

Patterns of Arterial Arcades of the Superficial Palmar Arch: A Study In Embalmed Cadaver Palms

Suman Udipi *¹, Pushpa Gowda ².

*¹ Associate Professor, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India.

² Associate Professor, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India.

ABSTRACT

Background: The complex and variable pattern of the arterial arcades of the palm form an interesting area of study anatomically and surgically. In the present study arches were classified into complete and incomplete types, the complete type being the most prominent in 88.6% of the palms. Among the complete type, arch formed by ulnar artery alone supplying the thumb and index finger was found in majority of the specimens (50%). The classical or standard superficial palmar arch formed by the superficial palmar branch of radial and ulnar arteries was found in only 28.5%. Different patterns of the arterial arcades of the superficial palmar arch are normally encountered during routine anatomical dissections of the palm which needs to be emphasized and highlighted for a desired surgical outcome during microvascular reconstructive surgeries of the palm and during radial artery cannulation.

Context: With technological advancements in microsurgical procedures of the hand, fields of anatomical interest like the classification of arterial arcades of the palm, now becomes essential for operating vascular surgeons for a desired surgical outcome

Purpose of the study: The present study was taken up to analyze and document varying patterns of the arterial arcades of the superficial palmar arch.

Methods and Material: the study was conducted by dissecting 70 randomly obtained formalin fixed cadaver palms.

Results: In the present study arches were classified into complete and incomplete types, the complete type being the most prominent in 88.6% of the palms. Among the complete type, arch formed by ulnar artery alone supplying the thumb and index finger was found in majority of the specimens (50%). The classical or standard superficial palmar arch formed by the superficial palmar branch of radial and ulnar arteries was found in only 28.5%. Out of the 70 hands, incomplete arches were found only in 8 hands with an incidence of 11.4%.

Conclusion: Knowledge of arterial pattern of the hand is very important to vascular and reconstructive surgeons for effective treatment of injuries of the hand. Such a knowledge of the disposition of the arterial arcades of the palm also enables cardio-vascular surgeons to plan and modify surgical procedures such as radial artery harvesting, cannulation and in preventing the ischemia of hands in such procedures.

KEY WORDS: Superficial palmar arch, Arterial arcades, Complete arch, Incomplete arch.

Corresponding Author: Dr Suman U, Associate professor, Department of Anatomy, Kempegowda Institute of Medical Sciences, Bangalore, Karnataka, India. Phone numbers: 9980013352

E-Mail: sumanvahiraj@gmail.com

Access this Article online	Journal Information
Quick Response code  DOI: 10.16965/ijar.2021.156	International Journal of Anatomy and Research ISSN (E) 2321-4287 ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar 
	Article Information
	Received: 18 Jun 2021 Peer Review: 19 Jun 2021 Revised: None
	Accepted: 29 Aug 2021 Published (O): 05 Sep 2021 Published (P): 05 Sep 2021

INTRODUCTION

The pattern of arterial arcades of the palm presents a very interesting study anatomically

and surgically as the hand is an indispensable prehensile organ. The palm is supplied by two sets of arterial arches-superficial and deep, the

superficial palmar arch being the principal source of blood supply to the palm and the digits. The superficial palmar arcade lies immediately deep to palmar aponeurosis but is superficial to all the other structures in the palm. It is formed by the direct continuation of the ulnar artery beyond the flexor retinaculum and in a complete arch, it becomes continuous with the superficial palmar branch of radial artery [1].

Different patterns of arterial arcades of the superficial palmar arch are normally encountered during routine dissections of the palm. Arterial variations are variable facts of human constitution that can be observed time and time again [2]. A better understanding of the disposition of arterial arcades of the palm has become necessary with the advancement in microsurgical techniques for hand repair and reconstructive surgeries.

The present study was taken up to analyze and document varying patterns of the arterial arcades of the superficial palmar arch. In this study we have grouped and classified the arterial arcades of the superficial palmar arch according to the classification by Coleman & Anson [3].

MATERIALS AND METHODS

The present study comprised of 10% formalin fixed seventy cadaver palms, both from the right and left hands and obtained from Kempegowda institute of medical sciences, Bangalore, Karnataka. The dissection of the hands was performed as per Cunningham 's manual of practical anatomy [4].

After dissection, the pattern of superficial palmar arch was observed and documented. After observation, the moisture over the superficial palmar arch was removed with Whatman's filter paper. It was then dehydrated with acetone and painted with artist oil color using amyl acetate, thinner and solvent. The specimens were painted in red using round table hair oil brush. All specimens were duly numbered and color photographs taken. The data obtained was recorded and documented in an order. The results were analyzed and classified into complete and incomplete arches

and their subdivisions according to Coleman and Anson classification [3].

RESULTS

In the present study, out of 70 hands, 62 were seen to form complete arches with an incidence of 88.5%. Summarizing the groups of arches whether complete or incomplete is illustrated in table 1. Among these complete arches, 20 palms (28.5%) were seen to have the classical or standard superficial palmar (Type A) (Fig 1), where the arch is formed by ulnar artery completed on the radial side by superficial palmar branch of the radial artery. Complete type B, where the arch is formed by ulnar artery, which supplies thumb and index finger was seen in 35 hands with an incidence of 50% (Fig 2). Complete type C was found in 2 hands with an incidence of 2.8%, complete type C is medio-ulnar arch (Fig 3). Complete type D which is radio-medio-ulnar communication where three vessels enter into the formation of the arch was not seen in the present study. Complete arch type E, where the arch is initiated by ulnar artery and completed by a large sized vessel from the deep arch was found in 5 palms (7.14%) (Fig 4). Summarizing the data on types of complete arches is shown in table 2.

Out of the 70 hands, incomplete arches were found only in 8 hands with an incidence of 11.4%. Among the incomplete arches, type A where both radial and ulnar arteries supply palm and fingers but fail to anastomose was found in three hands with an incidence of 4.28% (Fig 5). Incomplete type B where ulnar artery forms the superficial palmar arch but does not supply thumb and index finger was found in 2 hands (2.85%) (Fig6). Incomplete type C where the superficial vessels receive contributions from both median and ulnar arteries but without anastomosis was found in 3 out of 70 hands (4.28%) (Fig 7). Type D form of incomplete superficial palmar arch in which all three vessels, radial, median and ulnar arteries give origin to the superficial vessels but do not anastomose, was not found in the present study. Summarizing the data on incomplete arches in the present study is shown in table 3.



Fig. 1: photograph showing complete arch type A (arch is formed by ulnar artery completed by the superficial palmar branch of radial artery).



Fig. 4: photograph showing complete arch type E (arch formed by ulnar artery completed by a branch from the deep palmar arch)



Fig. 2: photograph showing complete arch type B (arch formed by ulnar artery alone which supplies thumb & index fingers)



Fig. 5: photograph showing incomplete arch type A (both superficial palmar branch of radial & ulnar arteries supplies palm and fingers but fail to anastomose)



Fig. 3: photograph showing complete arch type C a (medio-ulnar arch)



Fig. 6: photograph showing incomplete arch type B (arch formed by ulnar artery which fails to supply thumb & index finger)



Fig. 7: photograph showing incomplete arch type C (superficial vessels receive contributions from both median & ulnar arteries but fail to anastomose).

Table 1: Illustrating the groups of arches in the present study (based on the classification by Coleman & Anson [3])

Groups of Arches	Number of specimens	Percentage%
Complete Arches	62/70	88.60%
Incomplete Arches	8/70	11.40%

Table 2: Illustrating the types of Complete arches in the present study (based on the classification by Coleman & Anson [3])

Serial number	Types of complete arches	Number of specimens	Percentage%
1	Type A	20/70	28.57%
2	Type B	35/70	50%
3	Type C	2/70	2.85%
4	Type D	-	-
5	Type E	5/70	7.14%

Table 3: Illustrating the types of incomplete arches in the present study (based on Coleman & Anson [3] classification)

Serial number	Types of incomplete arches	Number of specimens	Percentage%
1	Type A	3/70	4.28%
2	Type B	2/70	2.85%
3	Type C	3/70	4.28%
4	Type D	-	-

DISCUSSION

The arterial arcades of the superficial palmar arch are complex and variable. There are several classifications of the arterial arcades of the arch described by many authors [3,5,6]. The classical description and classification of the arches given by Coleman and Anson [3] is adequate and easy to follow.

Coleman and Anson [3] found that the superficial palmar arch form several diversified patterns that permits classification into well-defined categories. They divided superficial palmar arches into two major groups- complete and incomplete. Formation of the arch is complete if a) ulnar artery anastomoses with superficial branch of radial/median/branch from the deep arch or b) ulnar artery alone supplies all digits including thumb and index finger. Incomplete arch is the one in which superficial vessels (either the radial or median) do not anastomose with the ulnar artery, or the ulnar artery fails to supply thumb and radial side of index finger. They found complete arches in 510 out of 650 hands they studied with an incidence of 78.5% and incomplete arches in 140 hands with an incidence of 21.5%.

Comparison of the groups of arterial arcades of superficial palmar arch with other workers is shown in table 4.

Table 4: Comparison & summarizing the data on groups and types of superficial palmar arches.

Authors	Complete arches	Incomplete arches
Jaschtschinski [5] 1896	68%	-
Coleman & Anson [3] 1961	78.50%	21.50%
Al-Turk & Metcalf S et al [12] 1984	84%	16%
Gellman H et al [8] 2001	84.40%	15.50%
Ruengsakularch P et al [9] 2001	66%	-
Patnaik et al [10] 2002	78%	16%
Loukas M et al [11] 2005	90%	10%
Singh S et al [12] 2017	92%	8%
Present study	88.60%	11.40%

In the present study we found the complete superficial palmar arches in large number of the hands with an incidence of 88.6 % and incomplete arches in only 11.4%. This finding is in accordance with the earlier studies and it is seen that majority of the hands have complete type of superficial palmar arterial arcades. Whether the superficial palmar is complete type or incomplete type can be assessed clinically by Allen test [13], Doppler ultrasonography [14] & angiography [15]. In cases of incomplete arches as there is no direct connection between the main vessels forming the arch, occlusion of the ulnar artery could have significant clinical consequence [1]. Coleman and Anson [3] further classified the

Table 5: Comparison & summarizing the data on groups types of complete superficial palmar arches.

Authors	Type A	Type B	Type C	Type D	Type E
Jaschtschinski [5] 1896	27%	38%	3%	-	-
Coleman & Anson [3] 1961	34.50%	37%	3.80%	1.20%	2%
Al-Turk & Metcalf S et al [12] 1984	78%	-	4%	2%	-
Gellman H et al [8] 2001	35.50%	31.10%	13.30%	2.20%	2.20%
Ruengsakularch P et al [9] 2001	10%	66%	--	-	-
Patnaik et al [10] 2002	76%	2%	-	-	-
Loukas M et al [11] 2005	40%	35%	15%	6%	4%
Singh S et al [12] 2017	44%	46%	-	2%	-
Present study	28.60%	50%	2.85%	-	7.14%

complete arches into five types. Type A or the classical radio-ulnar arch formed by superficial palmar branch of radial and ulnar arteries (34.5%). Type B -where the arch is formed ulnar artery alone, they found this pattern in 37% of the palms. Type C medio -ulnar arch composed of ulnar artery and an enlarged median artery in 38% of the specimens. Type D radio-medio-ulnar communication in which three vessels enter into the formation of the arch (1.2%). Type E -arch initiated by ulnar artery and completed by a large sized vessel from the deep arch in 2% of the palms. Comparison of the types of complete arcades of superficial palmar arch with other workers is shown in table 5.

In the present study we found the complete arch type A in 28.5% (20 out of 50 limbs), type B in 50% of the hands, type C in 2.85% and type E in 7.14% of the hands. Complete arch type D arch where all the three vessels contribute to the formation of the arch was not seen in the present study. The most common type of arch formation seen in the present study seen in 50% of the palms is complete type B, where ulnar artery alone forms the arch and supplies the thumb and index finger. This in accordance with the study conducted by Ruengsakularch P et al [9]

It can be noted that in majority of the earlier studies the incidence of arch formation by radio-ulnar arch (complete type A) and ulnar artery alone (complete type B) is about the same. The incidence of complete arch type E is notably higher in the present study with an incidence of 7.14%.

Furthermore, Colman and Anson [3] subdivided the incomplete arches into four subtypes Incomplete type A -where both superficial palmar branch of radial and ulnar artery supply the palm and fingers, but fail to

anastomose (in 3.2% of the palms). Type B-where ulnar artery forms the superficial arch but it is incomplete as it does not supply thumb and index finger (in 13.4%). Type C where superficial vessels receive contributions from both median and ulnar arteries but without anastomosis (in 3.8%). Type D -here radial, median, ulnar arteries give origin to the superficial vessels but do not anastomose (in 1.1%). Summary and comparison on the types of incomplete superficial palmar arches with other studies is shown in table 6.

Table 6: Comparison & summarizing the data on groups types of incomplete superficial palmar arches.

Authors	Type A	Type B	Type C	Type D
Coleman & Anson [3] 1961	3.20%	13.40%	3.8%	1.10%
Al-Turk & Metcalf S et al [12] 1984	2%	8%	-	-
Gellman H et al [8] 2001	4.40%	11.10%	-	-
Patnaik et al [10] 2002	12%	-	4%	-
Singh S et al [12] 2017	8%	-	-	-
Present study	4.28%	2.80%	4.28%	-

In the present study we found type A and type C incomplete superficial arches in 4.28% of the hands each, incomplete type B in 2.8%. Incomplete type D was not found in the present study. In the present study there was no pattern dominance owing to the small number of hands showing incomplete arches.

The most common etiological factor for hypothenar hammer syndrome is occupational trauma where the workers use hand as a hammer. The extent of ischemia of the fingers depends upon the branching pattern of the superficial palmar arch [16]. In injuries to the radial artery following cannulation, the continued viability of the hand depends on the ulnar arterial supply to the superficial palmar arch. In radial dominant incomplete palmar arch, occlusion of the radial artery following cannulation would be catastrophic.

Hence routine use of doppler test is recommended in patients requiring cannulation of radial artery to avoid ischemia of fingers [14]. Circulatory dynamics in the hand follow a very variable pattern, variations in the collateral adequacy in the hand may be responsible for 'hammer hand syndrome' in patients after radial cannulation and in cases of A-V fistula [17]. Radial artery harvest for coronary artery bypass might lead to digital ischemia if collateral circulation is inadequate in cases such as incomplete superficial palmar arch or radial dominant superficial palmar arch [18]. Although the classical type of superficial palmar arch occurs infrequently, there is always a significant anastomosis between radial and ulnar arteries and in the absence of vascular disease, harvesting the radial artery can be considered as safe procedure [9].

CONCLUSION

The fast-growing population, increased industrialization and mechanization, is reflected in the ever-increasing incidence of hand injuries. Though a person with injury to the hand is otherwise healthy, nothing is more satisfying than to restore him to his complete health and full earning capacity. Hence, knowledge of arterial pattern of the hand is very important to vascular and reconstructive surgeons for effective treatment of injuries of the hand. With technological advancements in microsurgical procedures of the hand, fields of anatomical interest like the classification of arterial arcades of the palm, now becomes essential for operating vascular surgeons for a desired surgical outcome. Such a knowledge of the disposition of the arterial arcades of the palm also enables cardio-vascular surgeons to plan and modify surgical procedures such as radial artery harvesting, cannulation and in preventing the ischemia of hands in such procedures.

ABBREVIATIONS

SPA - Superficial palmar arch **UA** - Ulnar artery
RA - Radial artery **MA** - Median artery
Sp br of RA - Superficial palmar branch of radial
CDA - Common digital artery
PDA - Palmar digital artery

Conflicts of Interests: None

REFERENCES

- [1]. Sinnatamby CS. Last's Anatomy Regional and Applied. 10th ed. Edinburgh: Churchill Livingstone; 1999.
- [2]. Chhatrapati DN. Absence of radial artery. Indian J Med Sci 1964; 18:462-465.
- [3]. Coleman S, Anson BJ. Arterial patterns in the hand based upon a study of 650 specimens. Surg Gynecol Obstet 1961; 113:409-424.
- [4]. Romanes G J. Cunningham's Manual of Practical Anatomy. 15th ed. Oxford university press 2005; vol 1: 174-179.
- [5]. Jaschtschinski S N. Morphologie and topographie des arcus volaris sublimis and profundus. Anat Hefte:1897; 7:163-188.
- [6]. Adachi B. Des arterien- system des Japaner, Kyoto, 1928; 1:365-389.
- [7]. Al -Turk M, Metcalf W K. A study of the superficial arteries using the doppler ultrasonic flowmeter. J Anat 1984; 139:27-32.
- [8]. Gellman H, Botte M J, Shankwiler J, Gelberman R H. Arterial patterns of the deep and superficial palmar arches. Clin Orthop and Related research 2001; 383:41-46.
- [9]. Reungsakularch P, Eizenberg N, Fahrner C, Fahrner M, Buxton B Surgical implications of variations in hand collateral circulation: Anatomy revisited. The J Thoracic Cardiovasc surg 2001;122(4):682-686.
- [10]. Patnaik V V G, Kalsey G, Singla R K. Palmar arterial arches -a morphological study. Journal of Anatomical society of India 2002;51(2): 187-193.
- [11]. Loucas M, Holdman D, Holdman S. Anatomical variations of the superficial and deep palmar arches. Folia Morphol (warsz) 2005;64(2) :78-83.
- [12]. Singh S, Lazarus L, De Gama B. Satyapal K S. An anatomical investigation of the superficial and deep palmar arches. Folia Morphol 2017 ;76(2) :219-225.
- [13]. Koman L A, Urbanaik J R. Ulnar artery insufficiency: A guide to treatment. J Hand Surg 1981;6(1) :16-24.
- [14]. Maj Mozersky D J, Lt Col Capps W F Jr, Col Danne Miller F J Jr. Ultrasonic evaluation of palmar circulation. A useful adjunct to radial artery cannulation. The Am J of surgery 1973; 126:810-812.
- [15]. Kaplanoglu H, Beton O. Evaluation of anatomy and variations of superficial palmar arch and upper extremity arteries with C T angiography. Surg Radiol Anat 2017;39(4):419-426.
- [16]. Conn J, Bergann JJ, Bell JL. Hypothenar hammer syndrome post traumatic digital ischemia. Surgery 1970;68(6):1122-1128.
- [17]. Little J M, Zylestra P L, West J, May J. Circulatory patterns in normal hand. Brit J Surg 1973; 60:652-655.
- [18]. Starnes S I, Wolk S W, Lampman R M, Shanley C J, Prager R L, Kang B K et al. Noninvasive evaluation of hand circulation before radial artery harvest for coronary artery bypass grafting. The J Thorac Cardiovasc Surg 1999; 117:261-266.

How to cite this article: Suman Udipi, Pushpa Gowda. Patterns of Arterial Arcades of the Superficial Palmar Arch: A Study In Embalmed Cadaver Palms. Int J Anat Res 2021;9(3.3):8097-8102. DOI: 10.16965/ijar.2021.156