



VARIATIONS IN BRANCHING PATTERN OF BRACHIAL ARTERY – A STUDY IN CADAVERS

Anatomy

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ABSTRACT

Brachial artery in arm is commonly used for percutaneous arterial catheterization, angiography, vascular flaps for reconstructive surgeries, and can be injured in fractures of arm or elbow region. Knowledge of variations in branching pattern is must for all clinicians and especially for vascular and orthopaedic surgeons to avoid complications like haemorrhage, ischemia and necrosis during various surgical procedures. This study was done to observe variations in branching pattern of brachial artery in cadavers and its clinical applications. The study was conducted on eighty upper limbs of 40 cadavers (30 males and 10 females) of age group 50-70 years in the Dept of Anatomy, R.N.T. Medical College, Udaipur (Raj). In 30 cadavers branching pattern of brachial artery was normal. In 10 cadavers either unilaterally or bilaterally variable branching pattern was noticed in the form of (1) Absence of profunda brachii artery (2) Origin of Profunda brachii artery from axillary artery (3) Termination of brachial artery i.e. in the middle of arm into radial and ulnar artery (4) Termination of brachial artery in arm into medial and lateral branches continuing distally as radial and ulnar artery respectively. Genetic predisposition, chemical factors or hemodynamic forces can be the reasons for arterial variations in the upper limb.

KEYWORDS

Variations, brachial artery, branching pattern

INTRODUCTION

Brachial artery is continuation of axillary artery at the distal border of teres major muscle and terminates as radial and ulnar artery at the level of neck of radius. Branches from brachial artery are profunda brachii, nutrient, superior and inferior ulnar collateral, deltoid, muscular, radial and ulnar artery¹. Though variations in branching pattern of brachial artery are less common as compared to those of radial artery and ulnar artery. But due to clinical importance of brachial artery in measurement of blood pressure, angiographies, trauma and reconstructive surgeries, knowledge of these variations is must for all clinicians.

MATERIAL AND METHOD

The study was done on 80 upper limbs of 40 cadavers (30 male and 10 female) of the age group 50-70 years in the department of anatomy at R.N.T. Medical College, Udaipur (Rajasthan). Upper limbs having scar marks, congenital anomalies or deformities were excluded from the study.

Dissection of pectoral region, axilla, arm, cubital fossa, forearm and hand was done according to the steps described in Cunningham's manual of practical anatomy (volume one)². Axillary artery and brachial plexus were exposed. All the branches of axillary artery were separated, studied and photographed. Brachial artery was now exposed. Its origin; length; branches and termination were noted and photographed. Course of terminal branches i.e. radial and ulnar artery in forearm and formation of palmar arches in hand were also studied.

OBSERVATIONS AND RESULTS

Total upper limbs studied – 80 in 40 cadavers

Normal brachial artery - 30 cadavers (75%)
Variations seen in - 10 cadavers (25%) (7 Male (17.5%) and 3 Female (7.5%))
Unilateral anomalous branching pattern seen in - 8 cadavers (20%) (5 Male and 3 Female) (All variations were seen on right side)
Bilateral anomalous branching pattern seen in - 2 cadavers (5%) (2 Male)
(1) Variations in Profunda brachii artery - 6% of Upper Limbs (3 cadavers - 5% - B/L in two male cadavers, U/L in one male)
(2) Variations in Superior ulnar collateral artery - 11% of Upper Limb (8 cadavers (20%) - B/L in One Male and U/L in three female and four male cadavers)
(3) Variations in Inferior ulnar collateral artery - 8% of Upper limb (6 cadavers (15%) - U/L in four male and two female cadavers)
(4) Variations in Terminal branches - 7.5% of Upper Limb (6

cadavers - 15% - U/L in three males and three females)
{B/L-bilateral U/L-unilateral}

- 1) Normal course and termination was observed in 30 cadavers (23 Males and 7 females).
- 2) Origin - At the lower border of teres major
- 3) Avg. length (from lower border of teres major muscle to bifurcation) of brachial artery was - 24 cm
- 4) Termination - 2.5 cm to 3.0 cm below intercondylar line of humerus.
- 5) Branches - Profunda brachii, Superior ulnar collateral, inferior ulnar collateral, muscular branches, radial and ulnar artery were normally observed from brachial artery.

VARIATIONS

(1) In Profunda brachii Artery

(a) Profunda brachii artery was a branch from II part of axillary artery - (Fig-1) [Unilaterally (right upper limb)] in one male cadaver. Profunda brachii artery gave posterior circumflex humeral and subscapular branch in axilla. Lateral and medial root of median nerve were seen superficial and deep respectively to profunda brachii artery. Rest of profunda brachii artery and brachial artery was normal in course, branching pattern and termination.

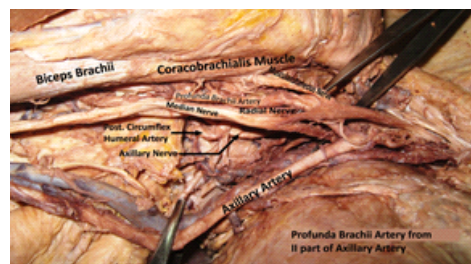


Figure 1: Profunda Brachii Artery from II part of Axillary Artery

(b) Profunda brachii artery was absent (Fig-2) bilaterally in one male cadaver. A descending branch from posterior circumflex humeral artery was seen in the radial groove along with the radial nerve following the course of profunda brachii artery. Middle collateral branch and radial collateral branch were from this descending branch of posterior circumflex humeral artery.

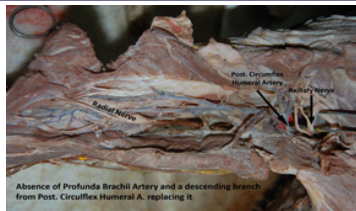


Figure 2: Absence of Profunda Brachii Artery and a descending branch from Post. Circumflex Humeral A. replacing it

(c) Profunda brachii artery and superior ulnar collateral artery were having a common trunk of origin (Fig-3) Bilaterally in one male cadaver.

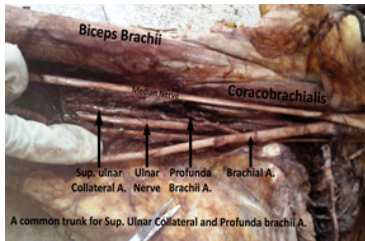


Figure 3: A common trunk for Sup. Ulnar Collateral and Profunda Brachii A.

(2) In Superior Ulnar Collateral Branch

(a) Profunda brachii artery and superior ulnar collateral artery were having a common trunk of origin (Fig-3) Bilaterally in one male cadaver.

(b) Superior ulnar collateral artery was arising before profunda brachii artery unilaterally in one female cadaver (Right side) (Fig-4)

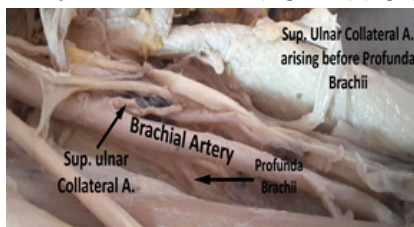


Figure 4: Sup. Ulnar Collateral A. arising before Profunda Brachii

(3) Superior ulnar collateral and inferior ulnar collateral branch

(a) Superior ulnar collateral and inferior ulnar collateral artery was a branch of ulnar artery when brachial artery had a termination in middle of arm (One male and one female cadaver unilaterally (Right side) (Fig-5)

(b) Superior ulnar collateral and inferior ulnar collateral artery (Fig-6) were from medial branch of brachial artery when the latter terminated in arm into medial and lateral branches (one male and one female cadaver unilaterally) and from lateral branch in one male cadaver (Fig-7)

(c) Superior ulnar collateral and inferior ulnar collateral branch were from superficial ulnar artery in one male cadaver unilaterally. (Fig-8)

(4) In terminal Branches

(a) Brachial artery terminated as radial and ulnar arteries in middle of arm at the lower border of teres major muscle unilaterally in one male cadaver and one female cadaver (Right Side) (Fig -5) Superior and inferior ulnar collateral branches were from ulnar artery in the arm.

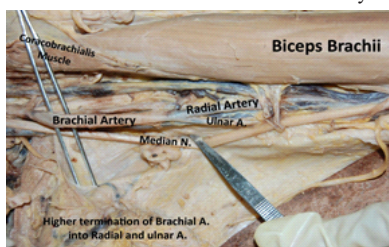


Figure 5: Higher termination of Brachial A. into Radial and Ulnar A.

(b) Brachial artery terminated into medial and lateral branch unilaterally (Fig-6) in two male and one female cadaver (Right side) and lateral and medial branch continued as ulnar artery and radial artery respectively in forearm. Profunda brachii artery was from brachial artery just before its termination. Superior and inferior ulnar collateral branches were from the medial branch. Medial branch crossed the median nerve superficially from medial to lateral side deep to bicipital aponeurosis and later followed the course of radial artery in the forearm. Radial recurrent artery was from this medial branch in the cubital fossa.

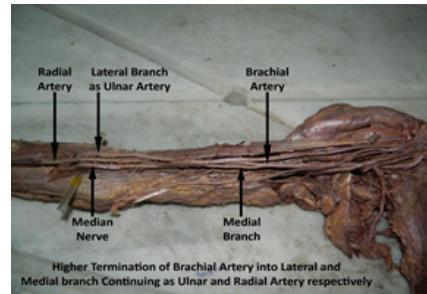


Figure 6: Higher termination of Brachial Artery into Lateral and Medial branch continuing as Ulnar and Radial A. respectively.

In one male cadaver same type of termination into medial and lateral branch was seen but the two arteries joined by an anastomotic channel in the cubital fossa. (Fig -7) A branch from lateral division also joined this anastomosis at the cubital fossa. Superior ulnar collateral artery and inferior ulnar collateral branch were from lateral branch. Anterior and posterior ulnar recurrent branches were from ulnar artery (Lateral branch).

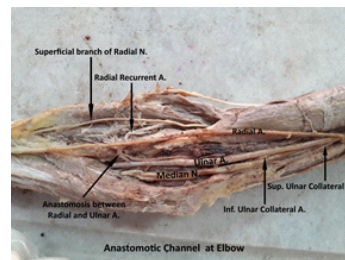


Figure 7: Anastomotic Channel at Elbow

(c) Brachial artery terminated into radial artery and common interosseus artery in cubital fossa (Fig -8) unilaterally in one male cadaver (Right side). Ulnar artery was from brachial artery in middle of arm and was having a superficial course throughout arm and forearm. Profunda brachii branch was from brachial artery. Superior ulnar collateral artery and inferior ulnar collateral were branches from superficial ulnar artery. Anterior ulnar recurrent artery was a branch from brachial artery and it anastomosed with inferior ulnar collateral artery. This superficial ulnar artery was maintaining its superficial course throughout in the arm and forearm, being superficial to flexor muscles in forearm. Posterior ulnar recurrent artery was from common interosseus artery and it passed deep to flexor muscles to anastomose with superior ulnar collateral artery. Superficial ulnar artery passed superficial to flexor retinaculum along with the ulnar nerve to form the superficial palmar arch.

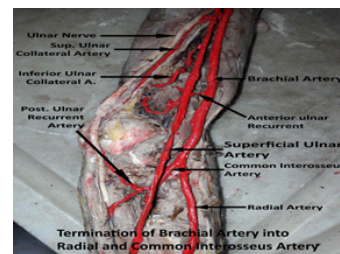


Figure 8: Termination of Brachial A. into Radial and Common Interosseus A.

DISCUSSION

Variations in branching pattern of brachial artery have been studied by various authors and incidence has been reported to be 26% by Patnaik

et al³ and 18.53% by McCormack et al⁴. Unilateral and bilateral variations were found to be 24.5% and 6.32% respectively by McCormack et al⁴.

Variations have been found to be either as high division of brachial artery (Kumar V et al 2014)⁵ or as superficial brachial artery with high division (Singla et al 2012)⁶ or as double axillary artery and double brachial artery (Jayakumari S 2006)⁷ or as superficial course of radial artery (Singh et al 2010)⁸. According to Arey LB⁹ anomalous blood vessels may appear due to persistence of vessels which are normally obliterated or obliteration of vessels which are normally present or fusion and absorption of usually distinct part. Genetic predisposition, chemical factors or hemodynamic forces can be the reasons for arterial variations in the upper limb¹⁰.

Variable branching pattern of brachial artery was observed in about 25% of cadavers in our study which is quiet similar to that of study by Patnaik et al³. Unilateral and bilateral incidence was about 15 % and 10 % respectively. Numerous types of variations in branching pattern of brachial artery such as higher termination, presence of superficial ulnar artery and absence of profunda brachii artery etc. were observed.

Profunda brachii artery showed anomalous branching pattern in about five of upper limbs (6%). Charles et al¹¹ had specified seven types of variations in origin of profunda brachii artery. We have observed Type II (arising as a common trunk with superior ulnar collateral artery), Type VI (profunda brachii as a common trunk with subscapular and both circumflex humeral from axillary artery), Type VII (absence of profunda brachii artery) variables in origin of profunda brachii artery. Some variations observed by us such as absence of profunda brachii artery are rare type of variations where a descending branch of posterior circumflex humeral artery (PCHA) runs along with radial nerve in radial groove. This has been reported by K.G. Rao 2012 et al¹² and Ojha et al (2015)¹³. In many reports' occlusion of PCHA has been mentioned as a cause of quadrangular space syndrome^{14,15}. Pain in this syndrome can reach up to the posterolateral part of the arm, lateral part of the forearm and elbow, due to the involvement of radial collateral artery if it is a branch from PCHA. Patients in the quadrangular space syndrome may require surgical decompression of the space through the posterior approach if not responding to conservative treatment^{12,16}. It is essential for the surgeons to be aware of this variant course of the PCHA and radial collateral artery.

Common trunk for profunda brachii and superior ulnar collateral artery predisposes the latter to injury during flap harvesting or other procedures of the arm (Madhyastha et al., 2009)¹⁷. High origin of the profunda brachii artery is a vulnerable site in downward dislocation of the shoulder joint. Though the percentages of arterial lesions are low in upper extremity dislocation, Bravman et al¹⁸ emphasize its significance as a "diagnostic challenge" even in minor trauma. A case of anterior dislocation of the shoulder resulting in avulsion injury to the branches of the circumflex humeral artery with expanding hematoma in the axilla has been mentioned by them. A high level of suspicion, along with knowledge of sensitive and specific clinical signs is must for an accurate and timely diagnosis. High origin of the profunda brachii artery can be beneficial for collateral circulation connecting the distal part of the axillary artery with branches of the radial and ulnar arteries at anastomosis around the elbow.

Six upper limbs (7.5%) showed termination of brachial artery in middle of the arm. In three upper limbs, terminal branches were as radial and ulnar artery and in other three limbs brachial artery terminated into two branches, medial and lateral branch which continued as radial and ulnar artery respectively. Variations like crossing of branches in arm or cubital fossa are also rare and may cause difficulty in measurements of blood pressure or may get accidentally punctured. Such an anomalous origin of vessels can be explained on the basis of Singer¹⁹ staging of development of brachial artery which shows that, it develops in five stages where in stage IV of development a superficial brachial artery (SBA) develops in the axillary region and runs from radial to ulnar side of the forearm to the posterior surface of the wrist and in stage V, distal portion of SBA enlarge sufficiently to form radial artery and the proximal part atrophies. In the present case proximal part of SBA has persisted resulting in crossing of vessels in elbow region.

Superficial ulnar artery has been observed by us unilaterally in one cadaver only (2.5%). Incidence of superficial ulnar artery is 0.7-9.3%

and more common unilaterally (Rodriguez et al)²⁰. Presence of superficial ulnar artery is rare in Japanese as compared to Indians (Nakatani et al)²¹. Superficial ulnar artery runs close to basilic vein making it more prone to trauma and haemorrhages. Identifying a superficial blood vessel as an artery or vein is difficult, even for experienced anesthetists. Even absence of pulsation is an unreliable sign. Intra-arterial cannulation is suspected by pulsatile retrograde flow of blood, intense pain on injection of drugs and cutaneous signs of distal ischaemia. Awareness of an anomalous artery also facilitates early diagnosis and anaesthetists should always be aware of the common anatomical variations in blood vessels²². A case report of gangrene of upper extremity following intra-arterial injection of drugs has been reported by Goldberg et al., 1984²³. Study of anomalous branching pattern is of importance to both physicians and surgeons especially cardiovascular and orthopaedic surgeons performing procedures in this region.

Reconstructive surgeries with flaps are becoming common now a days. Superficial ulnar artery may get damaged in forearm free flaps based on the radial artery resulting in ischemia of the hand²⁴. Presence of SUA should be ruled out by careful palpation of the cubital fossa or by doppler ultrasound examination before performing the above mentioned procedures²⁵. But if recognized preoperatively SUA, can also be used with advantage in raising a skin flap for reconstructive surgeries²⁶ and is also clinically significant in arterial anastomosis performed for haemodialysis^{27,28}.

CONCLUSIONS

Some variations like absence of profunda brachii branch and continuation of medial branch of brachial artery as radial artery are rare patterns reported infrequently in literature. Awareness of such variations is valuable during diagnostic and surgical procedures to avoid complications.

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