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Research Article

A study of anatomical variations of median nerve in human cadavers

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Abstract

Comprehensive knowledge pertaining to anatomical variations of median nerve is extremely important in clinical and surgical procedures so as to avoid injury to it. The objectives of the study were to know about the variations of median nerve in its formation, course, and distribution in arm. Dissection method was employed and 50 upper limbs were studied for anatomical variations of median nerve obtained from the Department of Anatomy.

Median nerve was formed by two roots in 37(74%) and by three roots in 13 (26%) specimens. It was formed in axilla in 32(64%), in upper third of arm in 10 (20%), middle third of arm in 6 (12%) and lower third of arm in 2 (4%) specimens. In one specimen high division of brachial artery in the middle third of the arm was observed along with formation of median nerve at the same level. Formation of median nerve was lateral to axillary artery in 42 (84%), anterior to axillary artery in 5 (10%), medial to axillary artery in 3 (6%) specimens. Median nerve coursed lateral to brachial artery in 47 (94%), medial to brachial artery in 3 (6%) specimens Median nerve was supplying flexor muscles of arm in 6 (12%) specimens. In two of these six specimens there were concomitant neurovascular variations as well. The present study may provide additional information as such neurovascular variations encountered here are important to be noted during surgical procedures as these are more prone to iatrogenic injuries.

Keywords: Neurovascular; musculocutaneous; communications; vena comitans; median nerve

1. Introduction

Normal and anomalous position of the arteries and veins may be determined preoperatively by angiographic studies but in case of nerves it is not possible to detect such an anomaly. Only at the time of surgery the surgeon is exposed to such variations.[1] Descriptions of nerve variations are useful in clinical and surgical practice, as an anatomical variation can be the cause of a nerve palsy syndrome due to differing relations of a nerve with a related muscle.[2] Communication between nerves and unusual branching patterns of nerves are also extremely important with respect to compressive neuropathies of the upper extremity. These are significant sources of misdiagnosis.[3] Considering the clinical significance of diagnosis and treatment in neurosurgical cases and for the reasons cited above, a study of anatomical variations of median nerve in the arm was taken up.

2. Materials and Methods

The present descriptive study was carried out over a period of two years from 2007 to 2009 by dissecting 50

specimens (25 right and 25 left upper limbs) available in the Department of Anatomy, J N Medical College Belgaum. Dissection method was employed as per Cunningham's manual of practical anatomy. Median nerve was identified. Its formation and any variations in it were noted. To note the level of formation, arm length was measured from tip of acromion process to lateral epicondyle by using measuring tape and the same was divided into upper, middle and lower third. Connecting branch from musculocutaneous nerve to median nerve if present in axilla or upper third of arm was considered as second lateral root and if in middle or lower third of arm as communication. The course of the median nerve was observed by tracing median nerve distally in the arm. Any variation in its course in relation to brachial artery was noted. Absences of musculocutaneous nerve and branches given by median nerve to muscles of flexor compartment of arm were also noted. Communications between median and musculocutaneous nerves in arm as said above were looked for. Photographs were taken. Schematic diagrams were drawn & photographs were labeled. The data collected in the present study was recorded, tabulated, analyzed and compared with that of the previous studies.

Following parameters were studied.

2.1 Formation

Number of roots and level of formation of median nerve

Formation of median nerve in relation to axillary artery

2.2 Course: Course of median nerve in upper part of arm in relation to brachial artery

2.3 Branching pattern/ distribution in arm: Muscles of anterior compartment of arm innervated by median nerve

2.4 Communications: Median nerve communications with Musculocutaneous nerve

2.5 Statistical analysis: The data were tabulated and analysed. Rates and ratios were calculated.

3. Results

The data obtained on different parameters were tabulated and recorded as follows.

Table – 1: Number of roots and level of formation of median nerve

Level of formation of median nerve	Number of specimens	
	with 2 Roots	with 3 Roots
Axilla	26	6
Upper third of arm	3	7
Middle third of arm	6	-
Lower third of arm	2	-

Table – 2: Formation of median nerve in relation to axillary artery

Formation of median nerve	Number of specimens
Lateral to axillary artery	42
Anterior to axillary artery	5
Medial to axillary artery	3

Table - 3: Course of median nerve in upper part of the arm in relation to brachial artery

Course of median nerve	Number of specimens
Lateral to brachial artery	47
Medial to brachial artery	3

Table - 4: Innervation of muscles of anterior compartment of arm by median nerve and musculocutaneous nerve

Nerve of anterior compartment of arm	Number of specimens
Median nerve	6
Musculocutaneous nerve	44

Table - 5: Communications of median nerve with musculocutaneous nerve

Communication of median nerve	Number of specimens
With musculocutaneous nerve	6

4. Discussion

Previous research studies have reported the fact that the variant median nerve with abnormal formation, course and distribution in arm is more prone to accidental injuries and entrapment neuropathies.

Accordingly, a view of previous studies of median nerve, along with observations made in the present study is assessed through following important parameters.

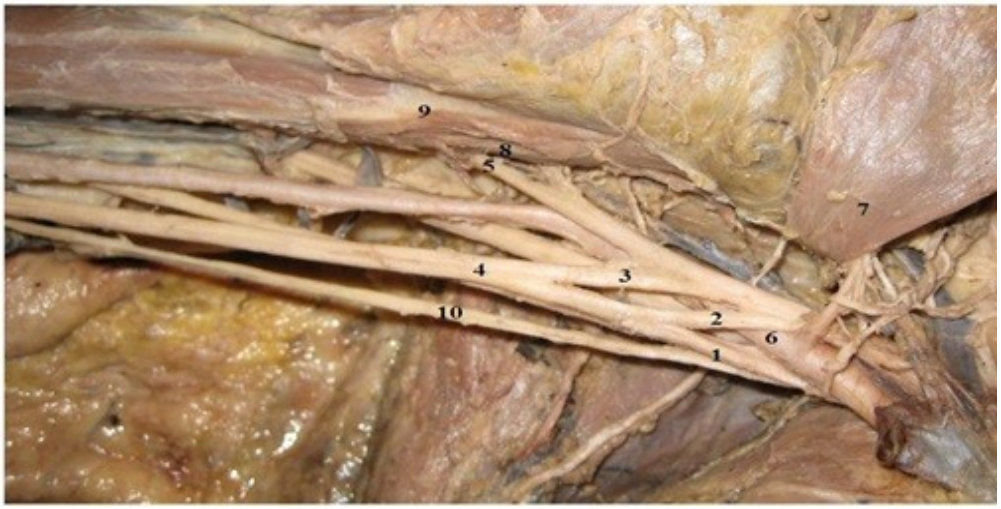
4.1 Formation

4.1.1 Number of roots and level of formation of median nerve

Eglseder and Goldman (1997) have found that median nerve was formed from three roots in 14% of specimens.[4] Uzun and Bilgic (1999), in their study of 130 brachial plexuses noted variation in the formation of the median nerve (10.77%), with fusion of three roots.[5] Uzun *et a.l* (2001) have reported a variation in the formation of median nerve wherein the median nerve was formed by the fusion of four branches.[6] Badawoud (2003) in his study of 48 upper limbs, found median nerve to be formed by four roots in 1 (2.1%) and by three roots in 3 specimens (6.3%).[7] Fazan *et al.* 2003 in their study of 54 upper extremities found median nerve to be formed by three roots in 28 (52%) limbs.[2] Gupta M *et al.* (2005) reported a case of median nerve formation by union of two lateral and one medial root.[8]

In the present study median nerve was found to be formed by two roots in 37 (74%) and three roots in 13 (26%) specimens (Fig-1).

Fig-1: Median nerve formation in axilla by three roots.

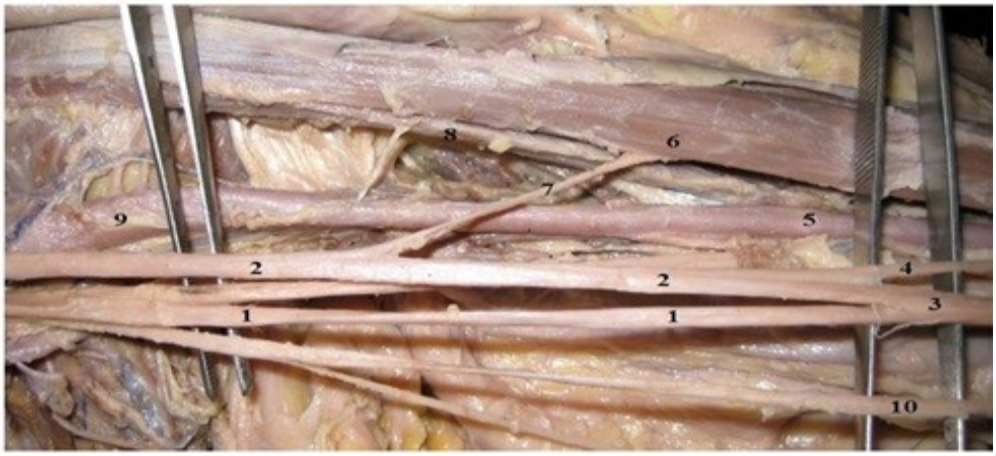


1. Medial root of median nerve	6. Axillary artery
2. Lateral root of median nerve	7. Pectoralis minor
3. Second lateral root	8. Coracobrachialis
4. Median nerve	9. Biceps brachii
5. Musculocutaneous nerve	10. Ulnar nerve

Fazan *et al.* (2003) in their study of 54 upper limbs noticed formation of median nerve distally in the arm in 4 (7%) limbs.[2] Nayak *et al.* (2006) have reported formation of median nerve below the midpoint of arm just medial to brachial artery.[9] Pandey and Shukla (2007) in their study of 344 specimens have observed median nerve formation at lower level in 6 (1.7%) limbs[10] but the authors have not mentioned the exact level of formation.

In the present study the median nerve was found to be formed in axilla in 32 (64%), in upper third of arm in 10 (20%), in middle third of arm in 6 (12%) and in lower third of arm in 2 (4%) specimens (Fig-2).

Fig-2: Median nerve formation in lower third of arm & absence of musculocutaneous nerve. Nerve to biceps brachii and lateral cutaneous nerve of forearm given by lateral root of median nerve.



1. Medial root of median nerve	6. Biceps brachii
2. Lateral root of median nerve	7. Nerve to biceps brachii
3. Median nerve	8. Coracobrachialis
4. Lat cut nerve of forearm	9. Axillary artery
5. Brachial artery	10.Ulnar nerve

In one specimen wherein median nerve was formed in middle third of arm, high division of brachial artery at the same level was noticed (Fig-3).

Fig-3: Median nerve formation in middle third of arm and high division of brachial artery.

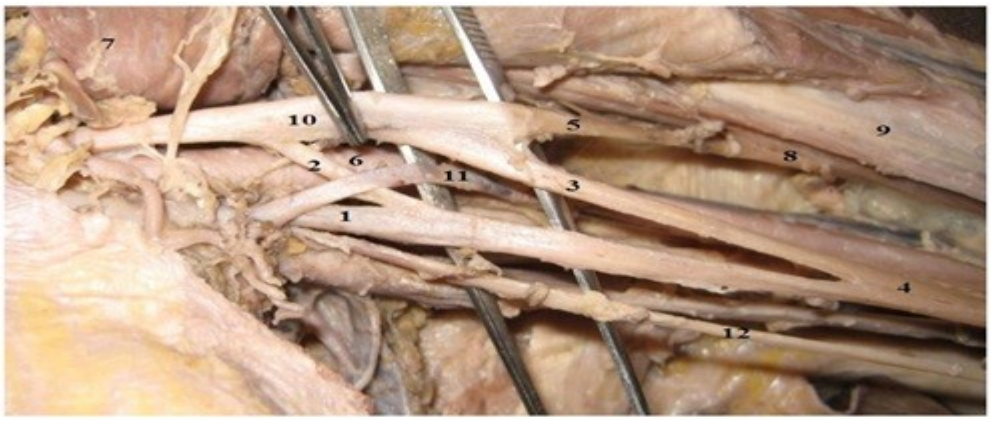
1. Medial root of median nerve	5. Ulnar nerve
2. Lateral root of median nerve	6. Brachial artery
3. Median nerve	7. Ulnar artery
4. Musculocutaneous nerve	8. Radial artery

4.1.2 Formation of median nerve in relation to axillary artery

The text book description is that formation of median nerve is either anterior or lateral to third part of axillary artery.[11] Chitra (2007) has reported a case of formation of median nerve medial to axillary artery bilaterally[12] and in another case, formation of median nerve posterior to third part of axillary artery.[13] Pandey and Shukla (2007) in their study of 344 axillae have reported formation of median nerve, medial to axillary artery in 8 (2.3%) cases.[10]

In the present study formation of median nerve was lateral to axillary artery in 42 (84%), anterior to axillary artery in 5 (10%), medial to axillary artery in 3 (6%) specimens (Fig-4). Formation of median nerve posterior to the axillary artery was not found in any of the specimens. Of the three specimens where median nerve was formed medial to axillary artery, in two specimens both the lateral roots crossed the axillary artery from lateral to medial to join medial root (Fig-4).

Fig-4: Median nerve formation in upper third of arm by three roots and vena comitans passing through a loop formed by two lateral roots.



1. Medial root	7. Pectoralis minor
2. Lateral root	8. Coracobrachialis
3. Second lateral root	9. Biceps brachii
4. Median nerve	10. Lateral cord
5. Musculocutaneous nerve	11. Vena comitans
6. Axillary artery	12. Ulnar nerve

4.2 Course

Course of median nerve in upper part of arm in relation to brachial artery

Nayak *et al.* (2006) have reported median nerve to descend medial to brachial artery.[9] Chitra (2007) reported median nerve to descend medial to brachial artery bilaterally and in another case, posterior to brachial artery.[12, 13]

In the present study median nerve coursed lateral to brachial artery in 47 (94%), medial to brachial artery in 3 (6%) (Fig-4) and posterior to brachial artery in none of the specimens

4.3 Branching

Muscles of anterior compartment of arm innervated by median nerve

Le Minor (1990) has reported absence of musculocutaneous nerve where in lateral cord of brachial plexus gave muscular branches to coracobrachialis and biceps brachii.[14] Gumusburun and Adiguzel (2000) have noted bilateral absence of musculocutaneous nerve. Two branches from the lateral cord innervated the coracobrachialis muscle. The median nerve innervated the biceps brachii and brachialis muscles.[15] Sud and Sharma (2000) have reported absence of musculocutaneous nerve.[16] Beheiry (2004) noted absence of musculocutaneous nerve in one limb (1.7%) out of 60 upper limbs studied.[17] Guttenberg and Ingolotti (2009) in their study of 56 upper limbs have noticed absence of musculocutaneous nerve in 2

(3.6%) limbs.[18]

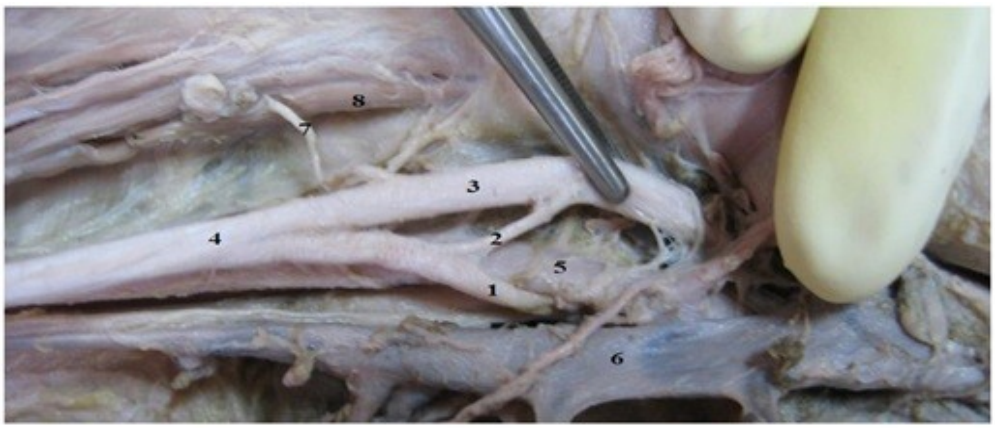
In the present study absence of musculocutaneous nerve was noted in 6 (12%) specimens and it was bilateral in one cadaver. The branches either from lateral roots of median nerve or directly from median nerve innervated the biceps brachii, coracobrachialis and brachialis muscles in all these six specimens (Fig-5).

Fig-5: Absence of musculocutaneous nerve. Biceps brachii, coracobrachialis and brachialis muscles supplied by median nerve.

1. Medial root of median nerve	6. Coracobrachialis
2. Lateral root of median nerve	7. Nerve to coracobrachialis
3. Median nerve	8. Nerve to biceps brachii
4. Axillary artery	9. Nerve to brachialis
5. Biceps brachii	10. Axillary vein

Out of these six specimens, two specimens had coexisting variations. The median nerve was formed by three roots in these two. In one specimen there was an extremely thin normal lateral root and a significantly thick second lateral root of median nerve (Fig-6).

Fig-6: Absence of musculocutaneous nerve & formation of median nerve in axilla by three roots with very thin lateral root and significantly thick second lateral root.



1. Medial root of median nerve	5. Axillary artery
2. Lateral root of median nerve	6. Axillary vein
3. Second lateral root of median nerve	7. Nerve to coracobrachialis
4. Median nerve	8. Coracobrachialis

In another specimen vena comitans was coursing within a loop formed by the two lateral roots of median nerve (Fig-7).

Fig-7: Absence of musculocutaneous nerve. Median nerve formation in upper third of arm by three roots and vena comitans passing through a loop formed by two lateral roots of median nerve.

1. Medial root of median nerve	6. Vena comitans
2. Lateral root of median nerve	7. Nerve to coracobrachialis
3. Second lateral root	8. Biceps brachii
4. Median nerve	9. Lateral cord
5. Axillary artery	

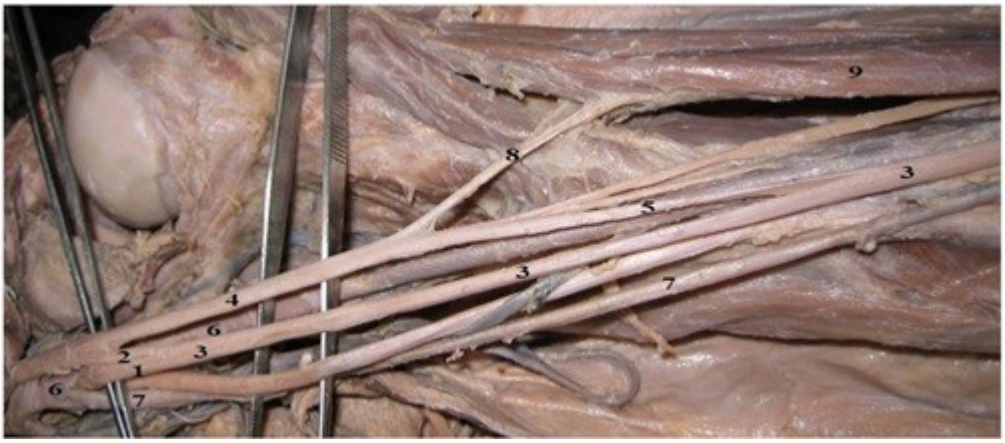
4.4 Communications

4.4.1 Median nerve Communications with musculocutaneous nerve.

Median nerve communications with musculocutaneous nerve have been reported by several authors.[12, 19, 20, 21, 22] Venierator and Anagostopoulou (1998), in their study of 158 upper limbs found median nerve communications with musculocutaneous nerve in 22 (13.9%) limbs. In 6 cadavers these were bilateral.[23] Eglseder and Goldman (1997) in their study of 54 cadaver arms noticed interconnections between median nerve and musculocutaneous nerve in 36% cases.[4] Aktan *et al.* (2001) in their study of 48 limbs, have reported median nerve communications with musculocutaneous nerve in 5 (5%) limbs.[24] Choi *et al.* (2002) in their study of 276 upper limbs found median nerve communications with musculocutaneous nerve in 73 (26.4%) limbs. In 9 cadavers these were bilateral.[25] Beheiry (2004) in his study of 60 cadaver arms noticed communications between median nerve and musculocutaneous nerve in 3 (5%) limbs.[17] Guttenberg and Ingolotti (2009) in their study of 56 upper limbs have reported median nerve communications with musculocutaneous nerve in 30 (53.6%) limbs.[18]

In the present study communications were found in 6 (12%) specimens. In one specimen along with communication in middle third of arm there was high division of axillary artery as well (Fig-8).

Fig-8: Communication between median nerve and muculocutaneous nerve and high division of axillary artery.



1. Medial root of median nerve	6. Axillary artery
2. Lateral root of median nerve	7. Radial artery
3. Median nerve	8. Nerve to biceps brachii
4. Musculocutaneous nerve	9. Biceps brachii
5. Communicating branch	

5. Conclusion

The key to carry out therapeutic and diagnostic procedures successfully, on upper limbs depends on the knowledge of the possible variations of nerves and arteries which may be encountered. Such neurovascular variations are not only more prone to iatrogenic injuries but they interfere in the correct interpretation of clinical conditions as well. Some of the complications that have been reported include injuries to nerves, arteries and wrong diagnosis.

In the present study an attempt is made to know the possible variations of median nerve in its formation, course, branching pattern in arm so as to provide additional information which may help to decrease the risk of diagnostic and operative complications.

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