# Musculocutaneous Nerve Anomalies: Intraoperative Dilemma for Peripheral Nerve Surgeons

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## Abstract

**Objective** Absence of musculocutaneous nerve is reported only in cadaver studies. This remains unnoticed in living subjects as the median nerve takes over the function of muscles originally supplied by the musculocutaneous nerve. However, its knowledge is of paramount importance. We analyze the findings of the cadaveric studies and our cases with musculocutaneous nerve anomalies.

**Materials and Methods** In the manuscript, the data published in the cadaveric studies on the anomalies of the absent musculocutaneous nerve have been collected and summarized. The data on musculocutaneous nerve exploration for the past 3 years at our center have been collected and intraoperative findings of the musculocutaneous anomaly in our cases have been analyzed.

**Result** The reported incidence of musculocutaneous nerve anomalies in cadaveric studies ranges from 1.66 to 13.33%. In our study, we observed an incidence of musculocutaneous anomaly around 16.66% intraoperatively.

**Conclusion** Musculocutaneous nerve anomalies are common. This anomaly can deceive the surgeon intraoperatively in cases of brachial plexus injury where nerve transfers have been undertaken in brachial plexus injury patients. Knowledge of these anomalies will help the brachial plexus surgeons, especially young surgeons, to manage these patients.

**Keywords**

- musculocutaneous nerve
- musculocutaneous nerve anomaly
- absent musculocutaneous nerve
- brachial plexus injury

## Introduction

The data on musculocutaneous anomalies are drawn from cadaveric studies. The reported developmental anomalies of the musculocutaneous nerve ranges from 1.66% (1:60 limbs) to 13.33% (4:30 limbs).[1] There are only case reports documenting bilateral absence of the musculocutaneous nerve in cadavers. Upon review, just one study was found that reported the absence of the musculocutaneous nerve in 1 out of 15 cadavers.[2] Occurrence of this anomaly cannot be estimated in female cadavers, the reason being underrepresentation of female cadavers in these studies. After a search, we found one study that reported the absence of the musculocutaneous neve in 1 of 20 dissected limbs of female cadavers.[3] When the musculocutaneous nerve is absent, the elbow flexors are supplied by the median nerve. The most important clinical use of the musculocutaneous nerve branches is their neurotization in patients with brachial plexus injury. To regain elbow flexion, in pan-plexus palsy, the biceps and the brachialis branch of the

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musculocutaneous nerve are neurotized with the intercostal nerve. However, in isolated upper trunk injuries (damage to the C5/C6 nerve root), the biceps branch of the musculocutaneous nerve is anastomosed to the ulnar nerve fascicles (Oberlin 1 procedure), and the brachialis branch of the musculocutaneous is anastomosed to the median nerve fascicles (Oberlin 2). Thus, knowledge of musculocutaneous nerve anomalies becomes important for brachial plexus surgeons. Intraoperatively, anomalies of the musculocutaneous nerve may confound the surgeon. This may lead to inadvertent damage to the nerve branches of the biceps and brachialis or abandoned the procedure without neurotization. Since the preoperative investigations in brachial plexus injuries like magnetic resonance imaging (MRI) concentrates on the supraclavicular portion, this anatomical variation remains underdiagnosed, and herein we describe and analyze musculocutaneous nerve anomalies that we found intraoperatively during the nerve transfer procedure in a patient with brachial plexus injury.

## Methods

A retrospective analytical study was performed, collecting details of all cases involving brachial plexus surgeries over the past 3 years presented to our department, which included both pan-palsy and partial injuries. A total of 82 cases were operated on, and upon review, 24 cases were identified in which musculocutaneous nerve neurotization was performed using the intercostal and ulnar nerves. Intraoperative details of these procedures were obtained from the case sheets and analyzed. Among these 24 cases, anatomical variations in the musculocutaneous nerve were observed in 4 cases (16.66%) during neurotization. The patients are in follow up till now. The details of the patients with these anatomical anomalies are summarized in ►**Table 1**.

## Cases Details

Intra-operative findings of the cases are summarised below.

### Case 1

Through an upper medial arm incision, the donor nerve (ulnar nerve) and recipient nerve (musculocutaneous nerve branches) were searched. Upon dissection, the nerve to the biceps and brachialis were identified; however, the musculocutaneous nerve was absent. These nerves were traced proximally and found to be branching out from the median nerve (►**Fig. 1**). No separate musculocutaneous nerve was found. Intraoperative stimulation of the median nerve (from which branches to the biceps and brachialis were coming out) caused visible contraction of the long flexors and intrinsic muscles of the hand, confirming it to be the median nerve. The nerve branch innervating the biceps was dissected up to the origin from the median nerve and cut proximally. Two posteromedial nerve fascicles of the ulnar nerve were dissected and cut distally to neurotize with the branch of the biceps branch coming out of the median nerve.

### Case 2

In this case of pan-brachial plexus injury, the fourth and fifth intercostal nerves were dissected out; however, when the recipient nerve branches to the biceps and brachialis were explored, no distinct musculocutaneous nerve was found in its usual anatomical location. Indeed, on tracing the nerve branches of the biceps and brachialis proximally, the musculocutaneous nerve was sharing a common fascial sheath along with the median nerve with a distinct cleavage between the two nerves (►**Fig. 2**). Following neurolysis, the musculocutaneous nerve was separated from the median nerve and the nerve branch supplying the biceps was divided proximally and neurotized with the intercostal nerves.

**Table 1** Details of patients with musculocutaneous nerve anomaly in our study

| Case no. | Age (y)/ gender | Diagnosis | Anomaly | Procedure done | Follow-up/muscle power (MRC grade) |
|---|---|---|---|---|---|
| 1 | 28/male | Right postganglionic upper brachial plexus injury (C5–6 roots) | Absent musculocutaneous nerve; biceps and brachialis branch arising from the median nerve | Oberlin 1 transfer | Grade 4 (24-mo follow-up) |
| 2 | 44/male | Right preganglionic pan-brachial plexus injury (C5–T1 roots) | Musculocutaneous nerve and median nerve encased in the common nerve sheath | Intercostal nerve (4th, and 5th) to musculocutaneous nerve transfer | Grade 4 (20-mo follow-up) |
| 3 | 25/male | Right postganglionic upper brachial plexus injury (C5–C6 roots) | Absent musculocutaneous nerve; biceps and brachialis branch arising from the median nerve | Oberlin 1 transfer | Grade 2 (9-mo follow-up) |
| 4 | 23/male | Left side postganglionic pan-brachial plexus injury (C5–T1 roots) | Musculocutaneous nerve and median nerve sharing a common fascial sheath | Intercostal nerve (3rd, 4th, and 5th) to musculocutaneous nerve transfer | Grade 0 (3-mo follow-up) |

 

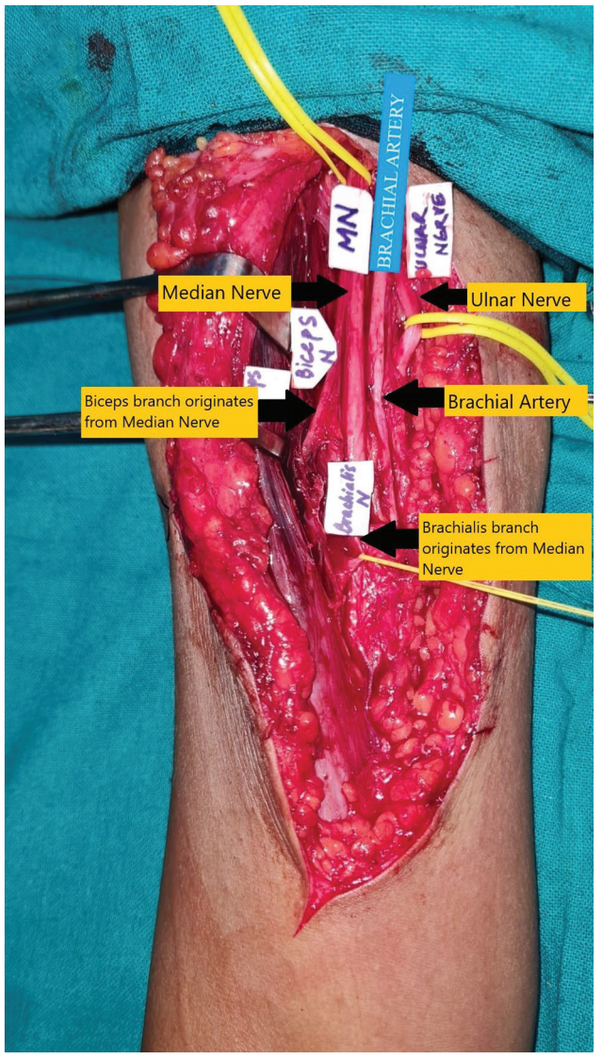


**Fig. 1** Intraoperative finding: musculocutaneous nerve absent. Image showing the nerve to the biceps branching from the median nerve.

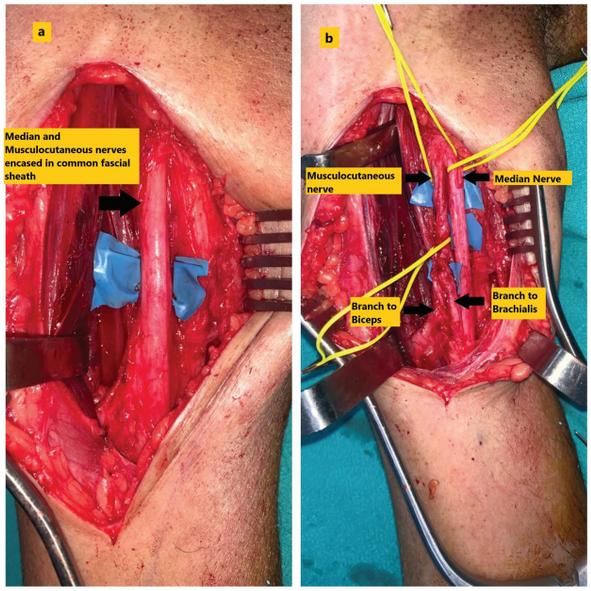


**Fig. 2** (**a**) Intraoperative image showing the median and musculocutaneous nerves traveling in the common fascial sheath. (**b**) The musculocutaneous nerve and its branches neurolyzed from the median nerve.

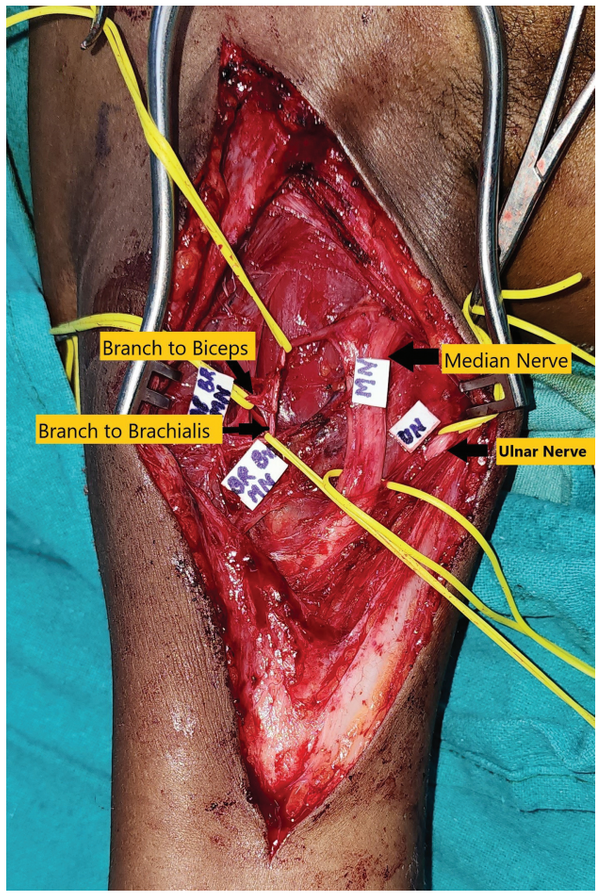


**Fig. 3** Intraoperative image showing the nerve to the biceps and brachialis branching out from the presence of the median nerve.

### Case 3

In this case, while undertaking the Oberlin 1 procedure to restore elbow flexion in C5, C6, and C7 root avulsion injury, the musculocutaneous nerve was found to be absent, but the nerve branches to the biceps and brachialis were first identified and traced proximally. They were found to be branching out from the median nerve (►**Fig. 3**). The nerve branch to the biceps was dissected up to the origin from the median nerve, cut, and neurotized with two fascicles of ulnar nerve.

### Case 4

In another case of pan-brachial plexus injury, the third, fourth, and fifth intercostal nerves were harvested as donor nerves. Further exploration revealed no distinct musculocutaneous nerve. By tracing proximally, the nerve branches to the biceps, brachialis, and lateral antebrachial nerve were found running together with the median nerve within a common fascial sheath. These nerves were then carefully

 

**Table 2** Details of cadaveric studies reporting absence of the musculocutaneous nerve

| Study | Type of study | No. of cadavers | Gender | Laterality | Anomaly noted | |
|---|---|---|---|---|---|---|
| | | | | | Muscle | Supplied by |
| Nayak[7] | Case report | 1 | Male | Unilateral | Biceps brachii and brachialis<br>Coracobrachialis<br>Lateral cutaneous nerve of the forearm | Median N<br>Median N<br>Median N<br>Median N |
| Tomar and Wadhwa[8] | Case report | 1 | Male | Unilateral<br>Right side | Biceps brachii and brachialis<br>Coracobrachialis<br>Lateral cutaneous nerve of the forearm | Median N<br>Not mentioned<br>Nerve from the lateral cord<br>Median N |
| Nasr[3] | Cadaveric study<br>2 cadavers with absent musculocutaneous nerves | 30 cadavers (60 upper limbs)<br>Males: 20<br>Females: 10 | Male<br>Female | Unilateral<br>Right side<br>Unilateral<br>Left side | Biceps brachii and brachialis<br>Coracobrachialis | Median N<br>Median N<br>Median N |
| Bhanu and Sankar[9] | Case report | 1 | Female | Bilateral | Biceps brachii<br>Brachialis<br>Coracobrachialis | Median N<br>Median N<br>Nerve from the lateral cord |
| Parchand and Patil[10] | Case report | 1 | Male | Unilateral | Biceps brachii and brachialis<br>Coracobrachialis<br>Lateral cutaneous nerve of the forearm | Median N<br>Median N<br>Median N<br>Median N |
| Kaur et al[2] | Cadaveric study<br>3 cadavers with absent musculocutaneous nerves 1 | 15 cadavers (30 upper limbs) | | • Bilateral<br>• Unilateral: right side<br>• Unilateral: right side | Biceps brachii and brachialis<br>Coracobrachialis | Median N<br>Median N<br>Median N |
| Sarkar and Saha[11] | Case report | 1 | Male | Bilateral | Biceps brachii and brachialis<br>Coracobrachialis<br>Coracobrachialis (left side) | Median N<br>Median N<br>Median N<br>Nerve from the lateral cord |
| Padur et al[12] | Cadaveric study<br>Two cadavers with absent musculocutaneous nerves | 41 cadavers (82 upper limbs)<br>Males: 40<br>Female: 1 | | • Unilateral: left side<br>• Unilateral: right side | Biceps brachii and brachialis<br>Coracobrachialis | Median N<br>Median N<br>Median N |
| Raza et al[13] | Case report | 1 | Male | Unilateral | Biceps brachii and brachialis<br>Coracobrachialis | Median N<br>Media N<br>Nerve from the lateral cord |
| Moore et al[6] | Case report | 1 | Male | Unilateral | Biceps brachii and brachialis<br>Coracobrachialis<br>Lateral cutaneous nerve of the forearm | Median N<br>Median N<br>Median N<br>Median N |

Abbreviation: N, nerve.
Note: "1" indicate number of cadavers.

 

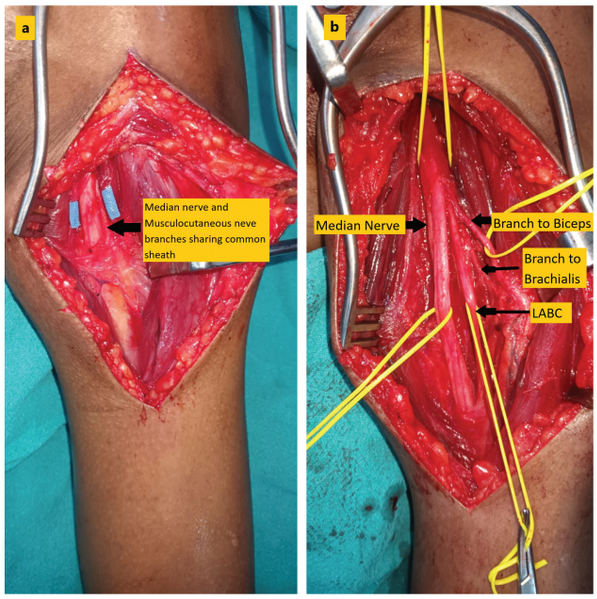


**Fig. 4** (**a**) Median nerve and branches of the musculocutaneous nerve running in a common fascial sheath. (**b**) Branches of the musculocutaneous nerve and median nerve neurolyzed.

dissected from the common sheath and neurotized with the intercostal nerves (►**Fig. 4**).

## Discussion

Most cases of absent musculocutaneous nerves anomaly go undetected. The explanation is that there is no functional loss in the limb despite the absence of the musculocutaneous nerve. Also, the absence of the musculocutaneous nerve is reported in cadaver dissection studies only (►**Table 2**).[1–13]

In all cadaveric studies with findings of absent musculocutaneous nerve, the branch to the biceps and brachialis comes out from the median nerve (►**Table 2**). This can be explained by the embryological development of the brachial plexus.

The brachial plexus develops from a radicular growth cone in the upper limb between 34 and 35 days of gestation, which further divides into the ventral and dorsal segments. The ventral segment gives rise to the median nerve and musculocutaneous nerve. The dorsal segments give rise to the radial nerve. The musculocutaneous nerve then branches out from the median nerve.[4]

Thus, clinically, the limb has no functional and sensory loss even if the musculocutaneous nerve is absent. The function is commonly overtaken by the median nerve because they have the same embryological origin (►**Table 2**), that is, less commonly from the lateral root of the median nerve or the lateral fasciculus of the brachial plexus.[5]

Other reported variations associated with this anomaly include the presence of the accessory head of the biceps with entrapment of the ulnar nerve, vascular anomalies, bifid median nerve, splitting of the median nerve into the median and musculocutaneous nerve proper, and abnormal communications between the median and musculocutaneous nerves.[6] Nayak reported a rare finding of a tight connecting band between the medial and lateral roots of the medial nerve, which compressed the third part of the axillary artery.[7]

Although not disabling, this absent musculocutaneous nerve anomaly must be acknowledged because it may lead to unusual presentation and function loss in the limb after median nerve injury in the arm, after lymph node dissection in the axilla and after open or closed injuries. When an axillary block is given for regional anesthesia, there may be an atypical area of anesthesia after the block due to the variations mentioned earlier.

In cases of absent musculocutaneous nerve, the biceps and the brachialis nerve branches originated from the median nerve. However, these direct contributions of the upper trunk brachial plexus travel in a common sheath with the median nerve. In our cases (cases 1 and 3), these branches were coming out of the median nerve, whereas in case 2 and case 4, the musculocutaneous nerve was traveling in a common sheath with the median nerve.

## Conclusion

The musculocutaneous nerve anomalies may not be as uncommon as reported. As in our study, the reported incidence of musculocutaneous nerve anomaly is 16.66% (4 of 24 cases) in brachial plexus injury cases, which we explored for musculocutaneous nerve neurotization. This does not cause any physical disability in living individuals and therefore remains undiagnosed. In our cases, the musculocutaneous nerve anomalies were intraoperative finding. These variations should be kept in mind to avoid intraoperative dilemma during brachial plexus surgeries, unforeseen complications during axillary surgeries, and unexpected findings following trauma.

Due to this anomaly, the surgeon should not abandon the neurotization procedure. Certain preoperative investigations like MRI of the infraclavicular plexus and individual nerves in the arm can alert the surgeon about the possibility of these variations and appropriate intraoperative precautions.

### Declaration

This study was reviewed and approved by the Institutional Review Board (IRB). All procedures performed in the study were in accordance with the ethical standards of the IRB and the Declaration of Helsinki, ensuring that the rights, well-being, and confidentiality of participants were safeguarded throughout the research process.

### Authors' Contributions

J.K.M. and S.A.S. contributed to the study design, collection of data, data analysis/interpretation, and writing of the manuscript. J.J.R. and A.K.G. contributed to the collection of data and writing of the manuscript. A.V. contributed to the data analysis/interpretation and writing of the manuscript.

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Conflict of Interest
None declared.

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