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The Superficial Ulnar Artery: Development and Surgical Significance

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The upper limbs of 72 formalin-fixed human cadavers were examined by dissection for arterial anomalies. In one subject, the ulnar artery was noted to be a branch of the second part of the axillary artery on both right and left sides. It ran a superficial course in the arm, crossed the elbow immediately subjacent to the median cubital vein, and continued its course in the forearm in a subcutaneous position. In the hand it played a dominant role in the formation of the superficial palmar arch. The anomalous ulnar artery was of a smaller caliber than both the radial and common interosseous arteries.

Although superficial ulnar arteries have been reported in the literature, the combination of bilateral superficial ulnar arteries originating from the axillary arteries appears to be rare. The developmental and surgical significance of the findings are discussed.

Key words: upper limb, anomalous ulnar artery

INTRODUCTION

Normally, the ulnar artery begins distal to the bend of the elbow as the larger of the two terminal divisions of the brachial artery. It runs deep to the antebrachial flexor muscles and then superficial to the flexor retinaculum. The artery ends by forming the superficial palmar arch with a contribution from the superficial branch of the radial artery. The arch gives palmar digital branches to the medial three fingers and also to the medial half of the index finger. The lateral aspect of the index finger and the thumb normally receive their arterial supply from the radial artery through the radialis indicis and the princeps pollicis arteries, respectively (Hollinshead, 1971).

In a meticulous review of arterial aberrations of the upper limbs of human fetal and adult cadaveric material, Adachi (1928) reported anomalous arteries in 17 upper limbs out of 200 fetuses studied. Fifteen of these anomalies were superficial ulnar arteries, while the remaining two were arteries accompanying the median nerve through the carpal tunnel (median arteries). Out of 1,537 adult upper limbs reviewed, there were 20 cases of superficial ulnar arteries, eight cases of median arteries, and five other supernumerary vessels. Generally, the anomalous ulnar arteries ran deep to the bicipital aponeurosis and became superficial only in the forearm. Adachi (1928) and McCormack et al. (1953) observed that the superficial ulnar artery in a small number of subjects arose proximal to the elbow. In these circumstances, the brachial artery was more often its source than the axillary artery. The aberrant artery was then usually superficial to the flexors of the forearm under the deep fascia. It was rarely subcutaneous (De Garis and Swartley, 1928; Hazlett, 1949).

In a series of 480 subjects studied, Miller (1939) did not see anomalous ulnar arteries on either side of the body. Corroborative information reported by Hazlett (1949) suggested that bilateral superficial ulnar arteries were uncommon. Richards et al. (1993) reported three cases in which the ulnar artery (at the wrist) was superficial to the palmaris brevis muscle at the level of Guyon's canal.

Variations of the superficial palmar arch were reported by Dubreuil-Chambardel (1926) and Mozersky and associates (1973). Both studies correlate well and emphasize the importance of understanding these variations for the purposes of microvascular repair and reimplantation.

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The ulnar artery may be involved in cutwounds, intra-arterial injection (Hazlett, 1949), aneurysms (Haesler et al., 1994), and occlusions (Monstrey and Jones, 1994; Zimmerman et al., 1994). Fatah et al. (1985) found that a superficial ulnar artery originating from the brachial artery could be at risk of injury when raising radial forearm free flaps. The use of ulnar artery free flap to repair defects in some surgical operations was found to be more favorable than the radial artery free flap (Christie et al., 1994). Owing to its surgical importance, variations of the ulnar artery merit description.

MATERIALS AND METHODS

Seventy-two randomly selected cadavers assigned to medical students for dissection were studied. All had been embalmed soon after death with a mixture of 10% formaldehyde, glycerol, methylated spirits, and 10% phenol in water. The topography of the upper limb arteries of all the cadavers was examined during dissection and those showing anomalies were recorded and described. The diameters of the arteries were also measured by means of Vernier calipers.

RESULTS

In one cadaver, the brachial artery terminated at the elbow, by dividing into radial and common interosseous arteries (Fig. 1). Bilateral abnormal ulnar arteries showing variations in many aspects were seen in this subject out of the 72 examined. On each side, the artery arose from the anterior aspect of the second part of the axillary artery deep to the pectoralis minor muscle (Fig. 2). Its origin was between those of the acromio-thoracic artery proximally and the posterior circumflex humeral artery distally (Fig. 3).

The nerve loop formed by the union of the medial and lateral roots of the median nerve was located in the angle between the anterior surface of the second part of the axillary artery and the beginning of the anomalous ulnar artery (Figs. 2, 3). From its origin, the artery descended on the medial side of the arm, superficial and medial to the proximal part of the median nerve. It then pierced the deep fascia and continued its descent subcutaneously, running on the medial aspect of the distal part of the belly of the biceps brachii muscle (Fig. 4A). The ulnar artery remained subcutaneous throughout its course in the arm and forearm, running in the same plane as the superficial veins. It crossed the elbow superficial to the bicipital aponeurosis and immediately subjacent to the median cubital vein (Fig. 4). The artery continued

Fig. 1. Dissection of the right cubital fossa showing the terminal part of the right brachial artery (a) at the elbow, dividing into radial (b) and common interosseous (c) arteries. No ulnar artery is seen here.

distally, inclining medially, superficial to the flexor muscles of the forearm (Figs. 3, 5, 6). It crossed the pronator teres and flexor carpi radialis muscles and ran superficial to the flexor digitorum superficialis muscle. The palmaris longus muscle was absent on both sides in this subject (Fig. 6). The ulnar nerve in this subject was not accompanied in its course in the forearm by an artery.

At the wrist, the superficial ulnar artery followed a course that was typical of the ulnar artery. The ulnar nerve was medial to it. The artery passed lateral to the pisiform bone between the superficial and deep layers of the flexor retinaculum. Its carpal branches were given off at this point. The ulnar artery and nerve then passed into Guyon's canal, deep to the palmaris brevis muscle. Each divided into superficial and deep branches distal to the palmaris brevis. The superficial branch of the ulnar artery anastomosed with the superficial palmar branch of the radial artery to form the superficial palmar arch. The branches of the arch were distributed to the little, ring, middle, and medial half of the index fingers through palmar digital branches.

Fig. 2. Photograph showing the origin of the left superficial ulnar artery (▶) from the axillary artery (a) between the origins of the acromiothoracic artery (*) and the posterior circumflex humeral artery (c). The loop formed by the union of the medial (m) and lateral (l) roots of the median nerve is located in the angle between the ulnar artery and the axillary artery. p, pectoralis minor muscle; n, median nerve; b, posterior cord of brachial plexus.

Fig. 3. Diagram illustrating the origin, course, and termination of the superficial ulnar artery as shown in Figs. 2, 4A, 5, and 6. The proximal part of the median nerve (n) is deep and lateral to the artery (→). a, axillary artery; c, bicipital aponeurosis; u, ulnar nerve; p, palmaris brevis muscle.

The artery to the radial side of the index finger (radialis indicis artery) also arose from the lateral part of the superficial palmar arch (Fig. 6).

Caliber of the Anomalous (Superficial) Ulnar Artery

Near its origin, the ulnar artery measured about 2.5 mm in diameter. In the forearm it was about 1.5 mm compared with the radial artery, which was 3 mm in diameter (Fig. 5). The dimensions of the ulnar and radial arteries were comparable on the right and left sides.

DISCUSSION

There have been few previous reports of superficial ulnar arteries. Evidence suggests that these anomalous arteries are highly variable topographically (Hollinshead, 1971).

Adachi (1928) gave the incidence of superficial arteries as 3.3 ± 0.58% on the right side and 2.0 ± 0.46% on the left side. Thirty-five of 50 cases of superficial arteries identified in the upper limb were ulnar artery anomalies. Twenty-one of these were right-sided anomalies, while 14 were on the left side. McCormack et al. (1953) reported that the incidence of superficial ulnar arteries in their series was 2.26%. Out of this, one-third of the subjects had ulnar arteries originating from the axillary artery. They did not report bilateral superficial ulnar arteries. The present observation adds to the range of variations of the superficial ulnar arteries, by demonstrating the rare situation in which the artery begins from a very high origin bilaterally and runs subcutaneously. Moreover, on both sides, the ulnar artery had a dominant role in the formation of the superficial palmar arch.

Developmentally, the upper limb bud is initially supplied by a vascular plexus derived from four or five

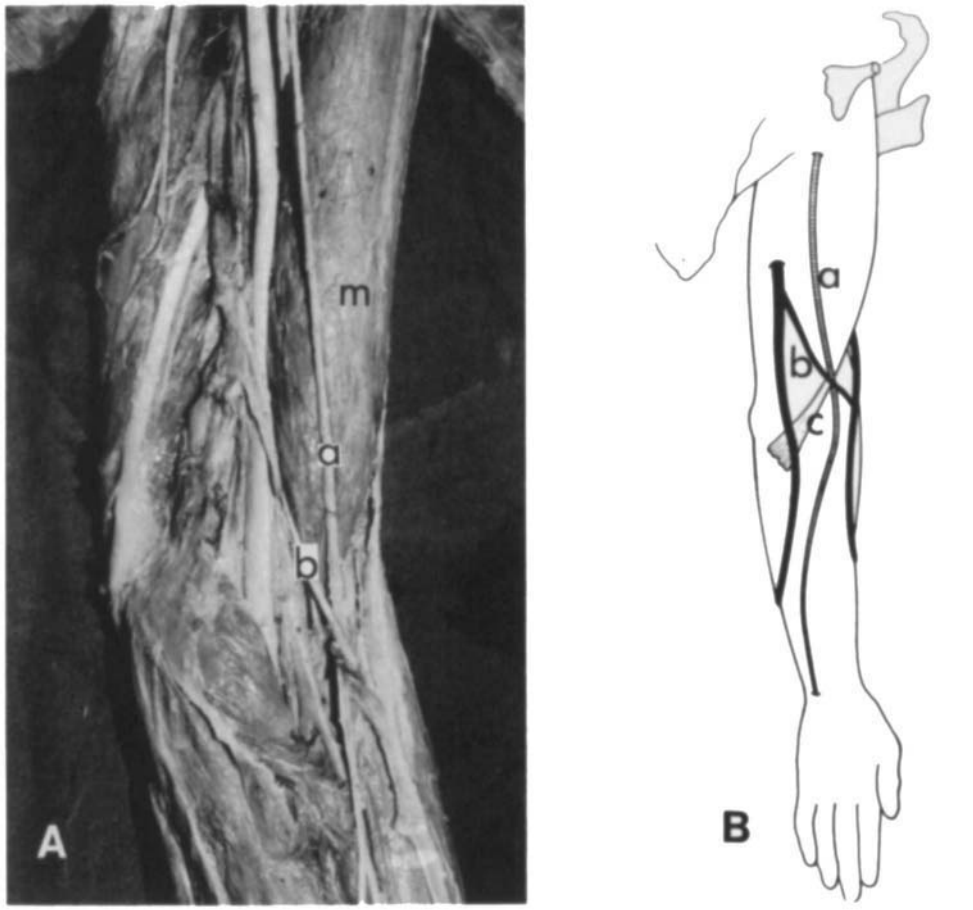

Fig. 4. **A:** Photograph showing the close relationship of the superficial ulnar artery (a) and the median cubital vein (b). m, biceps brachii muscle. **B:** Diagram showing the main features of A. The artery runs in the same plane as the superficial veins. Note that at the elbow, the superficial ulnar artery (a) is sandwiched between the median cubital vein (b) and the bicipital aponeurosis (c).

consecutive intersegmental branches of the dorsal aortae. Very early in development, the seventh cervical intersegmental branch enlarges and becomes consolidated as the main artery (axis artery) to the developing upper limb bud. This axis artery gives rise to the subclavian, axillary, brachial, and interosseous arteries and to the deep palmar arch. Other arteries of the upper limb develop as sprouts of the axis artery (Arey, 1966; Patten, 1968; Allan, 1969; Hamilton and Mossman, 1972). As a result of genetic and hemodynamic factors, most of the interconnecting channels of the vascular plexus disappear. The ulnar artery develops from persistence of channels on the postaxial border of the distal segment of the limb bud. This is followed later by the formation of the radial artery from the preaxial channels (Allan, 1969). Anomalies in the formation of these vessels are common. This may result from persistence of channels that should normally be obliterated or from a choice of unusual paths in the primitive vascular plexuses (Arey, 1966).

The ulnar arteries in the present subject clearly appeared to have resulted from a combination of both factors. It is intriguing that the anomaly was present bilaterally. Clearly, the hemodynamic factors prevailing at the time of the development of the limbs favored the choice and persistence of these channels. The reasons for this are not clear. Genetic factors and limb position at the time of angiogenesis are probable contributory causes.

Vascular anomalies occurring in common surgical sites tend to increase the likelihood of damage during surgery. Owing to its unusual origin in the axilla and its subcutaneous course, the superficial ulnar artery would be particularly vulnerable in surgical procedures within the axilla. In the present subject the ulnar artery was immediately subjacent to the median cubital vein. This would predispose the vessel to inadvertent penetration during attempts at venipuncture of the median cubital vein.

Fig. 5. Photograph showing the superficial palmar arch supplying the medial four fingers, including the lateral aspect of the index finger (arrow). The superficial ulnar artery in the forearm (a) passes superficial to the flexor digitorum superficialis, to join the ulnar nerve (*). b, superficial palmar branch of the radial artery.

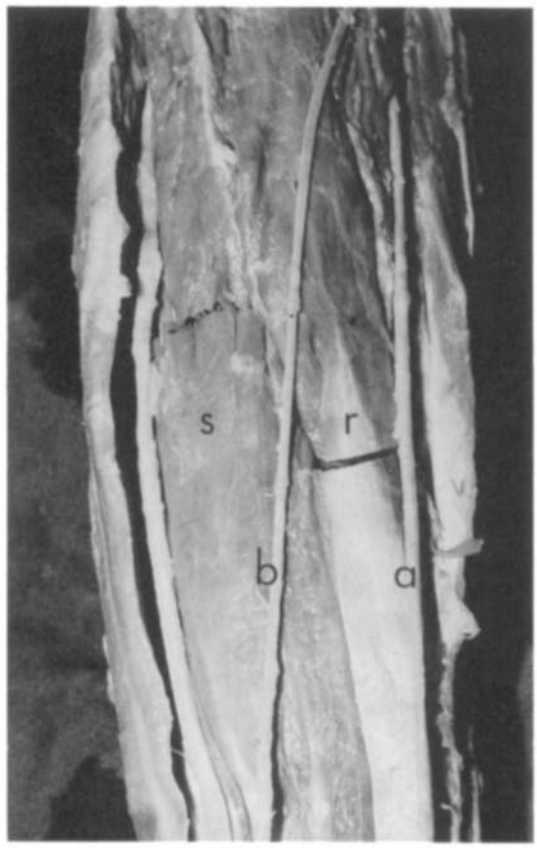

Fig. 6. Photograph of the ventral aspect of the left forearm showing the difference in caliber of the radial artery (a) and the ulnar artery (b). r, flexor carpi radialis; s, flexor digitorum superficialis.

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