e - ISSN - 2349 - 8005

INTERNATIONAL JOURNAL OF ADVANCES IN CASE REPORTS

Journal homepage: www.mcmed.us/journal/ijacr

UNILATERAL MULTIPLE ARTERIAL VARIATIONS IN THE UPPER LIMB- A CASE REPORT

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Article Info
Received 19/06/2015
Revised 28/06/2015
Accepted 16/07/2015

Key words: Brachial artery, Variation, Radial artery, Ulnar artery, Median nerve, Musculocutaneous nerve.

ABSTRACT
Normally, the brachial artery divides into radial and ulnar arteries at the level of the neck of the radius in the cubital fossa. However, higher division of the brachial artery has been reported earlier. Here, we report multiple arterial variations in the right upper limb with rare communication between the musculocutaneous nerve and the median nerve. During the routine dissection, we found higher division of the brachial artery unilaterally up in the arm into radial and ulnar arteries. The brachial artery unusually gave rise to only the profunda brachii artery and muscular branch to the triceps. Its other branches like the nutrient artery to the humerus, upper and lower ulnar collateral and other muscular branches were found to arise from the ulnar artery in the arm. At the level of the apex of the cubital fossa the ulnar artery gave rise to common interosseous artery and large muscular branch to the extensor compartment. The radial artery had the superficial course in the arm and in the forearm and did not contribute to the superficial palmar arch in the palm. In the same limb, a branch from the musculocutaneous nerve emerged from the short head of the biceps and communicated with the median nerve. Such variations may be explained on embryological basis owing to the complex relationship between the nerves and vessels in the upper limb. The knowledge of these types of arterial variations are important for surgeons, radiologist and also for the anatomist and may also explain uncommon symptoms and syndromes in the upper limb.

INTRODUCTION

Normally brachial artery terminates into radial and ulnar artery in the cubital fossa at the level of the neck of the radius [1]. General textbook description of the axillary artery has shown it as continuing as the brachial artery and was observed in 80% of specimens and in remaining 20% of the cases the termination of the brachial artery showed varieties of variations. One of the major variations is the high proximal division of the brachial artery into terminal branches (radial, ulnar, common interosseous, vas aberrans, and superficial median antebrachial artery) [2].

According to Feinberg, ectodermal-mesenchymal interactions and extracellular matrix components within the developing limb bud are controlling the initial patterning of blood vessels [1]. Further, there is a view that some inductive factors from the limb mesenchyme cause the changes in the blood vessel pattern [3]. High division of the brachial artery can also be explained on the basis of observations made by Arey in 1957 where he highlighted that, there may be persistence of vessels which normally obliterate and disappearance or failure of development of vessels which normally persist [4]. This reversal of the normal process of vascular development is largely due to altered local hemodynamic environment [5].

Communication between the median and the musculocutaneous nerves are also common and usually occur in the lower third of the arm [1]. However the present case explains both the arterial and nerve variations

in the middle third of the arm and are thus unusual.

CASE REPORT

During routine dissection of upper limb in the Department of Anatomy, Kasturba Medical College, Manipal, India, out of 44 upper limbs dissected, in one right upper limb of a 58 year old male cadaver, we found the present variations. In the arm, the brachial artery provided only a small profunda brachii artery and few muscular branches to nearby muscles. Its usual branches like the superior and inferior ulnar collateral artery and the nutrient artery to the humerus were found to arise from the ulnar artery in the lower arm. The brachial artery divided into radial and ulnar arteries in the middle third of the arm (Figure 1). The radial and ulnar arteries then traversed parallel to each other initially under the biceps brachii muscle and then both the arteries became superficial in the lower part of the arm before entering into the cubital fossa.

Brachial artery (Ba) divides into Radial (Ra) and Ulnar artery (Ua) in the middle third of the arm. The brachial artery (Ba) gave rise to profunda brachii (PBa) artery and muscular artery (Ma) in the arm before providing its terminal branches. These two terminal branches run parallel to each other in the arm in close relation to the biceps brachii (Bm) muscle and enters the cubital fossa. Small communicating branch from the musculocutaneous nerve (Cb) was coming out of Bm and running between Ra and Ua before joining the median nerve (Mn).

The ulnar artery entered the cubital fossa under the common flexor group of muscles arising from the medial epicondyle of the humerus. In the cubital fossa, the ulnar artery gave rise to common interosseous artery, anterior and posterior ulnar recurrent arteries, and a large muscular branch to the posterior compartment (Figure 2). The ulnar artery then continued into forearm between the two heads of the pronator teres muscle. The common interosseous artery further divided into anterior and posterior interosseous arteries in the cubital fossa.

(Ua) entering the cubital fossa and providing a large muscular branch (Mb) to the posterior compartment and a common interosseous artery (Ci) which further divided into anterior (Ai) and posterior interosseous arteries (Pi). The ulnar artery then continued into forearm between the two heads of the pronator teres muscle (Pt) to proceed towards the palm. The radial artery (Ra) entered the cubital fossa under cover of the brachioradialis muscle (Br) and had normal branches and course in the cubital fossa and in the forearm. Mn- Median nerve.

The radial artery after emerging under the biceps brachii muscle in the lower arm deviated to lateral side to run superficially in the cubital fossa and in the forearm (Figure 3). We did not notice any changes in its branching pattern in the cubital fossa. However, near the wrist, the radial artery did not give rise to the superficial palmar branch to complete the superficial palmar arch. The superficial palmar arch was found to be formed only by the superficial branch of the ulnar artery and the arch gave rise to one proper digital artery to the ulnar side of the little finger, and four common palmar digital branches to all the web spaces (Figure 4). The latter then divided into proper digital arteries to supply the corresponding sides of the finger.(Ua) after running superficial to the flexor retinaculum, it formed the superficial palmar arch (Spa) from which five common digital arteries were arising. The radial artery (Ra) did not contribute to the formation of the superficial palmar arch and continued its course on to the dorsal side of the hand.

In the same arm we also found a communicating branch from the musculocutaneous nerve that emerged from the medial side of the upper part of the short head of the biceps brachii muscle, after having a short course between the radial and the ulnar artery, it then joined the median nerve in the lower part of the arm (Figure 1).

Fig 1. Showing the high division of the Brachial artery. Brachial artery (Ba) divides into Radial (Ra) and Ulnar artery (Ua) in the middle third of the arm. The brachial artery (Ba) gave rise to profunda brachii (PBa) artery and muscular artery (Ma) in the arm before providing its terminal branches. These two terminal branches run parallel to each other in the arm in close relation to the biceps brachii (Bm) muscle and enters the cubital fossa. Small communicating branch from the musculocutaneous nerve (Cb) was coming out of Bm and running between Ra and Ua before joining the median nerve (Mn)

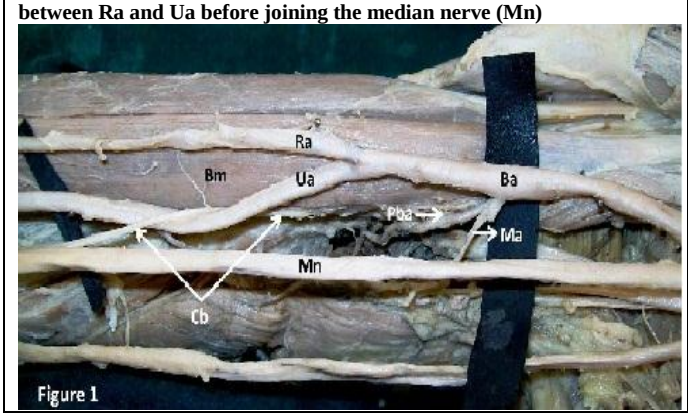

Fig 2. Showing the ulnar arteryartery **(Ua) entering the cubital fossa and providing a large muscular branch (Mb) to the posterior compartment and a common interosseous artery (Ci) which further divided into anterior (Ai) and posterior interosseous arteries (Pi). The ulnar artery then continued into forearm between the two heads of the pronator teres muscle (Pt) to proceed towards the palm. The radial artery (Ra) entered the cubital fossa under cover of the brachioradialis muscle (Br) and had normal branches and course in the cubital fossa and in the forearm. Mn- Median nerve**

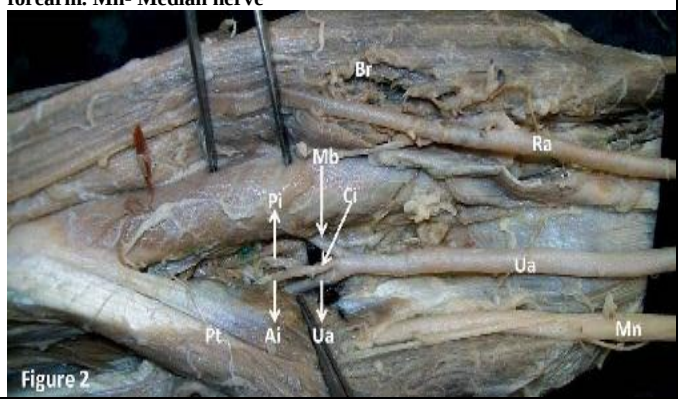

Fig 3. In the cubital fossa the Radial artery (Ra) was running superficial to the superficial flexors of the forearm and continued its course into anatomical snuff box. Ua-Ulnar artery

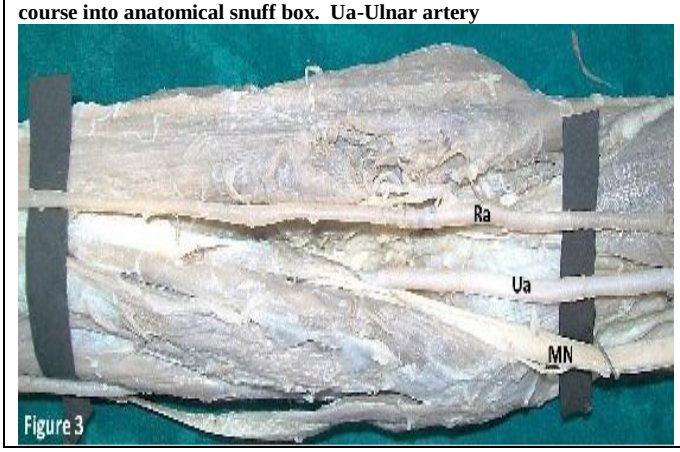

Fig 4. Ulnar artery (Ua) after running superficial to the flexor retinaculum, it formed the superficial palmar arch (Spa) from which five common digital arteries were arising. The radial artery (Ra) did not contribute to the formation of the superficial palmar arch and continued its course on to the dorsal side of the hand.

DISCUSSION & CONCLUSION

The development of arteries of upper limb has been proposed in five stages [6, 7]. In the first stage an axial system represented in the adult by axillary artery, brachial artery and interosseous artery develops first while other branches develop later from the axial system. In the second stage, median artery branches from the anterior interosseous artery, while the ulnar artery branches from the brachial artery. In third stage, formation of a superficial brachial artery from axillary artery and its continuation as radial artery marks the stage. In fourth stage, regression of the median artery and an anastomosis between the brachial artery and superficial brachial artery with regression of the proximal segment of the latter gives rise to definitive radial artery.

According to Adachi, the most significant case of variation of the bifurcation of the brachial artery is that the radial artery branches arise from the brachial artery 4cm proximal to the level of the humeroradial joint [8].

Anomalies of the vascular pattern have been reported to cause delay in the differentiation of the palmar arch. Compta described a high division of the radial artery together with a superficial palmar arch formed entirely by the ulnar artery [9]. Therefore the variations described in the present case could be attributed to the errors in the arterial development.

It has been suggested that, the following are the most common possible variations in the premature branching of the brachial artery: 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 [10].

High division may occur at any point in the normal course of the vessel, but is most common in the upper third of the arm and less frequent in the middle third. In most of the cases, the brachial artery divides into two arteries i.e., radial and ulnar which usually run parallel to each other in the arm and then have a normal course and branching pattern in the cubital fossa. However, there are reports to show abnormal course and branches of these two terminal branches such as - the two arteries communicate at the elbow by a cross branch, or reunite and then divide again in the usual manner; one vessel follows the course of the ulnar artery in the forearm, and the other divides into the radial and common interosseous; one artery divides into the radial and ulnar as usual, and the other takes the course of the common interosseous and divides into the anterior and posterior interosseous arteries or, much more rarely, takes the course of the posterior interosseous artery; the vessels follow a different course in the upper arm different from that of the usual brachial artery [11].

Ulnar artery in the cubital fossa usually gives rise to common interosseous artery and the ulnar recurrent artery [1]. The ulnar artery may arise from the brachial artery above the usual point of division or from the axillary artery. In cases of high division of the brachial artery, the ulnar artery may run in a superficial, subcutaneous position or beneath the fascia throughout its extent in the forearm. In some cases of high origin and superficial course, it gives rise to the subscapular and profunda brachii but not the common interosseous. It may also provide an accessory ulnar recurrent, radial recurrent, or accessory interosseous branch, which may enter the palm and provide any of the branches of the superficial palmar arch. The ulnar artery is more variable in its position than the radial artery [10]. The present case also agrees with the previous studies.

Variations in the origin and course of principal arteries are of significant clinical importance for the radiologist and surgeon. Angiographic images with such vascular patterns may lead to confusion in interpretation and complications in surgeries. As in the present case, the high division of the brachial artery and the superficial course of the radial artery can make them more vulnerable to trauma and more accessible for cannulation. They may also cause complications to plastic surgeons in raising a radial artery or ulnar artery flap [12]. The superficial course of the radial artery is worth considering during raising the free flaps and the techniques employed to avoid

compromising both limb and skin paddle perfusion [13]. High division of brachial artery may also be worth considering while assessing the association between flow-mediated dilatation (FMD) of brachial artery, a noninvasive measure of endothelial function, and future cardiovascular events [14], while quantifying the functional, structural and physicomechanical parameters of the brachial artery which is the early, sensitive and non-invasive diagnostic test of vascular function in patients prone to vascular disease [15].

Superficial palmar arch (SPA) is the dominant vascular structure of the hand and is mainly formed by the anastomosis of ulnar artery with superficial branch of radial artery, or arteria radialis indicis or arteria princeps pollicis from radial Artery. A classical type of SPA is described as direct continuity between ulnar artery and superficial branch of radial artery confirms the presence of collateral supply in hand [16]. An incomplete arch has an absence of communication or anastomosis between the vessels constituting the arch. In an incomplete SPA, ulnar artery does not anastomose with the radial or median artery and fails to reach the thumb and index finger [17].

Knowledge of variation of vascular pattern of hand gains more importance in microsurgical techniques, reconstructive hand surgeries, preoperative screening of RA harvesting for myocardial revascularization and also in arterial interventions that include RA cannulation and RA forearm flap [17].

The anastomosis between musculocutaneous and median nerve is by far the most frequent of all the variations that may be observed in the formation and course of the nerves of the brachial plexus. A plausible explanation of this fact is that this frequent anastomosis is equivalent to the presence of a double lateral root of the median nerve. This may be attributed to random factors influencing the mechanism of formation of the limb muscles and the peripheral nerves during embryonic life. As it is known the limb muscles develop from the mesenchyme of seemingly local origin, while the axons of the spinal nerves grow distally to reach the muscles and/or the skin [4]. Thus, a lack of coordination between these two processes may lead to the variation. Good knowledge of the possible communications between musculo cutaneous and median nerves may prove valuable in traumatology of the shoulder joint [18], as well as in relation to repair operations [19, 20]. As a matter of fact, the anterior surgical approach to the shoulder joint may be complicated by the presence of communicating neural branches.

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