

Anatomical Variations in the Formation of Median Nerve - A cadaveric Study

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ABSTRACT

Introduction: brachial plexus arises from the ventral rami of C5 to T1 located in the anterior neck it supplied motor and sensory innervation to the upper limb. The contribution of C4 is termed as prefixed and the contribution from T2 is postfixed. The roots which divided in to main three trunk. They give anterior and posterior division to enumerate the origin of cords. Each cords gives branches to supply the upper limbs. The median nerve is formed by the union of medial and lateral root of median nerve which comes from the medial and lateral cords respectively. Formation of median nerve is lateral to the axillary artery in the axilla and mainly median nerve abnormalities is associated with communications of other extra branches and the distal formation from the point of origin.

Methods: the study was carried out in 23 embalmed cadavers (46 specimens) in the Department of Anatomy at JSS Medical College, Mysore. Bilateral upper limbs of these cadavers were dissected. Median nerve variations were examined. The distance of the point of joining of the lateral and medial cords to form the median nerve from the lower border of pectoralis minor muscle was noted. The variations in the formation of median nerve and contribution of communicating branch was examined.

Results: in addition to lateral and medial roots an additional root was noted in 16 specimens (Fig 1). The additional root was arising from lateral cord.

The maximum length noted of the median nerve on the left side was 36.5 cm and on the right side was 35.6 cm. The mean length of median nerve measured 24.8 ± 4.5 cm on the right side and 27.4 ± 5.4 cm on the left side. The mean length was greater on the left side than the right.

Conclusion: anatomical differences in the brachial plexus are quite prevalent. The brachial plexus contributes to more than half of all the anatomic variations in the human neural systems that have been documented. The anatomical abnormalities of the brachial plexus may cause difficulty in achieving nerve blocks in the region. Variations can also be a cause of damage of the plexus as in cases of radial neck dissection and other surgical operations of the axilla and the upper arm.

The knowledge of different possible variations in the nerve plexus is of great importance for clinicians to perform successful surgical procedures and treatments pertaining to the upper limbs and also to diagnose clinical signs and symptoms that manifest in the upper limbs.

Keywords: Median nerve; Brachial plexus; Variations; Length.

Introduction

An anatomical collection of nerves that originate from the roots of the cervical and thoracic spinal nerves from the brachial plexus¹. It supplies the motor, sensory and sympathetic fibres to the upper limbs and courses from the neck to the axilla² and it is formed by contributions from ventral rami of C5 to T1 roots. The trunk divides in to anterior and posterior division, enumerating the cords origin³. Median Nerve is formed in the axilla just below the pectoralis minor by two roots, the lateral root arising from the lateral cord and medial root from the medial cord. After it passes distally crosses to the brachial artery on the medial side it runs downwards enter to the cubital fossa there it passes between the flexor digitorum profundus and flexor digitorum superficialis also it runs deep to the flexor retinaculum and palmaris longus. Then it provides nerve supply to the palm⁴.

Variations in the formation and branches of brachial plexus are very common. Commonest variation of median nerve is of lateral root, it can arise as two or three roots. Variations of the brachial plexus are important and significant during surgical and anaesthetic procedures of axilla⁵.

Aims And Objectives

Present study was taken to study the morphological variations in the formation of median nerve and presence of any additional contribution to its formation.

Material and Methods

Ethical clearance was obtained from institutional ethical committee. The study was conducted on 46 upper limbs (23 right and 23 left) during the routine dissection of axilla according to Cunningham manual. The skin, superficial fascia, and deep fascia along with

the pectoralis muscle were reflected and noted the formation of median nerve. The length and distance of the point of joining of the lateral and medial roots to form the median nerve from the lower border of pectoralis minor muscle was measured using vernier calliper and presence of any additional contribution to its formation was examined.

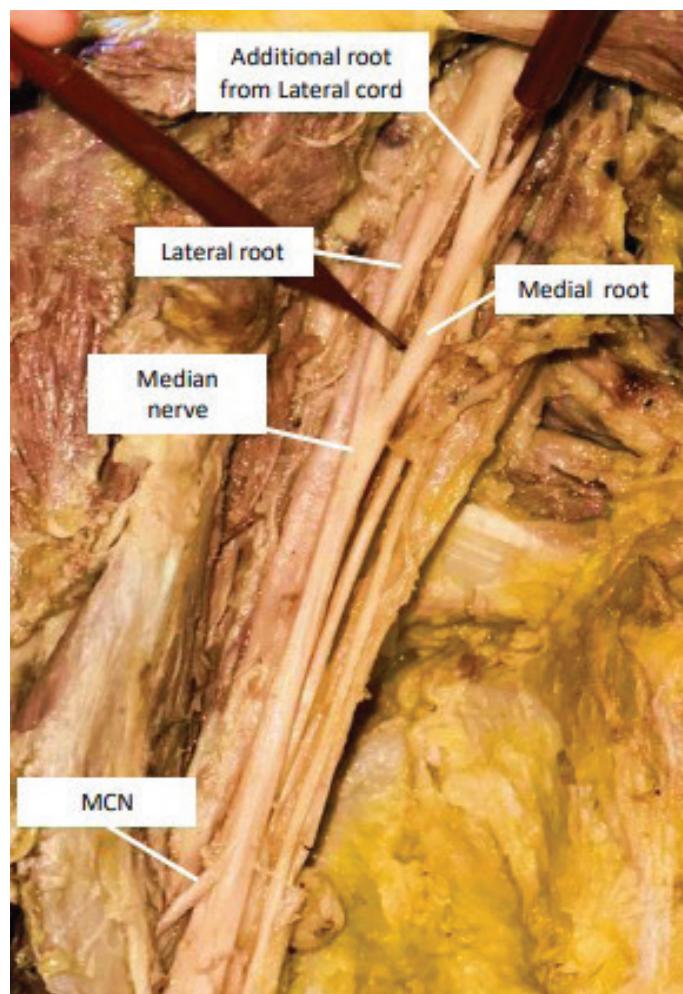


Figure 1. Additional root originating from the lateral root of median nerve.

Results

In addition to lateral and medial roots an additional root was noted in 16 specimens (Fig 1). The additional root was arising from lateral cord. The mean distance of formation of median nerve from lower border of pectoralis minor is 3.27 cm, range from 0.5 to 8 cm (Fig 2 & Fig 3) in 2 specimens it was at the lower border of pectoralis minor. Table 1 summarizes the results described in the literature in the last 15 years.

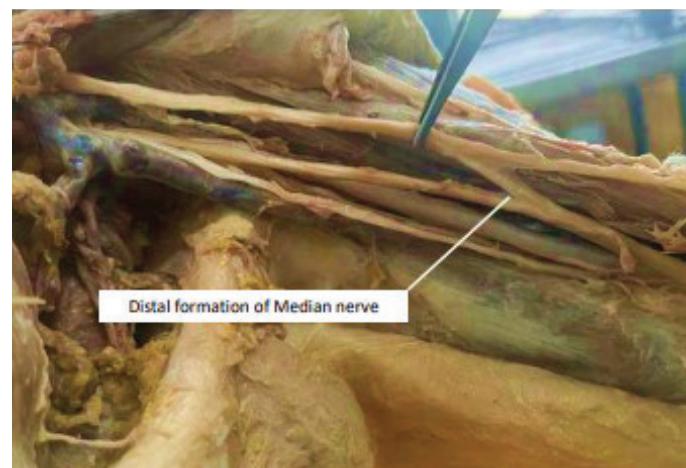


Figure 2. Distal formation of median nerve compared to the common point of origin.

Discussion

Limbs are developed from somites, and when they migrate, they carry their own nerve and maintains its original segmental innervations. Brachial plexus, which innervates the whole of upper limb develops as a single structure in upper limb bud and then it divides longitudinally into ventral and dorsal divisions and any abnormal division will lead into the variations in the formation of median nerve⁶.

The brachial plexus is completely formed by the 13th week of intrauterine life⁷.

Normally the cords of brachial plexus are seen in

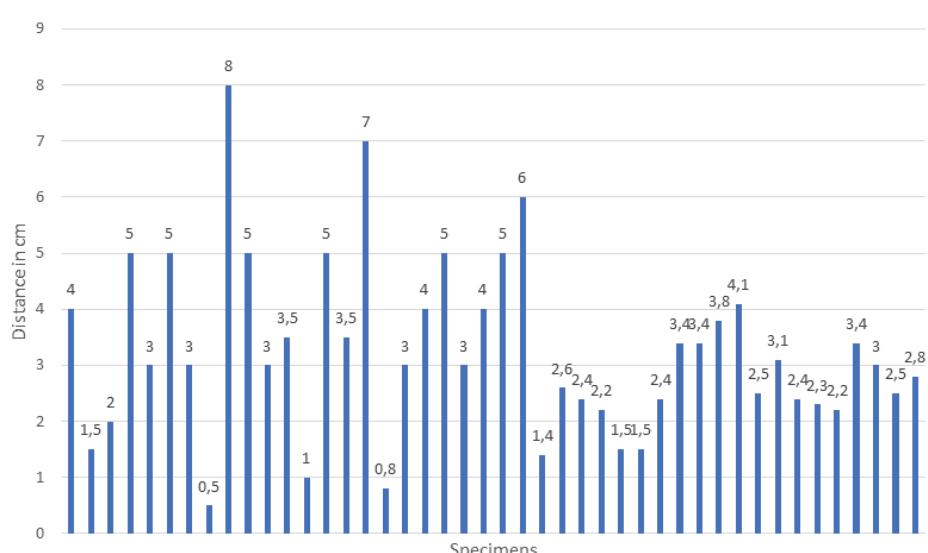


Figure 3. Distance of median nerve from the lower border of pectoralis minor.

Table 1. Variations in the formation of Median nerve in the last 15 years.

Sl.no	Authors	Year	Number of specimens	Variations in the formation of Median nerve
1	Budhiraja V <i>et al.</i> ¹⁶	2011	196	Three roots - 22.4% (44/196) upper limbs, in 14.2% (28/196) upper limbs the third root arose from lateral cord of brachial plexus and 8.16% (16/196), upper limbs the third root arose from musculocutaneous nerve. Four roots - 3.57% (7/196) 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) upper limbs, median nerve formation medial to axillary artery in 6.12% (12/196). Median nerve formation anterior to axillary artery in 1.53% (3/196).
2	Pattanshetti SV <i>et al.</i> ¹⁷	2012	60	Extra lateral root of MN seven out of 60 - 11.67% Medial root of MN not given from medial cord two out of 60 - 3.33%
3	Mat Taib CN <i>et al.</i> ¹⁴	2017	44	Three roots - 36.4% (8) in left upper limb and 18.2%. The median nerve formed from one root - 4.5% Four roots - 4.5%.
4	Samarawickrama MB <i>et al.</i> ¹⁸	2017	98	Three roots with two lateral roots - 6 (6.12%) Three roots with two medial roots - 1 (1.02%) Four roots with three lateral roots - 2 (2.04%) Two lateral roots with absent medial root - 2 (2.04%). Duplicate lateral root with accessory channel - 3 (3.06%). Two roots one medial and one lateral (Normal) 83 84.69 Total 98 100
5	Priya A <i>et al.</i> ¹⁹	2019	60	Three roots - 8 (13.33%). Communications between median nerve and musculocutaneous nerve were noted in 8 (13.33%).
6	Hada S <i>et al.</i> ²⁰	2020	50	Three roots - 10 specimens (20%) Four roots - 1 (2%)
7	Passey J <i>et al.</i> ⁵	2022	40	Six had triple roots including a supernumerary root contributing to the medial nerve formation. The supernumerary root was a branch of the lateral cord in five cases, and it had an additional contribution from the medial cord in one case
8	Akhtar <i>et al.</i> ²¹	2022	84 (56 male, 28 female)	Two roots - 59(70.23%) Three roots - 20 (23.8) Four roots - 05 (5.95%)
9	Manuel Encarnacion <i>et al.</i> ²²	2022	84	19 (22.6%) presented a median nerve origin with more than 2 branches. Three roots - 17 (20.2%) specimens and Four roots - 2 (2.4%).
10	Sumit Patil <i>et al.</i> ²³	2023	68	s. Out of 68 axillae, two (2.9%) showed median nerve formation by a single root, 19 (27.9%) showed median nerve formation by three roots, and three (4.4%) showed median nerve formation by four roots. A normal pattern of median nerve formation by fusion of two roots was seen in 44 (64.7%) axilla
11	Present study	2023	46	16 specimens with additional root.

relation to the seventh (7th) cervical segmental artery, which gives origin to the axillary artery that passes between lateral and medial cords. Sometimes the subclavian-axillary stem is derived from the sixth or eighth segmental arteries and then it has an abnormal relation to the cords of brachial plexus.

In the upper limb bud, brachial plexus appears as a single radicular cone. This cone divides longitudinally into dorsal division which further gives rise to the radial and axillary nerve, ventral divisions giving rise to median and ulnar nerve. The variations of the cords and the median nerve are mainly based on developing

anomalies. An abnormal embryological relation between the cords of brachial plexus and cervical segmental branches of the dorsal aorta are the reasons for the different types of variations in relation to the formation, location, and course of the cords and the median nerve with their communicating branches⁸.

In the current study, anatomical variation in the formation of median nerve is discussed. Normally the formation of median nerve is lateral to the axillary artery and medial root which crosses anteriorly to the axillary artery join to the lateral root of median nerve, lateral to the axillary artery.

Sontakke, Tarnekar, Waghmare et al. have mentioned that median nerve was formed by three root i.e. two roots formed from the lateral root and another from the medial cords⁹. Median nerve is usually formed in the axilla but Nayak S, Samuel and Soumyajit found the formation of median nerve in the midpoint of hand¹⁰.

In the present study, out of the 46 specimens examined in this study, in about 8 upper limbs the median nerve formed was noted distal to its point of origin. In 8 cadavers, between the formation of median nerve from the median and lateral roots, an additional branch is also formed.

In our study, communicating branches were seen arising between the medial and lateral roots of the median nerve. A contributing branch from the lateral cord in one of the upper limbs joined the lateral roots that made up the median nerve. This was also described by some authors in their study. It indicates that due to the presence of an additional lateral root to the median nerves near proximity to the axillary artery during axillary surgery, this type of variation might cause harm and reduce the supply of blood to the arms by compressing the artery^{11,12}. The brachial plexus is completely formed by the 13th week of intrauterine life. Although the precise reason of pre-fixation or post-fixation is unknown, some scholars think that it is a straightforward concordance between the position of the limb buds along the rostro-caudal axis of the embryo. Depending on when the limb buds mature, the brachial plexus may show major differences in the nerves that cause it⁷. The terms used to indicate whether a plexus is prefixed or postfixed have also been extremely varied.

The additional roots taking part in the formation of the median nerve either contributed from the lateral cord, medial cord or the musculocutaneous nerve. These types of the anomalous origin in the formation of median nerve may lead to confusion in surgical procedures and nerve block anaesthesia.

Ghosh B et al reported that the additional roots taking part in the formation of the median nerve were aroused from the posterior cord of the brachial plexus¹³.

Authors have also reported a median nerve formation from one root that was directly coming from the medial cord in 4.5% of the cases¹⁴.

Since anatomical variations might result syndrome of nervous palsy because of a variable relationship between the nerves and the linked muscle, descriptions pertaining to nerve variants are helpful in clinical and surgical practice¹⁵. In our study, communicating branches were seen arising between the medial and lateral roots of the median nerve. Same as our study was also described by some authors in their study. It indicates that due to the presence of an additional lateral root to the median nerves near proximity to the axillary artery during axillary surgery, this type of variation might cause harm and reduce the supply of blood to the arms by compressing the artery^{11,12}. According to what we already know about these differences it is imperative that further study be conducted on anatomical variation in the median nerve which help during clinical surgical procedure.

Conclusion

This cadaveric study advances our understanding of the median nerve anatomical variances, which is crucial for anatomists, radiologists, anaesthesiologists, and surgeons. Additionally, the prevalence of anatomical variants in the peripheral nervous system explains the unexpected clinical symptoms. These variances must be understood by surgeons who do procedures involving neoplasm or mending trauma. When performing orthopaedic and other surgical procedures, the median nerve with extra roots is more likely to be implicated and may cause sensory, motor, vasomotor, and trophic changes.

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Mini Curriculum and Author's Contribution

1. Pushpalatha K – MBBS MD Anatomy. Contribution: conceptualization, effective scientific and intellectual participation for the study, data acquisition, preparation of draft, critical review and final approval.
2. Helen Shaji – MSc Anatomy. Contribution: conceptualization, effective scientific and intellectual participation for the study, data acquisition, data interpretation, preparation of draft.
3. Uma Shivanal – MBBS MD Anatomy. Contribution: conceptualization, effective scientific and intellectual participation for the study, data acquisition, data interpretation, preparation of draft.

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