CASE REPORT

Bilateral asymmetry of the highly bifurcated brachial artery variation

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Abstract

High bifurcation of the brachial artery seems to be a common variation, which can occur in many different forms, and some of them might be rather rare. We report an unusual case of bilateral high bifurcation of the brachial artery in a male cadaver. On the right arm, high origin of the ulnar artery as superficial ulnar artery was observed. The brachial artery continued and divided at the level of the elbow into radial and common interosseous artery. On the left arm, a high bifurcation of the common interosseous artery occurred, while the rest of the brachial artery continued and at the level of the elbow bifurcated into radial and superficial ulnar artery. In both arms, the common interosseous artery followed the branching pattern of the normal ulnar artery. The so formed superficial ulnar arteries gave each four common palmar digital arteries. This case is being reported for the bilaterally different variational anatomy of the upper limb arteries.

Keywords: interosseous artery, radial artery, recurrent arteries, superficial palmar arch.

Introduction

The brachial artery (BA) constitutes the continuation of the axillary artery in the arm. The artery begins at the distal border of the tendon of teres major and terminates by dividing into the radial (RA) and ulnar arteries (UA), about a centimeter distal to the elbow joint [1, 2].

The UA is the larger terminal branch of the BA [2]. In the forearm, the artery lies deep to the pronator teres, flexor carpi radialis, palmaris longus and flexor digitorum superficialis muscles [2]. At the wrist, the UA is covered by skin, fasciae and palmaris brevis and lies between the superficial and main parts of the flexor retinaculum [2].

The RA is smaller than the UA, but seems to be a more direct continuation of the BA [2]. The RA normally emerges 1 cm distal to the flexion crease of the elbow and descends along the lateral side of the forearm, from the medial side of the neck of the radius to the wrist [2]. At the wrist, the RA passes on to the dorsal aspect of the carpus [2].

The common interosseous artery (CIA) is a short branch of the ulnar artery, which normally passes back to the proximal border of the interosseous membrane and it divides into the anterior and posterior interosseous arteries [2]. Occasionally, the CIA could emerge from the RA [2].

Variations of the BA are common [1, 2, 4]. The artery could divide proximally into two trunks, which then reunite [2]. The BA could also follow a superficial course, coursing in front of rather than behind the median nerve [1, 4]. This superficial brachial artery has an incidence, which, according to the available literature, varies from 3.6 to 9.6% [4].

Another frequent variation of the BA seems to be the high division of the artery (into its terminal branches) [1–3]. This high division might occur in several forms [1–4]. Most often the RA arises first (high origin of the RA, brachioradial artery), while the UA and CIA continue as a common trunk [1, 2, 4]. In this case, all the arteries in the forearm follow as a rule the normal course [1, 2, 4]. Less frequently, the UA might also arise proximally (high origin of the UA, brachioulnar artery), but in most of these cases the artery follows a superficial course and is described as a superficial ulnar artery (SUA), which replaces the normal UA [1, 4]. The radial and common interosseous arteries continue then as a common trunk [1, 2]. The SUA usually courses anterior to the median nerve, deep to the brachial fascia and passes superficially from the antecubital fossa, over the origins of the pronator teres, flexor carpi radialis and palmaris longus muscles [1]. Rarely, the CIA may arise proximally as well [2].

In the present study, we describe an uncommon case of bilateral high division of the BA with abnormal course of the CIA and coexistence of a SUA. The high division of the brachial artery follows a different and unusual pattern in each arm, which constitutes our case interesting and rare.

Materials, Methods and Results

The reported anatomical variations were discovered in the upper extremities of a male Caucasian cadaver (deceased at the age of 66), during routine educational dissection at the Anatomy Department of the Medical School of the University of Athens, Greece. The cadaver derived from body donation with informed consent, written and signed (with signature authentication) by the donator himself.

The anatomy of the branches of the BA was carefully examined in each arm. During this procedure, we discovered that the BA and its branches presented an abnormal pattern bilaterally.

On the right arm, the BA followed the normal course and branching pattern at the upper third of the arm. Then,
3.2 cm after the origin of the profunda brachii artery, 9.6 cm below the origin of the subscapular artery and 4.5 cm below the lower border of the major teres muscle, the artery bifurcated in two branches (Figure 1a). The diameter (d) of the artery at this level was 0.45 cm. The medial branch (d=0.31 cm) descended along the arm, superficial to the biceps brachii muscle in the middle third of the arm and superficial to the brachialis muscle in the inferior third of the arm (Figure 1a). This artery was considered as a SUA (high origin of the ulnar artery). In the forearm, it continued this superficial course, as it passed over the biceps aponeurosis and it entered the forearm where it coursed superficial to the flexor carpi ulnaris muscle and over the ulnar nerve (Figure 1b). Then, at the level of the wrist, the artery passed over the flexor retinaculum and entered the palm, where it created the superficial palmar arch, which gave off four common palmar digital arteries (Figure 2). The three first of them were the normally expected ones, while the forth was an aberrant one and supplied the index and thumb (Figure 2) (normally irrigated by the radial artery itself or the deep palmar arch). The superficial palmar arch was complete, as a fairly wide remaining branch continued towards the RA. The SUA also gave off a branch, which participated in the creation of the deep palmar arch and had no other branches.

The lateral branch (d=0.43 cm) followed in the arm the normal course of the brachial artery. Then, at the level of elbow, it divided into two branches (Figure 1b), from which the lateral one (d=0.25 cm) followed the course of the RA. The other branch (d=0.37 cm) run median and deep to the forearm muscles, following in the upper third of the forearm the expected course of the UA and then that of the CIA (Figure 1b). This branch gave off both the normal branches of the UA and the CIA. The artery ended at the level of the wrist. It also should be pointed out that only the interosseous recurrent artery existed.

On the left arm, the BA (d=0.31 cm) divided into two branches, 5.5 cm and 12 cm after the origin of the profunda brachii and the subscapular artery respectively and 9.8 cm below the lower border of the major teres muscle (Figure 3a). In this case, the medial branch (d=0.34 cm) descended along the arm, following the course of the BA and then, at the level of the elbow coursed deep to the forearm muscles and followed the expected course of the CIA (Figure 3b). Consequently, this was considered as a high origin of the CIA. The interosseous and ulnar recurrent arteries were absent. This CIA gave off muscle branches for the forearm muscles, comprising those, normally supplied by the UA.

The lateral branch (d=0.34 cm) ran superficial to the biceps brachii and brachialis muscle and at the level of the elbow bifurcated into the RA (d=0.33 cm) and a
The RA laid between the brachioradialis and flexor carpi radialis muscles in both arms.

Discussion

According to the available literature, the BA might present deviation from the normal pattern in 20% of the cases (based on studies by various authors of 3337 upper limbs [5]). High bifurcation of the BA is reported to be one of the most common variations [1, 3], with an overall incidence of 8% [6]. In the study of Kian et al. (2012) [3], high bifurcation of the BA occurred in 14.3% of the cases (69/481). The BA may divide in its final branches, namely the UA and RA, at any part of the arm, most frequently in the upper third [5]. The variations of this vessel are usually unilateral [5, 6]. Quain (1844) [7] observed high bifurcation in 61 specimens (61/429), from which only 18 presented the presentation bilaterally (29.5%). The same variation was found in five cases (5/18, 27.8%), while in the rest of the sample (13/18, 72.8%), the variation differed on the two sides.

High bifurcation of the BA might have one of the following types [5, 8]:

- **Type I:** High origin of the RA, while the rest of the BA divides into the RA and CIA. This seems to be the most frequent type, with an incidence of 15% of individuals [1, 5].
- **Type II:** High origin of the UA, while the rest of the BA continues as RA and CIA. This type is rare, with an incidence less than 2% [1, 5], while the UA follows most commonly a superficial course (SUA, 2.7% of the cases [4]). The normal course of the UA was observed only in the 0.33% of the cases [4]. Additionally, any recurrent branches (normally of ulnar origin) must derive from the interosseous artery [5].
- **Type III:** High origin of the CIA or persistent median artery combined with a radioulnar trunk (RUT).
- **Type IV:** RA, UA, and CIA running separately and
- **Type V:** A vas aberrans and normal BA.

The last three types seem to be very rare and their incidence is not recorded in the available literature. There is only one report of high origin of the CIA, which originated in the upper one third of the arm, followed the course of the BA and gave off muscular branches and radial as well as ulnar recurrent arteries [9]. The BA divided into normal UA and RA above the superior border of the pronator teres muscle (RUT). Occasionally, high origin of the CIA may be combined with a superficial brachial artery [10].

The SUA is a well-known but rare anatomical variation of the arteries of the upper limb. Although the SUA is found more frequently unilaterally than bilaterally, its incidence increases when one is already found in the same human individual [5]. The coexistence of a SUA and a normal UA derived from a bifurcation of the BA is extremely rare, with an incidence of 0.16% [4].

Usually, the superficial palmar arch is an anastomosis fed by the UA (mainly) and the RA, which gives off the three common palmar digital arteries [2]. In 20% of the cases, four common palmar digital arteries (one for each web space) may rise from the superficial branch of the UA [2].

In the present case report, high origin of the UA (Type II) was observed on the right side and high origin of the CIA on the left (Type III). The high origin of the UA in the right side was a superficial one (SUA), which seems to be the most frequent form (2.7% of the cases [4]). This variation was combined with an abnormal branching pattern of the CIA, which actually replaced the absent normal UA. The SUA gave branches only for the superficial and deep palmar arches. It should be pointed out that the ulnar recurrent arteries were not observed and that the superficial palmar arch gave four instead of three common palmar digital arteries. This whole pattern seems to be unusual and rare.

High origin of the CIA is extremely rare, as there is only one report in the available literature [9]. In this case, the high origin of the CIA is accompanied by a RUT (see Type III), while in our specimen the common trunk gave off the RA and a SUA. To our knowledge, the combination of this variation with a SUA has never been explicitly described before. The fact that the CIA presented an abnormal branching pattern, replacing (as in the right side) the branches of the normal UA increases the rarity of this variation.

Although high bifurcation of the BA seems to be common, the bilateral occurrence of different forms is rare, as mentioned above. If we take into account that the observed and described bifurcation Types (II and III) are much less common than Type I, their bilateral occurrence might be considered as extremely rare.

According to the current embryological notions, the axillary and brachial arteries are parts of the so-called axial artery of the upper limb, which represents an enlargement of the seventh cervical artery during the limb development of the embryo. A superficial brachial artery is a consistent embryonic vessel coexisting or not with the axial artery, but it usually regresses in the subsequent stages [1, 10]. Its persistence in adult life may quite plausibly engender variations in the brachial and antebrachial arterial pattern [10].

As various surgical and invasive procedures are performed in the upper extremity, the knowledge of arterial variations of this region is very important [6], in order to avoid injury. Inappropriate cannulation in cases of aberrant locations of the arteries of the upper arm can result in thrombosis, gangrene, and even limb loss [6]. These undesired outcomes are due to the smaller diameter and subsequent greater vulnerability of the cannulated artery. Cannulation of the BA is performed for the diagnostic and curative management of many diseases, such as the coronary artery disease, the aortic and peripheral vascular disease, and chronic renal failure [6]. High bifurcation of the BA might cause major clinical implications including high failure rate and decreased functional patency of an arteriovenous fistula [3]. A SUA may be mistaken for a vein due to its decreased functional patency of an arteriovenous fistula [3]. A SUA may be mistaken for a vein due to its clinical implications including high failure rate and decreased functional patency of an arteriovenous fistula [3].

Conclusions

In a cadaveric specimen, we observed an unusual case of bilateral high division of the BA with abnormal
course of the CIA and coexistence of a SUA. A different pattern was followed in each side. More specifically, high origin of the ulnar artery (Type II: The BA sends off a SUA and continues to further divide into the CIA and RA) was observed on the right side and high origin of the common interosseous artery (Type III: CIA and radioulnar trunk) on the left. This variation was combined with an abnormal branching pattern of the CIA, which actually replaced the normal UA. The SUA gave only branches for the superficial and deep palmar arches in both sides. This whole pattern seems to be unusual and rare. Surgeons and interventional radiologists must be familiar with the existence of arterial anomalies, which may complicate their work.

References

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