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STUDY OF VARIANT CONNECTIONS OF MEDIAN NERVE WITH MUSCULOCUTANEOUS NERVE

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ABSTRACT

Aim: Study of variant connections of median nerve with musculocutaneous nerve.

Materials and Methods : 100 upper limbs of 50 donated embalmed cadavers (45 males & 5 females) of age group ranging from 70 to 80 years were studied in the department of Anatomy at K. J. Somaiya Medical College, Sion, Mumbai, INDIA, the variant connections between the median nerve and the musculocutaneous nerve were observed. The finding was noted after thorough and meticulous dissection of the upper limbs of both sides. The arterial pattern in the arm was also observed. The photographs of the communication were taken for proper documentation.

Observations: Out of 100 specimens the variant connections between the median nerve and the musculocutaneous nerve were found in 30 specimens i.e. 30% of the total specimens. Out of 30 specimens, 4 specimens showed the median nerve getting the communicating branch from the musculocutaneous nerve, 6 specimens showed the formation of the median nerve by medial and lateral roots in the middle of the arm; 12 specimens showed that the musculocutaneous nerve traveled some distance with the median nerve and then it got separated from the median nerve, the remaining 8 specimens showed that all the muscles of the front of the arm were supplied by the median nerve. The musculocutaneous nerve was absent. There were no associated arterial variations seen in any of the specimens.

Conclusion: The presence of such type of variations is clinically important for surgeons, orthopaedicians and anaesthetist performing pain management therapies on the upper limb. These variations are compared with the earlier data & it is concluded that variations in branching pattern of cords of brachial plexus are a rule rather than exception.

Keywords: Brachial plexus, Brachial Artery, Median Nerve, variant connections, Musculocutaneous nerve, Communicating branch, Pain Management Therapies.

INTRODUCTION

The median nerve is normally formed by the union of lateral root of median nerve arising from the lateral cord (C5, C6, C7) of brachial plexus and medial root of median nerve arising from the medial cord (C8, T1) of brachial plexus anterior to the axillary artery. Some fibres from C7 often leave the lateral root to join the ulnar nerve. Clinically they are believed to be mainly motor to the flexor carpi ulnaris. The median nerve enters the arm at first lateral to the brachial artery. Near the insertion of the coracobrachialis, it crosses in front of the artery, descending medial to it, to the cubital fossa, where it is posterior to the bicipital aponeurosis and anterior to the brachialis. It usually enters the forearm between the heads of the pronator teres, crossing to the lateral side of the ulnar artery and separated from it by the deep

head of pronator teres (1). Anomalous pattern of the median nerve can be explained on the basis of embryological development The upper limb buds lie opposite the lower five cervical and upper two thoracic segments. As soon as the buds form, the ventral primary rami of the spinal nerves penetrate into the mesenchyme of limb bud. Immediately the nerves enter the limb bud, they establish intimate contact with the differentiating mesodermal condensations and the early contact between nerve and muscle cells is a prerequisite for their complete functional differentiation (2). The growth as well as the path finding of nerve fibres towards the target is dependent upon concentration gradient of a group of cell surface receptors in the environment (1). Several signalling molecules and transcription factors have been identified which induce the differentiation of the dorsal and ventral motor horn cells The high percentage of anomalies as mentioned above emphasizes the complexities and irregularities of this anatomic region with regard to surgical approaches (3). Knowledge of such variations is important for surgeons to perform surgical procedures in the axillary region and arm (4). Considering the high percentage of anomalies in the formation of median nerve and its paramount clinical importance, the present variations are documented.

Variations in the formation and branching pattern of the brachial plexus constitute an important anatomical and clinical entity and have been reported by several investigators (5,6,7). The median, musculocutaneous and ulnar nerves after their origin from the brachial plexus, pass through the anterior compartment of the arm without receiving any branch from any nerve in the neighbourhood (8). Although the communications between the different nerves in the arm are rare, those between the median nerve (MN) and musculocutaneous nerve (MCN) have been described from nineteenth century (9). Knowledge of anatomical variation of these nerves at the level of upper arm is essential in light of the frequency with which surgery is performed in the axilla and the surgical neck of the humerus (10).

MATERIALS AND METHODS

100 upper limbs of 50 donated embalmed cadavers (45 males & 5 females) of age group ranging from 70 to 80 years were studied in the department of Anatomy at K. J. Somaiya Medical College, Sion, Mumbai, INDIA, the variant connections between the median nerve and the musculocutaneous nerve were observed. The finding was noted after thorough and meticulous dissection of the upper limbs of both sides. The arterial pattern in the arm was also observed. The photographs of the communication were taken for proper documentation.

OBSERVATIONS

Out of 100 specimens the variant connections between the median nerve and the musculocutaneous nerve were found in 30 specimens i.e. 30% of the total specimens (Table - 1). Out of 30 specimens, 4 specimens showed the median nerve getting the communicating branch from the musculocutaneous nerve, 6 specimens showed the formation of the median nerve by medial and lateral roots in the middle of the arm; 12 specimens showed that the musculocutaneous nerve traveled some distance with the median nerve and then it got separated from the median nerve, the remaining 8 specimens showed that all the muscles of the front of the arm were supplied by the median nerve. The musculocutaneous nerve was absent. There was no associated arterial variations seen in any of the specimens.

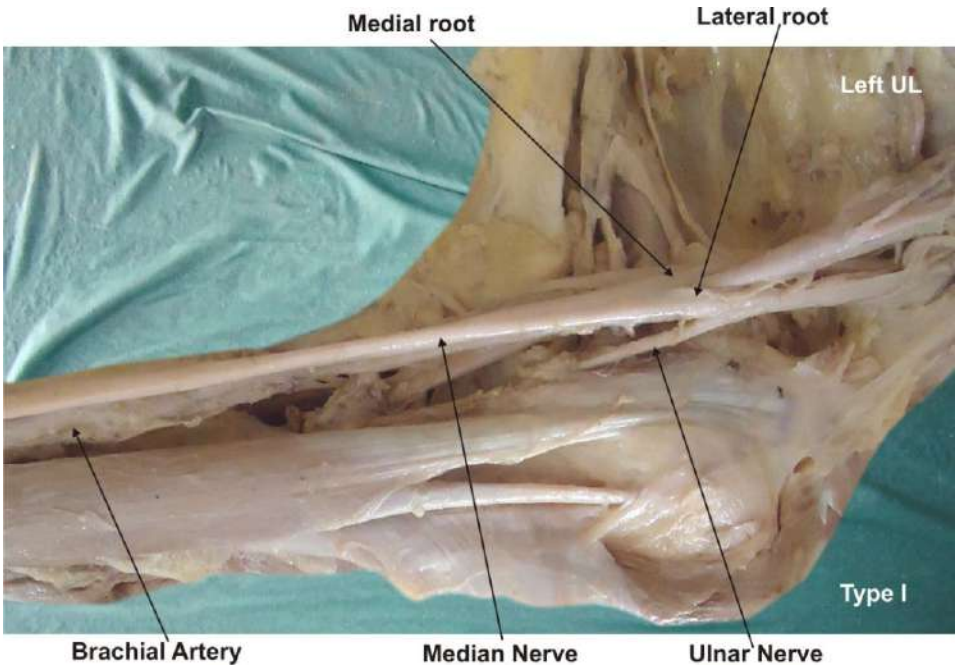


Fig. 1 : Photographic presentation of Type I - there is no communication between the median nerve and the musculocutaneous nerve, NORMAL

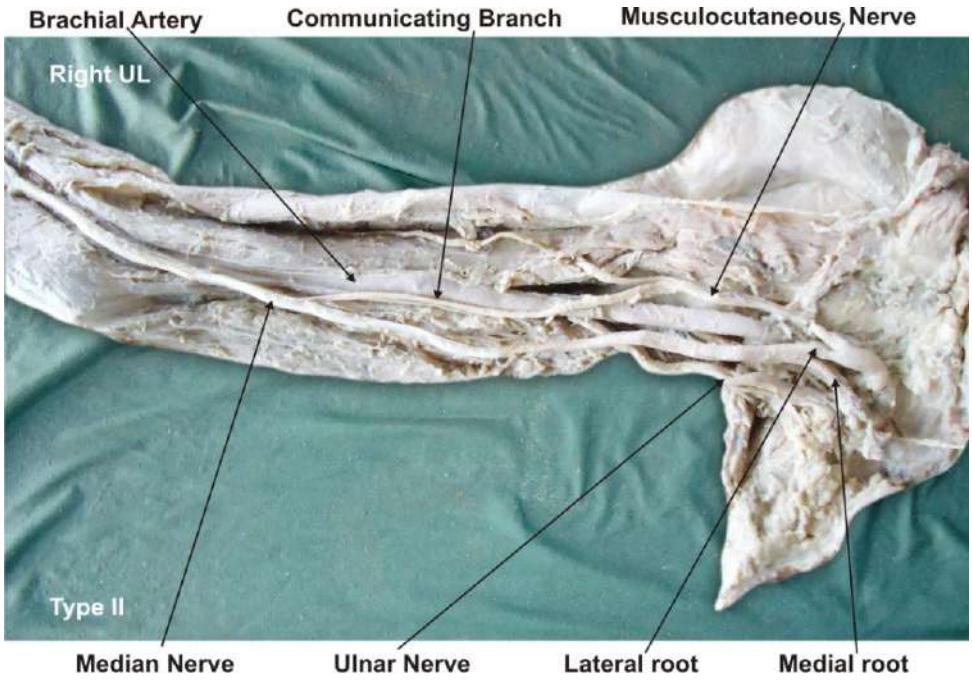


Fig. 2 : Photographic presentation of Type II - the fibers of the lateral root of the median nerve pass through the musculocutaneous nerve nerve and join the median nerve in the middle of the arm

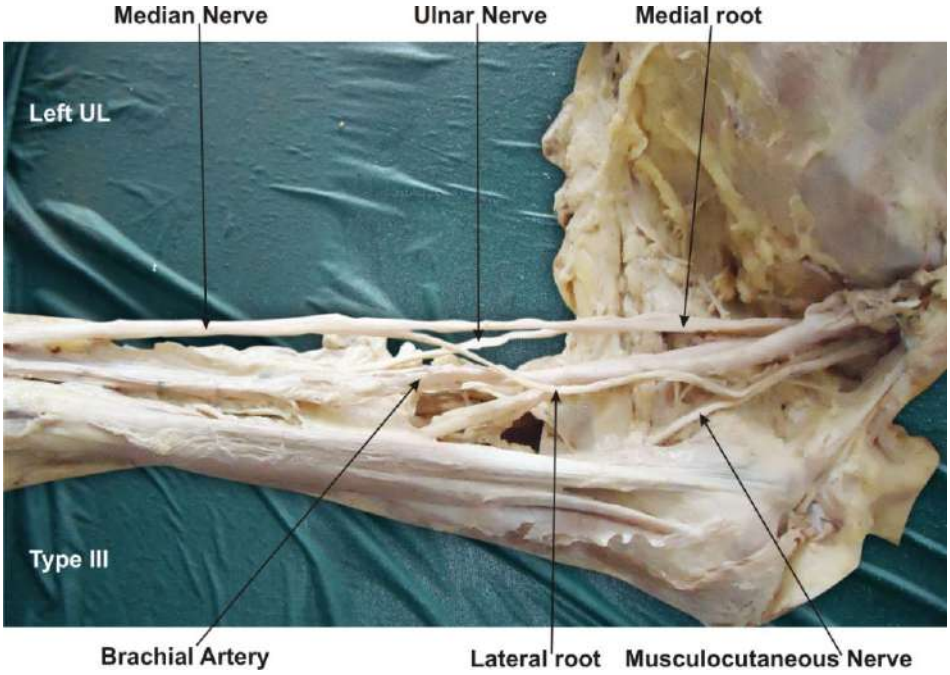


Fig. 3 : Photographic presentation of Type III - the lateral root fibers of the median nerve pass along the musculocutaneous nerve and after some distance, leave it to form the lateral root of the median nerve.

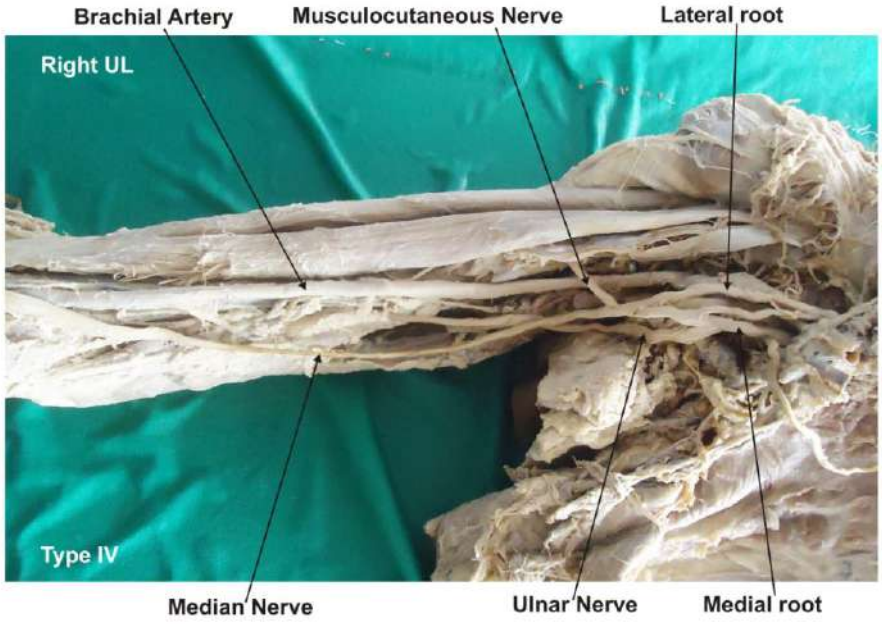


Fig. 4 : Photographic presentation of Type IV - the musculocutaneous nerve fibers join the lateral root of the median nerve and after some distance the musculocutaneous nerve arises from the median nerve.

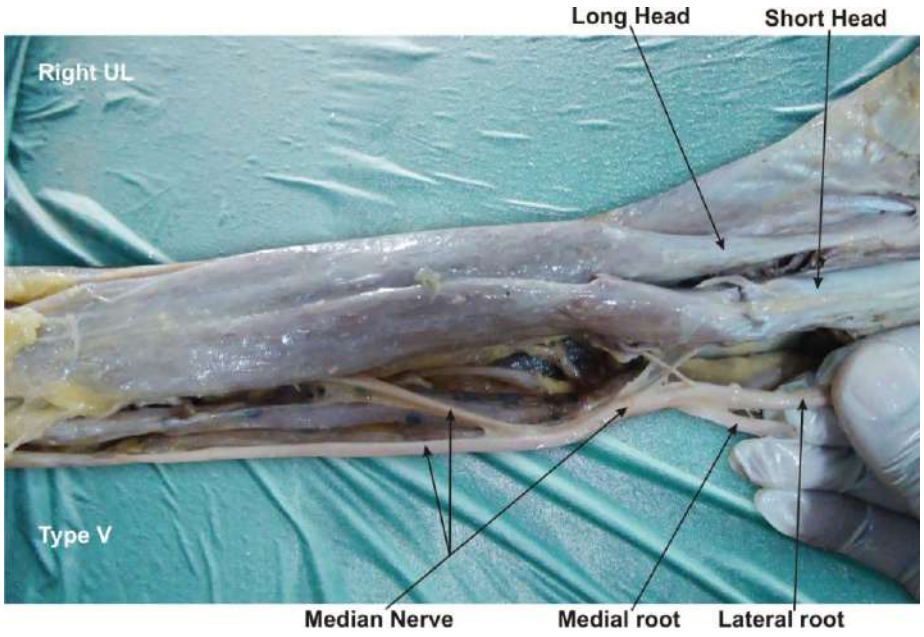


Fig. 5 : Photographic presentation of Type I - the musculocutaneous nerve is absent and the entire fibers of the musculocutaneous nerve pass through the lateral root and fibers to the muscles supplied by the musculocutaneous nerve branch out directly from the median nerve.

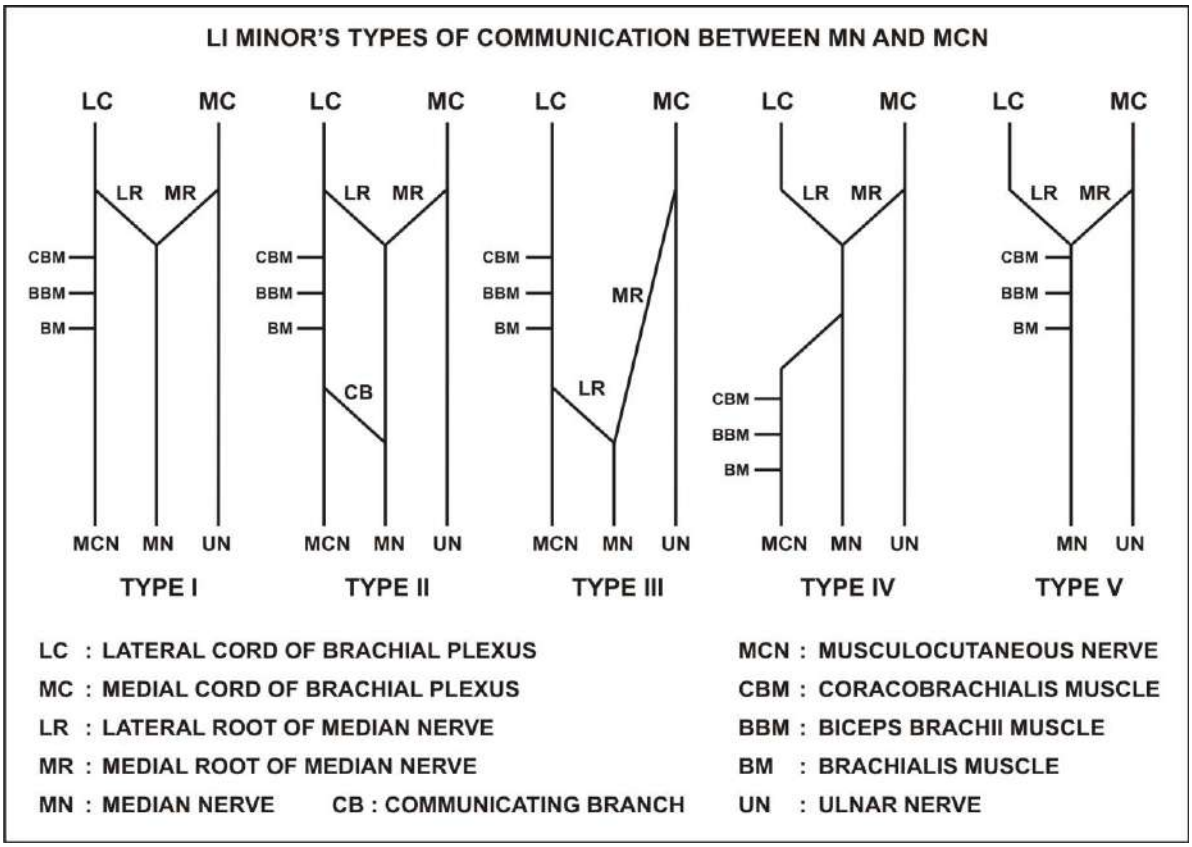
Table - 1 : The incidence of anastomosis between the musculocutaneous nerve and the median nerve as gleaned from literature.

Sr. no.	Author	Year	Incidence (%)
1	Watanabe et al (**11**)	1985	01.4
2	Kosugi, Mortia and Yamashita (**12**)	1986	21.8
3	Venieratos and Anagnostopoulou (**13**)	1998	13.9
4	Choi et al (**14**)	2002	26.4
5	Loukas and Aqueelah (**15**)	2008	63.5
6	Guerri-Guttenberg and Ingolotti (**16**)	2009	53.6
7	Maeda et al (**17**)	2009	41.5
8	Sawant et al (**present study**)	**2012**	**30**

DISCUSSION

The variant connections between the musculocutaneous nerve and the median nerve is by far the most common and frequent of all the variations that are observed among the branches of the brachial plexus (13). Above Table depicts the incidence of communication between musculocutaneous nerve and median nerve irrespective of its site or type as reported in literature. It is seen to vary between wide ranges of 1.4% to 63.5%. The communication between the musculocutaneous nerve and the median nerve have been classified in different types by Venieratos and Anagnostopoulou, Choi et al and

Li Minor (13,14,18). Li Minor categorized these communications into following five types: In type I, there is no communication between the median nerve and the musculocutaneous nerve, in type II, the fibers of the lateral root of the median nerve pass through the musculocutaneous nerve nerve and join the median nerve in the middle of the arm, whereas in type III, the lateral root fibers of the median nerve pass along the musculocutaneous nerve and after some distance, leave it to form the lateral root of the median nerve. In type IV, the musculocutaneous nerve fibers join the lateral root of the median nerve and after some distance the musculocutaneous nerve arises from the median nerve. In type V, the musculocutaneous nerve is absent and the entire fibers of the musculocutaneous nerve pass through the lateral root and fibers to the muscles supplied by the musculocutaneous nerve branch out directly from the median nerve (18).



In the present study all the above mentioned types of communication between the musculocutaneous nerve and the median nerve were observed (Table - 2). Out of 30 specimens, 4 specimens showed the median nerve getting the communicating branch from the musculocutaneous nerve i.e. Type II. 6 specimens showed the formation of the median nerve by medial root and lateral root in the middle of the arm i.e. Type III. 12 specimens showed the musculocutaneous nerve travels some distance with the median nerve and then it got separation from the median nerve i.e. Type IV. 8 specimens showed that all the muscles of the front of the arm were supplied by the median nerve. The musculocutaneous nerve was absent i.e. Type V. The remaining 70 specimens showed no communication between the musculocutaneous nerve and the median nerve i.e Type I of Li Minor's classification.

Table - 2 : Li Minor's classification

Li Minor's Type	No. of specimens	%
I	70	70
II	4	4
III	6	6
IV	12	12
V	8	8

Similarly based upon its site with relation to the coracobrachialis muscle Venierators and Anagnostopoulou (13) classified this communication into three types. In type I, communication between the musculocutaneous nerve and the median nerve is proximal to the entrance of the musculocutaneous nerve into the coracobrachialis, whereas in type II, the communication is distal to the muscle and in type III neither the nerve nor its communicating branch pierces the muscle. In the present study (Table - 3) 22 specimens are of Type II and 8 specimens are of type III of Venierators and Anagnostopoulou's classification.

Table - 3 : Venierators and Anagnostopoulou's classification

Venierators and Anagnostopoulou's Type	No. of specimens	%
I	22	22
II	Nil	Nil
III	8	8

Later on Choi et al. (**14**) in a study on 138 cadavers classified these communications into three types. The first pattern comprised of fusion of both nerves (19.2%). Pattern 2 showed the presence of one supplementary branch between both nerves (72.6%). This type was further subdivided as Pattern 2a, where a single root from musculocutaneous nerve, contributes to the connection (69.9%) while in Pattern 2b there are two roots from musculocutaneous nerve (2.7%). Pattern 3 showed presence of two branches between both nerves (6.8%). The most frequent variation is the presence of a communicating branch that emerges from the musculocutaneous nerve and goes distally to join the median nerve, an anastomosis observed in the lower third of arm (7,13). If this branch is given off in upper third of the arm, it is generally considered as third (double lateral) root of the median nerve (7). The median nerve, instead of having two roots may have three roots - either one each from lateral cord, medial cord and the musculocutaneous nerve (19,20) or two from lateral cord and one from the medial cord (21) or it may have even four roots - three from the lateral cord and one from the medial cord (22).

Ontogeny:

The presence of such different types of variant connections between the median nerve and the musculocutaneous nerve documented in 15 cases may be attributed to random factors influencing the mechanism of formation of limb muscles and the peripheral nerves during embryonic life. Significant variations in nerve patterns may be a result of altered signaling between mesenchymal cells and neuronal growth cones (**23**) or circulatory factors at the time of fusion of brachial plexus cords (**12**). Iwata believed that the human brachial plexus appears as a single radicular cone in the upper limb bud, which divides longitudinally into ventral and the dorsal segments (**24**). The ventral segments give roots to the median and the ulnar nerves with musculocutaneous nerve arising from the median nerve. He further kept the possibility of failure of the differentiation as a cause for some of the fibers taking an aberrant course as a communicating branch. Chiarapattanakom et al. (**25**) are of the opinion that the limb muscles develop from the mesenchyme of local origin, while axons of spinal nerves grow distally to reach the muscles and/or skin. They blamed the lack of coordination between the formation of the limb muscles and their innervation for appearance of a communicating branch.

Phylogeny:

Studies of comparative anatomy have observed the existence of such connections in monkeys and in some apes; the connections may represent the primitive nerve supply of the anterior arm muscles (**6**). Chauhan et al strongly recommend the consideration of the phylogeny and the development of the nerves of the upper limb for the interpretation of the nerve anomalies of the arm (**19**). Considering the communication between the musculocutaneous and the median nerve as a remnant from the phylogenetic or comparative anatomical point of view and that the ontogeny recapitulates the phylogeny, they feel that the variations seen are the result of the developmental anomaly.

Clinical significance

Injury to the median nerve could occur in cases of open or closed trauma to the arm, such as bullet and blade wounds or during surgeries on the axilla or arm. The median nerve and its roots are close to the axillary vein, which is used as the most cranial limit for axillary lymph node dissection, a procedure used in treating certain tumors, such as breast carcinoma and melanoma. If the dissection extends more cranially than normal, injury to the median nerve (or to its medial root)

may occur, with consequent dysfunction of the flexor musculature of the elbow if the anatomical variation described here is present. It would not be unlikely for such accidents to occur even with the most eminent surgeons, considering that the classical concept is that the median nerve does not give rise to branches in the arm (26). The clinical relevance of such variations might also be correlated to entrapment syndromes. Entrapment of musculocutaneous nerve is rare and has its origin either in physical activity (27) or in violent passive movements of arm and forearm (28). This knowledge of anastomosis between the musculocutaneous nerve and the median nerve may prove useful for clinicians in order to avoid an unnecessary Carpal tunnel release (13). The presence of such type of variations are clinically important for orthopaedicians operating on surgical neck of the humerus and anaesthetist performing pain management therapies on the upper limb. The anatomical variation described here has practical implications, since injury to the median nerve in the axilla or arm would, in this case, have caused unexpected paresis or paralysis of the flexor musculature of the elbow and hypoesthesia of the lateral surface of the forearm, in addition to the classical signs that are already well known.

CONCLUSION

The presence of such type of variations are clinically important for surgeons, orthopaedicians and anaesthetist performing pain management therapies on the upper limb. These variations are compared with the earlier data & it is concluded that variations in branching pattern of cords of brachial plexus are a rule rather than exception.

Competing Interests:

The authors declare that they have no competing interest.

Authors' contributions

SPS wrote the case report, performed the literature review & obtained the photograph for the study. RMM performed the literature search and assisted with writing the paper. STS conceived the study and helped to draft the manuscript. All authors have read and approved the final version manuscript.

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