

# A Study of Variations In The Formation of Superficial Palmar Arch In The Rural Population Of Sourthern Tamilnadu

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## ABSTRACT

**Introduction:** The hand in the humans, is abundantly supplied by blood by two anastomotic arches, they are being the superficial palmar arch (SPA) and the deep palmar arch (DPA).

These two arterial arcades are formed by the anastomosis between the two main arteries of the forearm ie. the radial, the ulnar and their branches.

The anatomy of the palmar vascular arches and their variations were one of the most interesting and challenging anatomical areas , traditionally the superficial palmar arch is formed by the union of superficial palmar branch of the ulnar artery with the superficial palmar branch of the radial artery or with the arteria radialis indicis , with the ulnar artery as the main feeding vessel .

**Aim of the study:** The fact that frequent anatomic variations in the arterial pattern of hand drew our attention so as to ascertain the prevalence of variations in the SPA of south Tamilnadu population.

**Materials And Methods:** In our study we took fifty (50) disarticulated upper limbs from 25 adult human cadavers, which included both the sexes.

All the cadavers were from the department of anatomy, which were used for routine undergraduate teaching. All the cadavers were embalmed and stored in tanks and all the limbs were dissected as per the instructions given by Cunnighams manual of practical anatomy,including the hand and if any variations found were noted and photographed.

**Results:** In our study we came across two variations in two different hands unilaterally on the right side belonging to male sex. In both the hands we found double superficial palmar arches, without median artery.

**Conclusion:** The present study has revealed details about some of the variations of superficial palmar arch in humans which will be supplementing our already existing knowledge of variations. Recent advances in the microvascular surgical techniques for reconstructive hand surgeries have made mandatory, the clear understanding of variant arterial arches encountered in our population, so a comprehensive knowledge of which will be useful for the hand surgeons and orthopedicians for surgical intervention and for a successful outcome after surgery.

**Key Words:** Superficial palmar arch, Morphology, Double superficial palmar arch, South Tamilnadu population, Variation.

## INTRODUCTION

The superficial palmar arch(SPA) is a dominant vascular structure of the palm and is located deep to the palmar aponeurosis.

It ensures suitable blood supply to the entire territory of the hand, thus maintaining the integrity of the tissues of the hand.

The general pattern of its formation is by the union of ulnar artery with the superficial palmar branch of the radial artery. On entering the palm, it curves laterally deep to the palmar

aponeurosis and superficial to the long flexor tendons, thus completing the arch by anastomosing with the superficial palmar branch of radial artery[1,2].

It gives off four palmar digital arteries; the medial most supplies the medial side of the little finger and is called the proper palmar digital artery. The other three are common palmar digital arteries which pass to the medial three interdigital clefts [3].

All the above mentioned structures are covered by skin, palmar aponeurosis, short palmar muscles, the short flexor muscles of the little finger, lumbrical muscles, the tendons of superficial flexor muscles of the fingers and sections of me-

dian and the ulnar nerves [2,4-6] .

Keen [7] in his study has observed three types of SPA. **Type -1-** Ulnar type in which the arch is formed by the Ulnar artery alone. **Type -2-** it is Radio-Ulnar type, in which both radial and ulnar arteries contribute in the formation of the SPA( classical type), **Type-3-** Median- ulnar or Median- Radial type in which the median artery forms a important component of the SPA. It is also important to note that the variations of SPA are more commonly encountered than the deep palmar arch, which relatively remains constant.

The fact that SPA is the main arterial supply to the palm, the details of its possible variations is important for hand surgeons, Orthopedicians and general surgeons during surgical procedures like reconstructive hand surgeries, angiographic procedures or even draining of deep lying abscess of the palmar spaces [8].

To our best of knowledge we encountered only a few studies by various authors which describes the variations of SPA [9-13]. Apart from that there is no such detailed study which would have highlighted the prevalence of possible variations of SPA in the south Tamilnadu population.

Hence the objective of this present study is to establish the prevalence of the possible variations of SPA in the south Tamilnadu population.

## MATERIALS AND METHODS

In our study we took fifty adult human cadaveric upper limbs in which twenty five belonged to the right side and twenty five belong to the left side. Among the twenty five cadavers, twenty two were male cadavers and the rest three were female cadavers. This study was conducted at Chennai Medical College Hospital and Research Centre (CMCH&RC), Irungalur, Trichy for a period of over three yrs.

All the cadavers belong to the Anatomy department for the purpose of undergraduate teaching. All the cadavers were embalmed with 10% formalin solution and were stored in tanks with subsequent tagging of their respective numbers, age and sex.

We took painstaking efforts to ensure that the deceased belong to south Tamilnadu by meticulously collecting details like the name, age, sex, reason for getting admitted in the hospital, diagnosis, treatment given or surgery done and the residential address etc.

We excluded from our study those cadavers which exhibited obscuring pathologies, previous trauma to the upper limb, fractures before death and also fractures after death due to poor handling during transportation and storage, and also any kind of surgical procedures in the hand particularly. As all the

above mentioned conditions may alter the arch pattern present in that person (cadaver) ultimately misleading our study.

The dissections were carried out as per the descriptions given by Cunninghams manual of practical anatomy [1]. The course and the branches of radial and ulnar arteries were meticulously dissected out and studied and if any variations found were noted and photographed.

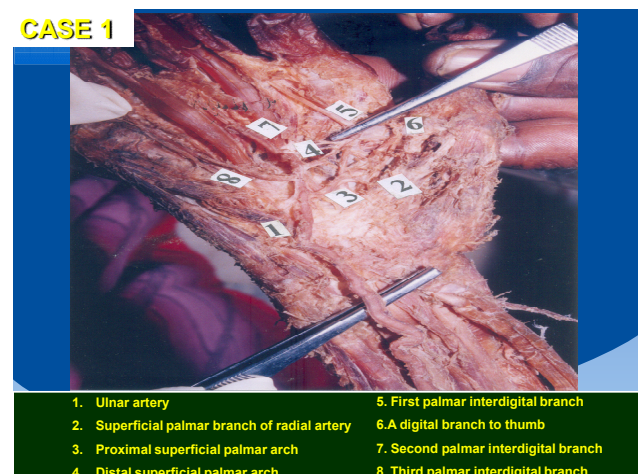
To avoid the observer's error the arterial pattern in all the limbs especially in the hand were observed by three different anatomists from our department and finally coming to a conclusion and confirming the variations by all the observers, it was noted in detail and photographed.

## RESULTS

Careful and meticulous dissection of all the fifty hands (25- left side & 25-right side) we came across two variations in the formation of SPA in two different hands unilaterally on the right side, both belonging to the male sex. The rest limbs (hands) showed classical arterial pattern of formation of SPA.

In the first variant, in the fore arm the ulnar artery was much bigger in caliber when compared to the radial artery and in the hand a double superficial palmar arch was noted, a proximal arch and a distal arch.

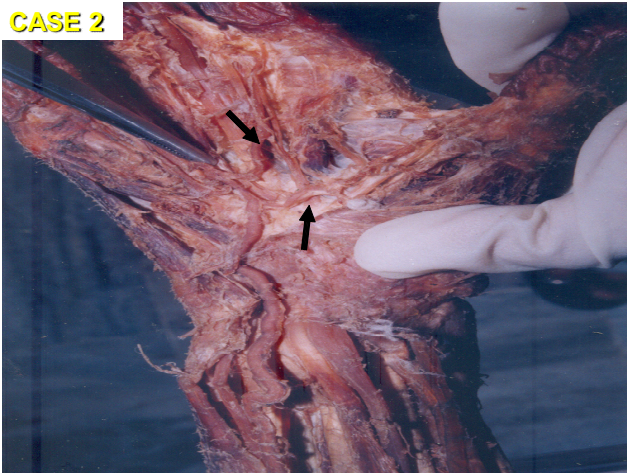
The proximal arch was formed by the complete union of Ulnar artery with superficial palmar branch of radial artery and the distal arch was formed by the union with the second common digital branch to complete the arch. In this hand we also noted that the 1st palmar inter digital branch which arose from the proximal superficial palmar arch where as the 2nd and 3rd common interdigital branch arose from the distal superficial palmar arch [Table/Fig-1].



In the second variant also there were two arches a proximal and a distal arch. The proximal arch was formed by the union

of ulnar artery with the superficial branch of radial artery and the distal arch was formed by the interconnection between 2nd & 3rd common digital branches [Table/Fig-2].

### CASE 2



**[Table/Fig-2]:** 2 Proximal Arch—normal formation where as the distal arch – formed by the interconnection of 2nd and 3rd common digital branches.

In our study we have not encountered any median artery.

## DISCUSSION

In a classical description the SPA is formed mainly by the ulnar artery, entering the palm with the ulnar nerve anterior to the flexor retinaculum and lateral to pisiform, passing medial to the hook of hamate further curving laterally to form the arch by anastomosing with the superficial palmar branch of the radial artery then it passes convex distally across the middle 1/3 rd of the palm and in the level with transverse line through the distal border of the fully extended pollicial base [1,14,15].

The SPA is formed in 1/3rd of cases by the ulnar artery alone; a further 1/3rd by anastomosing with the superficial palmar branch of the radial artery and a another 1/3rd by anastomosing either with the arteria radialis indicis or with arteria principis pollicis or with the persistent median artery [14-16].

According to various studies by different authors the prevalence of median artery contributing to the formation of SPA is 9.9% [16], 16% [17], 8% [18], 8.4% [19], 9.5% [7], & 4.0% [20].

But to our surprise we didn't have a median artery in both the hands in our study; it is hitherto a new finding.

As per the classification given by Coleman & Anson [16] there are two groups of SPA formation.

**Group-1:** complete arch(78.5%), which is further 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.

The contributing arteries to the SPA don't anastomose and when the ulnar artery fails to reach the thumb and index finger, the arch is incomplete. It is further divided into four subtypes.

**Type-A:** the superficial branch of radial and ulnar arteries take part in supplying the palm and fingers but doing so they fail to anastomose (3.2%).

**Type-B:** the ulnar artery forms the SPA but the arch is incomplete because it does not supply the thumb and index finger (13.4%).

**Type-C:** superficial vessels receive contributions from both median and ulnar arteries but without anastomosis (3.8%).

**Type-D:** radial, median and ulnar arteries give origin to superficial vessels but don't anastomose (1.1%).

In the above mentioned classification there is no mention about double superficial arch, as found in our present study. In our observation we had on the right side unilaterally on both the hands with double superficial arch.

The proximal arch in both the hands in our study fits to the category of type-A of group-1, ie. the classical radio-ulnar arch, where as the distal arch in the first case the ulnar artery anastomosed with the 2nd common digital branch to complete the arch and in the 2nd case the distal arch was formed by the communication of ulnar artery with 2nd and 3rd common digital branches.

In our study the distal arch had an unusual pattern of formation which does not fit to any of the above categories of classification.

Developmentally Arey [21] has described the anomalies of blood vessels may be due to (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 [22] the blood vessels arose from angioblastic 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 coalace to form vascular plexus, from which some may degenerate & others form such types of variations.

As per the theory proposed by Arey, hydro dynamically incompetent development of proximal SPA, which was so unable to give rise to interdigital branches, was being given off from the incomplete distal SPA.

In contrary to the previous studies in our present study we didn't encounter any median artery, which is hitherto a new finding, and also the formation of the arch by the union of ulnar artery with 2nd palmar digital artery in the first case and the intercommunication of adjacent palmar digital arteries in the second case are new findings.

In our study none of the cases exhibited the absence of deep palmar arch unlike the earlier reports by Jaschschinski [23] with a prevalence of 0.5% and a report by Poteat [24] where it was totally absent.

In our study both the hands showed a unique combination in itself exhibiting a different pattern of SPA not described earlier.

## CLINICAL IMPORTANCE

The palm is entirely supplied by both the SPA & the DPA (deep palmar arch) with their anastomosis. Vessels of the palm bleed profusely but at the same heal rapidly as like the scalp owing to a good anastomosis.

In hand surgeries the surgeon for arresting the bleeding from the palm, he has to ligate the radial or ulnar artery, or even sometimes the brachial artery if the median artery is present.

In cases when the bleeding is from interdigital branches of ulnar artery the surgeon has to ligate the ulnar artery above the proximal SPA anticipating the blood supply to be cut off from the interdigital artery where as actually it is not so because of an alternative route via the distal SPA.

The authors would conclude by stating that this study is not sufficient to make a final conclusion as this study lacks the most important aspect that is the larger sample size.

Apart from it, the sex ratio in our study also plays an important role as we had only three female cadavers where as 22 male cadavers, so to conclude by stating that this type of variations are more commonly seen in males will be not correct.

The authors would like to conclude that this type of studies has to be conducted in all the regions all over our country to ascertain the correct percentage of prevalence of variations in the formation of SPA.

Hence the knowledge of such anatomical variations is very important for the surgeons for a successful surgery and also for successful outcome.

## REFERENCES

- [1] ROMANES, G.J. *Cunningham's Manual of Practical Anatomy*. 15th ed. Oxford : Oxford University Press, 2005. Vol.1, p.74-104.
- [2] STANDRING, S. *Vascular supply and lymphatic drainage*. In: *Gray's Anatomy- Wrist and Hand*. 39th ed. Edinburgh: Elsevier Churchill Livingstone, 2005: 925-33.
- [3] SNELL, RS. *Clinical Anatomy*. 7th ed. Baltimore: Lippincott Williams and Wilkins, 2004. P. 545.
- [4] TESTUT, L., LATAJET, A. *Tratado de anatomia humana*. Barcelona: Salvat editores; 1977.
- [5] GARDNER, E., GRAY, D.J., O' RAHILLY, R. *Anatomia*. 4ed. Rio de Janeiro: Guanabara Koogan; 1988.
- [6] DANGELO, J.G., FATTINI, CA. *Anatomia humana sistemica e segmentar*. 2ed. Rio de Janeiro: Atheneu; 1998.
- [7] KEEN, JA. *Study of the arterial variations in the limbs, with special reference to symmetry of vascular patterns*. *American Journal of Anatomy*, 1961, vol. 108, n. 3, p. 245-61. PMID:14454801.
- [8] 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.
- [9] 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.
- [10] DHAR, P. and LALL, K. *An atypical anatomical variation of palmar vascular pattern*. *Singapore Medical Journal*, (2008), vol. 49, n. 9, p. e245-e249. PMID:18830531.
- [11] 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.
- [12] NAYAK, SR., KRISHNAMURTHY, A., RAMANATHAN, L. & 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.
- [13] RAO, S., VOLLALA, VR., PAMIDI, N., NAGABHOOSHANA, S. and POTU, BK. *Variant formation and distribution of the superficial arch*. *Indian Journal of Plastic Surgery*, 2010, vol.43, n.1, p.116-117. PMID:20924468. PMID:2938609.
- [14] MASSIE, G.: *Surgical Anatomy In*, 1944, 4th Edn. J&A Churchill Limited London p 177.
- [15] BOYD J.D., CLARK, W.E., HAMILTON, W.J., YOFFET, J.M., ZUKERMAN, S., & APPLETON, A.B., *Textbook of Human Anatomy 1956*. In: *CVS-Blood vessels*. Mac Millan & Co. Ltd., New York, London: Pp.341-46.
- [16] COLEMAN, SS. and ANSON, BJ. *Arterial pattern in hand based upon a study of 650 specimens*. *Surgery Gynaecology And Obstetrics*. 1961, vol.96, p.43-45.



- [17] TANDLER, J; Embryologie George Thilme, Stutt gart. 1897.
- [18] ADACHI,B: Das arterien system des japaner 1929, Kyoto Vol. p: 365-368, 389.
- [19] MISRA,B.D: The Arteria Mediana,1955. Journal of the Anatomical Society of India. (4): p.:48.
- [20] KARLSON,S.& NIECHAJEV,I.A. 1982: Arterial anatomy of the upper extremity. Acta Radiologica Diagnosis.23: 115-121.
- [21] AREY,L.B. Developmental anatomy In: Development of the arteries. 1952., 6th Edn W.B. Saunder's Co. Philadelphia. :375-7.
- [22] BHARGHAVA,I . 1956 ; Anamalous branching of axillary artery. Journal of anatomical society of India(5) : pp. 78-80.
- [23] JASCHTSCHINSKI,S.N. 1897 : Morphologia & topographie des arcus valaris sublimis et profundus. Anatomic Hefte 7: 163-168.
- [24] POTEAL, W.L. 1986: Report of a rare human variation: Absence of the radial artery. Anatomical Record. 214: 89-95.

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