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**ANATOMICAL VARIATIONS OF THE BRACHIAL ARTERY BIFURCATION**

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**Abstract.** *The morphology of the upper limb arteries is of great clinical significance as the number of imaging examinations and reconstructive surgery at that level, have considerably increased lately. The current study is a retrospective and descriptive one. The aim was to identify and describe the variations of the brachial artery bifurcation depending on gender and side of the body. For our purpose 42 upper limb arteries of adult embalmed cadavers were examined. Using anatomical dissection, the origin and course of the brachial artery, the types of ramification into its terminal branches, and its variations were identified. By morphometric method, quantitative data regarding brachial artery were obtained. The high level of bifurcation of the brachial artery was identified in 4.8% of cases; brachial artery trifurcation was identified in 7.2% of cases. The high origin of the radial and ulnar arteries was identified in 9.5% of cases, followed by the bifurcation of brachial artery into atypical terminal branches. Depending on gender and side of the body, the variants of the brachial artery bifurcation were more often revealed in males, in an equal proportion for both upper limbs.*

**Keywords:** *anatomical variations, bifurcation of the brachial artery, trifurcation of the brachial artery*

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**АНАТОМИЧЕСКИЕ ВАРИАНТЫ БИФУРКАЦИИ ПЛЕЧЕВОЙ АРТЕРИИ**

**Аннотация.** *Важность знания анатомических вариантов артерий верхней конечности вытекает из необходимости практической медицины, аргументированной постепенным увеличением числа радиологических интервенционных процедур, сосудистых и реконструктивных операций на этом уровне. Данное исследование было ретроспективным, описательным, направленным на выявление и описание вариантов бифуркации плечевой артерии в зависимости от пола и исследуемой части тела. Артерии верхней конечности были изучены на 42 верхних конечностях, бальзамированных трупов взрослых людей. Методом анатомической диссекции были выделены место начало и ход плечевой артерии, тип её разветвления на свои конечные ветви и, имеющиеся анатомические варианты. С помощью морфометрии были получены количественные данные, относящиеся к данной артерии. Высокая бифуркация плечевой артерии была выявлена в 4,8% случаев, а её трифуркация – в 7,2%. Высокое начало лучевой и локтевой артерий установлено в 9,5% случаев, сопровождающееся бифуркацией плечевой артерии на атипичные конечные ветви. В зависимости от пола и изученной части тела варианты бифуркации плечевой артерии чаще были выявлены у лиц мужского пола, в одинаковой пропорции для обеих верхних конечностей.*

**Ключевые слова:** *анатомические варианты, бифуркация плечевой артерии, трифуркация плечевой артерии*

**Introduction.** Brachial artery and its terminal branches are the main vascularization source of the upper limb. Its impairments may cause circulatory disturbances with severe consequences, such as arterial obstruction and ischemia. Knowledge about topographical and numerical variability of the upper limb arteries is highly important in diagnostics and treatment of the upper limb.

In the specialty literature there are very few studies about brachial artery bifurcation, performed on a large number of samples. The majority of available sources are based on case reports, identified by routine anatomical dissection [2].

**The aim of the study.** To identify and describe the anatomical variations of the brachial artery bifurcation, depending on gender and side of the body.

**Material and methods.** The study was carried out in full compliance with international legislation and the law of the Republic of Moldova regarding biomedical studies involving humans, respecting all ethical statements. The upper limb arteries of 42 embalmed human cadavers (23 females: 18 right upper limbs (RUL) and 5 left upper limbs (LUL); 19 males: 10 RUL and 9 LUL) from the Department of Anatomy and Clinical Anatomy of Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova, were dissected. The origin and the course of the brachial artery, types of its ramification, into terminal branches, and its variations were highlighted.

By morphometric method, the quantitative data, such as length, external diameter and the level of brachial artery bifurcation referred to the interepicondylar line (the line that connects the medial and the lateral epicondyles of the humerus) were obtained. The level of brachial artery bifurcation was measured as the distance between the interepicondylar line and the bifurcation point of the brachial artery.

The obtained data were stored, processed and statistically analyzed using the software Statistica 6.0 and Microsoft Excel.

**Results and discussions.** The mean length of the brachial artery was  $21.2 \pm 1.05$  cm. The mean value of the proximal external diameter of the brachial artery was  $0.44 \pm 0.02$  cm; the mean value of the external distal diameter was  $0.34 \pm 0.01$  cm.

The bifurcation level of the brachial artery was established as follows: bifurcation at a distance of 1.0 – 1.5 cm below the interepicondylar line was marked out in 32.5% of cases; at a distance of 1.6 – 2.5 cm, it was identified in 37.5% of cases; and at a distance of 2.6 – 3.5 cm, it was revealed in 10% of cases.

The most distal level of the brachial artery bifurcation exceeding a distance of 4 cm below the interepicondylar line was identified in 20% of cases (Figure 1).

The high bifurcation of the brachial artery into its typical branches was identified on 2 upper limbs in a male (one on each side of the body), representing 4.8% of the cases.

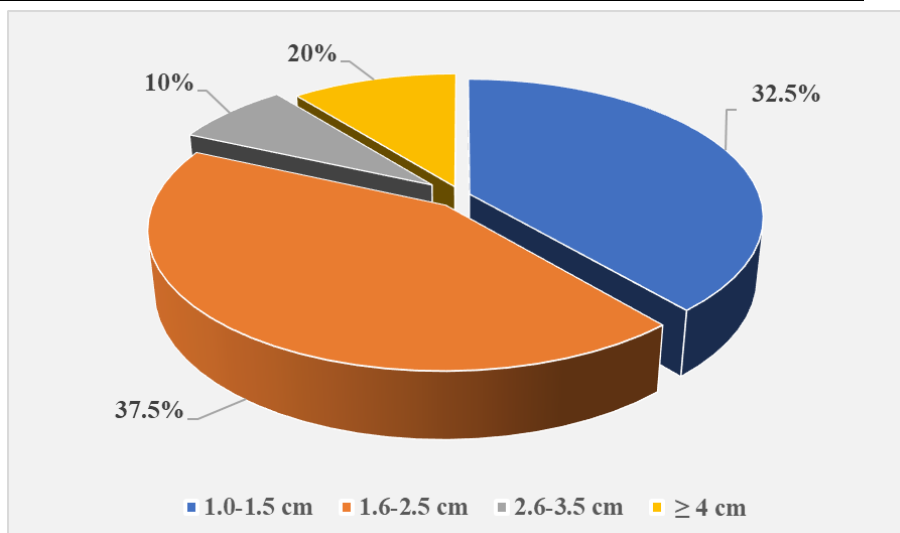


Fig.1. The level of the brachial artery bifurcation below the interepicondylar line.

On the right upper limb, the retro-pectoral part of the axillary artery bifurcated into 2 arterial trunks: the anterior trunk continued into the radial artery; the posterior trunk, continued into the ulnar one (Figure 2).



Fig.2. A high bifurcation of the brachial artery: 1 – axillary artery; 2 – bifurcation level; 3 – ulnar artery; 4 – radial artery; 5 – axillary vein.

On the arm, the radial artery lodged within the medial bicipital groove. In the upper third of the arm, the radial artery was located medially to the median nerve and brachial veins. In the middle third of the arm, it was located in front of the median nerve and brachial veins intersecting them. Finally, in the lower third of the arm, it had the most lateral position towards the median nerve and brachial veins. In the cubital fossa, it passed behind the aponeurosis of the biceps brachii

muscle, continuing its usual course on the forearm. At the level of the pectoral triangle, the radial artery gave off the lateral thoracic artery; at the level of the arm, the radial artery launched the deep brachial artery; and at the level of the forearm, it gave rise to the recurrent radial artery, muscular branches and superficial palmar artery.

In the axillary cavity, the ulnar artery was deeper than the radial one, and then continued through the medial bicipital groove, being located between the brachial veins, somewhat laterally to the median nerve. In the subpectoral triangle, from the ulnar artery originated the subscapular artery and the anterior and posterior circumflex humeral arteries; the upper and lower collateral ulnar arteries had their origin at the level of the arm. On the forearm, the ulnar artery did not show neither topographic nor branching variations.

Some authors, who reported a high level of the brachial artery bifurcation, named its terminal branches as brachioradial and brachioulnar arteries, according to their topography [3].

On the left upper limb, the bifurcation of the brachial artery was pointed out in the lower 1/3 of the arm, 5 cm above the interepicondylar line (Figure 3).



Fig.3. A high bifurcation of the brachial artery in the lower 1/3 of the arm: 1 – brachial artery; 2 – radial artery; 3 – ulnar artery; 4a, 4b – brachial veins; 5 – median nerve; 6 – pronator teres muscle.

Upon determining the type of brachial artery ramification at the level of terminal branches' origin, in 92.8% of cases, bifurcation of the brachial artery was established; in the remaining 7.2% of cases (2 male and 1 female upper limbs) the brachial artery trifurcated. In all three cases of trifurcation, the terminal branches

of the brachial artery were the ulnar artery, radial artery and recurrent radial artery (Figure 4).

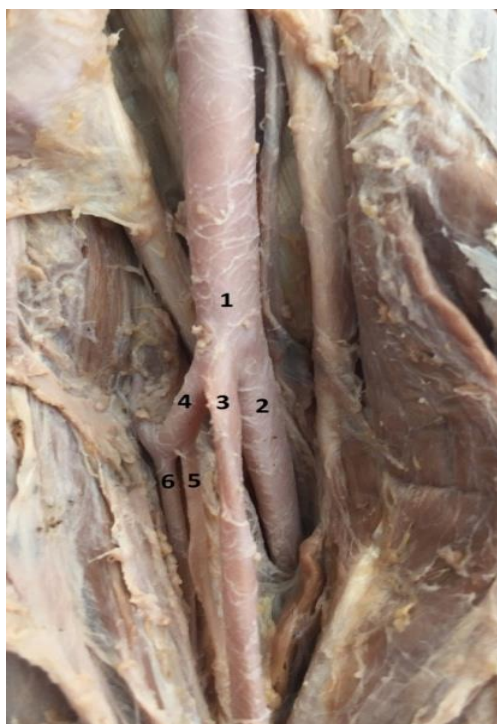


Fig. 4. Trifurcation of the brachial artery: 1 – brachial artery; 2 – ulnar artery; 3 – radial artery;  
4 – recurrent radial artery; 5, 6 –muscular branches.

On the female sample with brachial artery trifurcation, the recurrent radial artery split into two muscular branches, before ascending laterally to the elbow joint. The muscular branches descended to the forearm and penetrated the brachioradialis muscle and the extensor carpi radialis longus muscle respectively.

Taking into consideration the angiogenesis, presence of the recurrent radial artery as a terminal branch of the brachial one, can be explained as follows: in the 2<sup>nd</sup> month of embryonic development, after derivation of the radial artery from the brachial one, in the cubital fossa between those arteries an anastomosis forms through a branch called recurrent radial artery. Later the proximal part of the recurrent radial artery undergoes regression, remaining as a branch of the radial artery. In cases of some disturbances of the normal development, the recurrent radial artery regresses distally, remaining as a branch of the brachial artery; that results in three brachial artery branches (trifurcation), instead of two (bifurcation) [3].

The high origin of the radial and ulnar arteries, was established in 9.5% of cases, and it was present in cases of atypical brachial artery bifurcation into its terminal branches. On two of those upper limbs (1 female LUL and 1 male RUL) a high origin of the radial artery and bifurcation of the brachial one, into the ulnar and common interosseous arteries, were marked out (Figure 5).



The other two female upper limbs (RUL) presented a high origin of the ulnar artery and the bifurcation of the brachial artery into ulnar and common interosseous arteries.

When there is a high origin of the radial and ulnar arteries, they can arise at different levels: either from the retropectoral and infrapectoral parts of the axillary artery, or from the brachial artery, in the upper and middle thirds of the arm [5].



Fig. 5. High origin of the radial artery: 1 – brachial artery; 2 – radial artery; 3 – ulnar artery; 4 – superior collateral ulnar artery; 5 – median nerve; 6 – ulnar nerve; 7 – brachial vein.

Vandana R. considers high origin of the radial artery as one of the most common arterial variants of the upper limb arteries, with an incidence of 8.3%. The high origin of the ulnar artery was established in 2% of cases [4].

Fuss F. [1] reported the high origin of the radial artery more frequently on the right upper limb in males. Those variations have not been confirmed in our study.

In vascular and reconstructive surgery of the upper limb, the surgeons should take into consideration the anatomical variants of brachial artery bifurcation in order to avoid potential complications that may occur during surgery.

**Conclusion.** In 2/3 of cases, the brachial artery bifurcation level was established at a distance of 1-2.5 cm below the interepicondylar line. In the majority of cases (83.3%) the brachial artery bifurcated into its typical terminal branches – the radial and ulnar arteries. Anatomical variants of brachial artery bifurcation occurred more frequently in males, with the same proportion for both upper limbs.

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