



Contents lists available at BioMedSciDirect Publications

International Journal of Biological & Medical Research

Journal homepage: www.biomedscidirect.com



Original article

Variations in the formation of superficial palmar arch and its clinical significance in hand surgeries

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ARTICLE INFO

Keywords:

Superficial palmar arch
Palmar type of median artery
Radial artery
Ulnar artery
Common inter-osseous artery
CABG – Coronary artery bypass graft

ABSTRACT

The superficial palmar arch (SPA) and its contributing arteries are highly variable. The superficial palmar arch is usually formed by the superficial branch of ulnar artery and completed by one of the branch of radial artery i.e. superficial palmar branch, arteria radialis indicis or arteria princeps pollicis. It is rarely completed by the axis artery of the upper limb i.e. median artery which accompanies the median nerve. The present study was undertaken to investigate the presence of the median artery and its contribution to the formation of superficial palmar arch in 50 cadavers i.e. 100 upper limbs of Indian origin. Out of these, the median artery was found in 10 upper limbs. In 6 upper limbs the median artery took part in the formation of SPA and in the rest of four upper limbs, the median artery did not contribute to the formation of SPA. Of 6 upper limbs, the median artery anastomosed with ulnar artery in four cases and in 2 cases the median artery formed incomplete arch with the ulnar artery. The outer diameter of the median artery ranged between 0.6 to 2.4 mm. The present study of median artery, its origin, course and its contribution to the SPA will add to the existing knowledge of the reconstructive hand surgical procedures such as arterial repairs, vascular graft applications and re-implantations.

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1. Introduction

The superficial palmar arch (SPA), a dominant vascular structure of the palm is localized deep to palmar aponeurosis. The hand surgeon needs to refer to the existence and healthy functioning of the arch before surgical procedures such as, arterial repairs, vascular graft applications. The latest reports of Johnson et al (1998) on Coronary artery bypass graft (CABG) favors the use of an arterial graft, in particular the radial artery, as compared to saphenous vein [1]. The radial artery contributes greatly to the circulation of the hand but in many cases it can be removed as a non-essential vessel, with adequate circulation being provided by the remaining ulnar and in some cases, persistent median artery {Starnes et al.(1999) [2]}.

The median artery (MA) is the axis artery of the superior extremity during early embryonic life. It maintains the superficial palmar arch (SPA) while the radial and ulnar arteries are developing [3]. When the ulnar and radial arteries are fully developed the median artery disappears [4]. The median artery may persist in adult life as antebrachial or palmar median artery, based on their vascular territory. The palmar type is intimately related to median nerve and reaches the wrist and enters the palm by passing beneath the flexor retinaculum (FR) and may take part in the formation of SPA{Claassen H, Schmitt O, Wree A (2008) [5]}.

The median artery due to its close proximity to median nerve can be involved in several clinical disorders like carpal tunnel syndrome [3, 4, 6, 7] anterior interosseous nerve syndrome [8] and pronator syndrome [4].

In the present study, we observed the superficial palmar arch of 100 upper limbs, the persistence of median artery and its contribution to the formation of superficial palmar arch.

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2. Materials and Methods

The present cross-sectional study was conducted on 100 upper limbs of 50 male embalmed cadavers from the Andhra Pradesh region of India.

All the cadavers were selected randomly and studied in the dissection Hall of Department of Anatomy, Chalmeda Anand Rao Institute of Medical Sciences, Bommakal, Karimnagar.

The forearms were dissected and if median artery was observed, it was carefully dissected from its origin to its termination. The external diameters of the median artery were measured at the distal rim of the flexor retinaculum by a caliper, to a precision of 0.05mm.

Table showing the details of median artery

| Side | Origin | Course of MA in 'relation to MN | Outer diameter of MA at Carpal tunnel | Type of SPA |
|-------|--------|---------------------------------|---------------------------------------|--------------------------|
| Right | CIA | Anterior | 1 mm | Did not take part in SPA |
| Right | CIA | Anterior | 1.2 mm | Incomplete arch |
| Left | UA | Anterior | 0.8 mm | Did not take part in SPA |
| Right | UA | Anterior | 2.4 mm | Complete |
| Left | AIA | Anterior | 2.6 mm | Complete |
| Right | UA | Anterior | 2.3 mm | Complete |
| Right | CIA | Anterior | 0.6 mm | Did not take part in SPA |
| Left | UA | Medial | 0.9 mm | Did not take part in SPA |
| Right | CIA | Anterior | 1.4 mm | Incomplete |
| Left | AIA | Anterior | 2.4 mm | Complete |

UA-Ulnar artery , CIA- Common interosseous artery, AIA- Anterior interosseous artery, SPA- Superficial palmar arch, MA- Median artery, MN- Median nerve.

3. Results

Careful dissection of 100 upper extremities revealed the presence of median artery in 10 dissected upper limbs. We found the median artery in 6 right upper limbs (UL) and 4 left UL. Out of 10 UL, median artery in 4 cases arose from common interosseous artery (CIA), in 4 cases from ulnar artery [Figure-C] and in 2 cases from anterior interosseous artery (AIA).

In 8 upper limbs, median artery was anterior to median nerve [Figure-A & B] and in 2 upper limbs it was medial the median nerve (MN). The external diameter of median artery at the carpal tunnel was in the range of 0.6 to 2.4mm. Out of 6 cases, median artery forms complete arch with ulnar artery in 4 UL [Figure-A] and incomplete arch with UA in 2 Upper limbs [Figure-B].

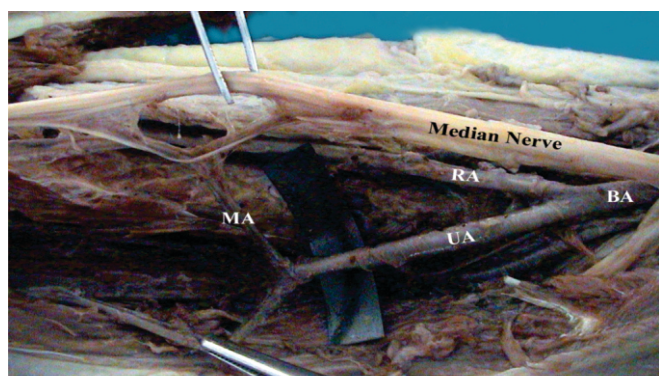


Figure - C : Origin of median artery from ulnar artery
BA- Brachial Artery, RA- Radial Artery,
UA- Ulnar Artery, MA- Median Artery



Figure - A : Complete superficial palmar arch formed by ulnar and median artery
UA- Ulnar Artery, MA- Median Artery, RA- Radial Artery,

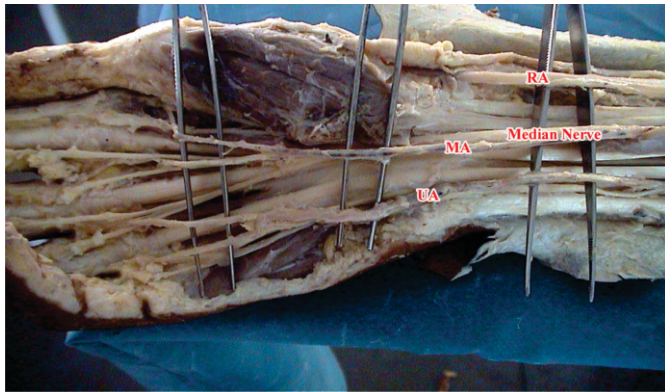


Figure - B : Incomplete superficial palmar arch formed by ulnar and median artery
UA- Ulnar Artery, MA- Median Artery, RA- Radial Artery.

4. Discussion

Recent advances in microsurgical techniques for the reconstruction of hand and upper extremity and the latest choice of radial arterial graft during CABG have necessitated the understanding of vascular patterns in the palm.

The SPA is classified into two categories complete or incomplete. An arch is said to be complete, if an anastomosis is found between the vessels contributing to 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 [9].

Coleman and Anson (1961) [10] observed the complete form in 78.5% and incomplete form in 21.5% of 650 hands. Ikeda et al (1988) [11], demonstrated 96.4% complete and 3.6% incomplete forms. In this series, complete arches were seen in 75% and incomplete in 25% subjects.

The median artery as a component of the SPA has been described in the literature. Coleman and Anson (1961) observed median – ulnar and radial – median-ulnar type of SPA in 3.8% and 1.2% of subjects respectively. Ikeda et al (1988) observed that the radial – median - ulnar type of SPA was absent in their study, and the median – ulnar type was found in 0.9% of subjects. In the present study we observed that the radial – median- ulnar type of SPA was absent.

Adachi (1928: quoted by Keen 1961) recorded the median – ulnar type of SPA in 9% of subjects which is relatively close to the present study i.e 6%. [12]

The percentages of hands in which the median artery made a contribution to the superficial palmar arch were reported to be 2.2% in Janevskis (1982) work which in the present study was found to be 6%. [13]

The origin of median artery has been previously described as arising from common interosseous, anterior interosseous and ulnar arteries frequently [14,15]. It can also arise from brachial artery or its branches [16]. Very rarely, the median artery arose from the RA as suggested by Acarturk et al (2008) [17] whereas in our study the median artery was taking origin from common interosseous or anterior interosseous or ulnar artery.

The external diameter of a persistent median artery is important. According to Bafred et al (1985), the MA with an external diameter of more than 2.0 mm can cause MN compression [18]. Gassner et al (2002) found two MA with a diameter of 3 mm each while conducting colour Doppler ultrasonography on the patients suffering from Carpal tunnel syndrome. In the present study, the external diameter of median artery exceeded more than 2.0 mm in 4 upper limbs. [19]

5. Conclusion

From the above discussion, we can conclude that the knowledge of median artery is important in surgical procedures of hand. Identifying the median artery is also important as its presence may cause carpal tunnel syndrome. In considering the radial artery harvesting for CABG least number of complications may be expected when the median artery forms SPA with Ulnar artery. In addition, the identification of any variation in the arterial pattern of the hand using Doppler ultrasonography, photoplethysmography and oximetric techniques acquires great importance in various surgical interventions of the hand.

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