

ONLINE FIRST

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.



ISSN: 0015-5659

e-ISSN: 1644-3284

## **Anatomical variation of a trifid (trifurcation) lateral root origin of the median nerve: a case report**

**Authors:** D. Chrysikos, S. Papapostolou, A. Samolis, I. Antonopoulos, T. Troupis

**DOI:** 10.5603/FM.a2020.0013

**Article type:** CASE REPORTS

**Submitted:** 2019-11-27

**Accepted:** 2020-01-16

**Published online:** 2020-02-05

This article has been peer reviewed and published immediately upon acceptance. It is an open access article, which means that it can be downloaded, printed, and distributed freely, provided the work is properly cited.

Articles in "Folia Morphologica" are listed in PubMed.

# **Anatomical variation of a trifold (trifurcation) lateral root origin of the median nerve: a case report**

A case report of a trifold (trifurcation) lateral root origin of the median nerve

D. Chrysikos, S. Papapostolou, A. Samolis, I. Antonopoulos, T. Troupis

*Department of Anatomy, Medical School, National and Kapodistrian University of Athens, Athens, Greece*

**Address for correspondence:** T. Troupis, MD, PhD, Department of Anatomy, School of Medicine, Faculty of Health Sciences, National and Kapodistrian University of Athens, 75 Mikras Asias str., Goudi, 11527 Athens, Greece, tel: +30-210-7462388, fax: +30-210-7462398, e-mail: ttroupis@gmail.com; ttroupis@med.uoa.gr

## **Abstract**

Anatomic variations of the brachial plexus are common. Awareness of these variations is of paramount importance in clinical practice mainly in achieving best results in minimal invasive or surgical procedures. The aim of our study was to depict a case of a trifold lateral root origin of the median nerve. This anatomical variation in the brachial plexus was encountered after dissection in upper extremities in a 90-year-old male cadaver.

**Key words: anatomical variations, median nerve, brachial plexus**

## **INTRODUCTION**

Anatomical variations in nerves' course and formation are quite common, especially those of the brachial plexus. It is remarkable that even half of anatomical variations in neural structures that have been described in human cadavers, arise from the brachial plexus and might be attributed to embryological development [1].

Deep knowledge of these variations is crucial in clinical practice especially for surgeons and anesthesiologists, to avoid a neural injury or damage. For instance, this may occur in radical neck dissection and other surgical operations of the axilla or the upper arm. The results of an injury can cause severe motor and sensory complications [2].

The brachial plexus supplies either motor or sensory innervation to the upper limb. Normally it is formed by the ventral rami of C5 to C8 and T1. The plexus arises in the neck and then crosses inferiorly over rib I. Afterwards, it enters the axillary cavity.

The median nerve (MN) arises, as known, from the plexus brachialis and is normally formed by two roots; a lateral (Lr) from the outer cord and a medial (Mr) one from the inner cord of the plexus brachialis. It receives filaments from the lower three cervical nerves as well as the first dorsal nerve. The (Lr) and (Mr) unite in a "V"-shaped formation that embraces the lower or third part of the axillary artery (AA), to form the MN [3].

The aim of our study was to depict an anatomical variation of trifold lateral root origin of the MN. These findings were observed after dissection of a cadaver at the Department of Anatomy, School of Medicine, in National and Kapodistrian University of Athens, Greece.

## **MATERIAL AND METHODS**

Four cadavers, of which two were males and two females, were dissected in the dissection room of the Department of Anatomy of the National and Kapodistrian University of Athens. Thiel solution was used for the embalment and the cadavers remained then in the refrigerators (-16/-18 °C) for an average four-months interval prior to dissection.

After dissection of the upper limb for medical undergraduate students, a variation of the MN nerve was found in the right upper extremities of a 94-year-old male cadaver in the Department of Anatomy, School of Medicine, in National and Kapodistrian University of Athens Greece.

This cadaver was fixed in 10% formalin and had a medical history of septic shock. As reported, no surgical or traumatic lesions to the right upper limb was found. The anatomical specimen of the axillary region was properly cleaned,

Our dissection protocol was in accordance with Cunningham's manual [4] of practical anatomy. Both upper limbs on the right and left sides were meticulously dissected.

In this case report, the right side was found to have an anatomical variation. Finally, photographs were taken in order to depict the anatomical variation (Fig. 1).

## **RESULTS**

During the dissection of the cadaver referred, we found a MN formed anterior-laterally of the axillary artery (the normal position) by a normal Mr and a trifold Lr. The first/outer branch of the Lr (Lr1) is the most sizeable of the three, while the inner one (Lr3) is the thinnest and resembles a precocious communicating branch between the two roots which form finally the MN (Fig. 1). This finding was observed unilaterally, id est only in the dexter axillary of the cadaver.

The course of the formed MN in the arm, forearm and carpal tunnel was found normal as well as its distribution in the forearm and palm. Also, the Anterior Interosseous Nerve was cleaned and found normal. The formation, course and distribution of the rest final nerves of the right brachial plexus were found without any deviation of the normal pattern. No irregularity was identified during the dissection in the course and branches of neither the axillary, nor the brachial artery.

## **DISCUSSION**

Cases of MN formation by more than two roots are less usual in comparison with cases of communication branches between the MC and the MN or its Lr. There also exist an embryological background of such abnormalities' cause. Precisely, the upper limb buds are formed opposite to lower cervical and upper thoracic segments (C5-T2). However, it has been reported that incomplete contact of ventral primary rami of spinal nerves that enter the mesodermal buds, might lead to anatomical variations, either of the brachial plexus nerves or the MN. In addition, trophic agents that enter the circulation, may be the reason of developmental anomalies or anatomical variations of peripheral nerves. A growth cone is formed at the top of axon growing to target tissue by providing molecules that are secreted by surrounding tissue. Uncontrolled expression of molecules such as N-CAM, L1 and cadherins act as transcriptional factors. Finally, these molecules and components of the extracellular matrix might have as a potential result irregular development of neural structures [5, 6].

Although there are many anatomical articles published referring to the plexus brachialis and especially the MN and variations related to its origin and course, not as much have been written for the unique type of formation, described above. The described cases of an anastomotic branch between the Musculocutaneous Nerve (MCN) either the MN or its Lr, and an existence of a trifid Lr or a four-roots MN formation is comparatively less common. Satyanarayana et al. reported in 2009 a similar case [7].

Such anatomical variations in the formation of the MCN and its communicating branches have been described by Le Minor in (1992). Five types of variations have been reported between the MCN and the median nerve [8].

**Type I:** no communication between the MCN and the MN The MCN penetrates the coracobrachialis muscle, as normally and divides into three branches to innervate the coracobrachialis, biceps and brachialis muscles,

**Type II:** fibers of the lateral and medial root of the MN pass through the MCN and join to the MN distally the coracobrachialis muscle.

**Type III:** the MCN arises from the lateral cord and after some distance provides communicating fibers to connect with the MN that is formed by the medial cord.

**Type IV:** The fibers of the MCN and the lateral root of the MN merge together. MCN stems from the MN and then divides into branches to innervate the biceps, coracobrachialis and brachialis muscles.

Various publications report, the presence of additional root in the formation of MN [9-11]. The incidence of formation of MN by two lateral and one medial root has been described by Sharmila et al.[12]. Three roots forming the MN was the most frequent anatomic variation that was reported in about 36.4% (8) in left upper limb and 18.2% in right one by Taib et al. MN may also be formed by four roots [2]. Our finding is also in accordance with Budhiraja et al. [13] who found two types of variation: median nerve formed by three roots and four roots in 22.4% (44/196) and 3.57% (7/196), respectively. The median nerve was formed by 2 lateral roots from lateral cord and 1 medial root from the medial cord in 6 cadavers by Emamhadi, et al. [14] Sargon et al [15] reported the formation of the median nerve by three roots in that one of the lateral cord roots was located with a very close course over the axillary artery.

It should be noted that this type of variation is attend to injury in surgical operations of the axilla and may lessen the blood supply of the upper extremity by compressing the vessel due to the very close course of the second lateral root of the median nerve to the axillary artery.

## **CONCLUSIONS**

Anatomical variations of the formation of the brachial plexus nerves and especially of the MN should be identified and recorded in order to advance the practice of medicine and the science of anatomy as well. Such variations as the one depicted, are of great significance and have a clinical or surgical impact. Anesthesiologists that perform axillary block or surgeons that operate in the arm or the axillary cavity, may cause unintentional injury to the MN. This may lead to paralysis of the anterior compartment muscles of arm (biceps brachii, brachialis, and coracobrachialis), motor disability of the elbow joint (flexion) and sensory deficiency in the lateral compartment of the forearm [16].

**CONFLICT OF INTEREST:** The authors declare no conflict of interest.

## REFERENCES

1. Nascimento S, Ruiz CR, Pereira E, et al. Rare anatomical variation of the musculocutaneous nerve– case report. *Rev Bras Ortop.* 2016; 51(3): 366-9.
2. Mat Taib CN, Hassan SN, Esa N, et al. Anatomical variations of median nerve formation, distribution and possible communication with other nerves in preserved human cadavers. *Folia Morphol (Warsz).* 2017;76(1):38-43.
3. Singhal S, Rao VV, Ravindranath R. Variations in brachial plexus and the relationship of median nerve with the axillary artery: a case report. *J Brachial Plex Peripher Nerve Inj.* 2007;2:21.
4. Cunningham D. J.. *Manual of Practical Anatomy. Upper and lower limbs.* 16th Edition. Oxford, United Kingdom 2017.
5. Brown MC, Hopkins WG, Keynes RJ. *This variation in the median nerve.* 1st Edition Cambridge, Cambridge University Press 1991.
6. Collins P. Embryology and development. In: Williams P, Bannister L, Berry M, editors. *Gray's Anatomy. In: Embryology and development.* 38th Edition., New York: Churchill-Livingstone 1999.
7. Satyanarayana N, Vishwakarma N, Kumar GP, et al. Rare variations in the formation of median nerve-- embryological basis and clinical significance. *Nepal Med Coll J.* 2009;11(4):287-90.
8. Sah SK, Chaudhary D, Pandey N. Prevalence of absence of musculocutaneous nerve among the nepalese cadaver. *International Journal of Scientific and Research Publications.* 2016; 6(8): 222-5.
9. Ajayi NO, Lazarus L, Satyapal KS. Multiple variations of the branches of the brachial plexus with bilateral connections between ulnar and radial nerves. *Int J Morphol.* 2012;30(2):656-60.
10. Das S, Paul S. Anomalous branching pattern of lateral cord of brachial plexus. *Int J Morphol.* 2005;23(4):289-92.
11. Tatar I, Brohi R, Sen F, et al. Innervation of the coracobrachialis muscle by a branch from the lateral root of the median nerve. *Folia Morphol (Warsz).* 2004;63(4):503-6.
12. Sharmila BP, Devi SK. Bilateral absence of musculocutaneous nerve with unusual branching pattern of lateral cord and median nerve of brachial plexus. *Anat Cell Biol.* 2012; 45(3): 207–210.
13. Budhiraja V, Rastogi R, Asthana AK. Anatomical variation of median nerve formation: embryological and clinical correlation, *J Morphol Sci.* 2011; 28(4): 283–286.

14. Emamhadi M, Chabok SY, Samini F, et al. Anatomical Variations of Brachial Plexus in Adult Cadavers; A Descriptive Study. Arch Bone Jt Surg. 2016 ;4(3):253-8.
15. Sargon MF, Uslu SS, Celik HH, et al. A variation of the median nerve at the level of brachial plexus. Bull Assoc Anat (Nancy). 1995; 79(246):25-6.
16. Virupaxi RD, Shirol VS, Desai SP, et al. Absence of musculocutaneous nerve in the left axilla. Int J Anat Var 2009; 2(1): 140-2.





**Figure 1:** Cadaveric dissection showing a trifid Median Nerve arising from Brachial plexus  
 AA: axillary artery AV:axillary vein CB: coracobrachialis muscle Lr1,Lr2,Lr3:roots of Median Nerve, UN:ulnar nerve MC:musculocutaneous nerve RN:radial nerve