



Superficial Palmar Arch: a study of morphological Variation patterns.

Rajiv Ranjan

Assistant Professor, Department of Anatomy, RIMS, Ranchi, India.

Dr A K Dubey

Associate Professor

Dr Amit Jain

Associate Professor, Department of Anatomy, RDGMC, Ujjain, India.

ABSTRACT

Aims and Objective: The aim of this study was to analyse the superficial palmar arch (SPA) and its variations and also to study its association with other variations of upper limb like high-up bifurcation of brachial artery, presence of median artery, absence of palmaris longus etc.

Materials and methods: 70 preserved cadavers were dissected during routine curricular dissection at RDGMC, Ujjain and RIMS, Ranchi; relevant anomaly of SPA and its association with any other anomaly was photographed and analysed

Result and discussion: Complete superficial palmar arch (SPA) variations were observed in 111 cadaveric hands; whereas there were 29 cadaveric hand with the variations incomplete superficial palmar arch (SPA). Also its association with other co-existing variation was observed, photographed and analysed.

Conclusion: Present study is clearly indicates the presence of collateral communication of radial artery in majority (78.3%) with ulnar artery or in some cases persistent median artery as a component of SPA.

KEYWORDS :

Introduction

The superficial palmar arch is an anastomosis fed mainly by the ulnar artery with variable contribution from branches of radial artery. Ulnar artery enters the palm with the ulnar nerve, anterior to the flexor retinaculum and lateral to the pisiform. It passes medial to the hook of the hamate, then curves laterally to form an arch that is convex distally and 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 the 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. The superficial palmar arch is covered by palmaris brevis and the palmar aponeurosis and it is superficial to flexor digiti minimi, branches of the median nerve and the long flexor tendons and lumbricals.¹

Three common palmar digital arteries and one proper palmar artery arise from the convexity of the superficial palmar arch. The former pass distally on the second to fourth lumbricals, each joined by a corresponding palmar metacarpal artery from the deep palmar arch, and divide into two proper palmar digital arteries. Palmar digital artery for the medial side of the little finger leaves the arch under palmaris brevis. Palmar digital arteries supply the metacarpophalangeal and interphalangeal joints and nutrient rami to the phalanges. They are the main digital supply, because the dorsal digital arteries are minute.

Since the SPA is the main source of arterial supply to the palm, the details about its possible variations is important for the reconstructive hand surgeons. The knowledge is important while performing the superficial dissections and to the radiologists while performing the angiographic procedures (LATIFF et al., 2008). Their variations being one of the challenging anatomical areas have long intrigued clinicians and radiologists. Though there are few cases reported in the literature (Patnaik V.V.G et al. 2000, CAMBRON et al., 2006; DHAR and LALL, 2008; VOLLALA et al., 2008; NAYAK et al., 2008; RAO et al., 2010) which describe the variations of SPA, the detailed anatomical studies about this subject are scarce.³⁻⁸ In the present investigation, the objective was to study the morphological variants of the SPA in adult humans. The clinical implications of these variant palmar arches are emphasized with relevant review of literature.

Our research goal was to outline the observed types SPAs that would allow for adequate blood supply to the hand once radial circulation is removed. Additionally, we would like to propose a

different view of the existing classification of circulation most commonly found in the hand in order to facilitate better documentation and communication amongst medical professionals in the field.

Material and methods

The present study included 70 human cadavers (140 hands) which were dissected during routine curricular dissection by first-year medical students in our department. Among them, 57 were male adult and 13 were female adult cadavers. They were fixed with 10% formalin solution. The hands were devoid of any external trauma and pathologies. The dissections of hands were performed as per the Cunningham's manual of practical anatomy (ROMANES, 2005).⁹ The course and branches of the radial and ulnar arteries in the hand were meticulously dissected, the morphology of SPA was studied and the variations were noted. The arches were observed and discussed by any two investigators of the present study in order to avoid the observer errors.

In order to obtain a clear field for visualisation of the superficial palmar arch the following structures were removed: skin and palmar aponeurosis, and wherever necessary, the flexor retinaculum. Following preliminary examination, images from all the dissected specimens were recorded and analysed.

Results and observations

Complete absence of superficial palmar arch (SPA) was not observed in any of the dissected specimen hand; neither any duplication of SPA was seen. Contribution of anterior interosseous artery in formation of SPA was also not observed in any specimen. The absence of palmaris longus was observed in 58% of specimen with an incomplete SPA; however in 32% of specimen with complete SPA, no palmaris longus was seen. Palmar aponeurosis was present in all the dissected specimen irrespective of the status of palmaris longus.

As per Coleman and Anson's classification complete SPA was noted in 78.3% of specimen with two major subtypes¹⁰

- I. Radio-Ulnar arch – formation of SPA by superficial branch of ulnar artery and completed by superficial branches of radial artery.
- II. Ulnar predominant arch – SPA and all its branches are fed by ulnar artery only and its termination usually anastomose with one of the branches of radial artery

Complete arch

Table 1: showing observation of variants of complete SPA

Type	Right Hand	Left Hand	Percentage	Remarks
A	23	22	32.1%	Most common
B	21	20	29.3%	2 nd most common
C	07	06	9.3%	
D	02	03	3.6%	
E	03	04	5%	

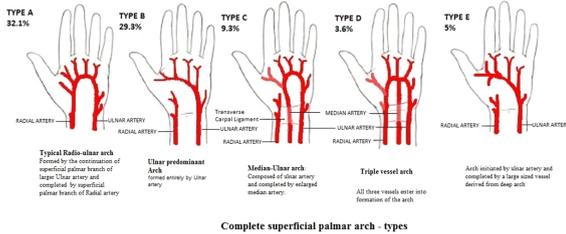


Figure : 1 showing diagrammatic representation of complete SPA variants



Picture : Typical Radio-Ulnar Arch (Type A)

Incomplete arch was observed in 20.23% of specimen with two major variants

- I. Ulnar type : all branches emerging from a larger ulnar artery without forming a crescent
- II. Radio-Ulnar type : branches emerging from both without anastomosis and crescent formation

Absence of palmaris longus was associated with incomplete arch in 58% of the specimen. Persistent median artery was observed in ~18% of dissected hand; of which ~5% exhibited an incomplete arch.

Incomplete arch

Type	Right Hand	Left Hand	Percentage	Remarks
F	05	09	10%	Most common

Table 3: showing comparative study of major work on SPA with present study

Features	Colemen & Anson ¹⁰	Ikeda et al. ¹¹	Patnaik et al. ¹²	M. Chimmalgi et al. ¹³	Bilge o et al. ¹⁴	Tagil et al. ¹⁵	Umapathy S. et al. ¹⁶	Present Study 2017
Sample size	650	220	50	-	50	20	50	70
Group I	78.5%	96.4%	78.0%	88%	86%	75%	78.5%	78.3%
Type A	34.5%	55.9%	76.0%	46%	34%	40%	37.5	32.1%
Type B	37.0%	25.5%	2.0%	26%	-	35%	37	29.3%
Type C	3.8%	-	-	8%	-	-	-	9.3%
Type D	1.2%	-	-	2%	-	-	-	3.6%
Type E	2.0%	-	-	6%	-	-	-	5%
Group II	21.5%	3.6%	16.0%	12%	14%	25%	21.5	20.23%
Type F	3.2%	-	12.0%	4%	-	-	2.08	10%
Type G	13.4%	-	-	2%	-	-	-	5.3%
Type H	3.8%	-	4.0%	4%	-	-	-	3.5%
Type I	0%	-	-	2%	-	-	-	1.43
Total	100.0%	-	94.0%	100%	-	-	97.91	100%

G	05	03	5.3%	2 nd most common
H	02	03	3.5%	
I	02	00	1.43%	

Table 2: showing observation of variants of incomplete SPA

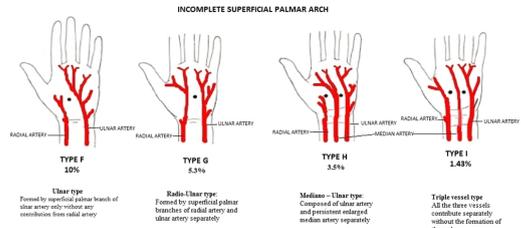


Figure showing diagrammatic representation of incomplete SPA variants



Picture 2 Ulnar type (F) of incomplete SPA



Picture 3 Radio- Ulnar type (G) of incomplete SPA

Discussion

Superficial palmar arch (SPA) can be broadly classified into two groups

- I. Complete SPA : when the anastomosis exist between the arteries forming the crescent
- II. Incomplete SPA : when there is no anastomosis between the arteries forming the crescent

This is by far the most convenient and accepted classification of SPA. Coleman and Anson subdivided this broad category into subgroups based upon their composition; complete SPA was divided into five subgroups (A to E) and incomplete SPA was divided into four sub groups (F to I).

Comparison with work of researchers like Ikeda et al.¹¹, Patnaik et al.¹², M. Chimmalgi et al.¹³, Bilge O et al.¹⁴, Tagil et al.¹⁵ and Umopathy S. et al.¹⁶, which followed Coleman and Anson's¹⁰ classification of SPA indicates that the typical palmar arch, i.e. Group I (Type A) of SPA is having a higher prevalence. This was in correlation with present study where the predominant pattern observed was of Group I (Type A) only Radio-ulnar type (32.1%) [Refer Table 1 and 3].

Also complete SPA was observed 78.3% of the specimen, shows high prevalence of collateral anastomotic pattern in hand.[Refer table 3]

The present study also correlates with the radiological and ultrasonographic findings of Mozersky et al.¹⁷ Higgins and Hayden¹⁸, Al Turk and Metcalf¹⁹ with complete type of SPA being predominant. However it differs from the findings of the works of Lippert H²⁰ and Mc Minn and Hutchings²¹.

Duplication of SPA was not observed in any of the specimen as reported by Jyoti A et al.²² and Patnaik V et al.³ Complete absence of SPA was also not seen in any of the specimen as reported by Paul S et al.²³ These cases are rare isolated examples of variation of SPA.

Persistence of median artery was observed in about 18% of dissected specimen, of which about 5% exhibit an incomplete SPA. In only one case the persistent median artery was bilateral; otherwise it was an unilateral presentation. As described by Jaschtschinsky²⁴; persistent median artery is an atavistic feature which participate in SPA in lower animals.

O.Sullivan and Mitchell²⁵ reported an absent PL in 22 patients out of 25 with an anomalous SPA. The absence of palmaris longus was observed in 58% of specimen with an incomplete SPA which is also highly significant.

Above observation clearly indicates that the variable counterpart in SPA is the radial artery; which is the main candidate for reconstructive hand surgeon as well as cardiac surgeon.

With the advancement of microsurgical procedure of hand reconstruction; there is a more emerging need for understanding the anatomy and variations of vascularity of hand. Also the elective preference of radial artery by cardiac surgeon in case of percutaneous transluminal coronary angioplasty 6 as well as coronary artery bypass graft (CABG). Owing to miniaturization, the percutaneous **Transradial** approach is becoming more popular throughout the world as an alternative to the femoral artery technique.

RA possesses several anatomical features that make it an excellent candidate for use in coronary revascularization.²⁶ The average length of the RA, >20 cm, makes it suitable to bypass all coronary artery territories, and its inner diameter, which is between 2 to 3 mm, closely matches that of the coronary arteries. Both coronary and aortic anastomoses are technically less demanding to construct with the RA when compared with other arterial conduits because of its thick muscular wall.²⁷

The radial artery (RA) was first used by Carpentier and colleagues in 1974²⁸ but subsequently abandoned due to high failure rates²⁹. In 1992, Acar et al.³⁰ reported the results from 104 patients who received a RA graft as a bypass conduit with 100% success by incorporating major modifications. The RA is becoming increasingly popular as a third arterial conduit in association with the LITA and RITA, or as the second in patients with contraindications to bilateral ITA harvesting.^{31,32}

Conclusion

Radial artery variants encountered during this study of SPA clearly indicates that prior to harvesting the RA, it is mandatory to assess the adequacy of the ulnar collateral circulation to the hand to avoid ischemia. Methods to detect adequate forearm collateral flow include the Allen test, static and dynamic Doppler testing, direct

digit pressure measurement during RA compression, and oxymetric plethysmography, together with the computation of a perfusion index^{33, 34}. High degree of association of absence of PL with incomplete arch also advocates confirming it with sonography beforehand. Any indicator of an incomplete SPA and absence clearly warrants the surgical handling of SPA or its components.

REFERENCES

- Gray's Anatomy: The anatomical basis of clinical practice, wrist and hand. 39th ed, Susan Standring London: Elsevier Churchill Livingstone; 2006. p.926–31.
- LATIFF, AA., OTHMAN, F., SUHAIMI, FH. and DAS, S. Anomalous superficial palmar arch: a cadaveric study with clinical implications. Archives of Medical Science, 2008, vol. 4, n. 2, p. 197-199.
- Patnaik V.V.G; Kalsey G; Singla RK. Superficial palmar arch duplication : a case report. Journal of The Anatomical Society of India. 2000 Jun; 49(1):63-6
- Dhar P, Lall K. (2008) An atypical anatomical variation of palmar vascular pattern. Singapore Med. J. 49: e245- e249.
- CAMBRON, BA., FERRADA, P., WALCOTT, R., KARTHIK, S. and KAYNAR, AM. Demonstration of unilateral absence of the palmar arch without collateral circulation. Circulation, 2006, vol. 113, n. 1, p. e6-e7. PMID:16391162.
- VOLLALA, VR., NAGABHOOSHANA, S., BHAT, SM., RODRIGUES, V., RAO, M., PAMIDI, N. and SURENDRAN, S. Rare anatomical variant: arterial circle in palm and at the base of the thumb. Romanian Journal of Morphology and Embryology, 2008, vol. 49, n. 4, p. 585-587. PMID:19050813.
- NAYAK, SR., KRISHNAMURTHY, A., RAMANATHAN, L. and PRABHU LV. The median-radial type of superficial palmar arch: a case report and review of the literature. Clinics, 2008, vol. 63, n. 3, p. 409-410. PMID:18568255. PMID:2664227.
- RAO, S., VOLLALA, VR., PAMIDI, N., NAGABHOOSHANA, S. and POTU, BK. Variant formation and distribution of the superficial palmar arch. Indian Journal of Plastic Surgery, 2010, vol. 43, n. 1, p. 116-117. PMID:20924468. PMID:2938609.
- ROMANES, GJ. Cunningham's Manual of Practical Anatomy. 15th ed. Oxford: Oxford University Press, 2005. vol. 1, p. 74-104.
- Coleman SS, Anson BJ. Arterial patterns in the hand based upon a study of 650 specimens. Surgery Gynaecology and Obstetrics. 1961;113:409–24.
- Ikeda, Ugava, Kazihara and Hamada. Arterial patterns in the hand based on a three-dimensional analysis of 220 cadaver hands. Am Journal of Hand Surgery. 1988;13(4):501–09.
- Patnaik VVG, Kalsey G, Singla Rajan K. Palmar arterial arches – A morphological study. Journal of Anatomical society of India. 2002;51(2):7–12.
- M Chimmalgi, SM Sant, SR Chhibber, RS Humberwadi. A study of superficial and deep palmar arches in human hands, Anatomica Karnataka. 2004;1(5):90–97.
- Bilge O, Pinar Y, Ozer MA, Govsa F. A morphometric study on the superficial palmar arch of the hand. Surg Radiol Anat. 2006;28(4):343–50.
- Süleyman Murat Tagyl, Aynur Emine Çiçekciabıy, Tunç Cevat Ögün, Mustafa Büyükmumcu, Ahmet Salbacak, Variations and Clinical Importance of the Superficial Palmar Arch, SDÜ Týp Fak Derg. 2007;14(2):11–16.
- Umopathy Sembian, Kamala E, Muhil M, Nalina Kumari. A Study of variations in the formation of superficial palmar arch in the rural population of southern tamilnadu International Journal of Anatomy Radiology and Surgery. 2012-June, Vol-1[1]:7–11.
- Mozersky DJ, Buckley CJ, Hazard CO Jr, Capps WF Jr, Dannemiller FJ Jr. Ultrasonic evaluation of Palmar Circulation: A useful adjunct to Radial artery cannulation. American J of Surg. 1973;126:810–12.
- Higgins CB, Hayden WG. Palmar arteriography in acronecrosis. Radiology [United States]. 1976;119(1):85–90.
- Al Turk M and Metcalf WK. A study of the superficial palmar arteries using the Dopplerultrasonic Flowmeter J Anat [England]. 1984;138:27–32.
- Lippert H. Variability of hand and foot arteries. Handchir Plast Chir [German West]. 1984;16(4):254–58.
- Mc Minn RMH, Hutchings. Colour Atlas of Human Anatomy. 2nd ed. Chicago: Book Publishers; 1988. p. 133.
- Jyoti A1, Kumar SR, Vandana M, Gayatri R, Vijay K.. Unilateral duplication of palmar arterial arches—a case report. Ital J Anat Embryol. 2008 Oct-Dec; 13(4):257–63.
- Paul, S., & Das, S. (2007). Absence of superficial palmar arch with associated anomaly of ulnar artery and nerve: A case report with clinical implications. Archives of Medical Science, 3(1), 79-81
- Jaschtschinski SN. Morphologie und Topographie des Arcus Volaris Sublimis und Profundus. Anat Heft. 1897;7:163-88.
- O'Sullivan E, Mitchell BS. Association of the absence of palmaris longus tendon with an anomalous superficial palmar arch in the human hand. J Anat 2002; 201: 405-408.
- van Son JAM, Smedts F, Vincent JG, et al. Comparative anatomic studies of various arterial conduits for myocardial revascularization. J Thorac Cardiovasc Surg. 1990; 99: 703-707.
- Fremes SE, Christakis GT, Del Rizzo DF, et al. The technique of radial artery bypass grafting and early clinical results. J Card Surg. 1995; 10: 537-544.
- Carpentier A, Guernonprez JL, Deloche A, et al. The aorta-to-coronary radial artery bypass graft. A technique avoiding pathological changes in grafts. Ann Thorac Surg 1973;16:111-21
- Geha AS, Krone RJ, McCormick JR, et al. Selection of coronary bypass. Anatomic, physiological, and angiographic considerations of vein and mammary artery grafts. J Thorac Cardiovasc Surg 1975;70:414-31
- Acar C, Jebra VA, Portogheese M, et al. Revival of the radial artery for coronary artery bypass grafting. Ann Thorac Surg. 1992; 54: 652-660.
- Kobayashi J, Tagusari O, Bando K, et al. Total arterial off-pump coronary revascularization with only internal thoracic artery and composite radial artery grafts. Heart Surg Forum. 2002; 6: 30-37.
- Tanaka H, Narisawa T, Mori N, et al. The left internal thoracic artery and radial artery composite graft in off-pump coronary artery bypass grafting. Ann Thorac Cardiovasc Surg. 2002; 8: 204-208
- Parolari A, Rubini P, Alamanni F, et al. The radial artery: which place in coronary artery? Ann Thorac Surg. 2000; 69: 1288-1294.
- R.A. Archbold, N.M. Robinson, R.J. Schilling Radial artery access for coronary angiography and percutaneous coronary intervention (Clinical review). BMJ, 329 (2004), pp.443-446