

# Bilateral Variations in Median Nerve Formation with Embryological Basis and Clinical Correlation

Bikash Chandra Satapathy<sup>1</sup>,  
Soumitra Trivedi<sup>2</sup>

<sup>1</sup>Senior Resident, Department of  
Anatomy, AIIMS Raipur.

<sup>2</sup>Assistant Professor, Department of  
Anatomy, AIIMS Raipur.

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## ABSTRACT

During routine dissection of upper limb of a 68 year old male cadaver bilateral variations in median nerve were observed. On the left side the lateral cord pierced coracobrachialis without giving the lateral root of median nerve and after coming out of coracobrachialis it bifurcated in to musculocutaneous nerve and lateral root of median nerve. The medial root of median nerve continued up to the middle of arm and joined the lateral root and formed the median nerve in the middle of arm instead of axilla. On the right side there were two lateral roots of the median nerve that joined the medial root to form the median nerve. The musculocutaneous nerve after piercing coracobrachialis gave a communicating branch to the median nerve in the lower part of front of arm. These variations can lead to unusual innervation and entrapment neuropathies. Identification of these variants are valuable during surgeries performed in and around axilla and flexor compartment of arm.

**Keywords:** Brachial plexus, Median nerve, Musculocutaneous nerve, Lateral cord, Communication, Nerve compression.

## INTRODUCTION

Ventral rami of C5 to T1 spinal nerves join to form the brachial plexus, which is further divided into trunks, divisions, cords and finally branches, exhibiting the crossing over of above mentioned spinal nerve fibers at various levels. Thus, the different nerves in the limbs have different root values depicting the spinal nerve fibers running in them. Median nerve is formed by contribution from both lateral and medial cord, known as medial and lateral roots of median nerve respectively. Median nerve shows a lot of variability in their union and the level at which it is formed.

### Name & Address of Corresponding Author

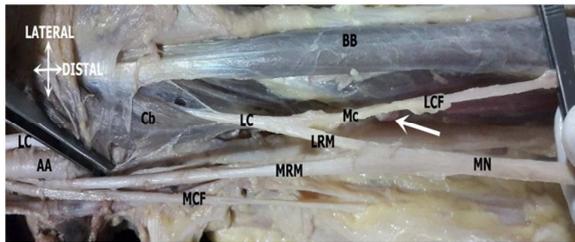
Dr Bikash Chandra Satapathy  
Department of Anatomy  
All India Institute of Medical Sciences  
Raipur – 492099  
Chhattisgarh.  
bikash.satapathy@gmail.com

## CASE REPORT

During routine dissection session for first year MBBS

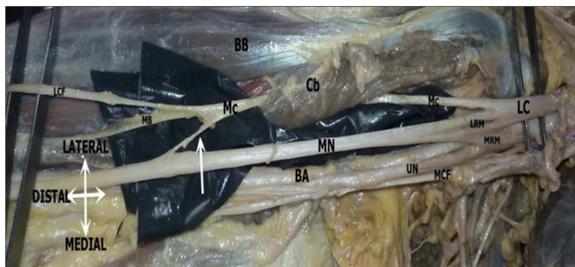
students in a 68 years old male cadaver of central India, the unusual arrangement of branches of lateral cord (LC) along with variant formation of median nerve (MN) were seen. On the left side [Figure 1] the lateral cord after giving rise to lateral pectoral nerve continued as a single bundle instead of branching into lateral root of median nerve (LRM) and musculocutaneous nerve (Mc). This single bundle pierced the coracobrachialis (Cb) muscle and supplied it. After coming out of coracobrachialis it divided in to lateral root of median nerve and musculocutaneous nerve. The lateral root joined the unusually long medial root of median nerve (MRM) at the level of mid of arm. The musculocutaneous nerve supplied other muscles of the arm and then continued as lateral cutaneous nerve of forearm (LCF). In the right upper limb [Figure 2] lateral root of median nerve was bifid and they joined medial root of median nerve at two different levels in the axilla to form the median nerve. The musculocutaneous nerve pierced coracobrachialis muscle and gave rise to a communicating branch (white arrow) that joined median nerve at the junction of lower one third and upper two third of arm. There were no other apparent variations in the upper limbs.

As our institute keeps the medical data of the donor and their family contacts, so we referred to them and found that there were no symptomatic abnormalities in function of upper limbs in the deceased donor.



**Figure 1:** Left upper limb showing variation in formation of MN.

AA- Axial Artery, BB- Biceps Brachii, LC- Lateral Cord, Cb- Coracobrachialis, Mc- Musculocutaneous nerve, LCF- Lateral Cutaneous nerve of Forearm, LRM- Lateral Root of Median nerve, MRM- Medial Root of Median nerve, MCF- Medial Cutaneous nerve of Forearm, MN- Median nerve, White Arrow- Muscular branch



**Figure 2:** Right upper limb showing communicating branch (white arrow) between Mc and MN.

BA- Brachial Artery, BB- Biceps Brachii, Cb- Coracobrachialis, Mc- Musculocutaneous nerve, LCF- Lateral Cutaneous nerve of Forearm, MB- Muscular branch, LRM- Lateral Root of Median nerve (Bifid), MRM- Medial Root of Median nerve, MCF- Medial Cutaneous nerve of Forearm, UN- Ulnar nerve, MN- Median nerve, White Arrow- Communicating branch between Mc and MN.

## DISCUSSION

Median nerve is formed by contribution from both lateral and medial cords, known as medial and lateral roots of median nerve respectively. Median nerve shows a lot of variability in their union and the level at which it is formed. Musculocutaneous nerve is formed from the lateral cord after giving rise to lateral root of median nerve. Musculocutaneous nerve then pierces coracobrachialis and further descends laterally between biceps brachii and brachialis.<sup>[1]</sup> Some fibers from lateral root of median nerve accompanying Musculocutaneous have been reported to join rest of the Median nerve after piercing coracobrachialis.<sup>[2,3]</sup>

Cases of communication between the MN and Mc or MN and ulnar nerve have been reported by many authors.<sup>[2-13]</sup> Many authors even have attempted to classify these bewildering number of variations.<sup>[3,4,14-17]</sup> Le Minor<sup>[4]</sup> and Venieratos and Anagnostopoulou<sup>[3]</sup> classifications are more commonly followed and

recently some authors like Ballesteros et al<sup>[11]</sup> have preferred the Maeda et al<sup>[17]</sup> classification. However for simplicity we followed Le Minor<sup>[4]</sup> and Venieratos and Anagnostopoulou<sup>[3]</sup> classifications.

Le Minor<sup>[4]</sup> has described the communication between median nerve and musculocutaneous nerve in to following five types.

Type I: No communication between the MN and the Mc. The Mc pierces coracobrachialis and innervates coracobrachialis, biceps brachii and brachialis.

Type II: MN is formed by joining of LRM and some fibers of MRM. The remaining fibers of the MRM pass through the Mc nerve and in the middle of the arm separate out from the Mc and join the MN.

Type III: Some of the LRM fibers of the MN pass along the Mc and after some distance become separate to join the MN in the lower part of arm.

Type IV: The Mc fibers join the LRM and after some distance the Mc arises from the MN.

Type V: The Mc is absent and all fibers of the Mc pass through the LRM and fibers to the muscles supplied by Mc are supplied from the MN.

Venieratos and Anagnostopoulou<sup>[3]</sup> described three different types of communication between the Mc and MN in relation to coracobrachialis.

Type 1: There is a communication between the Mc and MN proximal to the entrance of the Mc into coracobrachialis.

Type 2: The communication between the Mc and MN is distal to the muscle.

Type 3: Neither Mc nor its communicating branch pierce the muscle.

In the present case the variation observed on left side is of Le Minor type III and the variations observed on both left and right sides are of Venieratos and Anagnostopoulou Type 2.

Padur et al<sup>[13]</sup> described a case in which the median nerve was taking origin from three roots, wherein the LRM was bifid and was considered as two roots and they joined with the MRM at different levels in axilla which was similar in our case too. Natsis et al<sup>[12]</sup> reported a median nerve to have five roots, in which three roots from the lateral cord joined with two roots from medial cord. With this kind of description in use the median nerve on the right side in present case can be considered to have three roots of origin. Chauhan et al<sup>[2]</sup> described a peculiar case in which there were two lateral roots, but the second lateral root joined with the MRM in the lower part of the arm. They concluded as authors like Venieratos and Anagnostopoulou<sup>[3]</sup> considered that third root median nerve comes out from musculocutaneous nerve in the upper third of arm and joins the already formed median nerve hence the median nerve they described had three roots. But in our case on the right side as both lateral roots are directly derived from the lateral cord and the

communicating branch from musculocutaneous nerve is given in the lower part of arm hence we cannot consider this to be a median nerve with three roots. Guerri-Gutenberg and Ingolotti<sup>[16]</sup> described this dilemma of authors regarding confusing nomenclature of variations in median nerve and musculocutaneous nerve in detail.

Embryological explanation:

Different explanations regarding the multitude of variations in median nerve formation are proposed. Chauhan et al<sup>[2]</sup> discussed that these variations are probably an example of ontogeny repeating phylogeny. As lower vertebrates have only one trunk which is equivalent of that of median nerve, so in a developed animal like human when the median nerve is formed in a variant case it might have skipped the fusion of lateral cord and medial cord and persisted as a single trunk which is the case in our left side up to the mid part of arm. Other variations are difficult to explain from this explanation only.

In humans around fifth week of embryonic life the upper limb buds organize themselves from paraxial mesenchyme against the lower five cervical and upper two thoracic segments. The ventral primary rami of spinal nerve penetrate the buds. The peripheral processes of motor and sensory nerves spread in various directions inside the organizing mesenchyme. Muscles are derived from precursors of somatic muscle cells, whereas the nerves are derived from neural tube and neural crest. Though the exact mechanism or reason of adult formation of nerves and brachial plexus is not known, but precise coordinated site signaling done by chemoattractants and chemorepulsants are believed to regulate the formation of nerves. Any kind of altered signals will lead to a change in the normal presentation of brachial plexus, which might lead to abnormal communications between adjacent nerves thus presenting as variations. These variant nerve formation and communications once formed persists throughout life<sup>[18]</sup>.

## CONCLUSION

Morphological variation of lateral cord, musculocutaneous nerve and median nerve are though not uncommon individually, but their presence in a single individual is rare and it points towards certain developmental forces that resulted in such a variation. Although this type variation is quite distant from what is considered standard or normal, the absence of any abnormality in function of upper limb rules out probable functional loss in this type of abnormality. These variations though are not unsuitable for normal function, but are important for the treating surgeon and

anesthetists, who would delve this field. The knowledge of such variations seen in the branching of lateral cord and communication between median nerve and musculocutaneous nerve should be kept in mind by neurologists and surgeons. These abnormal branching and unconventional communications might be a reason for unexplained signs and symptoms of upper limb like pain and paresthesia, as well as pose risk for unnecessary injury to them while attempting surgery around the axilla and flexor compartment of arm. The abnormal communications in the middle of the arm could be a potential site for compression neuropathy and even can be damaged during surgery. The nerve fibers of lateral root of median nerve piercing the coracobrachialis along with musculocutaneous nerve, instead of musculocutaneous nerve alone, might produce symptoms of compression neuropathies showing unexplained areas of distribution.

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