superficial palmar branch of radial artery and the larger ulnar artery which constitute to 34.5%). **Type-B:** formed entirely by ulnar artery alone (37%). **Type-C:** ulnar artery with an enlarged median artery (3.8%). **Type-D:** the arch is formed by the combination of three vessels namely radial, median and ulnar (1.2%). **Type-E:** the arch is formed by ulnar artery and completed by a large sized vessel derived from the deep arch (2%). **Group-2: Incomplete arch. (21.5%)** The contributing arteries to the SPA don't anastomose. It is further divided into **Type-F:** the superficial branches of radial and ulnar arteries take part in supplying the palm and fingers but doing so they fail to anastomose (3.2%). **Type- G:** the ulnar artery forms the SPA but the arch is incomplete because it does not supply the thumb and index finger (13.4%). **Type-H:** superficial vessels receive contributions from both median and ulnar arteries but without anastomosis (3.8%). **Type-I:** radial, median and ulnar arteries give origin to superficial vessels but don't anastomose (1.1%).

Loukas, Holdman & Holdman observed 40% of complete arches formed by anastomosis between superficial palmar branch of radial and superficial branch of ulnar arteries, 35% formed entirely by ulnar artery, 15% had anastomosis between ulnar and median arteries, 6% showed anastomosis between ulnar, radial & median arteries. In the remaining 4% cases, the arch was formed by a branch of deep palmar arch communicating with the superficial palmar arch [5]. In the present study we observed a rare type of complete arch where superficial palmar branch of radial artery passed superficial to thenar muscles to complete the arch (figure no-2) and directly supplying radial side of index and both sides of thumb without completing arch (figure no-3) which are a rare varieties.

The hand surgeons should be well known about these different types while doing reconstructive hand surgeries, arterial repairs & vascular graft applications. The incomplete arch was observed earlier by Loukas, Holdman and Holdman [7, 8], in 10% of their cases and 16% by Patnaik, Kassey and Singla [9]. Ikeda et. Al [10] observed the median – ulnar type of complete arch in 0.9% of subjects of their study. The percentage of hands in which the median artery made a contribution to the superficial palmar arch was reported to be 2.2% in study by Janevskis [11] whereas in present study it was 12%. Keen [12] in his study observed three types of superficial palmar arch. **TYPE-1:** Ulnar type, in which the arch was formed by the ulnar artery alone. **TYPE- 2:** Radio-ulnar type, in which both radial and ulnar arteries contributed in the formation of the arch (classical type). **TYPE- 3:** Median-ulnar or Median-radial type, in which the median artery forms an important component of the arch. Rodriguez et al confirmed the persistence of median artery in adult life in two different patterns - Palmar and Ante brachial based on their vascular territory. The palmar type represents the embryonic pattern which reaches the palm whereas the ante brachial type represents a partial regression of the embryonic artery which is slender, short and terminates before reaching the wrist [13].

The incidence of palmar type has complications associated with pronator teres syndrome, carpal tunnel syndrome and anterior interosseous nerve syndrome. The knowledge of different patterns in formation of superficial palmar arch is important while performing the superficial dissections and to the radiologists while performing the angiographic procedures. 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. During surgical procedures of thumb & in the cases similar to our study, ligation of radial artery may not be sufficient to stop the profuse bleeding since major blood supply would be coming from the ulnar artery. The knowledge of arterial anatomy and its morphology may be of use in graft surgeries, especially when the arteries of upper limb are harvested for the coronary artery

bypass grafts [14]. But in some cases like our study (Incomplete arches), the radial artery cannot be harvested because the amount of anastomosis between radial and ulnar arteries will be minimal, so the radial side of hand may suffer ischemia leading to gangrene. Allen's test, Doppler ultra sound, Arterial angiography and Pulse oximetry should therefore be used to assess the efficiency of collateral circulation before surgical interventions.

Embryology: Arey [15] has described the causes of anomalous blood vessels developmentally. (a) The choice of unusual paths in the primitive vascular plexus. (b) The persistence of vessels normally to be obliterated. (c) The disappearance of vessels normally retained. (d) Incomplete development and (e) Fusion & absorption of the parts usually distinct. According to Bhargava [16] the blood vessels arose from an-gioblastic tissues of mesenchyme which form blood islands, further these islands become hollowed out and acquire a lining of endothelial cells (squamous cells) & these isolated spaces coalesce to form vascular plexus, from which some may degenerate & others form such types of variations.

CONCLUSION

The palm is entirely supplied by the anastomosis between ulnar and radial arteries in the form of superficial & deep palmar arch. Vessels of the palm bleed profusely but at the same time heal rapidly because of good anastomosis and maintain collateral circulation in case of obstruction. Superficial palmar arch plays a principal role in microsurgeries following crush injuries of hand. The plastic surgeons and hand surgeons should be aware of these different patterns of anastomosis before attempting surgical procedure like vascular repair, graft application. Knowledge of these variable vascular patterns of hand gained more importance in microsurgical techniques, preoperative screening of radial artery harvesting for myocardial revascularization and also in arterial interventions that include radial artery cannulation and radial artery forearm flap. A lack of knowledge of these variables might complicate any hand surgeries.

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Conflicts of Interests: None

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