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ASSESSING THE BRACHIAL ARTERY AND ITS VARIATIONS WITH ITS ONTOGENIC BASIS: A CADAVERIC STUDY

Dr Archana Gautam,[1] Dr Manjulata Ganware,[2] Dr Gouri Shankar Jha,[2]

Dr. Kunal Kishor Gautam[4*]

[1]MBBS, MS (Anatomy), DGO, Tutor, Department of Anatomy, Darbhanga Medical College, Darbhanga, Bihar

[2]MBBS, MD, Assistant professor, Department of Anatomy, B.R.L.S.A.B.V. Memorial Medical College Rajnandgaon, Chhattisgarh

[2]MBBS, MS (Anatomy) D-Ortho, PhD (Ortho), Assistant Professor, Department of Anatomy, Darbhanga Medical College, Darbhanga, Bihar

[4*]MBBS, MD (Physiology), Tutor, Department of Physiology, Patna Medical College, Patna, Bihar

Address for correspondence

Dr. Kunal Kishor Gautam

Email Id - drkkg5@gmail.com

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ABSTRACT

Background: In vascular and orthopedic surgeries, thorough knowledge of the brachial artery and its branches is vital with its varied origin, course, and branching. The variability in the brachial artery can be due to regression failure in some paths of embryonic arterial trunks.

Aim: The present study was done to assess the brachial artery and its variation with its ontogenic basis in cadavers.

Materials and methods: The study assessed 112 upper limbs from different genders and age groups 18 females and 38 males. The identification was done for the brachial artery and its branching pattern. The relationship between the brachial plexus and brachial artery was observed in the arm along with the documentation of the absence or presence of variations.

Results: In 112 upper limbs, 94.64% (n=106) limbs had the normal morphological patterns in the branchial artery, and tortuous brachial artery with trifurcation to the radial artery was seen in 1.78% (n=2) limbs, and superficial brachial artery in 5.35% (n=6) limbs. Also, the common interosseous artery and the ulnar artery were seen in 1.78% (n=2) limbs each.

Conclusion: The present study, considering its limitations concludes that it is clinically vital to study the brachial artery, its course, variation, and branching pattern for orthopedic surgeons

treating supracondylar fractures and during various vascular surgeries. It is also vital for radiologists to assess the angiography of the upper limb.

Keywords: Median Nerve, Common Interosseous Artery, Superficial Brachial Artery, Ulnar Artery, Trifurcation

INTRODUCTION

The principal artery of the arm is the brachial artery which starts as an axillary artery continuation from the distal border of the tendon of the teres major muscle which accompanies the median nerve and then enters the cubital fossa.[1] Under the bicipital aponeurosis cover, the brachial artery divides into the posterior and anterior interosseous arteries. Initially, the brachial artery is medial to the humerus and gradually wraps anterior to the humerus unless it lies middle between the epicondyles of the humerus. The pulsation of the brachial artery can be felt throughout its course.[2]

On the distal part of the brachial artery, pulsed doppler ultrasonographic measurements and blood pressure are assessed routinely. Thorough knowledge of the brachial artery and its branches is vital in vascular surgeries including these vessels. Previous literature studies on various clinical and cadaveric studies showed a wide variation in branching pattern, course, and origin including the common interosseous artery, ulnar artery, radial artery, trifurcation, tortuosity, and superficial artery.[3]

SBA or the superficial brachial artery starts from the axillary artery and has a course superficial to the median nerve and can be seen as a superficial pulse. These variations superficially can be misunderstood as veins and can be dangerous to venipuncture during draining of the blood, infusions, injections, and intravenous intervention and can lead to ligature or intraarterial injections in place of veins in the cubital fossa. It can also lead to dangerous conditions including the loss of a hand, and/or gangrene.[4]

Acute bends, loops, or tortuosity in the branchial artery or its branches is one of the reasons for the failure of access during coronary interventions that could lead to vessel occlusion further leading to ischemia. The present study was an attempt to widen the currently known knowledge concerning the branching and course of the brachial artery. This knowledge is vital in the diagnosis and treatment of the pathologies of the upper extremities.[5] These morphologic variations are also vital for nephrologists as establishing the arterio-venous access with anomalous arteries can be a useful alternative route in a few cases.

Comprehensive knowledge of these unusual deviations and variations in the brachial artery, its origin, and branching is also vital to radiologists in reducing therapeutic and diagnostic errors.[6] Hence, the present study was done to assess the normal branching pattern in the brachial artery and its variation concerning the course and branching of the brachial artery.

MATERIALS AND METHODS

The present study aimed to assess the normal branching pattern in the brachial artery and its variation concerning the course and branching of the brachial artery. The study was commenced at the Department of Anatomy of the Darbhanga Medical College, Darbhanga, Bihar after the Ethical clearance was taken from the Institutional Ethical committee.

The study included 112 limbs from 58 cadavers from the Indian subjects belonging to different genders and age groups comprising 18 females and 38 males. The limbs were studied in the Department of Anatomy and were taken from the limbs for dissection of first-year students from the medical field of the Institute.

Meticulous dissection was done in the upper limb to assess the branching pattern and course of the brachial artery following the standard procedure. This was followed by the identification of the brachial artery and it's tracing distally to the cubital fossa and proximally to the continuation with the axillary artery at the lower border of teres major till its bifurcation.

The relation and branching pattern of the brachial artery with the brachial plexus and branches of the medial or lateral cord in the arms were assessed. In every cadaver included in the study, dissection was done for both the upper limbs to assess the absence or presence of any variation in the brachial artery, if observed and their presence either bilaterally or unilaterally. The photography was also done for documentation of the recorded data. The data collected were analyzed statistically using SPSS software version 21.0 and the results were formed.

RESULTS

The present study assessed a total of 112 upper limbs to assess the variations in the morphology of the brachial artery. The results of the study showed that in 94.64% (n=106) limbs the brachial artery and its branching pattern were normal. In these limbs, the brachial artery originated as a continuation to the third part of the axillary artery from the inferior border of the teres major muscle which was then superficially crossed by the median nerve in front of the artery. All the other branches of the arm were found to take normal origin in the upper limb from the brachial artery as shown in Table 1. The origin of the profunda brachial artery was seen from the posteromedial portion of the proximal brachial artery and distal to the teres major. The origin of the superior ulnar collateral artery was seen from the distal part of the middle of the arm and the origin of the inferior ulnar collateral artery was proximal to the elbow.

The normal terminal branching for the brachial artery was seen into ulnar and radial arteries at the neck of radius level in the cubital fossa. The superficial brachial artery (SBA) as a morphological variation in the normal brachial artery morphology was seen in 5.35% (n=6) of upper limbs. The tortuosity in the brachial artery and trifurcation was seen in 1.78% (n=2) limbs each as depicted in Table 1.

The superficial brachial artery with tortuosity and trifurcation was seen in two cadavers of 53 years old male and 49 years old male cadaver. In these cadavers, in the third part of the axillary artery, was the profunda brachial artery that showed continuation to the brachial artery that superficially crossed the median nerve from medial to the lateral side in the middle of the arm as SBA (superficial brachial artery). The superficial brachial artery was named in 1928 by Adachi owing to its superficial course to the median nerve and replacing the main trunk. However, in these cadavers, no other variation was seen on the left side.

The superficial brachial artery (SBA) was seen in two cadavers of 43 years old and 41 years old male subjects showing a superficial course in the upper limb on the medial surface of the biceps brachii. In the third part of the axillary artery, the profunda brachial artery originates and

continues as the brachial artery crosses the median nerve from the superficial aspect running from the medial to the lateral side in the middle of the arm as the superficial brachial artery. In both the cadavers, no variation was seen on another side.

In one cadaver of a male of 48 years, trifurcation was seen for tortuous and superficial brachial artery. In the third part of the axillary artery, the profunda brachial artery originated and continued as a brachial artery on the lower border of the teres major and superficially crossed the median nerve from the medial to lateral side in the middle of the arm as the superficial brachial artery. During its complete course, the artery had a tortuous course. At a distance of 3 cm, in the cubital fossa, at the level of the neck of radius and from the intercondylar line despite bifurcation into ulnar and radial artery showed trifurcation to common interosseous, radial, and ulnar artery. These were seen on the right side of the limb and not on the left side.

DISCUSSION

The results of the present study showed that in 94.64% (n=106) limbs the brachial artery and its branching pattern were normal. These results were consistent with the previous studies reporting the normal brachial arterial pattern in the range of 77% to 96% by Melani Rajendran and Murugapermal G[7] in 2014 and by the study of Jayasree and Reddy[8] in 2017.

The variation in the arteries is seen commonly in the upper limb. These variations can be attributed to various underlying mechanisms including the normal passage of the brachial artery deep to the median nerve from the medial to lateral side in front of the limb. However, when crossing it superficially it takes place of the main trunk and is named as superficial brachial artery as confirmed by Singla RK[9] in 2011 and Adachi B[10] in 1928. Also, it could have an associated trunk parallel to the median nerve and deep to it in the normal place. These superficial brachial arteries can continue to the cubital fossa and can show bifurcation to the ulnar and radial artery as seen normally with deep division going to the forearm forming the interosseous complex. Suggested by Keen JA[11] in 1961. A study in 2011 done by Singla and Lalit assessing previous literature has shown that morphologic variations in the brachial artery range between 0.2% to 22%.

The results of the present study have shown that superficial brachial artery (SBA) as a morphological variation in the normal brachial artery morphology was seen in 5.35% (n=6) of upper limbs. These results were in agreement with the previous studies of 1886 by Poirier and Patnaik et al[12] in 2002 reporting SBA in 6% of cases, and Yang et al[13] in 2008 reporting SBA in 12.2% of cases.

The tortuosity in the brachial artery and trifurcation was seen in 1.78% (n=2) limbs in the results of the present study. A previous study conducted in 1999 by William et al[14] showed that the brachial artery can show proximal bifurcation and unite again to form one single trunk or can, at times, show trifurcation to common interosseous, radial, and ulnar arteries. The work of Merugaparmal G[7] has reported the trifurcation of the brachial artery into the middle of the arm instead of the cubital fossa, whereas, Patnaik[12] in 2001 found recurrent radial artery as the third branch in cases of brachial artery trifurcation in the right limb of male cadaver making an incidence of 2%. Another study of 2002 by Malcic-Gurbuz et al[15] reported brachial artery

trifurcation to ulnar collateral, ulnar, and radial artery. The incidence of brachial artery trifurcation is reported to be 10% in a 2015 study by Shivanal U et al.[16] A study by Bilodi and Sanikop[17] in 2004 reported trifurcation of the brachial artery to common interosseous, ulnar, and radial artery from capillary plexus arising from dorsal aorta arising at a rate similar to the limb. It involves a process of remodeling involving differentiation and enlargement in selected parts.

The appearance of these variations can be attributed to fusion enlargement, incomplete development, disappearance, persistence, and/or part differentiation of initial networks that would otherwise regress or remained as capillaries as reported by the study by Arey[18] in 1957. This remodeling ability loss is attributed to the initial studies and experimental data from animal embryos reporting the loss of remodeling ability when a muscle coating is gained by an endothelial tube.

The majority of these vascular variations can be attributed to vascular embryology where these deviations resemble patterns of the lower animals as embryology shows evolution. Concerning phylogeny, SBA is an atavistic condition commonly seen in primates, and the majority of the seen variations in humans represent the reappearance or retention of the primitive patterns which is consistent with the fact that ontogeny repeats phylogeny which was also confirmed by Smith MT[19] in 1910.

CONCLUSION

Considering its limitations, the present study concludes that the superficial brachial artery along with the superficial position of radial and ulnar arteries and tortuous course make them more vulnerable to trauma and bleeding and makes it more accessible to cannulation if required. These arteries can also be misunderstood as veins. Also, in retention cases of SBA, it leads to retarded palmar arch development. The brachial artery trifurcation in the lower part of the arm can lead to excessive hemorrhage in cases of supracondylar humerus fracture. Limited knowledge about these variations with varying patterns can complicate the surgery and lead to unnecessary bleeding. Hence, clinicians and surgeons need to have knowledge about normal brachial artery anatomy and their branching pattern along with the variations to plan therapeutic intervention, and diagnostic interpretation, and to prevent iatrogenic injuries to reduce mortality and morbidity.

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TABLES

S. No	Limbs assessed (n)	Morphologic variations	Variation number (n)	Side		Percent of incidence (%)
				Left	Right	
1.	112	SBA trifurcation or tortuosity	2	-	2	1.78
2.		SBA	6	-	6	5.35

3.		Normal	106	56	50	94.6

Table 1: Variation and morphology as seen in the brachial artery for the present study

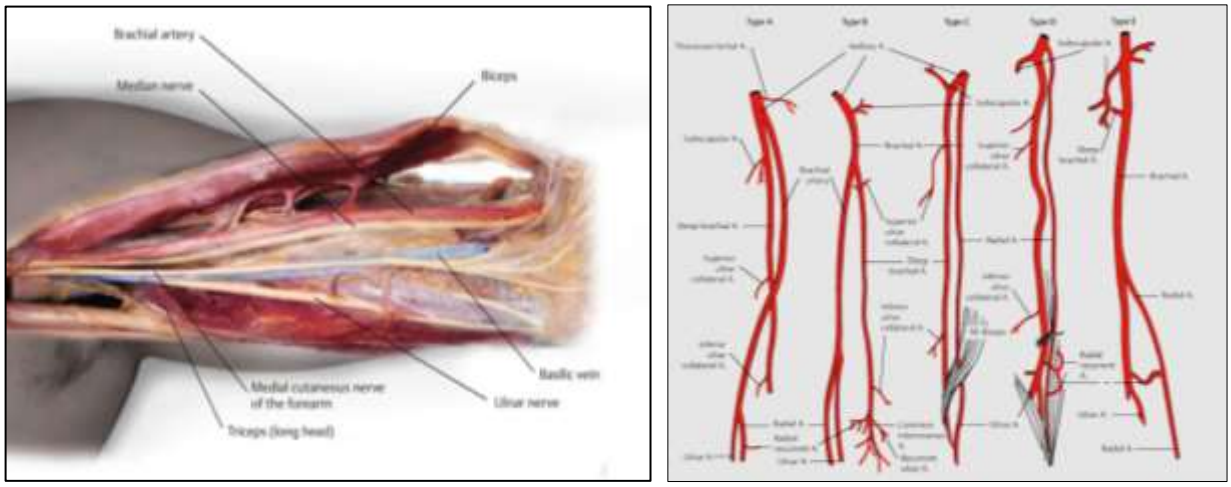

Image Courtesy: Musculoskeletal Key