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## Variants of branching of the upper limb arteries

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### Abstract

**Background:** The study of anatomical variability is a component of one of the largest compartments of anatomy and it is a current direction of the modern morphology, conditioned by the nowadays requirements of practical medicine. The presence of anatomical variants is closely related to the abnormal development of the arterial system during intrauterine life, mainly that of the primary axial artery of the upper limb. Those variants do not lead to functional disorders, but they may become fatal under certain circumstances.

**Material and methods:** During the dissection of a 60-year-old male cadaver an unusual arterial variant was found out on the right upper limb, using classical methods of the upper limb arteries dissection.

**Results:** In its retropectoral part the axillary artery was bifurcated into two arterial trunks, the brachioradial and brachioulnar arteries. The brachioradial artery represented the anterior trunk of the axillary artery bifurcation, having a superficial trajectory, while the brachioulnar artery was the posterior and deeply located one. In the specialty references, the brahioradial and brachioulnar arteries are defined as high origin of radial and ulnar arteries, which arise more common from the brachial artery and less frequently from the axillary one.

**Conclusions:** The variants of origin and trajectory of the upper limb arteries are of clinical significance to both imagists and vascular surgeons. The imagists may misinterpret the angiographic images with such vascular patterns and surgeons may encounter difficulties in surgery at that level.

**Key words:** axillary artery, brahioradial artery, brachioulnar artery.

### Introduction

The specialty references describe the variability of the upper limb arteries as one of the most common variations and it is reported by different researches. According to McCormack L. the upper limb arterial variants were depicted in 18.5% of cases, and according to Uglietta J. – the incidence of variations was 9%, and among those the most common was related to the axillary artery, followed by the radial and brachial arteries [1, 2, 3].

Unlike anatomical variants of the venous system, most of the arterial ones, do not affect the functions of the human body, being detected during dissection, or when performing angiography at that level [4].

The appearance of different variants of the upper limb arteries may be caused by genetic factors, or by the disturbances of the development of the primary axial artery, which is related to the embryonic period, dependent of oxygenation and nutrition, and related to the hemodynamic force of the blood system, but at the same time, it might be influenced by the local factors, such as fetal position in the uterus, early limb movements, or unusual muscular development [5, 6].

Malci-Gurbuz I. [7] sustains that genetic factors are the most probable cause leading to arterial variations during angiogenesis; and as a result of that complex and dynamic process, it is not surprising that the variability of the axillary and brachial arteries is quite common.

Arey L. B. [8] mentioned that arterial variations appear

as consequences of unusual way of development of the primary vascular plexus, or because of the presence and development of the blood vessels that under normal conditions should go through involution. In some cases, arterial variants are formed due to the regression and disappearance of blood vessels that under normal conditions must be present, or due to the incomplete development of the blood vessels, their fusion or resorption of some of them, which normally do exist separately.

The topographic and numerical variability of the upper limb arteries is of clinical significance for imagistic diagnostics, and important for surgeons in choosing the right way and tactics in stenting coronary angioplasty [9].

### Material and methods

At the Department of Human Anatomy, of Nicolae Testemitsanu State University of Medicine and Pharmacy, during the dissection of a 60-year-old male cadaver an unusual arterial variant was found out on the right upper limb. When preparing the axillary artery, its bifurcation into two arterial trunks at the retropectoral level – the brahioradial artery and brachioulnar artery, was observed (fig.1).

Before its bifurcation, the axillary artery was of 5 cm in length and its external diameter was 0.5 cm. In its first portion the axillary artery had a usual trajectory and it had given off its typical branches: the superior thoracic and thoracoacromial arteries.

The brachioradial artery was the anterior trunk of the axillary artery bifurcation, while the brachioulnar artery –



Fig. 1. Branching of the axillary artery: 1 – axillary artery; 2 – bifurcation of the axillary artery; 3 – brachioulnar artery; 4 – brachioradial artery.



Fig. 2. Arteries of the forearm: 1 – brachioradial artery; 2 – brachioulnar artery; 3 – superficial palmar branch.



Fig. 3. Brachioulnar artery with the subscapular artery: 1 – brachioulnar artery; 2 – subscapular artery; 3 – circumflex scapular artery; 4 – thoracodorsal artery.



Fig. 4. Brachioulnar artery and its branches: 1 – brachioulnar artery; 2 – common arterial trunk; 3 – posterior circumflex humeral artery; 4 – anterior circumflex humeral artery; 5 – deep brachial artery; 6 – radial nerve.

the posterior trunk; the last one had a larger external diameter (which proximally was 0.5 cm and distally – 0.3 cm), in comparison with the external diameter (proximally it was 0.3 cm and distally – 0.24 cm) of the brachioradial artery.

On the arm the brachioradial artery was located along the medial bicipital groove, and in its upper third the artery passed medially to the median nerve and brachial veins; in the middle part of the arm it crossed them anteriorly, to change its position, so, in the lower third of the arm – the brachioradial artery had the most lateral position.

In the cubital fossa it passed behind the aponeurosis of the biceps brachii muscle to continue on the forearm with the trajectory characteristic of the radial artery (fig. 2).

At the level of the pectoral triangle, the lateral thoracic artery originated from the brachioradial artery, while on the arm it did not give off any branches, only on the forearm it gave off the recurrent radial artery, muscular branches and the palmar superficial branch.

At the level of the subpectoral triangle, the brachioulnar artery was located posteriorly and deeper than the brachioradial one, then it continued on the arm along the medial bicipital groove, being located between the brachial veins and laterally to the median nerve, while on the forearm it had a common for the ulnar artery trajectory, giving off branches characteristic of it.

In the subpectoral triangle, the brachioulnar artery gave rise to the subscapular artery with the external diameter of 0.2 cm, and it divided into its thoracodorsal and circumflex scapular arteries (fig. 3).

At the lower margin of the pectoralis major muscle, from the brachioulnar artery originated a common trunk of the same diameter as the subscapular artery, that immediately branched out into three arteries: the anterior circumflex humeral artery with a diameter of 0.03 cm, that emerged from the brachioulnar artery; the posterior circumflex humeral artery with a diameter of 0.1 cm and the deep brachial one – 0.08 cm in diameter (fig. 4).

At the level of the upper third of the arm, the brachioulnar artery gave off the superior collateral ulnar artery and

in the inferior third – the inferior collateral ulnar artery; the external diameter of the first one was 0.04 cm, and its angle of origin was 55°, the diameter of the second one was 0.02 cm, and the angle of its origin – 80°; the upper collateral ulnar artery bifurcated into two branches: a muscular one, which supplied the medial head of the triceps brachii muscle and an articular branch – to the elbow joint; the inferior collateral ulnar artery was a single arterial trunk, that participated in formation of the elbow joint arterial network.

On the forearm, the brachioulnar artery had the usual to the ulnar artery trajectory, lodging in the ulnar groove and giving off its typical branches.

## Discussion

The brachioradial artery is defined as the high origin of the radial artery that may be present on the arm with the brachial artery, or with superficial brachial one, at the level, where those arteries branch out into the ulnar and common interosseous arteries [4].

The brachioradial artery in the specialty reference sources is described as the most common arterial variant of the upper limb, originating from the axillary, or from the brachial artery (table 1).

According to F. Fuss [10] the brachioradial artery, is more frequently present in males and predominantly on the right side, though these differences are not so significant, that fact was also confirmed by A. Rodriguez-Baeza [11].

From the topographic point of view, the brachioradial artery crosses the median nerve anterosuperiorly on the entire length of the arm, while the brachial artery – posteriorly or in some cases – anteriorly; therefore the brachioradial artery was named by some researchers – as superficial brachial artery [12, 4].

According to our case, in the cubital fossa, the brachioradial artery passed behind the bicipital aponeurosis and it was also confirmed by some authors, based on case study references [13].

The brachioradial artery can anastomose with the brachial artery by means of a spiral, or by a straight branch [11, 5].

Table 1

Origin of the brachioradial artery according to the reference sources based on a large research

Author	Number of cases	Axillary artery	Brachial artery	Brachial artery		
				Upper 1/3 of the arm	Middle 1/3 of the arm	Lower 1/3 of the arm
Quain R. (1844)	53	16 (30%)	37 (70%)	19(35.9%)	13 (24.6%)	5 (9.5%)
Muller E. (1903)	31	8 (25.8%)	23 (74.2%)	22 (71%)	1 (3.3%)	0
Adachi B. (1928)	29	9 (31%)	20 (69%)	-	-	-
Karlsson S. (1982)	8	1 (12.5%)	7 (87.5%)	5 (62.5%)	2 (25%)	0
Uglietta J. (1989)	8	1 (12.5%)	7 (87.5%)	2 (25%)	2 (25%)	0
Rodriguez-Baeza A. (1995)	6	1 (16.7%)	5 (83.3%)	3 (50%)	1 (16.65%)	1 (16.65%)
Rodriguez-Niedenfuhr M. (2001)	52	12 (23%)	40 (77%)	34 (65.4%)	4 (7.7%)	2 (3.9%)
Vandana N. (2012)	20	6 (8.3%)	14 (19.6%)	-	-	-
Chandni Gupta, (2012)	12	2 (2.66%)	10 (26.6%)	-	-	-

The presence of the brachioradial, or of the median artery is a common variation due to their high incidence, while the origin of a median artery from the brachioradial one, in the distal third of the forearm mentioned by Muler [14] is a rare variant; the occurrence of that variant can be explained by close correlation between the radial and medial arteries and by the anastomosis between them at the level of the forearm during embryogenesis [4].

The brachioulnar artery is defined as a high origin of the ulnar artery, which may exist as an arterial variant of the upper limb, along with the brachial artery, that bifurcates into the radial and common interosseous arteries.

That pattern of axillary artery branching is less frequent than the presence of the brachioradial artery, and in terms of its distribution by gender and body part, the specialty literature does not make any references, since it has almost always been occasionally detected [15,16].

In the specialty references, a high origin of the ulnar artery was most commonly mentioned, when it started in the upper third of the arm, but it originated very rarely from the retropectoral portion of the axillary artery [17, 18].

Uglietta J. [2] noted that in 2% of cases, the ulnar artery had its origin from the axillary artery, having a monolateral character, and according to Al-Sowayigh M. [19] the incidence was 1.7%.

According to the bibliographic data, at the level of the arm, the brachioulnar artery passes in front of the median nerve, and on the forearm – beneath the bicipital aponeurosis, and then continues the trajectory common to the ulnar artery [20]. This fact was confirmed by the data of our study.

Rodriguez-Niedenfuhr M. [4] performed the study on 384 upper limb samples and he analyzed statistically the distribution of the anatomical variants by gender and body part. The similar data were obtained in our case. Table 2 shows the data obtained by Rodriguez-Niedenfuhr M.

**Table 2**

**Distribution of the brachioradial and brachioulnar arteries by gender and part of the body (M. Rodriguez-Niedenfuhr)**

Gender	Number	Brachioradial artery		Brachioulnar artery	
		Left	Right	Left	Right
Male	91	9 (9.9%)	11 (12.1%)	3 (3.3%)	3 (3.3%)
Female	101	14 (13.9%)	19 (18.8%)	5 (4.9%)	5 (4.9%)
Total	192	23 (12%)	30 (15.6%)	8 (4.2%)	8 (4.2%)

**Conclusions**

The variants of origin and trajectory of the upper limb arteries are of clinical significance to both imagists and vascular surgeons. The imagists may misinterpret the angiographic images with such vascular patterns and surgeons may encounter difficulties in surgery at that level.

**References**

- McCormac LJ, Cauldwell MD, Anson BJ. Brachial and antebrachial arterial patterns. *Surg Gynecol Obstet.* 1953;96(1):43-54.
- Uglietta JP, Kadir S. Arteriographic study of variant arterial anatomy of the upper extremities. *Cardiovasc Intervent Radiol.* 1989;12(3):145-8.
- Cherucupuli C, Dwivedi A, Dayal R. High bifurcation of brachial artery with acute arterial insufficiency: a case report. *Vasc Endovascular Surg.* 2008;41(6):572-4.
- Rodriguez-Niedenfuhr M, et al. Variations of the arterial pattern in the upper limb revisited: a morphological and statistical study, with a review of the literature. *J Anat.* 2001;199(5):547-66.
- Rodriguez-Niedenfuhr M, Vazquez T, Parkin IG, Sanudo JR. Arterial pattern of the human upper limb: update of anatomical variation and embryological development. *Eur J Anat.* 2003;7(Suppl 1):21-8.
- Aughsteeen A A, Hawamdeh HM, Al-Khayat M. Bilateral variations in the branching pattern of brachial artery. *Int J Anat Var.* 2011;4:167-70.
- Malcic-Gurbuz J, Gurunluoglu R, Ozdogmus O, Yalin A. Unique case of trifurcation of the brachial artery: its clinical significance. *Clin Anat.* 2002;15(3):224-7.
- Arey LB. Development of the Arteries. In: *Developmental Anatomy.* 6th ed. Philadelphia: Saunders; 1954. p. 375-7.
- Jurjus A. Sfeir R, Bezirdjian R. Unusual variation of the arterial pattern of the human upper limb. *Anat Rec.* 1986;215(1):82-3.
- Fuss FK, Matula CW, Tschabitscher M. Die arteria brachialis superficialis [The superficial brachial artery]. *Anatomischer Anzeiger [Anatomical indicator].* 1985;160(4):285-94. German.
- Rodriguez-Baeza A, Nebot I, Ferreira B, Reina F, Perez I, Sanudo IR. An anatomical study and ontogenetic explanation of 23 cases with variation in the main pattern of the human brachio-antebrachial arteries. *J Anat.* 1995;187(Pt 2):473-9.
- Adachi B. Das arteriensystem der japaner [The arterial system of the Japanese]. Kyoto: Maruzen Press; 1928. p. 285-356. (Anatomie der Japaner; vol. 2). German.
- Melling M, Wilde J, Schnallinger M, Karimian-Teherani D, Behnam M, Firbas W. Rare variant of the brachial artery: superficial lateral inferior Type VII EAB. *Clin Anat.* 2000;13(3):216-22.
- Muller E. Beitrage zur morphologie des gefasssystems. 1, Die Arterien des Menschen [Contributions to the morphology of the vascular system. 1, The arteries of man]. *Anatomischer Hefte [Anatomical books].* 1903;22:377-575. German.
- Wood SJ, Abrahams PH, Sannudo JR, Ferreira BJ. Bilateral superficial radial artery at the wrist associated with a radial origin of a unilateral median artery. *J Anat.* 1996;89(Pt 3):691-3.
- Cavdar S, Zeybek A, Bayramic M. Rare variation of the axillary artery. *Clin Anat.* 2000;13(1):66-8.
- Yazar F, Kirici Y, Ozan H, Aldur MM. An unusual variation of the superficial ulnar artery. *Surg Radiol Anat.* 1999;21(2):155-7.
- Gadzhieva FG. Otsenka variantnoi anatomii podmyshechnoi i plechevoi arterii [Evaluation of variant anatomy of the axillary and brachial arteries]. In: [Actual issues of morphology. Materials of the international scientific conference dedicated to professor B. Z. Perlin centenary]; 2012 Sep 20-22; Chisinau: [publisher unknown]; 2012. p. 216-9. Russian.
- Al-Sowayigh MA, Zaki AI, El-Haggagy AA, Abdel AH, Badawoud MH. Anatomical variation of brachial artery bifurcation. *Saudi Med J.* 2013 Sep;34(9):908-12.
- Yuksel M, Yuksel E, Weinfeld AB, Shenaq SM. Superficial ulnar artery: embryology, case report and clinical significance in reconstructive microsurgery. *J Reconstr Microsurg.* 1999;15(6):415-20.
- Karlsson S, Niechajev IA. Arterial anatomy of the upper extremity. *Acta Radiol Diagn (Stockh).* 1982;23(2):115-21.
- Vandana N, Lakshmi Prabha R, Veena P. Variation in Course and Branching Pattern of Brachial Artery. *Anatomica Karnataka.* 2012;6(3):42-8.
- Chandi Gupta, Vikram Palimar, Murlimanju BV, Vaishali RS. A Morphological study of variations in the origin and course of radial artery. *Res J Pharm Biol Chem Sci.* 2012 April- June;3(2):333-40.