Case Report
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The Coexistence of an Incomplete Superficial Palmar Arch and a Berrettini Anastomosis: A Case Report

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Abstract

Objective. The aim of this study is to present a relatively rare case of the coexistence of an incomplete superficial palmar arch and a Berrettini anastomosis, identified in a cadaveric specimen, and further discuss the potential clinical implications of such anatomical variations. **Case Report.** The variation was found in the left hand of a formalin-fixed male cadaver of Greek origin, that was dissected under an operating microscope (×4, ×10 magnification) in our Anatomy Department. In the specimen, we found an incomplete superficial palmar arch, formed only by the superficial branch of the ulnar artery, and a Type 1 Berrettini Anastomosis, originating from the ulnar nerve and joining a branch of the median nerve. **Conclusion.** To avoid iatrogenic damage and permanent loss of sensation, hand surgeons and microsurgeons should be aware of the presence of a BA, and the potential coexistence of this variation with vascular abnormalities in the hand that may complicate surgical procedures.

Key Words: Median Nerve ▪ Ulnar Nerve ▪ Superficial Palmar Arch ▪ Microsurgical Anatomy ▪ Berrettini Anastomosis.

Introduction

Both the descriptive and microsurgical anatomy of the human hand are of undeniable complexity. Specifically, the vascular anatomy of the hand is of paramount importance for radiologists and hand surgeons (1).

The vascularization of the hand is dependent on the superficial and deep palmar arches. The superficial palmar arch (SPA) is formed in most cases by the superficial branch of the ulnar artery (SUA) completed by a superficial palmar branch of the radial artery (SRA). The SPA normally lies superficially to the long flexor tendons and lumbricals, and beneath the palmaris brevis, as well as the palmar aponeurosis. It provides the three common palmar digital arteries (CDA) and a fourth digital artery that supplies the ulnar half of the 5th finger, the so-called Digiti Minimi Artery (DMA) (1-3). However, the formation of the SPA is subject to non-negligible variability (1, 4). There have been many reported patterns of SPA formation. The first described classification, and one of the most frequently used, is the classification of Coleman and Anson (1). According to this classification, the classical formation pattern of the SPA, with equal contributions from the SUA and SRA, is Type A. Type B SPA refers to an arch formed solely by the SUA, Type C to a mediano-ulnar SPA, Type D to a radio-mediano-ulnar SPA, and Type E SPA to an arch initiated by the SUA and finished by an enlarged arterial branch from the deep palmar arch (1).

Two nerves contribute to the sensory and motor innervations of the palmar surface of the hand: the median nerve (MN) and the ulnar nerve (UN). From the MN the first three common digital nerves arise (CDN) that provide sensory innervation of the first 3 and a half fingers, and the fourth CDN comes from the UN, innervating the ulnar half of the 4th finger and the radial half of the 5th finger

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(2). Two of the most prevalent communications that occur between the MN and UN in the hand are the Riche-Cannieu Anastomosis between the 1st and 4th CDNs, and the Berrettini Anastomosis (BA) between the 3rd and 4th CDNs, or between the 3rd CDN and the main stem of the UN (5-7). Specifically, the BA was first described in 1741 by Berrettini, and includes 3 subtypes. According to Roy et al., Type 1 BA is a communicating branch from the UN towards the MN, Type 2 is a branch from the MN towards the UN, and Type 3 includes diffuse interconnecting communication branches between the UN and the MN (7).

Our aim is to present a relatively rare case of the coexistence of an incomplete SPA and a BA, identified in a cadaveric specimen, further discuss the potential clinical implications of such anatomical variations, and highlight the significance of deep knowledge of the complex anatomy of the hand.

Case Report

The left hand of a formalin-fixed (10% v/v solution) male cadaver was dissected under a Carl Zeiss™ operating microscope (×4, ×10 magnification) using microsurgical instrumentation, for research purposes, in the Dissection Hall of our Anatomy Department. The cadaver was of Greek origin and obtained through body donation, with the written and informed consent of the donor, according to the relevant legislation (8). A Würth™ digital Vernier caliper (0.01 mm, accuracy) was used for the measurements of distances and the vessels' outer diameters (d), calculated at their point of origin.

In the dissected hand, we found an incomplete superficial palmar arch, formed only by the SUA (d: 1.48mm). This branch gave rise to the 1st, 2nd and 3rd CDAs (d: 1.13 mm, 1.18 mm, 1.04 mm) the DMA (d: 0.64 mm) and a small thenar branch (d: 0.61 mm) (Figure 1). The thumb was supplied by a princeps pollicis branch, originating from the deep palmar arch. In the part of the SUA between the origin of the 2nd and 3rd CDA, it followed a curly course, being in quite a close relationship with the 3rd CDN.

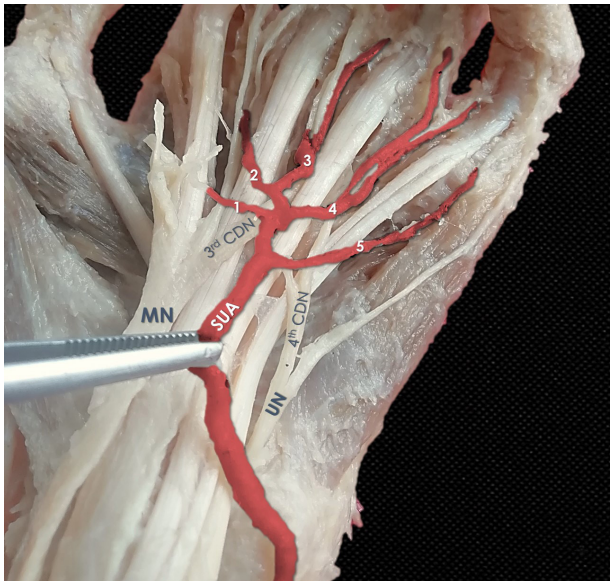

Figure 1. The incomplete Superficial Palmar Arch; MN=Median Nerve; UN=Ulnar Nerve, 3rd CDN= 3rd Common Digital Nerve; 4th CDN=4th Common Digital Nerve; SUA=Superficial branch of the Ulnar Artery; 1= Small thenar branch (cut); 2-4=1st -3rd Common palmar Digital Arteries; 5=Digiti Minimi Artery.

Figure 2. The Berrettini Anastomosis (white arrow); The branches of the Superficial Palmar Arch have been retracted; MN=Median Nerve, UN=Ulnar Nerve; 3rd CDN=3rd Common Digital Nerve; 4th CDN=4th Common Digital Nerve, TCL=Transverse Carpal Ligament.

In addition, a BA was identified (between the 3rd and 4th CDNs). It followed an oblique trajectory, from proximally and medially to distally and laterally (Type I BA) (7), and was 17.88 mm in length and 0.72mm in width (Figure 2).

Discussion

Embryology

The seventh cervical intersegmental artery of the upper limb, the axis artery, continues, initially, as the anterior interosseous artery. It extends along the ventral axial line, and ends in the palmar surface of the hand as a deep capillary plexus. When the latter recedes, the median artery expands distally and joins the superficial palmar capillary plexus. The superficial palmar capillary plexus gives rise to the digital arteries of the hand. The median artery finally recedes and is replaced by the radial artery (RA) and UA. The RA appears first and joins the deep palmar arch, while the UA later joins the SPA (3).

Embryologically, variations in the blood vessels of the hand, may be explained as resulting from the persistence of vessels that are normally obliterated, the disappearance of vessels that are normally retained, incomplete development of the vessels, and the abnormal merging and absorption of elements that are usually distinct. Thus, the variance in SPA formation could be attributed to any of the aforementioned mechanisms (3).

The embryological basis of the BA (and every intercommunicating neural branch in general) is related to the neural fibers of the MN or the UN, that have abnormally fused with another nerve (UN or MN) at its rising point on the brachial plexus and, after covering some distance with that nerve, they finally split at the hand and rejoin the UN or the MN (2).

Prevalence

The pattern reported of incomplete SPA formation, i.e. stemming entirely from the SUA without supplying the thumb, is Type – F SPA, according to the Gellman et al., classification (4). The frequency of this SPA type varies between studies. Gellman et al. reported a frequency of 11.1% in 45 cadaveric specimens (4). Joshi et al. (2014) reported that 66% of 100 upper limbs presented a SPA formed exclusively by the SUA; however, in this study there were no specific data about the thumb supply and the termination of the SUA in the thenar (9).

The BA is the most frequent (60.9%) type of anastomosis between the UN and the MN. The second most frequent type is a Riche-Cannieu anastomosis, the prevalence of which has been found to be up to 55.5% (7). However, the prevalence of each of the three subtypes of BA varies. Type 1 BA, like the one described in the current report, is the most common of the three subtypes, accounting for 86.2 % of all BA cases. The other two subtypes are significantly less common, with the prevalence of Type 2 at 9.4% and Type 3 at 4.4% (7).

The prevalence of the coexistence of these two anatomical variations is considered rare, given that there are only a few descriptions of this condition (10). One such description is the case study by Sirasanagandla et al. (10).

Clinical Considerations

The perfusion of the hand is bifid. The normal presence of both the deep and superficial palmar arches offers collateral perfusion via a wide anastomotic network, that protects the hand from ischemia. In cases in which the deep or superficial palmar arch is incomplete, occlusion of the RA or the UA, e.g. due to thrombosis following cannulation, can lead to severe ischemia of the hand (3). In addition, the UA is more vulnerable than the RA, given its course around the hook of the hamate bone, so, in cases like the one reported in this paper, partial hand ischemia may occur as a result of an UA injury.

Several authors have discussed the clinical implications of the BA. A case was described of a patient with traumatic laceration of the BA, leading to sensory loss between the 3rd and 4th fingers. The symptoms improved after the laceration was surgically repaired. Additionally, carpal tunnel release has been reported to involve injuries of the

communicating branch in BA cases (7). A "danger zone" has been described, which extends to the middle half of the hypothenar eminence, and which is limited distally by the proximal transverse crease of the palm, and radially by the longitudinal crease between the eminences of the thenar and hypothenar (6). To avoid iatrogenic damage and resulting permanent loss of sensation, hand surgeons and microsurgeons should be aware of the presence of a BA, with the greatest risk emerging in procedures such as carpal tunnel release, Dupuytren fasciectomy, 4th finger flexor tendon surgery, as well as mobilization of neurovascular island flaps (7).

Conclusion

The case described is a combination of two relatively common anatomical variations of the hand. However, being aware of such structural abnormalities is of non-negligible practical significance for hand surgeons, as vascular and neural abnormalities in the hand that may complicate surgical procedures.

What Is Already Known on This Topic:

The vascular and neural anatomy of the hand is of indisputable complexity. Berrettini anastomosis between the ulnar and median nerves is a well-described anatomical variation in the hand. An incomplete superficial palmar arch is also a relatively common anatomical entity.

What This Study Adds:

This study describes (also using detailed dissection images) a relatively rare case of the coexistence of a Berrettini anastomosis and an open superficial palmar arch, and highlights the clinical significance of such variations that may complicate surgical procedures in the hand.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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