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Original Article

Study of communication between musculocutaneous and median nerves in man

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ABSTRACT

Introduction: The median and musculocutaneous nerves are functionally most important terminal branches of brachial plexus. Injuries involving median or musculocutaneous nerve proximal to the anastomotic branch may give rise to unexpected presentation of weakness of forearm flexor and thenar muscles or present as double nerve injury. This inspired us to study the exact topography of communication between median nerve and musculocutaneous nerve and to discuss its morphological and clinical significance.
Methods: The study was conducted in 50 cadavers (100 upper limbs) in duration of two and a half years. Proper cadaveric dissection was done during 2010–2013 in the department of Anatomy, Jawaharlal Nehru Medical College, and also in department of Anatomy Mahatma Gandhi Aurvadic Medical College, Sawangi, Wardha.
Result: Present series, studied musculocutaneous and median nerves in 50 cadavers (100 upper limbs) to evaluate the communication between these two nerves. In 42% cadavers (2-bilateral and 19 –unilateral) communicating branch was present, mostly single and distal to coracobrachialis muscle. More than one communicating branch was observed in 4% cadavers.
Discussion: The incidence of communication between musculocutaneous and median nerve is quite high (42%). Previous studies carried out in different countries and ethnicities showed abnormal communication between these two nerves ranged from 6–68%.Lesions of communicating nerve may give rise to pattern of weakness that may impose difficulty in diagnosis. So it is important to have awareness of these variations that are observed and discussed in present study.

1. Introduction

Median and musculocutaneous nerves are functionally most important terminal branches of brachial plexus. Musculocutaneous nerve (C5, 6, 7) arises from lateral cord as one of the terminal branches opposite the lower border of pectoralis minor and usually pierce coracobrachialis and descends laterally between the biceps brachii and brachialis, to the lateral side of the arm and continues as lateral cutaneous nerve of forearm.[1] It supplies coracobrachialis, biceps brachii and medial part of brachialis muscles. Distal to elbow it contains only sensory fibres and supplies skin of lateral aspect of forearm.

Although communications between the nerves in the arm are rare, but communication between the median nerve (MN) and musculocutaneous nerve (MCN) were described from nineteenth century (Testut,[2] 1899; Villar,[3] 1888; Harris,[4] 1904). The most frequent of these variations consists of the presence of a communicating branch that bifurcates from the musculocutaneous nerve and goes distally to join the median nerve.[5] The opposite situation namely the presence of a communicating branch from median nerve to musculocutaneous nerve is rarely encountered.[5] Some have attempted to classify these communications on the basis of several different criteria (Le Minor,[6] 1990; Venieratos and Anagnostopoolou,[5] 1998; Choi et al.[7] 2002).

Importance of this communication lies in the cases where injuries involving median or musculocutaneous nerve proximal to the anastomotic branch may give rise to unexpected presentation of weakness of forearm flexor and thenar muscles or present as double nerve injury.[8]

Gross anatomical knowledge of nerves like origin, course, branches and distributions as well as communications is essential. Anomalies in

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the peripheral nerves and their connections are clinically important hence the anatomical variation of these nerve needs in depth evaluation for better understanding and replay its importance in clinical evaluation because the variations reported are not uncommon and are vulnerable to lesion in surgical access to the arm.

This inspired us to carry out the present work of studying communication between musculocutaneous and median nerve. Our objectives were to study the exact topography of communication between median nerve and musculocutaneous nerve and to discuss its morphological and clinical significance.

2. Material & method

The study was conducted in department of Anatomy, Jawaharlal Nehru Medical College, Sawangi, Wardha. Prior permission from the Institutional Ethical Committee was obtained. Study duration was two and half years during 2010–2013 and include 50 cadavers (100 upper limbs).

During the routine dissection of cadavers for the undergraduate students after completion of pectoral region the brachial plexuses of both sides were dissected strictly following the instruction of Cunninghams[9] dissector carefully. We dissected axilla & arm by giving a longitudinal incision at the anterior aspect of the arm, from the level of acromion process to a point about 2.5 cm below the elbow joint. A horizontal incision was made bilaterally in both proximal and distal ends of longitudinal incision and reflects the skin. We removed the loose connective tissue, fat and lymph nodes from the axilla to expose the contents. Coracobrachialis and short head of biceps muscles arising from the tip of coracoid process were exposed. Then we found the axillary artery and median nerve medial to these muscles and musculocutaneous nerve entering the deep surface of coracobrachialis follow this nerve upwards and find its branch to the muscle.

We reflected the flaps to uncover biceps brachii, lifted this muscle forwards and the musculocutaneous nerve was found in the delicate septum which separates biceps from the brachialis muscle posteiorly. We followed the musculocutaneous nerve and the biceps and coracobrachialis muscle proximally and distally.[9]

Communication between the median nerve and musculocutaneous nerve was dissected very carefully and length of the communicating branch was measured. Site of the origin of the communicating branch was meticulously measured from the two bony landmark namely coracoid process (proximally) and medical epicondyle (distally) similarly its termination was also located properly from the two bony landmark.

Study was analysed by comparing with normal standard origin, courses and branches as stated in the Gray's Anatomy. Analysis was done by using SPAPA 11.1 version and data was presented in mean ± SD (standard deviation), frequency, percentage. In the case of categorical data Chi square test was used. P value <.05 is taken as statistically significant.

3. Results

Communications studied with regard to its

A Number of communicating branches
B Direction of communication
C Side of communication
D Length of communicating branches
E Distance of communicating branch from two important bony landmarks, coracoid process and medial epicondyle.

In present study communicating branches were mostly single and directed downward and medially (that means originating from the musculocutaneous nerve and going toward the median nerve) result are depicted in Table 1 and Fig. 1.

A) We observed two communicating branches in 4% cadavers but they are different in each case. Double communicating branches from musculocutaneous to median nerves were seen only in one cadaver (2%). One communicating branch arose from the musculocutaneous nerve before piercing the coracobrachialis and another after piercing the coracobrachialis muscle (Fig. 3). In present study the branch which was given off in upper third of the arm proximal to coracobrachialis, was considered as third root of median nerve.

B) Direction of the communicating branches was downward and medially in 19 out of 23 arms (82.6%) and in four arms (15.4%) it was downward and laterally (that means originating from median nerve and going toward the musculocutaneous nerve) Fig. 2.

In one cadaver (2%) median nerve received two communicating branches, one from musculocutaneous nerve and another from ulnar nerve approximately 14 cms distal to coracoid process (Fig. 4). The length of communicating branch which arose from musculocutaneous nerve was 8 cms and which arose from ulnar nerve was 10 cms.

C) Unilateral communicating branches were more common (right side -11upper limbs- 22% and left side -8 upper limbs – 16%)) in comparison to bilateral.

Communicating branches in both upper limbs of a cadaver were observed in 4% (2 cadavers). Two cadavers had bilateral communicating branches, out of which in one cadaver in right upper limb the communicating branch directed from median to musculocutaneous nerve and in left upper limb the direction was from musculocutaneous to median nerve.

D)The length of these communicating branches was measured 1–12 cms (mean length 4.6 ± 3.3). Observations are depicted above in Table 2 and Graph 1 , showing measured length of communicating branches.

E) In 42% cadavers (23 upper limbs) the communicating branch joined musculocutaneous nerve after piercing coracobrachialis muscle at the distance of 7–22 cms (mean 13.1 ± 4.03) distal to the coracoid process and 6 to 25 cm (mean 17.1 ± 4.61) proximal to medial epicondyle. Observations are depicted above in Table 2.

Communicating branches between musculocutaneous and median nerve, reached the median nerve at distance of 11 to 24 cms (mean 16.8 ± 3.04) from the coracoid process and 6 to 22 cms

Table 1
Side, number and direction of the communicating branches.

Serial No.	Cadaver No	R – Right /L – Left Upper Limb	Number of Communication	Direction of communication
1	2	R	1	A
2	4	R	1	A
3	8	R	1	A
4	15	L	1	A
5	16	R	1	A
6	17	L	1	B
7	21	R	1	A
8	22	L	1	B
9	24	R	2	A
10	25	L	1	A
11	27	L	1	A
12	28	L	1	B
13	30	R	1	B
14	30	L	1	A
15	33	R	1	A
16	35	R	1	A
17	37	R	1	A
18	37	L	1	A
19	39	R	1	A
20	41	R	1	A
21	46	L	1	A
22	47	L	2	A
23	49	R	1	A

*A- Downward and medial & B - Downward and laterally.

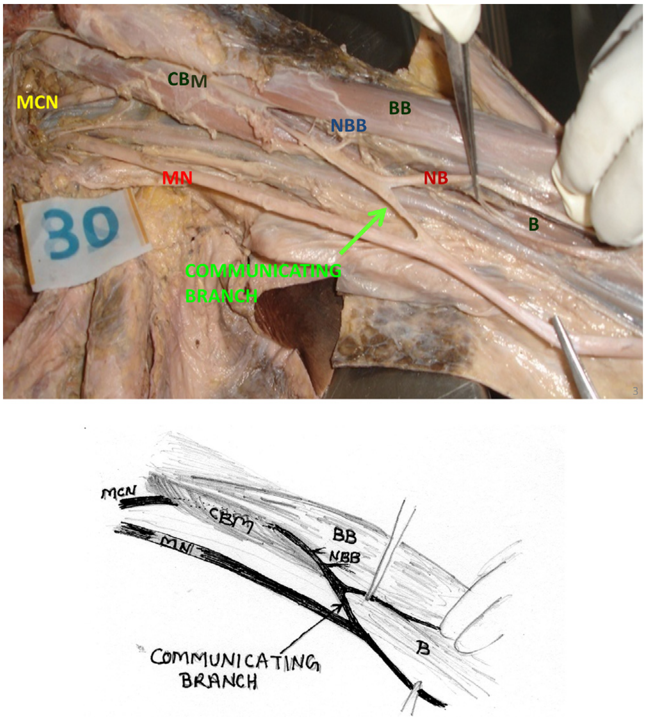
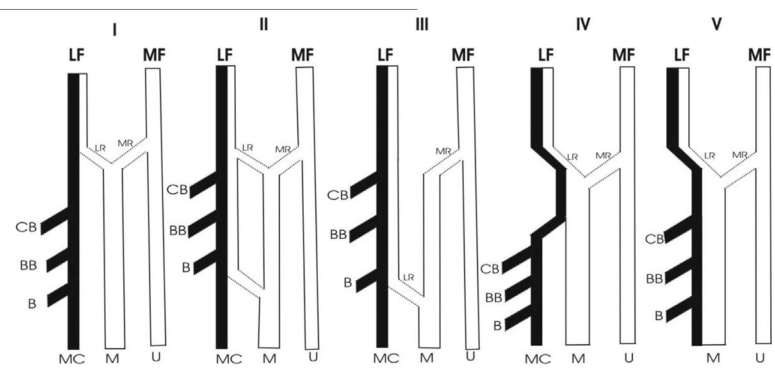


Fig. 1. Communicating branch between musculocutaneous and median nerves. Schematic representation (Fig. 1) of left axilla and arm showing communication between MCN and MN.
MCN- Musculocutaneous nerve, MN- Median nerve, NBB- Nerve to biceps brachii, NB- Nerve to brachialis, B- Brachialis, BB-Biceps Brachii, CBM-Coracobrachialis.

(mean 14.3 ± 3.91) proximal to the medial epicondyle. Fig. 5 shows small communicating branch and Fig. 6 shows long communicating branch. We have found absent musculocutaneous in fair number of cadavers in present study but are not discussed in this manuscript.



4. Discussion

Distribution, course and branching pattern of the nerves of brachial plexus is important from the clinical point of view. More precise knowledge than that found in classical anatomical texts is necessary for the clinical investigations and surgical treatment of peripheral nerve injury. In the present series, we studied the musculocutaneous and median nerves in 50 cadavers (100 upper limbs) to evaluate the communication between these two nerves.

We found 42% cadavers were showing communications between these two nerves. Previous studies carried out in different countries and ethnicities showed abnormal communication between these two nerves ranged from 6-68%.[10]

Most of the series on this variation has shown no relation of variation with gender.[7,11] In our series there were only six female cadavers. Communicating branch was seen in 16.7% of female cadavers. The results of Uzun, and Bilgic[12] on brachial plexus of 34 males, 31 females cadaver (aged 1-7days) suggested variations in the formation of brachial plexus are not influenced either by sex or body side. G.E. Anyanwu[13] also reported that prevalence and pattern of communication of median and musculocutaneous nerves is not affected by gender, ethnicity or side of arm.

4.1. Incidence of communications

Communication between musculocutaneous and median nerve is by far the most common variation that is observed among the branches of brachial plexus. Its incidence varies from 3% (G.E. Anyanwu et al[13]) to 42% (Morios Loukas[14]). In present study 23 arms were observed to have communication between musculocutaneous and median nerve. The results were comparable with studies of Choi et al[7] and Virendra Budhiraja.[15]

Variations in the musculocutaneous and median nerve have been classified by earlier workers.

1 To the best of our knowledge Gegenbaur[33] (1867) was the first author to investigate variations of communication patterns between musculocutaneous and median nerve. In his study of 28 cases, he described communication in two types. (quoted from Loukas[14] -2005). Type –1. Communications were proximal to the point of entry of the musculocutaneous nerve into the coracobrachialis (20/28–71.4%). Type –2. Communications were proximal to the point of entry of the musculocutaneous nerve into the coracobrachialis and additional communication took place distally (5/28 – 17.8%).
2 Le Minor[6] (1990) classified the communications between the median nerve and the musculocutaneous nerve into five types:

LF- lateral cord, MF- medial cord, LR- lateral root of median nerve, MR- medial root of median nerve, MC- musculocutaneous nerve, M-median nerve, U- ulnar nerve, CB- nerve to coracobrachialis, BB- nerve to biceps brachii, B- nerve to brachialis.

In Le Minor's classification type IV and V indicates absent musculocutaneous nerve. We did not observe type III variation in our study.

- In 2002 Choi et al[7] in their study of 138 cadavers (276 arms) described 3 patterns for the connection between the median and the musculocutaneous nerves:
  - Pattern 1: fusion of the nerves (14 arms, 19.2%).

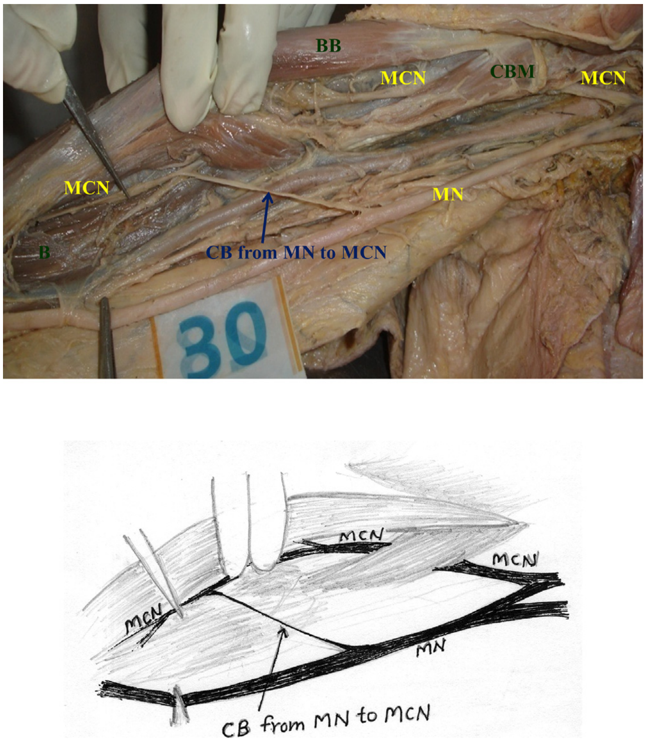


Fig. 2. Direction of communicating branch from median to musculocutaneous nerve.
Diagrammatic representation (Fig. 2) of right arm showing CB from MN to MCN.
MCN Musculocutaneous nerve, MN- Median nerve, CB- Communicating branch, B-Brachialis, BB-Biceps Brachii, CBM-Coracobrachialis.

- Pattern 2: one connecting branch present between the nerves (53 arms, 72.6%).
- Pattern 3: two connecting branches present between the nerves (5 arms, 6.8%).

A combination of Patterns 1 and 2 was observed in one case (1.4%) (Table 3).

Our results are comparable and similar to Choi et al though the observed variations are on higher side in our study. After comparing our results with different classification we found that incidence of variation was more in our study in terms of communicating branches arising from musculocutaneous nerve after piercing coracobrachialis (23%) muscle and absent musculocutaneous nerve (15%) in present study. Lesions of the communicating nerve may give rise to pattern of weakness that may impose difficulty in diagnosis. Clinical implication of this could be that injury of musculocutaneous nerve proximal to the communicating branch between musculocutaneous and median nerve may lead to unexpected presentation of forearm flexors and thenar muscles.

4.2. Direction of communicating branch

Communicating branch originating from musculocutaneous nerve and joining median nerve was more common (34%) than communicating branch arising from median nerve and going to musculocutaneous nerve (8%). Direction of communicating branches was compared with other studies in Table 4.

On comparing our results with different studies, it was come in the range of study by Iwamoto et al. In our study communicating branch arising from median nerve and going to musculocutaneous nerve was observed in 8% cadavers. In literature only few case reports were available in which the direction of communication

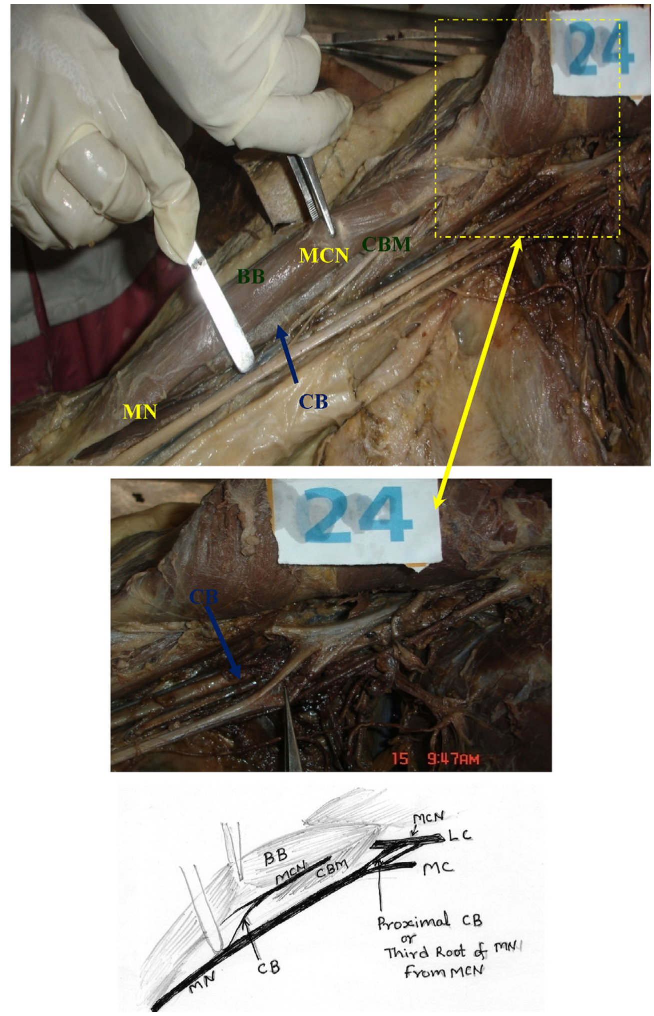


Fig. 3. Two communicating branches.
Diagrammatic representation of Fig. 3 showing double communicating branches in right arm.
MCN -Musculocutaneous nerve, MN- Median nerve, CB- Communicating branch, BB-Biceps Brachii, CBM-Coracobrachialis, LC-Lateral cord, MC-Medial cord.

from median nerve to musculocutaneous nerve is mentioned (Krelinger,[20] Fercey Giulec,[21] Arora J,[22] Saeed and Rufai[23]). Communication between median and musculocutaneous nerve is attributable to common origin of the musculocutaneous and median nerve during development. Compression of this communicating branch may simulate the finding of compression of median nerve.

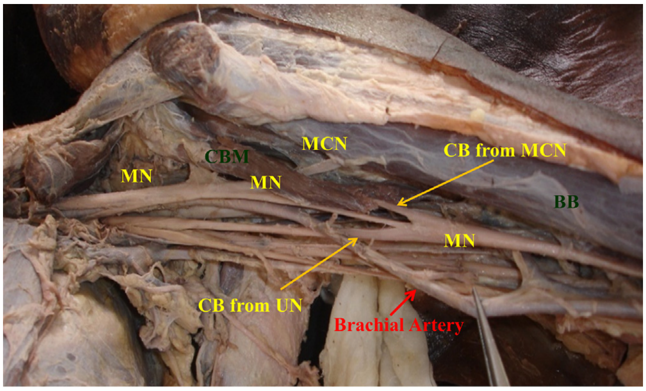
4.3. Length of communicating branch

The length of these communicating branches measured minimum 1 cm to maximum 12 cms (mean length 4.6 ± 3). Length of communicating branches was compared with other studies in Table 5.

4.4. Number of communicating branches

In present study communicating branches were mostly single and directed downward and medially (that means originating from the musculocutaneous nerve and going toward the median nerve).

Two or more communicating branches between musculocutaneous and median nerves are a rare finding and were observed in only 1% upper limbs (2% cadavers) in our study, whereas it ranged



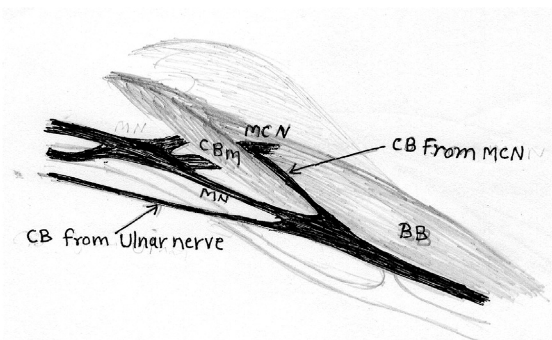


Fig. 4. Number of communicating branches (two).
Diagrammatic representation of Fig. 4, showing two CB in left arm.
MCN-Musculocutaneous nerve, MN- Median nerve, CB- Communicating branch, UN- Ulnar nerve, BB-Biceps Brachii, CBM-Coracobrachialis.

between 0–3.8% in different series. In another cadaver (2%) we observed median nerve received two communicating branches one from musculocutaneous nerve and another from ulnar nerve.

4.5. Side of communicating branches

Communicating branches were more common on right side (11upper limbs- 22%) in comparison to left side (8 upper limbs – 16%). Communicating branches in both upper limb of a cadaver was observed in 4% (2 cadavers). Bilateral communication is rare and observed in 4% cadavers in present study. In different studies bilateral communications were ranging in between 0–4%.

4.6. Site of communicating branch from coracoid process

In 42% cadavers (23 limbs) the communicating branch joined musculocutaneous nerve after piercing coracobrachialis muscle at the distance of 7–22 cms (mean 13.1 ± 4.03) from the coracoid process. These communicating branches reached median nerve at distance of 12–24 cms (mean 16.8 ± 3.04) from the coracoid process. We observed communicating branches in middle third of arm. Most commonly communicating branches originated from musculocutaneous nerve approximately at the junction of upper one third and middle one third of arm and reached to the median nerve approximately at the junction of lower one third and middle one third of the arm.

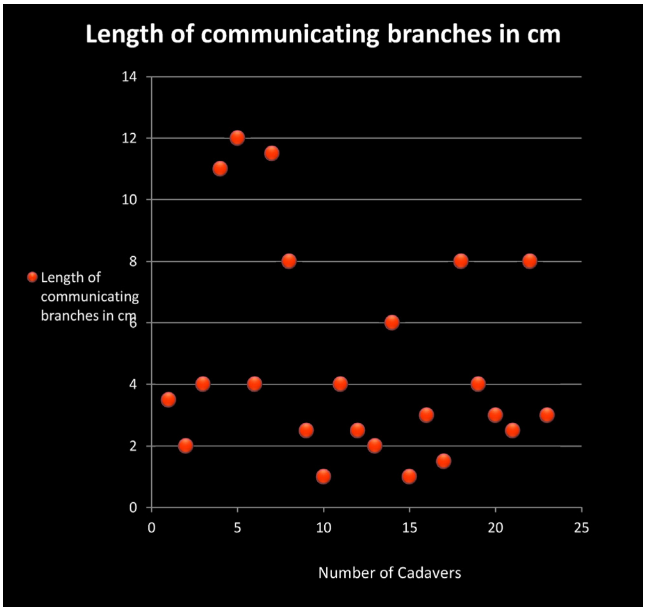
Median nerve and musculocutaneous are the two nerves which are more prone for variations; either in their Anatomical course or in the communication between these two nerves and common origin of the median and musculocutaneous nerves also explains the frequent presence of communicating branches between these two nerves, which are found in up to one third of all individuals (Prasada Rao[29]).

It must be noted that the primary ventral branches of the spinal nerves that form the musculocutaneous and the lateral root of median nerve are common to these two nerves (C5-7). Considering that in the present study the musculocutaneous nerve was absent, it is not surprise that the nerve fibre heading for flexor musculature of the elbow and the skin of the lateral surface of the forearm (coming from the C5 to C7spinal nerve) would accompany those of the median nerve in the lateral fasciculus and, from there, would follow the median nerve along its path in the forearm.[30]

Table 2
Length and site of the communicating branches (CB).

Serial no.	Cadaver no	Length of CB in c.m.	Site of communication			
			Site of CB on MCN from CP in cms	Site of CB on MCN from ME in cms	Site of CB on MN from CP in cms	Site of CB on MN from ME in cms
1	2	3.5	13.5	16	15	14
2	4	2	15	22	18	19
3	8	4	16	20	17	17.5
4	15	11	9	22	19	11
5	16	12	8	22	19	11.5
6	17	4	11	18	13	22
7	21	11.5	8	20	19	8.5
8	22	8	20	9	15	17
9	24	2.5	15	15	18	12.5
10	25	1	11	18	18	14
11	27	4	7	21	11	18
12	28	2.5	22	6	21	8
13	30	2	16	15	18.5	14
14	30	6	18	12	13	16
15	33	1	16	14	18	13
16	35	3	13	16	15	14
17	37	1.5	15	15	16	15
18	37	8	15	12	24	6
19	39	4	11	21	18	13
20	41	3	15	16	19	12
21	46	2.5	9	19	12	17
22	47	10 & 8	8	25	14	20
23	49	3	12	21	16	17

MCN- musculocutaneous nerve, MN- medaian nerve, CB- communicating branch,CP-coracoid process, ME- medial epicondyle.



Graph 1. Graph showing length of communicating branches.

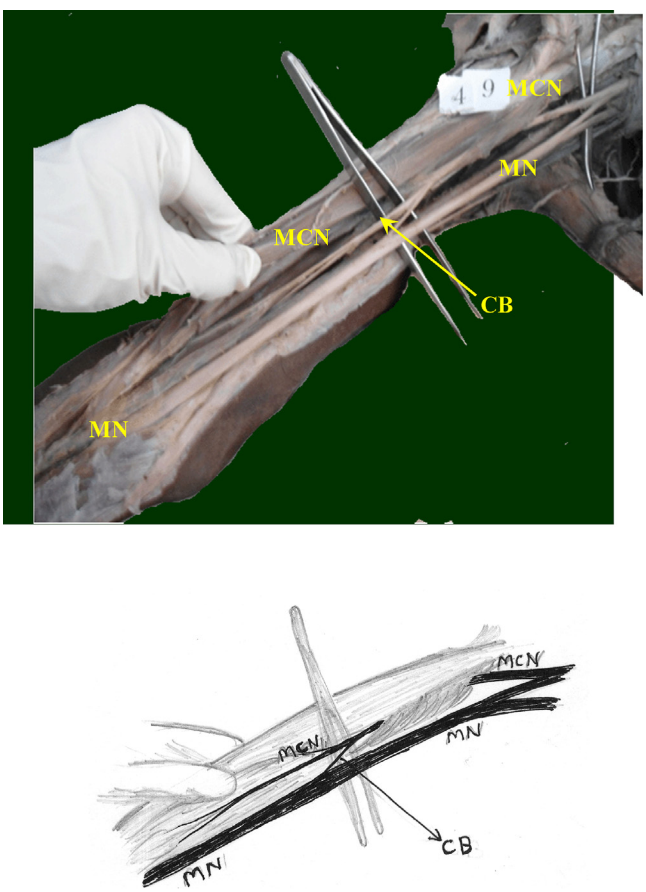


Fig. 5. Length of communicating branch.
Diagrammatic representation of Fig. 5, showing small CB in right arm.
MCN Musculocutaneous nerve, MN- Median nerve, CB- Communicating branch.

Communication between the musculocutaneous and median nerve is considered as a remnant from the phylogenetic or comparative point of view. Kosugi et al[31] reported that there was only one trunk equivalent to the MN in the thoracic limb of the lower vertebrates (amphibians, reptiles and birds). In the context

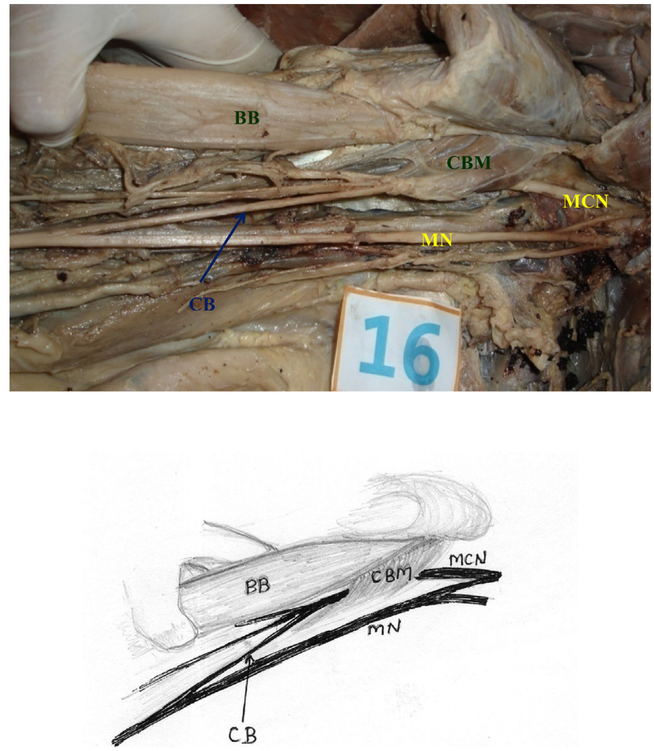


Fig. 6. Length of communicating branch.
Diagrammatic representation of Fig. 6, showing length of CB in right arm.
MCN Musculocutaneous nerve, MN- Median nerve, CB- Communicating branch, BB-Biceps Brachii, CBM-Coracobrachialis.

that ontogeny recapitulates phylogeny; it is possible that the variation seen in the current study is the result of a developmental anomaly. 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.[32]

Understanding the embryologic development of the brachial plexus is important in explaining the origin of possible anatomic variations. The human upper limb bud appears at 26–27 days in the developing embryo and motor axons arising from the spinal cord enter the limb buds during the fifth week.[33] Formation of the brachial plexus is evident from about 34–35 days as a single radicular cone in the upper limb. Between 38 and 40 days, the major branches of the brachial plexus become visible, and the median, radial and ulnar nerves enter the hand plate.[34,35] The brachial plexus is divided into ventral and dorsal segments and the ventral segment gives roots to the median and ulnar nerves. The musculocutaneous nerve arises from the median nerve.[36] About 46–48 days, all the upper limb nerves comprise an orientation and arrangement similar to those seen in the adult. Communication between the median and musculocutaneous nerves is attributable to the common origin of the musculocutaneous and median nerves during development.

The growth as well as the path finding of nerve fibres towards the target is dependent upon the concentration gradient of a group of cell surface receptors and several signalling molecules in the environment. Significant variations in the nerve patterns may be a result of altered signalling between mesenchymal cells and neuronal growth cones or circulatory factors at the time of fusion of brachial plexus cords.[32] Specifically, such developmental abnormalities for axonal guidance in the coracobrachialis muscle could readily produce a situation where the musculocutaneous nerve does not pass through the coracobrachialis muscle, as seen here.[16,32] Iwata in his studies held the failure of the differentiation

Table 3
Comparison with Choi et al.

Pattern	Choi et al (upper limbs)	Present study (upper limbs)
Patter-1	14(5%)	15(15%)
Pattern-2	53(19.2%)	22(22%)
Pattern-3	5(1.8%)	1(1%)
Combination of pattern 1 & pattern 2	1(0.36%)	1(1%)

Table 4
Direction of communicating branches, comparison with different studies.

Serial no.	Authors	Incidence of Direction of CB from MCN to MN (%)	Incidence of Direction of CB from MN to MCN (%)	Communications in both direction
1.	Kasugi et al[17] (1992)	32%	16%	5%
2.	Iwamoto et al[18](1990)	15-30%	3-13%	0-5%
3.	S.D.Joshi et al[19](2008)	6.4%	5.88%	1.76%
4.	Present study	19%	4%	None

CB- communicating branch, MCN-musculocutaneous nerve,MN-median nerve.

Table 5
Comparison of length of communicating braches.

Serial no.	Authors	Length of communicating branch in cm
1.	Eglseder and Goldman[24] (1997)	1.77 cm (avg)
2.	AKTAN[25] (2001)	5.50 ± 2.50 cm
3.	Morios Loukas[14](2005)	2.5 to 7.8 (mean 4.6)
4	R.Chitra[26] (2007)	2 to 6 cm
5.	A.Nene[27] (2010)	2.7 cm (avg)
6.	Arora[22], Necdet Kocabiyk[28]	Varies from 2.5 to 12.6 cm
7.	Present study	1 to 12 cms (mean4.6 ± 3.3)

of nerves as a cause for some of the fibres taking an aberrant course as a communicating branch. Likewise, Chiarapattanakom et al[37] stated that the lack of coordination between the formation of the limb muscles and their innervation is responsible for the appearance of a communicating branch. Once formed, any developmental differences would obviously persist postnatally.

It was revealed that there was a definite rule in the distribution of the nerve fibres in the communications between musculocutaneous and median nerves. The area of the distributions was expanded in order from the thenar muscles to the flexor muscles of the forearm. Study on these communications is useful for proper diagnosis and treatment of the peripheral nerve injuries involving the musculocutaneous and median nerves.[38–41]

Differentiation between the sensory and motor fascicles is difficult due to the nature of the peripheral nerves. Nevertheless, intraneural topography of various nerves at different levels and intraoperative sketches of the fascicular patterns, as demonstrated by Sunderland, is helpful to surgeons. Moreover, nerve morphology alone is not helpful for their identification. To try to identify the fascicles, various electrophysiological methods & staining methods have been applied during the course of an operation.

5. Conclusion

Our study has reaffirmed that communication between the musculocutaneous nerve and median nerve are common and their presence must be determined during clinical assessment and repair of upper limb and brachial plexus.

Conflict of interest

There is no conflict of interest

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