

Unilateral Variation of the Arterial Pattern of the Human Upper Extremity with a Muscle Variation of the Hand

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A unilateral variation in the origin and distribution of the arterial pattern of the human upper extremity on the right side is reported on. Apart from its usual branches, the third part of the right axillary artery gave origin to a common branch, the profunda brachii artery and the superior ulnar collateral artery. The right brachial artery, at a point 5.0 cm distal to its origin, bifurcated into the radial and ulnar arteries; their origin was in a position opposite the usual location. The radial artery continued on the medial side of the arm for 2.5 cm and crossed the ulnar artery anteriorly to gain a lateral position in the arm. The inferior ulnar collateral artery arose not from the brachial artery, but from the ulnar artery. A muscle variation was also observed in the right hand, which is compatible with the notion variations within one system of a limb will frequently be accompanied by variations in other systems of the same limb.

Key words: axillar artery, brachial artery, arterial variation

Accurate knowledge of the normal and variant arterial pattern of the human upper extremities is important both for reparative surgery and for angiography. There have been many reports regarding arterial variations of the upper extremities (1, 2). Some reports are concerned only with single example of unusual patterns (3, 4). To the best of our knowledge, no pattern such as the one described herein has been reported previously.

Subjects and Methods

A dissection was made of both upper extremities and

axilla of a 70-year-old male cadaver. The variation in the arterial pattern and muscle was only present on the right side. Several small branches of the brachial plexus had been lost by the time the students brought the variation to the attention of the author. The nomenclature used here is the English version of the Paris Nomina Anatomica and is consistent with that of Gray's Anatomy, 38th edition.

Results

The course and distribution of the first and second parts of the right axillary artery were normal. The branches of the brachial plexus surrounded the third part of the axillary artery: Lateral to the third part of the axillary artery were the lateral root and then the lateral trunk of the median nerve and, for a short distance, the musculocutaneous nerve. The musculocutaneous nerve continued downward for 4 cm and here, it joined with the median nerve. Medial relations were the medial cutaneous nerve of the forearm, the ulnar nerve and the medial cutaneous nerve of the arm. The radial and axillary nerves were the posterior to the artery. The medial root of the median nerve crossed anteriorly to the artery (Fig. 1a). Besides its usual branches, the third part of the axillary artery gave off three branches: a) The common branch arose from the posterolateral aspect of this part 4.0 cm distal to the origin of the anterior circumflex humeral artery and lay on the anterior aspect of the radial nerve. It reached the inferior border of the tendon of teres major and then passed through the long and lateral head of the triceps. There, it divided into three terminal branches: the periosteal branch for the humeral shaft, the muscular branch for the long and lateral head of triceps, and the descending branch passing under to the lateral head of triceps. b) The profunda brachii artery, the second un-

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usual branch, arose from the third part of the axillary artery just distal to the common branch. It followed the radial nerve closely, at first back between the long and lateral heads of triceps and then, in the nerve groove where it divided into several muscular branches and a descending branch. The vessel had neither a middle collateral nor a radial collateral artery. c) 2.5 cm distal to the origin of profunda brachii artery, the superior ulnar collateral artery arose, and coursed inferiorly by accompa-

nying the ulnar nerve. This artery terminated by anastomosing with the anterior ulnar recurrent artery at the elbow (Figs. 1a, 2a and 3).

The brachial artery began at the inferior border of the tendon of teres major as a continuation of the axillary artery in the usual way. It divided into the radial and ulnar arteries about 5.0 cm distal to its origin where the musculocutaneous nerve gave off the muscular branches to the brachialis and biceps brachii muscles after it pierced

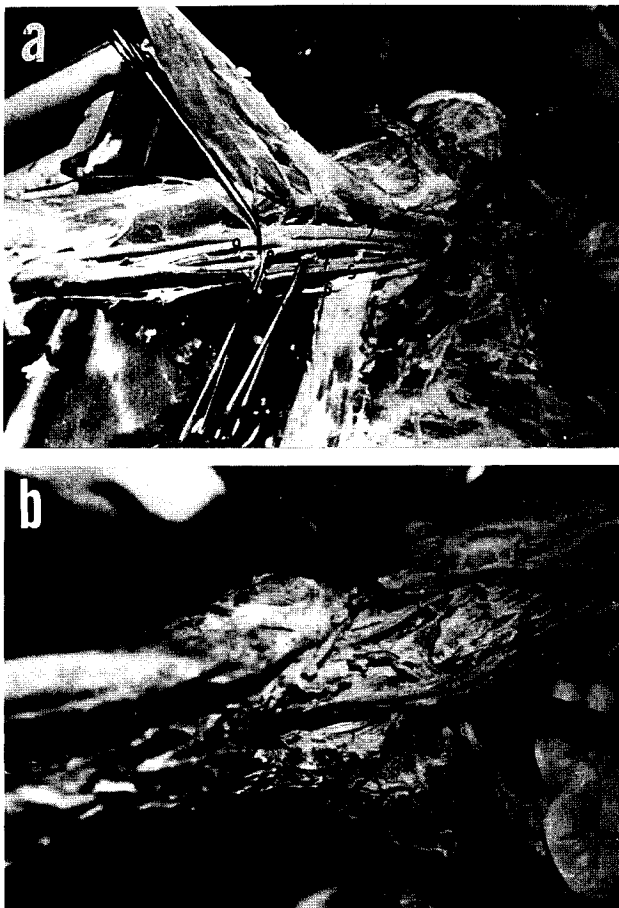


Fig. 1 Anterior view of the right upper extremity. **a)** The relationship between vessels and nerves in the axilla and upper arm. 1: Axillary artery; 2: Median nerve; 3: Musculocutaneous nerve; 4: Profunda brachii artery with radial nerve; 5: Medial cutaneous nerve of the forearm; 6: Medial cutaneous nerve of the arm; 7: Ulnar nerve; 8: Radial artery; 9: Ulnar artery. **b)** The relationship of the vessels to the nerves in the distal arm and proximal forearm: The ulnar artery was retracted medially. 1: Median nerve; 2: Ulnar artery.

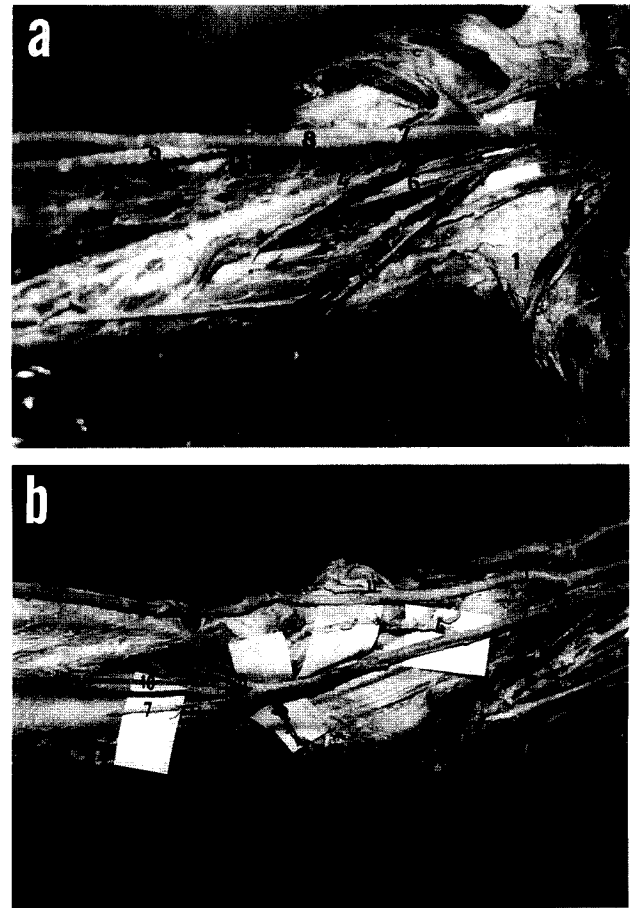


Fig. 2 **a)** Anterior view of the right arm. 1: Latissimus dorsi muscle; 2: Long head of triceps; 3: Lateral head of triceps; 4: Coracobrachialis; 5: Profunda brachii artery; 6: Radial nerve; 7: Brachial artery; 8: Radial artery; 9: Ulnar artery; 10: Superior ulnar collateral artery. **b)** Anterior view of the distal arm and proximal forearm. 1: Radial artery; 2: Ulnar artery; 3: Inferior collateral ulnar artery; 4: Common branch of the ulnar artery (muscular and nutrient branches); 5: Anterior ulnar recurrent artery; 6: Ulnar artery; 7: Nutrient artery; 8: Common interosseus artery; 9: Posterior interosseus artery; 10: Anterior interosseus artery; 11: Radial recurrent artery.

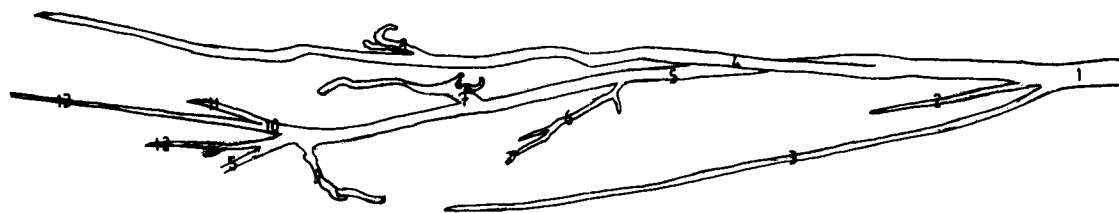


Fig. 3 Schematic representation of the vessels of the right upper extremity. 1: Brachial artery; 2: Profunda brachii artery; 3: Superior ulnar collateral artery; 4: Radial artery; 5: Ulnar artery; 6: Inferior collateral ulnar artery; 7: Common branch of the ulnar artery (muscular and nutrient branch); 8: Radial recurrent artery; 9: Anterior ulnar recurrent artery; 10: Common interosseus artery; 11: Posterior interosseus artery; 12: Nutrient artery; 13: Anterior interosseus artery.

the coracobrachialis. The radial artery originated from the medial side of the brachial artery. It descended laterally to the ulnar nerve for about 2.5 cm and then crossed obliquely/anteriorly to the ulnar artery to reach the lateral side of the arm; there it passed between the biceps and brachialis muscles (Figs. 1b and 2b). Along its course in the arm, it was medial to the median nerve. The vessel did not have any branches in the arm and no difference was observed in its course and distribution in the forearm. The ulnar artery began as the lateral terminal branch of the brachial artery. At first, it coursed medial to the median nerve, then it continued in an arciform manner medially and maintained this position along its entire course. The ulnar artery and the ulnar nerve were closely apposed in the lower two-thirds of the forearm, with the artery on the lateral side. The inferior collateral ulnar artery arose from the ulnar artery 10.0 cm proximal to the elbow. This artery gave off an ascending branch supplying the biceps muscle, and a descending branch dividing into two terminal branches. One of them, the anterior branch, passed under the brachialis muscle and distributed branches to the front of the elbow joint. The second, the posterior branch, supplied the articular capsule of the elbow joint via a small ramus and terminated by anastomosing with the interosseus recurrent artery (Fig. 2b).

A common branch which was crossed anteriorly by the median nerve arose from lateral side of the ulnar artery near the elbow joint and sent two muscular branches to the biceps muscle and a nutrient ramus to the radius. The nutrient artery supplying the ulnar shaft arose from the medial side of the ulnar artery near the origin of the common interosseus artery. The common interosseus artery gave off its normal branches, except for the posterior interosseus artery. They were in a normal relationships to the nerves (Figs. 1b and 2b). No vessel identi-



Fig. 4 Variant muscle in the right hand.

able as the posterior ulnar recurrent artery was observed.

The arterial patterns of both hands of this specimen were completely normal, but in the right hand, there was an extra quadrilateral muscle that arose under the palmaris brevis from the pisiform bone to the flexor retinaculum (Fig. 4).

Discussion

The arterial pattern of this specimen is different from other reported arterial variations, because (a) the profunda brachii and the superior ulnar collateral arteries arose from the third part of the axillary artery instead of the brachial artery, (b) there was a significant difference in the origin and the proximal course of the radial and ulnar arteries, (c) the inferior collateral ulnar artery arose from the ulnar artery, (d) there was common branch formation

of the axillary and ulnar arteries, and (e) all arterial variations of the present case have never been observed previously in a single specimen. The present case is similar to the case reported by Adachi (1) but it is not entirely the same.

In the case described by Maraspin (3), both the profunda brachii artery and the superior ulnar collateral artery arose from the common trunk of the deep brachiothoracic artery, and this artery was considered as a branch from the anomalous bifurcation of the second part of the axillary artery. In the present case, the first and second parts of the axillary artery were completely normal. The profunda brachii and superior ulnar collateral artery directly arose from the third part of the artery.

High division of the brachial artery is not uncommon (5-7). In other reported cases, the brachial artery bifurcated in the following ways: (a) the radial artery most commonly arose high up as a single branch, leaving the ulnar artery to follow its normal course and distribution (2, 5, 6, 8), (b) less commonly, the ulnar artery arose high up as a single branch, and since its course generally was superficial, it was known as the superficial ulnar artery (5, 6, 8, 9), (c) the superficial brachial artery arose from the brachial or the axillary artery and divided into the radial and ulnar arteries either above or below the elbow joint (3, 6, 10), and (d) the brachial artery divided into two equally sized arteries and one of them divided farther into the radial and ulnar arteries at the elbow joint (11).

The chief difference in the present case is that the brachial artery terminated after 5.0 cm by dividing directly into the radial artery as a medial branch and the ulnar artery as a lateral branch. The further difference is in the proximal course of these arteries. Since their course through forearm was not changed, both terminal branches may not be regarded as superficial arteries.

Trunk formation of some branches is the most frequently observed anomaly, occurring in 50 % of cases (10). There also was common branch formation in this case.

Normally, in embryos of about 11 mm length, the seventh cervical intersegmental artery enlarges and becomes the dominant vessel of axilla. C6, C7 and T1 segmental arteries and most of the longitudinal anastomoses which link up the intersegmental arteries degenerate slowly. The numerous alternatives that exist during the formation of upper limb vessels seem to be responsible for anomalous arterial branching patterns (6, 7, 9, 10). The close relationship between the bundles of bra-

chial plexus and the axial artery during the development underlies the morphogenesis of vascular and nervous anomalies. In the present case, the bundles of brachial plexus and their relationship with the axillary artery and branches of the axillary artery shows that the axillary artery of this case normally derived from the seventh cervical intersegmental artery. The proximal course of radial artery represents the remnants of the longitudinal anastomoses between the seventh and eighth cervical intersegmental arteries. The ulnar artery of this case may be regarded as the direct continuation of the brachial artery. The presence of arterial variation in the right upper extremity of this specimen is consistent with previously published reports by McCormack *et al.* (6), Janevski (12), and Uglietta and Kadir (2) which stated that the arterial variations exist on the right side more frequently than on the left side.

Variations of muscles and nerves that occur in conjunction with major arterial variations have been observed by other investigators (9, 10, 13). Caplan and Koutroupas (14) also stated that the vasculogenesis of the limb is a significant factor for mesenchyme differentiation into muscle and bone. It is interesting to note that muscle variation in the right hand was also present in this specimen. Besides its anatomical and embryological implications, this arterial variation is of practical importance. In angiographic studies, high division of the brachial artery and anomalous origin of its branches may lead to accidental injection of the contrast solution into the radial or the ulnar arteries. The resultant misleading images could lead to erroneous diagnosis and improper intervention or surgical treatment (2, 4-6).

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Received February 16, 1998; accepted October 19, 1998.