

Clinically Relevant Variations in Origin in Brachioradial Artery and Its Significance Nagarathnamma B*

Associate Professor, Department of Anatomy, JJM Medical College, Davanagere, Karnataka, India

Received: 16-10-2021 / Revised: 05-12-2021 / Accepted: 21-12-2021

Abstract

Background: This study thoroughly analyzes the anatomic variations of the brachioradial artery based on the variability of its origin, the presence and types of anastomosis with the brachial artery, as well as the vascular territory within the hand. **Materials and methods:** The present study was performed on 78 embalmed cadaveric upper limb specimens. The examined specimens were obtained from the collection of formalin preserved 39 upper limb of cadavers; they are used for routine dissection by the undergraduate students in the Department of Anatomy JJM Medical College, Davanagere, Karnataka for a period of 2 years from August 2018 to August 2020. **Results:** Among the 78 examined upper limbs, the brachioradial artery was found to have variation in origin in 7 specimens (7/78; 8.9% of the total number of limbs) 4 male limbs (4/45; 8.8% of male limbs) and five female limbs (3/33; 9% of female limbs). Variation was found on the right side in 4 cases (4/41; 9.7% of right limbs) and on the left side in 3 cases (3/37; 8.1% of left limbs). Anatomical variations of the origin of the brachioradial artery was found to arise in the axilla in 1.28% of all limbs and 14.2% of brachioradial arteries, both cases were observed in male right limbs. The 6 remaining cases (7.6% of all limbs) all arose on the arm within the medial bicipital groove. The brachioradial artery arose at a point between 125 mm and 250 mm above the intercondylar line (mean 170 mm, \pm 46 mm). **Conclusion:** An awareness of such a presence is valuable for the surgeons and radiologists in evaluation of angiographic images, vascular and re-constructive surgery or appropriate treatment for compressive neuropathies.

Keywords: Brachioradial Artery, anatomical variation, Vasculature.

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Variations in the Brachioradial Artery have been reported in studies on cadavers and angiographic images[1]. The variations observed were mostly in the origin and proximal course of the Brachioradial Artery, rather than its distal course and termination[2]. The radial artery is the smaller part of the two terminal branches of the brachial artery arising in the cubital fossa. The proximal two-thirds of the radial artery courses underneath the brachioradialis muscle; whereas the distal third of the radial artery becomes superficial. Besides, it is positioned between the tendons of the brachioradialis and flexor carpi radialis[3]. The variant high origin of the Brachioradial Artery is explained as arising either from the brachial or axillary artery[4]. It may later pass superficial to the brachioradialis muscle in the forearm[5]. The knowledge of the variations in the Brachioradial Artery is clinically important, as it is often used in interventional cardiology. Since the radial artery is often used in vascular, plastic, and reconstructive surgery, as well as for arterial puncture and cannulation (transradial access), knowledge of its variations can be of great clinical significance[6-8]. The pre-requisite knowledge of Brachioradial Arterial variations is essential for surgeons. Furthermore, it is equally imperative for interventional radiologists and paramedical technicians to avoid serious complications. In this context, it is also important to know the possible anatomic variations of the brachioradial artery, including the variability of its origin, the presence of anastomosis with the brachial and the vascular territory in the hand.

*Correspondence

Dr.Nagarathnamma B

Associate Professor, Department of Anatomy, JJM Medical College, Davanagere, Karnataka, India

E-mail: rathnajjmmc@gmail.com

Materials and Methods

The present Study was performed on 78 embalmed cadaveric upper limb specimens. The examined specimens were obtained from the collection of formalin preserved 39 upper limb of cadavers; they are used for routine dissection by the undergraduate students in the Department of Anatomy for a period of 2 years. These specimens and cadavers were obtained from the anatomy lab and cadavers and upper limb specimens were dissected, fixed, and preserved in the formalin based solution. The ethical standards of managing cadavers for teaching and learning purposes were followed during the procedures.

The required sample size was calculated by following equation $N = Z^2 \cdot X(p \cdot X q) / e^2 = (1.96)^2 \cdot X0.908X(1-0.908) / (0.07)^2 = 70$

Where, N=minimum required sample size;

Z=1.96 for 95% Confidence Interval (CI);

p=prevalence of the normal origination of radial artery as 90.8% (Kadel M et al study)[9]

e=margin of error, 7%.

According to this calculation, ≥ 70 samples were required, i.e., the sample size available and used in the present study. The arteries in the upper limb were appropriately cleaned. Moreover, their course, relations and branches were studied in detail and the variations were noted. Prior to procedure, a thorough visual external inspection was performed to exclude specimens with deformations or traces of trauma or surgical procedures. Furthermore, limbs demonstrating anatomical variations of the arterial pattern not associated with the radial or brachioradial arteries and their branches were also excluded from further analysis. The classification of anatomical variations of the arterial pattern in the upper limb used in this study was based on those proposed by Rodríguez-Niedenführ et al.^{9,10} The measurement of blood vessels was performed using vernier callipers scale and measuring tape. A Digimatic Caliper was used to take the following measurements: vessel diameter, the distance between the origin of the radial or brachioradial artery, and the intercondylar line of the humerus. Each measurement was taken twice, and the mean of both measurements was accepted as the final result.

The calculations were made with SPSS software. The Chi Square test was used to test relationships between selected variables, for example, the frequency of occurrence of the brachioradial artery with regard to sex or side of the body. The significance level adopted in the analysis was $p = 0.05$.

Results

Among the 78 examined upper limbs, the radial artery was found to have a high origin in 7 specimens (7/78; 8.9% of the total number of limbs); 4 male limbs (4/45; 8.8% of male limbs) and five female limbs (3/33; 9% of female limbs). Moreover, this variation was found on the right side in 4 cases (4/41; 9.7% of right limbs) and on the left side in 3 cases (3/37; 8.1% of left limbs). No statistically significant difference was found between both the frequency of the occurrence of the brachioradial artery and either sex or the side of the body.

Anatomical Variations of the Origin of the Brachioradial Artery was found to arise in the axilla in one out of 78 dissected upper limbs (i.e., 1.28% of all limbs and 14.2% of brachioradial arteries); both cases were observed in male, right limbs. The 6 remaining cases (7.6% of all limbs) all arose on the arm within the medial bicipital groove. This variation was observed in 3 male and 3 female upper limbs. In this variant, the brachioradial artery branched off the medial aspect of the brachial artery and ran superficial to the median nerve, with its course initially being slightly medial to it. The brachioradial artery arose at a point between 125 mm and 250 mm above the intercondylar line (mean 170 mm, ± 46 mm). However, in typical cases the division of the brachial artery into terminal branches (namely, brachial and radial arteries) was located in the cubital fossa below the intercondylar line of humerus. In all cases, the brachioradial artery ran under the deep (brachial and antebrachial) fascia and passed deep to the bicipital aponeurosis.

Table 1: Comparison between the origin of the radial and brachioradial arteries in relation to the intercondylar line of the humerus

Typical origin of the radial artery, distance below the intercondylar line [mm]					
	Mean	Median	Minimal value	Maximal value	Standard deviation
Male limbs	39.8	37.3	23.9	52.6	8.4
Female limbs	31.1	30.1	19.5	43.9	8.6
Total	35.45	36.4	19.5	52.6	8.5
High origin of the radial artery (brachioradial artery), distance above the intercondylar line [mm]					
	Mean	Median	Minimal value	Maximal value	Standard deviation
Male limbs	190	170	143	250	42
Female limbs	150	143	125	220	36
Total	170	170	125	250	39

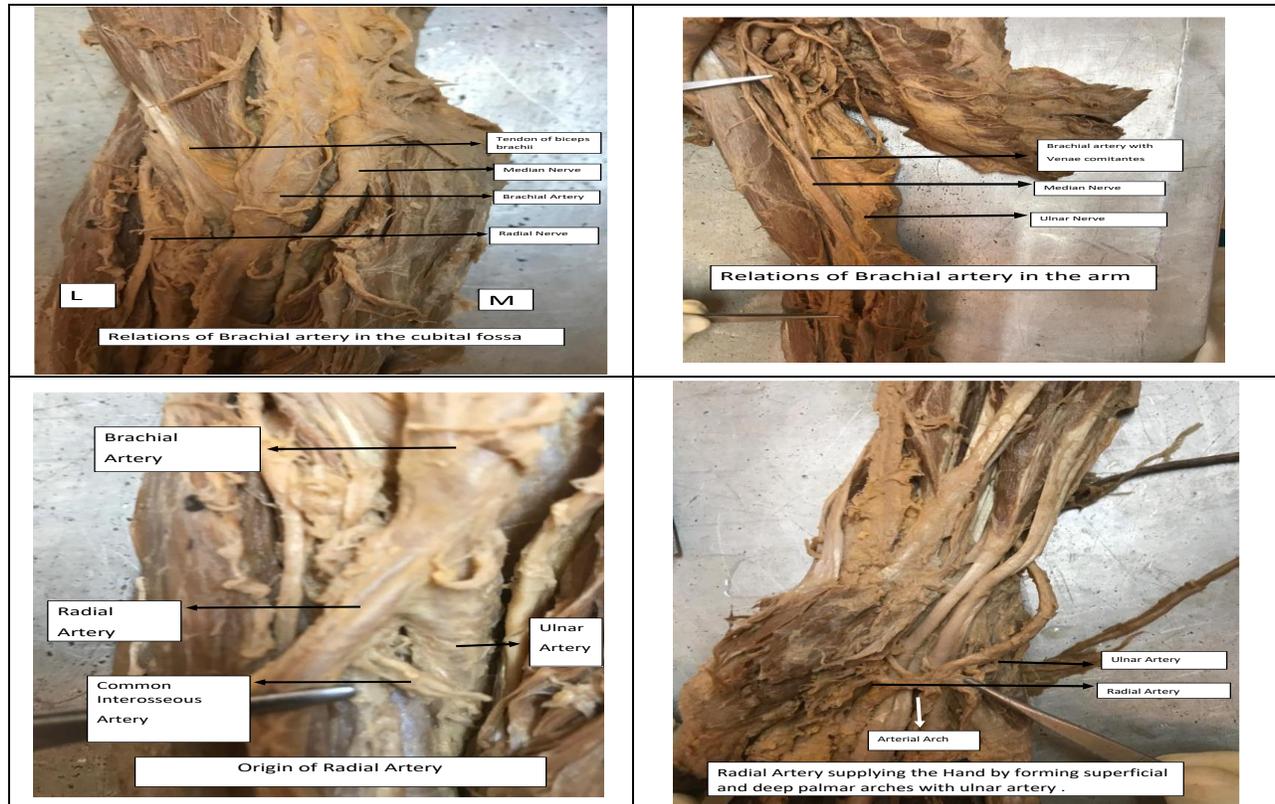




Fig 1: Variations of the Origin of the Brachioradial Artery in present study

Discussion

Variations in the arterial pattern of the upper limb have been observed frequently, either in routine dissections or in clinical practice. Anatomy textbooks make reference to 'vas aberrans' in the main brachio-antebrachial arterial pattern. Explanations for arterial variations in the human upper limb have generally been based on the classical outlines of arterial development[13]. Accordingly, we have studied a series of variations observed in the main pattern of the human brachio-antebrachial arteries in order to provide an clinical orientation to surgeons. The prevalence of the high origin of the radial artery (brachioradial artery) according to different authors varies from 4.67% to 15.6% [14,15]. This variation was observed

most often unilaterally[16]. However, the identified dependence of the occurrence of the brachioradial artery in relation to gender and the side of the body varies between studies. In a study carried out on 750 upper limbs, McCormack et al[17] found a radial artery with a high origin originating from the brachial artery in 57 right and 37 left upper limbs and from the axillary artery in 14 left and two right upper limbs. Rodríguez-Niedenführ et al[10] noted this variant more frequently in women and on the right side. In the present study, no statistically significant differences were observed in the prevalence of the brachioradial artery with regard to gender or side of the body. However, the origin from the axillary artery was observed only in two right male upper limbs.

Table 2: Frequency of the brachioradial artery given by selected authors.

Author, year of study	Sample (No. of limbs)	Frequency		
		Origin from axillary artery	Origin from brachial artery	All cases of the brachioradial artery
Karlsson and Niechajev et al[18]	82 patients with demonstrated anatomy of the whole upper extremity	1.22% of all patients (12.5% of brachioradial arteries)	8.54% of all patients (12.5% of brachioradial arteries)	97.5% of the cases in angiographic studies
Uglietta and Kadir et al[15]	100 angiographic studies of the upper limb	1% of all cases / 12.5% of brachioradial arteries	7% of all cases / 87.5% of brachioradial arteries	8% of all examined cases
Rodríguez-Baeza et al[19]	150	0.67% of total / 14.28% of brachioradial arteries	4% of total / 85.72% of brachioradial arteries	4.67%
Rodríguez-Niedenführ et al[10]	384	3.1% of total (23% of brachioradial arteries)	3.1% of total (23% of brachioradial arteries)	13.8% of total amount of upper limbs and 20.3% out of 192 cadavers
Nasr et al[4]	100	1% of total (1 out of 8 brachioradial arteries)	7% of total	8% of total amount of upper limbs
Robert Haładaj et al[20]	120	1.67% of all upper limbs and 18% of brachioradial arteries	7.5% limbs subjected to autopsy	9.2% of total amount of upper limbs
Present study	78	1.28% of all upper limbs and 14.2% of brachioradial arteries	7.6% limbs subjected to autopsy	8.9% of total amount of upper limbs

The brachioradial artery may take the origin from all parts of the axillary artery or, more commonly, it branches off the medial circumference of the brachial artery. The frequency of the origin of brachioradial artery from the axillary or brachial artery recorded in the studies of other authors is presented in Table 2. According to Nasr[4], the mean distance between the intercondylar line of the humerus and the normal origin of RA was 38.7 ± 9.5 mm in male cadavers and 36.5 ± 8.5 mm in female cadavers. In the Robert Haładaj et al[20] study, the brachioradial artery usually arose between 126 mm and 260 mm above the intercondylar line of the humerus (mean 178 mm, ± 44 mm). In present study brachioradial

artery arose at a point between 125 mm and 250 mm above the intercondylar line (mean 170 mm, ± 46 mm). Similar cases were reported where the radial artery had a high origin and the course of the artery in the forearm was superficial. Since the radial artery is often used in vascular, plastic, and reconstructive surgery and routinely used for puncture and cannulation, knowledge of its variations can be of great clinical significance. Transradial access can be hindered by the presence of an unusual origin and course of the vessel. It has been recently noted that the presence of a high origin of the radial artery (namely, the brachioradial artery) “considerably contributed to the development of tortuosity”, which can increase the risk of failure of transradial catheterization. The

presence of atypical arterial patterns in the upper limb can be predicted based on the Color Doppler ultrasonography, which facilitates the assessment of the origin, course, variations, and locations of both arteries and accompanying veins.

Conclusion

An accurate knowledge anatomical variation of the brachial artery course, branching, bifurcation/termination, the course of its terminal branches and relationship with the surrounding structures is essential prerequisite during vascular and reconstructive surgeries of arm and forearm. Anatomical variations of brachial artery noted in this study are rare and very important clinically. Accessory brachial artery and superficial accessory ulnar arteries noted in this study may be mistaken for a vein and may complicate intravenous drug administration and venipuncture in general, also percutaneous brachial catheterization. A detailed knowledge of such vascular variations is essential not only to anatomists, but also to radiologists, orthopedists, vascular and plastic surgeons.

References

1. Agarwal S, Lalwani R, Ramesh Babu CS. High origin of radial artery: A comparative, anatomical and embryological consideration. *International Journal of Research in Medical Sciences*. 2016; 4(8):3295-8.
2. Jyothsna P, Nayak SB, Mohandas Rao KG, Kumar N, Abhinitha P. High level branching and very superficial course of radial artery in the anatomical snuffbox: Its clinical and surgical implications. *OA Case Reports*. 2013; 2(7):66.
3. Gray H, Williams PL, Bannister LH. *Gray's anatomy: The anatomical basis of medicine and surgery*. 38th edition. London: Churchill Livingstone, 1995.
4. Nasr AY. The radial artery and its variations: Anatomical study and clinical implications. *Folia Morphologica*. 2012; 71(4):252-62.
5. Rodríguez-Niedenführ M, Vázquez T, Nearn L, Ferreira B, Parkin I, Sañudo JR. Variations of the arterial pattern in the upper limb revisited: A morphological and statistical study, with a review of the literature. *Journal of Anatomy*. 2001; 199(Pt5):547-66.
6. Franchi E, Marino P, Biondi-Zoccai GG, De Luca G, Vassanelli C, Agostoni P. Transradial versus transfemoral approach for percutaneous coronary procedures. *Current Cardiology Reports*. 2009; 11(5):391-7.
7. S. Dharma, S. Kedev, T. Patel, S.V. Rao, O.F. Bertrand, I.C. Gilchrist. "Radial artery diameter does not correlate with body mass index: A duplex ultrasound analysis of 1706 patients undergoing trans-radial catheterization at three experienced radial centers," *International Journal of Cardiology*. 2017; 228:169-172.
8. E. Wessel, K. Hessel, A. Glaros, A. Olinger. "Quantification of the distal radial artery for improved vascular access," *Folia Morphologica*. 2015; 74(1):100-105.
9. Kadel M, Hada S, Sedhain BP. Anatomic variation in the origin and course of radial artery: A descriptive cross-sectional study. *Journal of Nepal Medical Association*. 2019; 57(220):420-3.
10. M. Rodríguez-Niedenführ, T. Vázquez, L. Nearn, B. Ferreira, I. Parkin, J. R. Sañudo. "Variations of the arterial pattern in the upper limb revisited: a morphological and statistical study, with a review of the literature," *Journal of Anatomy*. 2001; 199(5): 547-566.
11. M. Rodríguez-Niedenführ, I.G. Parkin, J.R. Sañudo. "Arterial patterns of the human upper limb: Update of anatomical variations and embryological development," *European Journal of Anatomy*. 2003; 7(1):21-28.
12. Arey LB. The development of peripheral blood vessels. In *The Peripheral Blood Vessels* (ed. J. L. Orbison & D. E. Smith), 1963, 1-16p. Baltimore: Williams and Wilkins.
13. Carlson BM: *Human Embryology and Developmental Biology*, 1994, 197-201. St Louis, MO: Mosby.
14. G. Wysiadecki, M. Polguy, R. Haładaj, M. Topol. "Low origin of the radial artery: a case study including a review of literature and proposal of an embryological explanation," *Anatomical Science International*. 2017; 92(2):293-298.
15. J.P. Uglietta, S. Kadir. "Arteriographic study of variant arterial anatomy of the upper extremities," *CardioVascular and Interventional Radiology*. 1989; 12(3):145-148.
16. V.K. Yagain, M.R. Dave, S. Anadkat. "Unilateral high origin of radial artery from axillary artery," *Folia Morphologica*. 2012; 71(2):121-124.
17. L.J. McCormack, E.W. Cauldwell, B.J. Anson. "Brachial and antebrachial arterial patterns; a study of 750 extremities," *Surgery, Gynecology & Obstetrics*. 1953; 96:43-54.
18. S. Karlsson, I. A. Niechajev. "Arterial anatomy of the upper extremity," *Acta Radiologica*. 1982; 23(2):115-121.
19. A. Rodriguez-Baeza, J. Nebot, B. Ferreira et al. "An anatomical study and ontogenetic explanation of 23 cases with variations in the main pattern of the human brachio-antebrachial arteries," *Journal of Anatomy*. 1995; 187(2):473-479.
20. Robert Haładaj, Grzegorz Wysiadecki, Zbigniew Dudkiewicz, Michał Polguy, Mirosław Topol. *The High Origin of the Radial Artery (Brachioradial Artery): Its Anatomical Variations, Clinical Significance, and Contribution to the Blood Supply of the Hand* *BioMed Research International*. 2018:1-11

Conflict of Interest: Nil

Source of support:Nil