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Original Research Article

ANATOMICAL STUDY OF SUPERFICIAL PALMAR ARCH AND ITS VARIATIONS WITH CLINICAL SIGNIFICANCE

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ABSTRACT

Background: Superficial Palmar Arch (SPA) is an arterial arcade usually formed by the continuation of ulnar artery and the superficial branch of radial artery. Variations can occur in the vessels contributing to the formation of SPA. Knowledge of such variations will be very much helpful to microvascular surgeons, plastic surgeons and orthopaedicians to bring a better outcome in their surgical procedures. Also, it will be useful to the cardiovascular surgeons to carryout radial artery harvesting procedures for the purpose of Coronary Artery Bypass Grafting. The main objective is to study the different patterns of formation of the superficial palmar arch with an emphasis on their clinical importance.

Materials and methods: This study was done in 40 upper limb specimens from 20 embalmed human adult cadavers at the Institute of Anatomy, Madras Medical College, Chennai. In every upper limb specimen, the palm was dissected as per the steps described in the Cunningham's Manual of Practical Anatomy. The Superficial Palmar Arch was exposed and the vessels taking part in its formation were studied. Variations in the formation of Superficial Palmar Arch were noted and analysed.

Results: Out of 40 specimens, the Superficial Palmar arch was found to be complete in 29 specimens (72.5%) and incomplete in 11 specimens (27.5%).

Conclusion: Information about the different patterns in the formation of the Superficial Palmar Arch will be extremely useful for hand surgeons, microvascular surgeons, plastic surgeons and orthopaedicians to bring out a successful and beneficial postoperative outcome. Awareness about these variations will also help in appropriate interpretation of investigations prior to radial artery harvesting for the purpose of Coronary Artery Bypass Grafting.

KEY WORDS: Superficial Palmar Arch; ulnar artery; radial artery; median artery.

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INTRODUCTION

Arterial supply to the human hand is chiefly by the radial and ulnar arteries in the form of superficial and deep palmar arches. These were studied as early as 1753 by Haller, while notable variations were described by Tiedman in 1831 [1]. The Superficial Palmar Arch (SPA) is mainly formed by the continuation of the ulnar artery which enters the palm with the ulnar nerve, anterior to the flexor retinaculum and lateral to

the Pisiform. It passes medial to the hook of hamate, then curves laterally to form an arch that is convex distally and in level with a transverse line through the distal border of the fully extended pollicial base. About a third of the superficial palmar arches are formed by ulnar artery alone: a further third are completed by the superficial palmar branch of the radial artery; and a third by the arteria radialis indicis, a branch of either arteria princeps pollicis or the median artery [2]. The Superficial Palmar Arch is covered by the palmaris brevis muscle and the palmar aponeurosis. It is superficial to the flexor digiti minimi muscle, the branches of the median nerve and the long flexor tendons and lumbricals.

The superficial position of the arch makes it more prone to injuries. The anastomosis between the radial and ulnar arteries in the palm helps to prevent tissue damage and also aids in rapid healing of wounds. Presence of a good collateral supply in the palm, makes radial artery harvesting possible for the purpose of Coronary Artery Bypass Grafting. The radial artery though contributes greatly to the circulation of hand, in many cases it can be removed, with adequate circulation being provided by the remaining ulnar and in some cases by a persistent median artery [3]**.** Knowledge of variations in the SPA gains more importance under such circumstances. Moreover, advancements in microsurgical procedures & reconstructive hand surgeries necessiate prior identification of the arch pattern through investigations like Doppler ultrasonagraphic studies & angiography for fruitful outcomes.

The variations of the SPA were first classified into two groups viz. complete and incomplete by Jachtschinski in 1897 [4]. Adachi (1928) has described 3 types of superficial palmar arch namely ulnar type, radio ulnar type and mediano ulnar type based on the arteries which contributed to the SPA [1].

Coleman and Anson (1961) [5] elaborated more on SPA and reclassified it as follows:

Group I: Complete arch

It was further divided into five types :-

Type A: The classical radio ulnar arch formed by the superficial palmar branch of radial artery and the larger ulnar artery.

Type B: Arch formed entirely by the ulnar artery.

Type C: Mediano ulnar arch, composed of the ulnar artery and an enlarged median artery.

Type D: Radio mediano ulnar arch in which 3 vessels enter into the formation of the arch.

Type E: Consists of a well formed SPA initiated by the ulnar artery and completed by a large sized vessel derived from deep palmar arch.

Group II: Incomplete arch

When the contributing arteries to the superficial palmar arch do not anastomose or when the ulnar artery fails to reach the thumb and index finger, the arch is incomplete. It was further divided into 4 types.

Type A: Both the superficial palmar branch of radial artery and the ulnar artery took part in supplying the palm and the fingers but in doing so, failed to anastomose.

Type B: Only the ulnar artery formed the superficial palmar arch. The arch was incomplete in the sense that the ulnar artery does not take part in the supply of thumb and index finger.

Type C: Superficial vessels received contributions from both the median and the ulnar arteries but without anastomosis.

Type D: The radial, the median and the ulnar artery, all give origin to superficial vessels but do not anastomose.

In the present study, variations of the SPA were documented and compared with those of the previous studies.

MATERIALS AND METHODS

This study was done in 40 upper limb specimens obtained from 20 embalmed human adult cadavers at the Institute of Anatomy, Madras Medical College, Chennai by the conventional dissection method.

The dissection steps were followed as per the instructions given in Cunningham's Manual of Practical Anatomy (Vol.1). After making the skin incision of the palm, the skin and the superficial fascia were reflected. Then, the exposed Palmar aponeurosis was cut at the proximal end (apex) and reflected towards the fingers, after carefully slicing the intervening medial and lateral septae. The Superficial Palmar Arch with

its branches was exposed and clearly dissected by removing fat and fascia. The arteries taking part in the formation of the Superficial Palmar Arch were studied and documented. The results were analysed by statistical methods.

RESULTS

Out of the total 40 specimens, the Superficial Palmar Arch was found to be complete in 29 specimens (72.5 %). The following are the different Patterns of complete type of Superficial Palmar Arch observed in this study:

i) SPA formed by the superficial branch of ulnar artery and the superficial branch of radial artery (Coleman & Anson: Group I Type A). This pattern was observed in 14 specimens (35%) (Fig.1).

ii) SPA formed by ulnar artery alone which gave branches to all the fingers including the thumb (Coleman & Anson: Group I Type B). This pattern was observed in 11 specimens (27.5%) (Fig.2).

iii) SPA formed by the superficial branch of ulnar artery and the median artery (Coleman & Anson: Group 1 Type C). This pattern was observed in 3 specimens (7.5%) (Fig.3).

iv) SPA formed by the superficial branch of ulnar artery, the superficial branch of radial artery and the median artery (Coleman & Anson: Group I Type D). This pattern was observed in 1 specimen (2.5%) (Fig.4). In this specimen, the superficial branch of radial artery was found to be very slender piercing the thenar muscles.

Out of the total 40 specimens, the SPA was found incomplete in 11 specimens (27.5%). The following are the different patterns of the incomplete type of SPA observed in the present study.

i) SPA formed by the superficial branch of ulnar artery and that of radial artery without anastomosis (Coleman & Anson: Group II Type A). This type was observed in 3 specimens (7.5%) (Fig.5).

ii) SPA formed by the superficial branch of ulnar artery and supplying the fingers till the ulnar side of index finger (Coleman & Anson: Group II Type B). This pattern was observed in 6 specimens (15%) (Fig.6).

iii) SPA formed by the superficial branch of ulnar artery and the median artery without anastomosis (Coleman & Anson: Group II Type C). This pattern was observed in 2 specimens (5%) (Fig.7).

Overall, complete radio ulnar type of SPA was the predominant pattern in this study comprising 35% of specimens.

Fig. 1: Radio ulnar type of complete Superficial Palmar Arch.

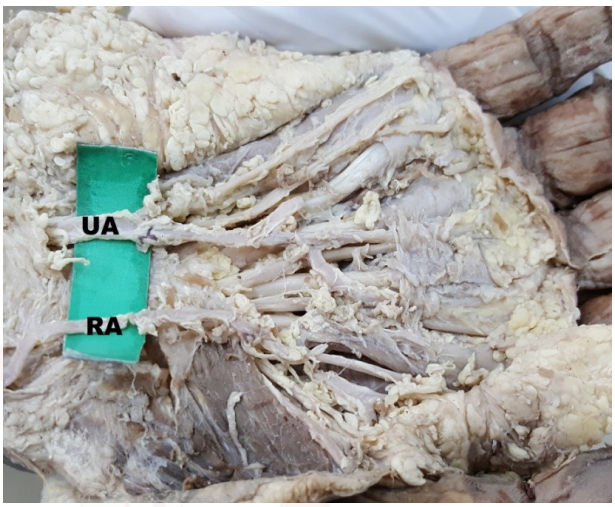


Fig.2: Ulnar type of complete Superficial Palmar Arch.

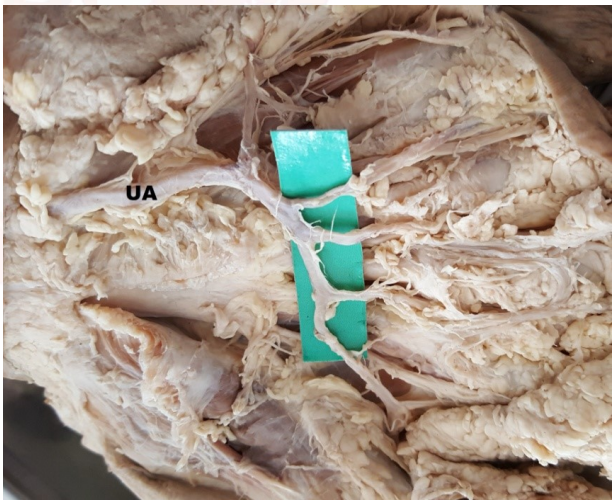


Fig.3: Mediano ulnar type of complete Superficial Palmar Arch.

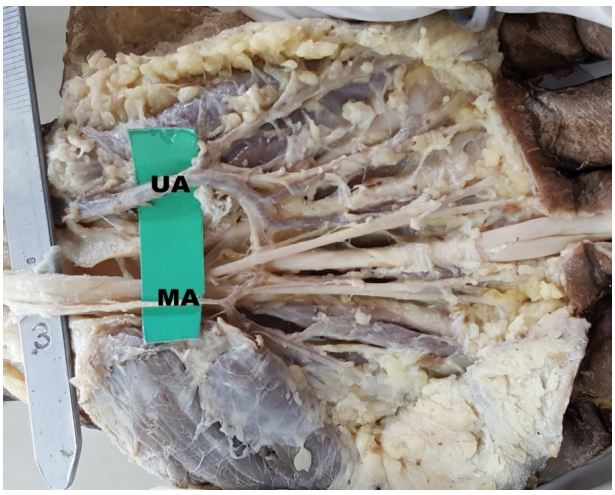


Fig.4: Radio mediano ulnar type of complete Superficial Palmar Arch.

Fig.5: Radio ulnar type of incomplete Superficial Palmar Arch.

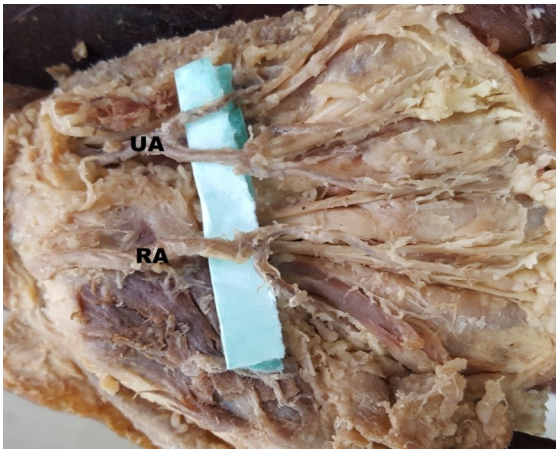


Fig.6: Ulnar type of incomplete Superficial Palmar Arch.

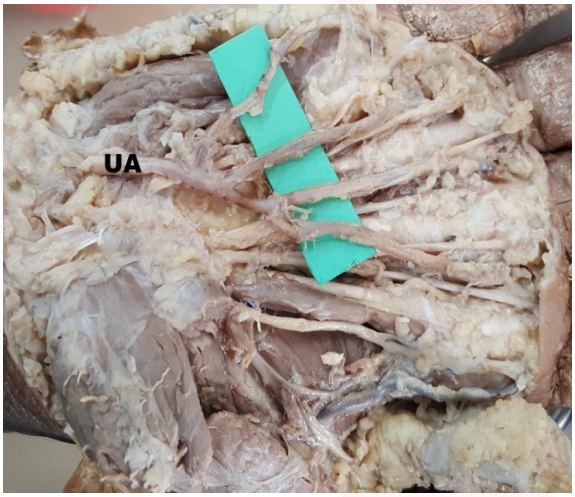


Fig.7: Mediano ulnar type of incomplete Superficial Palmar Arch.

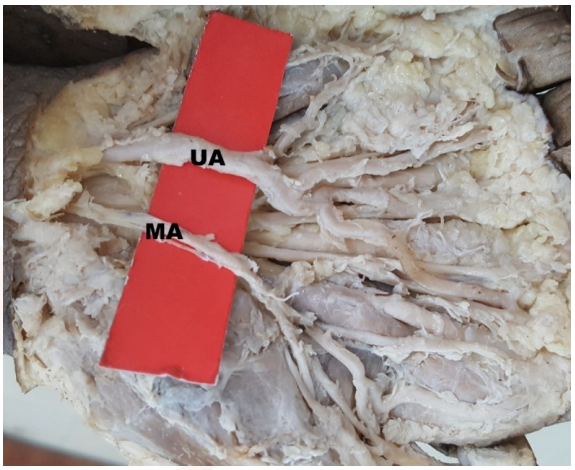


Table 1: Different patterns of SPA in the present study (classified as per Coleman & Anson Classification).

Coleman & anson classification		Present study	
		Number of specimens (out of 40)	Percentage
Group I	Type A	14	35%
	Type B	11	27.50%
	Type C	3	7.50%
	Type D	1	2.50%
	Type E	0	-
Group II	Type A	3	7.50%
	Type B	6	15%
	Type C	2	5%
	Type D	0	-

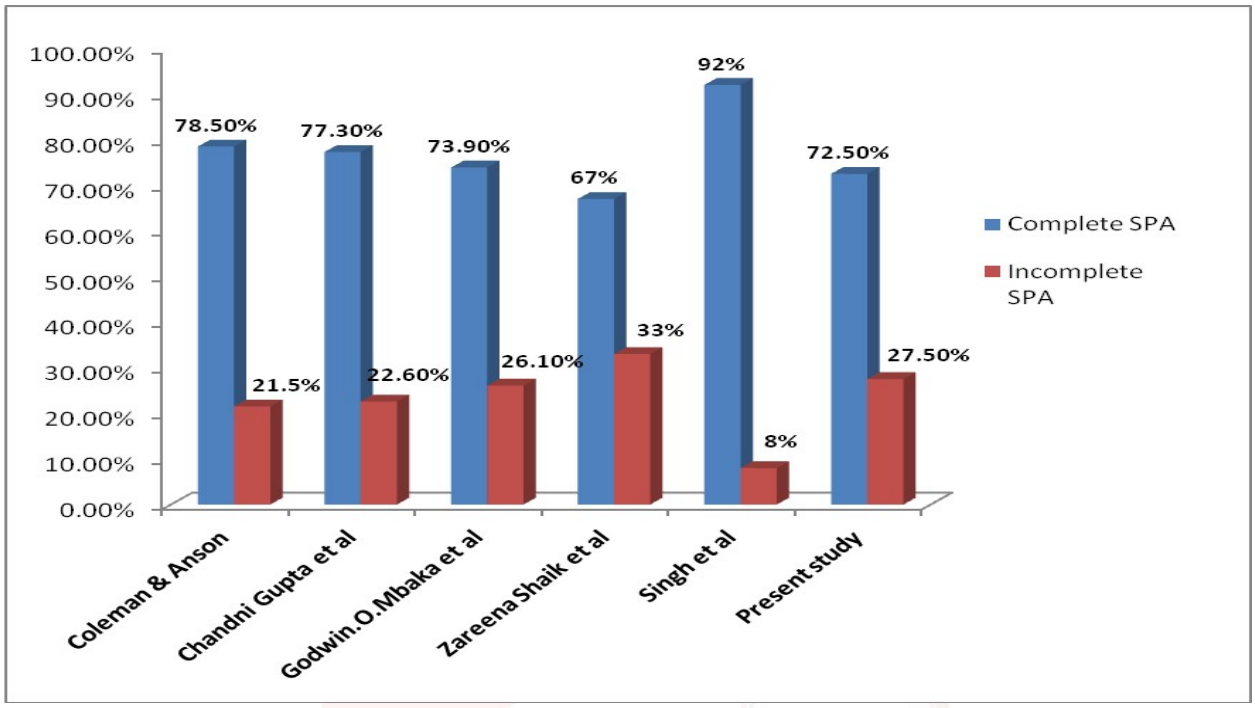
DISCUSSION

Coleman & Anson in their study found complete type of SPA in 78.5% and incomplete type in 21.5% of specimens [5]. Godwin.O.Mbaka et al in their study on Negro population observed complete SPA in 73.9% and incomplete SPA in 26.1% [6]. Chandni Gupta et al in their study found complete SPA in 77.3% and incomplete SPA in 22.6% [7]. Zareena Shaik et al in their study noticed complete SPA in 67% and incomplete SPA in 33% [8]. Singh et al in their study observed complete SPA in 92% of specimens and incomplete type of SPA in remaining 8% of specimens [9]. Mamatha Tonse et al in their study found complete SPA in 88% of specimens and incomplete arch in 12% of the specimens [10]. The observations in the Present study i.e complete SPA in 72.5% and incomplete SPA in 27.5%, were closer to that of Godwin.O.Mbaka study.

Table 2: Comparison of SPA types in the present study with previous studies.

Study on SPA	Complete type	Incomplete type
Coleman & Anson	78.50%	21.50%
Chandni Gupta et al	77.30%	22.60%
Godwin.O.Mbaka et al	73.90%	26.10%
Zareena Shaik et al	67%	33%
Singh et al (2017)	92%	8%
Present Study	72.50%	27.50%

Fig. 8: Comparison of SPA types in the present study with previous studies.



Patnaik et al in their study found the following results. SPA was found to be single in 94% limbs (complete in 78%, incomplete in 16%). In 6% of specimens, double SPA was observed with proximal complete (radioulnar arch in 4% & mediano ulnar arch in 2%) & distal incomplete types [1]. Double SPA was absent in the present study.

Complete radioulnar arch was observed in 34.5% of specimens by Coleman & Anson in their study [5]. Rajesh et al in their study on 24 upperlimb specimens, observed usual radioulnar pattern of complete arch in 95.8% [4]. In the Present study, classical radio ulnar arch was seen in 35% which is nearer to that of Coleman & Anson study.

A complete arch formed by ulnar artery alone is a common variation where the arteria princeps pollicis and radialis indicis arise from SPA. It is the predominant pattern of SPA both in Adachi's study (found in 59%) and Coleman & Anson's study (found in 37%) on SPA [1]. In the present study, this pattern was observed in 27.5%. Ikeda, Ugawa, Kazihara et al, termed the artery which supplies the first web space that comes from the superficial arch as the first common palmar digital artery [11]. The arteries arising from the SPA which supply the first web space acquire greater importance in case of absence of arterial supply from the deep arch to that region [12]. Sharmistha Biswas et al in their study reported a variation of SPA where the radial most common palmar digital artery supplied radial side of index finger and ulnar side of thumb. A separate proper digital artery arising directly from SPA, supplied the radial side of thumb. In this case, the typical pattern of an arteria radialis indicis and a princeps pollicis arising from the first common palmar digital artery was absent [13]. This type of variation was observed in a single specimen in the present study. Godwin O.Mbaka et al, observed a rare pattern in 0.8% of specimens, in which the superficial palmar branch of the ulnar artery gave rise to the princeps pollicis artery whereas the radialis indicis had its origin from the deep palmar branch of radial artery [6]. This kind of variation was not seen in the present study.

Incomplete radio ulnar pattern of SPA is a significant variation, where there is no anastomosis between the radial and ulnar artery branches and both the vessels shared equal proportions of palmar supply. Coleman & Anson [5] observed this variation in 3.2% whereas in the present study the incidence was slightly higher with 7.5%. The radial artery in such a circumstance is of immense importance. The distribution of radial artery should be carefully evaluated before it is harvested for an arterial transplant [6].

Median artery is a part of the axis artery of the upper limb that accompanies the median nerve.

Usually, when the superficial palmar arch is established by the ulnar and radial arteries, this median artery disappears. In some cases, the median artery may persist till adult life and take part in the formation of SPA.

A persistent median artery may take part in SPA in different patterns. Coleman & Anson in their study reported the contribution of median artery to SPA in 9.9 %, among which 3.8 % of specimens were complete mediano ulnar type, 1.2% complete radio mediano ulnar type, 3.8% incomplete mediano ulnar and 1.1% incomplete radio mediano ulnar type [5]. Mamatha Tonse et al observed mediano ulnar type of complete arch in 12% [10]. Takkallapalli Anitha et al in their study, found median artery contribution to SPA in 6% of specimens, of which 4% showed complete mediano ulnar type and 2% showed incomplete mediano ulnar type [3]. In the present study, persistent median artery taking part in SPA was found in 15% specimens, of which 7.5% specimens is of complete mediano ulnar, 2.5% is of complete radio mediano ulnar type and 5% specimens is of incomplete mediano ulnar type. Incomplete arch formed by all the three vessels was absent in the present study.

In case of mediano ulnar type of complete SPA, the source for both the feeding vessels is ulnar artery proper, as median artery arises from the anterior interosseous branch of ulnar artery [3]. In considering radial artery harvesting for CABG, least number of complications may be expected when the median artery forms SPA with ulnar artery. In cases of management of severe bleeding from palm injuries, when the ulnar artery is to be ligated at its origin close to the bifurcation of the brachial artery, blood flow in this arch via both these routes gets completely cut off. Then the only source of blood supply is via the radial artery through the deep palmar arch and the perforating arteries indicating their greater importance [1].

The reason for the occurrence of variations in the formation of SPA seem to have an embryological and evolutionary basis. Arey (1957) opined that the anomalies of blood vessels develop because: (1) Unusual pathway of the primitive vessels, (2) Persistence of vessels normally obliterated, (3) Disappearance of vessels normally retained, (4) Incomplete development, (5) Fusion and absorption of distinctive parts [13]. Ottone, Prum, Dominguez et al opined that the ulnar artery always takes part in the vascularisation of the hand, whether it forms the arch or not. They proposed that any variation of the SPA depend completely on variations of the radial artery [14].

Manners Smith studied the comparative anatomy of arteries of hands in primates and proposed that many of the variations observed in human hand represent a persistence or reappearance of primitive patterns [1].

It can be observed from the above mentioned facts and the inferences from previous studies, that there is a possibility of a wide range of variations in the SPA. Therefore, it is essential for a surgeon to recognize the functional arterial arch before performing any interventional or surgical procedure in the palm, to avoid inadvertant injuries and to maintain the vascularity of the hand and digits.

CONCLUSION

Knowledge of variations of the vascular patterns of the hand gains more importance with the advent of microsurgical techniques and reconstructive hand surgeries. The radial artery is being frequently manipulated for several procedures. It is one of the common sites for introducing catheter for arterial pressure monitoring, to create arterio venous fistula and for elevating radial artery forearm flap. Hence, any variation in the collateral blood flow between the ulnar and radial arteries becomes surgically significant [10].

Awareness about the different SPA patterns plays a crucial role during the preoperative screening for radial artery harvesting for the purpose of myocardial revascularization. A review of vascular pattern prior to invasive or intervention surgery is strongly recommended, which would allow to detect anomalies likely to necessitate modification of surgical procedures. Therefore, it is essential to assess the SPA with the help of investigations like Allen's test, Doppler ultrasonography, angiography, photoplethysmography and oximetric technique studies of the hand before doing any invasive procedure in hand to avoid inadvertant complications.

ABBREVIATION

SPA – Superficial Palmar Arch
UA – Ulnar Artery
RA – Radial Artery
MA – Median Artery

Conflicts of Interests: None

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