ANATOMICAL VARIATION OF THE HUMAN SUPERFICIAL PALMAR ARCH: A CADAVERIC STUDY

Allin Pradhan, Usha Chalise, Shaligram Dhungel

Department of Human Anatomy, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal

ABSTRACT

Superficial palmar arch is the main arterial supply of palm and formed by the superficial terminal branch of ulnar artery and superficial palmar branch of radial artery. Coleman and Anson, classified the superficial palmar arch (SPA) in two groups, Group I and Group II. Group I, complete arch which is further divided into five types as A, B, C, D and E. Group II, incomplete arch, which is further divided into four types as F, G, H and I. Therefore, the aim of this study was to demonstrate anatomical variation of the human superficial palmar arch in human beings taking examples from cadaveric study. In the present study 50 embalmed cadaveric upper limbs of both side were dissected over a period of one year available in the Department of Human Anatomy, Nepal Medical College, Kathmandu, Nepal. The complete type of SPA according to Coleman and Anson classification was found in 48 (96.0%) hands and incomplete types of SPA was found in 2 (4.0%) of the hands. Two subgroups were observed in the complete SPA group: Type A - formed by the ulnar artery and the superficial branch of the radial artery was observed in 41 (82.0%) hands. Type B - formed by ulnar artery was seen in 7 (14.0%) hands. One subgroup of incomplete Type G - was found in 2 (4.0%) hands. This study provides details about the anatomical variations of superficial palmar arch in humans which aims to be enlightening for the operating hand surgeons and orthopedicians.

KEYWORDS

Superficial palmar arch, ulnar artery, radial artery, variations, complete arch and incomplete arch

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CORRESPONDING AUTHOR

Dr. Allin Pradhan,
Associate Professor,
Department of Human Anatomy,
Nepal Medical College Teaching Hospital,
Attarkhel, Gokarneshwor-8, Kathmandu, Nepal
Email: meallinsh@gmail.com
Orcid No: https://orcid.org/0000-0001-5729-8811
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INTRODUCTION

Human hand is highly evolved in terms of its complexity and variation.[1] The radial and ulnar arteries and their terminal branches in the form of two arterial arches, superficial and deep palmar arches supply the palm. Superficial palmar arch is the main arterial supply of palm.[2,3] The superficial palmar arch is an anastomosis fed mainly by the ulnar artery. The 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 hamates, and then curves laterally to form an arch. The convexity of arch is directed distally on a level with the distal border of outstretched thumb.[4] The arch is formed by the superficial terminal branch of ulnar artery and completed on the lateral side by one of the following arteries: (a) Superficial palmar branch of radial artery (b) Arteria princeps pollicis (c) Arteria radialis indicis or (d) Arteria nervi mediana which accompanies the median nerve.[5] The formation of superficial palmar arch is highly variable with various types of contributions coming from ulnar, radial and median arteries.[6]

Superficial palmar arch is said to be entirely formed by ulnar artery when it does not receive any contribution from the radial artery and is found with a higher incidence than the classical type in a study by Suman *et al*[8] where this type was found in 50.0% of specimens and it was suggested that it cannot be called as a variation. They also opined that ulnar artery occlusion may cause claudication and gangrene in the digits.[7-9] The variations in the formation of the superficial palmar arch was first reported by Jaschtschinski[10] in 1897 and classified into complete and incomplete arches. The vascular patterns of the palmar arches and their interconnecting branches present a complex and challenging study. Many attempts have been made to classify these variations. One of the first reports that presented a classification of palmar arches was the classic work of Coleman and Anson.[1] According to Tagil *et al*,[11] Coleman and Anson in 1961, classified the superficial palmar arch in two groups, Group I and Group II as follows. Group I is the complete arch: Contributing vessels anastomose with each other constituting arch which are further divided into five types. Type A, Type B, Type C, Type D and Type E. Group II is the incomplete arch: Contributing vessels do not anastomose with each other which are further divided into four types that is F, G, H and I.

Group I-

Type A: SPA formed by the ulnar artery and the superficial branch of the radial artery.

Type B: SPA formed entirely by the ulnar artery.

Type C: SPA formed by the median and ulnar arteries.

Type D: SPA formed by the radial, median and ulnar arteries.

Type E: SPA formed by the ulnar artery (a branch from deep palmar arch).

Group II-

Type F: SPA formed by the ulnar artery which doesn't contribute to the blood supply to the thumb and index finger.

Type G: SPA formed by the ulnar artery and the superficial branch of the radial artery.

Type H: SPA formed by the independent radial, median and ulnar arteries, where the 1st and

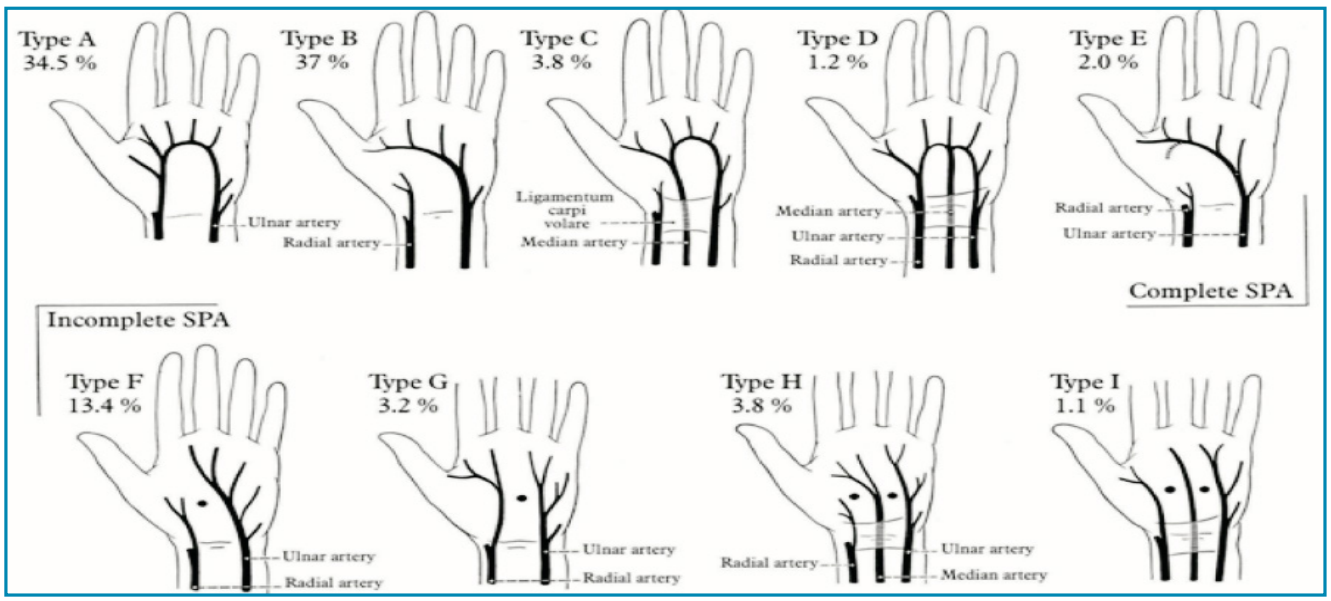

Fig. 1: Complete and incomplete types of the SPA and incidence which were described by Coleman and Anson.[1,11]

2nd digits involved branches of median artery.

Type I: SPA formed by the independent radial, median and ulnar arteries.[11]

Considering the recent progress of microsurgery in revascularization, re-implantation and composite tissue transfer, detailed knowledge about circulatory dynamics of hand including possible variations would be fundamental in clinical practice.[12,13] Effective collateral circulation in palm is essential in peripheral arterial diseases such as Raynaud's disease and in harvesting radial artery or the ulnar artery for coronary artery bypass graft (CABG) surgery.[3] In the perspective of updating the unusual configurations, the present study is attempted to revisit the morphological details of SPA and provide clinico-anatomical correlations.[14] Therefore, the aim of this study was to demonstrate anatomical variation of the human superficial palmar arch in a cadaver.

MATERIALS AND METHODS

The present study was observational, descriptive and cross-sectional study. In which 50 embalmed cadaveric upper limbs of both side available in the Department of Human Anatomy, as well as upper limbs dissected during routine dissection classes of first year medical undergraduates were dissected over a period of one year from May 2024 - April 2025, at the Department of Human Anatomy of the Nepal Medical College, Kathmandu, Nepal. The study was carried out after getting an ethical approval from the Institutional Review Committee of Nepal Medical College Teaching Hospital, Gokarneshwor-8, Kathmandu, Nepal (Ref. No.: 64-080/081).

Two horizontal incisions were made, one at the wrist joint and another incision along the root of fingers. A vertical incision was made from the middle of the wrist to the 3rd metacarpo-phalangeal joint. The skin of the palm and the palmar aponeurosis were reflected. The surrounding adipose tissue were removed to view the course and branches of the radial artery, ulnar artery and superficial palmar arch.[5] The variations patterns of the superficial palmar arches were observed and if variation was present, it was categorized with reference to Coleman and Anson[1] classification. Variation that did not correspond to Coleman and Anson[1] classification were presented as other pattern. The variation patterns of the SPA were observed and photographs were taken by digital camera and documented. All observed and collected data were analyzed statistically by using SPSS-16.

Fig. 2: Type A: SPA (complete type) formed by the ulnar artery and the superficial branch of the radial artery (right hand).

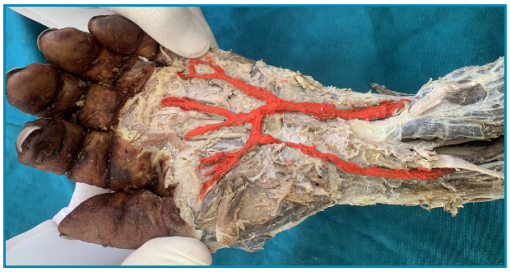

Fig. 3: Type A: SPA (complete type) formed by the ulnar artery and the superficial branch of the radial artery (left hand).

Fig. 4: Type B: SPA (complete type) formed entirely by the ulnar artery (right hand)

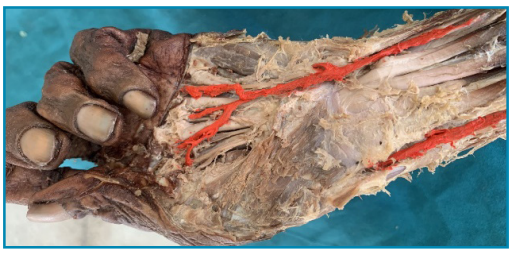

Fig. 5: Type B: SPA (complete type) formed entirely by the ulnar artery (left hand)

Fig. 6: Type G: SPA (incomplete type) formed by the ulnar artery and the superficial branch of the radial artery (right hand)

RESULTS

Variation patterns in formation of superficial palmar arch in the present study are shown in Fig. 7. The complete type of SPA according to Coleman and Anson[1] classification was found in 48 (96.0%) hands and incomplete types of SPA was found in 2 (4.0%) of the hands. Two subgroups were observed in the complete SPA group: Type A: SPA formed by the ulnar artery

Table 1: Incidences percentage of variations in the current study

Arch Types	Total Number of hands (50)	Percentage (100.0%)
Complete arch	48	96.0%
Type A	41	82.0%
Type B	7	14.0%
Incomplete arch (Type G)	2	4.0%

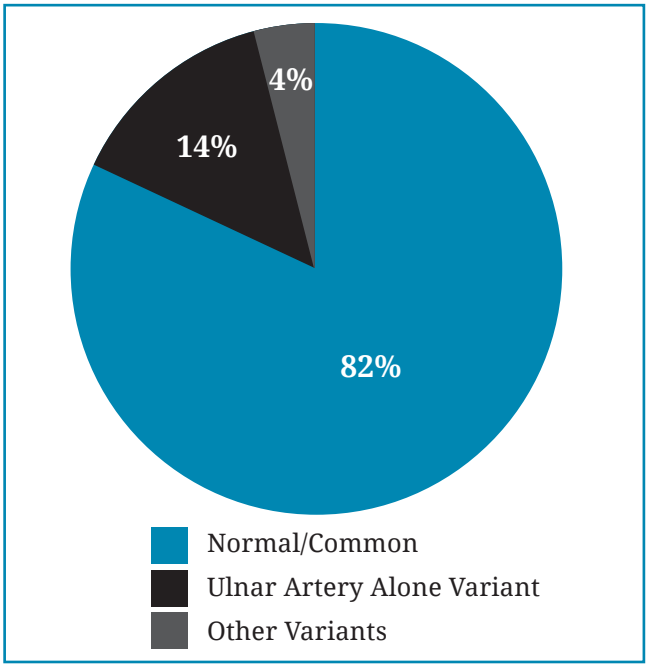

Fig. 7: Variation patterns in formation of superficial palmar arch

Table 2: Showing observation of variants of complete superficial palmar arch

Type	Right Hand	Left Hand	Percentage	Remarks
A	21	20	82.0%	Most common
B	4	3	14.0%	Second most common

Table 3: Showing observation of variants of incomplete superficial palmar arch

Type	Right Hand	Left Hand	Percentage	Remarks
G	2	0	4.0%	Exclusively found on right hand

Table 4: Showing Comparison of superficial palmar arch in different studies

Features	Colemen and Anson 1961[1]	Ikeda *et al* 1988[12]	Patnaik *et al* 2002[24]	M. Chimmalgi *et al* 2004[25]	Bilgeo *et al* 2006[26]	Tagil *et al* 2007[11]	Umpaththy *et al* 2012[27]	Dubeyak 2017[21]	Jose BA 2017[28]	Madhyastha *et al* 2011[16]	Present study
Sample size	650	220	50		50	20	50	70	69	45	50
Group I	78.5%	96.4%	78.0%	88.0%	86.0%	75.0%	78.5%	78.3%	96.0%	93.7%	96.0%
Type A	34.5%	55.9%	76.0%	46.0%	34.0%	40.0%	37.5%	32.1%	39.0%		82.0%
Type B	37%	25.5%	2.0%	26.0%		35.0%	37.0%	29.3%	17.0%	2.1%	14.0%
Type C	3.8%			8.0%				9.3%	9.0%		
Type D	1.2%			2.0%				3.6%			
Type E	2%			6.0%				5.0%	31.0%		
Group II	21.5%	3.6%	16.0%	12.0%	14.0%	25.0%	21.5%	20.2%	4.0%	6.2%	4.0%
Type F	3.2%		12.0%	4.0%			2.1%	10.0%			
Type G	13.4%			2.0%				5.3%	4.0%		4.0%
Type H	3.8%		4.0%	4.0%				3.5%			
Type I	0.0			2.0%				1.43%			
Total	100.0%		94.0%	100.0%			97.9%	100.0%			

and the superficial branch of the radial artery was observed in 41 (82.0%) hands (Fig. 2 and 3). Type B: SPA formed by ulnar artery was observed in 7 (14.0%) hands (Fig. 4 and 5). One subgroup of incomplete SPA: Type G was found in 2 (4.0%) hands (Fig. 6). Incidence percentage of variations in the current study are shown in Table 1. Among them also Type A present in 21 right hands and 20 left hands (Fig. 2 and 3), Type B Present in 4 right hands and 3 Left hands (Fig. 4 and 5) and Type G was found both in right hands (Fig. 6). Showing observations of variants of complete and incomplete superficial arch are shown in Table 2 and Table 3, respectively. Table 4 shows the comparison of superficial palmar arch in different studies.

DISCUSSION

Variations in the arterial pattern of the upper limbs have frequently been observed in routine dissections. Comparison of the result of this study with other studies is shown in Table 4.

In our study, a complete arch was observed in 96.0%, which was similar to the study done by Jose *et al*,[28] Ikeda *et al*,[12] Madhyastha *et al*[16] where they found such type in 96.0%, 96.4%, 93.7% respectively but in contrast to our study others authors; Dubey *et al*,[21] Umapathy *et al*,[27] Tagil *et al*,[11] and Coleman *et al*,[1] found complete arch in 78.3%, 78.5%, 75.0% and 78.5% respectively.

We found Type A SPA in 84.0% of the cases, which was similar to Madhyastha *et al*[16] and Vidhya *et al*,[17] where they found in 82.0% and 86.0% respectively. Unlike other authors (Dubey *et al*,[21] Coleman and Anson[1] and Tagil *et al*,[11] they found Type A in 32.1%, 34.5% and 40.0%, respectively).

In the result of the present study, Type B SPA was observed in 14.0% of the cases which was found similar to Madhyastha *et al*[16] and B.Jose *et al*[28] in their finding they recorded 14.0% and 17.0% of the cases, respectively. In contrast to our type B was more prevalent in other studies as indicated in the study of Tagil *et al*,[11] Umpaththy *et al*[27] and Coleman and Anson[1] where they found type B in 35.0%, 37.0% and 37.0%, respectively.

In our study, an incomplete arch was seen in 4.0% which was as similar to the study carried out by different authors[28,12,16,17] where they found such incomplete type in 4.0%, 3.6 %, 6.25% and 8.0% respectively. Our study differs from other authors as Dubey *et al*,[21] Umapathy *et al*,[27] Tagil *et al*[11] and Coleman and Anson[1] who had reported incomplete type in increased pattern 20.23%, 21.5%, 25.0% and 21.5%, respectively.

Jose *et al*[28] found type G incomplete SPA in 4.0% of the cases which was similar to our study that was 4.0% whereas Coleman and Anson[1] found in 13.4%, where their percentage was higher than our studies. In our study, we found type A in 21 right hands and 20 left hands which was similar to the study of Rajan *et al*[21] and Vidhya *et al*.[17] They found type A in 23 right hands and 22 left hands and 22 right and 21 left hands respectively.

In our study type B was found in 4 right hands and 3 left hands which was similar to Vidhya *et al*[17] where they found type B in 2 right hands and 1 left hand. In contrast to our study Rajan *et al*[21] found type B in 21 right hands and 20 left hands. Hence type A found in our study was almost similar to the study carried out by Rajan *et al*[21] but type B were more in number compared to our findings.

We found type G only in 2 right hands but Rajan *et al*[21] got the pattern of type G in both 5 right and 3 Left hands. Thus with the established information and result of the present study adds to the existing knowledge about the anatomical variations associated with superficial palmar arch. In our study complete SPA was observed in 96.0% of the specimen, which showed high prevalence of collateral anastomotic pattern in hand as shown in Table 4 and complete absence of SPA was not observed in any of the specimen as reported by Paul *et al*.[29]

In conclusion, the knowledge of variations in the pattern of superficial palmar arch is significant for Anatomists, Orthopaedicians, Radiologists and Traumatic care surgeons for micro vascular arterial restorations in cases of inefficient collateral circulation due to ulnar artery occlusions. Effective collateral circulation in palm is essential in peripheral arterial diseases such as Raynaud's disease and in harvesting radial artery or the ulnar artery for Coronary Artery By pass Graft (CABG) surgery. The present study will provides details about anatomical variations of superficial palmar arch in humans which aims to be enlightening for the operating hand Surgeons and Orthopedicians and recent advances in the microsurgical techniques for reconstructive hand surgeries.

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