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Anatomical variations of the median nerve distribution and communication in the arm

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Anatomical variations of peripheral nerves constitute a potentially important clinical and surgical issue. The aim of this work is to study the variations of the median nerve in the arm with respect to its branching pattern and distribution as well as its possible communication with the musculocutaneous and/or ulnar nerves. Sixty arms pertaining to 30 preserved human cadavers, ranging in age from 30 to 67 years, were dissected in pursuit of this aim. In one limb out of 60 (1.7%) the median nerve gave off muscular branches to the brachialis muscle as well as a branch from its lateral root to supply both heads of the biceps brachii muscle. Concomitantly the musculocutaneous nerve was absent. The same limb demonstrated a branch from the lateral cord of the brachial plexus supplying the coracobrachialis muscle. Three limbs (5%) showed a communicating branch between the median and the musculocutaneous nerves. These observations should be considered when a high median nerve paralysis is shown to originate in the axilla or proximal arm in a patient presenting with weakness of forearm flexion and supination. Similarly, it can explain weakness of the arm flexor muscles in thoracic outlet syndrome with median nerve affection.

Key words: median nerve, variations, communicating branches, musculocutaneous nerve

INTRODUCTION

Anomalies in the peripheral nerves and their connections are a clinically important consideration. Patnaik et al. [18] reported that the anterolateral surgical approach to the humerus described by Henry [8] was superior to the posterior approach described by Berger and Backwalter [3]. Thus a thorough knowledge of the possible variations of the median and musculocutaneous nerves, both branches of the brachial plexus [9], can be of the utmost importance in routine surgery where such branches can be injured.

The aim of this article is to study the anatomical variations of the median nerve with special reference to its branches, distribution and possible communication with other nerves, namely the musculocutaneous and/or ulnar nerves in the arms of preserved human cadavers.

MATERIAL AND METHODS

Thirty preserved human cadavers aged from 30 to 67 years were used. These were obtained from the dissecting room of the Department of Anatomy and Embryology in the Faculty of Medicine, Alexandria University. The axilla and arm regions of right and left upper limbs in each cadaver were dissected through an incision along the anterior axial line. The median nerve was studied as regards its abnormal branches, distribution and communication with other nerves especially the musculocutaneous and/or ulnar nerves.

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RESULTS

During dissection of the left arm of a 65-years--old male cadaver the muscular branches of the median nerve to the muscles of the arm were observed as follows. A branch was seen to arise from the lateral root of the median nerve at 1.5 cm above the point of union of the two roots of the median nerve and 10 cm distal to the acromion. This branch was divided into two branches that passed laterally beneath the short head of the biceps brachii muscle (Fig. 1A). One of these supplied the short head of the biceps through two small branches. The other passed laterally to supply the long head of the biceps brachii. A second branch arose from the median nerve 16 cm distal to the acromion. It passed downwards and laterally between the biceps brachii and brachialis muscles and gave off three muscular branches to the brachialis muscle. These entered the muscle at distances of 18 cm, 20 cm and 24 cm distal to the acromion (Fig. 1B). This second branch continued descending to appear at the lateral border of the biceps brachii muscle in the lower arm as the lateral cutaneous nerve of the forearm (Fig. 1B). A communicating branch between the median nerve and the previous branch was observed arising from the median nerve 20 cm distal to the acromion (Fig. 1B). The musculocutaneous nerve was absent. The coracobrachialis muscle was supplied by a single branch from the lateral cord of the brachial plexus that entered the muscle 2 cm distal to the tip of the coracoid process of the scapula (Fig. 1C). The right side of the cadaver was normal and there were no vascular anomalies on either side.

In the left arm of a 58-year-old male cadaver there was a communicating branch emanating from the musculocutaneous nerve 7 cm distal to the acromion and 3 cm before the point where it pierced the coracobrachialis muscle. This branch pierced the coracobrachialis muscle with the musculocutaneous nerve and then curved medially to join the median nerve 18 cm distal to the acromion and 13 cm above the medial epicondyle. Its length was 13 cm (Fig. 2).

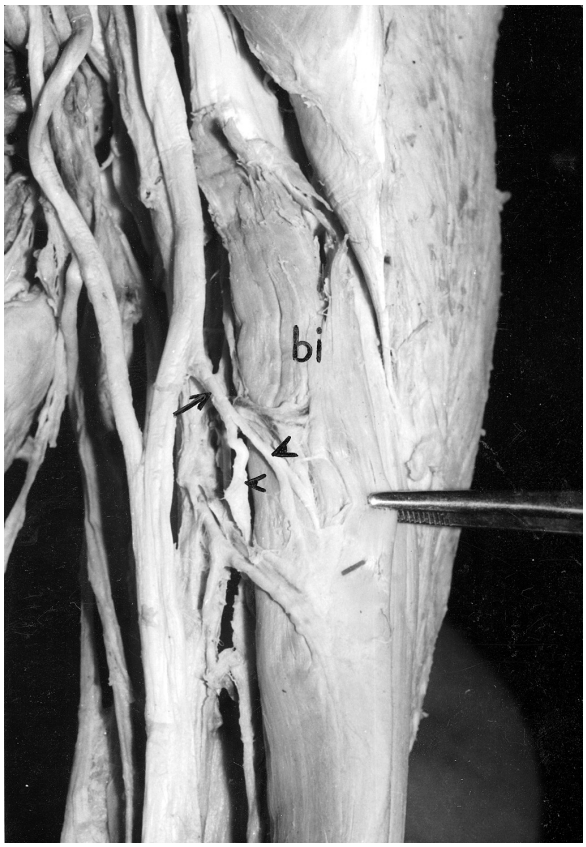

Figure 1A. A photograph of the anterior aspect of the left arm in an adult human cadaver. The short head of the biceps brachii muscle is reflected laterally, showing division of the branch (arrow) arising from the lateral root of the median nerve into two subdivisions (arrow heads), one of which supplies the short head of the biceps brachii muscle (bi) through two smaller branches.

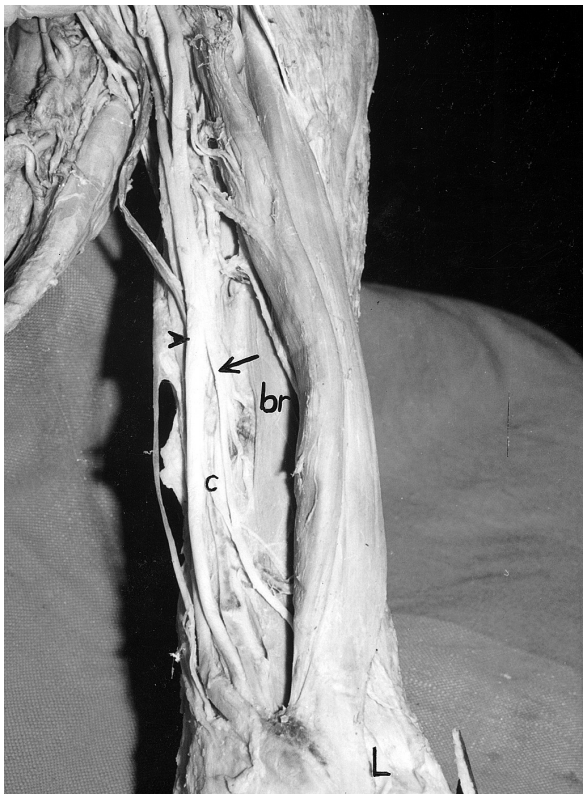

Figure 1B. A photograph of the previous specimen showing a branch (arrow) arising from the median nerve (arrow head) to supply the brachialis muscle (br). It continues between the biceps and the brachialis muscles as the lateral cutaneous nerve of the forearm (L). A communicating branch between the median nerve and the previous branch is shown (c).

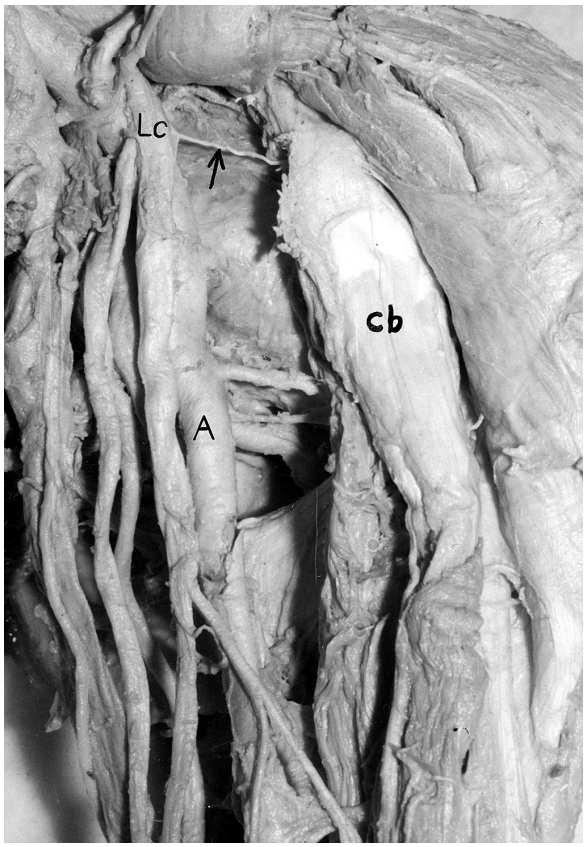

Figure 1C. A photograph of the left axilla showing a branch (arrow) arising from the lateral cord of the brachial plexus (Lc) and supplying the coracobrachialis muscle (cb); A — axillary artery.

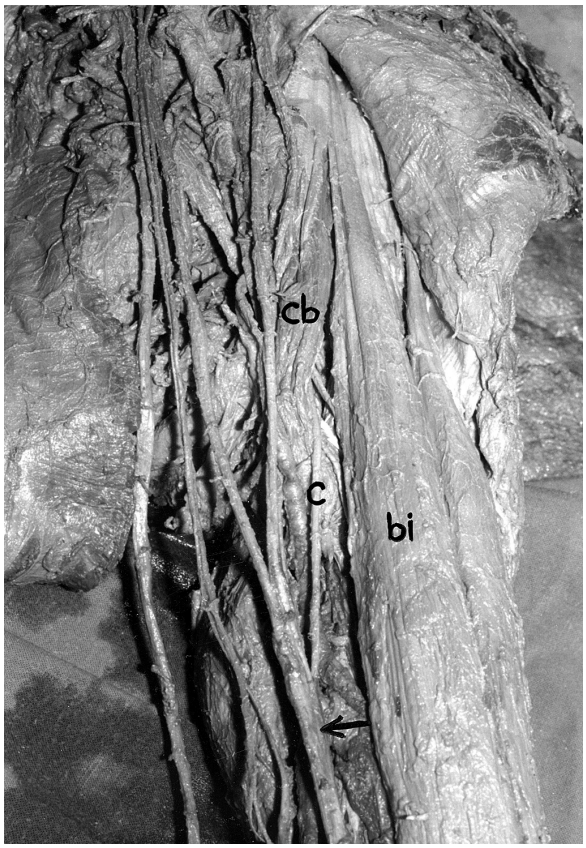

Figure 2. A photograph of the left axilla and arm regions of an adult human cadaver showing a communicating branch (c) between the median (arrow) and the musculocutaneous nerves. A low fusion of the two roots of the median nerve is shown; cb — coracobrachialis muscle, bi — biceps brachii.

On the same side there was low fusion of the two roots of the median nerve 15.3 cm distal to the acromion and 15.7 cm above the medial epicondyle (Fig. 2). The right side of the cadaver was normal and there were no vascular anomalies on either side.

While dissecting the right arm of a 63-year-old male cadaver a communicating branch was found arising from the musculocutaneous nerve after piercing the coracobrachialis muscle 9 cm distal to the acromion. This joined the median nerve 18 cm distal to the acromion. In this arm the axillary artery was divided into superficial and definitive brachial arteries. The superficial brachial artery gave off the radial artery, while the definitive brachial artery gave off the ulnar artery (Fig. 3). The left side was normal.

Finally, during dissection of the left arm of a 55--year-old male cadaver a communicating branch was observed to originate from the musculocutaneous nerve after piercing the coracobrachialis muscle 7 cm distal to the acromion. It joined the median nerve 17.5 cm distal to the acromion. No communicating branches between the median and the ulnar nerves appeared in any of the dissected arms.

DISCUSSION

Variations of the nerves of the upper limb may have clinical implications, so it is important to report them during cadaver dissection. Abnormal electromyography (EMG) of the biceps muscle may be expected in a patient with thoracic outlet syndrome showing other evidence of median nerve affection. Similarly, a nerve conduction test of the musculocutaneous nerve would be unobtainable in the absence of this nerve.

The anatomical variations of the median nerve reported in the present study include 3 main categories (Fig. 4). Firstly, in one limb out of 60 (1.7%) the median nerve gave off a branch from its lateral root to supply both heads of the biceps brachii, as well as branches to the brachialis muscle before it continued as the lateral cutaneous nerve of the forearm. Secondly, in one limb out of 60 (1.7%) there was absence of the musculocutaneous nerve and derivation of the nerve supply to the coracobrachialis muscle through a single branch from the lateral cord of the brachial plexus. Thirdly, in three limbs out

Figure 3. A photograph of the anterior aspect of the right arm in an adult human cadaver. The biceps brachii muscle (bi) is reflected laterally to show a communicating branch (c) between the median (arrow) and the musculocutaneous nerves (arrowhead); cb — coracobrachialis muscle; 1 — axillary artery, 2 — superficial brachial artery, 3 — definitive brachial artery.

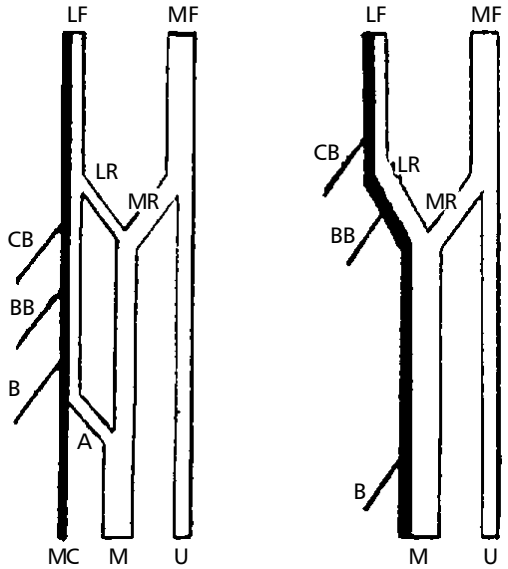

Figure 4. Diagrammatic illustration of the anatomical variations of the median and the musculocutaneous nerves in the present study; LF — lateral cord, MF — medial cord, MC — musculocutaneous nerve, M — median nerve, U — ulnar nerve, CB — coracobrachialis muscle, BB — biceps brachii, B — brachialis muscle, A — communicating branch, LR — lateral root of the median nerve, MR — medial root of the median nerve.

of sixty (5%) a communicating branch between the musculocutaneous and the median nerves was observed. The variations of the median nerve, as well as its communication with the musculocutaneous nerve, have been reported before [5, 6, 11, 12, 20, 21].

The anatomical variations of the musculocutaneous and the median nerves in the arm were classified into 5 types [16]:

- Type 1: there are no communicating fibres between the musculocutaneous and the median nerves. The musculocutaneous nerve pierces the coracobrachialis muscle and innervates the coracobrachialis, biceps brachii and brachialis muscles.
- Type 2: although some fibres of the medial root of the median nerve unite with the lateral root of the median nerve to form the median nerve, some leave to run within the musculocutaneous nerve and after some distance leave it to join their proper trunk.
- Type 3: the lateral root of the median nerve runs into the musculocutaneous nerve and, after some distance, leaves it to join its proper trunk.
- Type 4: the fibres of the musculocutaneous nerve unite with the lateral root of the median nerve and, after some distance, emanate from the median nerve.
- Type 5: the musculocutaneous nerve is absent. Its fibres run within the median nerve along its course.

In the study conducted by Kerr [13] (quoted from [24]) on 75 brachial plexuses, the Type 5 variation was found in 3 cases (1.7%). However, a communicating branch between the two nerves was observed in 18 cases (24%). Adachi [1] (quoted from [7]) reported a case that had a fine communication between the median and musculocutaneous nerves in the forearm, which was located posterior to the radial artery at the level of the humeroradial joint. Lang and Spinner [15] reported a complete fusion of the median and the musculocutaneous nerves in a case report. Watanabe et al. [26] found two cases (1.4%) of fusion of the median and musculocutaneous nerves among 140 upper limbs. Nakatani et al. [17] observed absence of the musculocutaneous nerve with innervation of the coracobrachialis, biceps brachii and brachialis muscles and the lateral border of the forearm by branches from the lateral cord of the brachial plexus. Although variations reported in the present study conformed to Type 5, the coracobrachialis muscle was supplied by a branch from the lateral cord of the brachial plexus and not from the median nerve. Ihunwo et al. [10] reported absence of the musculocutaneous nerve bilaterally in a male cadaver where the flexors of the arm were supplied

by branches from the median nerve. Similarly, Gumusburun and Adiguzel [7] reported bilateral absence of the musculocutaneous nerve in a 72-year-old female cadaver where the median nerve supplied the biceps brachii and brachialis muscles and also gave off the lateral cutaneous nerve of the forearm. The coracobrachialis muscle was supplied by branches from the lateral cord of the brachial plexus. There were no vascular anomalies in this cadaver. Sud and Sharma [23] reported a case of absence of the musculocutaneous nerve with innervation of the coracobrachialis and biceps brachii via the median nerve. The lateral cutaneous nerve of the forearm originated from the median nerve and gave off a muscular branch to the brachialis muscle. Prasada and Chaudhary [19] reported two cases of absence of the musculocutaneous nerve out of 24 upper limbs dissected (8%). The median nerve took over the area of supply of the musculocutaneous nerve by giving off both muscular and sensory branches.

The communicating branch between the median and the musculocutaneous nerves observed in the present study could be classified as Type 2 according to Le Minor´s classification [16]. Kosugi et al. [14] reported the same finding in 43 out of 75 limbs. Venieratos and Anagnostopoulou [25] studied 79 cadavers and found 22 communications between the median and the musculocutaneous nerves. Such communications were classified into 3 types:

- Type 1: the communication was proximal to the entrance of the musculocutaneous nerve into the coracobrachialis muscle (9/22).
- Type 2: the communication was distal to the coracobrachialis muscle (10/22).
- Type 3: the musculocutaneous nerve as well as the communicating branch did not pierce the muscle (3/22).

Basar et al. [2] reported a case of a communicating branch between the median and the musculocutaneous nerves in a 42-year-old male cadaver. One of the brachial veins was present between the connecting branch and the median nerve. Uzun and Seelig [24] reported a communicating branch that originated 1.6 cm distal to the origin of the musculocutaneous nerve and before it pierced the coracobrachialis muscle. It then joined the median nerve at the meeting of its two roots 20 cm above the intercondylar line of the humerus. Sarikcioglu et al. [22] reported the presence of a communicating branch between the median and the musculocutaneous nerves on the right side of a 60-year-old male cadaver in which the innervation of the coracobrachialis muscle was mediated by an accessory nerve originating from the lateral cord of the brachial plexus. Choi et al. [4] in their study of 138 cadavers (276 arms) described 3 patterns for the connection between the median and the musculocutaneous nerves:

- Pattern 1: fusion of the nerves (14 arms, 19.2%).
- Pattern 2: one connecting branch present between the nerves (53 arms, 72.6%).
- Pattern 3: two connecting branches present between the nerves (5 arms, 6.8%).

A combination of Patterns 1 and 2 was observed in one case (1.4%).

CONCLUSIONS

In conclusion, the likelihood of the median nerve innervating the arm flexors should be considered when a high median nerve paralysis takes place in the axilla or proximal arm in a patient presenting with weakness of forearm flexion and supination. Similarly, this variation may explain the presence of weak arm flexors in patients with thoracic outlet syndrome and median nerve affection. Finally, we report here for the first time the origin of the muscular branches to the biceps brachii from the lateral root of the median nerve.

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