

# Multiple variations involving all the terminal branches of the brachial plexus and the axillary artery – a case report

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## SUMMARY

Several case reports on variations of the brachial plexus have been reported in the literature. These reports provide valuable information for understanding the clinical signs related to neuropathy of varying origins. The authors of this report present a case that involved all the terminal branches of the brachial plexus and the axillary artery in a cadaver used for routine teaching practice. Four variations were noted: (i) the median nerve was formed by three roots: from the lateral cord, the medial cord and the musculocutaneous nerve; (ii) the ulnar nerve received a contribution from the lateral root of the median nerve; (iii) the lateral and the medial roots of the median nerve surrounded the third part of the axillary artery, and (iv) the superficial branch of the radial nerve was replaced by the lateral cutaneous nerve of the forearm. The aim of this study was to describe the course of these variant nerves and suggest how knowledge of these variations can help to interpret some uncommon clinical signs, such as the manifestations of ulnar nerve palsy resulting from damage to the lateral cord and manifestations of median nerve palsy resulting from damage to the musculocutaneous nerve.

**Key words:** Median nerve – Axillary artery – Musculocutaneous nerve – Radial nerve – Lateral cutaneous nerve of the forearm

## INTRODUCTION

Several authors have described variations in the brachial plexus (Hollinshead, 1958; Venieratos and Anagnostopoulou, 1998; Gumusburun and Adiguzel, 2000; Sarikcioglu et al., 2001; Saeed and Rufai, 2003; Goyal et al., 2005; Johnson and Ellis, 2005). Knowledge of anatomical variations of the peripheral nervous system can help to provide an explanation when encountering an incomprehensible clinical sign (Gumusburun and Adiguzel, 2000). Thus, abnormal communications between the branches of the brachial plexus are of clinical importance. A number of anomalous vascular relationships among the branches of the plexus have been reported (Miller, 1939; as quoted by Hollinshead, 1958). The close relationship of the variant nerves with the axillary artery may result in its compression, leading to ischaemic pain or varying degrees of arterial insufficiency during certain postural maneuvers of the shoulder joint (Saeed and Rufai, 2003). The unusual

course of the brachial plexus, following a very close and oblique course over the axillary artery, makes it more prone to injury in radical neck dissections and in surgical operations of the axilla.

The brachial plexus is known to be formed by the union of the ventral rami of the lower four cervical (C5 to C8) and first thoracic (T1) spinal nerves. It supplies motor, sensory, and sympathetic nerve fibres to the upper limb. The fourth cervical ventral ramus frequently gives off a branch to the fifth one and the first thoracic ventral ramus receives a contribution from the second thoracic ventral ramus.

A brief description of certain branches of the brachial plexus is given in order to highlight the variations described in this case report. The median nerve (C5-C8, T1) is formed by the union of its medial and lateral roots, derived from the medial and lateral cords of the brachial plexus (Fig. 1). The median nerve is formed anterolateral to the second part of the axillary artery. Thus, it carries nerve fibres from the anterior divisions of the upper, middle and lower trunks of the brachial plexus.

The lateral cord gives off the lateral pectoral nerve and then the lateral root of the median nerve and ends by continuing as the musculocutaneous nerve (C5-C7) in the axilla. It pierces the coracobrachialis and descends on the lateral side of the arm. Just below the elbow it pierces the deep fascia to become the lateral cutaneous nerve of the forearm. This nerve descends along the radial border of the forearm, supplies the skin of the anterolateral surface of the forearm and ends at the wrist.

The radial nerve (C5-C8, T1) arises from the posterior cord of the brachial plexus and contains nerve fibres of the posterior divisions of the three trunks of the brachial plexus. It courses through the spiral groove and reaches the lateral side of the humerus where it pierces the lateral intermuscular septum and enters the anterior compartment of the forearm. Anterior to the lateral epicondyle, it divides into the superficial and deep branches. The superficial branch courses under the brachioradialis muscle, and it becomes subcutaneous at the distal end of the forearm. It supplies the lateral two thirds of the dorsum of the hand and the lateral three and half digits up to the middle interphalangeal joints. The aim of this case-report is to describe certain unilateral variations involving all the terminal branches of the brachial plexus, their relationships to

the axillary artery, and the area of supply of the musculocutaneous nerve and to note its possible importance.

## MATERIALS AND METHODS

During routine dissection of the right upper limb of an adult female cadaver for undergraduate teaching, variations of the brachial plexus were found. All the branches were traced to their terminations. The relations of the cords and branches of the brachial plexus were noted. The supraclavicular part of the brachial plexus was also dissected to note its formation. The variations were noted and photographed.

## RESULTS

Dissection of the specimen showed that the roots of the brachial plexus were from the C5 to T1 ventral rami. No variation was observed in the formation and division of the trunks, and the formation of the cords from the divisions.

The usual relationship of the three cords to the first part of axillary artery (superolateral to the artery) was observed. However, all the cords ran downwards and laterally, lying superolateral to the second part of the axillary artery. This is in contrast to the usual pattern where the cords surround the second part of the axillary artery and are related to it according to their names.

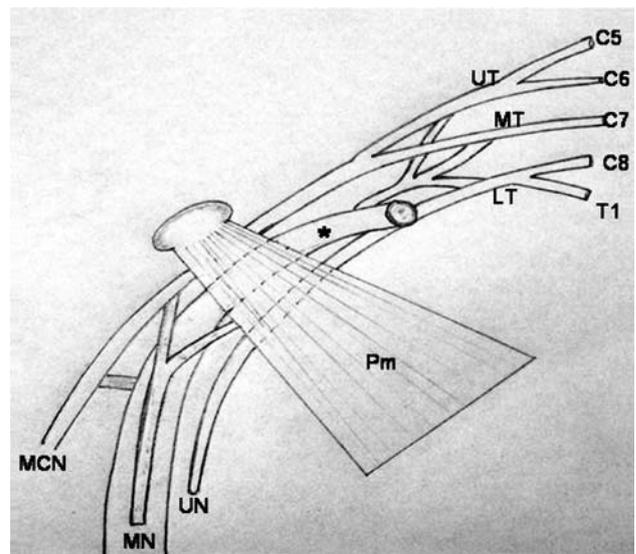


Fig. 1. Usual relations of the brachial plexus and axillary artery. C5, C6, C7, C8, T1 – roots; UT: upper trunk; MT: middle trunk; LT: lower trunk; MCN: musculocutaneous nerve; MN: median nerve; UN: ulnar nerve; Pm: pectoralis minor muscle; \*: axillary artery.

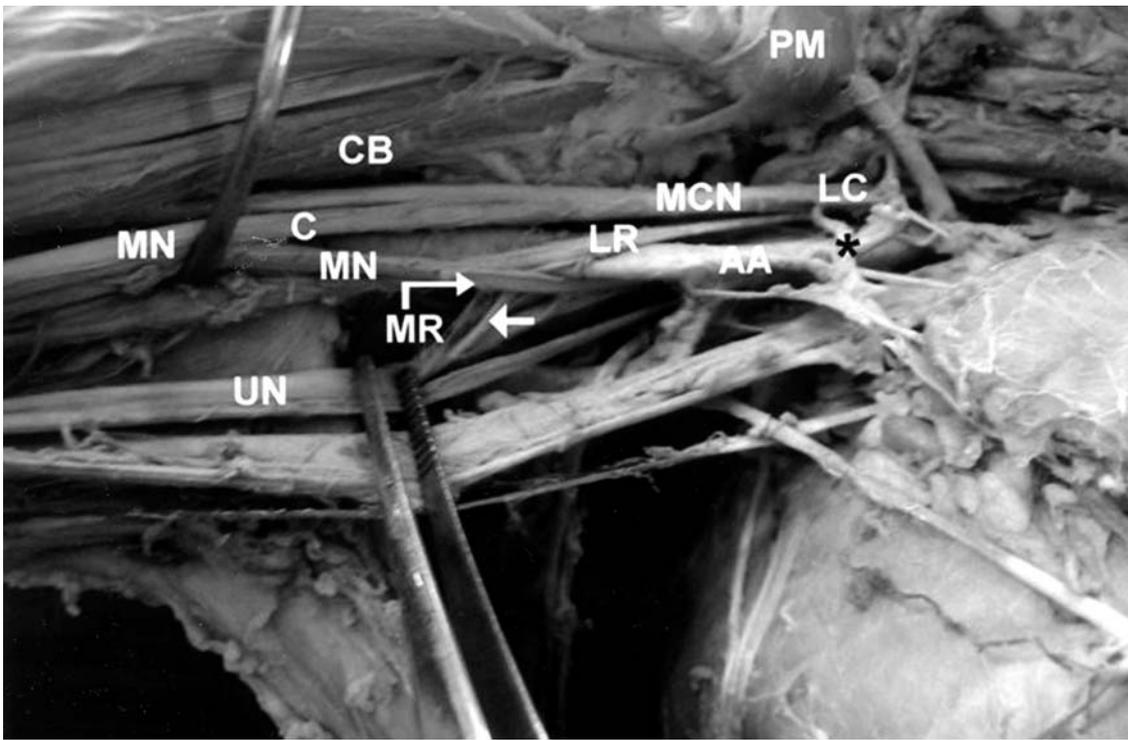


Fig. 2. Brachial plexus of the right side. PM: Pectoralis minor reflected laterally; CB: coracobrachialis; LC: lateral cord; AA: third part of axillary artery; MCN: musculocutaneous nerve; LR: lateral root of median nerve; MR: medial root of median nerve; MN: median nerve; C: communicating branch to the median nerve; UN: ulnar nerve; arrow: communicating branch to the ulnar nerve; \*: lateral pectoral nerve in front of the second part of axillary artery.



Fig. 3. Cubital fossa. LCN: lateral cutaneous nerve of the forearm; RN: radial nerve; BB: biceps brachii muscle; BR: brachioradialis muscle; \*: branch of radial nerve to extensor carpi radialis brevis muscle.

Anterior to the second part of the axillary artery, there was a communication between the medial and lateral pectoral nerves (Fig. 2). Usually this communication is found in front of the first part of the axillary artery.

The median nerve was formed by the union of the lateral root of the median nerve from the lateral cord and the medial root of the median nerve from the medial cord of the brachial plexus. Since all the cords of the brachial plexus were superolateral to the second part of the axillary artery, the third part of the axillary artery was surrounded by the two

roots of the median nerve. The lateral root passed anterior to the artery and the medial root passed posterior to it. The lateral root gave off a communication to the ulnar nerve, in front of the third part of the axillary artery and behind the medial root. The lateral cord continued as the musculocutaneous nerve. The musculocutaneous nerve gave off a direct branch to the coracobrachialis muscle and then gave off a communicating branch to the median nerve. This branch was thicker than the lateral root of the median nerve (Fig. 2). Then, the musculocutaneous nerve passed

through the coracobrachialis, supplied the biceps and brachialis, and continued as the lateral cutaneous nerve of the forearm. The lateral cutaneous nerve of the forearm pierced the deep fascia below the elbow, ran, in the superficial fascia, along the radial side of the forearm and passed in the roof of the anatomical snuffbox. It replaced the normal area of distribution of the superficial branch of the radial nerve (Figs. 3, 4 and 5).

In the cubital fossa the radial nerve did not divide into superficial and deep branches; it continued along the normal course of the deep branch of the radial nerve. The superficial branch of the radial nerve was absent (Fig. 3).

No variation in the brachial plexus was present on the left side.

#### DISCUSSION

Reports on the presence of variations in the brachial plexus have been reported. The presence of unusual communications between the terminal branches of brachial plexus is clinically important.

This report presents five variations involving all the terminal branches of the brachial plexus: (i) the lateral and medial roots of the median nerve surrounding the third part of the axillary artery, (ii) a communication from

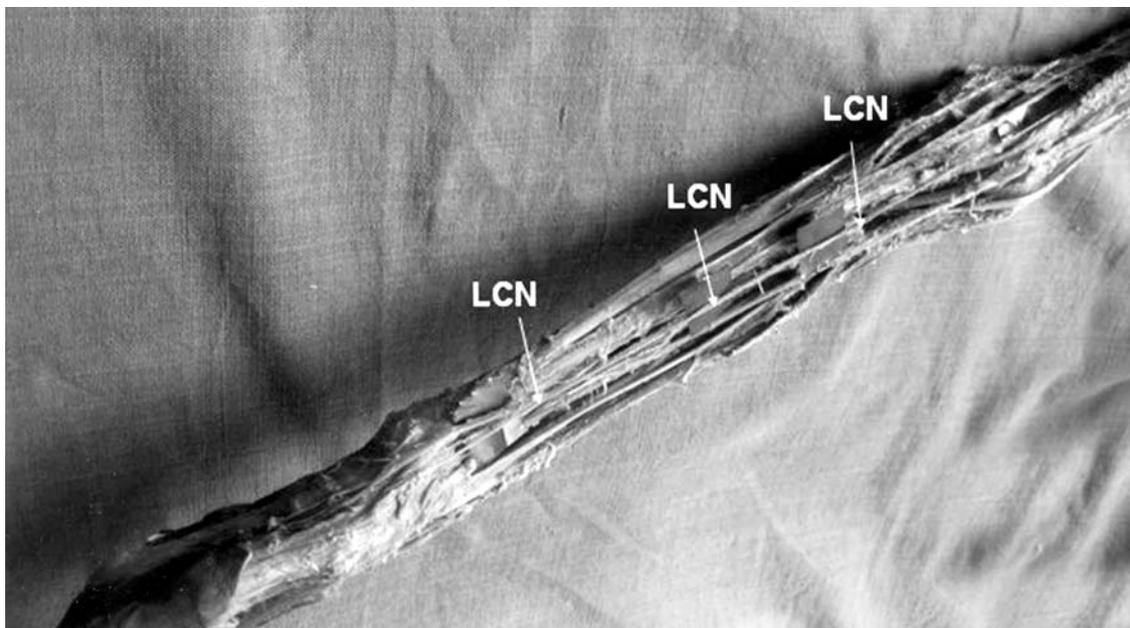


Fig. 4. Anterolateral aspect of the forearm. LCN: lateral cutaneous nerve of the forearm.

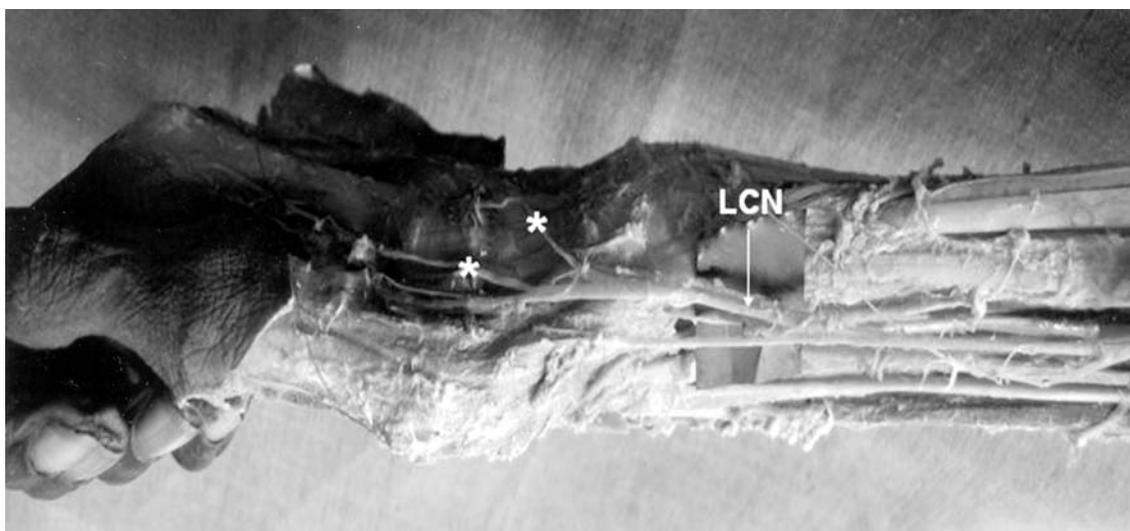


Fig. 5. Back of distal end of the forearm and back of hand. LCN: lateral cutaneous nerve of the forearm; \*:digital branches of lateral cutaneous nerve of the forearm.

the lateral root of the median nerve to the ulnar nerve (iii) a communication from the musculocutaneous nerve to the median nerve, (iv) the absence of the superficial branch of the radial nerve and (v) the lateral cutaneous nerve of the forearm supplying the area usually supplied by the superficial branch of the radial nerve.

It is known that if the lateral root of the median nerve is small, the musculocutaneous nerve connects with the median nerve distal to the lateral root from the lateral cord. Several terms have been used to describe the communication between the musculocutaneous nerve to the median nerve, such as third (double lateral) root of the median nerve (Venieratos et al., 1998), abnormal lateral root of the median nerve (Saeed and Rufai, 2003), additional lateral root (Goyal et al., 2005) and accessory branch of musculocutaneous nerve (Kocabiyik et al., 2005). Apparently, fibres of the median nerve take an unusual course over a short distance. Unusual communications between the musculocutaneous and median nerves have been found in 26.4% of 276 dissections and a bilateral anomaly was very rare (Choi et al., 2002 - quoted by Goyal et al., 2005). The sites of occurrence of these communications have been described in relation to the coracobrachialis muscle (Venieratos and Anagnostopoulou, 1998). Those authors noted that if a musculocutaneous nerve that contains fibres of the median nerve becomes entrapped, this could result in symptoms of median nerve neuropathy, similar to carpal tunnel syndrome.

A contribution from the lateral cord to the ulnar nerve introduces nerve fibres from at least as high as the seventh cervical nerve (Hollinshead, 1958). A lateral root of the ulnar nerve from the lateral cord was present in 42.8% of 175 dissections of the brachial plexus (Kerr, 1918 - quoted by Hollinshead, 1958). It has been described that some C7 fibers often leave the lateral root in the lower part of the axilla, pass posterior to the medial root of median nerve, usually anterior to the axillary artery, and join the ulnar nerve.

Clinically, the variations in the present case are important because in a complete lesion of the lateral cord some muscles innervated by the ulnar nerve would be paralysed and paraesthesia could occur in the area of skin supplied by the ulnar nerve. In the case of injury to the medial cord, some of the fibres to the muscles and area of skin supplied by the ulnar nerve would not be affected. Injury to the musculo-

cutaneous nerve proximal to its communicating branch would result in the involvement of some of the muscles and/or the area of skin supplied by the median nerve.

The third part of the axillary artery is known to be embraced by the formation of the median nerve from the lateral and medial roots. In the present case, the third part of the axillary artery was surrounded by the two roots of the median nerve; the lateral root passed anterior to the artery, and the medial root emerged from behind the artery and crossed it anteriorly to join the lateral root.

The unusual relation of the artery to the nerves reported in this case may be attributed to a variation in the formation of the axillary artery (Miller, 1939 - quoted by Hollinshead, 1958), and the persistence and/or abnormal degeneration of certain embryonic anastomoses between the developing arteries in the upper limb (Sarikcioglu et al., 2001).

The total replacement of the superficial branch of radial nerve by the lateral cutaneous nerve of the forearm has been described earlier (Appleton, 1912 - quoted by Kocabiyik et al., 2005). This variation could be a reason for the failure to achieve anaesthetic blockade of the superficial branch of the radial nerve by injecting the radial nerve.

Some reports in the literature describe the lateral cutaneous nerve of the forearm as having connections with the posterior cutaneous nerve of the forearm and the terminal branches of the radial nerve (Johnson and Ellis, 2005). The lateral cutaneous nerve of the forearm contains fibres from the anterior divisions of the brachial plexus and innervates the skin of the flexor surface (anterolateral surface of forearm), while the superficial branch of the radial nerve has fibers from the posterior divisions of the brachial plexus and supplies the skin of the dorsal aspect (Hollinshead, 1958). In the present case, the lateral cutaneous nerve of the forearm was seen to pass to the skin on the back of the hand. This may be because during development the flexor skin migrated excessively onto the back of the hand dragging its nerve supply with it. Alternatively, the lateral cutaneous nerve of forearm might have contained some fibers from the posterior divisions of the brachial plexus that usually would have passed via the superficial branch of the radial nerve.

Knowledge of the anatomical variations of the brachial plexus described in this report may be helpful for explaining unusual clini-

cal signs such as apparent involvement of the ulnar nerve in cases of injury to the lateral cord or apparent involvement of the median nerve in cases of injury to the musculocutaneous nerve. These variations are also evidently of clinical interest when performing surgical procedures involving the axillary region, and in explaining the failure of anaesthetic blockade of the cutaneous area supplied by the superficial branch of the radial nerve.

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