

Anatomical variations of median nerve formation: embryological and clinical correlation

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Abstract

Introduction: Median nerve is one of the terminal branches of the brachial plexus. It is formed by union of two roots, lateral root and medial root coming from lateral and medial cord respectively. Formation of median nerve occur lateral to axillary artery in axilla. Median nerve is associated with several variations which include abnormal communications with other nerves such as musculocutaneous and ulnar nerves, splitting of the nerve, penetration of the nerve by other vessels such as brachial artery. In the present study we observed anatomical variations of median nerve formation. **Material and methods:** We studied anatomical variations of median nerve formation in 98 cadavers i.e. 196 upper limbs of formalin preserved cadavers. **Results:** We observed following Anatomical variations of median nerve formations- Three roots taking part in the formation of median nerve in 22.4% upper limbs. Four roots taking part in formation of median nerve in 3.57% upper limbs. Median nerve formation in the arm was seen in 17.3% upper limbs, median nerve formation medial to axillary artery in 6.12% upper limbs and median nerve formation anterior to axillary artery in 1.53% upper limbs. **Conclusion:** Knowledge of such anatomical variations is of interest to the anatomist and clinician alike. Surgeons who perform procedures involving neoplasm or repairing trauma need to be aware of these variations.

Keywords: anatomical variations, cadaver, median nerve, lateral cord.

1 Introduction

Median nerve is formed by union of two roots, lateral root and medial root coming from lateral and medial cord of brachial plexus respectively. Formation of median nerve occur lateral to axillary artery in axilla (RICHARD, WAYNE and ADAM, 2005). Formations and anomalies of the nerves of the upper limb have been described by many authors (VOLLALA, RAGHUNATHAN and RODRIGUES, 2005; SARALAYA, NAYAK, SEQUEIRA et al., 2009). Nerve variations of the upper limb are very important in routine surgery and during radical neck dissections where these variations are more prone to injury (GACEK, 1990). These variations may also help in interpretation of a nervous compression having unexplained clinical symptoms.

2 Material and methods

The formaline fixed 98 cadavers 196 upper limbs constitute the material for study. During routine dissection of axilla for medical undergraduate's skin and various muscles were reflected, superficial fascia and deep fascia separated to visualize the formation of median nerve and variation in its formation were noticed.

3 Results

Variations in formation of median nerve were observed in 196 upper limbs. Variations in formation of median nerve includes, Three roots taking part in the formation of median nerve in 22.4% (44/196) upper limbs, in 14.2% (28/196) (Figure 1) upper limbs the third root arose from lateral cord of brachial plexus and 8.16% (16/196) (Figure 2)

upper limbs the third root arose from musculocutaneous nerve. Four roots taking part in formation of median nerve in 3.57% (7/196) (Figure 3) upper limbs, the third and forth root arose from lateral cord and musculocutaneous nerve respectively. Median nerve formation in the arm were seen in 17.3% (34/196) (Figure 4) upper limbs, median nerve formation medial to axillary artery in 6.12% (12/196) (Figure 2 and 4) upper limbs and median nerve formation anterior to axillary artery in 1.53% (3/196) (Figure 1) upper limbs.

4 Discussion

Median nerve as reported in literature, is associated with several variations which include abnormal communications with other nerves such as musculocutaneous and ulnar nerves (CHAUHAN and ROY, 2002), splitting of the median nerve (SUNDARAM, KUMAR, SETHUPATHI et al., 2008) and unusual innervations of flexor muscles of arm by the median nerve (NAYAK, 2007). In the present study we looked for unusual formation of median nerve including additional roots taking part in formation, formation in the arm, formation medial to axillary artery, formation anterior to axillary artery and correlated it embryologically and clinically.

Variations in formation of median nerve were reported earlier by some authors (BHANU, SANKAR and SUSAN, 2010). Sontakke, Tarnekar, Waghmare et al. (2011) described a case where median nerve was formed by three roots; two of them came from lateral cord and one from medial cord. The first root that arose from lateral cord joined the medial root in the axilla but the second one joined

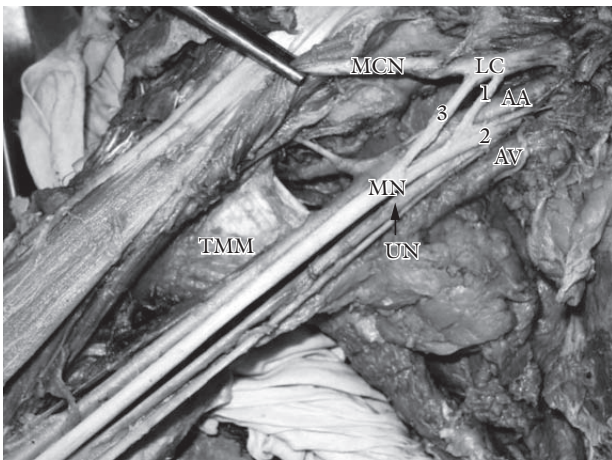


Figure 1. Formation of median nerve anterior to axillary artery by three roots, additional root originating from lateral cord of brachial plexus [LC- Lateral cord AA- Axillary artery, AV- Axillary vein, MCN- musculocutaneous nerve, 1, 2, 3- roots of median nerve (1- Lateral root of median nerve, 2- Medial root of median nerve, 3- Additional root of median nerve), MN- Median nerve, UN- Ulnar nerve, TMM- Teres major muscle].

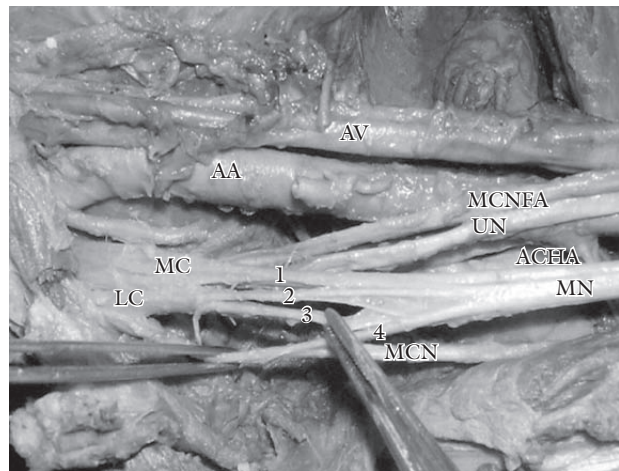


Figure 3. Formation of median nerve by four roots [LC- Lateral cord, MC- Medial cord AA- Axillary artery, AV- Axillary vein, MCN- musculocutaneous nerve, MN- Median nerve, UN- Ulnar nerve, MCNFA- Medial cutaneous nerve of forearm, ACHA- anterior circumflex humeral artery, 1, 2, 3, 4- Roots of median nerve (1- from medial cord, 2, 3- from lateral cord, 4- from musculocutaneous nerve)].

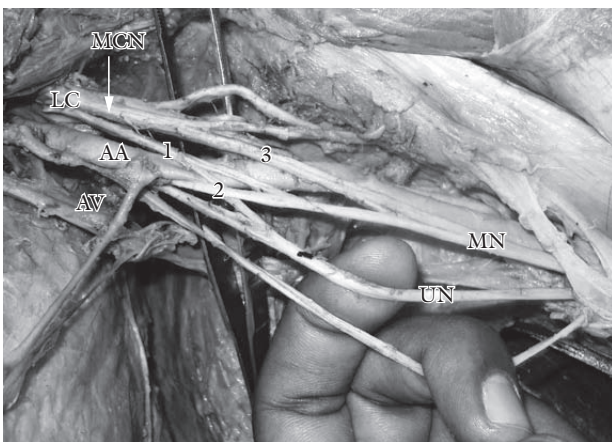


Figure 2. Formation of median nerve medial to Axillary artery by three roots, additional root originating from musculocutaneous nerve [LC- Lateral cord AA- Axillary artery, AV- Axillary vein, MCN- musculocutaneous nerve, 1, 2, 3- roots of median nerve (1- Lateral root of median nerve, 2- Medial root of median nerve, 3- Additional root of median nerve), MN- Median nerve, UN- Ulnar nerve].

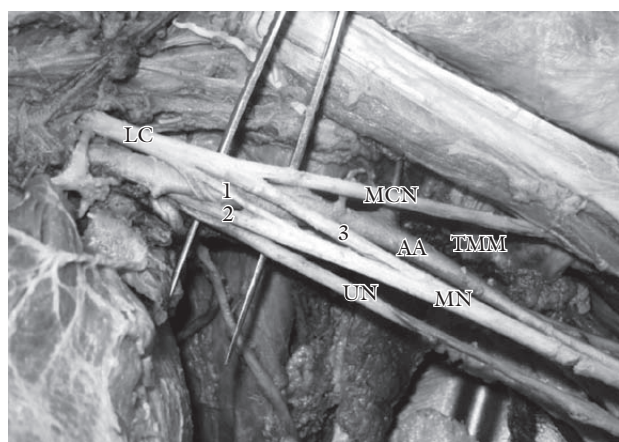


Figure 4. Formation of median nerve in upper arm medial to Axillary artery by three roots, additional root originating from musculocutaneous nerve [LC- Lateral cord AA- Axillary artery, MCN- musculocutaneous nerve, 1, 2, 3- roots of median nerve (1- Lateral root of median nerve, 2- Medial root of median nerve, 3- Additional root of median nerve), MN- Median nerve, UN- Ulnar nerve, TMM- Teres major muscle].

with the medial root in the arm to form the median nerve, however Pais, Casal, Santos et al. (2010) reported median nerve formation by three roots two roots came from lateral cord and one from medial cord but both the roots coming from lateral cord joined with medial root in the axilla, the first root of lateral cord was a smaller branch arising from its terminal portion. In the present study it has been observed that in 14.2% upper limbs the third root (additional root) arose from lateral cord of brachial plexus.

Ramachandran Kanakasabapathy and Holla (2006) found three roots forming median nerve, but the third root was coming from musculocutaneous nerve; on the other hand Uzun and Seeling (2001) described a case in which median

nerve was formed by the fusion of four branches, three of them coming from the lateral cord and one from medial cord. In the present study we observed that in 8.16% upper limbs the third root arose from musculocutaneous nerve and in 3.57% upper limbs median nerve was formed by four roots two from lateral cord, one from medial cord and one from musculocutaneous nerve.

Median nerve usually formed in the axilla. Nayak, Samuel and Somayaji (2006) observed a case where median nerve was formed just below the midpoint of the arm. In their case medial and lateral roots of median nerve were very long and median nerve was formed just medial to brachial artery. Satyanarayana, Vishwakarma, Kumar et al. (2009a) reported

a case of median nerve formation by medial root and lateral root (coming from medial and lateral; cord respectively) proximal to the insertion of coracobrachialis muscle; both the roots were lateral to third part of axillary artery. In the present study we also observed low formation of median nerve in the arm in 17.3% where medial and lateral roots were very long. Such cases of low origin of median nerve may lead to confusions in surgical procedures and nerve block anesthesia.

Normally formation of median nerve comes in lateral relation of third part of axillary artery, as medial root crosses the axillary artery anteriorly to join with lateral root, lateral to axillary artery. Haviarova, Falougy and Killingerova (2001) reported a case where median nerve was formed posterior to axillary artery. There are also reports where median nerve was formed medial to axillary artery (CHITRA, 2007; SURUCHI, VANI and ROOPA, 2007; SATYANARAYANA, VISHWAKARMA, KUMAR et al., 2009b). Pandey and Shukla (2006) reported median nerve formation medial to third part of axillary artery in 4.7% cases. In these cases the lateral root (inspite of medial) crossed the axillary artery anteriorly to join with medial root lying medial to axillary artery. In the present study in 6.12% upper limbs the median nerve formed medial to third part of axillary artery (lateral root crossed the axillary artery from lateral to medial) and in 1.53% upper limbs median nerve formed anterior to axillary artery. Knowledge of such variation has clinical importance especially in post traumatic evaluations and peripheral nerve repair.

These variations can be explained embryologically. The upper limb buds lie opposite to the lower five cervical and upper two thoracic segments. As soon as buds form, the ventral primary rami of the spinal nerves penetrate into the mesenchyme of limb bud and establish intimate contact with differentiating mesodermal condensations. The early contact between nerve and muscle cell is a prerequisite for their complete functional differentiation (BROWN, HOPKINS and KEYNES, 1991; LARSEN, 1997). The variations could arise from circulatory factors at the time of fusion of brachial plexus cord. In human, the forelimb muscles develop from the mesenchyme of the para-axial mesoderm during fifth week of embryonic life (LARSEN, 1997). The axon of spinal nerve grows distally to reach the limb bud mesenchyme. The peripheral process of the motor and sensory neurons grows in the mesenchyme in different directions. Once formed, any developmental differences would obviously persist post-natally (BROWN, HOPKINS and KEYNES, 1991). As the guidance of the developing axons is regulated by expression of chemo-attractants and chemo-repellants in a highly coordinated site specific fashion, any alteration in signaling between mesenchymal cells and neuronal growth cones can lead to significant variations (SAMNES, REH and HARRIS, 2000).

Knowledge of such anatomical variations is of interest to the anatomist and clinician alike. Variations assume significance during surgical exploration of the axilla and can even fail nerve block of infraclavicular part of brachial plexus. Surgeons who perform procedures involving neoplasm or repairing trauma needs to be aware of these variations.

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