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Research Article

DIFFERENT TYPES OF COMMUNICATIONS BETWEEN MUSCULOCUTANEOUS NERVE AND MEDIAN NERVE -A CADAVERIC STUDY IN NORTH INDIAN POPULATION

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ABSTRACT
Intercommunication between peripheral nerves deserves special attention in view of their clinical significance. Communication between musculocutaneous and median nerve are the most frequently encountered variations among the reported brachial plexus variations in upto 33.3% population.The present article pertains to different types of communications between musculocutaneous and median nerve.Communication was encountered in 7(11.7%) out of 60 upper limbs of the present study. An interesting and unusual finding observed in the present study was a communicating ramus from musculocutaneous nerve which originated in lower 1/3rd of the arm, crossed the elbow joint,pierced the pronator teres muscle and joined the median nerve in forearm. Earlier,communication of median nerve with musculocutaneous nerve in the arm is reported with a prevalence rate of 1.4%- 33.3% but intercommunication at elbow or forearm has occasionally been described. Further its ontogeny,phylogeny and clinical implications are discussed in detail.

Key Words: *Intercommunication, Median Nerve Communication, Communication Piercing Pronator Teres, Musculocutaneous Nerve Communication, Communication in Elbow*

INTRODUCTION
Variations in the formation,course and distribution of brachial plexus and its branches have been reported earlier by many authors Kerr (1918), Linell (1921), Adachi (1928), Norton *et al.,* (2001), Buch-Hansen (1955). These may present clinically or be observed at surgery, autopsy and cadaveric dissections.One such variation is the presence of a communicating branch from musculocutaneous nerve to median nerve reported with an incidence of 1.4-33.3% by different authors.It is usually seen in the arm but rarely may be seen in the forearm as well.These are important not only clinically but also in diagnostic neurophysiology Choi *et al.,* (2002). Both ontogenic as well as phylogenic explanations have been provided for their origin (Abhaya, 2003; Sannes *et al.,* 2000; Kosugi *et al.,* 1986 and Chauhan and Roy, 2002).

MATERIALS AND METHODS
The present study was conducted in 60 upper limbs belonging to 30 formalized and preserved cadavers (M: F: 28:2) obtained from Department of Anatomy,Government Medical College, Amritsar,Punjab,India. These limbs were labelled from 1-30 with letters M or F representing male or female sex respectively and letter R or L representing right or left sided limbs. Then these limbs were dissected as per dissection guidelines given by Cunningham's manual of Practical Anatomy to expose median nerve in its whole course from formation till termination. Similiarly musculocutaneous nerve was traced till its termination (Romanes, 1986). The communicating ramus was identified, cleared and photographed in all the cases.

Observations
Out of the 60 limbs, different types of communications between musculocutaneous nerve and median nerve were observed in 7(11.7%) limbs (See Table I).

Table I: Showing details of communications between musculocutaneous nerve and median nerve

S.No.	*Limb No.*	*Description of the communication*	*Nerve supply of flexors of arm*	*Photograph No.*
1.	3MR	Lateral cord trifurcated into musculocutaneous nerve and 2 lateral roots of median nerve.	MCN	-
2.	10MR	MCN after piercing the coracobrachialis gave a communicating ramus to median nerve	MCN	1
3.	11MR	MCN was absent,all flexors muscles of arm were supplied by median nerve	MN	-
4.	17ML	Lateral cord trifurcated in musculocutaneous nerve and 2 lateral roots of median nerve	MCN	2
5.	19MR	MCN gave a communicating ramus to median nerve before piercing coracobrachialis	MCN	3
6.	27MR	MCN gave a communicating ramus in lower one-third of arm which crossed the elbow, pierced the pronator teres muscle and then joined median nerve in forearm	MCN	4
7.	28ML	MCN fused with MN after supplying coracobrachialis	CB-MCN Others-MN	5

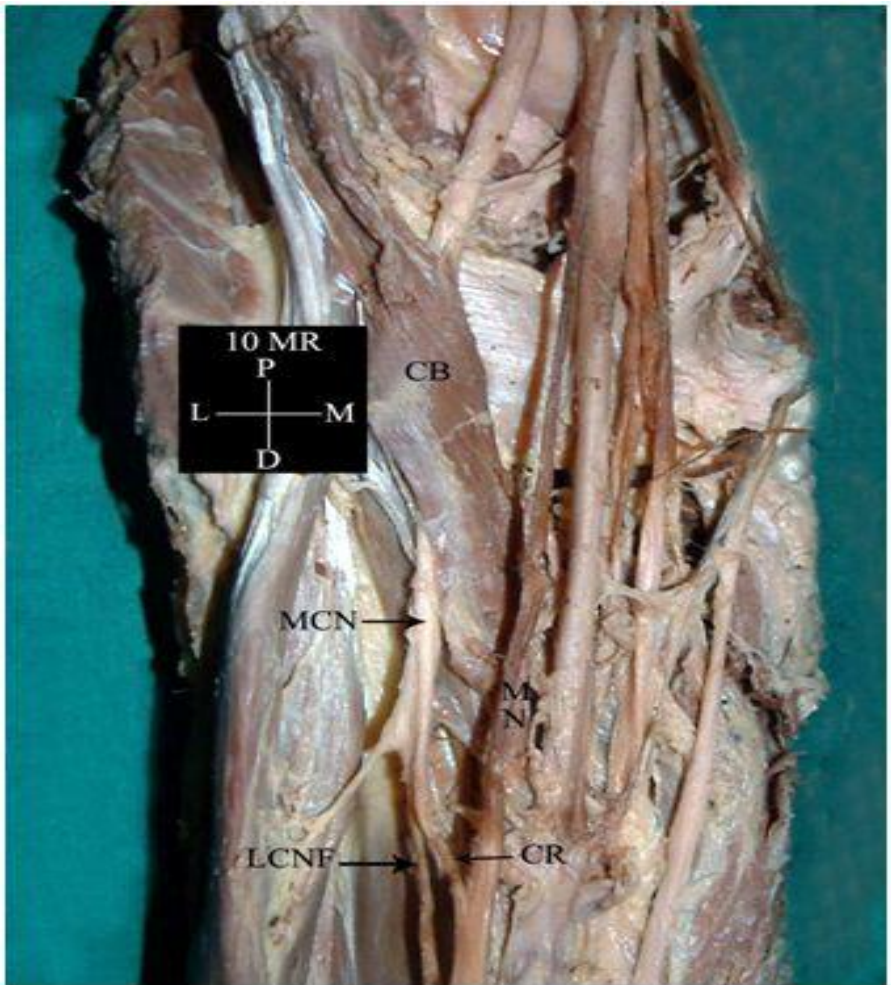

Figure 1: Communicating ramus (CR) from musculocutaneous nerve(MCN) to median nerve(MN) after piercing coracobrachialis(CB)(LCNF-Lateral cutaneous nerve of forearm)

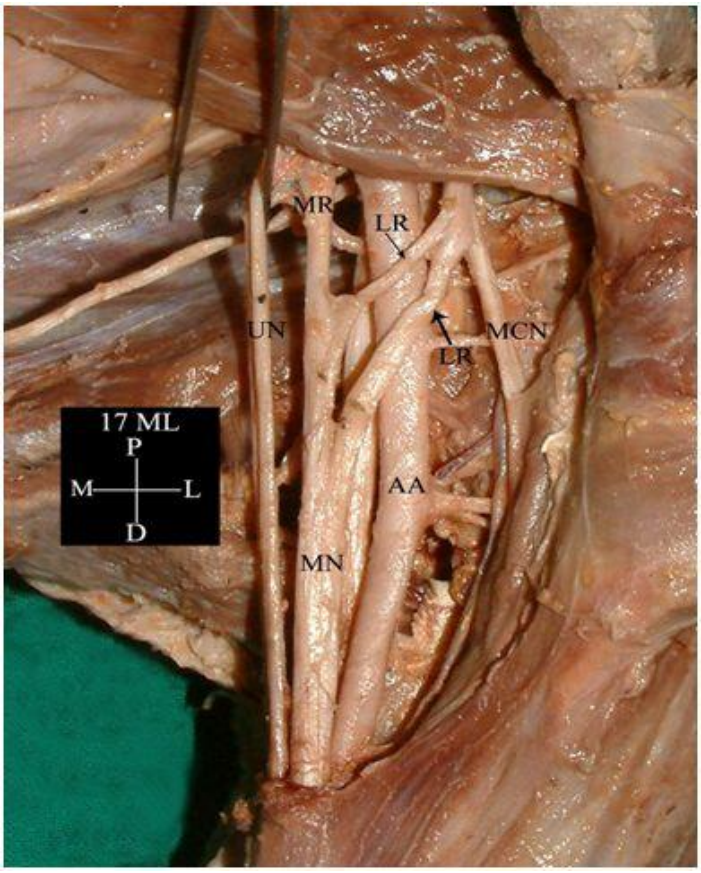

Figure 2: Median nerve(MN) formed by two lateral roots(LR) and one medial root(MR),medial to third part of axillary artery(AA),(MCN-Musculocutaneous nerve,UN-Ulnar nerve)

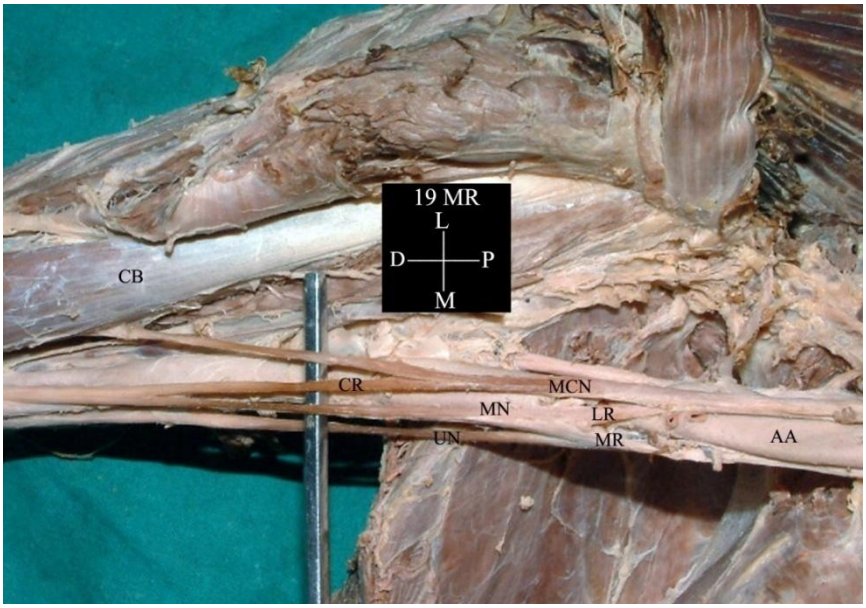

Figure 3: Communicating ramus(CR) from musculocutaneous nerve(MCN) to median nerve(MN) before piercing coracobrachialis(CB).(MR-Medial root,LR-Lateral root,AA-Axillary artey, UN-Ulnar nerve)

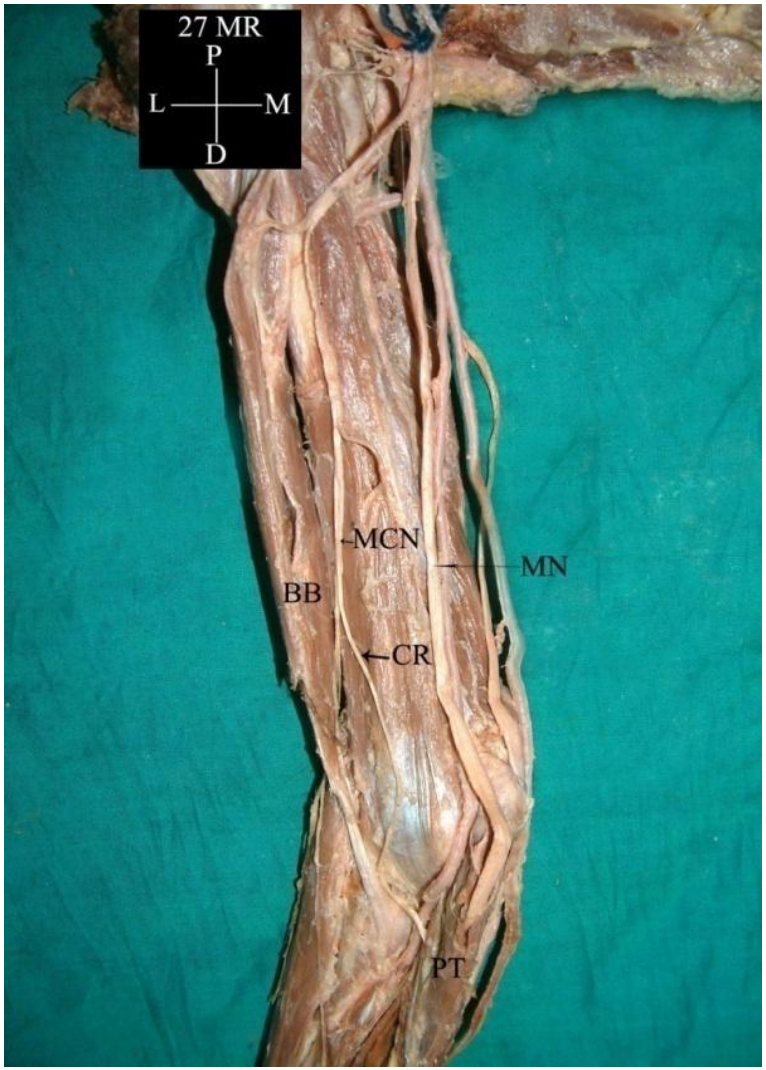

Figure 4: Communicating ramus(CR) from musculocutaneous nerve(MCN) to median nerve(MN)piercing pronator teres(PT). (BB-Biceps brachii)

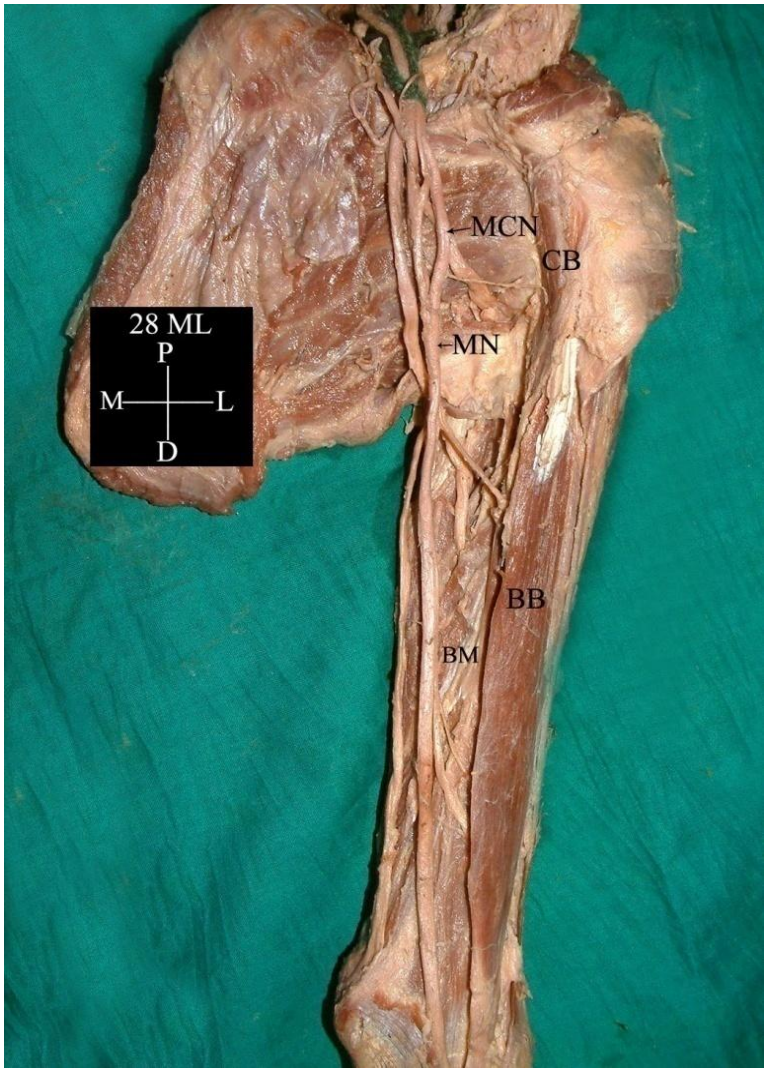

Figure 5: Musculocutaneous nerve (MCN) fuses with median nerve (MN) after supplying coracobrachialis (CB). Biceps brachii (BB) and brachialis muscle (BM) supplied by median nerve (MN).

All the seven variant limbs belonged to male sex with five belonging to right side and two to the left side.None of the cadavers showed a bilateral communication.In most of these, the communication was seen in upper 1/3rd of the arm but in limb no. 27MR, the communicating ramus arose in lower 1/3rd of arm after the musculocutaneous nerve had supplied all flexors of arm. It travelled in front of the elbow joint, pierced the pronator teres muscle and then joined the median nerve in forearm. This is a very rare type of communication which could not be traced in the accessible literature.

DISCUSSION

Communication between musculocutaneous and median nerve has been reported to seen with an incidence varying between 1.4%-33.3 percent (See Table II).

Table II: Incidence of communication between the Musculocutaneous Nerve and Median Nerve

Sr. No.	Author	Year	Incidence (%)
1.	Watanabe et al	1985	01.4
2.	Kosugi et al	1986	21.8
3.	Yang et al	1995	12.5
4.	Venieratos and Anagnostopoulou	1998	13.9
5.	Rao and Chaudhary	2000	33.3
6.	Aktan et al	2000	10.4
7.	Choi et al	2002	26.4
8.	Present study	2013	11.7

Such a wide discripency in its incidence may be attributed to different types of classifications provided by earlier workers (Kosugi, 1986; Romanes, 1986; Venieratos and Anagnostopoulou, 1998 and Li Minor, 1992). Out of these the classification by Li Minor (1992) is most widely accepted one.

According to it these communications are divided into 5 types-

Type I-There is no communication between median nerve and musculocutaneous nerve.

Type II- Some fibres of lateral root of median nerve pass through musculocutaneous nerve and join median nerve in the middle of the arm.

Type III- All the fibres of lateral root of median nerve pass along musculocutaneous nerve and after some distance leave it to form the lateral root of the median nerve.

Type IV- Musculocutaneous nerve joins the lateral root of median nerve and after some distance the musculocutaneous nerve arises from the median nerve.

Type V- Musculocutaneous nerve is absent and entire fibres of musculocutaneous nerve pass through lateral root of median nerve to median nerve. The fibres to the muscles supplied by musculocutaneous nerve branch out directly from the median nerve.

Thus 2 limbs (Limb No.10MR and 19MR) fall in Type II, one limb (Limb No. 11MR) falls in Type I of Li Minor (1992) classification. However another 2 limbs (limb no.3MR and 17 ML) depict a clear trifurcation of lateral root with one branch continuing as musculocutaneous nerve and the other two as two lateral roots of median nerve. As such Li Minor (1992) is silent about this trifurcation but may be kept under Type II with slight modification that the communicating ramus from musculocutaneous nerve is as proximal as to give appearance of trifurcation.Thus Type II of Li Minor (1992) can be further divided in 2 Subgroups-

Group A- Fibres of median nerve pass via musculocutaneous nerve and join the former in middle of arm.

Group B- The communicating ramus is so proximal that it gives appearance of trifurcation of lateral cord.

In one of our limb (Limb No. 28 ML),the musculocutaneous nerve fused with median nerve completely after supplying flexors of arm and lateral cutaneous nerve of forearm came from median nerve.This may also partially fit in Type V of Li Minor(1992) with slight modification ie.

Group A –Musculocutaneous nerve absent with all its branches coming from median nerve (ie.complete fusion)
Group B- Fusion of musculocutaneous nerve with median nerve after supplying flexors of arm.
One of our limbs (Limb No. 27MR) does not fit at all in any of the types described by Li Minor (1992). So it deserves a new place in classification as type VI.
Considering the other types of classification by Kosugi *et al.,* (1986) and Veneiratos *et al.,* (1998).
four limbs of the present study fit into Type I of Veneiratos(1998) and Anagnostopoulou (1998)classification and Type II a of Kosugi *et al.,* (1986) ie.communication proximal to entrance of musculocutaneous nerve to coracobrachialis.Two limbs of present study fits into TypeII(b) of Kosugi et al(1986)classification and Type II Veneiratos and Anagnostopoulou (1998) classification ie. communication distal to entrance of musculocutaneous nerve into coracobrachialis.Communication between two nerves in the forearm,as in limb no.27MR of the present study is very rare and has been reported in literature by Adachi(1928) as fine anastomosis between median and musculocutaneous nerve in forearm located posterior to radial artery at level of humero-radial joint. However he is silent about piercing of pronator teres muscle by communicating branch.
Thus considering all the above classifications and our cases as well we propose a newer classification (termed as Kaur and Singla classification) as follows:-
Type I- No communication.
Type II-Some fibres of lateral root of median nerve pass through musculocutaneous nerve and join the median nerve at different levels in the form of communicating ramus.
GroupA-A communicating ramus leaves musculocutaneous nerve immediately after the later is formed so that it gives appearance of trifurcation of lateral cord into a musculocutaneous nerve and two lateral roots.
Group B-The communicating ramus leaves musculocutaneous nerve before it pierces coracobrachialis (All flexor muscles supplied by musculocutaneous nerve)
Group C- The communicating ramus leaves musculocutaneous nerve after it has pierced coracobrachialis. (All flexor muscles supplied by musculocutaneous nerve before the origin of communicating ramus)
Type III-All fibres of lateral root of median nerve pass with musculocutaneous nerve. The median nerve is just continuation of medial root only. However the musculocutaneous nerve after supplying flexors of forearm gives lateral root of median nerve to join the same. In other words the lateral root arises distal to origin of muscular branches from musculocutaneous nerve.
Type IV- Whole of lateral cord continues as lateral root of median nerve ie. Musculocutaneous nerve joins lateral root of median nerve and after some distance musculocutaneous nerve arises from the median nerve.
Group A- Musculocutaneous nerve arises from median nerve proximal to muscular branches for flexors of arm which are thus supplied by musculocutaneous nerve.
Group B- Musculocutaneous nerve arises from median nerve after the former had supplied muscles of forearm.Then the musculocutaneous nerve continues only as lateral cutaneous nerve of forearm.
Type V- Complete fusion of musculocutaneous and median nerve at different levels.
Group A- Musculocutaneous nerve is altogether absent with all its fibres passing through lateral root of median nerve.All branches of musculocutaneous nerve come from median nerve.
Group B- Musculocutaneous nerve supplies coracobrachialis and then completely fuses with median nerve.Rest of its branches come from median nerve.
Group C- Musculocutaneous nerve supplies all flexors of arm and then fuses with median nerve.The lateral cutaneous nerve of forearm comes from median nerve.
Type VI- The communicating ramus arises in lower one-third of arm after musculocutaneous nerve has supplied all flexors of arm.It crosses the elbow joint and reaches forearm where it joins median nerve.
Group A- The communicating ramus joins median nerve without piercing pronator teres.
Group B- The communicating ramus joins median nerve after piercing pronator teres
According to this classifications the 60 limbs of the present study can be grouped as shown in Table NoIII

Table III: Showing grouping of limbs of present study according to Kaur and Singla classification

Serial no.	No. of limbs (%age)	Limb No.	Type
1.	53(88.3%)	-	TypeI
2.	2(3.3%)	3MR,17ML	TypeII GroupA
3.	1(1.66%)	19MR	TypeII GroupB
4.	1(1.66%)	10MR	TypeII GroupC
5.	1(1.66%)	11MR	TypeV GroupA
6.	1(1.66%)	28ML	TypeV GroupB
7.	1(1.66%)	27MR	TypeVI GroupB

Ontogeny

The presence of the communications may be attributed to the random factors influencing the mechanism of formation of the limb muscles and the peripheral nerve during the embryonic life. Significant variations in the nerve patterns may be a result of the altered signalling between the mesenchymal cells and neuronal growth cones or these may be due to circulatory factors at the time of fusion of the brachial plexus cords (Abhaya, 2003; Sannes *et al.*, 2000 and Kosugi *et al.*, 1986).

Phylogeny

Chauhan and Roy(2002) strongly recommended 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.In the lower vertebrates of the Artiodactyla and Perissodactyla (amphibians, reptiles and bird) there is only one nerve i.e. median nerve supplying the muscles of the upper arm and an independent musculocutaneous nerve is absent (Sisson and Grossman, 1961 and Arlamowska-Palider, 1970). The same was seen in one of our limbs (Limb No.11 MR).In dogs, the musculocutaneous nerve sends a communicating branch to the median nerve (Sisson and Grossman, 1961). It was seen in all of the other variant limbs of the present study.

Clinical Significance

Rao and Chaudhary (2000) correlated such communications to the entrapment syndromes of the musculocutaneous nerve in which a part of the median nerve also passes through the corocobrachialis muscle. This exhibited the signs and symptoms similar to those encountered in the median nerve neuropathy as in the carpal tunnel syndrome or the pronator syndrome. Knowledge of the communicating branch may be useful for clinician thereby avoiding unnecessary carpal tunnel release in such cases. Sunderland (1978) is of the opinion that the lesions of the communicating nerve may give rise to the patterns of weakness that may impose difficulty in the diagnosis. Further an injury to the musculocutaneous nerve proximal to the anastomotic branch between the musculocutaneous nerve and the median nerve may lead to the unexpected presentation of weakness of the forearm flexors and the thenar muscles. Choi *et al.*, (2001) stressed upon the significance of these communicating branches in diagnostic clinical neurophysiology. Leffert (1985) emphasized to rule out such communications to prevent the unwanted outcomes of operations conducted on the musculocutaneous nerve.

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