DISCUSSION

Arterial supply of a human hand is derived from two arches, superficial palmar arch and deep palmar arch, formed by the contribution of two main arteries of forearm i.e. radial and ulnar arteries along with their branches. The intact superficial palmar arch is important to ensure uninterrupted blood supply to the hand.

Although the superficial palmar arch is classically described with the presence of the anastomosis, the arch can be found without anastomosis. Various authors have described the variations in the construction of a complete SPA and its prevalence. Recent advances in innovative microsurgical procedures in reconstructive hand surgeries requires in depth, the knowledge of vascular structure of hand. The comprehensive knowledge of SPA and DPA is needed to determine the successful outcome of these procedures. Doppler and angiographic studies allow visualisation of the vascular structures of the hand, but may not accurately assess the small vessels contributing in the perfusion of the hand. In addition, vasospasm and reactive vasodilatation following dye injection may make interpretation of angiogram unreliable. So results of anatomical studies play an important role in accurately identifying and classifying different palmar arches which will be helpful in planning various vascular and reconstructive surgeries.

‘A key guide to understand the anatomy of the arterial distribution of the SPA is the classification into complete and incomplete arches based on the presence or absence of a communication between the constituting vessels or the possible formation from a single vessel’. This mode of classification by Dhar and Lall, 2008 was first put forward as far back as the 18th century and has remained the best approach for understanding the various patterns of the arterial arrangement.
Discussion

SPA is the attraction for most of the surgeons since ancient periods. Classification of SPA into complete or incomplete category depending on the presence or absence of communication between contributing vessels was put forth as early as 1753 one of the first reports that presented a complex classification of the superficial palmar arches was the classic work of Coleman and Anson (1961). Since then, many other classifications have been suggested by different authors.

In our study among 177 hands dissected, the complete SPA i.e. having anastomosis between the contributing vessels was found in 78 hands (44.07%) and incomplete arch i.e. having no communication between arteries contributing in its formation in 99 hands (55.93%).

The previous studies have reported higher prevalence of complete arch as compared to incomplete SPA. Coleman and Anson reported complete palmar arch in 78.5% of specimens, Patnaik reported in 78% of specimens, while Loukas reported in 90% of specimens. These studies were not found consistent with the results of our study.

Some authors like Valeria et al, 2004 (47.5%) and Elizabeth O’Sullivan et al, 2002 (46.8%) have reported lesser incidence of complete arches. The results of these studies were found in accordance with results of our study.

Wide variation were found in various studies with reference to prevalence of complete palmar arch and incomplete palmar arch. Developmentally, the anomalies of blood vessels may be due to:

i. The choice of unusual paths in the primitive vascular plexuses.

ii. The persistence of vessels which normally obliterate.

iii. The disappearance of vessels which normally retain.
iv. Incomplete development

The complete arch formed by anastomosis between arteries ensures collateral blood supply which may prevent ischemia in case of blockage or injury of any one of the contributing artery.

The complete superficial palmar arch is further classified into six groups based upon the arteries anastomosing to form the SPA.

The “traditional classification” consists of linkage between the superficial palmar branches of radial and ulnar arteries. The “traditional classification” has been reported in as many as 55.9% of specimens in the research of Ikeda et al or as few as 10% of specimens according to Ruengsakulrach et al.

As per classical description of superficial palmar arch, Coleman and Anson in their study found incidence of traditional arch 34.5%. Gellman reported 35.5% and Ottone reported in 22.1% of specimens in their studies. Our data indicates that this “traditional classification” is found in 21.46% of our specimens. These studies have consistent results with our study.

This classical pattern confirms that the radial artery harvesting is possible in such hands as this kind of arch assures the preservation of blood supply by collateral supply and which will prevent the ischemic changes.

In a cadaveric study, Gellman et al identified 5 variations in the palmar arches. The commonest being the radio-ulnar type. Olave et al showed in their study a predominance of the classic palmar arch in 30% of specimens. Ikeda et al. Subdivided SPA into ulnar-dominant type in (33.2%) of specimens, radial-dominant (1.4%), and equal types (21.3%).
While Moraes et al found dominant ulnar type in 23.34% of specimens. In our study we found ulnar dominant arch in 35.03% specimens. We could not find radial dominance.

If the ulnar dominant arch is present then radial artery can be harvested comfortably in coronary bypass surgeries without any risk. Since SPA is the center of attraction for most of the procedures and traumatic events in the hand, the hand surgeon needs to refer to the existence and healthy function of the arch before surgical procedures such as, arterial repairs, vascular graft applications, free / or pedicled flaps depending on radial or ulnar artery, in order to maintain or not to harm the perfusion of the hand and digits

Adachi and Keen described the ulnar type as the more popular arch (59%), followed by the radio-ulnartype (32%) and the median-ulnar type (9%), this study support our results.

Ulnar-median arch is reported up to 5%, by other authors. In our study this was found in 5.07% hands.

Gellman et al described an incomplete superficial palmar arch in 15.5% of specimens in their study, while in our study we found this phenomenon in majority of the specimens.

Nair CKV et al (2013) concluded that in incomplete SPA, the radial artery cannot be harvested because the amount of anastomosis between radial and ulnar arteries is minimal, so the radial side of hand may suffer ischemia leading to gangrene.

Anneh Mohammad Gharravi (2013) mentioned that in cases of incomplete palmar arch, the Allen’s test will be confirmed negative and both radial and ulna arteries will
behave as ‘end arteries’. Thus any procedure on radial or ulnar artery needs to be carefully planned and potential of ischemic complications should be kept in mind.\textsuperscript{54}

It is obvious that in cases of ulnar dominance the blood supply to hand will not be significantly affected by removal of the radial artery.\textsuperscript{3}

They concluded that in cases of ulnar side palmar injuries may damage the ulnar artery which causes interference of adequate blood flow to the entire superficial structures of the palm and it may leads to ischemia and ultimately leads to inefficient movements of fingers.\textsuperscript{59}
Table 9: Comparison of prevalence of different arches between different studies

<table>
<thead>
<tr>
<th>Type of arch</th>
<th>Present study (%)</th>
<th>Coleman and Anson</th>
<th>Karlsson and Niechajev</th>
<th>Nicolas Ottone et al</th>
<th>Bilage et al</th>
<th>SB Joshi et al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch type</td>
<td>44.07</td>
<td>78.5</td>
<td>86.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-arch type</td>
<td>55.93</td>
<td>21.5</td>
<td>14.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arch type</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar art + SBRA</td>
<td>15.25</td>
<td>34.5</td>
<td>32</td>
<td>20.0</td>
<td>34</td>
<td>4</td>
</tr>
<tr>
<td>Ulnar art + SBRA (classical)</td>
<td>2.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar art. + sup radial + 1st palmar metacarpal</td>
<td>3.39</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar art. + 1st DMA</td>
<td>5.08</td>
<td></td>
<td>8.0</td>
<td>28.0</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Ulnar art + median art.</td>
<td>10.16</td>
<td></td>
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<tr>
<td>Ulnar + median art. + 1st metacarpal art.</td>
<td>0.56</td>
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<tr>
<td>Ulnar + proper radial + 1st DMA</td>
<td>2.26</td>
<td></td>
<td></td>
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<tr>
<td><strong>Non-arch type</strong></td>
<td></td>
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<td></td>
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<tr>
<td><strong>Dominant ulnar</strong></td>
<td>35.03</td>
<td>13.4</td>
<td>64</td>
<td>23.2</td>
<td>14</td>
<td>56</td>
</tr>
<tr>
<td><strong>Co-dominant</strong></td>
<td></td>
<td></td>
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<tr>
<td>Ulnar radio palmar</td>
<td>6.78</td>
<td></td>
<td>8.3</td>
<td>8.0</td>
<td>4.0</td>
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</tr>
<tr>
<td>Ulnar pattern</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar + sup radial + 1st palmar metacarpal</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar + median palmar</td>
<td>2.82</td>
<td></td>
<td>4.7</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Ulnar + median + 1st DMA</td>
<td>2.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar + 1st DMA</td>
<td>0.56</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar + 1st palmar metacarpal art.</td>
<td>4.52</td>
<td></td>
<td>13.4</td>
<td>10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulnar + proper radial</td>
<td>1.13</td>
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</tbody>
</table>
The persistent median artery contributing to the SPA is reported up to 5% by others (ulnar-median).\(^9\) in our study this was found in 4.51% of hands.

The palmar types of median arteries appear to be a predisposing factor in carpal tunnel syndrome and in pronator teres syndrome. An anomalous artery which penetrates the median nerve in the arm can compress it and produce symptoms of proximal median neuropathy. A persistent median artery may compensate the blood supply to hand in radial or ulnar artery injuries, or it may be used as a graft elsewhere in the body, if present. Barfred et al have reported carpal tunnel syndrome caused by a thrombosed persistent median artery.\(^{99}\)

Since FDMA often has a fascial course on the dorsal surface of the index head of first interosseus muscle, this artery can be easily injured in an intervention over the carpometacarpal joint of the thumb, when approached from the dorsum of this joint.\(^9\)

Coleman SS and Anson BJ (1961) found the incidence of complete arch formed entirely by ulnar artery in 37% of specimens. Earley MJ (1986) noted the incidence of complete arch formed entirely by ulnar artery in 8 hands (20%).\(^{100}\) Gellman H et al (2001) found the incidence of complete arch formed entirely by ulnar artery in 31.1% of hands.\(^{28}\) In our study we found it in 35.03% specimens.

Hypothenar hammer syndrome occurs in people who use hand as a hammer. Any finger could become ischemic following occlusion of ulnar artery or superficial volar arch depending upon the pattern of branching present in the superficial arch and the distribution of digital arteries.\(^{101,102}\)

Ottone, Prum, Dominguez et al. (2010) is of opinion that the ulnar artery always takes part in the vascularization of the hand, whether it forms arch or not.\(^5\) They
proposed that any variations of the SPA depend completely on variations of the radial artery.

To best of our knowledge, few of the variations were found in the present study i.e. SPA by contribution of 1st metacarpal artery, Ulnar + median artery + 1st metacarpal artery, Ulnar + proper radial + 1st dorsal metacarpal artery which were not found by earlier researchers.

Ruengsakulrach et al reported in 66% of the hands all the fingers were supplied by the SPA. The similar case was observed by Vollala et al., who reported that superficial arch gave origin to four common palmar digital arteries instead of three. The arteries arising from the SPA that supply the first web space acquire great importance, in case of absence of arterial supply from the deep arch to this region. This carries more significance, when a arch is formed superficial to and outside the protection given by palmar apponeurosis. Thus making it more vulnerable.

In our study we found different types of arches on right and left side in 34 cadavers (68 hands). In the study conducted by O Bilge et al (2006), difference in the types of arches on right and left sides in twenty four bilaterally dissected cadavers was documented. Among these cadavers, bilateralism of the complete arch was detected on 20 cadavers (83.33%) and 12 of them (60%) exhibited the same type of arch. Bilateralism of an incomplete arch was detected in one cadaver (4.1%). With identical types of incomplete arch. No other study was found in literature for comparison of the types of arches between sides.

In 1910, Manners-Smith proposed two theories for the cause of the variations in the arteries of the upper limb. Manners-Smith performed a comparative study of the
arteries of the limb in different groups of primates and came to the conclusion that many of the variations in the upper limb arteries that occur in human subjects represent a retention or a reappearance of primitive patterns, which are normally found in the gorilla, chimpanzee and other primates.  

Rodríguez-Niedenführ et al proposed that the arterial pattern of the upper limb develops from an initial capillary plexus by a proximal to distal differentiation (in the forearm with a posterior anterior polarity) due to the maintenance, enlargement, and differentiation of certain capillary vessels, and the regression of others. It is suggested that the initial capillary plexus, which would normally remain in a capillary state may regress or persists and gives rise to variations in the definitive arterial pattern. ‘The comparative study of arteries of hands in primates confirmed that the variations noted in man represent a retention or reappearance of primitive pattern.’
A) Formation of superficial palmar arch from persistence of terminal portion of median artery.

B) Regression of median artery along with corresponding arch.

C) Formation of superficial palmar arch from plexus formed by superficial antebrachial artery.

a: primary axial artery;
b: superficial brachial artery;
c: lateral branch of superficial brachial artery;
d: medial branch of superficial brachial artery – superficial antebrachial artery;
e: trunk of deep origin of radial artery;
f: radial artery;
g: ulnar branch of superficial antebrachial artery;
h: median branch of superficial antebrachial artery;
j: trunk of deep origin of median artery;
k: ulnar artery;
l: trunk of deep origin of ulnar artery;
m: common interosseous artery;
n: median artery; o: superficial palmar arch
Variations in blood supply to thumb and index finger:

In our study we found in majority of specimens thumb was supplied by superficial branch of ulnar artery i.e. 43.5% followed by complete SPA formed by ulnar and radial artery in 15.25% hands. While Tandler (1897) found superficial palmar branch of the radial artery supplying thumb in majority of specimens. Parks et al (1978), in a dissection of 50 cadaveric hands found that the principal blood supply to the thumb was coming from the first palmar metacarpal artery, in our study it was found in only 5 (2.82%) specimen. The findings in this study and previous research indicate wide variation in the blood supply to thumb.

McCormack LJ et al (1953) in their comprehensive study on the arterial pattern of 750 hands did not find the origin of the princeps pollicis and radialis indicis arteries from the SPA. Gajisin and Zbrodowski (1993), in their series of 200 specimens, found three common palmar digital arteries from SPA in addition to numerous small branches. They did not refer to any branches from the superficial arch supplying the first web space.

Salgado L S S et al (2014) reported arterial supply to thumb different on radial and ulnar side. The radial side was supplied by superficial palmar branch of radial artery in 80% specimens and the arteria princeps pollicis in 20% specimens, while ulnar side was supplied by proper palmar digital artery from SPA in 44% specimens, arteria princeps pollicis in 32% specimens and FDMA in 24% specimens. In our study we found such different blood supply on two sides in 6 (3.39%) hands.
In our study we found in majority of the hands i.e. 97 (54.8%) the index finger was supplied by superficial branch of ulnar artery followed by superficial palmar arch in 38 (21.44%) hands.

Turk and Metcalf found the common palmar digital arteries to the II., III. and IV. interdigital spaces arising from SPA with an additional branch which was supplying the ulnar side of the thumb and the radial side of the index finger and they termed it as the first common metacarpal artery (Mookambica RV et al 2010).\textsuperscript{50}

Erbil et al. (1999) described five cases in which the SPA provided the blood supply to the thumb and index fingers through the princeps pollicis and radialis indicis arteries. None of the above studies showed that princeps pollicis and radialis indicis arteries can arise from superficial branch of ulnar artery.\textsuperscript{76}

Mamatha Tonse et al (2014) reported arteria princeps pollicis and arteria radialis indicis were branches from FDMA. In their study they found that in 10% cases SPA was completed by arteria princeps pollicis and in 6% specimens it was completed by arteria radialis indicis.

Mathew L S and Ebby S et al (2012) in their case report reported the superficial palmar arch exclusively formed by the ulnar artery and its branches.\textsuperscript{52} The lateral one third of the arch was completed by the median artery. The arch had given off four branches, with an additional branch arising from the median artery supply medial side of thumb and lateral aspect of index finger. While deep palmar arch formed by ulnar and radial artery gave two branches arising from radial artery supplying the radial side of thumb and the index finger.
In our study the superficial arch predominated over the deep arch in the region of the thumb and index finger. This is similar to the cases reported by Ugawa A and Ikeda A (1985) where the princeps pollicis artery of monkeys originated from the superficial palmar arch.

Clinically it is important to have knowledge about blood supply of thumb, mainly availability of collateral circulation. In majority of specimens i.e. 43.5% in our study we observed the blood supply to thumb was entirely by superficial palmar branch of ulnar artery and in 10% hands it is by persistent median artery, in such cases in any trauma or occlusion of the feeding artery may lead to pain, paraesthesia, or gangrene of the thumb. Similarly the knowledge of digital blood supply to index finger and other digits is necessary.

In the absence of arterial supply from the deep arch, the arteries arising from the SPA to the first web space acquire great importance and should be handled with care in various surgical operations, such as resection of the second metacarpal bone in complex hand injuries to achieve improved function.

Injury to the SPA or ulnar artery can compromise the arterial supply of the fingers, especially if there is an insufficient anastomosis between the superficial and deep palmar arches.

Injuries to vital vascular structures in the hand can occur during routine surgical procedures. We investigated the location of the SPA in reference to important visible anatomical landmarks in the hand by gross dissection.

In our study we found mean distance 51.46 mm and 51.53 mm on right and left side respectively between SPA and skin crease while M.Kwiatkowska et al in their study...
mentioned mean distance of 59.5 mm they did not compared on the both sides. The value is found consistent with our study.

Also the consistent finding was reported by Kia M. McLean et al in their study with mean distance of 51.8 mm. Our study results for distance between KCL and SPA on ulnar side and radial were found consistent with the results of Anand P. Panchal et al and Vella et al.

Importantly, KCL has been described as representing the surface correlate of the motor branch of the median nerve, deep branch of ulnar nerve, distal extent of the transverse carpal ligament, and the SPA, it becomes paramount to accurately define the landmark.

Knowledge of these anatomic relations may be helpful to clinicians in microsurgical procedures, treatment of vaso-occlusive diseases, interpretation of arteriograms, and avoidance of iatrogenic injury during the carpal tunnel release.

Very few studies have reported the arterial diameters of arteries contributing in the formation of SPA. We have taken measurements of diameters of arteries and compared between sides. Fazan et al reported mean diameter of ulnar artery, 2.5 ± 0.2 on right and 2.6 ± 0.1 mm on left side which is lesser than the values in our study. Fazan et al found ulnar artery larger than radial artery and the difference was statistically significant; this finding is consistent with the result of present study. Fazan et al reported the mean diameter of median artery at wrist level 1.7 ± 0.3 mm which was significantly smaller than radial artery and ulnar artery. These values are more than the present study. Gellman et al reported average diameter of radial artery 2.6 mm but did not compared between sides (Fazan VP et al).
Arterial diameter is an indicator of blood flow and is therefore important to ensure good reperfusion of local structures during reconstructive surgery. It is also important in relation to alterations in diseases like hypertension and diabetes.

Deep palmar arch variations reported in the literature are very few. Deep branch of ulnar artery anastomosing with deep branch of 2nd dorsal metacarpal artery was found in 3 (1.69%) specimens in our study. According to Gellman H et al (2001), the most common anatomic variation (44%) is when the deep palmar arch is formed by the inferior deep branch of the UA and the deep volar branch of the RA.^{28}

The presence of an accessory abductor digiti minimi was noted during our study. The belly of the abductor digiti minimi was composed of two well-defined parts: lateral and medial (Figure 1). The medial part originated from the pisiform bone; the lateral part originated from fascia of forearm, the antebrachial fascia. The two parts fused to form a single belly that attached to the ulnar side of the base of the proximal phalanx of little finger. The ulnar artery and nerve passes beneath the lateral head of muscle that arising from fascia near the wrist. This can cause compression of artery and nerve causing neuropathy and ischemia of hand during movements of hand. G. P. Georgiev et al found same variant ADM in their case report which was composed of two well-defined parts, medial and lateral.^{110} V Ramana Vollala et al reported an accessory belly of the abductor digiti minimi muscle that originates from the deep fascia of forearm, traversed Guyon’s canal superficial to the ulnar nerve and vessels, and inserted into the lateral side of the abductor digiti minimi and stated that this variation is an unusual persistence of an undifferentiated group of mesenchymal cells.^{47} However, variations belonging to abductor digiti minimi may lead to serious complaints in certain professional groups.
CLINICAL SIGNIFICANCE

1. Knowledge of the variations in the arterial patterns may be a useful guide for the radiologists and the vascular surgeons, when they perform grafting procedures and reconstructive vascular surgeries.

2. Knowledge of anatomical variations of the arterial pattern of the hand is crucial for safe and successful hand surgery.

3. Arterial diameter is an indicator of blood flow and is therefore relevant in ensuring good reperfusion of local structures during reconstructive surgery.

4. Information on normal arterial diameters is also important in relation to changes in response to drugs or different treatments, or alterations in pathologies such as hypertension and diabetes.

5. Since SPA is the center of attraction for most of the procedures and traumatic events in the hand, the hand surgeon needs to refer to the existence and healthy function of the arch before surgical procedures such as, arterial repairs, vascular graft applications, and free or pedicled flaps depending on radial or ulnar artery, in order to maintain or not to harm the perfusion of the hand and digits.

6. Even while making incisions to evacuate pus from the hand, special attention should be paid to the superficial position of termination of ulnar artery and SPA.

7. The knowledge of arterial anatomy and its morphology may be of use in graft surgeries, especially when the arteries of upper limb are harvested for the coronary artery bypass grafts.\(^2\)

8. Recent advances in the microsurgical procedures for reconstructive hand surgeries have necessitated a clear understanding of the arterial variations.\(^{111}\)
9. The use of radial artery as the arterial bypass conduit is becoming popular among various hospitals. The harvesting of radial artery is an invasive procedure with potential risks, as suggested by sporadic reports of hand ischemia after the arterial removal.\textsuperscript{13}

10. It was reported that the patients should be screened before harvesting the radial artery to confirm the presence of a viable collateral circulation in the hand.\textsuperscript{97}

11. The morphology of arterial arches of hand is important for microvascular surgeons as well as orthopaedicians.\textsuperscript{4}

12. The clamping of radial artery is contraindicated in cases of deficient collateral flow through the ulnar artery, as it can lead to ischemia and gangrene of the fingers.\textsuperscript{5}

13. Injury to the SPA or ulnar artery can compromise the arterial supply of the fingers, especially if there is an insufficient anastomosis between the superficial and deep palmar arches.\textsuperscript{108}

14. The present study has provided the knowledge about few of the morphological variants of SPA in humans which will be helpful for the clinicians and surgeons who are involved in the surgical procedures of the hand.

15. The knowledge about these variant arches is essential for the safe and successful outcome of the hand surgeries.

16. The existence of both common and rare anatomic variations in the formation of superficial palmar arch as well as the absence of collateral circulation between ulnar and radial arteries necessitates the proper knowledge of vasculature of the
hand in order to avoid or minimize the risk of complications during vascular surgeries or reconstructive surgeries in the hand.

17. As Ruengsakulrach and co-authors suggested, awareness about variation in collateral circulation, like the occurrence of an incomplete SPA, becomes necessary while harvesting the radial artery for arterial by-pass channels or while harvesting the free Radial Forearm Flap.\textsuperscript{32}

18. As discussed by Rao et al, (2010) if ulnar and radial arteries fail to communicate, manifestations of claudication, rest pain or gangrene may develop in case of occlusion of ulnar artery since there will not be collateral blood flow.\textsuperscript{112} This can be applied to the incomplete arch seen in the present study where it was formed only by ulnar artery.

19. Developmentally Arey has described the anomalies of blood vessels\textsuperscript{113} 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 which should normally be retained.

d. Incomplete development of arches

e. Fusion and absorption of the parts which are usually distinct.

20. The palm is entirely supplied by both the SPA and the DPA (deep palmar arch) with their anastomosis, vessels of the palm bleed profusely but at the same time heal rapidly like scalp owing to a good anastomosis and profuse blood supply.
21. In hand surgeries, the surgeon, for arresting the bleeding from the palm, has to ligate the radial or ulnar artery, or even sometimes the brachial artery if the median artery is present.

22. In case where the bleeding is from interdigital branches of ulnar artery before ligating the ulnar artery, surgeon should keep in mind that there may be two parallel communications between superficial branch of ulnar and radial arteries as proximal and distal superficial palmar arches. In such case ligation of ulnar artery above the proximal SPA will not stop the bleeding.

23. These various clinical conditions require complete evaluation of circulation in hand i.e. Proper visualization of blood circulation of the hand with modern imaging modalities like CT scan or MRI to assure a good perfusion and collateral circulation of hand is necessary.

24. The variations are equally important for the anatomists, to help in enhancing the knowledge of the medical students, while teaching during dissection and lectures so that students will be aware of such variations which will help them in their clinical practice.