

High up bifurcation of the right superficial brachial artery with Brachio radial artery

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ABSTRACT

Dissection of an elderly male cadaver revealed an unusual short segment of brachial artery coursing superficial to the median nerve with high up bifurcation/termination into the medial ulnar & lateral radial arteries. The point of termination/bifurcation was about 11.5 cm above the horizontally drawn line joining the medial and lateral epicondyles of humerus. The superficial brachial artery is defined as brachial artery which courses in front of the median nerve. The medial ulnar artery coursed forwards towards the cubital fossa and had a deeper routine course. The median nerve was seen lying between the radial and ulnar arteries below the bifurcation. The lateral radial artery remained superficial in its entire course from middle 1/3 of arm, elbow, forearm up to wrist (The brachio radial artery is defined as radial artery with high origin).

Key words: High bifurcation/termination, Branchial artery, Brachio radial artery, Superficial Radial artery

Abbreviation: CABG – Coronary Artery Bypass Graft Surgery; AVF – Arterio Venous Fistula; BCAVS Procedure – Brachio – Cephalic Arterio Venous Shunt.

1. INTRODUCTION

Brachial artery which begins as continuation of axillary artery at the distal border of teres major muscle. It is the principal artery irrigating the arm. It begins on the medial side of the upper part of the arm, and runs downwards and slightly laterally to end in front of the elbow. Within the cubital fossa at level of neck of radius the artery ends by bifurcating into its terminal branches i.e., radial and ulnar arteries. The median nerve crosses in front of the artery from lateral to medial side, at the middle of the arm. Supplying the structures of the arm are the profunda brachii, superior ulnar collateral artery, inferior ulnar collateral artery, nutrient artery to the humerus and few unnamed muscular branches (Standstring, 2005). Variations in the division of the brachial artery have been reported, the brachial artery divides more proximally than usual into radial, ulnar and common interosseous artery. The anomalous brachial vessels sometimes result from high division of brachial artery with two arteries namely the radial & ulnar proceeding to the cubital fossa instead of the usual one (Standstring, 2005; Hollinshead, 1962).

1.1. Embryological basis

Anomalies of the forelimb vasculature especially the brachial arterial variations are very common. This is mainly because of their multiple and plexiform sources, the temporal succession of emergence of principal arteries, anastomoses and periarticular networks and functional dominance

followed by regression of some paths (Williams, 1995). Occasionally the artery divides proximally into two trunks, which may reunite. Frequently it divides more proximally than usual, and this unusually short segment brachial artery may bifurcate as usual or it may trifurcate into radial, ulnar and common interosseous arteries. More often the radial artery arises proximally, leaving a common trunk for the ulnar and common interosseous; arteries. Rarely the ulnar artery arise proximally, the radial and common interosseous forming the other division; the common interosseous may also arise proximally (Johnson, 2005). The unusually short segment brachial artery with its high up division into smaller lateral radial and larger medial ulnar arteries discovered in the present case report can be explained in the light of embryogenic development. The early limb bud receives blood via intersegmental arteries, which contribute to a primitive capillary plexus. At the tip of the limb bud there is a terminal plexus that is constantly renewed in a distal direction as the limb grows. Later a single principal artery supplies the limb and the terminal plexus; hence it is termed the axis artery.

The aforesaid terminal plexus at the tip of the upper limb bud is separated from the outer ectodermal sleeve of the limb by an avascular zone of mesenchyme which contains an extracellular matrix consisting largely of hyaluronic acid. Degradation of hyaluronic acid by hyaluronidase results in vascularization of the tissue since partial degradation products of hyaluronic acid are angiogenic. Thus ectodermal-mesenchymal interactions and extracellular matrix components are controlling the initial sprouting of

Brachio radial artery:
The radial artery with high origin is called the brachio radial artery.

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Comparison:

There is striking controversy regarding the percentage of the incidence of the present variation. The incidence of high division of brachial artery is rare accounting to 0.5% (Biertolazzo, 1981) as only one variant was discovered after dissecting the upper extremities of 202 cadavers. After dissection of 750 upper extremities the incidence was reported to be frequent accounting to 18.53% (McCormack, 1953). Several variations with regard to the termination/bifurcation of the brachial artery have been reported by many anatomists. High bifurcation of the brachial artery can occur in a frequency from 1 out of 8 (12.5%) to 1 out of 10 individuals (10%), being the unilateral event more frequent than the bilateral occurring in the right upper limb (Testut, 1954). Preoperative duplex scan performed in 105 patients undergoing autologous BC AVS procedures revealed high bifurcation of brachial artery in 29 patients (27.6%). The bifurcation was axillary in six patients and located at the proximal middle and distal third of the humerus in nine, seven and seven patients respectively (Lioupis C, 2010.) The present variation is located at the proximal middle and distal third of humerus as reported in the nine patients. High up division of brachial artery into the terminal radial and ulnar arteries in the middle of the arm was associated with variant median nerve and absent musculocutaneous nerve (Guha et al. 2005).

Content:

High origin of radial artery was noticed due to the high bifurcation of the brachial artery (Keen, 1961). He explained this variant on the basis of Arey's observations regarding anomalous blood vessels (Arey LB, 1957) according to him the anomalous vessels could be due to:-

- The choice of unusual paths in the primitive vascular plexus
- Persistence of vessels normally obliterated
- The disappearance of vessels normally retained
- Incomplete development
- Fusions and absorption of the parts usually distinct.

In fact, Keen highlighted that there was persistence of the upper portion of the radial artery arising from the brachial artery proximal to the origin of ulnar artery followed by failure of development of the new connection of the radial artery with the brachial artery at the level of origin of ulnar artery.

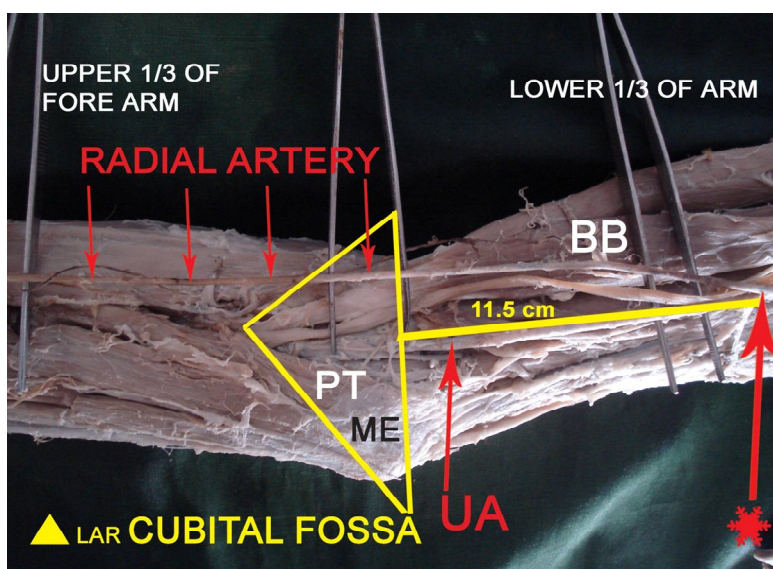


Figure 1

Superio lateral view of lower 1/3 of right arm, cubital fossa, upper 1/3 of fore arm. Bifurcation / termination of brachial artery, Cubital Fossa – The yellow triangle seen, RA – Radial Artery- coursing superficially in the arm and fore arm, UA – ulnar artery is coursing deep, PT –Pronator Teres

blood vessels within the limb (Feinberg, 1991). The axillary artery of the upper limb bud is derived from the lateral branch of the seventh intersegmental artery (subclavian). The arterial trunk grows outwards along the ventral axial line and terminates in the deep plexus in the developing hand. Proximal part of the main trunk forms the axillary and brachial arteries and its distal part persists as the anterior interosseous artery and the deep palmar arch. The radial and ulnar arteries are the latest arteries to appear in the forearm from the axis artery (brachial). Initially the radial artery arises more proximally than the ulnar artery. Later, it establishes a new connection with the main trunk at or near the level of origin of the ulnar artery and the upper portion of its original stem usually disappears to a large extent.

2. SCOPE OF STUDY

An advantage is that the superficial location of radial artery offers relatively easy accessibility for cannulisation and harvesting a graft during (CABGS) coronary artery bypass graft surgery. However being located superficially has its own disadvantages. Worldwide dialysis access surgeons and nephrologists have concluded the high take off the radial artery and lying superficially just below the subcutaneous tissue/fascia, represents an unappreciated cause of fistulae-radial artery cephalic vein reconstruction

non maturation. Prosthetic bridge graft failure due to thromboses and vascular steel syndrome. The superficial location of the radial artery makes it more vulnerable to trauma leading to haemorrhage. By mistaking it for a vein accidentally intra venous injection can be given leading to reflex vascular occlusion resulting in dangerous consequences like gangrene of hand. The brachial artery is frequently used in medical procedures like brachial pulse palpation, recording of blood pressure which is one of the vital parameter recorded in every patient and diagnostic evaluation of angiographic images may be disturbed. Preoperative vascular imaging protocols should be implemented to develop to facilitate identification of this vascular variation.

2.1. Materials

An embalmed elderly male cadaver along with routine dissection instruments like Scalpel, Blade, Surgical forceps, Anatomical Forceps, Dissector, Metallic Scale with Calibrations and a pair of gloves were required.

2.2. Methodology

During the routine prosection hours of the upper limb, the flexor (anterior) compartment of arm, cubital fossa and forearm were dissected according to the instructions given in the standard dissection manual. A vertical incision was made extending from the shoulder to the middle of the arm. The skin, superficial fascia, deep fascia and muscles were separated using a scalpel and forceps. The origin and course of the vessels and nerves were studied in both the arms. The cubital fossa was also dissected and the structures present in its roof floor and contents were studied. The forearm was dissected and the nerves, blood vessels and the flexors were observed. A variation was seen in the right upper limb of an adult male cadaver, which was seen as a high up bifurcation of brachial artery. The brachial artery was carefully followed noting its commencement, course, bifurcation/termination, its muscular branches & the course of superficially coursing radial artery were observed.

3. RESULT/OBSERVATION

During routine dissection of a fifty year old male cadaver in the department of Anatomy, Shadan Institute of Medical Sciences, Teaching Hospital & Research Center, Hyderabad, Andhra Pradesh, India. An unusually short segment of brachial artery with high up bifurcation into radial and ulnar arteries was discovered. The axillary artery continued as the brachial artery at the lower border of teres major. The radial artery was lying lateral and superficial, ulnar artery was lying medial and deep. The brachial artery was seen lying superficial to the median nerve. After the point of bifurcation the median nerve was seen lying between the (medial) ulnar and (lateral) radial arteries between the middle one third and lower one third of the right arm. The bifurcation of the brachial artery was about 11.5 cm above the horizontal line joining the medial and lateral

Cubital Fossa:

It is a triangular hollow situated on the front of the elbow between the brachium and antebrachium. It is homologous with the popliteal fossa of the lower limb situated on the back of the knee.

Superficial Brachial Artery:

The brachial artery which courses in front of the median nerve is called the superficial brachial artery.

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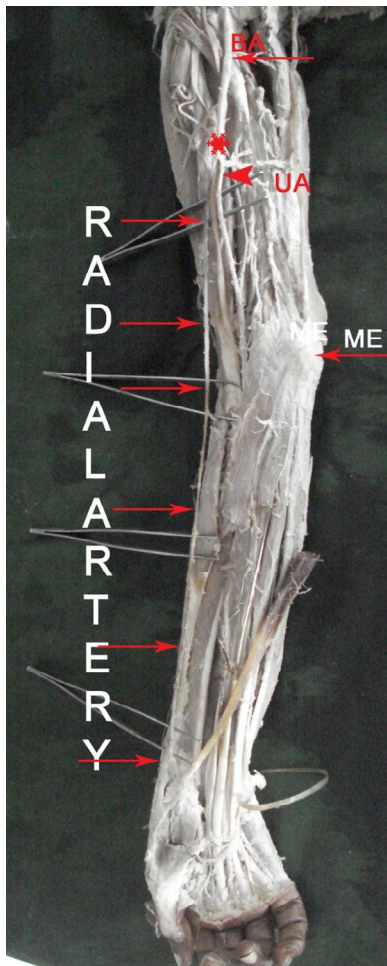


Figure 2
Right upper limb

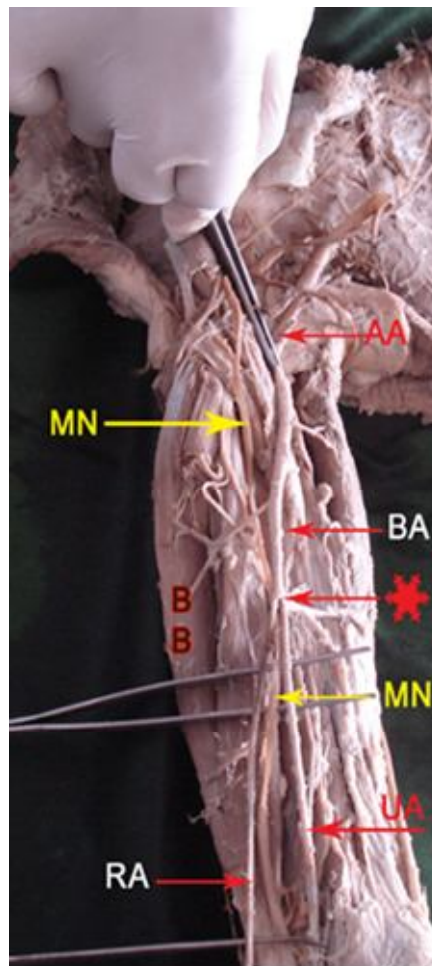


Figure 3
Right arm

Anterior view of dissected right upper limb and right arm, AA – Axillary Artery, BA – Brachial Artery, - Bifurcation / Termination, RA – Radial Artery, UA – Ulnar Artery, BB – Biceps Brachii, ME – Medial Epicondyle, MN – Median Nerve

Brachium (upper arm) (arm):

It is the portion of the upper extremity which extends from the shoulder to the elbow.

Antebrachium (forearm):

It is the portion of the upper extremity which extends from the elbow to wrist joint.

condyles of humerus (Figure 1, 2 & 3). The superficial brachial is defined as brachial artery which courses in front of the median nerve (Figure 2, 3 & 4). The brachio radial artery is defined as radial artery with high origin. The radial artery remained superficial in its entire course from middle 1/3 of arm, elbow, forearm upto the wrist (Figure 2 & 3). It was covered by brachial and antebrachial fascia. The ulnar artery gave a small muscular branch coursing laterally just below its origin. About 4.5 cm proximal to the bifurcation a solitary muscular branch was coursing laterally to supply the biceps brachii muscle. 0.5 cm proximal to it, small but many muscular branches arose to supply the long head of triceps (Figure 3, 4, 5 & 6). Also profunda brachii artery was seen entering in the shaft of humerus via the nutrient foramen. The left upper limb did not reveal any search variation.

4. DISCUSSION

SUMMARY OF RESEARCH

In the present case both the terminal branches i.e., radial and ulnar arteries arose more proximally, leading to the formation of an unusually short segmented brachial artery near the middle of the arm. The point of termination/bifurcation was about 11.5 cm above the horizontally drawn line joining the medial and lateral epicondyles of humerus. The profunda brachii artery took origin from the short segment brachial artery along with its other muscular branches prior to its bifurcation. The superficial location of the radial artery has few advantages but many disadvantages leading to many iatrogenic injuries. Preoperative vascular imaging protocols should be implemented to develop to facilitate identification of this clinically silent vascular variation. In the era of machine vision the horizon for discovery of such variations is opening up. Earlier days the high bifurcation was thought to be a rarity. But in the recent years due to non invasive and cost effective radiological techniques its existence is discovered more frequently.

After dissection and observation of upper extremities of 192 embalmed cadavers the incidence of superficial brachial artery was found in 10 male cadavers (11%), 1 case bilaterally and 9 cases unilaterally (5 right, 4 left). Also found in 8 female cadavers (7.9%), all cases unilaterally (5right, 3 left). Consequently the total incidence of the superficial brachial artery was 18 of 192 cadavers (9.4%), or 19 of 384 upper limbs (4.9%). The incidence of brachio-radial artery was 39 out of 192 cadavers that is 20.3%. The brachio-radial artery was seen in 15 male cadavers (16.5%) unilaterally in 10 cases (6 right, 4 left) and bilaterally in 5. It was found in 24 female cadavers (23.8%), with 15 cases unilateral (10 right, 5 left) and 9 bilateral (Rodríguez-Niedenfuhr, 2001). Out of 56 cadavers dissected and studied, only one specimen with a bilateral high bifurcation of the brachial artery over the brachial plexus in the superior part of the upper one third of the arm accounting to 1.78%. The point of bifurcation in the right and left arms were 20.0 cm and 21.5 cm from the right and left cubital fossae respectively. Indicating the rare existence of this anomaly bilaterally (Rossi Junior, 2011). The present right sided uni-lateral variant had the point of bifurcation about 11.5 cm above the imaginary lines joining the two medial and lateral condyles of humerus. In an adult male cadaver bilateral variation of high bifurcation of brachial artery with superficial course of radial artery in forearm was discovered. The right brachial artery divided 7.5 cm and the left brachial artery bifurcated 10.5 cm above the line joining two humeral epicondyles respectively. The radial artery in both the arms coursed superficially covered by brachial and anti brachial facial (Harbans Singh, 2010). The present case is a unilateral variant occurring in the right arm and the point of bifurcation was 11.5 cm above the line joining the two humeral epicondyles. Another case of bilateral variant of high up division of brachial artery with right brachial artery bifurcating into radial artery that ended in the cubital fossa and superficial ulnar artery arose in the upper one third of the arm (Adib A. Aughsteen, 2011). The present case is a right unilateral variant and only the radial artery had a superficial course. The ulnar artery was seen coursing deep in between the heads of pronator teres. An unusually short segment of brachial artery bifurcated at level of insertion of coraco brachialis in the middle of the right arm into radial and ulnar arteries of same caliber (Satyanarayana Namani, 2010). He gave a detailed description of the embryological basis and highlighted medical and surgical importance of such a variation. The present case report is a unilateral variation showing an unusually short segment of brachial artery which bifurcated into larger medial ulnar artery and smaller lateral radial artery.

5. CONCLUSION

The present case was discovered in a male cadaver having both the elements i.e. the brachial artery being superficial to median nerve hence aptly termed superficial brachial artery and the radial artery had a high origin hence aptly termed as brachio radial artery. An accurate knowledge of the variations in the course, branching and bifurcation/termination and the course of the terminal branches and their relationship with the surrounding structures is essential prerequisite during vascular and reconstructive surgeries of arm.

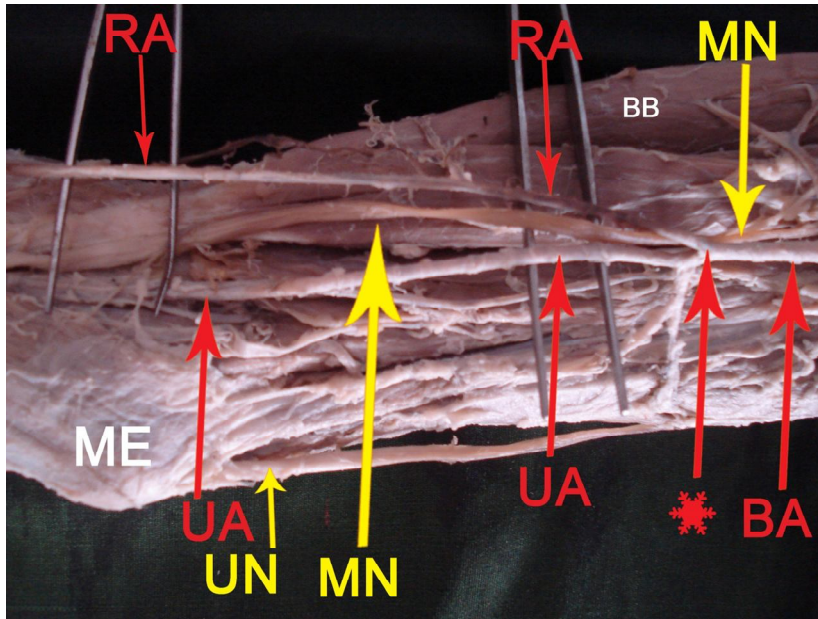


Figure 4

Superio lateral view of lower 1/2 of right arm
BA – short segment of brachial artery, MN – median nerve, -bifurcation / termination of brachial artery. RA – radial artery (smaller and lateral), UA – ulnar artery (larger and medial), BB – biceps brachii, ME – medial epicondyle, MN – median nerve, UN – ulnar nerve, **NOTE 1:** the brachial artery is superficial to the median nerve, 2: the median nerve-mn1 is lying in between the radial and ulnar arteries. 3: in the cubital fossa– the radial artery -RA1 coursing superficially, the ulnar artery -UA1 coursing deep

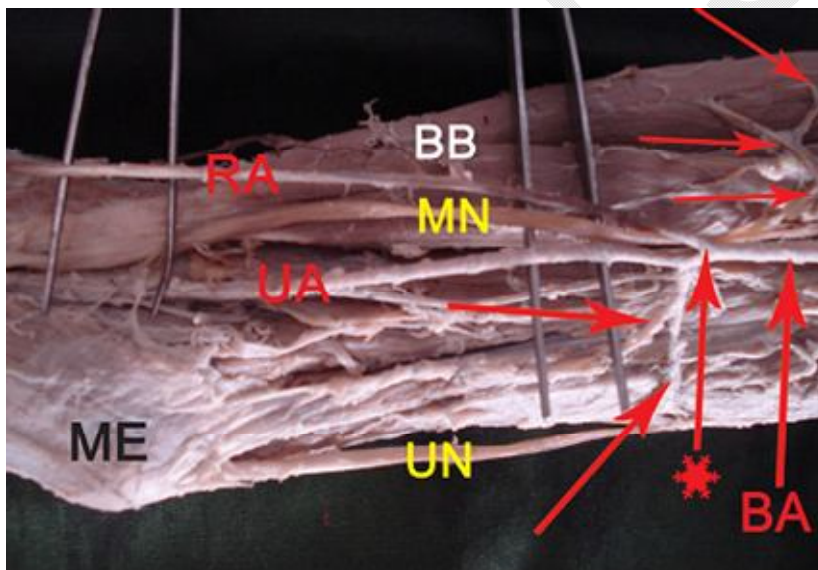


Figure 5

Superio lateral view of lower 1/2 of right arm
BA – short segment of brachial artery, MN – median nerve, **NOTE:** the brachial artery is superficial to the median nerve - bifurcation / termination of brachial artery. RA – radial artery (smaller and lateral), UA – ulnar artery (larger and medial), BB – Biceps Brachii, ME – Medial Epicondyle, MN – Median Nerve, UN – Ulnar Nerve, **NOTE:** Numerous arrows are drawn to show the branches of brachial artery.

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FUTURE ISSUES

The high bifurcation of brachial artery was reported in 61 patients (12.3 %) after studying the doplor ultrasound used for preoperative mapping of the arteries of upper extremities in 481 arms (right arm 181 and left arm 300) of patients with advanced chronic kidney disease and end-stage renal disease on chronic hemo-dialysis (Kian, 2012). Recent data emphasises that high bifurcation of brachial artery can have major clinical implications including high failure rate and decreased functional patency of an arteriovenous (AV) fistula. The observation of color Doppler visualizations of 278 upper extremity scans within a 7-year period had revealed that 26 (12%) patients had high bifurcations of the brachial artery. 14 (53%) of these patients had bilateral scans. Of the 14 patients, 36% were noted to have high bifurcations bilaterally and 64% were unilateral (Ellender, 1999). The present case is a right sided unilateral variation upper limb. The left arm showed no such variation. The dialysis surgeon should develop an algorithm for managing aberrant brachial artery anatomy.

DISCLOSURE STATEMENT

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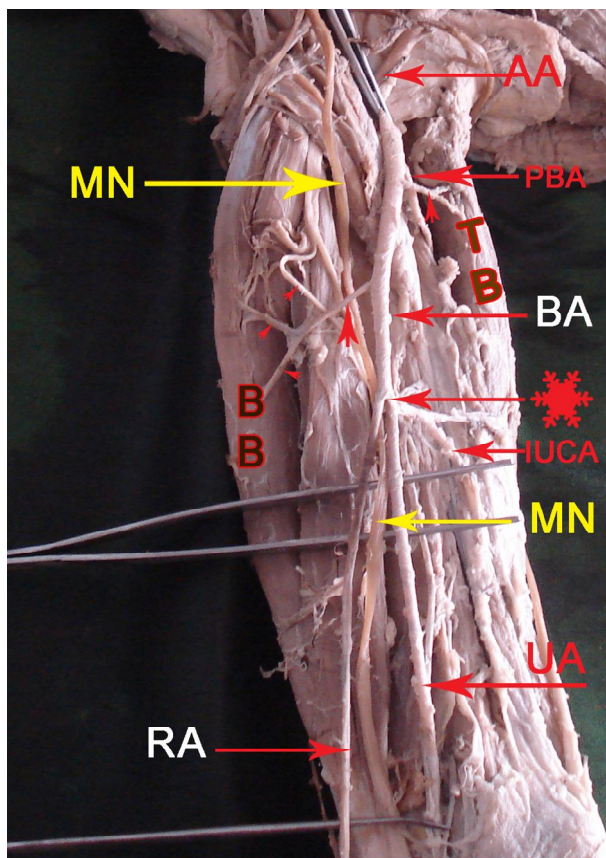


Figure 6

Anterior View of Right Arm; AA – Axillary Artery, BA – Brachial Artery, *Bifurcation / Termination, RA – Radial Artery, UA – Ulnar Artery, BB – Biceps Brachii, TB – Triceps Brachii, MN – Median Nerve, IUCA – Inferior Ulnar Collateral Artery, PBA – Profunda Brachii Artery, small arrow heads represent the muscular branches.

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