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Original Article

# COMMUNICATING RAMUS FROM LATERAL ROOT OF MEDIAN NERVE TO ULNAR NERVE AND FUSION OF MUSCULOCUTANEOUS NERVE & MEDIAN NERVE- A CONJUNCTION OR CO-INCIDENCE?

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## ABSTRACT

**Background:** The brachial plexus has a complex anatomical structure since its origin in the neck throughout its course in the axillary region. It also has close relationship to important anatomic structures what makes it an easy target of a sort of variations and provides its clinical and surgical importance. The presence of communicating branches between the terminal branches of the brachial plexus are relatively common & reported by many of the authors but very few studies are there in literature about communicating branch from the lateral root of the median nerve to the ulnar nerve. **Materials and Methods:** The present study was conducted on 60 upper limbs belonging to 30 cadavers ( Male:Female = 28:02 ), ( Right:Left = 30:30 ) obtained from Department of Anatomy. **Observations:** Communicating branch from the lateral root of the median nerve to the ulnar nerve was seen in 2 limbs (3.33%). These limbs also depicted fusion of musculocutaneous & median nerves. **Discussion & Conclusion:** Whether this is a conjunction or just a co-incidence, remains to be verified on a larger database. However the existence of communicating branches may be of importance in the evaluation of unexplained sensory loss after trauma or surgical intervention in a particular area. Further ontogeny & phylogeny of the variant patterns are discussed.

**KEY WORDS:** Brachial plexus; Ulnar nerve; Lateral root of median nerve; Median nerve; Musculocutaneous nerve.

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## BACKGROUND

The anatomical variations of the peripheral nervous system are often used to explain unexpected clinical signs and symptoms. A knowledge of such variations is useful in clinical/surgical practice as these may be the cause of a nerve palsy syndrome due to a different relation of a nerve and a related muscle. In most of these cases, surgery can lead to a rapid recovery of nerve function [1]. Moreover, it seems that failure of certain surgical treatments of brachial plexus lesions are related to the presence of anatomical variations.

The ulnar nerve normally originates from medial cord of brachial plexus, with its components derived from spinal segments C8 & T1. These traverse the lower trunk of brachial plexus, its anterior division and finally enter the medial cord. However in a considerable number of cases, the ulnar nerve receives fibers also from

the seventh cervical segment. These fibres reach the ulnar nerve via middle trunk, its anterior division, lateral cord, lateral root of median nerve & then a communicating ramus from lateral root of madian nerve to ulnar nerve [2, 3, 4]. The communicating ramus may be sometimes called lateral root of ulnar nerve [3]. Though a mention has been made of this variant in standard text books of anatomy [3, 4] but all are silent about its incidence.

According to Doyle & Botte [5], communicating ramus bringing fibres from C7 may arise not only from lateral root of median nerve but even proximal to it i.e. lateral cord, the anterior division of middle trunk or even middle trunk itself. Whatever may be the origin, this communicating ramus is termed as the lateral root of ulnar nerve. It usually joins the ulnar nerve at or distal to the inferior border of the subscapularis muscle & may provide innervation to flexor carpi ulnaris muscle.

The existence of such rami may be of importance in the evaluation of unexplained sensory loss after trauma or surgical intervention in a particular area [6]. One must be aware that this kind of variation is more prone to injury in surgical operations of the axilla and that, the very close course of the unusual communicating ramus to the axillary artery may lessen the blood supply of the upper extremity by compressing the vessel [7].

## MATERIALS AND METHODS

The material for the present study comprised of 60 upper limbs belonging to 30 adult human cadavers of known sex [ Male:Female :: 28:02 ] obtained from the Department of Anatomy, Govt. Medical College, Amritsar. These were serialized from 1-30 with suffix 'M' for male or 'F' for female and 'R' for right or 'L' for left.

The brachial plexus was dissected and exposed according to the methods described by Romanes [8] in Cunningham's Manual of Practical Anatomy. All its roots, trunks, divisions, cords and branches were exposed & cleaned. All the limbs were examined for presence or absence of communicating ramus from lateral root of median nerve to ulnar nerve.

## OBSERVATIONS

Out of 60 upper limbs dissected, communicating branch from the lateral root of the median nerve to the ulnar nerve was seen in 2 limbs (3.33%) ie., limb no. 1MR & 4ML. Thus both the limbs belonged to the male sex and one was of right side while the other was of the left side.

In limb no. 1MR, a communicating ramus emerged from medial border of lateral root of the median nerve about 1.5 cm proximal to its union with medial root to form median nerve. It coursed medially behind the medial root of median nerve & joined the ulnar nerve ( Fig. 1 ).

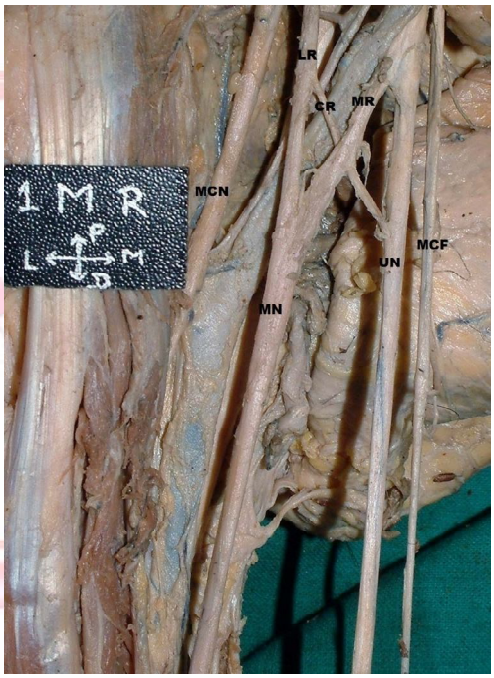


**Fig.1:** Communicating ramus **(CR)** from Lateral root **(LR)** of Median nerve **(MN)** to Ulnar nerve **(UN)** [**MCN-** Musculocutaneous nerve; **MR**- Medial root of median nerve; **MCF-** Medial Cutaneous nerve of forearm].

The length of the communicating ramus was 2.8 cm. The lateral cord was formed normally i.e. by union of anterior divisions of upper ( C5,6 ) & middle ( C7 ) trunks. Since the communicating ramus was emerging from medial border of lateral root of the median nerve, it may be assumed that the root value of this communicating ramus must be C7 ie., anterior division of middle trunk which joins anterior division of upper trunk on its medial aspect. Apart from this communicating ramus, the musculocutaneous nerve which was formed normally, after piercing & supplying the coracobrachialis, completely fused with the median nerve and latter supplied the rest of the muscles of anterior compartment of arm (Fig.2 ).

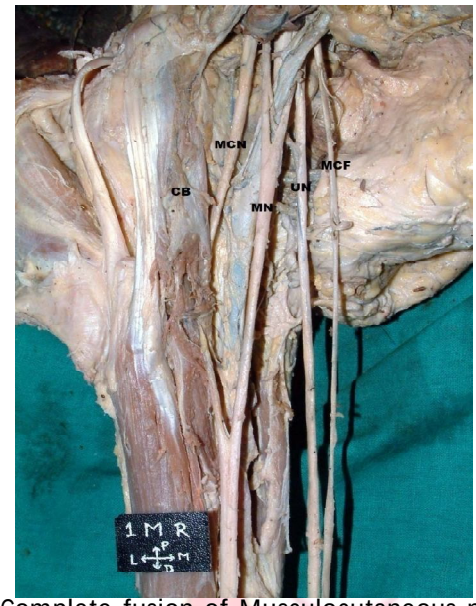


**Fig. 2:**Complete fusion of Musculocutaneous nerve **(MCN)** with Median nerve **(MN)** after the former pierces the Coracobrachialis **(CB)**
[**UN**- Ulnar nerve; **MCF**- Medial Cutaneous nerve of forearm]


**Fig. 3:** Communicating ramus **(CR)** from Lateral cord **(LC)**/ lateral root **(LR)** of median nerve **(MN)** bifurcating to join the Medial root **(MR)** of Median nerve and Ulnar nerve **(UN)** [**MC**- Medial cord; **Ax** -Axillary nerve ]

In limb no. 4ML, the musculocutaneous nerve was not formed, the lateral cord gave a branch to coracobrachialis and continued as the lateral root of median nerve. The median nerve supplied the biceps brachii & brachialis muscles. In other words, musculocutaneous nerve completely fused with the median nerve. In this limb, communicating ramus arose from the medial aspect of lateral cord or in other words, from lateral root of the median nerve ( because lateral cord continued as the lateral root of the median nerve ) at a distance of 1 cm. from its formation & bifurcated with one branch going to medial root of the median nerve & the other joining the ulnar nerve ( Fig. 3 ).

## DISCUSSION

Knowledge of variations in anatomy is important to anatomists, radiologists, anesthesiologists and surgeons, and has gained even more importance due to the wide use and reliance on computer imaging in diagnostic medicine [9]. It must be remembered that the brachial plexus is merely a routing mechanism to get nerves with a common function into the proper terminal nerves and the errors in distribution which occur proximally, are corrected distally in the arm, forearm or hand, resulting in anatomical variations of the plexus [10]. Some variations are vulnerable to damage in radical neck dissection and other surgical operations of the axilla and upper arm [11].

The ulnar nerve has its roots C8 and T1 and it is a branch of medial cord. To have fibres of C7 root in it, the ulnar nerve must receive the contribution from lateral cord. Though a mention of this contribution is made by almost all standard text books of anatomy [3, 4] but at the same time, all are silent about its incidence. According to Hollinshead [3] the contribution from lateral cord to ulnar nerve may be in the form of a small branch which is sometimes known as lateral root of ulnar nerve.

It was Martin [12] who first described a communication from the median nerve to the ulnar nerve and later Gruber [13] reported the similar communications. So Sonek et al [14] called these as"**Martin Gruber communication"**. However these were seen in the forearm and not from lateral root of median nerve to ulnar nerve in arm.`

The communicating ramus from the lateral root of the median nerve to the ulnar nerve or we can say lateral root of ulnar nerve has been reported earlier by Fazan et al [15] in 30% & Fuss [16] in 56% of their dissections. Fuss [16] further divided this lateral root of ulnar nerve into two types viz type 1 & 2 depending upon whether it is accompanied by fibres of median nerve ( type 1 ) or not ( type 2 ). He also classified the lateral root into type a & b depending upon whether some fibres of medial root of median nerve pass

behind the lateral root of ulnar nerve ( type a ) or all fibres of medial root of median nerve pass infront of lateral root of ulnar nerve ( type b ). He further emphasized that since the lateral root of ulnar nerve is seen in 56% of dissections, it should be considered as a normal entity & not a variation.

The incidence of lateral root of ulnar nerve in the present study is much less as compared to study of Fuss [16] & Fazan et al [15]. Anyhow according to Ist classification by Fuss [16], the limb no. 1MR falls in type 2 & limb no. 4ML falls into type 1. On the other hand, according to his IInd classification, both of the limbs of the present study fall into type b.

Both the variant limbs with communicating ramus from lateral root of median nerve to ulnar nerve also showed another type of communication. In limb no. 1MR, the musculocutaneous nerve supplied the coracobrachialis & then completely fused with median nerve while in limb no. 4ML, the musculocutaneous nerve was not formed or in other words it was completely fused with median nerve. In this limb, the coracobrachialis was supplied by lateral cord/ lateral root of median nerve while biceps & brachialis were supplied by the median nerve. Many workers have classified these communications in different ways [17, 18, 19] but recently Kaur & Singla [20] have provided the most elaborated classification as under-

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.

Group A- 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 classification, the limb no. 1MR of present study falls into Type V group B & limb no. 4ML partially falls into Type V group A where musculocutaneous nerve is altogether absent with all its fibres passing into lateral root of median nerve but with a difference that coracobrachialis is supplied by lateral root of median nerve, not by median nerve.

Thus the interesting observation of the present study which is not reported earlier is that both limbs with communicating ramus from lateral root of median nerve to ulnar nerve also had a fusion between musculocutaneous & median nerve ( Type V, group A & B of Kaur & Singla classification ). Thus we can say that all the limbs with communicating ramus from lateral root of median nerve to ulnar nerve necessarily have a fusion between musculocutaneous & median nerve but the reverse ie., ' the limbs which have fusion ( or communicating ramus ) between musculocutaneous & median nerve also have a communicating ramus from lateral root of median nerve to ulnar nerve' is not true. Whether the former statement is a conjunction or simply a co-incidence needs to be investigated on a larger data base.

**Ontogeny**: Significant variations in the nerve patterns may be a result of the altered signalling between the mesenchymal cells and neuronal growth cones and once formed antenatally persist postnatally [21, 22] or these may be due to circulatory factors at the time of fusion of the brachial plexus cords [17]. The presence of the communications may be attributed to the random factors influencing the mechanism of formation of the limb muscles and the peripheral nerves during the embryonic life. Iwata [23] 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. 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 fibres taking an aberrant course as a communicating branch.

**Phylogeny:** Miller [24] threw a flood of light on brachial plexus of lower animals & observed that median & ulnar nerves are combined to form brachialis longus inferior ( anterior trunk ) in amphibians, reptiles & birds. As we ascend in phylogeny to monotremes, marsupials, lemurs, dogs, monkeys & man, this brachialis longus inferior is divided into distinct median & ulnar nerves. The communicating ramus from lateral root of median nerve to ulnar nerve as seen in the present study might be a failure on part of some of fibres to separate into median & ulnar nerves at appropriate level which took an aberrant course in the form of communicating ramus & joined their actual destination ie., ulnar nerve at a distal level.

As far as the fusion of musculocutaneous & median nerve is concerned, it may also be explained phylogenically. It is normally seen in lower vertebrates of the Artiodactyla and Perissodactyla (amphibians, reptiles and birds) that the musculocutaneous nerve is absent & there is only median nerve which supplies the muscles of front of arm as well as forearm [25, 26].

**Clinical significance:**

Sunderland [27] 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. Choi et al [28] stressed upon the significance of these communicating branches in diagnostic clinical neurophysiology.

Sargon et al [7] emphasized upon the value of the knowledge of communicating branch between the lateral root of median nerve & ulnar nerve in surgical operations of the axilla and that, the very close course of the unusual communicating ramus to the axillary artery may lessen the blood supply of the upper extremity by compressing the vessel.

Rao and Chaudhary [29] laid stress upon the value of the knowledge of communicating branch between the musculocutaneous and the median nerve in traumatology of the shoulder and / or the upper arm region and in situations when the surgeon has to isolate and trace the median and / or musculocutaneous nerve distally.

They also correlated such communications to the entrapment syndromes of the musculocutaneous nerve in which a part of the median nerve also passes through the coracobrachialis muscle exhibiting 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.

Leffert [30] emphasized to rule out such communications to prevent the unwanted outcomes of operations conducted on the musculocutaneous nerve.

## CONCLUSION

The brachial plexus has a complex anatomical structure since its origin in the neck throughout its course in the axillary region. The variations in formation & branching pattern of brachial plexus are very much common but very few studies are there in literature about communicating branch from the lateral root of the median nerve to the ulnar nerve, and along with fusion between musculocutaneous & median nerve: not reported earlier, as seen in present study. Whether it is a conjunction or simply a co-incidence needs to be investigated on a larger data base. A knowledge of such variations is useful in clinical/surgical practice as these may be the cause of a nerve palsy syndrome due to a different relation of a nerve and a related muscle.

**Conflicts of Interest:** None

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