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A Communicating Anomalous Vessel Between the Brachial and Radial Artery: A Cadaver Case Report

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
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Patient: Male, 95-year-old
Final Diagnosis: Communicating brachial artery
Symptoms: N/A
Clinical Procedure: —
Specialty: Anatomy • Surgery

Objective: Congenital defects/diseases

Background: The arrangement of the arm vasculature is known to vary between individuals with a majority being clinically silent. In this report, we describe a rare arterial anomaly in which a branch arises from the proximal brachial artery in the upper left arm and anastomoses with the radial artery near the cubital fossa.

Case Report: The brachial artery supplies most of the blood to the upper arm and normally bifurcates into the ulnar and radial arteries in the cubital fossa. During our dissection, an aberrant communicating artery was found branching off the brachial artery in the upper arm and anastomosing directly to the radial artery in the forearm. Reports of similar anomalous arteries (vasa aberrantia) have been reported in cadaver case studies, but we present an unusual case where the communicating branch rejoins the radial artery more distally, after the branching of the radial recurrent artery and a muscular branch providing blood supply to forearm muscles.

Conclusions: Knowing different variations of arm vasculature, such as the communicating artery presented in this case, is important to reduce risks that can happen in procedures of the arm such as endovascular angioplasty or atherectomy. This also includes understanding irregularities during angiographies due to these abnormalities. Further research can explore the prevalence of this variation and implications of varied arm vasculature.

Keywords: Anatomic Variation • Brachial Artery • Case Reports • Radial Artery

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Introduction

Typical left arm vasculature begins proximally with the subclavian artery, a branch off the aortic arch that comes up to the shoulder. As it travels past the lateral border of the first rib, the subclavian artery becomes the axillary artery (AA). The AA continues as the brachial artery (BA) after passing the lower border of the teres major muscle. At the cubital fossa, the BA bifurcates into the radial and ulnar artery (RA and UA, respectively). Branching off from the UA is the common interosseous artery, which further divides into the interosseus recurrent, posterior interosseous, and anterior interosseous arteries in the forearm. The RA has multiple vessels stemming from the main artery, including the radial recurrent artery (RRA), which travels back up the forearm to the elbow and proximal muscular branches to supply muscles of the forearm. Both the RA and UA supply the hands with vasculature through the palmar arches [1,2].

Variations in arm vasculature are well documented with anomalies found in about 25% of studied cases resulting in several known anatomical variations that deviate from the norm [3]. Awareness of common anatomical variations can be important in clinical settings, especially for vascular surgery and interventional radiology. This awareness can help reduce risk in vascular procedures and increase the understanding of irregularities in imaging.

A common pediatric variation is the persistence of the median artery, an embryological artery that normally gives vasculature to the distal limbs until it regresses with the eventual formation of the RA and UA [4,5]. This anomalous artery can be found running with the median nerve medially in the forearm into the wrist and hand instead of regressing as in normal development. Another common variation is the brachioradial artery (BRA), a radial artery that has an origin higher than the cubital fossa, most commonly in the upper third of the BA, or has even been documented to branch off the AA [3,6]. Similarly, cases of brachioulnar arteries (high origins of the ulnar arteries) have also been found, but these are less common than brachioradial arteries [7]. Other less common variants include the superficial radial artery, which travels over the tendons of the snuffbox rather than on the floor, and the superficial brachioulnoradial artery [8]. In the superficial brachioulnoradial artery, the UA and RA originate from the superficial BA, and the common interosseous artery is a continuation of the BA instead of the UA [4].

Here, we present an uncommon variation of upper arm vasculature that maintains an anomalous communicating branch (vasa aberrantia) between the BA and RA. Similar arteries have been discovered in cadaver studies, but the current case presents a rare course of the communicating branch rejoining the RA distally to the normal RRA and a muscular branch supplying the forearm muscles.

Case Report

During dissection of a male cadaver's left arm at the University of Toledo College of Medicine and Life Sciences, a unique anatomic variation of the arm vasculature was discovered. All superficial arm muscles and the median nerve were cut and reflected to properly show this anomaly. The BA was identified as the AA passed the inferior border of the teres major muscle. A communicating brachial artery (CBA), with a length of 190 mm and a diameter of 1.3 mm, branched laterally off the main BA (Point A in **Figure 1**) approximately 117.5 mm below the teres major. The CBA continued superficially down the arm while crossing the median nerve to the lateral side of the arm, as shown in **Figure 2**. The CBA rejoined with the RA distally to the cubital fossa, after the RRA branched from its expected location on the RA. In between bifurcation of the BA and the CBA connection, the RA measured 23.5 mm in length and 2.8 mm in diameter. An up-close image of this portion of the RA is shown in **Figure 3**. The BA bifurcated into the UA and RA at the cubital fossa as expected and traveled its normal course, as seen in **Figures 2 and 3**. This anatomical variation was only

Figure 1. The left arm and forearm neurovasculature detailing the point of origin of the anomalous communicating brachial artery from the brachial artery (point **A**) and the point of anastomosis of the communicating brachial artery distally to the radial artery (point **B**).

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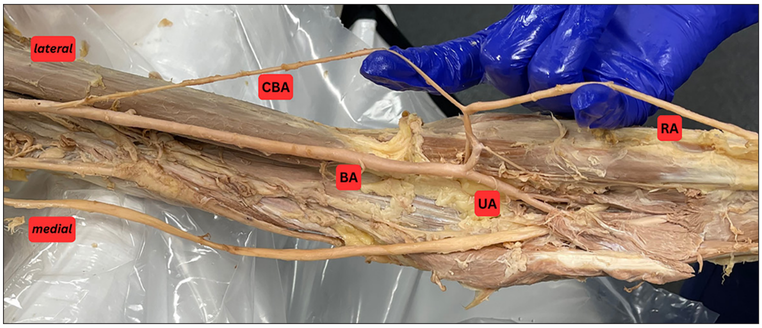

Figure 2. Anterior view of the left arm showing cadaver vasculature. The BA is shown to bifurcate near the cubital fossa into the RA and UA. The CBA is shown to be an accessory vessel between the BA and RA. BA, brachial artery; UA, ulnar artery; RA, radial artery; CBA, communicating brachial artery

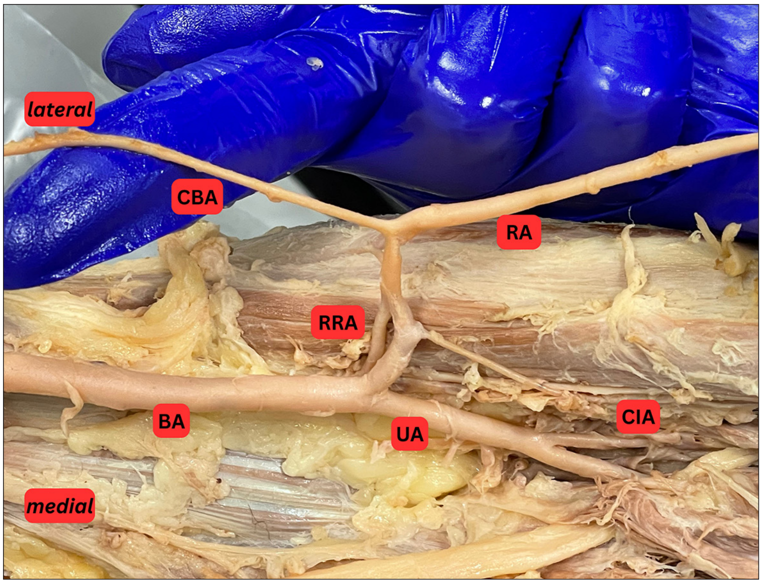

Figure 3. Anterior view of the left arm showing cadaver vasculature, enhanced version detailing the CBA anastomosis to the RA. It also details the RRA and CIA branching from their typical anatomical origins, the RA and UA, respectively. BA, brachial artery; UA, ulnar artery; RA, radial artery; CBA, communicating brachial artery; RRA, radial recurrent artery; CIA, common interosseus artery

found in the left arm, as the right had the typical anatomical tract of the BA, RA, and UA. There were no other vascular variations found in the left arm.

Measurements for length and circumference were made using the thread method; a piece of fine thread was placed along the vessel's length or around the vessel in 2 locations near the middle (average taken between the 2 locations), cut, and measured with a ruler. The diameter was then calculated from the circumference by dividing the measured number by pi.

All body donors at the University of Toledo signed informed consent allowing for learning and research activities. Donor dignity was upheld to the highest standards during this study.

Discussion

To understand how these morphological variations came to be, an understanding of embryological vasculature is vital. The vascular and mesenchymal tissue of the limb starts growing and differentiating proximally and progresses distally as embryological development continues. Originally, the seventh intersegmental artery stems from the aorta, becomes the subclavian artery, and continues into the limb bud as the axial artery that ends in a capillary plexus [9]. As the limb elongates, capillaries continue distally to supply the end of the limb, whereas the proximal portions of the capillaries either differentiate as major blood vessels from the axial artery or regress [10,11]. The axial artery continues to grow along the midline of the developing limb with the proximal segments becoming the AA and then the BA. As development continues, the axial artery turns into the median artery in the forearm. It then begins to regress around the eighth week as the RA and UA bifurcate from the BA to supply blood to the distal portions of the limb [12]. According to Rodriguez-Niedenfuhr et al, the capillary plexus is thought to be the origination of aberrant vasculature in the limbs [10,11].

As previously mentioned, some capillaries are maintained and differentiate into prominent vessels that persist throughout life. Some of these vessels are normal, whereas others are aberrant growths from capillaries that failed to regress, which is a suspected cause of the variant described in this case report. The CBA may be a persistent capillary from the axial artery that was maintained as a branch of the BA segment. As

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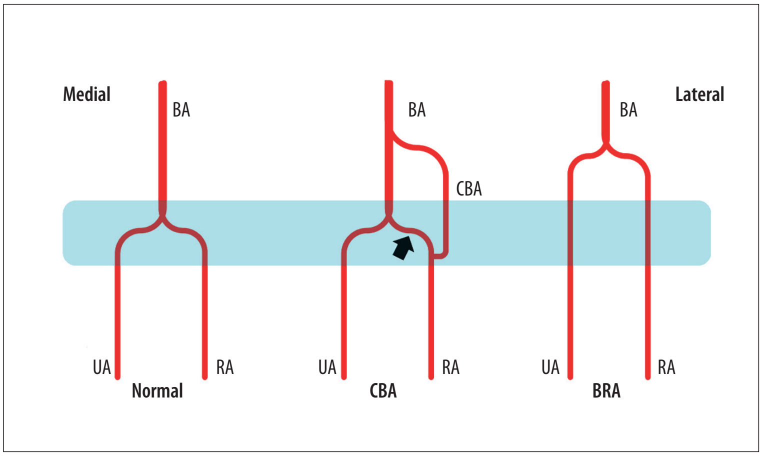

Figure 4. This illustration shows the differences between the normal BA tract, CBA tract, and BRA tract. The black arrow points to the 'cubital crossover' that is mentioned in cases of a BRA. Black arrow, 'cubital crossover'; blue highlighted area: cubital fossa. Diagram created using Canva.com. BA, brachial artery; UA, ulnar artery; RA, radial artery; CBA, communicating brachial artery; BRA, brachioradial artery.

suggested by Susan et al, since this vessel reattaches back to the radial artery, it may be a proximal remnant of the radial artery within the capillary plexus that was preserved during development [13]. Our unusual case has the CBA reattaching distal to the RRA, which could be due to longer conservation of the vessel during development before ultimately rejoining its correct course.

Although these embryological disturbances may remain unnoticed throughout a person's life, knowledge of anomalies in arm vasculature can be important for angiography and surgery [14]. Surgically, the RA is a popular access site in endovascular procedures and can be chosen over the femoral artery due to fewer complications with the RA in comparison with the femoral artery [4]. When using the RA for access, anomalies make the artery difficult to navigate and can negatively affect the procedure, especially if the vascular anomaly is previously unknown in the patient. Additionally, the presence of vascular anomalies may disrupt angiographic imaging with abnormal or unexpected blood flow patterns.

Besides surgical and radiographical implications, the CBA may be important clinically as it may provide an alternative pathway for blood in the presence of an obstructed BA. An obstruction in the BA will normally cause a decrease in blood flow distally to the forearm and hand, affecting sensation and movement in a patient. However, the CBA could maintain collateral blood flow by passing the obstruction and therefore allow continued flow down the arm to the RA. Although this could potentially limit the clinical presentation in a patient with a blocked BA, this idea is speculative and has not been assessed in scientific studies. Moreover, structures supplied by vessels branching from the original BA before the CBA rejoins distally may not benefit from this collateral flow as they may not receive needed blood to function.

As mentioned in the introduction, there are many different vasculature variations in the arm originating from multiple locations and traveling various courses [6,11]. However, there are multiple case reports that classify vessels like the CBA presented in this report and similar vasa aberrantia as BRAs. A BRA is defined as "a radial artery with a high origin" with the BA continuing its normal track and renamed the UA after the cubital fossa, and the BRA continuing as the RA as it enters the forearm and travels laterally to the hand [11]. Sometimes, there is a supposed 'connection' between the BRA and BA in the cubital fossa, or an anastomosis scientists have termed the "cubital crossover" [6,10,15]. It has been reported that this 'anastomosis' is present in 17.8%-54.6% of cases with a BRA [6,10,15]. Haladaj et al described 3 distinct types of this anastomosis in the presence of a BRA: dominant (~16.7%), balanced (~50%), and minimal (~33.3%) cubital crossover. The dominant variation occurs if the BRA is smaller than the 'anastomosis', leading to an increase in size when combined. If this nomenclature were applied to the present case, it would be classified as this variation of a cubital crossover, as the diameter of the CBA increases by over 2-fold (269%), from 1.3 mm to 3.5 mm, after joining with the anastomosis to become the RA. It is worth noting that this supposed cubital crossover in our case also has branches for the RRA and a muscular branch. While not inherently rare, Rodriguez-Niedenfuhr et al documented that about 20% of RRA's stem from the cubital crossover in the presence of a BRA, while Haladaj et al only found these branches from the anastomosis in the balanced variation [6,10].

There seems to be some discrepancy in classification of a BRA and other BA tracts, like the CBA presented in this report. Although there are many publications presenting findings of a 'cubital crossover' between the BRA and BA, there are also other publications that classify identical tracts as vasa aberrantia. These latter publications state that the anomalous vessel simply connects the BA to the RA distally and is not a high origin of the RA itself with a supposed 'cubital crossover' [13,16]. A diagram illustrating these differences is provided in **Figure 4**. In these classifications, the 'cubital crossover' (as shown in **Figure 4**) is the normal RA that bifurcated from the BA at its expected location in the cubital fossa, and not an anastomosis between a BA and a BRA. Moreover, the anastomosis would be the CBA, connecting the BA to the RA in an aberrant manner. This terminology distinction could be important for clarifying future classifications of vascular anomalies of the upper extremities and providing clear understanding for clinical uses as well.

Conclusions

This case report illustrates an anomalous CBA arising from the BA and reconnecting with the RA, distal to the cubital fossa. This vessel shows an unusual finding: anastomosis of the CBA to the RA after the bifurcation of the RRA and a muscular vessel branch from the RA. This observational case report of an abnormal vessel pathway can remind clinicians to be cautious of anomalies when performing procedures in the arm, such as minimally invasive endovascular procedures. Future research can explore the prevalence of this anomalous variation and implications that may arise from it.

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Institution Where Work Was Done

College of Medicine and Life Sciences, University of Toledo, Toledo, OH, USA.

Patient Consent

All body donors at the University of Toledo signed informed consent allowing for learning and research activities. Donor dignity was upheld to the highest standards during this study.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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