

Superficial brachial artery – A case report with commentaries on the classification

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ABSTRACT

Variations of the brachial plexus and median nerve relationships with the axillary and brachial artery may be significant to anatomists, radiologists, anesthesiologists, and surgeons. In some cases, the coexistence of anatomical variations of the nerves and vessels may also be a source of conflict between individual structures, e. g., entrapment neuropathy of the median nerve due to atypical (superficial to the nerve) course of the brachial artery.

The presented report describes coexisting anatomical variations in the neurovascular topography within the axillary fossa, arm, forearm, and hand. The presence of the superficial brachial artery originating from the second part of the axillary artery was observed. Atypical common stem for the subscapularis, posterior humeral circumflex, double profunda brachii, and superior ulnar collateral arteries was also found deep to the median nerve roots. In the forearm, the persistent median artery contributing to the blood supply of the hand was exposed. The classification issues were also discussed.

1. Introduction

Typically, the brachial artery is a direct continuation of the axillary artery. The change of name of the upper limb's main axial artery occurs on the lower border of the tendon of teres major muscle [1]. The median nerve occupies an anterolateral position to the brachial artery at its proximal aspect, whereas the medial cutaneous nerve of the forearm and the ulnar nerve occupy a medial position to the artery proximally. In some cases, the brachial artery courses superficially to the median nerve. In those atypical situations, the term "superficial brachial artery" (*arteria brachialis superficialis*) is applied [2]. In the literature, however, there is a discrepancy in both the frequency of superficial brachial artery and the classification used. This variant's incidence differs significantly between literature reports and ranges from less than one percent to 25% [3]. According to Singhal et al. [4], variations of brachial plexus and median nerve relationship with the axillary and brachial artery may be important to anatomists, radiologists, anesthesiologists, and surgeons. In some

cases, the coexistence of anatomical variations of the nerves and vessels may also be a source of conflict between individual structures, e.g., entrapment neuropathy of the median nerve due to atypical (superficial to the nerve) course of the brachial artery [5].

The presented report describes coexisting anatomical variations in the neurovascular topography within the axillary fossa, arm, forearm, and hand. The presence of the superficial brachial artery originating from the second part of the axillary artery was observed. Atypical common stem for the subscapularis, posterior humeral circumflex, double profunda brachii, and superior ulnar collateral arteries was also found deep to the median nerve roots. In the forearm, the persistent median artery contributing to the blood supply of the hand was exposed. The classification issues were also discussed.

2. Case description

The case described in this report was an incidental finding during

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routine dissection of an isolated left female upper limb fixed in 10% of formalin solution with phenol. The dissection of neurovascular structures was carried out following classical gross anatomical dissection methods. The measurements were taken with a Digimatic Caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan).

Dissection within the axillary cavity revealed that the second part of the axillary artery (of 6.13 mm at diameter) was divided into two main arterial trunks (see Figs. 1 and 2). The first trunk had a diameter of 3.3 mm and was a common origin for the subscapularis, posterior humeral circumflex, double profunda brachii, and superior ulnar collateral arteries (Fig. 2). That trunk resembled a rudimentary brachial artery of ordinary (deep to the median nerve) position. The anterior humeral circumflex artery was not present. All arteries branched off from the common stem in the abovementioned order, and the diameter of that vessel decreased gradually. Its direct continuation was the superior ulnar collateral artery, which then pierced the medial intermuscular septum to accompany the ulnar nerve. The second trunk originating from the axillary artery was the superficial brachial artery with 3.7 mm in diameter. The superficial brachial artery arose 230 mm above the inter-epicondylar line of the humerus and 50 mm above the lower border of the tendon of teres major muscle. It was located in front of both medial and lateral roots of the median nerve (Fig. 1). In the arm, the superficial brachial artery ran along the medial border of the biceps brachii muscle, in front of the median nerve. It gave muscular branches to the biceps brachii and brachialis muscles. It was located laterally to the ulnar nerve and superior collateral ulnar artery, from which a medial intermuscular septum separated it.

The superficial brachial artery was divided into the radial and ulnar arteries in the cubital fossa, 35 mm below the humerus inter-epicondylar line of the humerus. A persistent median artery was found in the forearm, accompanying the median nerve. The artery ran within the carpal tunnel on the nerve's anterolateral surface and contributed to the hand's blood supply, giving off the common palmar digital artery to the second intercostal space and a branch to the first lumbrical muscle (Fig. 3). The ulnar artery supplied the other two intercostal spaces. No anastomosis was found between the median and ulnar arteries in hand; thus, the superficial palmar arch was incomplete. The radial artery gave no contribution to the superficial palmar arch. The diameters of the radial, ulnar, and persistent median arteries at the wrist level were 2.11 mm,

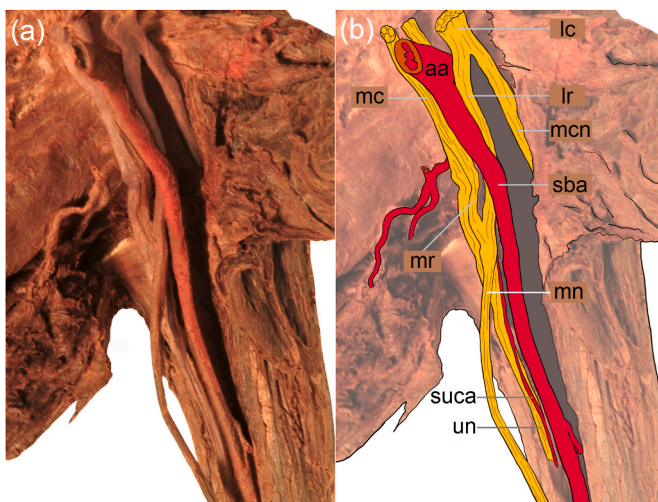


Fig. 1. Anterior view of the left axillary cavity. (a) Anatomical specimen of the superficial brachial artery (sba) and its relation to the brachial plexus. (b) Schematic representation of the main anatomical structures. aa – axillary artery; lc – lateral cord of the brachial plexus; lr – lateral root of the median nerve; mc – medial cord of the brachial plexus; mcn – musculocutaneous nerve; mn – median nerve; mr – medial root of the median nerve; suca – superior ulnar collateral artery; un – ulnar nerve.

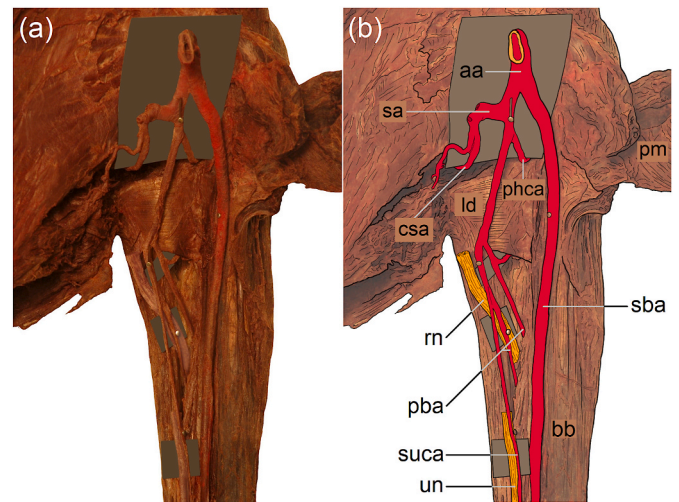


Fig. 2. Anterior view of the left axillary cavity. Brachial plexus is removed. (a) Anatomical specimen of the superficial brachial artery and rudimentary brachial artery of a typical position. (b) Schematic representation of the main anatomical structures. The axillary artery (aa) is divided into two trunks. The first trunk is the common origin for the subscapular (sa), posterior humeral circumflex (phca), double profunda brachii (pba), and superior ulnar collateral (suca) arteries. The second trunk is the superficial brachial artery (sba). bb – biceps brachii muscle; csa – circumflex scapular artery; ld – tendon of the latissimus dorsi muscle; pm – pectoralis major muscle; rn – radial nerve; un – ulnar nerve.

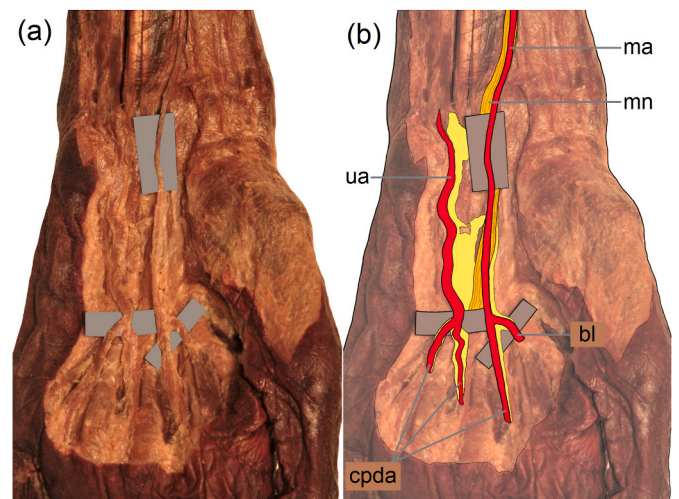


Fig. 3. Anterior view of the left hand. (a) Palmar surface of the hand dissected to expose the carpal tunnel and incomplete superficial palmar arch. (b) Schematic representation of the main anatomical structures. A persistent median artery (ma) travels on the median nerve's (mn) anterolateral surface. The artery gives off the common palmar digital artery (cpda) to the second intercostal space and a branch to the first lumbrical muscle (bl). The ulnar artery (ua) gives off the common palmar digital arteries (cpda) the other two intercostal spaces. No anastomosis exists between the median and ulnar arteries in the hand.

1.78 mm, and 0.97 mm, respectively.

3. Discussion

A large number of possible arterial variations within the upper limb, their separate analysis for the arm and forearm, and different terminological criteria may cause discrepancies in the results for superficial brachial artery reported by different authors [2–17]. For instance, an accessory artery in the arm may occupy a superficial position to the

median nerve due to numerous anatomical variations, which generate terminological problems. Numerous cases involve the presence of an accessory artery superficial to the median nerve; Such an atypical arterial trunk may continue as a radial, ulnar, superficial ulnar, or interosseous artery and rarely gives origin to both radial and ulnar branches [2–12]. Based on the topographical approach, in all the cases mentioned above, the term superficial brachial artery was occasionally used regarding an atypical artery in the arm. Simultaneously, in the forearm, it was renamed based on its location and blood supply territory [2,6]. Rodríguez-Niedenführ et al. [6–8] revisited variations of the arterial pattern in the upper limb and proposed a new approach regarding the terminology of artery located superficially to the median nerve. Based on this proposal, if an accessory artery is present in the arm, it should be named as brachioradial artery (when it continues as a radial artery in the forearm), superficial ulnar artery (for ulnar artery with a high origin, which courses over the superficial forearm flexor muscles), or superficial brachioradial artery (for an accessory, superficial brachial artery dividing at elbow level into radial and ulnar arteries and coexisting with a "normal" brachial artery that continues as the common interosseous trunk in the forearm) [7]. Thus, the term superficial brachial artery should be reserved for particular cases. According to the definition provided by McCormack et al. [2 p. 44], the superficial brachial artery "lies superficial to the median nerve in an abnormal site and forms a common stem of origin for the radial and ulnar arteries." The above-mentioned authors point to the descriptive accuracy of the term "*arteria brachialis superficialis*" [2]. Rodríguez-Niedenführ et al. [6–8] provide a similar definition. According to those authors: "The superficial brachial artery represents a brachial artery, which instead of coursing deep to the median nerve runs in front of it after adopting its superficial course. This variation does not present any further deviation from the norm and at the elbow it branches into the forearm arteries" [6 p. 23].

McCormack et al. [2] observed the superficial brachial artery in eight out of 750 limbs, which made up an incidence of 1.07% of all specimens examined and 5.75% of all upper limb arterial variations. In those series, in only one specimen, the main trunk of the superficial brachial artery arose from the axillary artery and coursed between the median nerve roots, as in our case; In the remaining seven cases, it took origin from the brachial artery [2]. Quain found this variant in one out of 506 limbs [10], while Müller found it in one among 100 specimens [13]. According to Rodríguez-Niedenführ et al. [7], the total incidence of the superficial brachial artery was 18 out of 192 cadavers (9.4%), or 19 out of 384 upper limbs (4.9%) with no statistically significant differences between males and females or right and left sides. The results of cited authors show that the superficial brachial artery adopts its superficial course to the median nerve more frequently below the roots of the nerve [2,7]. De Garis and Swartley [17], in their study on "The axillary artery in white and negro stocks," described several patterns of the axillary artery, including "pattern G" in which the continuation of the axillary artery emerges between the two "heads" of the median nerve to enter the arm as the superficial brachial artery. The cited authors reported an incidence of that pattern to be 11.6 per 1000 for whites and 51.1 per 1000 for black-skinned individuals [17].

In the case described in this report, the superficial brachial artery arose in the axillary cavity and replaced the "normal" brachial artery on its entire course. The remnant of the typical brachial artery was a rudimentary trunk giving origin to some branches of the brachial artery, i.e., profunda brachii and superior ulnar collateral artery. Observed atrophy of the brachial artery located in the normal position is similar to other authors' observations concerning the superficial brachial artery. Yoshinaga et al. [11] described the superficial brachial artery's case in which the remnant of the brachial artery terminated as the inferior ulnar collateral artery. The arterial pattern in that case vary from present finding, as rudimentary brachial artery branched into a muscular branch to the long head of the triceps, a common origin of the profunda brachii and posterior humeral circumflex arteries, superior ulnar collateral

artery, small branches to the biceps and brachialis muscles, and then terminated as the inferior ulnar collateral artery. The remnant of the brachial artery of ordinary course is occasionally described as a branch directing posteriorly from the point in which the superficial brachial artery obtains its superficial course to the median nerve; This branch provides some regular branches of the brachial artery (profunda brachii, superior ulnar collateral, etc.) [7]. Adachi stresses that in some cases, this branch may be thin and special attention must be made to reveal it [14]. Cases contradictory to the superficial brachial artery were also described, in which an aberrant axillary artery descended deep beneath the brachial plexus [15]. The superficial brachial artery is a variant that may be of importance in everyday clinical practice due to the atypical position regarding the brachial plexus and the median nerve [4,5].

Another variation observed in the present case was the independent origin of both terminal branches of the profunda brachii artery (also known as the deep artery of arm or deep brachial artery). According to Bergman et al. [16], in 55% of individuals, the profunda brachii artery arises as a single trunk from the posteromedial side of the brachial artery. However, it may take origin from the third part of the axillary artery (in 16% of cases); It may form a common origin with the subscapular artery (in 19% of cases), it may also arise as a common trunk with the superior ulnar collateral artery (22%) or even anterior or posterior humeral circumflex artery (in 7%) [16]. In the case described in this report, the coexistence of variants mentioned above was observed since there was a common origin for the subscapularis, posterior humeral circumflex, superior ulnar collateral, and doubled profunda brachii arteries. Based on the research of Huelke [18], the posterior humeral circumflex artery takes origin from the third part of the axillary artery in 78.7% of sides, from the subscapular artery in 15.2%, and rarely from any other source. Huelke also described a variation in which the posterior humeral circumflex artery originated from "deep brachial artery" (2.8% of cases); This author clarifies that in such cases, the second part of the axillary artery bifurcated into "brachial" (superficial) and "deep brachial" arteries [18]. De Garis and Swartley [17], as well as P'an [19], found a similar variant in 1.4% and 2.1% of cases, respectively. The anterior humeral circumflex artery may show numerous anatomical variations, and in the report of Huelke was observed absent in 6.2% of cases [18]. Duplication of the profunda brachii is described when the terminal branches of the artery (i.e., radial and middle collateral artery) take their origin separately. Variations of the profunda brachii artery may influence the harvesting of the lateral arm flaps [20].

Anatomical variations may also involve the carpal tunnel [21–25]. Occasionally, the persistent median artery may contribute to the hand blood supply. In those cases, an unexpected arterial trunk is present in the carpal tunnel. The persistent median artery may occupy a variable position to the median nerve. In one of the latest studies, the persistent median artery was found in 5 specimens (4% of the total number of limbs). In the carpal tunnel, the artery occupied the anterolateral position regarding the median nerve in 2 cases, the anterior position in 2 cases, and the anteromedial position in 1 case [20]. According to Bergman et al. [16], the persistent median artery incidence ranges up to 8%. The persistent median artery may contribute to the hand's arterial blood supply and occasionally cause clinical symptoms, including carpal tunnel syndrome [23,25].

3.1. Limitation of the study

The quality of the specimen was influenced by phenol as a preservative. Phenol oxidizes, which causes the brownish color of the specimen. Thus figures show little contrast between anatomical structures. Since the dissection was conducted on a single, isolated upper limb, we could not perform a whole-body study of anatomical variations. Kahn et al. [26] suggest that a whole-body study of arterial variants in a single anatomical donor should be performed. However, in presented report, a detailed description of the combination of neurovascular structures' variants within the upper limb was provided. Reporting anatomical

variations has cognitive value and allows for verification and deepening of existing knowledge [27].

4. Conclusions

Keeping in mind possible atypical relations between the axillary artery and brachial plexus may be necessary during axillary cavity surgical exploration. The possibility of the superficial brachial artery's presence should be considered when planning surgical and anesthesiology procedures. Also, the coexistence of anatomical variations of neurovascular structures may occur, which clinicians should consider.

Ethical statement

N/a

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Declaration of competing interest

None declared.

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