



RESEARCH ARTICLE – MEDICINE (MISCELLANEOUS)

## Cadaveric Study of the Median Nerve Variations; Roots and Communication in the Arm and Forearm

Afnan Ali<sup>1\*</sup>, Mohammed A.A. Abdelmotalab<sup>1,2</sup>, Omer Ahmed Awad Abdelaziz<sup>1</sup>, Ammar Mohammed Ali<sup>1,2</sup>

<sup>1</sup>Anatomy Department, Faculty of Medicine and Health Science, Omdurman Islamic University, Sudan

<sup>2</sup>Anatomy Department, Faculty of Medicine, International University of Africa, Sudan

\*Corresponding Author E-mail: [plasticsurgeon96@gmail.com](mailto:plasticsurgeon96@gmail.com)

Article Info.	Abstract
<i>Article history:</i> Received 8 Jan. 2026  Revised 20 Feb. 2026  Accepted 2 March.2026  Publishing 10 May. 2026	<b>Background:</b> Anatomical Variations of the median nerve and its communication have been described in the academic literature. These variations are important clinically during anesthesia of the median nerve block and surgical exploration. <b>Objective of study:</b> This study aims to investigate the median nerve anatomy from the root and its communication with the musculocutaneous and ulnar nerves. <b>Materials and Methods:</b> This is a descriptive cadaveric-based study, which was carried out at the laboratory dissection of the College of Medicine and Health Science, Omdurman Islamic University, Sudan. It was performed on 25 formaldehyde-preserved Sudanese cadavers; each upper limb was properly dissected and assessed for any variations. The data was analyzed by the SPSS program. <b>Results:</b> Bilateral 50 upper limbs of Sudanese cadavers were studied. The male-to-female ratio was 23:2. Median nerve root variation was found in 10% in the form of three nerve roots instead of two. Communication in the arm region between the musculocutaneous nerve and the median nerve was observed in 10% of study subjects, whereas communication in the forearm region between the median nerve and the ulnar nerve was found in 4% of study subjects. <b>Conclusion:</b> The variation of median nerve roots was noted in 10% of the study population. Regarding the communication in the forearm and arm regions was detected as 10% and 4%, respectively. Recommendation: Median nerve anatomical variations should be considered in any planned surgical intervention or regional anesthesia.

This is an open-access article under the CC BY 4.0 license (<http://creativecommons.org/licenses/by/4.0/>)

Publisher: Middle Technical University

**Keywords:** Musculocutaneous Nerve, Ulnar Nerve; Median Nerve; Communicating Branch CB; Cadaveric Variation.

### 1. Introduction

The median nerve is generated at the lower border of the axilla by connecting its medial and lateral roots to the corresponding cords of the brachial plexus. The median nerve enters the forearm through the cubital fossa, located between the pronator teres' two heads. It extends deep into the fibrous arch of the flexor digitorum superficialis and distally to the posterior part of the flexor digitorum superficialis. Above the wrist, the median nerve emerges superficially across the space separating flexor digitorum superficialis and flexor carpi radialis, then the nerve goes just laterally to the tendon of palmaris longus, higher to the elbow the median nerve gives branches to the pronator teres, flexor carpi radialis, and palmaris longus [1]. Complex passway of the MN can be involved in entrapment syndromes like the pronator teres, carpal tunnel, and anterior interosseous syndromes [2]. In 1 out of 60 upper extremities, the Brachialis muscle was innervated by a branch from the MN. In addition, there is a branch from the lateral root supplied the short and long heads of biceps brachialis muscle. However, the coracobrachialis receives branch originated from the lateral cord of the Brachial plexus. The MCN absence was recognized in this Egyptian study. Also, in 5% the MN was communicated with MCN nerves [3]. A study done in Malaysia, they studied 22 formalin-preserved human cadaver dissected upper limbs, bilaterally to study the median nerve thoroughly from the root till the forearm. They found that the typical configuration of two roots give median nerve was observed in 63.6% for left side and 72.7% for the right side [4].

The MN was arising in the form of three root by 36.4% of cases in left side 18.2% of the cases in the right side. The right side of upper extremities was noted with further variations. One root was also outlined and four roots, in 4.5% each. Most of the MNs show no communication with other nerves. MN communication with the MSC was documented and only 4.5% had communication with the ulnar nerve in the right forearm in the study subjects [5-7]. A case report by Surendran et al. showing that three lateral nerve roots constitute the MN. In a Brazilian

study, thirty forearms were dissected; they determined three cases that contained the Martin anastomosis and one contained the Marinacci anastomosis. This study aimed to describe the median nerve root variation in the median nerve root and its communications in the arm and the forearm [8, 9].

## 2. Materials and Methods

### 2.1. Study design

This is a cross-sectional descriptive, cadaveric-based study. It was conducted in Omdurman Islamic University's faculty of medicine and health sciences, in the dissection room on formalin-preserved human cadavers. It was completed between January 2022 to October 2022. It was conducted on twenty-five formaldehyde-preserved cadavers in the dissection room of Omdurman Islamic University, Faculty of Medicine and Health Science, Department of Anatomy. The study was conducted on twenty-five formaldehyde-preserved cadavers, with a bilateral upper limb examined from each cadaver, totaling fifty upper limbs.

### 2.2. Selection criteria

All cadavers should be well preserved with bilateral upper limbs to be included in the study. Any damage in the cadaver upper limbs or those that contain a single unilateral upper limb, and damage to the median nerves in the cadavers, were excluded from the study data.

### 2.3. Data collection

The study was approved by the research committee of Omdurman Islamic University's (OIU) Faculty of Medicine and Health Science. The study data were collected by assessing MN variations and communications by using a questionnaire designed for reporting variations. All dissection equipment and tapes were used to prepare specimens. The study was done in twenty-five formaldehyde-preserved human Sudanese cadavers. The median nerve was the core of the study. Bilateral upper limbs were dissected using the Cunningham manual technique. The dissection begins with the axilla, skin, and fascia being incised and reflected. The muscles and nerves were demonstrated. MN roots were cleaned and studied. After that, the MN was identified through meticulous dissection to study its variations and communications in relation to other peripheral nerves, including MCN and UN.

### 2.4. Statistical analysis

Data was collected and then organized and analyzed using Statistical Package for Social Science (SPSS) for Windows version 25 and presented as tables and figures displaying frequency and percentage of variation.

## 3. Results

The study included 50 MN in 50 upper limbs of 25 formalin-preserved cadavers. The gender distribution of the examined cadavers was male 23 (92%), while only 2 cadavers were female (8%); Table 1, demonstrates the gender distribution of the studied cadavers.

Table 1. Gender distribution of investigated cadavers

Gender	Frequency	Percentage%
Male	23	92
Female	2	8

MN formed from double root one from medial cord and single root from lateral cord this phenotyping was found in 45 (90%) of cases; only 5 (10%) of cases showed a different pattern, as MN has three nerve roots. Table 1 determines median nerve root variations; Figure 1 shows the variation of the median nerve roots. This variation was found in two variants; one variant shows that MN formed by one lateral root and two medial roots; this represents 8%. Another variant is that the median nerve is formed by double medial roots and one lateral root; this appears to be only 2% as shown in Table 2.

Table 2. Median nerve roots variations of the investigated cadavers

number of median nerves roots	Frequency	Percentage%
Two roots one from the medial cord and one from the lateral cord	45	90
Three roots two from the lateral cord and one from the medial cord	2	4
Three roots two from the medial cord, and one from the lateral cord	4	8

MN communication in the arm was found with the MCN in 5 upper limbs; symmetrical variation was found in two cadavers, whereas unilateral variation was found in one cadaver Figs. 1 and 2 show median nerve communication in the arm. There are two lateral roots and one medial root. LR1: Lateral nerve root No. 1 LR2: Lateral nerve root No. 2 MCN: Musculocutaneous Nerve MN Median Nerve UN: Ulnar Nerve A A: Axillary artery as shown in Fig. 3.

There is one cadaver that shows a complete absence of the MCN unilaterally. The biceps muscle and part of the brachialis are supplied by the MN instead of MCN, and give rise to the lateral cutaneous branch of the forearm. Figs. 4 and 5 shows the median nerve branches to arm muscles. Right MN gives muscular branches to the biceps and brachialis muscles. Notice the absence of MCN. Just above the elbow, the lateral cutaneous nerve of the forearm is a branch from the MN. MN communication in the forearm with the UN was found in 2 cadavers; only the unilaterally represents this communication. The right upper limb presents a communicating branch (CB) between the MN and the UN at the forearm near the wrist.

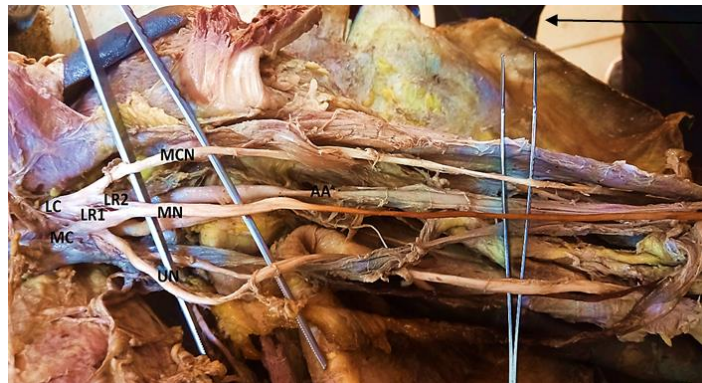


Fig. 1. Shows the number of MN communications in the arms, between MN & MCN

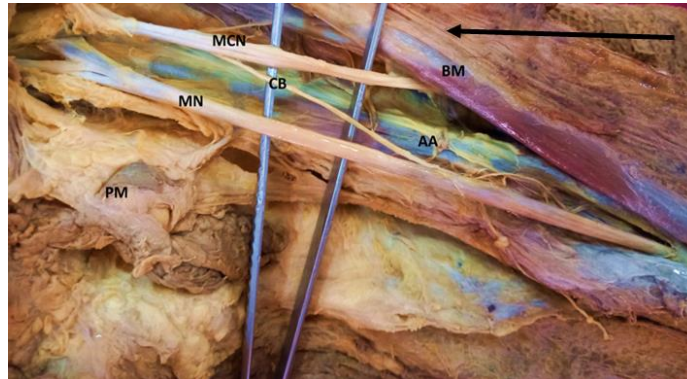


Fig. 2. The left side communicating branch between MN and MCN. AA axillary artery, BM biceps muscle, PM pectoralis muscle

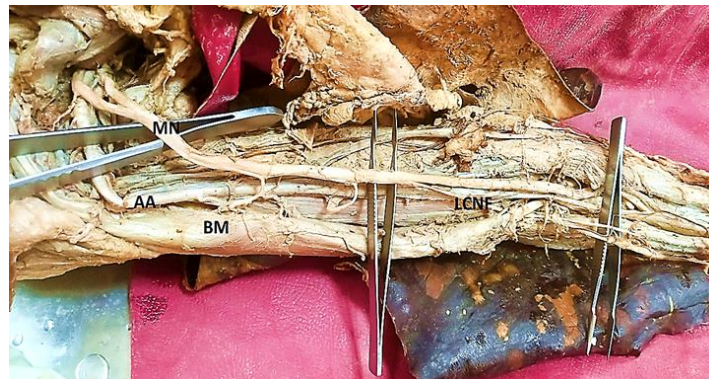


Fig. 3. The left arm demonstrates variation of the median nerve root

#### 4. Discussion

Fifty upper limbs in this study were evaluated for MN roots variation and communication with nerves in the forearm and arm. This study illustrated typical median nerve configurations of two roots, originating from the medial cord and the lateral cord, were 45(90%). However, MN composition by three roots is present in 5 (10%) as shown in table (4:2). This result was comparable with a study done in Sri Lanka, the author studied 98 upper limb and found that there was variation in the roots of the MN about 15.3% and it was consistent with this study result, also their study mentioned that 83 (84.69%) of MN roots had arisen as one root from medial and one from the lateral cords, another way of median nerve origin was described by their study, that the MN was arose by single root form the lateral cord and double roots form the medial cords 1 (1.02%) where in this study was found to be in 4(8%) of subjects. He reported that origin of MN by triple roots and double roots coming out of the lateral cord were 6 (6.12%) where in this study was detected in 2 (4%) of subjects [10].

In the current study, the MN originated from a double root emerging from the lateral cord and a single root coming out of the medial cord. This is the same result reported in a study done on a male cadaver 45-yearold. A similar situation was found during the dissection course, which was done of the left supraclavicular region and axilla of a preserved cadaver of a 69-year-old male, in which the median nerve received a subsidiary branch from the lateral cord [11,12]. This variation of the MN roots is due to embryological bases and genetic factors. The upper limb buds lie opposite the lower 5 cervical and 2 higher thoracic segments. The spinal nerve emerges from the ventral ramus, penetrates the limb bud mesenchyme, and starts connecting various mesoderm condensations. Early connection between the nerve and muscular component is essential for full functional differentiation [13]. MN variations in the arm that were detected in this study include identification of neural anatomical CB linking the MN to the MCN 5 (10%) specimen cadavers, as described in figure (4:3), while in the rest 45 (90%) cadavers, there is a lack of any CB linking those nerves. In Iran, they studied 26 upper limbs; they describe one case with MN to MCN communication [14]. The frequency of

communication between the previous two in other multiple studies ranges from 10%–53.6% [15-19]. This variability is attributed to biological features, methodology, and sample size that affect phenotyping in the studied populations. Understanding MCN-MN connections is essential in peripheral nerve surgery, particularly nerve transfer procedures. MN has been very successful in receiving the nerve transfer to restore elbow flexion. Moreover, the brachialis muscle motor branch has been employed as a donor graft nerve to the anterior and posterior interosseous nerves to treat lower brachial plexus injuries and tetraplegia [20- 23].

In contrast to the forearm MN course, communication to the UN. This association was demonstrated in this study specimen 2 (4%), as shown in figure (4:6), whereas in the remaining 48, this phenomenon is absent. In comparison, an Italian study of 53 upper limbs encountered MN and UN communication in 53% [23]. It is reported that there is a link between genetic factors and the presence of the communicating branch in members of the same family; this could be due to the influence of a hereditary autosomal dominant trait. It is also claimed that there is a genetic influence on the incidence of MN and UN connection, as evaluation of fetuses with congenital abnormalities revealed that all fetuses with trisomy 21 have this anatomic variation bilaterally [24, 25]. The MN communications can modify clinical symptoms, such as alterations in muscular innervation arrangements and hand sensory distribution. Thus, producing indications and symptoms that differ from those observed in ordinary clinical settings [26]. In this study, the MCN was absent in one cadaver unilaterally; the MN replaces the MCN and gives muscular branches to the biceps muscle and part of the brachialis, and also gives the lateral cutaneous nerve of the forearm, as shown in Fig. 3. In contrast with the Sudanese study, which describes a bilateral absence of MCN, the MN replaces its function and gives branches to the flexor muscles of the arm [27- 29]. This similarity between the results may be attributed to that both studies were done in Sudanese cadavers.

## 5. Conclusion

The MN root variation was detected in 10% of the cases. Regarding arm and forearm MN communication, it was 10% and 4%, respectively. The study of the variation of the root and the communication in the arm and forearm is of an important value at anatomical, medical, and surgical levels. which can result in altering the clinical outcome of a nerve injury, either accidental or iatrogenic, and may also affect the clinical course if nerve entrapment confuses the clinician.

## Acknowledgements

A great deal of appreciation to the directors for this research for their immense help and advice during this journey. Much gratitude to the dissection room workers and students for their assistance over the course of the study journey.

Nomenclature & Symbols			
MCN	Musculocutaneous Nerve	SPSS	Statistical Package for the Social Sciences
UN	Ulnar Nerve	LR1	Lateral nerve root No. 1
MN	Median Nerve	CB	Communicating Branch

## References

- [1] Patil, S., Rathinam, B., Kumar, B., Chaware, P., Wakode, N., Wakode, S., ... & Gandhi III, K. (2023). A cadaveric study to define the variant patterns of median nerve formation. *Cureus*, 15(5). doi: 10.7759/cureus.39806.
- [2] Akhtar, M. J., Kumar, S., Chandan, C. B., Kumar, B., Sinha, R. R., Akhtar, M. K., & Kumar, A. (2022). Variations in the formation of the median nerve and its clinical correlation. *Maedica*, 17(4), 878. doi:10.26574/maedica.2022.17.4.878.
- [3] Priya, A., Gupta, C., & D'souza, A. S. (2019). Cadaveric study of anatomical variations in the musculocutaneous nerve and in the median nerve. *Journal of Morphological Sciences*, 36(02), 122-125. doi: 10.1055/s-0039-1688799.
- [4] Taib, C. M., Hassan, S. N. A., Esa, N., Moklas, M. M., & San, A. A. (2017). Anatomical variations of median nerve formation, distribution and possible communication with other nerves in preserved human cadavers. *Folia morphologica*, 76(1), 38-43. doi: 10.5603/FM.a2016.0045.
- [5] Pandey, S. K., & Shukla, V. K. (2007). Anatomical variations of the cords of brachial plexus and the median nerve. *Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists*, 20(2), 150-156. doi: 10.1002/ca.20365.
- [6] Ballesteros, L. E., Forero, P. L., & Buitrago, E. R. (2015). Communication between the musculocutaneous and median nerves in the arm: an anatomical study and clinical implications. *Revista Brasileira De Ortopedia (English Edition)*, 50(5), 567-572. doi: https://doi.org/10.1016/j.rboe.2014.08.009.
- [7] Pattanshetti, S. V., Jevoor, P. S., Shirol, V. S., Dixit, D., & Bhimalli, S. (2012). A study of the formation and branching pattern of brachial plexus and its variations in adult human cadavers of north Karnataka. *Journal of the Scientific Society*, 39(2), 70-77. doi:10.4103/0974-5009.101846.
- [8] Passey, J., Rabbani, P., Razdan, S. K., Kumar, S., Kumar, A., & Razdan, S. (2022). Variations of median nerve formation in North Indian population. *Cureus*, 14(1). doi: 10.7759/cureus.20890.
- [9] Ghosh, B., Dilkash, M. N. A., Prasad, S., & Sinha, S. K. (2022). Anatomical variation of median nerve: cadaveric study in brachial plexus. *Anatomy & cell biology*, 55(2), 130-134. doi:10.5115/acb.22.022.
- [10] Natsis, K., Paraskevas, G., & Tzika, M. (2016). Five roots pattern of median nerve formation. *Acta Medica*, 59(1), 26-28. doi:10.14712/18059694.2016.52.
- [11] Butz, J. J., Shiwlochan, D. G., Brown, K. C., Prasad, A. M., Murlimanju, B. V., & Viswanath, S. (2014). Bilateral variations of brachial plexus involving the median nerve and lateral cord: An anatomical case study with clinical implications. *The Australasian Medical Journal*, 7(5), 227. doi: 10.4066/AMJ.2014.2070.
- [12] Parchand MP, Patil ST. Absence of musculocutaneous nerve with variations in course and distribution of the median nerve. *Anat Sci Int*. 2013;88(1):58–60. doi: 10.1007/s12565-011-0126.
- [13] Soleymanha, M., Mobayen, M., Asadi, K., Adeli, A., & Haghparast-Ghadim-Limudahi, Z. (2014). Survey of 2582 cases of acute orthopedic trauma. *Trauma monthly*, 19(4), e16215. doi: 10.5812/traumamon.16215.

- [14] Moasses, Z., Aryan, A., Hassanpour-Dehnavi, A., Zarenezhad, M., & Dorodchi, A. (2024). The anatomical variations of median nerve in Shiraz, Iran. *Anatomy & cell biology*, 57(1), 18-24. DOI: <https://doi.org/10.5115/acb.23.229>.
- [15] Soubeyrand, M., Melhem, R., Protais, M., Artuso, M., & Crézé, M. (2020). Anatomy of the median nerve and its clinical applications. *Hand Surgery and Rehabilitation*, 39(1), 2-18. DOI: 10.1016/j.hansur.2019.10.197.
- [16] Caetano, E. B., Vieira, L. Â., Cavalheiro, C. S., Razuk Filho, M., Almargo, M. A. P., & Caetano, M. F. (2016). Anatomic study of the nervous communication between the median and musculocutaneous nerve. *Acta Ortopédica Brasileira*, 24(4), 200-203. <https://doi.org/10.1590/1413-785220162404159372>.
- [17] Guerri-Guttenberg, R. A., & Ingolotti, M. (2009). Classifying musculocutaneous nerve variations. *Clinical Anatomy*, 22(6), 671-683. <https://doi.org/10.1002/ca.20828>.
- [18] Orebaugh, S. L., & Williams, B. A. (2009). Brachial plexus anatomy: normal and variant. *The Scientific World Journal*, 9(1), 300-312. doi: 10.1100/tsw.2009.39.
- [19] Bhattarai, C., & Poudel, P. P. (2009). Unusual variation in musculocutaneous nerves. *Kathmandu University Medical Journal*, 7(4), 408-410. doi: <https://doi.org/10.3126/kumj.v7i4.2763>.
- [20] Hada, S., Kadel, M., Pandit, T. K., & Basnet, K. S. (2020). Variations in formation of median nerve: a cadaveric study. *Journal of Chitwan Medical College*, 10(3), 66-68. doi:10.3126/jcmc.v10i3.32048.
- [21] Bala, A., Sinha, P., Tamang, B. K., & Sarda, R. K. (2014). Anatomical variation: Median nerve formation—A case vignette. *Journal of Clinical and Diagnostic Research: JCDR*, 8(6), AD03. doi: 10.7860/JCDR/2014/7620.4455.
- [22] García-López, A., Fernández, E., & Martínez, F. (2013). Transfer of brachioradialis motor branch to the anterior interosseous nerve in C8-T1 brachial plexus palsy. An anatomic study. *Microsurgery*, 33(4), 297-300. <https://doi.org/10.1002/micr.22068>.
- [23] Di Stefano, V., Gagliardo, A., Barbone, F., Vitale, M., Ferri, L., Lupica, A., ... & Brighina, F. (2021). Median-to-ulnar nerve communication in carpal tunnel syndrome: an electrophysiological study. *Neurology International*, 13(3), 304-314. <https://doi.org/10.3390/neurolint13030031>.
- [24] Bala, A., Sinha, P., Tamang, B. K., & Sarda, R. K. (2014). Anatomical variation: Median nerve formation—A case vignette. *Journal of Clinical and Diagnostic Research: JCDR*, 8(6), AD03. doi: 10.7860/JCDR/2014/7620.4455.
- [25] Gelmi, C. A. E., Pedrini, F. A., Fermi, M., Mariani, G. A., Cocco, L. I., & Billi, A. M. (2018). Communication between median and musculocutaneous nerve at the level of cubital fossa—a case report. *Translational Research in Anatomy*, 11, 1-4. doi: 10.1016/j.tria.2018.04.001.
- [26] Leijnse, J. N., de Bakker, B. S., & D'Herde, K. (2020). The brachial plexus—explaining its morphology and variability by a generic developmental model. *Journal of anatomy*, 236(5), 862-882. doi: 10.1111/joa.13123.
- [27] Abdelmotalab, M. (2024). Absence of the Musculocutaneous Nerve; Two Case Reports and Literature Review. *AL-Kindy College Medical Journal*, 20(1), 71-73. doi: <https://doi.org/10.47723/2zj9sm98>.
- [28] Leijnse, J. N., de Bakker, B. S., & D'Herde, K. (2020). The brachial plexus—explaining its morphology and variability by a generic developmental model. *Journal of anatomy*, 236(5), 862-882. DOI: 10.1111/joa.13123.
- [29] Darvishi, M., & Moayeri, A. (2019). Anatomical variations of the musculocutaneous and median nerves: a case report. *Folia Med (Plovdiv)*, 61(2), 327-331. DOI: 10.2478/folmed-2018-0080.