

ANATOMICAL VARIATIONS OF THE PALMAR ARCHES AND THEIR CLINICAL SIGNIFICANCE

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ABSTRACT

Background

A complex network of anastomoses and collateral vessels, represented by the superficial and deep palmar arches, ensures arterial supply of the hand. The interconnections of the radial, ulnar and anterior interosseous arteries, as well as their branches, exhibit unique anatomical variations, making this region a complex and challenging field of study.

Material and methods

In this paper are described two anatomical variants of the palmar arches, exhibited in the Anatomy Museum of Nicolae Testemitanu State University of Medicine and Pharmacy.

The staff of the Department of Anatomy and Clinical Anatomy revealed the given variants of the palmar arches, during routine anatomical dissection of human cadavers for the teaching process.

Results

According to Coleman and Anson [1], one of the presented variants was of a complete type or radio-ulnar type. The second variant, according to Coleman and Anson [1], was an incomplete palmar arch or type B, while Ottone [2] identified it as non-arch type or ulnar/radiopalmar „thenar” pattern.

Conclusions

Knowledge of anatomical variations and anomalies of the palmar arches is of practical relevance not only for anatomists but also for clinicians, particularly in the context of the advancing microvascular, plastic, orthopedic, and cardiac surgery. Preoperative evaluation of the vascular model allows adaptation of surgical techniques with the minimization of post-intervention risks and complications.

Key words: superficial palmar arch, deep palmar arch, radial artery, ulnar artery, median artery.

ABSTRACT

VARIANTE ANATOMICE ALE ARCADELOR PALMARE ȘI IMPORTANȚA LOR CLINICĂ

Introducere

Vascularizarea arterială a mâinii este asigurată de o rețea complexă de anastomoze și vase colaterale, reprezentată de arcadele palmare superficială și profundă. Interconexiunile arterelor radială, ulnară și interosoasă anterioară, precum și a ramurilor acestora, prezintă variații anatomice unice, ceea ce face regiunea dată un domeniu de studiu complex și provocator.

Materiale și metode

În această lucrare sunt descrise două variante anatomice ale arcadelor palmare, expuse în Muzeul de Anatomie al Universității de Stat de Medicină și Farmacie „Nicolae Testemițanu”. Variantele descrise ale arcadelor palmare au fost depistate de personalul Catedrei de anatomie și anatomie clinică, în timpul disecției anatomice de rutină a cadavrelor umane pentru procesul didactic.

Rezultate

Conform clasificării după Coleman și Anson [1], una dintre variantele prezentate a fost de tip complet sau de tip radio-ulnar. A doua variantă, după Coleman și Anson [1], a fost o arcadă palmară incompletă sau de tip B, în timp ce Ottone [2] a identificat-o ca tip non-arcuat sau tip ulnar/radiopalmar „tenar”.

Concluzii

Cunoașterea variantelor anatomice și a anomaliilor arcadelor palmare este de relevanță practică nu numai pentru anumiști, ci și pentru clinicieni, în special în contextul avansării tehnicilor în chirurgia microvasculară, plastică, ortopedică și cardiacă. Evaluarea preoperatorie a modelului vascular permite adaptarea tehnicilor chirurgicale cu minimizarea riscurilor și complicațiilor post-intervenționale.

Cuvinte cheie: arcada palmară superficială, arcada palmară profundă, artera radială, artera ulnară, artera mediană

INTRODUCTION

The superficial and deep palmar arches constitute a complex anastomotic network resulting from the union of the palmar carpal branches of the radial, ulnar and anterior interosseous arteries.

This variant of the distal circulation has proven to be the most efficient in terms of morphofunctional advantages, being perpetuated throughout phylogenesis and ensuring the vitality of the hand and fingers over the course of human evolution. The function of the hand depends on the mobility and functionality of the fingers, while the viability of its structures occur due to genetic mutations and disturbances of the embryogenesis [3].

It should be noted that in compromising arterial continuity, the blood flow could be redirected to the affected areas through two main arteries, the radial and ulnar ones, which are intensely anastomosed at the carpal and palmar levels, ensuring the maintenance of distal circulation, and implicitly, the vitality of the hand and fingers [3, 4, 5].

Variation in the palmar arches have aroused increased interest for many researchers since the 19th century, being the subject of scientific studies describing their topography, anastomoses and individual variability [6].

Contemporary medical fields, such as plastic, microvascular and orthopedic surgery, require detailed knowledge of the palmar vascular network, to progress and succeed in surgical interventions [7, 8].

In-depth study and the accumulation of new data about the palmar arches have enabled reconstructive intervention, including hand replantation using flaps, as well as the anticipation of severe ischemic phenomena associated with hand trauma [9].

In recent years, preoperative radial artery screening methods have made notable progress, capitalizing on its role in using it as a graft in coronary bypass or in myocardial and cerebral revascularization [10].

Individual anatomical variations of the palmar network represent a critical factor, with a high impact on the conduct of the surgical intervention, as well as on its prognosis.

Consequently, the choice of the surgical technique must be based not only on clinical criteria, but also the hard foundation of the hand should be considered [4 Cate].

MATERIAL AND METHODS

For our purpose, two cases of the anatomical variation of the palmar arches, exhibited in the Anatomy Museum of Nicolae Testemitanu State University of Medicine and Pharmacy were examined.

Those variants of the palmar arches were detected by the staff of the Department of Anatomy and Clinical Anatomy during routine anatomical dissection of human cadavers for teaching process.

For a better understanding of the classification and variability of the palmar arches the PubMed, Science Direct, Google Scholar, SpringerOpen databases were analyzed.

RESULTS AND DISCUSSION

The superficial palmar arch results from the anastomosis between the terminal segment of the ulnar artery and the superficial palmar branch of the radial artery [4].

Jaschtschinski, cited by Kalaiselvi et al. [10], did the first descriptions and classification of the anatomical variants of the superficial palmar arch in the 19th century, identifying two main groups: the complete and incomplete palmar arches.

In 1960, based on a study on 650 hands, Coleman and Anson [1], classified the anatomical variants of the superficial palmar arch into five subgroups within the complete type and four subgroups within the incomplete type (Figure 1).

Arrchana et al. [7], carried out a study on 40 samples of formalized human cadavers and classified the found variants, based on Coleman and Anson classification [1]. Thus, 5 types of complete superficial palmar arches and 4 types of incomplete superficial palmar arches were identified (Table 1 and Table 2).

According to the classification proposed by Jaschtsinski, cited by Kalaiselvi [10], the arch is of the complete type, while according to Coleman and Anson [1], the arch corresponds to type A, or the radio-ulnar type. According to Adachi's classification, cited by Gadzhieva [11], this arch corresponds to type 2, the classical radio-ulnar type.

Ottone et al. [2], classified the variants of the palmar arteries anastomoses into two main groups. The first group included arch type (52%) and the second one non-arch type (42%) of cases. The variants of the first group were divided into subtypes such as ulnar-radiopalmar (43%) and ulnar-radial subtype (15%).

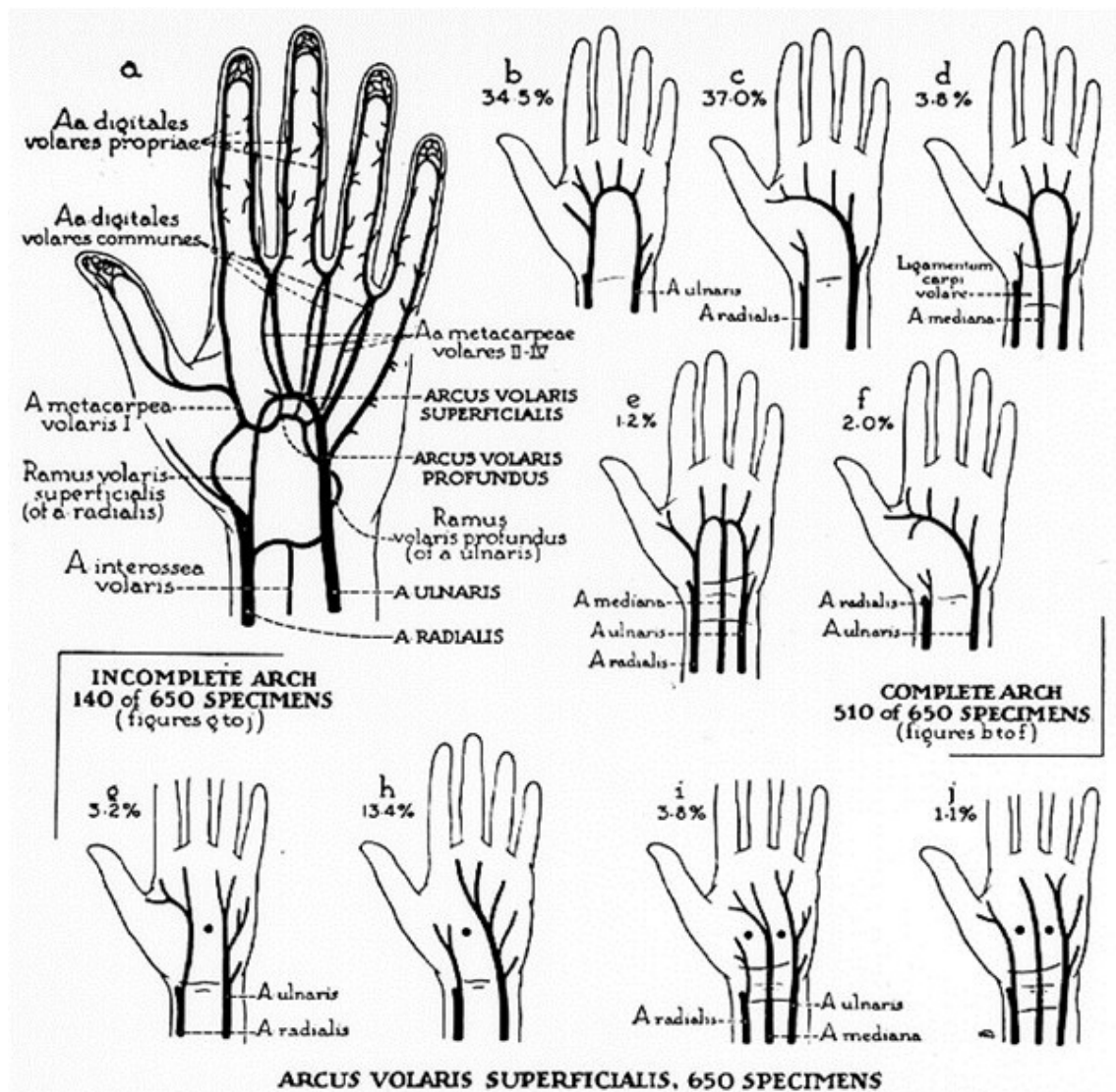


Figure 1. Classification of the superficial palmar arch variants (according to Coleman and Anson [1]).

Table 1. Complete superficial palmar arches, according to Coleman and Anson [1]

No	Type	Description of the anastomoses	Percentage
1.	Type A	Radio-ulnar arch, the classical type, formed by the anastomosis of the superficial palmar branch of the radial artery with the ulnar artery	34.5%
2.	Type B:	Ulnar arch, formed entirely by the ulnar artery	37%
3.	Type C	Medio-ulnar arch, formed by the anastomosis of the ulnar artery with the median artery	3.8%
4.	Type D	Radio-medio-ulnar arch, formed by the combination of three vessels, radial, median and ulnar arteries	1.2%
5.	Type E	Arch formed predominantly by the ulnar artery and supplemented by a large vessel derived from the deep arch	2%

Table 2. Incomplete superficial palmar arches, according to Coleman and Anson [1]

No.	Type	Description of the anastomoses	Percentage
1.	Type F	Arch resulting from the superficial branches of the radial and ulnar arteries, which contribute to the vascularization of the palm and fingers, but do not form anastomosis	3.2%
2.	Type G	Arch formed by the ulnar artery, but incomplete, as it does not supply the thumb and index finger	13.4%
3.	Type H	Arch resulting from the superficial branches of the median and ulnar arteries, which contribute to the vascularization of the palm and fingers, but do not form an anastomosis	3.8%.
4.	Type I	Arch formed by the radial, median and ulnar arteries, which give rise to superficial vessels but do not anastomose	1.1%

In one of the cases examined by us, the superficial palmar arch was formed by the anastomosis between the ulnar artery with the superficial palmar branch of the radial artery (Figure 2).

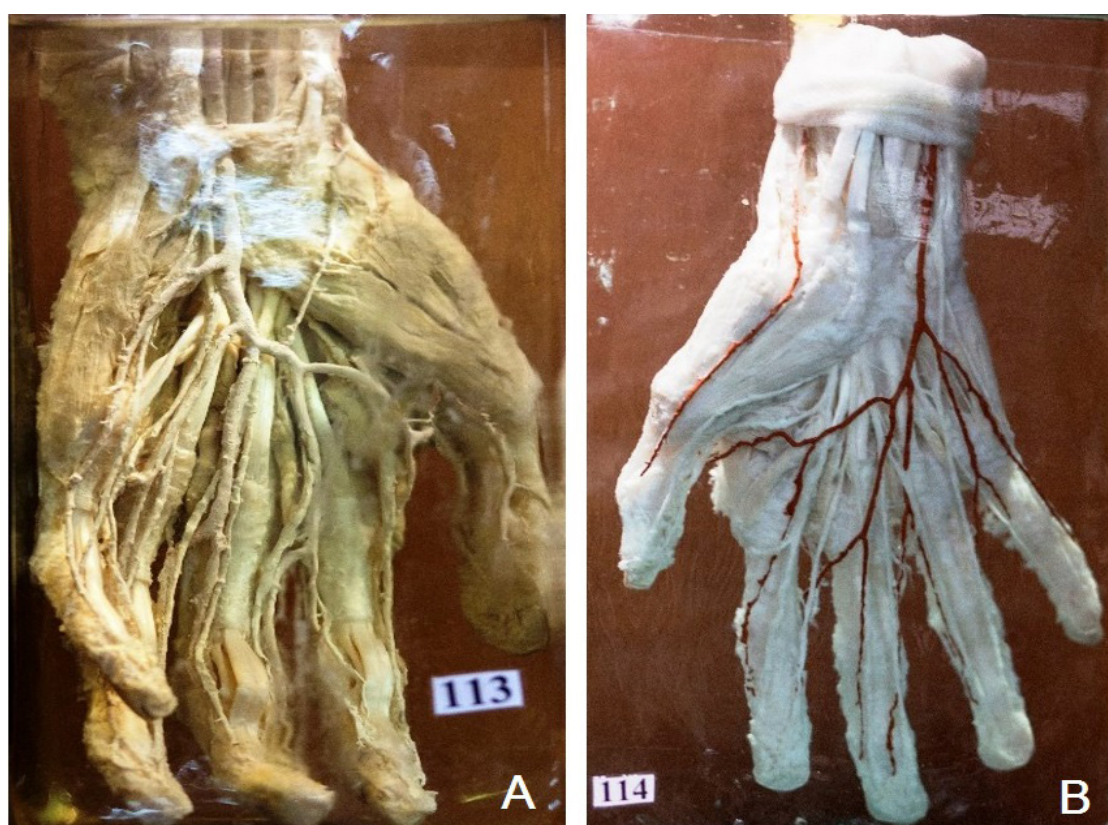


Figure 2. A. Complete arch type, identified by Coleman and Anson [1] as radio-ulnar type.
B. Incomplete, or non-arch type, Type B according to Coleman and Anson [1], or ulnar/radiopalmar „thenar” pattern, according to Ottone [2] (samples from Anatomy Museum of Nicolae Testemitanu State University of Medicine and Pharmacy).

The ulnar-radiopalmar subtype included ulnar pattern in 20.9% and the classic pattern in 22.1%. The ulnar-radial subtype included the ulnar + radial „proper pattern” (7%) and the ulnar + first dorsal interosseous pattern (8%).

The non-arch type included the dominant ulnar subtype in 29.0% with the ulnar pattern in 23.2% and ulnar/radiopalmar „thenar” pattern in 5.8% of cases. The second subtype was named codominant subtype (13%) with the ulnar/radiopalmar pattern in 8.3% and ulnar/median pattern in 4.7% of cases.

According to Ottone et al. [2], the arch in the figure 1B corresponds to the ulnar/radiopalmar „thenar” pattern of the non-arch subtype, when the ulnar artery mainly supplies the hand, while the radial artery does not play a significant role in vascularization of the hand.

Significant variability in upper limb arteries, including palmar arterial circulation and their developmental anomalies has been reported over the years in the works of many researchers, emphasizing the clinical relevance of their recognition in surgical and interventional practice [5, 9, 12, 13, 14, 15, 16, 17, 18, 19].

Rejeena et al. [20], described a case of superficial palmar arch formed exclusively by the superficial branch of the ulnar artery, continued by the first common digital artery to the interdigital space between the thumb and index finger, where it gives rise to the princeps pollicis artery or the radialis indicis artery.

This variant, classified as incomplete palmar arch that highlights the importance of clarifying the nomenclature of the arteries supplying the thumb and index finger, due to their clinical and surgical significance [19].

The specialized literature records several rare cases of congenital agenesis of the left ulnar artery, being functionally replaced by a large-caliber interosseous artery [2].

Another notable case was presented by Rodríguez-Niedenführ et al. [21], describing the presence of the median artery until adulthood as the main arterial source for the median nerve and adjacent structures. This anatomical variant, termed the persistent median artery, presents two distinct morphological types: antebrachial and palmar [1, 2, 16, 21].

A double superficial palmar arch is another rare anatomical variant, characterized by the presence of two distinct vascular arches in the palmar region, with a major role in the vascularization of the hand [8].

An exceptional variation was identified in a study conducted on a male cadaver, characterized by an unusual superficial topography relative to the palmar aponeurosis, located within the palmar subcutaneous layer of the superficial palmar arch [17].

CONCLUSIONS

A detailed understanding of the anatomical variants of the palmar arches is key to the success of surgical interventions on the hand, allowing for the validation of the various operative techniques used in practice and to development of new surgical approaches.

Given that the arterial networks represent the primary blood supply to the palmar area, their comprehension is essential for surgeons involved in the correction of congenital malformations, as well as in reconstructive or post-traumatic interventions [18].

The existence of a well-developed network of anastomoses and collateral vessels ensures the maintenance of arterial flow in case of injury or obstruction [14].

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