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Original Research Article

AN ANATOMICAL ANALYSIS OF VARIATIONS IN THE BRACHIAL ARTERY BRANCHING PATTERN

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Abstract

Background: Understanding both the typical and atypical arterial anatomy of the upper extremity holds vital clinical significance for vascular radiologists and surgeons. This knowledge ensures accurate diagnostic interpretation and facilitates the safe conduct of interventional and surgical procedures on the upper extremities. Awareness of anomalous branching patterns of the brachial artery is particularly crucial during percutaneous arterial catheterization to prevent complications from inadvertent vessel damage. Moreover, knowledge of variations is essential for plastic surgeons employing flaps in reconstructive surgeries.

Methods: The present study was undertaken on 50 upper limbs of both sexes from embalmed adult human cadavers used for undergraduate dissection from the Department of Anatomy, Prathima Institute of Medical Sciences, Naganur, Karimnagar.

Results: Double profunda brachii artery (DPBA): One specimen (2%) had two profunda brachii arteries arising from the brachial artery instead of the usual single profunda brachii. Trifurcation of brachial artery (TRI): Six specimens (12%) displayed a trifurcation, where the brachial artery divided directly into the radial, ulnar, and radial recurrent arteries, bypassing the usual further branching pattern. High origin of radial artery (HORA): One specimen (2%) had a higher origin of the radial artery than its typical location. High division of brachial artery (HDBA): One specimen (2%) showed an earlier division of the brachial artery into its radial and ulnar branches compared to the usual location.

Conclusion: Arterial variations in the arm hold significant clinical implications due to their frequent injury susceptibility and involvement in various surgical and invasive procedures. Precise understanding of these patterns is crucial for reparative surgeries around the shoulder, arm, and humerus fracture management. Documenting these variations is particularly vital for advanced microvascular reconstructive surgeries and radiologic diagnostics. Variations in the brachial artery branching pattern are pertinent in cardiac catheterization for procedures like angioplasty, pedicle flaps, or arterial grafting.

Keywords: Brachial artery, Brachial artery variations, Profunda brachial artery, Radial artery, Ulnar artery

Introduction

The term "Brachial" originates from the Greek word "Brakhion," meaning "Shorter," which also signifies "arm." The brachial artery serves as the primary artery of the upper limb, commencing as a continuation of the axillary artery at the inferior border of the teres major tendon and culminating at the neck of the radius, dividing into radial and ulnar arteries. [1] It courses superficially in the arm, positioned immediately beneath the deep fascia of the anteromedial arm, [2] providing the profunda brachial artery, superior and inferior ulnar collateral arteries, nutrient artery to the humerus, and

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muscular branches. The artery forms significant anastomoses with the proximal portions of the radial and ulnar arteries, ensuring circulation in instances of compromised blood flow during elbow joint flexion. [1] An understanding of the brachial artery's anomalous branching pattern is imperative during percutaneous arterial catheterization to avert complications resulting from inadvertent vessel damage. Additionally, familiarity with variations is crucial for plastic surgeons employing flaps in reconstructive surgeries. Notably, the brachial and antebrachial arteries are preferred for creating arterio-venous fistulas in the wrist region involving the radial artery and cephalic vein for dialysis in chronic renal failure treatment. These arteries offer longevity and require minimal maintenance. [3] Clinical applications of the brachial artery include blood pressure monitoring, arterial puncture for gasometry, and assessing Flow Mediated Dilation (FMD) for evaluating endothelial function, particularly in obstetrics. Moreover, the brachial artery serves as an alternative route for cardiac ventriculography when femoral access is unfeasible. [3] Considering these aspects, this study aimed to delineate variations in the course and branching pattern of the brachial artery to aid clinicians in diagnostic assessment and surgical management of vascular injuries and diseases.

Material and Methods

The study examined 50 upper limb specimens sourced from the Anatomy Department of Prathima Institute of Medical Sciences, Naganur, Karimnagar. Over a year and a half from January 2013 to June 2014. These specimens, obtained from embalmed human cadavers used for undergraduate studies, spanned various demographics, aged 18 to 80 years, irrespective of sex and race. Limbs exhibiting significant deformities, asymmetry, or partial amputation were excluded. Dissections focused on identifying the brachial artery and its branches, with subsequent tracing, cleaning, and observation. In the cubital fossa, dissections included the bicipital aponeurosis to expose and examine the terminal branches of the brachial artery. Cleaning of the brachial artery involved dividing the cross channels connecting the accompanying venae comitantes.

Results

The study examined 50 upper limb specimens sourced from the Anatomy Department of Prathima Institute of Medical Sciences, Naganur, Karimnagar, over a year and a half. These specimens, obtained from embalmed human cadavers used for undergraduate studies, spanned various demographics, aged 30 to 80 years, irrespective of sex and race. Limbs exhibiting significant deformities, asymmetry, or partial amputation were excluded. Dissections focused on identifying the brachial artery and its branches, with subsequent tracing, cleaning, and observation. In the cubital fossa, dissections included the bicipital aponeurosis to expose and examine the terminal branches of the brachial artery. Cleaning of the brachial artery involved dividing the cross channels connecting the accompanying venae comitantes.

In this study, one specimen exhibited a high origin of the radial artery, originating from the proximal one-third of the brachial artery. This radial artery followed a superficial course in the arm, crossing over the median nerve and descending laterally to it. Notably, the radial artery did not give rise to any branches in the arm. Additionally, a high division of the brachial artery was observed in one specimen, accounting for 2% of cases. In this study, a high division of the brachial artery was noted in one specimen, accounting for 2% of cases. Following the emergence of the profunda brachial artery and superior ulnar collateral artery, the artery bifurcated in the proximal third of the arm into the radial and ulnar arteries. The radial artery traversed superficially over the median nerve and maintained a superficial trajectory in the forearm. Notably, the inferior ulnar collateral artery did not arise from any of these terminal branches.

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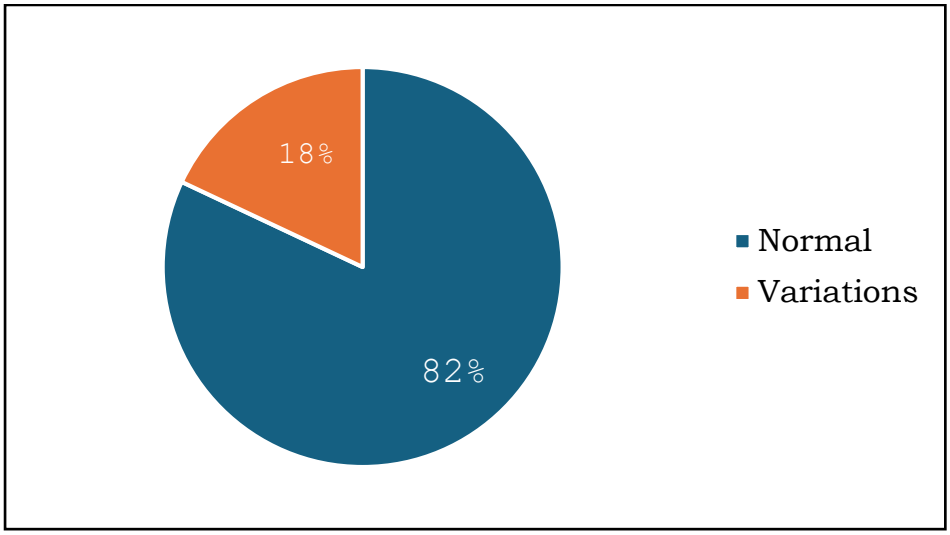

Figure 1: showing the frequency of variations of the brachial artery and its branching pattern.

Table 1 summarizes the findings of a study investigating variations in the brachial artery and its branching pattern. It likely presents a small sample set, possibly from cadaveric dissections. Double profunda brachii artery (DPBA): One specimen (2%) had two profunda brachii arteries arising from the brachial artery instead of the usual single profunda brachii. Trifurcation of brachial artery (TRI): Six specimens (12%) displayed a trifurcation, where the brachial artery divided directly into the radial, ulnar, and radial recurrent arteries, bypassing the usual further branching pattern. High origin of radial artery (HORA): One specimen (2%) had a higher origin of the radial artery than its typical location. High division of brachial artery (HDBA): One specimen (2%) showed an earlier division of the brachial artery into its radial and ulnar branches compared to the usual location. Table 1 highlights the existence of variations in the brachial artery and its branching pattern. It emphasizes the importance of anatomical knowledge during surgical procedures or diagnostic imaging in the upper limb. Understanding these variations can help medical professionals avoid complications and ensure proper treatment.

Table 1: analysis of the frequency of variations of the brachial artery and its branching pattern

Variations observed	*Frequency of specimens*	*Percentage*
Double profunda brachii artery arising from brachial artery (DPBA)	1	2
Trifurcation of brachial artery (TRI)	6	12
High origin of radial artery (HORA)	1	2
High division of brachial artery (HDBA)	1	2

Discussion

Variations in the vascular pattern of the upper limb are frequently observed, attributed to various factors such as chemical influences, hemodynamic forces, fetal positioning, genetic predisposition, and developmental anomalies during vascular formation. [4] Quain's 1844 literature review and cadaver dissections marked the first systemic classification of these variations. [5] In our study, trifurcation of the brachial artery was observed in six specimens, with the artery terminating into radial, ulnar, and radial recurrent arteries in the cubital fossa, accounting for 12% of variations, which was the most common. Patnaik et al. [6] reported a trifurcation case dividing into radial, ulnar, and radial recurrent

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arteries, while Bilodi AK et al. [7] described another case dividing into radial, ulnar, and common interosseous arteries. Malcic-Gurbuz et al. [8] noted a trifurcation dividing into radial, ulnar, and superior ulnar collateral arteries. These findings were similar to those reported by Patnaik VVG et al. but with higher frequency. Double profunda brachii arteries originating from a single brachial artery are rare, with implications for excessive hemorrhage in radial groove fractures. [9] Charles et al. [10] classified profunda brachii artery origins into seven types; our study identified Type Ia, where the artery originates from two separate branches, observed in 0.7% of dissections. Bifurcation of the brachial artery proximal to the intercondylar line denotes a high division. [6] Major variations, as indicated by the Compendium of Human Anatomic Variation, occur in approximately 25% of studied subjects, with high proximal division into radial, ulnar, common interosseous, vas aberrans, and superficial median antebrachial arteries. This division may occur at any point along the artery's course, with resulting branches paralleling each other to the elbow bend, resembling a simple high division. [11] Rossi et al. [3] encountered a rare case of high division in both arms, 20 cm above the right cubital fossa and 21.5 cm from the left. Quarrat-Ul-Ain et al. [12] (observed high division in two limbs out of 88 dissected upper limbs, where the artery divided into its branches after originating at the axilla's lower border, with the radial artery medially and the ulnar artery laterally, acquiring normal positions post-elbow joint crossing. High bifurcation, a common site for embolism, may result in larger ischemic areas, as observed in cases of acute ischemia secondary to embolic events, necessitating prompt intervention such as embolectomy for successful resolution, thus emphasizing its clinical significance. [13]

The brachioradial artery, often originating from the brachial rather than the axillary artery, typically arises from the upper third of the brachial artery, followed by the middle and inferior thirds. [14] This high origin of the radial artery (HORA) is the most common arterial variation in the upper limb, with reported incidences of 20.3% in dissected specimens and 9.75% in angiographic studies. Rodriguez et al. [14] found a prevalence of 20.3% in their study of 384 upper limbs. At the cubital fossa, the brachioradial artery may form an anastomosis with the brachial artery through a sling-like loop or rectilinear form. The embryological basis for this anomaly lies in the persistence of the embryological vessel, specifically the proximal or initial segment of the radial artery, giving rise to the high origin of the radial artery. Variations in radial artery anatomy can lead to failures in transradial procedures, emphasizing the importance of pre-procedural imaging of the radial artery to avoid complications. Physicians and surgeons should be mindful of this possibility before undertaking such procedures.

During development, the axis artery of the upper limb derives from the lateral branch of the 7th cervical intersegmental artery. This main arterial trunk extends outward along the ventral axial line and terminates in the capillary plexus of the developing limb bud. The proximal part of the main trunk forms the axillary and brachial arteries, while its distal part persists as the anterior interosseous artery and the deep palmar arch. The radial and ulnar arteries emerge as the last arteries in the forearm as sprouts from the axis artery. Initially, the radial artery arises more proximally than the ulnar artery from the main trunk and crosses in front of the median nerve. Subsequently, the radial artery establishes a new connection with the main trunk at or near the level of origin of the ulnar artery, with its upper portion typically regressing to a large extent. This results in the radial and ulnar arteries arising at the same level. The profunda brachii, nutrient branch, and ulnar collaterals develop as new offshoots of the primary axial vessel.

Conclusion

Arterial variations in the arm hold significant clinical implications due to their frequent injury susceptibility and involvement in various surgical and invasive procedures. Precise understanding of these patterns is crucial for reparative surgeries around the shoulder, arm, and humerus fracture management. Documenting these variations is particularly vital for advanced microvascular reconstructive surgeries and radiologic diagnostics. Variations in the brachial artery branching pattern are pertinent in cardiac catheterization for procedures like angioplasty, pedicle flaps, or arterial grafting.

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While the trans-radial approach in percutaneous coronary procedures reduces access site complications, it presents specific technical challenges compared to the transfemoral approach.

References

1. Standring S, Borely NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, et al. Upper arm. In: Standring S, Borely NR, Collins P, Crossman AR, Gatzoulis MA, Herly JC, et al., eds. Gray‟s Anatomy: The Anatomical Basis of Clinical Practice. 40th ed. London, UK: Elsevier Ltd; 2008: 835-836.
2. Sinnatamby CS. Upper limb. In: Sinnatamby CS., eds. Last S Anatomy. 11th ed. Philadelphia: Churchill Livingstone Elsevier; 2006: 61.
3. Junior R, Esteves, Simoes JS, Fernandes GJM. Bilateral high division of the brachial artery in one human male cadaver: a case report. J Morphol Sci. 2011;28(3):204-7.
4. Krstonosic B, Srdic B, Maric D, Gudovic R, Mijatov S, Babovic S. An anatomical study of double brachial arteries - a case report. IJAV. 2010;3:6-8.
5. Aughsteen AA, Hawamdeh HM, AL-Khayat M. Bilateral variations in the branching pattern of brachial artery. IJAV. 2011;4:167-70.
6. Patnaik VVG, Kalsey G, Rajan KS. Branching pattern of brachial artery - a morphological study. J Anat Soc India. 2002;51:176-86.
7. Bilodi AK, Sanikop MB. Variations in termination of brachial artery - a case report. Kathmandu Univ Med J. 2004;2(1):49-51.
8. Malcic GJ, Gurunluogl R, Ozdogmus O, Yalin, Aymelek A. Unique case of trifurcation of the brachial artery: its clinical significance. Clinic Anat. 2002 May;15(3):224-7.
9. Das S, Singh S, Paul S. Double profunda brachii and abnormal branching pattern of the brachial artery. TMJ. 2005;55:159-61.
10. Bidarkotimath S, Avadhani R, Arunachalam K. Primary pattern of arteries of upper limb with relevance to their variations. Int J Morphol. 2011;29(4):1422-8.
11. Bergman RA, Thompson SA, Afifi AK, Saadeh FA. Cardiovascular system. In: Bergman RA, Thompson SA, Afifi AK, Saadeh FA, eds. Compendium of Human Anatomic Variation. Text, Atlas and World Literature. 1st ed. Baltimore: Urban and Schwarzenberg; 1988: 73-74.
12. Quarrat-ul-Ain, Kauser Y, Raza TA. High division of brachial artery and analogous start of radial and ulnar arteries. Ann King Edward Med Coll. 2002 Jan-Mar;8(1):30-1.
13. Cherukupuli C, Dwivedi A, Dayal R. High bifurcation of brachial artery with acute arterial insufficiency: a case report. Vasc Endovasc Surg. 2008;41(6):572-4.
14. Rodriguez-Niedenführ M, Vazquez T, Nearn L, Ferreira B, Parkin I, Sanúdo JR. Variations of the arterial pattern in the upper limb revisited: a morphological and statistical study, with a review of the literature. J Anat. 2001;199:547-66.