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A rare constellation of multiple upper limb anomalies

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We describe an unusual combination of unilateral upper limb variations, including an axillary arch, absence of a "typical" musculocutaneous nerve, direct lateral cord innervation of the muscles usually supplied by the musculocutaneous nerve, variant superficial brachial artery, a high anomalous origin of the common interosseous artery and a superficial ulnar artery noted during routine cadaver dissection. The embryological basis, recent molecular insights concerning such a constellation of anomalies and its clinical relevance are discussed. (Folia Morphol 2008; 67: 236–239)

Key words: anomalies, axillary arch, superficial brachial artery, superficial ulnar artery, upper limb

INTRODUCTION

Information about variations in the arteries, nerves and muscles of the upper limb has academic as well as clinical and surgical relevance. Deviation in the progression of the normal stages of limb formation may result in multiple anomalies. The cases with multiple variations, although rare, need to be examined and operated upon with extra care, especially during reconstructive procedures.

MATERIAL AND METHODS

During routine dissection of a 70-year-old male cadaver multiple unilateral upper limb anomalies were noted on the right side.

RESULTS

In the axilla a fusiform musculotendinous slip arose from the upper third of the latissimus dorsi with an aponeurotic insertion into the fascia between the pectoralis major and biceps brachii, forming an axillary arch (Fig. 1, 2).

Two direct branches of the lateral cord, which arose at a distance of 4 and 6 cm respectively, distal to the coracoid process, innervated the coracobrachialis. The lateral cord, before continuing as the median nerve, gave off a branch, which bifurcated at the level of the upper third of the arm. While one branch supplied the biceps brachii, the other divided at the level of insertion of the coracobrachialis to supply the brachialis and continue in the forearm as the lateral cutaneous nerve of the forearm (Fig. 1, 2).

The axillary artery continued as the brachial artery at the lower border of teres major. The brachial artery, after giving off the profunda brachii artery distal to teres major, followed an unusual course. It bifurcated into a "superficial" branch in the upper third of the arm, which ran anterior to the median nerve (Fig. 1, 2). In the cubital fossa, this "superficial brachial artery" divided into a normally positioned radial artery and a "superficial" ulnar artery, which continued over the flexors without giving off any branches. When 2 cm proximal to the wrist, the "superficial" ulnar artery crossed posterior to the palmaris longus tendon to lie lateral to the ulnar nerve, with which it entered Guyon's canal and took part in the formation of "normal" palmar arches (Fig. 3).

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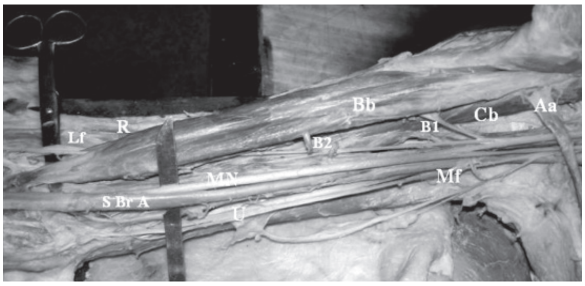

Figure 1. Dissected specimen of the right axilla and arm showing axillary arch (Aa) crossing over the lateral cord of the brachial plexus and the medial cutaneous nerve of the forearm (Mf). The lateral cord is seen giving rise to a branch, which bifurcated, into B1 and B2. The median nerve (MN) is seen crossing to go under the brachial artery making it superficial (SBrA); Bb — biceps brachii; R — radial nerve; Lf — lateral cutaneous nerve of the forearm; Cb — coracobrachialis; U — ulnar nerve.

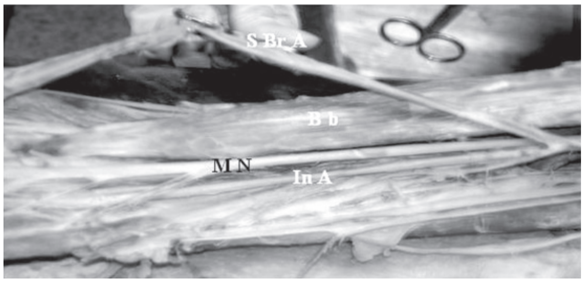

Figure 4. Specimen of the right arm showing the "duplicated" superficial brachial artery (SBrA) arising from the brachial artery in the middle of the arm and running anterior to the median nerve (MN), which has been freed, from the brachialis; Bb — biceps brachii; InA — common interosseous artery.

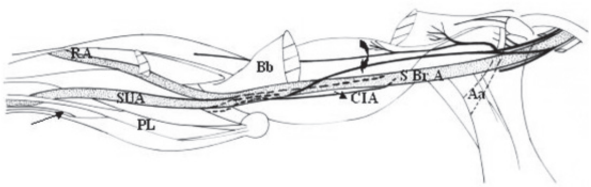

Figure 2. Diagrammatic representations of the multiple anomalies of the upper limb; Aa — axillary arch; SBrA — superficial brachial artery; CIA — common interosseous artery; Bb — biceps brachii; SUA — superficial ulnar artery; RA — radial artery; PL — Palmaris longus; curved arrow — median nerve; straight arrow — ulnar nerve.

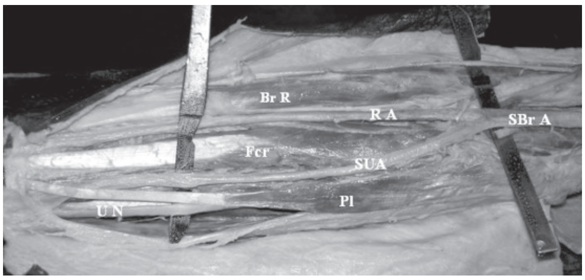

Figure 3. Forearm specimens showing the superficial ulnar artery (SUA) running superficial to the forearm flexors; Pl — Palmaris longus; Fcr — flexor carpi radialis; Br — brachioradialis, SBrA — superficial brachial artery; UN — ulnar nerve.

The "deeper" brachial artery ran posterior to the above-mentioned neurovascular bundle and entered the forearm as the common interosseous artery (Fig. 4). This vessel ran posterior to the pronator teres (a position usually occupied by the ulnar artery) and gave rise to the anterior and posterior ulnar recurrent arteries as well as the muscular branches of the muscles of the medial part of the forearm. Further distally it divided into its anterior and posterior interosseous arteries.

The remainder of the right upper limb was normal. The left upper limb was remarkably devoid of any abnormalities.

DISCUSSION

We found an unusual combination of unilateral muscular, neural and arterial variations in an upper limb: an axillary arch, absence of the "typical" musculocutaneous nerve, direct lateral cord innervation of the muscles usually supplied by the musculocutaneous nerve (coracobrachialis, biceps brachii and brachialis) and a duplication of the brachial artery. Other authors have also reported multiple variations in the upper limb [3, 18, 19] but such a combination of variations involving the arteries, nerves and muscles is unique.

Although a muscle of no definite known function or use, Langer's muscle or "axillary arch" is frequently described in the literature, and its variability in occurrence, description and nerve supply are well documented. Its presence in the axilla may reportedly be a potential cause of neurovascular compression and a hindrance to surgical exploration of the axilla and to lymph node dissection, as well as to differential diagnosis for an axillary swelling [1, 8, 21].

The musculocutaneous nerve, a branch of the lateral cord of the brachial plexus commonly supplies the coracobrachialis, pierces it and then courses lateral to the brachial artery in the arm. It gives out muscular branches to the brachialis and biceps brachii and continues as the lateral cutaneous nerve of the forearm. In our case a "typical" musculocutaneous nerve piercing the coracobrachialis was absent; however the muscles of the front of the arm were innervated by direct branches of the lateral cord. Variability in the course of the musculocutaneous nerve [22] and absence of the musculocutaneous nerve with a median nerve supplying the coracobrachialis, biceps brachii and brachialis have been reported [7, 14]. Nakatani et al. have reported an isolated anomaly similar to that observed by us, in which the musculocutaneous nerve is absent and the lateral cord supplies the coracobrachialis, biceps brachii and brachialis, giving rise to the lateral cutaneous nerve [10]. Koizumi [9] believes that the coracobrachialis is a composite muscle, which has at least two separate innervations, and that a change in the composition of the muscle altered the course of the musculocutaneous nerve. In his observation of 240 arms, only in extreme cases when the superficial part of the coracobrachialis was absent, did the musculocutaneous nerve not pierce the coracobrachialis.

Knowledge of the anatomical variations of the nerves has considerable clinical value, especially in the era of minimal access surgery, with smaller incisions reducing the scope of unforced errors. For instance, detailed knowledge of the brachial plexus is imperative for performing arthroscopy and safe surgeries in the management of fracture dislocations of the shoulder [2]. Similarly, flap dissections may be jeopardised by unexpected nerve variations, which can, potentially, lead to inadvertent nerve damage, especially in the hands of a surgeon unfamiliar with such variations.

The variations in the number, origin and course of the arteries, apart from generating interest among anatomists, are essential for surgeons, especially traumatologists and radiologists, in preventing complications during surgical and radiological procedures. In the present case, the variation noted corresponds to a "duplicated brachial artery" as described by Rodríguez-Niedenfuhr et al. [15]. In an extensive meta-analysis of 384 upper limbs, Rodriguez-Niedenfuhr M et al. [16, 17] re-classified upper limb arterial variations into seven different subtypes. Our noted variation does not exactly fit any one subtype mentioned. The "superficial brachioulnar artery" has been defined as a superficial ulnar artery with a high origin from the brachial/ superficial brachial artery, co-existing with the normal arterial pattern. The brachial artery then forms the radial and common interosseous divisions [16, 17]. The arterial anomaly noted by us does not fit the aforementioned definition, as (a) the site of the branching of the ulnar artery is normal, and (b) the radial arose from the superficial brachial artery, while the deeper branch alone continued as the common interosseous artery. Contrastingly, in the superficial brachioulnoradial artery group, both the radial and the ulnar artery lie over the superficial forearm flexors as also noted by D'Costa et al. [4].

This superficial brachial artery, generally visible under the skin surface, is easily palpated and readily recognisable on arteriography. Awareness of these anatomical variations helps prevent inadvertent disaster. Rodriguez-Niedenfuhr et al. [16, 17] included the "superficial ulnar artery group" under the superficial brachio-ulnar group, as most reports of the superficial ulnar artery reported a high origin (proximal brachial artery/axillary artery) [11, 12]. Yazar et al. [23], however, also noted a normally sited origin of a superficial ulnar artery (at the elbow) as seen in present case. It is reported that the incidence of the superficial ulnar artery ranges from 0.7% to 9.4% and that it is more common in Indians [5]. Complications following a mistaken intra-arterial injection into the superficial ulnar artery instead of an intravenous injection have been well described in the literature [6, 11]. Early detection of the superficial ulnar artery, on the other hand, can be useful in raising a forearm flap with neurosensory potential [5]. The superficial ulnar artery may even be useful in creating a distal arteriovenous fistula in patients requiring maintenance haemodialysis after failure of a radiocephalic shunt.

The details of the embryological mechanism for the formation of the arterial trunks in the limbs are not as yet clear. Various theories have been proposed for the morphogenesis of the arteries of the upper limb, involving the primitive axial artery and the superficial brachial artery. In 1995 Rodríguez-Niedenfuhr et al. [15] postulated that the superficial brachial artery was consistent in its development and formed anastomotic channels with the deep axial artery. Deep haemodynamic predominance caused the superficial arterial systems to regress, and the persistence of these anastomoses resulted in variations in the brachial and antebrachial artery. This explanation is in agreement with the proposal of Singer [20].

The selection and regression process of the capillary network which developed during embryogenesis of the limb [16] and, more recently, the programmed migration of primordial epithelial cells, routing themselves in a manner similar to the nerves, are other published proposals for the arterial development in the limbs. Blood vessels and nerves often follow parallel courses, thereby suggesting that distal targets probably use common cues that induce vascularisation and innervation. Netrin-1 is a secreted neural guidance cue with the unique ability to attract both blood vessels and axons, and any alterations may affect vascular and neural trajectories [13]. However, the molecular cascades of nerve and vascular pattern interactions needed to explain a constellation of derangements such as that reported in the present study are still far from understood.

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