

# Variations in the arteries of the upper limb - a clinical apropos

Smitha Elizabeth Kore\*, Nitin Vishwakarma

Department of Anatomy & Neurobiology, College of Medicine and Health Sciences, National University of Science and Technology, Sultanate of Oman

## Abstract

**Introduction:** Blood supply to the arm and forearm is conveyed by the brachial artery and its branches, the radial and the ulnar artery. Variations in these arteries are being increasingly reported in many studies. Most of these variations observed are mostly in the course and branching pattern of these arteries and have been accounted to be due to developmental defect, from varied causes.

**Materials and Methods:** In the present study dissection was done on fifty seven upper limb specimens obtained from the college of Medicine and Health Sciences, Oman. Variations observed in the origin and course of the arteries in the arm and forearm, were noted and later photographed.

**Results:** Out of the fifty seven upper limb specimens studied variations were noted in four limbs. In one limb there was a superficial branch originating from the brachial artery, that later divided into superficial radial and ulnar arteries. In two limbs the brachial artery was superficial to the median nerve, in one of them the brachial artery coursing superficial to the median nerve had a tortuous course. Superficial course of ulnar artery in the forearm was noted in another limb.

**Conclusion:** Surgical procedures are being increasingly done on the upper limb arteries, these procedures are either diagnostic or therapeutic interventions, such as arteriography, flap harvesting, creating arteriovenous fistulas etc. Knowledge of the variations in the upper limb arteries is essential before any surgical intervention is planned in the upper limb arteries in order to prevent unnecessary complications.

## Keywords

Brachial artery, ulnar artery, variations, anomalies, upper limb.

## Introduction

The arterial supply to the upper limb is described to start with the axillary artery, which is a continuation of the subclavian artery at the outer border of first rib. At the lower border of teres major muscle the axillary artery extends in the arm as brachial artery, which later enters the cubital fossa and usually terminates at the level of the radial neck into radial and ulnar artery. The median nerve crosses the brachial artery from the lateral to medial side near the distal attachment of coracobrachialis and thereafter lies medial to the brachial artery in the cubital fossa. The ulnar artery immediately gives off the common interosseous artery in the cubital fossa that divides into the anterior and posterior interosseous arteries. (Standring, 2008)

\* Corresponding author. E-mail: smithakore3@gmail.com

Variations are generally described as morphologies, which are encountered less frequently and are not abnormal and though subtle can affect the human body. (Willan & Humpherson, 1999)

Alteration in the normal course of the upper limb arteries are usually encountered in routine dissection done during undergraduate teaching.

Variations observed in the arterial pattern of the upper limb, is usually noted as absence of either the brachial artery, the radial artery, the ulnar artery, or variations in their branching pattern. Also reported are differences in the origin of these arteries and their courses which may interfere with therapeutic, diagnostic and surgical procedures. (Bidarkotimath et al., 2011)

In the upper limb arteries the variations are known to be more common in radial artery followed by the ulnar artery and less common in the brachial artery. (Chakravarthi et al., 2014)

In Compendium of Human Anatomic variation, Bergman et al (2015) noted that major variations were present in 25% of the subjects in whom brachial artery was studied. They quoted Latarjet as having described five types of branching patterns in case of 'premature' division of the brachial artery, it can terminate as: radial and ulnar-common interosseous trunk; ulnar and a radial-common interosseous trunk; common interosseous or persistent median artery and a radioulnar trunk; radial, ulnar, and a common interosseous artery and a vas aberrans and normal brachial artery.

Rodríguez-Niedenführ et al. (2001) in their study on 384 upper limb specimens reported 7 different arterial variations of the major arteries of the upper limb.

Knowledge of the variations in the arterial anatomy of the upper limb is of significant practical importance for both the vascular radiologist and surgeon and aids them in diagnostic interpretation as well as in the conduct of interventional and surgical procedures on the upper limb. (Uglietta & Kadir, 1989)

Reporting of the variations is not only of academic and clinical relevance, it can also add to the statistics and literature already available. (Patil et al., 2014)

## Materials and methods

The present study was carried on 57 embalmed cadaveric upper limb specimens, which were obtained from the collection of formalin preserved 27 upper limb specimens and 15 upper limbs of cadavers, being utilised for routine dissection by the undergraduate students in the Department of Anatomy and Neurobiology, College of Medicine and Health science (COMHS), National University of Science and Technology (NUST), Sultanate of Oman, during a study period of 3 years.

These specimens and cadavers were obtained from the anatomy lab of medical school of West Virginia University (WVU) United States of America (USA). The cadavers and upper limb specimens were dissected in anatomy lab of WVU, and later sent to College of Medicine and Health sciences, NUST.

None of the cadavers and prosected limbs studied, had any pathological lesions, traumatic lesions or surgical procedures in the upper limb.

The arteries in the upper limb were cleaned appropriately and their course, relations and branches were studied in detail and the variations were noted.

Photographs were taken under good lighting, using digital camera and were labelled later.

Approval for conducting the research was taken from the Research and Ethics Committee, of the college.

## Results

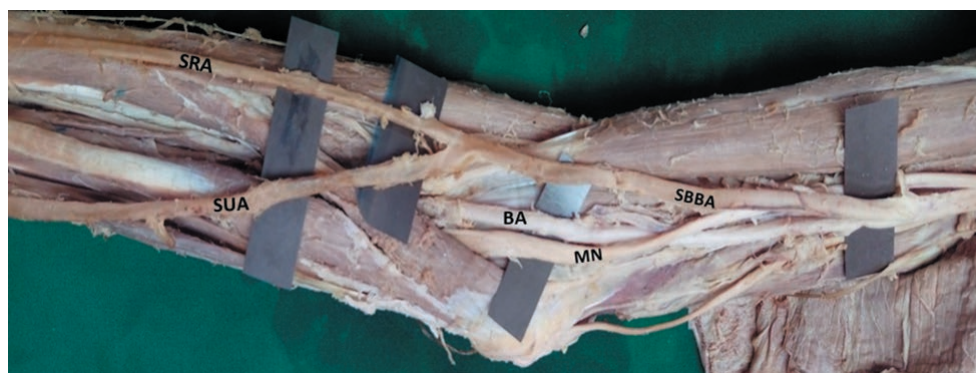
In the 57 upper limbs studied, variations were observed in 4 upper limb specimens.

In an upper limb specimen of the right side, a branch (superficial brachial artery) arose from the brachial artery that coursed laterally in the arm crossing the median nerve. After entering the cubital fossa, this branch divided into radial and ulnar artery. Both the radial and ulnar artery had a superficial course in the forearm. The ulnar artery passed superficial to the superficial flexors, and continued as the superficial palmar arch in the hand. The radial artery coursed superficial to the brachioradialis muscle and had a normal course in the hand.

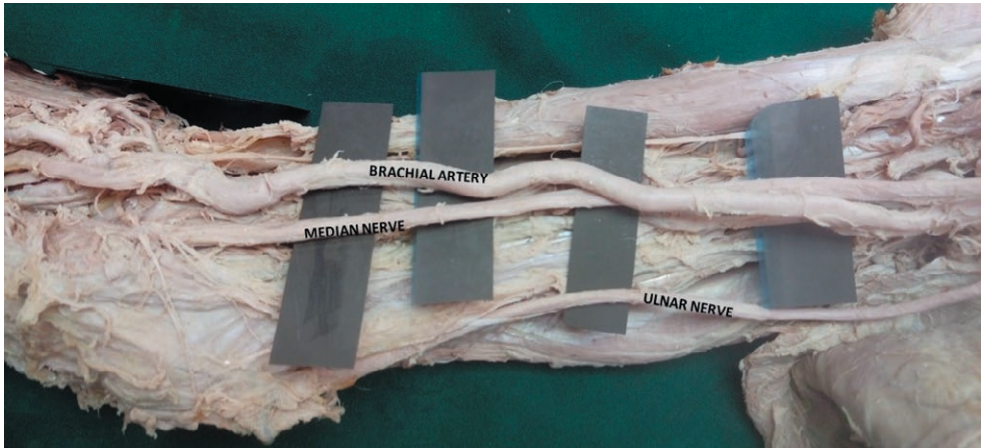
The brachial artery after entering the cubital fossa continued as the common interosseous artery, which later divided into anterior and posterior interosseous arteries. All the recurrent branches arose from the common interosseous artery. The median nerve crossed the brachial artery in the lower third of the arm. (Figure 1)

In another specimen of the left side, the brachial artery was tortuous and superficial to the median nerve, termed as superficial brachial artery (SBA). It crossed the median nerve and descended on the lateral side of the arm, it later entered the cubital fossa where it divided into the ulnar and radial artery, their courses were normal later in the forearm.

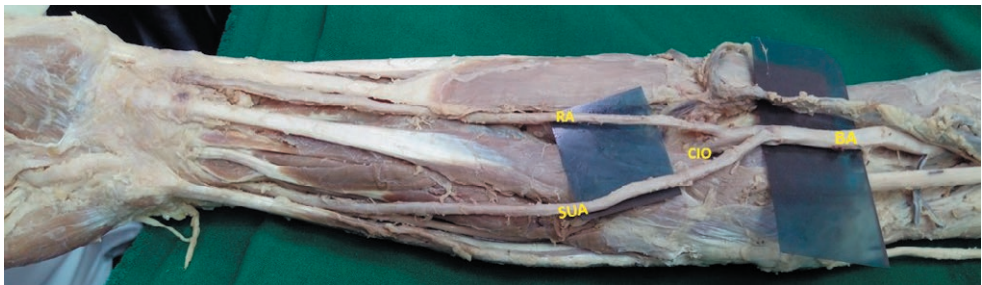
The common interosseous artery which usually arises from the ulnar artery arose from the radial artery, it later divided into the anterior and posterior interosseous artery. (Figure 2)



**Figure 1.** BA=Brachial artery; SBBA= Superficial branch of brachial artery; MN= Median nerve; SRA= Superficial radial artery; SUA= Superficial ulnar artery. SBBA arising from the BA and coursing laterally in the arm crossing the MN. After entering the cubital fossa, the SBBA divided into SRA and SUA. BA after entering the cubital fossa continued as the common interosseous artery.



**Figure 2.** Brachial artery is tortuous and superficial to the median nerve. Common interosseous artery was seen as a branch of radial artery in this specimen.



**Figure 3.** BA=Brachial artery; RA= Radial artery; SUA= Superficial ulnar artery; CIO=Common interosseous artery. The ulnar artery after originating from the BA in the cubital fossa had a superficial course in the forearm i.e. SUA. The CIO arose as a branch of the RA in the cubital fossa, the radial artery had a normal course in the forearm.

Similar variation was seen in another limb of the left side, where the brachial artery was superficial to the median nerve, in the arm. But in this limb the brachial artery was not tortuous and the common interosseous artery arose from the ulnar artery as is seen generally.

In another right sided limb specimen, the ulnar artery after originating from the brachial artery in the cubital fossa had a superficial course in the forearm, termed as superficial ulnar artery. It descended superficial to the pronator teres, flexor digitorum superficialis and flexor carpi radialis muscles in the upper two thirds of the forearm and in the distal one third, followed a typical course for the ulnar artery. At the wrist it was accompanied medially by the ulnar nerve and the tendon of the flexor carpi ulnaris, it then traversed the flexor retinaculum, and continued across the palm as the superficial palmar arterial arch. The common interosseous artery arose as a

branch of the radial artery in the cubital fossa, the radial artery had a normal course in the forearm. (Figure 3)

## Discussion

Anomalies of the upper limb arteries are seen to be more common. This has been assumed due to their multiple and plexiform sources, the temporal succession or emergence of principal arteries, anastomoses and periarticular networks and functional dominance followed by regression of some paths. (Gujar, et al., 2014)

Rodriguez-Niedenfuhr et al (2001) defined superficial brachial artery as the brachial artery coursing in front of the median nerve. If the superficial brachial artery branched at elbow level into radial and ulnar arteries, coexisting with a normal brachial artery that continues as the common interosseous trunk it was termed as superficial brachioulnoradial artery. The prevalence of superficial brachial artery noted in their study was varying from 0.2-25%, whereas the total incidence of superficial brachioulnoradial artery was 2 out of the 384 upper limbs (0.52%).

In present study the superficial brachial artery was seen in 2 limbs, one of them followed the course of the superficial brachioulnoradial artery.

Neelamjit Kaur et al. (2011) in their case report also reported similar course of the brachial artery as seen in our case.

Wadhwa et al. (2008) reported a constellation of multiple upper limb anomalies with unilateral muscular, neural and arterial variations. The arterial variation noted in their case was, the division of the superficial brachial artery into radial and ulnar arteries in the cubital fossa. The deep branch of brachial artery continued as the common interosseous artery, but only the ulnar artery had a superficial course in the forearm.

In another study done on 130 upper limbs, superficial radial and superficial ulnar artery arose from the bifurcation of a superficial brachial artery in the cubital fossa but in their case the normal or deep brachial artery was not seen. (Kachlik, et al., 2011).

Variations in the origin of common interosseous artery have also been reported. In one of the limbs in the present study, the superficial brachial artery was seen tortuous in its course and the common interosseous artery arose from the radial artery and not from the ulnar artery as is seen normally.

The incidence of origin of common interosseous from radial artery is uncommon.

Jayakumari et al (2006) noted that in addition to the presence of double brachial artery seen in their case, they also noticed the common interosseous arising from the radial artery.

In a study done on 102 upper limb specimens, the common interosseous artery arising from radial artery was seen in 12.7% cases and the superficial ulnar artery in 1.8% cases. (Baral & Koirala, 2012).

Similar origin of the common interosseous artery from radial artery was also reported by Udayavar (2004).

Arole et al (2016) reported in their case, the presence of a superficial brachial artery arising from the axillary artery, which later continued as the superficial ulnar artery, the main brachial artery continued as the radial artery, and the common interosseous artery arose as a branch from the radial artery.

In one of the limbs we noticed that the superficial brachial artery was tortuous in the arm. Presence of tortuous brachial artery has been reported earlier, and is noted to be less common than a tortuous radial artery. Due to its larger diameter the tortuous brachial artery does not seem to cause problems clinically. (Sirisha, et al., 2015)

The term superficial ulnar artery is applied to an artery which arises from the axillary, brachial or superficial brachial arteries and courses over the origins of the superficial forearm muscles to join at the midlevel of the forearm with the ulnar artery, sometimes replacing it. (Reddy & Vollala, 2007)

In the present study we found two limbs where the ulnar artery after originating from the brachial artery had a superficial course in the forearm, and since only the ulnar artery had a superficial course it cannot be termed as a brachioulnoradial artery as described by Rodriguez-Niedenfuhr et al (2001).

The prevalence of the superficial ulnar artery is reported to be 0.7–9.4% and the incidence of a combined superficial radial artery and superficial ulnar artery is far less seen. (Kumka and Purkiss, 2015).

The superficial ulnar artery can course over the forearm flexors either after passing over the antebrachial fascia or under the antebrachial fascia a subcutaneous position, crossed by the median cubital vein. It reaches the lateral border of the flexor carpi ulnaris either at the midforearm level or after passing deep to the palmaris longus. (Reddy and Vollala, 2007).

In the present study the superficial ulnar artery was seen superficial throughout the forearm, passing above to the tendon of flexor carpi ulnaris muscle.

In an analysis of intraoperative findings during harvest of ulnar free forearm flap for head and neck reconstruction, aberrant superficial ulnar artery was observed in 5 of 322 (1.5%) cases. (Hakim, et al., 2014).

Casal D et al, (2012) reported superficial brachioulnar artery, found bilaterally where the superficial brachioulnar artery originated at midarm level from the brachial artery, pierced the brachial fascia immediately proximal to the elbow, ran over the pronator teres muscle subsequently it ran deep to the palmaris longus muscle and later was lateral to the flexor carpi ulnaris muscle.

Of all vascular surgical procedures, approximately 4% of upper extremity ischemia is seen to require surgical intervention. Apart from occlusive disease in the upper extremity, presence of emboli, trauma (iatrogenic or noniatrogenic), collagen vascular disease, and thromboangiitis obliterans is found to be more common distal to the axillary artery. (Roddy et al., 2001)

The clinical use of brachial artery for diagnostic and curative treatment of many diseases, such as chronic renal failure, coronary artery disease, aortic and peripheral vascular disease, and also for use in interventional radiology is well documented. In individuals undergoing arteriography of the brachial artery unexpected complications can be noted in asymptomatic patients with arterial anomalies. (Jo, et al., 2005)

Uneven tortuous course of superficial brachial artery in relation to the median nerve as noted in one of the limb in the present study, may lead to compression of the median nerve in the arm. The clinician may confuse it with compression that usually is caused by more common causes, such as radiculopathy and carpal tunnel syndrome or pronator teres syndrome. The superficial tortuous brachial artery may be mistaken subcutaneous veins during cannulation and can lead to limb ischemia. (Wadhwa et al., 2008)

During harvesting ulnar free forearm flap presence of superficial ulnar artery can lead to failed flap raising. Even during harvesting the radial forearm flap, if circumferential incision of a large skin paddle encounters the superficial ulnar artery running underneath it might be injured thus the perfusion of the whole hand can be at risk. (Hakim et al., 2014)

Careful palpation or by using vascular doppler, the presence of superficial ulnar artery and its course can be diagnosed preoperatively in order to prevent accidental division of these vessels.(Ghosh et al., 2016)

Cases of superficial arteries being mistaken for veins are also reported, such an error can lead to intra-arterial injections, (Senanayake, et al., 2007) misinterpretation of angiographic images or severe disturbances of hand irrigation during surgical procedures on the arm or forearm. (Ghosh et al., 2016)

## Conclusion

Variations in the course of the arteries of upper limb are known to exist, and may be treated unimportant in asymptomatic patients. But knowledge of these variations are definitely indispensable for clinicians and surgeons who undertake procedures involving the vessels in the upper limb.

The lookout for such variations preoperatively by palpation for arteries passing superficially or through imaging in cases where the artery is absent or having variation in its course or branching pattern, can prevent unnecessary complications that can risk the procedure.

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