International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(3.1):6706-11. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2019.194

Original Research Article

ANATOMICAL VARIATIONS IN THE FORMATION OF MEDIAN NERVE WITH ITS CLINICAL IMPLICATION: A CADAVERIC STUDY

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ABSTRACT

Background: The brachial plexus is a major and complicated plexus that gives rise to a number of nerves to the muscles of the back and the upper limb .Median nerve (MN) is one of the terminal branches of the brachial plexus (BP). It is normally formed in the axilla by union of lateral and medial spinal roots, which arise from lateral and medial cords of brachial plexus. The purpose of this study is to provide additional information about variations in the formation of median nerve as its abnormal branching pattern constitutes a major importance in anatomical, clinical and surgical fields.

Methods: Observational based descriptive study was made on sixteen cadavers comprising of 32 upper limbs, of which one specimen was female cadaver. The dissection was performed bilaterally on both upper limbs and the axillary regions of the cadavers. Careful observation for the variation in the formation of median nerve has been carried out. The finding was properly photographed for proper documentation.

Results: It was observed that out of 32 upper limbs 5 (15.63%) showed anatomical variations in the formation of median nerve, with its course, branching pattern and communication with musculocutaneous nerve. Among the variations in 1(3.13%) median nerve was formed by the fusion of three roots, two from the lateral and one from the medial cord of the brachial plexus (BP). Further in 2(6.25%) medial root of medial cord receive additional unusual small lateral root from lateral cord forms median nerve. In other 2(6.25%) median nerve also receive communication rami from musculocutaneous nerve at the lower third of the arm just below coracobrachialis muscle.

Conclusion: The anatomical variations were not bilateral in any cadaver, hence 4 (12.50%) of the variations occurred more often on the left side, and 1(3.13%) occurred in right side. Therefore knowledge of such variations is important for anatomists, radiologists, neurologists, anesthesiologists, and surgeons for proper clinical diagnosis. So, these variations should be well kept in mind.

KEY WORDS: Brachial plexus, Median nerve, Musculocutaneous nerve, Anatomical Variations, Formation of median nerve.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2019.194	**Article Information** Received: 02 Apr 2019 Accepted: 06 May 2019 Peer Review: 02 Apr 2019 Published (O): 05 Jul 2019 Revised: None Published (P): 05 Jul 2019

INTRODUCTION

The brachial plexus is a major and complicated plexus of nerves extends downward and laterally, and then passes over the first rib behind the clavicle and enters the axilla. The brachial plexus gives rise to a number of nerves to the muscles of the back and the upper limb [1]. The plexus has supraclavicular and infraclavicular

parts. The supraclavicular part includes the roots, trunks and divisions. The infraclavicular part consists of the cords and its branches. Three main trunks are composed by joining these five roots to-gether. Each one of these three trunks divides into posterior and anterior divisions. These divisions give rise to medial, lateral and posterior cords. The axillary nerve and the radial nerve are branches of posterior cord. The medial cord gives rise to the ulnar nerve and medial root of the median nerve. The lateral cord gives rise to the lateral root of the median nerve and the musculocutaneous nerve [2, 3].

Median nerve (MN) is one of the terminal branches of the brachial plexus (BP). It is normally formed by union of lateral and medial spinal roots, which arise from lateral and medial cords of BP. Its fibers are derived from the sixth, seventh, and eighth cervical and first thoracic nerves. The roots fuse together at anterior or lateral side of the third part of the axillary artery to form MN [4].

In the arm the nerve passes at first lateral to brachial artery (near the insertion of musculus coracobrachialis),then crosses in front of (rarely behind) the artery, descending medial to it in the cubital fossa where it passes posterior to the bicipital aponeurosis and anterior to the brachialis muscle without giving out any branches. In the forearm, it passes between the heads of pronator teres muscle and crosses lateral to the ulnar artery. Median nerve descends after that between flexor digitorum superficialis and flexor digitorum profundus muscles. Near the retinaculum flexorum the nerve descends lateral to musculus flexor digitorum superficialis, and passes to the palm between the muscle and retinaculum flexorum. In forearm and palm it gives motor branches for the flexors and sensitive branches to the skin of lateral side of the palm [5–7].

The musculocutaneous nerve, which is a branch of the lateral cord of the brachial plexus, passes through the coracobrachialis muscle to supply Coracobrachialis, Biceps and Brachialis muscles. It also gives articular branches to Shoulder and Elbow joint. Then it continues as the lateral cutaneous nerve of the forearm without any communication with the median nerve, or other nerve [8].Anastamoses between different nerves in the arm are rare, but those between the Median nerve (MN) and the Musculocutaneous Nerve (MCN) have been reported since 19th century [1].

Therefore, this study was carried out to investigate more information about the brachial plexus varia-tions and mainly focused on the formation of MN.

Aims and Objectives: The present study is carried out with an aim to provide additional information about variations in the formation of median nerve or in its abnormal branching pattern constitute a major concern in clinical and surgical field. Knowledge of these variations not only provides the clinician with a proper interpretation of the case, but also minimizes the complication in surgical approaches in this region.

MATERIALS AND METHODS

The present study was conducted based on observational descriptive study by dissection of 32 upper limbs of embalmed human cadavers (15 males and 1 female) obtained from the Department of Anatomy, division of Bio medical Sciences, school of medicine ,college of health sciences Mekelle university, Ethiopia. The dissection was performed during under and postgraduate teaching of students both the upper limbs and the axillary regions of the cadavers as mentioned in the 12th edition Grant dissector (2005) guide for dissection. Variations were observed in five of the cadavers. It was properly cleaned and photographed for proper documentation.

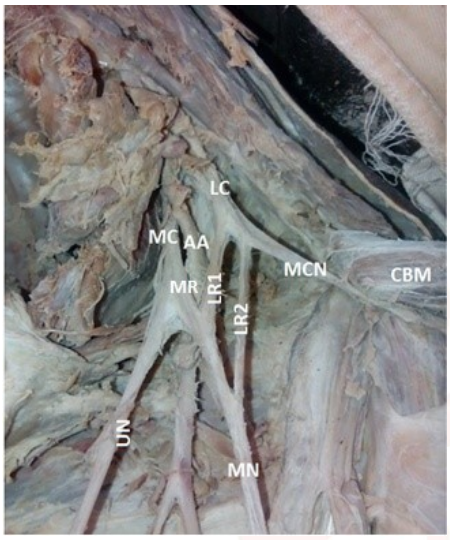
RESULTS

Sixteen cadavers (32 upper limbs), were used in the present study .Among them 5 (15.60%) were encountered anatomical variations in formation, course and branching patterns between Musculocutaneous and Median nerves, while the rest 27 (84.40%) upper limbs of the cadavers did not show any relevant variation between these nerves. The anatomical variations were not bilateral in any cadaver.

Case 1: Formation of median nerve by three roots: In 1(3.13%) the median nerve was formed in the axilla by three roots (two from lateral cord and one from medial cord). The two roots were

noted to arise from the lateral cord proximal to the origin of coracobrachialis muscle and joining individually with medial root of medial cord forming the median nerve trunk. This anomaly was detected unilaterally in the left arm of male cadaver. **(Fig1)**

Fig. 1: Photograph of male cadaver in left axilla showing formation of median nerve by three roots**.**



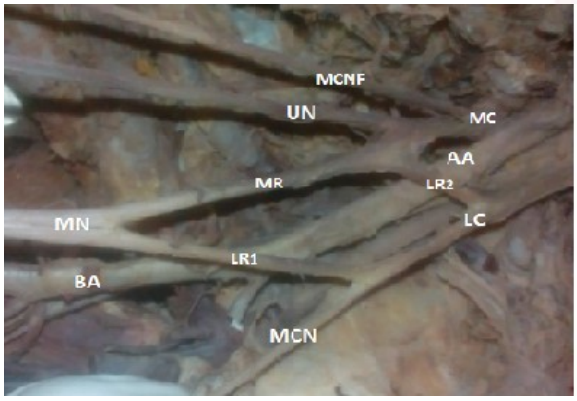
MN: median nerve **MCN:** musculocutaneous nerve **CBM:** coracobrachialis muscle **MC**: medial cord of brachial plexus **AA**: Axillary artery **LR1:** first lateral root of the median nerve; **LR2** :second lateral root of the median nerve **MR**: medial root of median nerve; **UN**; ulnar nerve

Case 2: Formation of median nerve from unusual communication roots of lateral & medial cords of BP in the axilla

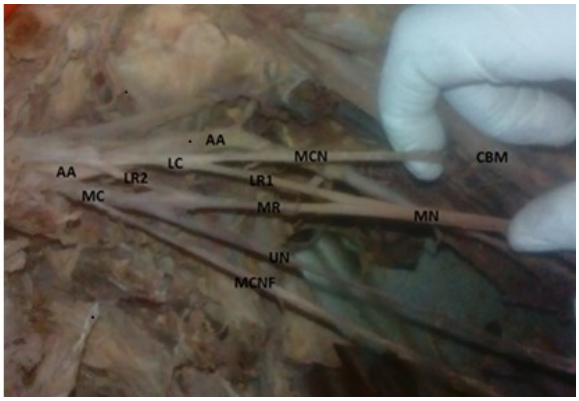
In 2(6.25%) upper limbs the additional small lateral roots (LR2) arose from lateral cord of BP joined with the medial root (MR) of medial cord of BP and together with the usual origin of lateral root (LR1) that arose from lateral cord of BP forming the main median nerve trunk (MN).(fig2a&b)

Fig 2a&b: Photograph of male cadavers in left axilla showing formation of median nerve from unusual communication roots of lateral & medial cords of BP.

a Photograph of male cadavers in left axilla



b Photograph of male cadavers in left axilla



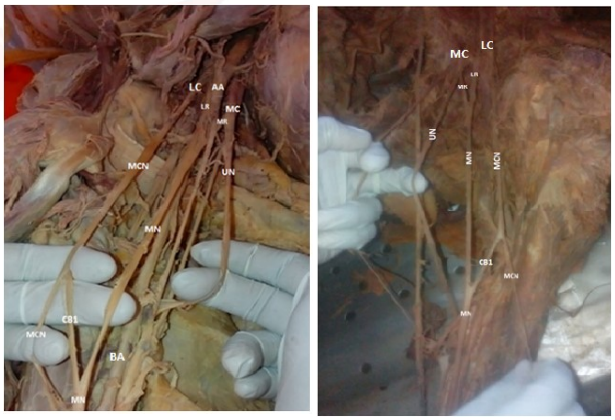
CBM:coracobrachialis muscle **MCN**:musculocutaneous nerve; **MN**: median nerve **UN**; ulnar nerve **MC**: medial cord of brachial plexus **LC**: Lateral cord of brachial plexus **AA**: Axillary artery **LR1**: First lateral root of the median nerve;**LR2**: Second lateral root of median nerve; **MR**: medial root of median nerve; ; **MCNF;** medial cutaneous nerve of forearm

Case 3: Communication between MCN and MN distal to coracobrachialis.

2(6.25%) cadavers communication rami were present between the musculocutaneous nerve and the median nerve in the lower third of the arm just below coracobrachialis muscle. (Fig. 4&5).

Fig. 3 A &B: Showing Communication between MCN and MN distal to coracobrachialis.

A.rghit arm of male cadaver B. left arm of male cadaver



LC: Lateral cord of brachial plexus **MC**: medial cord of brachial plexus **AA**: Axillary artery **LR**: lateral root of the median nerve; **MR**, medial root of the median nerve; **MN**: median nerve, **MCN**: musculocutaneous nerve; **CB1;** communicating branch ;**UN**: ulnar nerve ; **BA:** brachial artery

DISCUSSION

Variations in the formation, course and distribution of the brachial plexus (BP) are very common & have been reported in the literature. Median nerve is one of the branches of the brachial plexus which shows frequent variations,

which include abnormal formation and abnormal communications with other nerves such as musculocutaneous and ulnar nerves [9, 10]. Moreover, the occurrence of 15.63 %(5⁄32) of communications between the MN and the MCN we found in the present study. Among the communications 12.5% (4⁄32) on the left side and 3.13% (1⁄32) on the right side of the cadavers. 3.13% (1⁄32) of left axilla, we found formation of median nerve by three roots as opposed to the usual two roots. The roots were originated two from lateral cord and one from medial cord of BP (FIG .1). Similar finding was reported by C.N. Mat Taib et al. [11] in Forty-four upper limbs from 22 cadavers and found formation of the median nerve from three roots in 54.6% (12⁄22). Among which the two roots were originated from lateral cord and one from medial cord of BP.

Another study conducted by Darji et al. [12] on 100 upper limbs from 50 cadavers and reported that there was multiple communications between Medial & Lateral root of median nerve in 3 upper limbs. Among which one limb shows that the median nerve was formed by two lateral roots and one medial root. The formation of median nerve by two roots from lateral cord in both the cadavers and one root from the medial cord.

Amrita et al. [13] studied anatomical variations in the formation of median nerve in 10 adult cadavers and found variant communications between musculocutaneous nerve (MCN) and median nerve (MN) in two cadavers, Among the two variations, in one right upper limb cadaver median nerve was formed by three roots and the roots were originated from the lateral cord and one root originated from the medial cord of BP.

Furthermore, many authors have also been reported by similar findings in the formation of median nerve by three roots, in which two of the roots originated from lateral cord and one from medial cord of BP [9, 14-21]. Albeit, the percentage of the present study findings has not accurate similarity from those of the findings which was reported by the above authors, this is may be due to a difference in the sample size or sample always doesn't matter for accurate results in such anatomical variation studies. this kind of variation is more prone to injury in surgical operations of the axilla and that, the very close course of the second lateral root of the median nerve to the axillary artery may lessen the blood supply of the upper extremity by compressing the vessel [17].

On the other hand in 12.05% (2) cases of the present study, there were additional small lateral roots as (LR2) arose from lateral cord joining medial root of medial cord to form main median nerve trunk (Fig. 2). This finding is similar to that of C.N. Mat Taib et al.,Buddhadeb Ghosh et al.,Sontakke et al.,and Pais et al., who reported that the lateral root originated, as usual, from the lateral cord, whereas the medial root received not only a major contribution from the medial cord, to form main median nerve trunk [11, 22-24].

The most frequent variation which is in the presence of large communicating branch of median nerve, originated from the musculocutaneous nerve and joins to the median nerve, at the distal third of the arm, has also been reported by several authors [25-30]. Such variations are predominantly unilateral [21]. Similar findings of the above study, we found in 2 (12.05%) cases. In this case, large communicating branches between the MN and the MCN at the distal third of the arm were noticed unilaterally. According Choi *et al*., the bilateral variations are very rare [26].This kind of variation occurred may be due to small lateral root of median nerve [31].In addition, Arora *et al*., have also described the presence of a small lateral root as the cause for such variations, where the fibers of the median nerve take an unusual course over a short distance along the lateral cord or musculocutaneous nerve to reach the median nerve as additional roots. Normally the musculocutaneous nerve arises from lateral cord of brachial plexus but it has frequent variations. The nerve may be doubled, unusually short or even absent [32]. Embryologically the mesenchyme, which is derived from the somites, migrates and forms the muscle of the limb bud and same time it is penetrated by the ventral primary rami of spinal nerve. Further, the mesenchymal condensation forms the muscle. The disturbance in these processes, taking place in the 4th -7th weeks of development, leads to anatomical variation. Lack of co- ordination

between formation of limbs muscles & their innervations may be responsible for appearance of communicating branch [33].

In general several terms have been used to describe the communication between the musculocutaneous nerve to the median nerve, such as abnormal lateral root of the median nerve by Saeed and Rufai [21], third (double lateral) root of the median nerve by Venieratos et al., [25], and, additional lateral root by Goyal et al.,[34]. Clinically, these variations may be related to entrapment syndrome. If the entrapment of the musculocutaneous nerve coexists with a communicating branch between the musculocutaneous and median nerve may lead symptoms of median nerve neuropathy [34]. This knowledge may result useful to doctors to avoid an unnecessary carpal tunnel release [25].

The anatomical variations of the musculocutaneous and the median nerve in the arm have been classified into 5 types by Le Minor JM [**35**].

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 fibers 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 fibers run within the median nerve along its course. The present case describes a Type 2 variation which is the commonest type.

According to this description, the findings in the present study may be classified as a type 2&3.

Clinical Significance: Meticulous knowledge of possible variations of MCN and the MN may endow with valuable help in the management of traumatology of shoulder joint and arm as well as in circumventing iatrogenic damage during repair operations of these regions .Therefore knowledge of such variations is important for anatomists, radiologists, neurologists, anesthesiologists, and surgeons for proper clinical diagnosis.

CONCLUSION

Variations such as communications between median nerve and musculocutaneous nerve or in their abnormal branching pattern constitute a major concern in clinical and surgical field. Knowledge of such variations is important for anatomists, radiologists, neurologists, anesthesiologists, and surgeons for proper clinical diagnosis. So, these variations should be well kept in mind.

ABBREVIATIONS

BP: brachial plexus
MN: median nerve
MCN: musculocutaneous nerve
CBM: coracobrachialis muscle
MC: medial cord of brachial plexus
AA: Axillary artery
LR1: first lateral root of the median nerve
LR2: second lateral root of the median nerve
MR: medial root of median nerve
UN: ulnar nerve

ACKNOWLEDGEMENTS

All the authors wish to convey our sincere thanks to Mr.AMANEUL TESFAY and Mr.GETACHEW TESEMA. Authors also acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

Conflicts of Interests: None

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How to cite this article: Afewerki Bekele Degene, Birhanu Gebremeskel Gebremedhin, Kidanemariam Gaim kidanu. ANATOMICAL VARIATIONS IN THE FORMATION OF MEDIAN NERVE WITH ITS CLINICAL IMPLICATION: A CADAVERIC STUDY. Int J Anat Res 2019;7(3.1):6706-6711. **DOI:** 10.16965/ijar.2019.194