Original Article

AN ANATOMICAL STUDY OF SUPERFICIAL PALMAR ARCH

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ABSTRACT

Background: The study of superficial palmar arch and its variations has been reported rarely. The purpose of the study is to provide assessment of anatomical variations in the formation of superficial palmar arch in hand. A classic superficial palmar arch is formed by direct communication between the superficial branch of the ulnar artery and superficial branch of radial artery.

Materials and Methods: Twenty dissected upper limb specimens, out of which 16 males and 4 females aged between 18 – 75years were obtained from Department of Anatomy, Bangalore Medical College and Research Institute, Bangalore. The vascular pattern of superficial palmar arch was recorded.

Results and Discussion: The complete and incomplete formation of the superficial palmar arch was found in 19 and 1 hands respectively. This indicates that the incidences of complete and incomplete formation of superficial palmar arch are 95% and 5% respectively. **Conclusion:** The findings suggest that the incomplete formation of superficial palmar arch will lead to ischemia or poor nourishment of intrinsic muscles of the hand.

KEYWORDS: Superficial Palmar Arch; Micro-Vascular Anatomy of Hand; Reconstructive Surgeries.

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INTRODUCTION

Arterial supply to the man's hand is most important earning tool. It is derived from two anastomotic arches, superficial palmar arch and deep palmar arch formed by the anastomosis between main arteries of the hand that is radial and ulnar arteries and their branches in the palm. The SPA is a dominant vascular pattern of the palm. It is located just deep to palmar aponeurosis and superficial to digital branches of median nerve, long flexor tendons of the forearm and lumbricals of the hand. About two third of the SPA is formed by superficial branch of ulnar artery alone, remaining one third by superficial palmar branch of either arteria princeps pollices or the median artery [1]. Four digital arteries arise from the convexity of the arch and pass to the fingers. The most medial artery supplies the ulnar side of the little finger called proper digital artery and the remaining three common palmar digital arteries subdivides into two and supplies the contiguous sides of the little, ring, middle and index fingers respectively [2].

A detailed study of the functions of the hand is the basic requirement of all aspiring hand surgeons .This is an unfortunately a highly complex matter and though general guidelines can be given, continued clinical experience and

observations are necessary if treatment regime are put forward for the best advantage to the patient. Awareness and identification of the SPA variation in the hand is critical for orthopaedicians and micro-vascular surgeons performing advanced surgical procedures such as arterial repairs vascular applications. The knowledge of variations of vascular patterns of hand gained more importance in microsurgical techniques, reconstructive hand surgeries, preoperative screening of radial artery harvesting for myocardial revascularization and also in arterial interventions that include radial artery cannulation and radial artery forearm flap [3].

The objective of present study was to study the morphological variations of SPA in adult human. The clinical implications of these are emphasized with relevant review of literature.

MATERIALS AND METHODS

Twenty dissected upper limb specimens, out of which 16 males and 4 females aged between 18 - 75 years were obtained from the Department of Anatomy, Bangalore Medical College and Research Institute, Bangalore. Karnataka, India. The limbs were fixed in 10% formalin solution. The upper limbs were devoid of any injury or deformity. The dissection of the hand was performed as per Cunningham's manual of practical anatomy [4]. The limbs were dissected from the level of the wrist joint on the palmar aspect till the web spaces, superficial branches of radial and ulnar arteries were identified and the branching pattern and course were traced. The morphology of SPA was studied and variations were noted.

OBSERVATIONS AND RESULTS

Out of twenty specimens, nineteen showed the classic SPA. In all these cases the arch were formed by anastomosis between superficial branches of radial and ulnar arteries (95%).
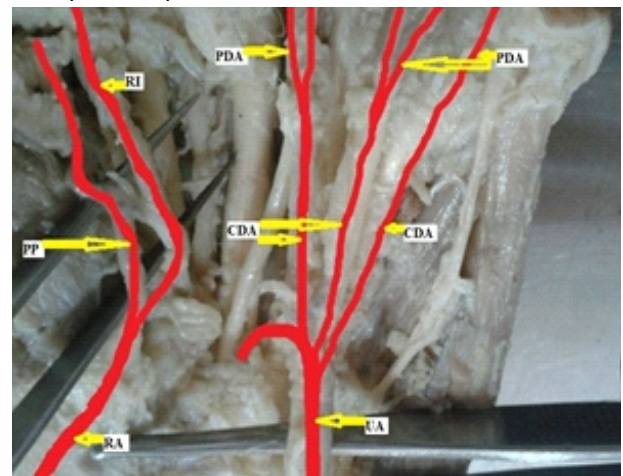
Only one specimen showed the incomplete SPA. There was no anastomosis between superficial branches of radial and ulnar arteries (5%). The ulnar artery is giving one proper branch supplying the ulnar side of the little finger and two common palmar digital branches. Each common palmar branch subdivides into two palmar digital branches. They were supplying the radial side of little finger, radial and ulnar sides of ring and middle fingers. The radial artery gave one common palmar digital branch which subdivided into two proper digital branches supplying the radial and ulnar side of index finger.

DISCUSSION

SPA is formed by anastomosis between superficial branches of the radial and ulnar arteries. But the variations are common. There may also be absence of SPA [5]. The SPA is classified into two categories: complete or incomplete. An arch is considered to be complete if an anastomosis is found between the vessels constituting it. An incomplete arch has an absence of a communication or anastomosis between the vessels constituting the arch. This classification is currently in use and provides the simplest understanding of the anatomic distribution of the arches [6].

Coleman et al observed the complete form in 78.5% and incomplete form in 21.5% of 650 hands [7]. Ikeda et al demonstrated 96.4% complete and 3.6% incomplete forms [8].

Fig. 1: Incomplete formation of superficial palmar arch.

Janevski et al study in 500 hands, the former was seen in 42.4% and the latter in 57.6% of subjects [9]. The complete SPA was observed in 90% and incomplete SPA was observed in 10 % of cases by Loukas et al [10], complete formation in 78% and incomplete formation in 16% cases by Patnaik et al [11] and complete formation in 84% and incomplete formation in 16% Al-turk et al [12].

In present study, there was higher frequency of the classical type arches compared to other previous studies done by other authors. The complete form is seen in 95% and incomplete SPA was found only in 5% case.
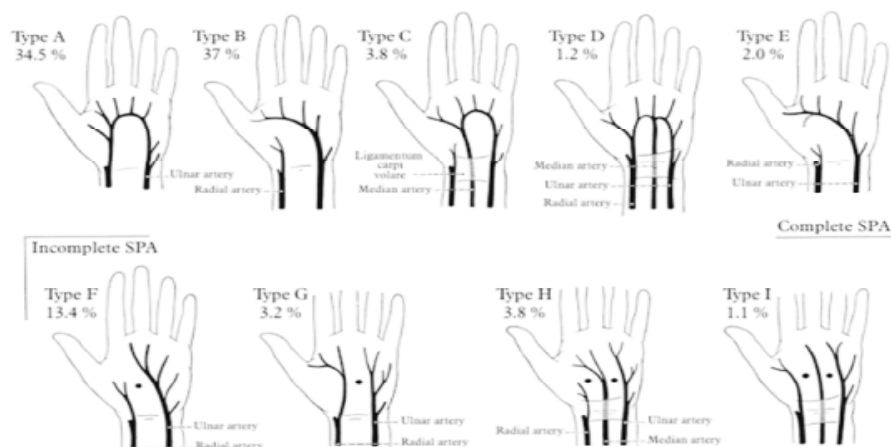
Among the complete arches, Loukas et al, observed that 40% were formed by anastomosis of superficial palmar branch of radial artery with the ulnar artery (type 1), 35% were formed entirely by the ulnar artery (type 2), 15% of them had anastomosis between ulnar and median arteries(type 3), 6% showed anastomosis between ulnar, radial median arteries (type 4) and in the remaining 4% cases, the arch was formed by a branch of the deep palmar arch communicating with the superficial arch. In contrast, Al-turk et al, observed that 78% of the complete arches were having the classical radio-ulnar type, 4% had medioulnar type and 2% were of radiomedianoulnar type.

Adachi has described 3 types of superficial palmar arch [13]. Type A: Ulnar type - in which contribution by radial artery is absent or minimal, Type B: Radioulnar type - in which arch is formed by the superficial palmar branch of radial artery and the larger ulnar artery, Type C: Mediano ulnar type - in which arch is formed by

the median artery and the larger ulnar artery. Coleman et al elaborated more on superficial palmar arch and reclassified it as follows:

Group I: Complete arch. It can be further divided into five types: Type A: The classical radio ulnar arch is formed by superficial palmar branch of radial artery and the larger ulnar artery. Type B: This arch is formed entirely by ulnar artery. Type C: Mediano ulnar arch is composed of ulnar artery and an enlarged median artery. Type D: Radio-mediano-ulnar arch in which 3 vessels enter into the formation of arch. Type E: It consists of a well formed arch initiated by ulnar artery and completed by a large sized vessel derived from deep arch. The latter vessel comes to superficial level at the base of the thenar eminence and join the ulnar artery.

Group II: Incomplete arch: When the contributing arteries to the superficial arch do not anastomose or when the ulnar artery fails to reach the thumb and index finger, the arch is incomplete. It can be further divided into 4 types. Type A: Both superficial palmar branch of radial artery and ulnar artery take part in supplying palm and fingers but in doing so, fail to anastomose. Type B: Only the ulnar artery forms superficial palmar arch. The arch is incomplete in the sense that the ulnar artery does not take part in the supply of thumb and index finger. Type C: Superficial vessels receive contributions from both median and ulnar arteries but without anastomosis. Type D: Radial, median and ulnar artery all give origin to superficial vessels but do not anastomose. The superficial palmar arch seen in the present case is Coleman & Anson's Type A.

According to Ruengsakulrach et al [14] and Ikeda et al, The classical SPA is found in 10%- 55% of the population. It is subdivided into ulnar dominant, radial dominant, equal dominant, entirely formed by ulnar artery as reported by Vollala et al [15], and the SPA formed by ulnar artery and median artery by described Vollala et al [16].

According to Ottone, et al [17] the present case is Ulnar / Radiopalmar pattern subtype of incomplete SPA. The incidence of this variation reported is 8.3%, 3.2% and 3.6% of cases in studies of Ottone, et al, Coleman et al and Ikeda et al.

The explanations for the arterial variations are based on classical outlines of arterial development. Developmental evidence shows that on reaching the hand the ulnar artery links with the superficial palmar plexus from which superficial palmar arch originates, while the median artery loses its distal connection and is reduced to a small vessel.

Ontogenic Basis: According to classic studies of Caplan and Koutroupas, myogenic areas become vascular and chrodrogenic areas become clear and avascular. By 6th week, ulnar artery is apparent and branches from brachial artery progressing down the hand plate to form the deep palmar arch. The radial artery develops later and is more variable progressing down the preaxial side of the limb. Eventually, median and interosseous arteries decrease in size, and median artery degenerates, providing only some blood supply to median nerve the small vestige of interosseous artery terminates in many small branches (rete system) in the carpus [18].

Arey is of the view that the anomalies of blood vessels may be due to the choice of unusual paths in the primitive vascular plexuses ,the persistence of vessels normally retained, incomplete development or fusion and absorption of parts usually obliterate, the disappearance of vessels normally retained, incomplete development, or fusion and absorption of parts usually distinct [19].

The radial artery is a frequent site for introducing catheter for ar-terial pressure monitoring or to create arteriovenous fistulae. Further-more, Acar et al [20] reported the artery has also been used as an alternative for myocardial revascularization. Such techniques are not without risk as they could cause necrosis in different parts of the hand or potential damage to the blood supply of the forearm and hand. The anastomosis between the ulnar and the radial arteries is important for maintaining adequate blood supply to the palm and its digits.

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 and/or pedicled flaps depending on radial or ulnar artery, in order to maintain or not to harm the perfusion of the hand and digits [21]. 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 [22].

CONCLUSION

Superficial palmar arch plays a principal role in microsurgeries following crush injuries of hand. It maintains the collateral circulation in case of obstruction of any of the arteries in hand. The plastic surgeons, hand surgeons should be aware of these variations before attempting surgical procedure like vascular repair, graft application. Recently, the artery of choice for coronary bypass graft is the radial artery. In case of classical SPA the radial artery can be harvested because of the rich anastomosis between ulnar and radial arteries which can maintain efficient collateral circulation. But in the present cases, 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.

Allen's test, Doppler ultra sound, arterial angiography, pulse oximetry should therefore be used to assess the efficiency of collateral circulation before surgical interventions [23]. Scientific improvement urges researchers and practitioners in any field of medicine to deepen knowledge. Thus, subspecialties have aroused. Being one of them, hand surgery requires more detailed knowledge each other day, about the complex anatomical structures

in the hand and upper extremity in order to fulfill the need for verifying the validity of various surgical procedures under practice and to define new.

ABBREVATIONS

SPA – Superficial Palmar Arch
UA – Ulnar Artery
RA – Radial Artery
CDA – Commom Digital Artery
PDA – Proper Digital Artery
PP – Princeps Policis
RI – Radialis Indicis

Conflicts of Interests: None

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