A STUDY ON THE MORPHOLOGICAL VARIATIONS OF SUPERFICIAL PALMAR ARCH

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ABSTRACT

BACKGROUND

Hands are the most important appendages of human beings. All human hands look alike. But on a detailed study, it can be seen that each and every human hand are unique. Superficial and deep palmar arches form the main feeder of the hand. A classic superficial palmar arch is formed by the superficial branch of the ulnar artery and superficial branch of radial artery. The deep palmar arch is formed by anastomosis of the radial artery with a deep branch of the ulnar artery.

The objective of the present study was to study the morphological variations of superficial palmar arch in human.

MATERIALS AND METHODS

Morphology of Superficial Palmar Arch (SPA) of 30 hands from 15 embalmed human cadavers with no sex or age discrimination were studied in the Department of Anatomy, Govt. T. D. Medical College, Alappuzha. The observations were then recorded and classified based on the classification put forward by Coleman S. S. and Anson B. J. in 1961.

RESULTS

The different types of superficial palmar arches obtained in the present study were as follows: Complete superficial palmar arch (93.33%) [Type A- 15 (50%), Type B- 10 (33.33%), Type C- 1 (3.33%), Type D- 0, Type E- 0, others- 6.66%]; Incomplete superficial palmar arch (6.66%) [Two cases of Type C only]. Median artery forming superficial palmar arch was seen in 16.66% of cases. In addition to this, two variant forms of superficial palmar arches were observed, which were rarely reported in available literature.

CONCLUSION

The present study confirms that the ulnar artery is the dominant vessel, which contributes for the superficial palmar irrigation and the incidence of complete superficial palmar arch is very high compared to the incomplete superficial palmar arch.

KEYWORDS

Superficial Palmar Arch, Complete Arch, Incomplete Arch.


BACKGROUND

The ability of human brain to think, assume, imagine and to dream could be practically projected only to a larger extent with the help of hands. Arterial supply of hand is mainly derived from two anastomotic arches (superficial and deep palmar arches), formed from two terminal branches of brachial artery i.e. radial and ulnar artery. Variations in the formation of superficial and deep palmar arch are very common. The superficial palmar arch is a dominant arterial arcade present over the palmar aspect of the hand formed by receiving a major contribution from ulnar artery.

Objective

The objective of present study was to study the morphological variations of superficial palmar arch in human.

MATERIALS AND METHODS

The material for present study comprised of 30 upper limbs taken from 15 cadavers with no sex or age discrimination, which were used for the routine undergraduate dissection in the Department of Anatomy, Govt. T. D. Medical College, Alappuzha. These cadavers were embalmed with 10% formalin and fixed. Superficial palmar arches in them were dissected with classical incisions and dissection procedure of Cunningham’s manual. Morphology of Superficial Palmar Arch (SPA) was studied in detail and variations from the usual patterns were observed. The Common Palmar Digital Arteries (CDA) were named from the first to fourth interosseous space of hand as 1st, 2nd, 3rd and 4th CDA. The observations were then recorded and classified based on the classification put forward by Coleman S. S. and Anson B. J. In 1961, Coleman S. S. and Anson B. J. classified superficial palmar arch into two groups. Group 1- Complete arch and Group II- Incomplete arch.

Group-1: Complete Arch (78%)

A complete arch is defined as an arch, in which the contributing arteries anastomose with each other or those arches in which ulnar artery reaches the first interosseous space to supply the thumb and index finger. It can be further divided into five types-
Type A- Classical radioulnar arch formed by superficial palmar branch of radial artery and large ulnar artery.

Type B- Arch entirely formed by ulnar artery and is complete in the sense that it supplies the thumb and index finger in addition to other fingers.

Type C- Mediano-ulnar in which ulnar artery anastomoses with an enlarged median artery to form the arch.

Type D- Radio-mediano-ulnar intercommunication, in which three vessels enter into the formation of superficial palmar arch.

Type E- A well-formed superficial palmar arch initiated by ulnar artery and is completed by a well-formed branch from the deep palmar arch.

Group II: Incomplete Arch
When the contributing arteries do not anastomose with each other or when the ulnar artery fails to reach the first interosseous space to supply the thumb and index finger, then it is called an incomplete arch.

Group II is further divided into four types-

Type A- Both superficial palmar branches of radial artery and ulnar artery contribute in supplying the palm and fingers, but they do not anastomose with each other.

Type B- Only the ulnar artery forms superficial palmar arch. But here the ulnar artery does not contribute in supplying thumb and index finger.

Type C- In this type median and ulnar artery are the contributing vessels, but they do not anastomose with each other.

Type D- Radial, median and ulnar arteries take part in the superficial irrigation of the palm, but do not anastomose.

RESULTS
In this study, we observed that out of 30 upper limbs studied, 28 (93.33%) were complete superficial palmar arches, in which the contributing vessels anastomosed with each other or the ulnar artery was capable to supply the adjacent sides of thumb and index finger. An incomplete superficial palmar arch, in which the contributing vessels did not anastomose with each other or the ulnar artery terminated without supplying thumb and index finger was observed in 2 hands (6.66%).

The different types of complete superficial palmar arches obtained in the present study (Chart-1) were as follows: Type A- 15 (50%), Type B- 10 (33.33%), Type C- 1 (3.33%), Type D- 0 and Type E- 0. In addition to this we got two (Fig. 7 and 8) variant forms of complete SPA, which cannot be classified according to Coleman S. S. and Anson B. J. classification.

The two incomplete arches (Fig. 6) we obtained in this study were of Type C (6.66%).
In Fig 1, Type A complete superficial palmar arch of classical variety can be seen. Here, the arch was formed by the superficial branch of ulna with superficial branch of radial artery. Both contributing arteries were fairly large and comparable in size. They made almost equal contribution to the formation of SPA. Here the superficial branch of radial artery gave off the first CDA to the first web space, which divided into proper palmar digital arteries to the adjacent sides of thumb and index finger; 2nd, 3rd and 4th CDA and proper palmar digital artery to the little finger arose from the superficial branch of ulnar artery. The peculiarity noted here was that the fourth CDA and PDA to the little finger arose as a common trunk.

**Figure 2**

In Fig 2, Type A complete superficial palmar arch formed by superficial palmar branch of radial artery and superficial branch of ulnar artery can be seen. Here, the connection between the contributing arteries was by a slender connecting vessel. Here the patterns of branching of palmar digital arteries were similar compared to Fig 1. A rare peculiarity noted here was that the 4th CDA and PDA to the ulnar side of little finger arose from a fairly long common trunk which reached up to the medial aspect of the long flexor tendon to the little finger and here it divided into proper palmar digital artery to the little finger and 4th CDA. The latter was passing deep to the long flexor tendons. This is a very rare variation in the course of common palmar digital artery.

**Figure 3**

In Fig 3, complete Type B superficial palmar arch can be seen. This arch was complete in the sense that the superficial branch of ulnar artery reached the first web space and supplied the adjacent sides of index finger and thumb by dividing into PDA (Coleman S. S. and Anson B. J.). It was noted that there was no contribution from the radial artery in the superficial irrigation of palm.

**Figure 4**

In Fig 4, Type B complete SPA can be seen. Here, the arch was formed by the anastomosis between superficial branch of ulnar artery and Princeps Pollicis Artery (PPA) from radial artery.
Figure 5

In Fig. 5, Type C complete SPA was formed by superficial branch of ulnar artery and median artery. Here, it formed a morphologically complete arch which gave rise to all the common digital arteries and proper digital artery to the radial side of thumb and ulnar side of little finger. In this case also, the fourth CDA and PDA to the little finger arose as a common trunk.

Figure 6

In Fig. 6, Type C incomplete SPA can be seen. The superficial irrigation of palm was contributed by the ulnar and median artery. After giving the PDA to the ulnar side of little finger, the superficial branch of ulnar artery passed forward and bifurcated into 3rd and 4th CDA. Median artery after emerging from the carpal tunnel gave rise to 2nd CDA and a common trunk, which passed through the interosseous space. After giving a PDA to the radial side of the thumb, it passed through the first interosseous space and gave two proper palmar digital arteries. Here, there was no anastomosis with the contributing arteries.

Figure 7

In Fig. 7, rare variety of superficial palmar arch which was not mentioned by Coleman S. S. and Anson B. J. (Median-radial type of SPA) can be seen. Here, the territory which had to be supplied by superficial palmar arch was irrigated by the ulnar, median and radial arteries. The median artery after its exit from the carpal tunnel was divided into 2nd and 1st common digital arteries. The 1st common palmar digital artery in turn was divided into proper palmar digital artery to the ulnar side of thumb anastomosed with Princeps Pollicis Artery (PPA) which arose from the radial artery, thus forming the median-radial type of SPA. But note that here the ulnar artery in spite of not forming part of superficial palmar arch, made the major contribution in the irritation of hand by forming proper digital artery to ulnar side of little finger and 3rd and 4th CDA.

Figure 8

In Fig. 8 also median-radial type of SPA with additional anastomoses with a branch from deep palmar arch can be noted. After the formation of second common palmar digital artery, the median artery reached the first web space and
anastomosed with a branch arising from the deep palmar arch. From this point of anastomosis, the artery passed forward as a common trunk for PDA to the radial side of thumb and 1st CDA. The proper palmar digital artery to the ulnar side of the thumb from 1st CDA anastomosed with 1st dorsal metacarpal artery (Fig 8- Inset) arising from radial artery. It should be noted that here the median artery or its branches made anastomosis with the branches of radial artery at two points. Even though the ulnar artery did not take part in formation of SPA, it supplied 3rd and 4th fingers, ulnar side of little finger and corresponding region of palm.

DISCUSSION

The superficial palmar arch is a dominant arterial arcade present over the palmar aspect of the hand formed by receiving a major contribution from the ulnar artery. In the present study also, we observed that the ulnar artery is the dominant vessel which contributes for the superficial palmar irradiation. In all hands in our study, ulnar artery is the sole vessel which supplies the palmar surface of medial 2 and half fingers and the corresponding parts of the palm. In addition to this in type B, complete SPA it extends up to the first web space and supplies all the fingers and palm except radial side of thumb. This dominance of ulnar artery in superficial irradiation has been highlighted by several workers. According to Kaplan (1961), the superficial palmar arch is formed by the ulnar artery in 66% of cases.

Adachi (1928) thinks that the superficial palmar arch has an ulnar-prevalent formation, which he calls the Ulnar-type and finds it in 59% of cases.

The variations of superficial palmar arch was studied in 30 hands and classified in accordance with Coleman S. S. and Anson B. J. Complete superficial arch, in which the contributing vessels anastomosed with each other or the ulnar artery was capable to supply the adjacent sides of thumb and index finger was found in 93.33% of hands in the present study. An incomplete superficial palmar arch in which the contributing vessels did not anastomose with each other or the ulnar artery terminates without supplying thumb and index finger was observed in 6.66% of hands.

The incidence of complete and incomplete superficial palmar arch observed by different authors was compared with the present study in Table 1.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Author</th>
<th>Complete SPA (%)</th>
<th>Incomplete SPA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jaschinski SN (1897)</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Piersol (1911)</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>Coleman SS, Anson B. J (1961)</td>
<td>78.5</td>
<td>21.5</td>
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<td>4</td>
<td>Mozerzyk DJ, et al (1973)</td>
<td>65.7</td>
<td>34.3</td>
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<tr>
<td>5</td>
<td>Janevski BK (1982)</td>
<td>42.4</td>
<td>57.6</td>
</tr>
<tr>
<td>7</td>
<td>Al Turk M, Metcalf WK (1984)</td>
<td>84</td>
<td>16</td>
</tr>
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<td>9</td>
<td>Pola (1996)</td>
<td>94.1</td>
<td>5.9</td>
</tr>
<tr>
<td>11</td>
<td>Gellman H, et al (2001)</td>
<td>84.4</td>
<td>15.6</td>
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</tbody>
</table>

Among these workers Coleman S. S., Anson B. J., Koman A et al (1999) and Patnaik et al (2002) reported 78.5% of complete superficial palmar arches.


The different types of complete superficial palmar arches obtained in the present study (Chart 1) were as follows: Type A-15 (50%), Type B-10 (33.33%), Type C-1 (3.33%), Type D-0 and Type E 0. In addition to this, we got 2 (6.66%) variant forms of complete SPA which cannot be classified according to Coleman S. S. and Anson B. J. classification.

These two variants can be named as median-radial type of superficial palmar arch, which was not mentioned by Coleman S. S. and Anson B. J. Median radial type is a very rare type of superficial palmar arch, where the median artery anastomoses with the radial artery and has a minimum or absent contribution of the ulnar artery in SPA. Although, the formation of the SPA by the MA and RA has been mentioned in the literature (Keen 1961), only one case was reported in the available literature by Soubhagya R. Nayak et al in 2008.

In one of the hands with the above discussed variant form (Fig 8), it not only anastomosed with 1st dorsal metacarpal artery of radial artery, but also anastomoses with a branch from deep palmar arch. This is also a very rare variety, which was not found in the available literature.

The incidence of different types of complete superficial palmar arch observed by different authors were compared with the present study in Table 2.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Author</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
<th>Type E</th>
<th>Others</th>
<th>Total</th>
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<tbody>
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<td>1</td>
<td>Coleman SS, Anson B. J (1961)</td>
<td>35</td>
<td>37</td>
<td>3.8</td>
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<td>0</td>
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<td>36</td>
<td>31</td>
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<td>0</td>
<td>0</td>
<td>66.6</td>
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<td>3</td>
<td>Patnaik VVG, et al (2002)</td>
<td>76</td>
<td>2</td>
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<td>0</td>
<td>0</td>
<td>78</td>
</tr>
<tr>
<td>4</td>
<td>Loukas M, et al (2005)</td>
<td>40</td>
<td>35</td>
<td>15</td>
<td>6</td>
<td>4</td>
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<td>5</td>
<td>Suleyman MT, et al (2007)</td>
<td>40</td>
<td>35</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>75</td>
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<td>6</td>
<td>Present study</td>
<td>50</td>
<td>33</td>
<td>3.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Table 1. Incidence of Complete and Incomplete Superficial Palmar Arch

Table 2. Incidence of Different Types of Complete Superficial Arch

In present study, the incidence of Type A complete SPA is slightly higher than the available studies except Patnaik et al. But in case of Type B complete arch, the result is comparable with the available studies except Patnaik et al. In the case of
Type C, SPA incidence obtained by Coleman S.S. and Anson B. J. was comparable with that of present study.

Type D and Type E complete superficial palmar arch, which was not obtained in present study.

The incomplete superficial palmar arches were also classified according to Coleman S. S. and Anson B. J. But we obtained only two incomplete arches (Fig. 6), which were of Type C (6.66%). The incidence of Type C incomplete is slightly higher than the available studies.

<table>
<thead>
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<th>Sl. No.</th>
<th>Author</th>
<th>Type of Incomplete SPA (%)</th>
<th>Total (%)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Coleman SS, Anson BJ (1961)</td>
<td>3.2 13.4 3.8 1.1 0</td>
<td>21.5</td>
</tr>
<tr>
<td>2</td>
<td>Gillman H, et al (2001)</td>
<td>4.4 11.1 0 0 0</td>
<td>15.1</td>
</tr>
<tr>
<td>3</td>
<td>Patnaik VVG, et al (2002)</td>
<td>12 0 4 0 0</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>Suleyman MT, et al (2007)</td>
<td>0 0 0 5 0</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>Present study</td>
<td>0 0 6.6 0 0</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Table 3. Incidence of different Types of Incomplete Superficial Palmar Arch

 Persistent palmar type of median artery with superficial palmar arch (Fig. 5 to 8) contributed by it was observed in 5 hands in the present study with an incidence of 16.66%. Out of the five hands, one hand showed a complete Type C superficial palmar arch and two hands showed incomplete Type C arch. The other two are the variant forms, which have discussed earlier.

The persistent median artery, which gave contribution to the superficial palmar arch was reported by many workers as shown in Table 4. The results are compared with those of other workers, who classified the superficial palmar arches in the same manner. Observations made by Tandler et al (1897) and Thakklapalli Anitha et al (2011) are comparable to that of present study (16.66%).

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Author</th>
<th>Incidence (%)</th>
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<tr>
<td>1</td>
<td>Tandler, et al (1897)</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Piersol (1911)</td>
<td>7.5</td>
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<tr>
<td>3</td>
<td>Adachi (1928)</td>
<td>8</td>
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<td>4</td>
<td>Coleman SS, Anson BJ (1961)</td>
<td>9.9</td>
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<td>5</td>
<td>Janevski BK (1982)</td>
<td>2.2</td>
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<td>6</td>
<td>Al Turk M, Metcalf WK (1994)</td>
<td>10</td>
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<td>7</td>
<td>Ikeda A, et al (1986)</td>
<td>0.9</td>
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<td>8</td>
<td>Rodriguez-Niedenfuhr M²¹(1999)</td>
<td>28</td>
</tr>
<tr>
<td>11</td>
<td>Thakklapalli Anitha et al (2011)</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Present study</td>
<td>16.6</td>
</tr>
</tbody>
</table>

Table 4. Incidence of Persistent Palmar type of Median Artery

The presence of persistent median artery is not bilateral in the present study. It is likely that the factors responsible for these variations could be acting unilaterally.

Common and proper digital arteries are branches of superficial palmar arch arising from its convex surface. According to the classic descriptions there are three common digital arteries corresponding to the 2nd, 3rd and 4th interosseous spaces. Tandler (1897) after an extensive study on 130 hands, proposed the existence of a common digital artery in the first web space and named it as the 1st common digital artery or the Tandler’s artery. Later Coleman S.S. and Anson B.J. and Al Turk M. et al confirmed this finding with their studies on superficial palmar arch. In the present study in 24 hands (80%), we had 4 common digital arteries either arising directly from the convex surface of arch or part of a common stem for CDA and PDA. So Tandler’s finding is again confirmed in the present study.

Out of these 24 hands, one showed a common trunk for the 1st CDA and PDA to radial side of thumb (Fig. 8). Out of all the hands studied in the present study, 3 hands showed a common trunk for the 4th common digital artery and proper digital artery to the ulnar side of little finger (Fig. 1, 2 and 5). A rare peculiarity, which was noted in one of the cases (Fig. 2) here is that the 4th CDA and PDA to the ulnar side of little finger arise from a fairly long common trunk, which reaches up to the medial aspect of the long flexor tendon to the little finger and there it divides into proper digital artery to the little finger and 4th CDA. The latter is passing deep to the long flexor tendon. This is a very rare variation in the course of common digital artery and is not found in available literature.

In 6 hands (20%), common digital arteries corresponding to the 2nd, 3rd and 4th interosseous spaces were found. Palmar digital arteries to the ulnar side of thumb and to the radial side of index finger originated separately from the arch. PDA to the ulnar side of little finger also arose as separate branch from the medial end of the arch.

CONCLUSION

The findings of the present study confirm that the main artery, which supplies the hand is the ulnar artery in spite of whether or not it is taking part in the formation of arch. It is important to note that the incidence of complete superficial palmar arch is very high compared to the incomplete superficial arch. The unique findings, which we have obtained from the present study are two variant forms of SPA contributed by median artery. The knowledge of the variation, which has been reported here is important for vascular surgeons in reconstructive surgeries.

REFERENCES


