

A STUDY ON THE MORPHOLOGICAL VARIATIONS OF SUPERFICIAL PALMAR ARCH

Sajey P. S¹, Shihas P. M², Romi S³

¹Assistant Professor, Department of Anatomy, Government T. D. Medical College, Alappuzha, Kerala, India.

²Assistant Professor, Department of Anatomy, Government T. D. Medical College, Alappuzha, Kerala, India.

³Professor and HOD, Department of Anatomy, Government T. D. Medical College, Alappuzha, Kerala, India.

ABSTRACT

BACKGROUND

Hands are the most important appendages of human beings. All human hands look alike. But on a detailed study, it can be seen that each and every human hand are unique. Superficial and deep palmar arches form the main feeder of the hand. A classic superficial palmar arch is formed by the superficial branch of the ulnar artery and superficial branch of radial artery. The deep palmar arch is formed by anastomosis of the radial artery with a deep branch of the ulnar artery.

The objective of the present study was to study the morphological variations of superficial palmar arch in human.

MATERIALS AND METHODS

Morphology of Superficial Palmar Arch (SPA) of 30 hands from 15 embalmed human cadavers with no sex or age discrimination were studied in the Department of Anatomy, Govt. T. D. Medical College, Alappuzha. The observations were then recorded and classified based on the classification put forward by Coleman S. S. and Anson B. J. in 1961.

RESULTS

The different types of superficial palmar arches obtained in the present study were as follows: Complete superficial palmar arch (93.33%) [Type A- 15 (50%), Type B- 10 (33.33%), Type C- 1 (3.33%), Type D -0, Type E -0, others- 6.66%]: Incomplete superficial palmar arch (6.66%) [Two cases of Type C only]. Median artery forming superficial palmar arch was seen in 16.66% of cases. In addition to this, two variant forms of superficial palmar arches were observed, which were rarely reported in available literature.

CONCLUSION

The present study confirms that the ulnar artery is the dominant vessel, which contributes for the superficial palmar irrigation and the incidence of complete superficial palmar arch is very high compared to the incomplete superficial palmar arch.

KEYWORDS

Superficial Palmar Arch, Complete Arch, Incomplete Arch.

HOW TO CITE THIS ARTICLE: Sajey PS, Shihas PM, Romi S. A study on the morphological variations of superficial palmar arch. J. Evolution Med. Dent. Sci. 2017;6(33):2741-2747, DOI: 10.14260/Jemds/2017/591

BACKGROUND

The ability of human brain to think, assume, imagine and to dream could be practically projected only to a larger extent with the help of hands. Arterial supply of hand is mainly derived from two anastomotic arches (superficial and deep palmar arches), formed from two terminal branches of brachial artery i.e. radial and ulnar arteries. Variations in the formation of superficial and deep palmar arch are very common. The superficial palmar arch is a dominant arterial arcade present over the palmar aspect of the hand formed by receiving a major contribution from ulnar artery.

Objective

The objective of present study was to study the morphological variations of superficial palmar arch in human.

Financial or Other, Competing Interest: None.

Submission 15-03-2017, Peer Review 11-04-2017,

Acceptance 17-04-2017, Published 24-04-2017.

Corresponding Author:

Dr. Shihas P. M,

Assistant Professor,

Department of Anatomy,

Government T. D. Medical College,

Alappuzha,

Kerala, India.

E-mail: shihaspm@yahoo.co.in

DOI: 10.14260/jemds/2017/591



MATERIALS AND METHODS

The material for present study comprised of 30 upper limbs taken from 15 cadavers with no sex or age discrimination, which were used for the routine undergraduate dissection in the Department of Anatomy, Govt. T. D. Medical College, Alappuzha. These cadavers were embalmed with 10% formalin and fixed. Superficial palmar arches in them were dissected with classical incisions and dissection procedure of Cunningham's manual.¹ Morphology of Superficial Palmar Arch (SPA) was studied in detail and variations from the usual patterns were observed. The Common Palmar Digital Arteries (CDA) were named from the first to fourth interosseous space of hand as 1st, 2nd, 3rd and 4th CDA. The observations were then recorded and classified based on the classification put forward by Coleman S. S. and Anson B. J.² In 1961, Coleman S. S. and Anson B. J. classified superficial palmar arch into two groups. Group 1- Complete arch and Group II- Incomplete arch.

Group-1: Complete Arch (78%)

A complete arch is defined as an arch, in which the contributing arteries anastomose with each other or those arches in which ulnar artery reaches the first interosseous space to supply the thumb and index finger. It can be further divided into five types-

Type A- Classical radioulnar arch formed by superficial palmar branch of radial artery and large ulnar artery.

Type B- Arch entirely formed by ulnar artery and is complete in the sense that it supplies the thumb and index finger in addition to other fingers.

Type C- Mediano-ulnar in which ulnar artery anastomoses with an enlarged median artery to form the arch.

Type D- Radio-mediano-ulnar intercommunication, in which three vessels enter into the formation of superficial palmar arch.

Type E- A well-formed superficial palmar arch initiated by ulnar artery and is completed by a well-formed branch from the deep palmar arch.

Group-II: Incomplete Arch

When the contributing arteries do not anastomose with each other or when the ulnar artery fails to reach the first interosseous space to supply the thumb and index finger, then it is called an incomplete arch.

Group II is further divided into four types-

Type A- Both superficial palmar branches of radial artery and ulnar artery contribute in supplying the palm and fingers, but they do not anastomose with each other.

Type B- Only the ulnar artery forms superficial palmar arch. But here the ulnar artery does not contribute in supplying thumb and index finger.

Type C- In this type median and ulnar artery are the contributing vessels, but they do not anastomose with each other.

Type D- Radial, median and ulnar arteries take part in the superficial irrigation of the palm, but do not anastomose.

RESULTS

In this study, we observed that out of 30 upper limbs studied, 28 (93.33%) were complete superficial palmar arches, in which the contributing vessels anastomosed with each other or the ulnar artery was capable to supply the adjacent sides of thumb and index finger. An incomplete superficial palmar arch, in which the contributing vessels did not anastomose with each other or the ulnar artery terminated without supplying thumb and index finger was observed in 2 hands (6.66%).

The different types of complete superficial palmar arches obtained in the present study (Chart-1) were as follows: Type A- 15 (50%), Type B- 10 (33.33%), Type C- 1 (3.33%), Type D- 0 and Type E- 0. In addition to this we got two (Fig. 7 and 8) variant forms of complete SPA, which cannot be classified according to Coleman S. S. and Anson B. J. classification.

The two incomplete arches (Fig. 6) we obtained in this study were of Type C (6.66%).

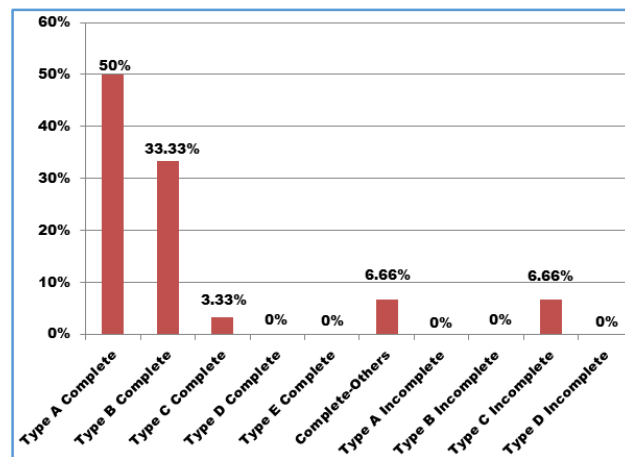


Chart 1. Incidence of different Types of Superficial Palmar Arches obtained in the Present Study

Persistent palmar type of median artery taking part in the formation of superficial palmar arch was observed in 5 hands (Fig. 5 to 8) in the present study with an incidence of 16.66%.

Out of the 15 cadavers, 4 cadavers showed the same type of superficial palmar arch in both hands (3 cadavers - Type A complete arch, 1 cadaver Type B complete arch). The occurrence of persisting median artery was unilateral in all the 5 cases.

In 24 hands (80%) we had 4 Common Palmar Digital Arteries (CDA), either arising directly from the convex surface of arch or part of a common stem for common palmar digital artery and proper Palmar Digital Artery (PDA). Out of these 24 hands, one showed a common trunk for the 1st CDA and PDA to radial side of thumb (Fig. 8). Out of all the hands studied in the present study, 3 hands showed a common trunk for the 4th common palmar digital artery and proper palmar digital artery to the ulnar side of little finger (Fig. 1, 2 and 5).

In 6 hands (20%) Common Palmar Digital Arteries (CDA) corresponding to the 2nd, 3rd and 4th interosseous spaces were found. Proper Palmar Digital Arteries (PDA) to the ulnar side of thumb and to the radial side of index finger originated separately from the arch. PDA to the ulnar side of little finger also arose as a separate branch from the medial end of the arch.

Following varieties of superficial palmar arches were observed in this study.

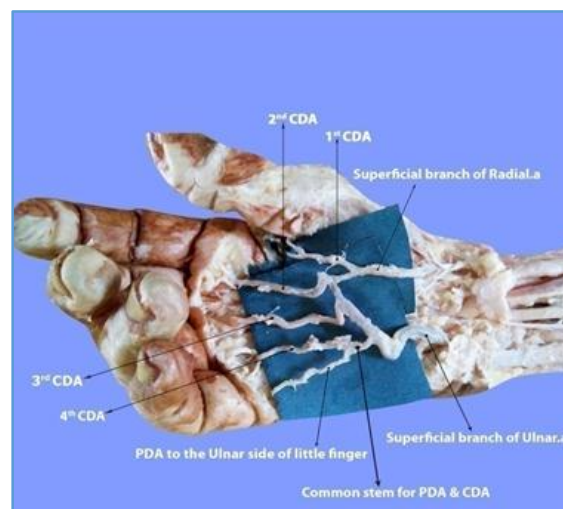


Figure 1

In Fig 1, Type A complete superficial palmar arch of classical variety can be seen. Here, the arch was formed by the superficial branch of ulna with superficial branch of radial artery. Both contributing arteries were fairly large and comparable in size. They made almost equal contribution to the formation of SPA. Here the superficial branch of radial artery gave off the first CDA to the first web space, which divided into proper palmar digital arteries to the adjacent sides of thumb and index finger; 2nd, 3rd and 4th CDA and proper palmar digital artery to the little finger arose from the superficial branch of ulnar artery. The peculiarity noted here was that the fourth CDA and PDA to the little finger arose as a common trunk.



Figure 2

In Fig. 2, Type A complete superficial palmar arch formed by superficial palmar branch of radial artery and superficial branch of ulnar artery can be seen. Here, the connection between the contributing arteries was by a slender connecting vessel. Here the patterns of branching of palmar digital arteries were similar compared to Fig. 1. A rare peculiarity noted here was that the 4th CDA and PDA to the ulnar side of little finger arose from a fairly long common trunk which reached up to the medial aspect of the long flexor tendon to the little finger and here it divided into proper palmar digital artery to the little finger and 4th CDA. The latter was passing deep to the long flexor tendons. This is a very rare variation in the course of common palmar digital artery.

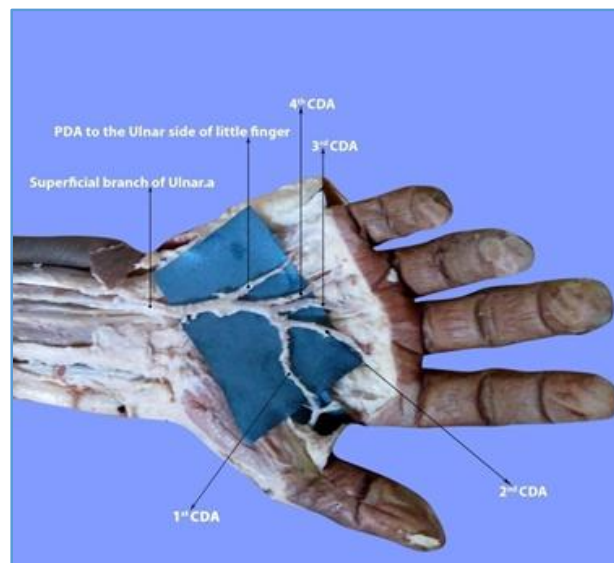


Figure 3

In Fig. 3, complete Type B superficial palmar arch can be seen. This arch was complete in the sense that the superficial branch of ulnar artery reached the first web space and supplied the adjacent sides of index finger and thumb by dividing into PDA (Coleman S. S. and Anson B. J.). It was noted that there was no contribution from the radial artery in the superficial irrigation of palm.

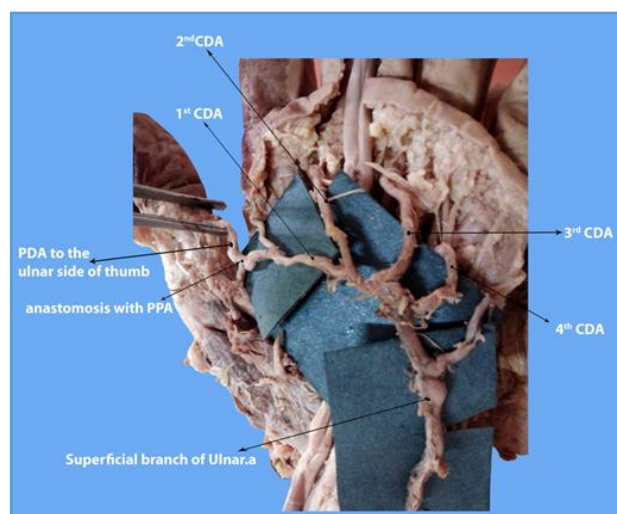


Figure 4

In Fig. 4, Type B complete SPA can be seen. Here, the arch was formed by the anastomosis between superficial branch of ulnar artery and Princeps Pollicis Artery (PPA) from radial artery.

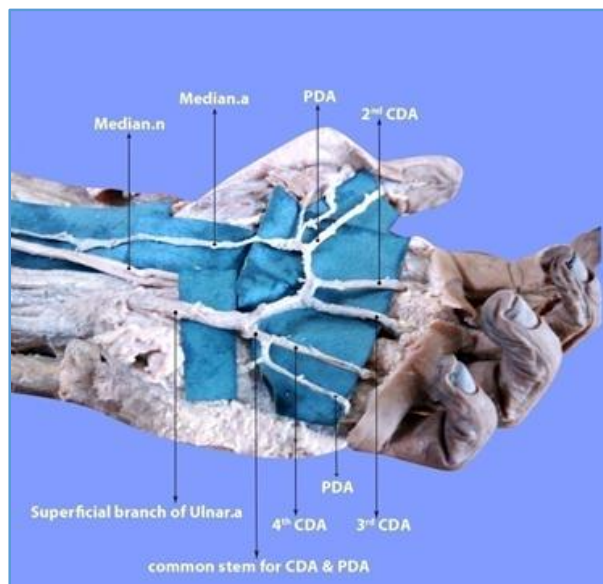


Figure 5

In Fig. 5, Type C complete SPA was formed by superficial branch of ulnar artery and median artery. Here, it formed a morphologically complete arch which gave rise to all the common digital arteries and proper digital artery to the radial side of thumb and ulnar side of little finger. In this case also, the fourth CDA and PDA to the little finger arose as a common trunk.

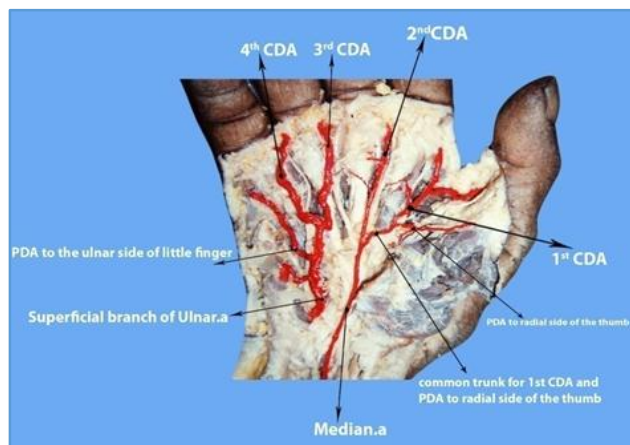


Figure 6

In Fig. 6, Type C incomplete SPA can be seen. The superficial irrigation of palm was contributed by ulnar and median artery. After giving the PDA to the ulnar side of little finger, the superficial branch of ulnar artery passed forward and bifurcated into 3rd and 4th CDA. Median artery after emerging from the carpal tunnel gave rise to 2nd CDA and a common trunk, which passed through the interosseous space. After giving a PDA to the radial side of the thumb, it passed through the first interosseous space and gave two proper palmar digital arteries. Here, there was no anastomosis with the contributing arteries.

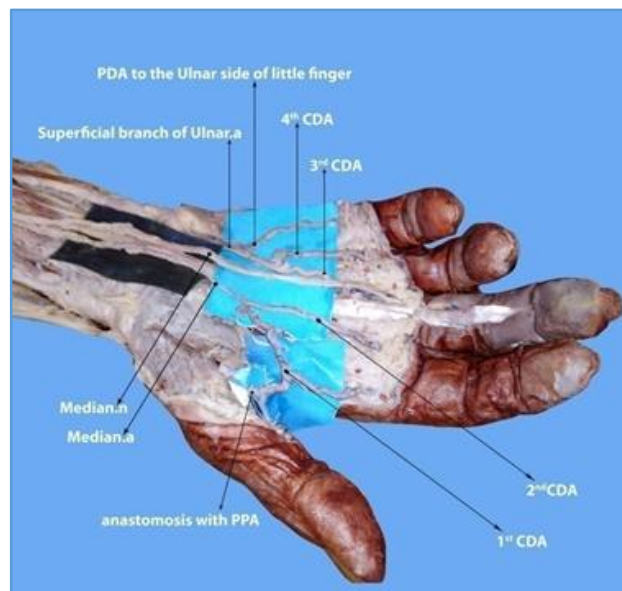


Figure 7

In Fig. 7, rare variety of superficial palmar arch which was not mentioned by Coleman S. S. and Anson B. J. (Median-radial type of SPA) can be seen. Here, the territory which had to be supplied by superficial palmar arch was irrigated by ulnar, median and radial arteries. The median artery after its exit from the carpal tunnel was divided into 2nd and 1st common digital arteries. The 1st common palmar digital artery in turn was divided into proper palmar digital artery to the ulnar side of thumb and radial side of index finger. The proper palmar digital artery to the ulnar side of thumb anastomosed with Princeps Pollicis Artery (PPA) which arose from the radial artery, thus forming the median-radial type of SPA. But note that here the ulnar artery in spite of not forming part of superficial palmar arch, made the major contribution in the irrigation of hand by forming proper digital artery to ulnar side of little finger and 3rd and 4th CDA.

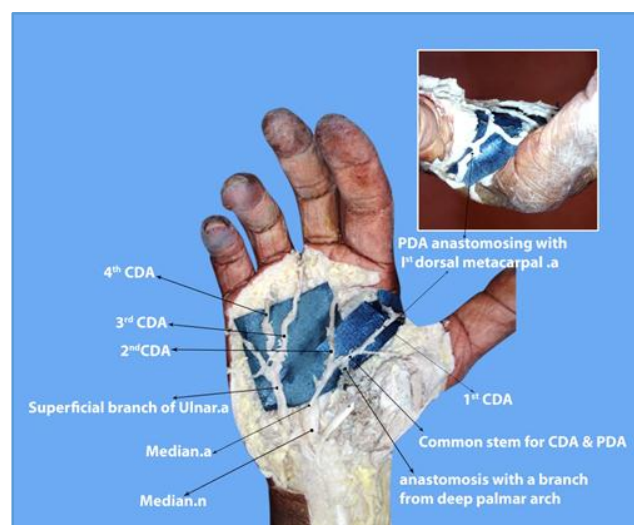


Figure 8

In Fig. 8 also median-radial type of SPA with additional anastomoses with a branch from deep palmar arch can be noted. After the formation of second common palmar digital artery, the median artery reached the first web space and

anastomosed with a branch arising from the deep palmar arch. From this point of anastomosis, the artery passed forward as a common trunk for PDA to the radial side of thumb and 1st CDA. The proper palmar digital artery to the ulnar side of the thumb from 1st CDA anastomosed with 1st dorsal metacarpal artery (Fig. 8- Inset) arising from radial artery. It should be noted that here the median artery or its branches made anastomosis with the branches of radial artery at two points. Even though the ulnar artery did not take part in formation of SPA, it supplied 3rd and 4th fingers, ulnar side of little finger and corresponding region of palm.

DISCUSSION

The superficial palmar arch is a dominant arterial arcade present over the palmar aspect of the hand formed by receiving a major contribution from the ulnar artery. In the present study also, we observed that the ulnar artery is the dominant vessel which contributes for the superficial palmar irrigation. In all hands in our study, ulnar artery is the sole vessel which supplies the palmar surface of medial 2 and half fingers and the corresponding parts of the palm. In addition to this in type B, complete SPA it extends up to the first web space and supplies all the fingers and palm except radial side of thumb. This dominance of ulnar artery in superficial irrigation has been highlighted by several workers. According to Kaplan³ (1961), the superficial palmar arch is formed by the ulnar artery in 66% of cases.

Adachi⁴ (1928) thinks that the superficial palmar arch has an ulnar-prevalent formation, which he calls the Ulnar-type and finds it in 59% of cases.

The variations of superficial palmar arch was studied in 30 hands and classified in accordance with Coleman S. S. and Anson B. J.² Complete superficial arch, in which the contributing vessels anastomosed with each other or the ulnar artery was capable to supply the adjacent sides of thumb and index finger was found in 93.33% of hands in the present study. An incomplete superficial palmar arch in which the contributing vessels did not anastomose with each other or the ulnar artery terminates without supplying thumb and index finger was observed in 6.66% of hands.

The incidence of complete and incomplete superficial palmar arch observed by different authors was compared with the present study in Table 1.

Sl. No.	Author	Complete SPA (%)	Incomplete SPA (%)
1	Jaschtschinski SN ⁵ (1897)	84	16
2	Piersol ⁶ (1911)	83	17
3	Coleman SS, Anson BJ ² (1961)	78.5	21.5
4	Mozersky DJ, ⁷ et al (1973)	65.7	34.3
5	Janevski BK ⁸ (1982)	42.4	57.6
6	Doscher WJ, ⁹ et al (1983)	89	11
7	Al Turk M, Metcalf WK ¹⁰ (1984)	84	16
8	Ikeda A, ¹¹ et al (1988)	96.4	3.6
9	Pola (1996) ¹²	94.1	5.9
10	Koman LA, ¹³ et al (1999)	78.5	21.5
11	Gellman H, ¹⁴ et al (2001)	84.4	15.6
12	Ruengsakulrach P, ¹⁵ et al (2001)	66	34
13	Patnaik VVG, ¹⁶ et al (2002)	78.5	21.5

14	Loukas M ¹⁷ , et al (2005)	90	10
15	Süleyman MT, ¹⁸ et al (2007)	75	25
16	Dhar P, Lal K, ¹⁹ (2008)	95.8	4.2
17	Present study	93.3	6.6
Table 1. Incidence of Complete and Incomplete Superficial Palmar Arch			

Among these workers Coleman S. S., Anson B. J., Koman A et al (1999) and Patnaik et al (2002) reported 78.5% of complete superficial palmar arches.

Observations made by Doscher W et al (1983), Ikeda A et al (1988), Pola (1996), Loukas M et al (2005), Dhar P and Lal K (2008) are comparable to that of present study (93.33%).

The different types of complete superficial palmar arches obtained in the present study (Chart 1) were as follows: Type A- 15 (50%), Type B- 10 (33.33%), Type C- 1 (3.33%), Type D- 0 and Type- E 0. In addition to this, we got 2 (6.66%) variant forms of complete SPA which cannot be classified according to Coleman S. S. and Anson B. J. classification.

These two variants can be named as median-radial type of superficial palmar arch, which was not mentioned by Coleman S. S. and Anson B. J. Median radial type is a very rare type of superficial palmar arch, where the median artery anastomoses with the radial artery and has a minimum or absent contribution of the ulnar artery in SPA. Although, the formation of the SPA by the MA and RA has been mentioned in the literature (Keen²⁰ 1961), only one case was reported in the available literature by Soubhagya R. Nayak²¹ et al in 2008.

In one of the hands with the above discussed variant form (Fig. 8), it not only anastomosed with 1st dorsal metacarpal artery of radial artery, but also anastomoses with a branch from deep palmar arch. This is also a very rare variety, which was not found in the available literature.

The incidence of different types of complete superficial palmar arch observed by different authors were compared with the present study in Table 2.

Sl. No.	Author	Type of Complete SPA (%)						Total (%)
		Type A	Type B	Type C	Type D	Type E	Others	
1	Coleman SS, Anson BJ (1961)	35	37	3.8	1.2	2	0	78.5
2	Gellman H, et al (2001)	36	31	0	0	0	0	66.6
3	Patnaik VVG, et al (2002)	76	2	0	0	0	0	78
4	Loukas M, et al (2005)	40	35	15	6	4	0	100
5	Süleyman M T, et al (2007)	40	35	0	0	0	0	75
6	Present study	50	33	3.3	0	0	6.7	93.33
Table 2. Incidence of different Types of Complete Superficial Arch								

In present study, the incidence of Type A complete SPA is slightly higher than the available studies except Patnaik et al. But in case of Type B complete arch, the result is comparable with the available studies except Patnaik et al. In the case of

Type C, SPA incidence obtained by Coleman S. S. and Anson B. J. was comparable with that of present study.

Type D and Type E complete superficial palmar arch, which was not obtained in present study.

The incomplete superficial palmar arches were also classified according to Coleman S. S. and Anson B. J. But we obtained only two incomplete arches (Fig. 6), which were of Type C (6.66%). The incidence of Type C incomplete is slightly higher than the available studies.

Sl. No.	Author	Type of Incomplete SPA (%)					Total (%)
		Type A	Type B	Type C	Type D	Others	
1	Coleman SS, Anson BJ (1961)	3.2	13.4	3.8	1.1	0	21.5
2	Gellman H, et al (2001)	4.4	11.1	0	0	0	15.1
3	Patnaik VVG, et al (2002)	12	0	4	0	0	16
4	Süleyman MT, et al (2007)	20	0	0	5	0	25
5	Present study	0	0	6.66	0	0	6.66

Table 3. Incidence of different Types of Incomplete Superficial Palmar Arch

Persistent palmar type of median artery with superficial palmar arch (Fig. 5 to 8) contributed by it was observed in 5 hands in the present study with an incidence of 16.66%. Out of the five hands, one hand showed a complete Type C superficial palmar arch and two hands showed incomplete Type C arch. The other two are the variant forms, which have discussed earlier.

The persistent median artery, which gave contribution to the superficial palmar arch was reported by many workers as shown in Table 4. The results are compared with those of other workers, who classified the superficial palmar arches in the same manner. Observations made by Tandler²² et al (1897) and Thakklapalli Anitha et al²³ (2011) are comparable to that of present study (16.66%).

Sl. No.	Author	Incidence (%)
1	Tandler, ²² et al (1897)	16
2	Piersol (1911)	7.5
3	Adachi (1928)	8
4	Coleman SS, Anson BJ (1961)	9.9
5	Janevski BK (1982)	2.2
6	Al Turk M, Metcalf WK (1984)	10
7	Ikeda A, et al (1988)	0.9
8	Rodriguez-Niedenfuhr M ²⁴ (1999)	28
9	Loukas M, et al (2005)	21
10	Classen H, ²⁵ et al (2008)	12
11	Thakklapalli Anitha ²³ (2011)	6
12	Present study	16.6

Table 4. Incidence of Persistent Palmar type of Median Artery

The presence of persisting median artery is not bilateral in the present study. It is likely that the factors responsible for these variations could be acting unilaterally.

Common and proper digital arteries are branches of superficial palmar arch arising from its convex surface. According to the classic descriptions there are three common digital arteries corresponding to the 2nd, 3rd and 4th interosseous spaces. Tandler²² (1897) after an extensive study on 130 hands, proposed the existence of a common digital artery in the first web space and named it as the 1st common digital artery or the Tandler's artery. Later Coleman S. S. and Anson B. J. and Al Turk M, et al confirmed this finding with their studies on superficial palmar arch. In the present study in 24 hands (80%), we had 4 common digital arteries either arising directly from the convex surface of arch or part of a common stem for CDA and PDA. So Tandler's finding is again confirmed in the present study.

Out of these 24 hands, one showed a common trunk for the 1st CDA and PDA to radial side of thumb (Fig. 8). Out of all the hands studied in the present study, 3 hands showed a common trunk for the 4th common digital artery and proper digital artery to the ulnar side of little finger (Fig. 1, 2 and 5). A rare peculiarity, which was noted in one of the cases (Fig. 2) here is that the 4th CDA and PDA to the ulnar side of little finger arise from a fairly long common trunk, which reaches up to the medial aspect of the long flexor tendon to the little finger and there it divides into proper digital artery to the little finger and 4th CDA. The latter is passing deep to the long flexor tendon. This is a very rare variation in the course of common digital artery and is not found in available literature.

In 6 hands (20%), common digital arteries corresponding to the 2nd, 3rd and 4th interosseous spaces were found. Palmar digital arteries to the ulnar side of thumb and to the radial side of index finger originated separately from the arch. PDA to the ulnar side of little finger also arose as separate branch from the medial end of the arch.

CONCLUSION

The findings of the present study confirm that the main artery, which supplies the hand is the ulnar artery in spite of whether or not it is taking part in the formation of arch. It is important to note that the incidence of complete superficial palmar arch is very high compared to the incomplete superficial arch. The unique findings, which we have obtained from the present study are two variant forms of SPA contributed by median artery. The knowledge of the variation, which has been reported here is important for vascular surgeons in reconstructive surgeries.

REFERENCES

- [1] Cunningham's textbook of Anatomy (Oxford Medical Publications). 15th edn. Upper and lower limbs. Oxford University Press 2004:77-9.
- [2] Coleman SS, Anson BJ. Arterial patterns in the hand based upon a study of 650 specimens. Surg Gynecol Obstet 1961;113:409-24.
- [3] Kaplan EB. Anatomía funcional y quirúrgica de la mano. 1st edn. Buenos Aires: Editorial Artecnic 1961:126-8.
- [4] Adachi B. Das arterien system der Japaner, Koyoto. Kenkyusha 1928;1:365-89.
- [5] Jaschtschinski SN. Morphologie und Topograohie des arcus volaris sublimis und profundus des menschen. Anat Hefte 1897;7:163-88.

- [6] Piersol. Hollinshed anatomy for surgery. Back and limbs. Vol 2. 4th edn. 1911;1962:506-11.
- [7] Mozersky DJ, Buckley CJ, Hagood CO, et al. Ultrasonic evaluation of palmar circulation. An useful adjunct to radial artery cannulation. American J of Surg 1973;126(6):810-2.
- [8] Janevski BK. Angiography of the upper extremity. The Hague, Boston, London: Martinus Nijhoff 1982:73-122.
- [9] Doscher W, Viswanathan B, Stein T, et al. Hemodynamic assessment of the circulation in 200 normal hands. Ann Surg 1983;198(6):776-9.
- [10] Al-Turk M, Metcalf WK. A study of the superficial palmar arteries using the doppler ultrasound flowmeter. J Anat 1984;138(Pt 1):27-32.
- [11] Ikeda A, Ugawa A, Kazihara Y, et al. Arterial patterns in the hand based on a three-dimensional analysis of 220 cadaver hands. A Journal of Hand Surgery Am 1988;13(4):501-9.
- [12] Pola P, Serricchio M, Flore R, et al. Safe removal of the radial artery for myocardial revascularization: a Doppler study to prevent ischemic complications to the hand. J Thorac Cardiovasc Surg 1996;112(3):737-44.
- [13] Koman LA, Rush DS, Smith PB, et al. Vascular disorders in Greens operative hand surgery. 4th edn. New York: Churchill Livingstone 1999:2254-302.
- [14] Gellman H, Botte MJ, Shankwiler J, et al. Arterial patterns of the deep and superficial palmar arches. Clin Orthop Relat Res 2001;383:41-6.
- [15] Ruengsakulrach P, Eizenberg N, Fahrner C, et al. Surgical implications of variations in hand collateral circulation: anatomy revisited. J Thorac Cardiovasc Surg 2001;122(4):682-6.
- [16] Patnaik VVG, Kalsey G, Rajan SK. Palmar arterial arches - a morphological study. J Anat Soc India 2002;51(2):187-93.
- [17] Loukas M, Holdman D, Holdman S. Anatomical variations superficial and deep palmar arches. Folia Morphol (Warsz) 2005;64(2):78-83.
- [18] Tagil SM, Çiçekcibasi AE, Ögün TC, et al. Variations and clinical importance of the superficial palmar arch. SDÜ Tıp Fak Derg 2007;14(2):11-6.
- [19] Dhar P, Lall K. A typical anatomical variation of palmar vascular pattern. Singapore Med J 2008;49(9):e245-9.
- [20] Keen JA. Study of arterial variations in the limbs, with the reference to simetry of vascular patterns. American Journal of Anatomy 1961;108(3):245-61.
- [21] Nayak SR, Krishnamurthy A, Ramanathan L, et al. The median-radial type of superficial palmar arch: a case report and review of the literature. Clinics (Sao Paulo) 2008;63(3):409-10.
- [22] Tandler J. Zur anatomie der arterien der hand. Anat Hefte 1897;7:263-82.
- [23] Anitha T, Kalbande S, Dombé D, et al. Variations in the formation of superficial palmar arch and its clinical significance in hand surgeries. Int J Biol & Med Res 2011;2(2):543-6.
- [24] Rodriguez-Niendenfuhr M, Sanudo JR, Vazquez T, et al. Median artery revisited. J Anat 1999;195(Pt 1):57-63.
- [25] Claassen H, Schmitt O, Wree A. Large patent median arteries and their relation to the superficial palmar arch with respect to history, size consideration and clinical consequences. Surg Radiol Anat 2008;30: 57-63.