


CASE REPORT

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A persistent median artery piercing the median nerve: a review and clinical implications

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Abstract

Background This case report documents a rare variation of a persistent median artery. Normally a transient vessel present during embryologic development of the limbs, the median artery typically regresses by the eighth week of life as the radial and ulnar arteries predominate the distal vascular supply of the hand. In a subset of the adult population, this artery remains as a persistent median artery which most often ends in the carpal tunnel or hand without significant vascular dependence.

Case presentation An 84-year-old female cadaver was found bilaterally to have an artery that penetrated the median nerve in the forearm, continued through the carpal tunnel, then joined the superficial arch, giving rise to the common digital artery to the second webspace. It also gave rise to the radialis indicis, the princeps pollicis, and an anastomotic branch to the radial artery.

Conclusions This anatomic variant of a persistent median artery piercing the median nerve, traversing the carpal tunnel, and providing aberrant primary blood supply to a large area of the hand are details clinically relevant to those who treat hand disorders and injuries.

Keywords Persistent median artery, Variant median artery, Variant digital blood supply, Carpal tunnel syndrome, Carpal tunnel release complications

Background

The median artery is a transient embryologic vessel present during early limb development. By the eighth week of life, the radial and ulnar arteries emerge through the antebrachium to supply the primary vasculature of the hand. The median artery provides the initial vascular supply of the growing limb in utero, regressing by the eighth week; coincident with the emergence of the radial and ulnar arteries (Moore et al. 2020). When it fails to

regress, the anatomical variation is termed a persistent median artery.

The persistent median artery has been documented in two distinct patterns, the predominant antebrachial pattern, in which there is an incomplete regression of the vessel in the antebrachium, and the less documented palmar branching patterns, in which the artery reaches the palm by way of the carpal tunnel (Alexander et al. 2020). In this case report, we found the persistent median artery piercing the median nerve, continuing through the carpal tunnel, and significantly contributing to the vascular supply in a unique manner. This variant median artery not only joined the superficial palmar arch, giving rise to the common digital artery to the second webspace, but it also gave rise to the princeps pollicis and radial indicis arteries, as well as an anastomotic branch to the radial artery. Any one of these isolated findings would be rare, however

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the combination of anatomic variants in this case makes it unique among existing literature.

There is a lack of consensus regarding the prevalence of this anatomic variation in current literature. Cadaveric studies describe a significant variability of 4–27% for the overall prevalence of a persistent median artery (Haładaj et al. 2019). A more recent publication by C. Townsend et al. described an 8.3% prevalence rate for the palmar variation in patients with carpal tunnel syndrome undergoing open carpal tunnel release (Townsend et al. 2022). This recent demonstration of the relatively common incidence of a persistent median artery emphasizes the need to contribute to its awareness. To that end, this case report provides a detailed account of a previously unidentified persistent median artery and discusses its clinical implications.

Case presentation

This study was carried out in the Clinical Anatomy department of Sam Houston State University College of Osteopathic Medicine (SHSU – COM) in Conroe, Texas. The Sam Houston State University Institutional Review Board ruled the study exempt. The donor was processed by the University of Texas McGovern Medical School in Houston, Texas, and was dissected at the SHSU – COM facility.

The variant median artery was identified in an 84-year-old female cadaver. In the proximal antecubital fossa, the brachial artery followed its typical path and branched into radial and ulnar arteries. At the distal antecubital fossa, beneath the wrist flexors and pronator teres muscle, the ulnar artery gave rise to both the common interosseous artery and the variant median artery (Fig. 1).

The common interosseous artery followed its typical path and branched into the anterior and posterior interosseous arteries. The ulnar artery similarly continued a typical path to Guyon’s Canal. The radial artery followed

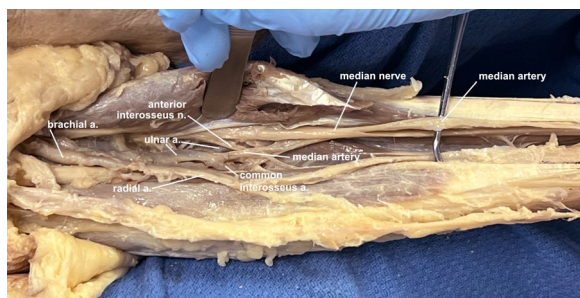


Fig. 1 Median artery within the forearm. The median artery was traced proximally and found to pierce the median nerve in the mid-forearm approximately six centimeters distal to its origin from the ulnar artery where the adjacent common interosseous artery also originated

a typical path within the forearm. Deep to the flexor digitorum superficialis muscle, the variant median artery coursed alongside the median nerve for six centimeters prior to perforating the median nerve. After perforating the nerve, the variant artery then continued alongside it through the carpal tunnel. Within the carpal tunnel, the variant artery was superficial to the median nerve. It then emerged from the carpal tunnel to join the superficial arch, giving rise to the common digital artery to the second webspace. It also gave rise to the radialis indicis, the princeps pollicis, and an anastomotic branch to the radial artery (Fig. 2).

Discussion

The persistent median artery arises from incomplete or absent regression of the median artery during early embryonic limb development. This period of limb development begins at five weeks with limb bud formation and concludes at approximately eight weeks. The vasculature of the forelimbs develops concurrently from the

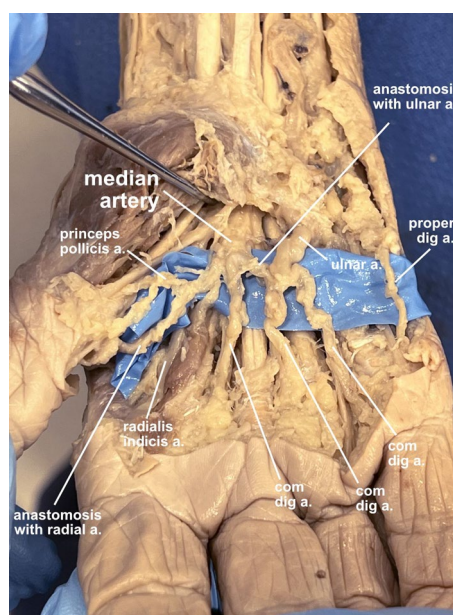


Fig. 2 Median artery course through the palm. Within the palm, the median artery was first seen exiting the carpal tunnel, alongside the median nerve, prior to branching and providing both proper digital vessels to the thumb and anastomosing with the radial artery over the adductor pollicis muscle. An additional branch to provide the proper digital artery of both the radial side of the index finger as well as the common digital artery to the second webspace as observed. In summary, the variant median artery observed provided the primary blood supply to the thumb, index finger, and the radial side of the long finger. It was observed proximally to provide another anastomotic branch to the ulnar artery. This anastomosis was after the ulnar artery had branched into the common digital arteries to the third and fourth webspace and the proper digital artery to the ulnar side of the fifth finger

intersegmental and primary axial arteries; themselves branches of the aorta. From the intersegmental artery arises the brachial artery within the arm, and the common interosseous artery within the antebrachium. The median artery first emerges as a branch of the common interosseous artery at approximately five weeks where it provides the initial vasculature for the hand throughout weeks six to seven. By the eighth week of development, the radial and ulnar arteries have branched from the brachial artery and have replaced the median artery in providing the primary vascular supply for the hand. This coincides with the regression of the median artery within the antebrachium (Moore et al. 2020).

The persistent median artery is a documented anatomic variation described previously in the literature; however, we discovered several features of this donor's anatomy that set it apart from other case studies. This donor's persistent median artery gave rise to the princeps pollicis and the radialis indicis arteries, usually supplied by the radial artery, and the common palmar digital artery to the second webspace, usually supplied by either the ulnar artery, superficial arch, or the radial artery. Additionally, this artery pierced the median nerve and was found to have the same anatomical composition bilaterally. Although persistent median arteries contributing to a portion of the hand's blood supply have been described, none appeared to have made as significant a contribution as was seen in this case (Townsend et al. 2022; Bathala et al. 2020). Haładaj et al. reported various contributions to the superficial palmar arch, however, the extent of vascular supply was less than in this case. (Haładaj et al. 2019). The persistent median artery is known to commonly travel alongside the median nerve, however, it is exceedingly rare to find evidence that it pierces the nerve. Kumar et al. reports one donor out of thirty in which the median nerve was pierced in a similar fashion. The same study also reported that this particular donor was the only one found in their cohort to have bilateral persistent median arteries (Kumar et al. 2012). Another study that retrospectively evaluated thirty-three patients for the presence of persistent median arteries during open carpal tunnel release procedures found no evidence of bilateral variants (Haładaj et al. 2019).

A recent prospective review demonstrated a prevalence rate for the palmar pattern of the persistent median artery, the less common variation, to be as high as 8.3% in patients with carpal tunnel syndrome undergoing open carpal tunnel releases (Townsend et al. 2022). In other cadaveric studies, the prevalence for the palmar pattern varies significantly from as low as 4% to as high as 27% (Haładaj et al. 2019).

The presence of a persistent median artery, when it extends into the carpal tunnel, has been previously

implicated as a potential cause for carpal tunnel syndrome (Alexander et al. 2020; Haładaj et al. 2019; Townsend et al. 2022). It is reasonable to speculate that any space occupying structure within the carpal tunnel could compress the median nerve, resulting in compressive neuropathy. Clinically, this neuropathy would reflect the sensory distribution of the median nerve to the first, second, third, and lateral half of the fourth digits, and motor innervation of the thenar muscles. Symptoms may be exaggerated by positioning or repetitive hand movements that cause further compression within the carpal tunnel. Additional consequences of persistent median nerve compression can include the atrophy of the thenar muscles. Notably, the skin sensation over the mid-palmar skin, provided by the superficial branch of the median nerve, would remain intact as it branches prior to entering the carpal tunnel. There are also instances of thrombosis within the persistent median artery in the carpal tunnel that have been documented to lead to mass effect within the carpal tunnel and median nerve compressive neuropathy (Jeon et al. 2020; AlModumegh et al. 2021).

Considering its relatively common incidence, associated compressive neuropathy, and vascular contributions to the hand, an awareness of the persistent median artery is of importance for surgical cases of the forearm, wrist, and hand (Alexander et al. 2020; Haładaj et al. 2019). In instances where the hand is exsanguinated and under tourniquet control during wrist or hand surgery, the presence of a variant median artery could be missed if one was unaware of its existence. This could lead to unrealized arterial damage and local hemorrhage that would not be evident until the tourniquet was released post-operatively. Should the median artery provide a significant contribution to the digital blood flow such as we observed in this donor, an injury could also lead to vascular insufficiency. This anomaly would readily be demonstrated by imaging during preoperative planning, such as ultrasound of the carpal tunnel. Awareness of a variant artery's presence and course through the forearm would prove useful to any surgical intervention in that region. To that end, we contribute to the literature a cadaveric case study of a previously undocumented bilateral persistent median artery that not only pierces the median nerve in the forearm before extending through the carpal tunnel, but also comprises the radial end of the superficial palmar arch by giving rise to the common digital artery to the second webspace. It also branched to form the radialis indicis, the princeps pollicis, and an anastomotic branch to the radial artery.

Conclusions

This constellation of anatomic variants discovered in a donor with a bilateral persistent median artery piercing the median nerve, traversing the carpal tunnel, and providing aberrant primary blood supply to a large area of the hand is distinctive from existing literature. Knowledge not only of a persistent median artery's existence, but also of its ability to provide extensive blood supply to the hand would be of utmost importance to prevent vascular injury during wrist and hand surgery or if relying on typical anatomic blood supply following a traumatic injury. Furthermore, this case report contributes to current literature which reports varying consensus in persistent median artery presence.

Abbreviation

SHSU – COM Sam Houston State University – College of Osteopathic Medicine

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Author contributions

EP, GK, ML contributed to Study conception and design, material preparation, dissection, data collection and analysis. All authors read and approved the final manuscript.

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Availability of data and materials

Other than referenced material, there are no other data sets to report. Additional information can be obtained by contacting corresponding author if needed.

Declarations

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki and its subsequent amendments. The Ethics Committee of Sam Houston State University College of Osteopathic Medicine ruled the study exempt.

Consent for publication

This study does not contain individuals personal data.

Competing interests

The authors declare that they have no competing interests.

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