

Variations and Clinical Importance of the Superficial Palmar Arch

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Özet

Arcus palmaris superficialis'in varyasyonları ve klinik önemi

Amaç: Bu çalışmanın amacı eldeki arcus palmaris superficialis (APS)'in varyasyonlarını tespit etmek ve anormal APS ile m. palmaris longus (MPL) kasının yokluğu arasındaki ilişkiyi ortaya koymaktır. **Gereç ve yöntem:** Çalışmamızda a. brachialis'lerinden kırmızı ile renklendirilmiş lateks ile doldurulmuş 20 kadavra eli diseke edilmiştir. Eldeki damarsal varyasyonlar ve MPL kasının varlığı veya yokluğu kaydedilerek fotoğraflanmıştır. **Bulgular:** APS'ler 15 elde (%75) komplet, 5 elde (%25) ise inkomplet olarak tespit edildi. APS'inde varyasyon bulunan ellerin %33'ünde MPL kasının bulunmadığı görüldü. MPL'u bulunmayan ellerin tümünde aponeurosis palmaris bulunmaktaydı. **Sonuç:** Arteriyel onarımlar, damar greft uygulamaları ve a. radialis veya a. ulnaris bazlı pediküllü veya serbest flep uygulamaları gibi rekonstrüktif el cerrahisi prosedürleri öncesinde elin vasküler yapısı ortaya konulmalıdır.

Anahtar kelimeler: Anatomi, Varyasyon, Arcus palmaris superficialis, M. palmaris longus.

Abstract

Objectives: The aim of this study was to provide an assessment of the anatomic variations of the superficial palmar arch (SPA) in the hand and to establish a correlation between an anomalous SPA and the absence of palmaris longus muscle (PL). **Methods:** Twenty conserved cadaver hands were dissected after latex solution colored with red ink had been injected into the vessels from the brachial artery. The vascular variations and the presence and absence of the PL were recorded and photographed. **Results:** The SPA was complete in 15 (75%) and incomplete in 5 (25%) of the hands. The palmaris longus tendon was absent in 33.3% of the hands with the variational SPA. We observed that in all hands without PL, the palmar aponeurosis existed. **Conclusion:** The vascular patterns of the hand may documented before reconstructive hand surgical procedures such as, arterial repairs, vascular graft applications, and free and/or pedicled flaps depending on radial or ulnar artery.

Key words: Anatomy; Variation; Superficial palmar arch; Palmaris longus muscle

Introduction

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.

The superficial palmar arch (SPA), a dominant vascular structure of the palm of the hand, is localized just deep to the palmar aponeurosis (1). The 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 (2-5) Physical examination including the Allen's test and contemporary imaging studies are not dependable or practical enough for each of the various scenarios (6,7) So, it is for the surgeon's

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own sake to possess a detailed background of pertinent anatomical knowledge including the variations of the SPA.

Although the radial and ulnar arteries provide most of the blood supply of the hand, additional circulation may come from the median artery or the interosseus arterial system (8) Various anomalous patterns in the arterial arches have been studied by several authors and a classification based on the relation between the superficial branches of the radial artery and of the ulnar artery has been proposed (Figure 1) (1,8-18).

Materials and Methods

The study was conducted in departments of anatomy of two different schools of medicine. Twenty conserved cadaver hands were finely dissected, following injection of red latex solution from brachial artery. Injection was thought to be adequate when the injected fluid was seen to flow through previously made digital incisions. A gauze bandage was then tied securely around the forearm to prevent backflow and the specimens were left at room temperature

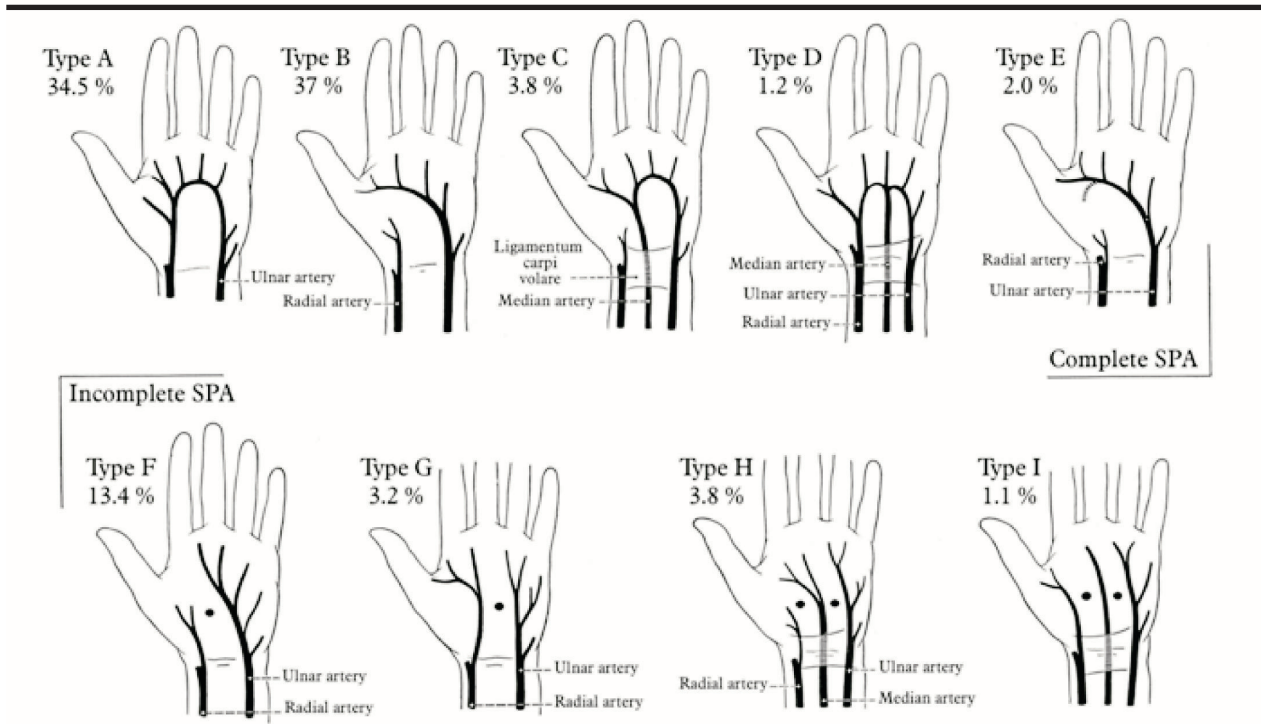


Figure 1. Complete and incomplete types of the SPA and incidence which were described by Coleman and Anson (9). [Complete arch which an anastomosis is found between the vessels constituting arch (Type A: SPA formed by the ulnar artery and the superficial branch of the radial artery; Type B: SPA formed entirely by the ulnar artery; Type C: SPA formed by the median and ulnar arteries; Type D: SPA formed by the radial, median and ulnar arteries; Type E: SPA formed by the ulnar artery (a branch from deep palmar arch)) Incomplete arch which an absence of a communication or anastomosis is found between the vessels constituting the arch (Type F: SPA formed by the ulnar artery which doesn't contribute to the blood supply to the thumb and index finger; Type G: SPA formed by the ulnar artery and the superficial branch of the radial artery; Type H: SPA formed by the independent radial, median and ulnar arteries, where the 1st and 2nd digits involved branches of median artery; Type I: SPA formed by the independent radial, median and ulnar arteries)]

However, antropometric features vary in different regions of the world, and there is a need to gather worldwide data. This study has been undertaken to contribute to the existing knowledge of SPA variations, and to establish a correlation between an anomalous SPA and the absence of palmaris longus muscle (PL), and also the presence of palmar aponeurosis and the

until hardening of latex had occurred. Then, the skin and subcutaneous tissues covering the flexor surface of the wrist and palm to the base of the digits were removed. The presence or absence of palmaris longus was recorded and the ulnar and radial arteries were identified at the wrist. The palmar aponeurosis was removed to reveal the SPA and this was clearly demonstrated by removal of adipose tissue and the branches of the median and ulnar nerves from the palm of the hand. The vascular patterns were sketched and photographed. The SPA is classified into two categories as complete or incomplete.

Results

There were no specimens that had complete absence of the SPA and the anterior interosseous artery also did not contribute to the formation of the SPA in any specimen. The SPA according to Coleman and Anson

(9) classification was complete in 15 (75%) and incomplete in 5 (%25) of the hands.

Two subgroups were observed in the complete SPA group:

Type A: SPA formed by the ulnar artery and the superficial branch of the radial artery was observed in 8 (40%) hands (Figure 2). Type B: SPA formed by ulnar artery (for all 5 digits) was seen in 7 (35%) hands (Figure 3).

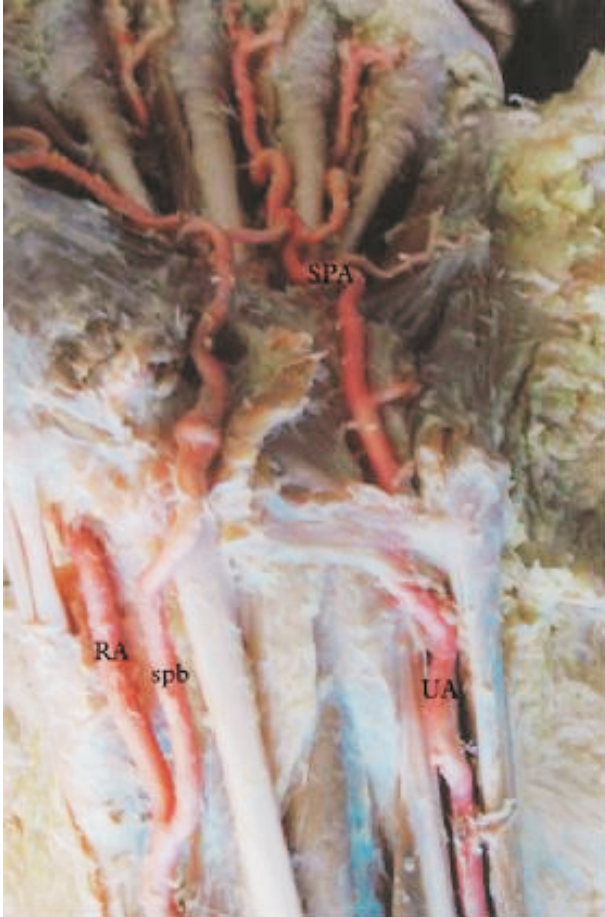


Figure 2. Type A complete SPA which is formed by the ulnar artery and the superficial branch of the radial artery. RA, radial artery; UA, ulnar artery; spb, superficial palmar branch; SPA, superficial palmar arch.

Two subgroups were detected in the incomplete SPA group:

Type F: SPA formed by ulnar artery (except 1st and 2nd digits) was observed in 4 (20%) hands (Figure 4). Type H: SPA formed by radial, ulnar and median arteries was seen in 1 (5%) hand (Figure 5). In 8 hands with type-A SPA, PL tendon was present. Out of 12 hands with other types of SPA, 4 (33.3%) had no PL. Two of these had type B and two type F SPA (Figure 6). In all hands without PL, the palmar aponeurosis existed.



Figure 3. Type B complete SPA which is formed entirely by the ulnar artery. RA, radial artery; UA, ulnar artery.

Discussion

Recent advances in microsurgical techniques for the reconstruction of hand and upper extremity after trauma and congenital deformities have necessitated better understanding of the vascular patterns of the vessels. Doppler and angiographic studies(6,7,10,19) allow visualization of vessels of the hand, but do not accurately assess the small connecting vessels. In addition, uncontrollable vasospasm and reactive vasodilatation following dye injection make interpretation of the angiograms unreliable.¹⁷ As a result, we still have to count on anatomical studies in planning surgical procedures.

The SPA is most easily 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(17). Coleman and Anson(9) observed the



Figure 4. Type F incomplete SPA which the ulnar artery forms the SPA but does not contribute to the blood supply to the thumb and index finger. RA, radial artery; UA, ulnar artery; spb, superficial palmar branch.

form in 78.5% and incomplete form in 21.5% of 650 hands. Ikeda et al(10) demonstrated 96.4% complete and 3.6% incomplete forms. On the other hand, in Janevski et al.'s study(20) in 500 hands, the former was seen in 42.4% and the latter in 57.6% of subjects. In this series complete arches were seen in 75% and incomplete in 25% of subjects.

The superficial branch of the radial artery joined the ulnar artery to form the SPA in 40% of the present specimens, whereas Coleman and Anson(9) reported the incidence of this type of SPA as 34.5%, Ikeda et al(10) as 55.9% and Jelacic et al(21) as 55%. The ulnar artery forming the SPA alone was reported by Coleman and Anson(9) as 37%, by Ikeda et al(10) as 25.5%, by Jelacic et al(21) as 10%. In this study, this type of SPA is found in 35% of subjects. An anterior median artery taking part in the formation of SPA together with the ulnar artery or the ulnar and radial arteries was reported as 3.8% or 1.2% respectively, by Coleman and Anson.9 In Ikeda's(10) series radiomedian-ulnar type of arch was absent,



Figure 5. Type H incomplete SPA which is formed by the independent radial, median and ulnar arteries. MA, median artery; UA, ulnar artery; spb, superficial palmar branch.

but they observed the arch formed by the median and ulnar arteries in 0.9% of subjects. In accordance with Ikeda, we did not observe median-ulnar type of anastomosis, but in contrast radial-median-ulnar type of anastomosis was also missing in our series. Whether, the relative rarity of median artery taking part in the formation of the SPA is a racial difference, is an issue to be further investigated. The percentages of hands in which the median artery made a contribution to the superficial palmar arch were reported to be 2.2% in Janevski's work(20). The ulnar-deep palmar arch type was absent in Janevski's study. Coleman and Anson(9) reported 2% and Gellman et al(17) 2.2% of this type of arch in their studies. Ikeda et al(20), once again reported which is 14.2%.

The incomplete SPA was reported to be present in 21.5% of Coleman and Anson's(9) subjects, 15.5% of Gellman's(17) and 3.6% of Ikeda's.(10) We observed this type in 25% of subjects. The most consistent incomplete form was the ulnar artery alone type of SPA which was seen in 20% of subjects in this study. Coleman and Anson's9 study had a similar value of

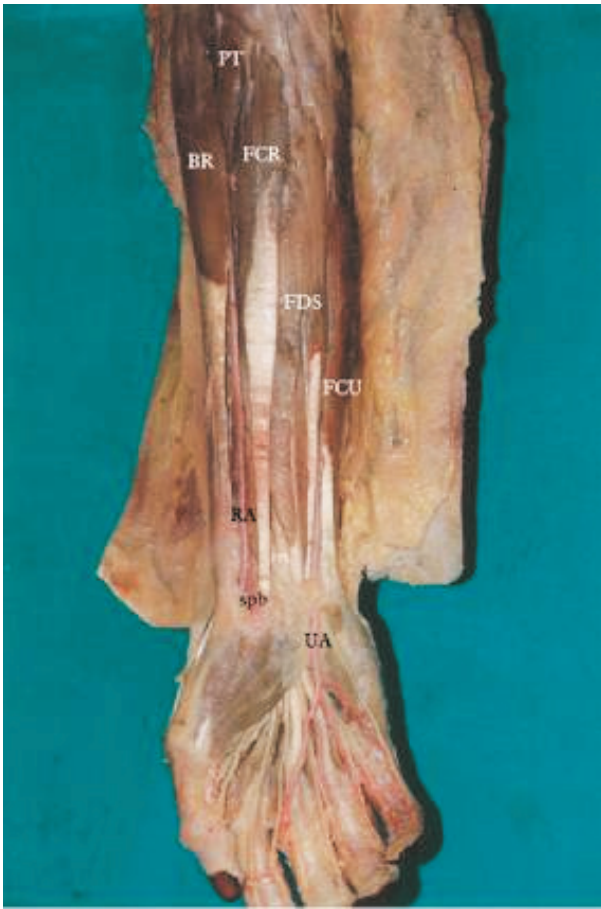


Figure 6. Type F incomplete SPA without PL. RA, radial artery; UA, ulnar artery; spb, superficial palmar branch; BR, brachioradial muscle; PT, pronator teres muscle; FCR, flexor carpi radialis muscle; FDS, flexor digitorum superficialis muscle; FCU, flexor carpi ulnaris muscle; FPL, flexor pollicis longus muscle.

13.4% and Gellman et al(17) showed this type in 11.1% of their subjects. One or more of Coleman and Anson's subtypes was absent in other studies. Ikeda et al(10) did not find other incomplete forms. Gellman et al(17) showed 4.4% of independent radial and ulnar artery type compared to 3.2% of Coleman and Anson's.(9) Our study revealed 5% of independent radial, median and ulnar artery type of incomplete SPA, where the 1st and 2nd digits involved branches of median artery, whereas Coleman and Anson(9) stated of this type as 3.8%.

It seems that the usual cause of variations is the radial artery, whereas the ulnar artery usually stays unvariable(14), and also the subtypes of the complete SPA are more consistent in light of various studies, whereas the incomplete subtypes are not fully present in most of the studies. The results indicate that the arteries supplying the palm mostly form an arch in spite of frequent variations. The relatively large differences in the percentages may have arisen from

the manner in which the analyses were carried out, the technical differences in materials and/or the differences in the classification of the arch, racial variations and varying sample sizes.

The PL is extremely variable muscles of the human body(22-24) and the absence of the PL has also been reported.(25,26) The absence of a PL tendon may be a predictor of the pattern of the SPA, as was stated by O'Sullivan and Mitchell.(27) This may have relevance in identifying suitable patients for surgery involving vascular supply to the hand especially harvesting upper limb vessels for coronary artery grafting, and exploratory or reconstructive hand surgery. O'Sullivan and Mitchell(27) reported an absent PL in 22 patients out of 25 with an anomalous SPA. This is a highly significant difference indicating a significant association between the two anatomical features. Although, the ratio was lower we had a similar observation in our series.

Caughell et al(28) supported that the palmar aponeurosis and the PL tendon were separate anatomic structures, which develop independently and were associated only by anatomic proximity. In accordance with their observations we had no correlation between the absence of palmar aponeurosis and the PL. These findings suggest that the patients should be evaluated in detail before surgical procedures depending on the SPA or its components. The hand surgeon can have an idea about the existence of an anomalous arch simply by checking the presence of PL.

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