



PATTERNS IN THE FORMATION OF SUPERFICIAL PALMAR ARCH-A CADAVERIC STUDY

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ABSTRACT **Background-** Superficial palmar arch is a major arterial anastomosis in the hand which is very much clinically relevant for the vascular surgeons & orthopedicians. A knowledge of the variations in the arteries contributing to the arch and its area of supply of hand can help them from unpleasant surprises during and after surgeries. This study aims to trace the patterns and variations in its formation in human cadavers. **Materials and Methods-** This study was done in 102 upper limb specimens used in the Department of Anatomy. The superficial palmar arch was dissected and grouped as described by Adachi as well as Coleman & Anson. **Results-** Single arch was found in 78 specimens and one double arch was found. 23 specimens were excluded. Of the 78 single arch specimens included in the study, 60 had complete arch and 18 had incomplete arch. The commonest type of complete arch as per Adachi classification was found to be Ulnar type (69.23%). As per Coleman & Anson classification, most common type of complete arch is found to be Type B, where the Ulnar artery predominantly forms the arch was found in 44 specimens (73.3%). It is considered complete since it crosses to radial side to supply thumb or the index finger. Type A pattern is found in only 14 specimens (23.3%). Type C where Median artery contributing to the arch is found in 2 specimens (3.33%). Among incomplete arches, Type G is found in 10 specimens (55.5%) & Type H arch in 8 specimens (44.4%). **Conclusion-** Ulnar Artery alone contributes to the Superficial palmar arch in majority. Radial artery or its branches need not always contribute to the formation or the arch need not always be complete. Knowledge of these variants is useful to avoid any vascular surgical complications.

KEYWORDS : Superficial Palmar Arch; Complete Arch; Incomplete Arch**INTRODUCTION**

Vascular anatomy of the hand has been an intriguing topic with myriads of literatures spanning from 19th century till present. The Superficial palmar arch (SPA) of hand is an important anastomosis in palm formed mainly by Ulnar artery (UA) which enters the palm anterior to flexor retinaculum. It forms the arch after a little curve to lateral side with its distal convexity in line with the distal border of base of fully extended thumb^[1]. The description on the formation of SPA is that a third of the arches are formed by the UA only. Another third is formed by UA which gets completed by the superficial palmar branch of the radial artery and one third is formed from UA completed by the Arteria radialis indicis or by the Median artery^[1,2]. The variations in the formation of arches and the course of the feeding arteries deserves extra attention while surgeons need to be cautious keeping these variations in mind. These vessels are accessed for Cardiac catheterisation, as access for Haemodialysis, for plastic & reconstructive hand surgeries and forearm flaps. Knowledge of the vascular pattern is essential during various orthopaedic procedures, vascular trauma and microvascular surgeries^[3,4,5]. An unexpected accessory vessel in this area can be a dangerous surprise for the surgeons.

Literature documents multiple classifications in the pattern of arch formation which is exhaustive and complex. The present study aims to re visit the vascular pattern in the formation of SPA and to view these patterns in a simpler and a clear way. This study aims to investigate and define the complete and an incomplete SPA in a newer perspective and to highlight the patterns in the formation of complete SPA. It also aims to investigate any variations from the normal pattern of SPA formation.

MATERIALS AND METHODS

This is a cross-sectional cadaveric study done in the Department of Anatomy during 2019 to 2023 after receiving IRB approval. The sample size was calculated using the mobile application "Sample size calculator- nCalculator." With an estimated 60% prevalence of variation using a 95% confidence level and 20% relative precision, the sample size was calculated to be sixty-five. 78 specimens were included in the study from the total 102 Upper limbs used for the study. The limbs were from Adult Cadavers of 30-90 years. First a transverse incision was put at the wrist joint followed by an incision to the 3rd metacarpophalangeal joint. After reflecting the skin of the palm, the palmar aponeurosis was removed to locate the SPA and its branches. The arteries forming the arch were identified and any variations from the usual pattern of its formation was noted. Details were documented and photographs were taken. Based on its formation, superficial palmar arch was classified as the following.

As per Adachi classification^[6], SPA can receive contributions either

mainly from UA, or from both radial and ulnar arteries. Or it can also receive contributions from Median artery.

As per Coleman and Anson^[7], the SPA is classified as complete and incomplete arch.

Complete arch: When the arteries forming the arch joins with each other or when the UA while supplying the palm reaches the thumb & index finger, the arch is considered complete.

Complete arch is further classified as Type A, B, C, D, E and the incomplete arch is classified as Type F, G, H, I

Type A: This classical arch is formed by superficial palmar branch of radial artery and the UA

Type B: The UA alone forms the arch

Type C: The UA forms the arch along with median artery

Type D: Radial, median, ulnar arteries join to form the arch

Type E: Formed by UA and completed by a branch from deep arch.

Group II: Incomplete arch: The arteries forming the arch does not join with each other or when the UA fails to reach the thumb and index finger

Type F: A branch of radial artery and UA forms supplies palm without anastomosis.

Type G: Only the UA forms SPA. The arch is incomplete because UA does not supply of thumb and index finger.

Type H: Both median and ulnar arteries supplies palm without anastomosis.

Type I: Radial, median, and ulnar supplies palm but do not anastomose.

RESULTS

Of the total 102 specimens, 15 specimens were excluded due to gross damage to the palm, 8 specimens could not be correctly placed to the defined groups and one had a double SPA. Thus 78 specimens were included in the study. 60 specimens were found to have a complete superficial palmar arch (Table 1) where the feeding arteries anastomosed with each other. An arch is complete when the main UA crossed to radial side to supply the thumb and index finger, even though it does not join with the other arteries forming the arch. 18 specimens were found to be incomplete where the UA does not join with other arteries or does not cross to radial side of palm.

Table 1 – Percentage Distribution of Complete and Incomplete Arch

Pattern	%
Complete arch	76.92
Incomplete arch	23.08

The main UA after giving a branch to the ulnar side of little finger gives a branch below the main arch which forms a second arch with in the concavity of the main arch. It joins the superficial palmar branch of radial artery and forms a complete arch. The main arch gives 3 common digital branches and further continues to course the palm to supply the index finger and thumb. Thus, its forms a double complete palmar arch.

The results of classification of SPA by Adachi is shown in Table 2. As per Adachi classification, most common type of complete SPA is found to be the Ulnar type^[6]

Table 2 – Percentage Frequency Of Various Types Of Superficial Palmar Arch As Per Adachi Classification Of Superficial Palmar Arch

Type	Adachi classification	Total- 78	%
1	Ulnar type	54	69.23
2	Radio-ulnar type	22	28.21
3	Mediano-ulnar type	2	2.56

Table 3 – Percentage Frequency Of Various Types Of Superficial Palmar Arch As Per Coleman & Anson Classification

Complete Arch	Total-60	%	Incomplete Arch	Total-18	%
Type A	14	23.33	Type F	8	44.44
Type B	44	73.33	Type G	10	55.55
Type C	2	3.33	Type H	0	0
Type D	0	0	Type I	0	0
Type E	0	0.00			

In the Coleman & Anson classification, as shown in Table 3, most common is Type B pattern (Figure 1) where UA predominantly forms the arch. Its considered complete since it crosses to radial side to supply thumb and the index finger. Type A (Figure 2) is found in 14 specimens where the larger UA receives contribution from Superficial palmar branch of Radial artery (SPR). Persistent median artery forming the complete SPA was found in 2 cases(Figure 3)

Among the Incomplete arch, Type G pattern is more common followed by Type F. Type G where UA alone forms the incomplete arch without crossing to the radial side is found in 10 specimens whereas Type F (Figure 4) incomplete arch with non-anastomosing UA and radial artery is found in 8 specimens.



Figure 1 – Shows Predominantly Ulnar Type Of Complete Arch - Type B Complete Arch
(SPA-Superficial Palmar Arch, UA-Ulnar artery, CPDA-Common Palmar Digital Artery, PDA-Proper Digital Artery)



Figure 2 – Shows Classic Radio Ulnar Complete Arch - Type A Complete Arch
(SPA-Superficial Palmar Arch, SPR- Superficial palmar branch of radial artery, UA-Ulnar artery, CPDA-Common Palmar Digital Artery)



Figure 3 – Shows Mediano Ulnar Arch- Type C Complete Arch
(SPA-Superficial Palmar Arch, UA-Ulnar artery, RA-Radial Artery, PMA-Persistent Median artery, MN-Median Nerve, CPDA-Common Palmar Digital Artery)

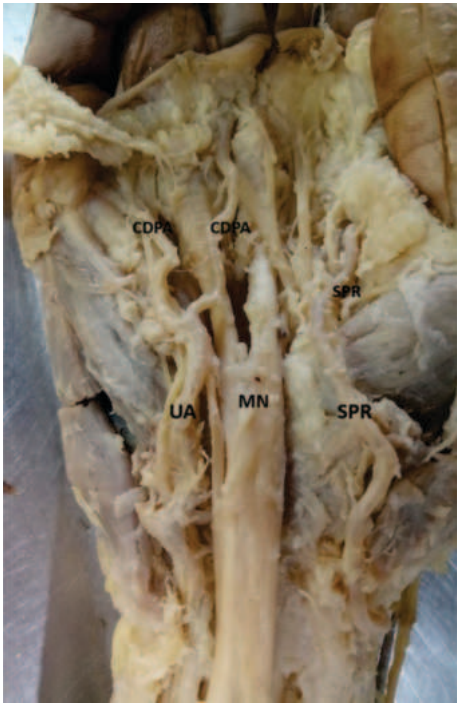


Figure 4 – Shows Incomplete Radio Ulnar Arch – Type F Incomplete Arch
(UA-Ulnar artery, SPR-Superficial Palmar Branch of Radial Artery, MN-Median Nerve, CPDA-Common Palmar Digital Artery)

DISCUSSION

Variations in the pattern of SPA are studied by different researchers like Jaschtschinski , Adachi , Anson, and Coleman. Previous authors like Karlsson (1982) , Joshi (2014) , Patnaik (2002) who have followed the classification either by Adachi or Coleman and Anson have found comparable observations [8,9,10]. The present study correlates with most of the earlier studies. The SPA is mostly of ulnar type followed by radio ulnar type in most cases (Table 4). In ulnar type of complete SPA, the arch is entirely formed by UA. It supplies thumb and index finger without forming any connections with radial artery. In these cases, since the sole supply is coming from a single artery any injury to this artery could put the thumb and index finger in danger [10]

Table 4- Comparison Of Types Of Arches With Previous Studies

Type	Parttern	Adachi (1928)	Karlsson (1982)	Joshi (2014)	Present Study
1	Ulnar type	59%	64%	66%	69.23
2	Radio-ulnar type	32%	32%	30%	28.21
3	Mediano-ulnar type	9%	4%	4%	2.56

On comparing the types of complete arch most studies including the present study found Type B as the most common study & type D being the least common as shown in the table 5.

Little JM et al found that usually there is collateral circulation in the palm. So, when either radial or UA was occluded at the wrist, viability of fingers is still maintained. But they found that in 9% of the cases, when the UA alone was occluded, there was a gross reduction of circulation [11]

Table 5- Comparison Of Types Of Arches With Previous Studies

Studies by different authors	Type A	Type B	Type C	Type D	Type E	Type F	Type G	Type H	Type I	oth ers
Present study	17.95	56.41	2.56	0	0	10.26	12.82	0	0	0
Coleman & Anson (1961)	34.5	37.1	3.8	1.2	2	3.2	13.4	3.8	1	0
Patnaik (2002)	76	2	0	0	0	12	0	4	0	6

Joshi (2014)	4	56	0	0	22	4	10	4	0	0
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Double superficial palmar arch as found in our study has been previously reported by authors like Patnaik , Jyoti, Gindha [10,12,13]. Patnaik, Jyoti reported double palmar arch of mediano ulnar type where as Gindha like the present study had radio ulnar type of double arch.

Median artery taking part in arch formation has been reported by authors like Coleman, Adachi, Simic Marko et al, Bhagyalakshmi et al [14,15] . Bhagyalakshmi reported a triarterial arcade -the radial, median,ulnar type of superficial palmar arch.Mookambika et al observes that in hand surgeries, one should be aware of the variations in the arches and the artery of their origin,.The greatest risk associated with radial artery graft specimen for bypass surgery is ischemia of soft tissues of palm . Complications will be less if UA is the main supply to first web space. A damage to the UA can cause an issue during ulnar skin flaps [16] It is important to screen the patient preoperatively to assure the presence of healthy collateral supply of hand . To conclude, the arterial pattern in palmar superficial arch is more an ulnar dominant and a complete one different from the classic description. Knowledge of normal variants in the pattern of the arch formation is useful to avoid any vascular surgical complications.

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