SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 15503-15509
Open Access. Online & Print

DOI: 10.5281/zenodo.20593046

ABSENCE OF THE MUSCULOCUTANEOUS NERVE WITH DIRECT INNERVATION OF ANTERIOR ARM MUSCLES FROM THE LATERAL ROOT OF THE MEDIAN NERVE: A CADAVERIC CASE REPORT

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Received: 04/04/2026
Accepted: 20/05/2026

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ABSTRACT

The musculocutaneous nerve arises from the lateral cord of the brachial plexus and contains fibers derived from the C5 to C7 spinal nerve roots. Typically, it provides motor innervation to the coracobrachialis, biceps brachii, and brachialis muscles. Variations in the anatomy of the brachial plexus have been widely documented in clinical-anatomical records. However, the absence of the musculocutaneous nerve is a rare anatomical variation, and its recognition may influence surgical procedures, regional anesthetic techniques, and neurological evaluation of the upper limb. During routine cadaveric dissection of an 85-year-old male specimen, an unusual neural arrangement was identified in the left upper limb. The musculocutaneous nerve was not present. Instead, three muscular branches arise from the lateral root of the median nerve before its union with the medial root. These branches provided motor innervation to the coracobrachialis, biceps brachii, and brachialis muscles. The branch directed to the brachialis muscle continued distally and formed the lateral cutaneous nerve of the forearm. In contrast, examination of the right upper limb revealed a normally developed musculocutaneous nerve that also demonstrated a communicating branch with the median nerve. Complete absence of the musculocutaneous nerve represents a rare anatomical variant of the brachial plexus. Awareness of this variation is important for clinicians performing surgical interventions in the axillary and upper-arm regions, administering brachial plexus blocks, or interpreting electrophysiological investigations, as unrecognized variations may increase the risk of nerve injury or diagnostic confusion.

KEYWORDS: Brachial Plexus; Musculocutaneous Nerve; Median Nerve; Coracobrachialis; Biceps Brachii; Brachialis; Lateral Antebrachial Cutaneous Nerve.

1. INTRODUCTION

The musculocutaneous nerve is a terminal branch of the lateral cord of the brachial plexus and typically carries fibers from the fifth to seventh cervical spinal nerves (C5–C7). It originates in the axilla, pierces the coracobrachialis muscle, and descends between the biceps brachii and brachialis muscles in the anterior compartment of the arm [1]. Along its course, it provides motor innervation to the coracobrachialis, biceps brachii, and brachialis muscles and continues distally as the lateral antebrachial cutaneous nerve, supplying sensory innervation to the lateral aspect of the forearm [2–4].

Although the classical anatomical pattern is well established, variations involving the musculocutaneous nerve and other components of the brachial plexus are frequently reported. These variations may include differences in origin, course, branching pattern, or communication with adjacent nerves, particularly the median nerve. Developmental studies suggest that such variations arise during early embryogenesis due to altered interactions between the ventral rami of cervical spinal nerves and the developing upper-limb musculature [5].

Cadaveric studies have demonstrated considerable variability in the branching pattern and course of the musculocutaneous nerve. Variations such as atypical branching, communication with the median nerve, and, in rare cases, complete absence of the musculocutaneous nerve have been reported [6]. Additional studies have described variations within the flexor compartment of the arm, indicating that its relationship with surrounding muscular structures may vary significantly among individuals [7].

Typically, the musculocutaneous nerve pierces the coracobrachialis muscle before descending between the biceps brachii and brachialis muscles. However, deviations from this pattern, including altered course, communication with the median nerve, or complete absence, have been documented [8]. In rare cases, the musculocutaneous nerve may be absent, with the median nerve assuming responsibility for both motor innervation of the anterior compartment muscles and sensory supply to the lateral forearm [9].

Variations of the brachial plexus are clinically important as they may influence surgical approaches, regional anesthesia techniques, and the interpretation of neurological deficits. Borthakur et al. reported a unilateral absence of the musculocutaneous nerve, where branches from the median nerve supplied the coracobrachialis, biceps brachii, and brachialis muscles [10]. Similar variations have been described in recent anatomical studies [11].

Recognition of these variations is essential, as the musculocutaneous nerve plays a key role in elbow flexion and forearm sensation. Detailed knowledge of its branching pattern is crucial during reconstructive procedures and nerve transfer surgeries aimed at restoring elbow function following brachial plexus injuries [12]. Furthermore, such variations may affect surgical approaches, nerve conduction studies, and the success of regional anesthesia [11].

The present case report describes a rare anatomical variation characterized by the complete absence of the musculocutaneous nerve, with direct muscular branches arising from the lateral root of the median nerve. Documentation of such variations enhances the understanding of brachial plexus anatomy and has important implications for clinical practice.

2. CASE PRESENTATION

We discovered that an 85-year-old male cadaver was examined during routine anatomical dissection conducted for educational purposes at the Medical University of the Americas. During the dissection of the left upper limb, an unusual variation in the brachial plexus was identified. The musculocutaneous nerve was absent, and the muscles of the anterior compartment of the arm received their motor innervation directly from branches arising from the lateral root of the median nerve.

Within the axillary region, the lateral root of the median nerve originated from the lateral cord of the brachial plexus and was positioned lateral to the axillary artery. Before joining the medial root in the axillary region to form the median nerve, anterior to the third part of the axillary artery, the lateral root gave rise to three separate muscular branches supplying the anterior compartment of the arm.

The first branch (Branch I) arose proximally from the lateral root and entered the coracobrachialis muscle. The second branch (Branch II) descended along the medial aspect of the biceps brachii muscle and provided direct motor innervation to it. The third branch (Branch III) travels inferiorly between the biceps brachii and brachialis muscles to supply the brachialis muscle. Distally, this branch continued as the lateral cutaneous nerve of the forearm (Branch IV), providing sensory innervation to the lateral region of the forearm. This pattern effectively replaced the typical distribution of the musculocutaneous nerve (Figure 1).

Aside from this variation, the remaining components of the brachial plexus and the surrounding neurovascular structures displayed their usual anatomical arrangement. The axillary artery and vein maintained their normal positional relationships with the cords of the brachial plexus.

In contrast, dissection of the right upper limb revealed a normally developed musculocutaneous nerve arising from the lateral cord of the brachial plexus. The nerve followed its usual course by piercing the coracobrachialis muscle and descending between the biceps brachii and brachialis muscles. However, a communicating branch was observed arising from the musculocutaneous nerve before it entered the coracobrachialis muscle. This communicating branch joins the median nerve in the lower portion of the axilla (Figure 2).

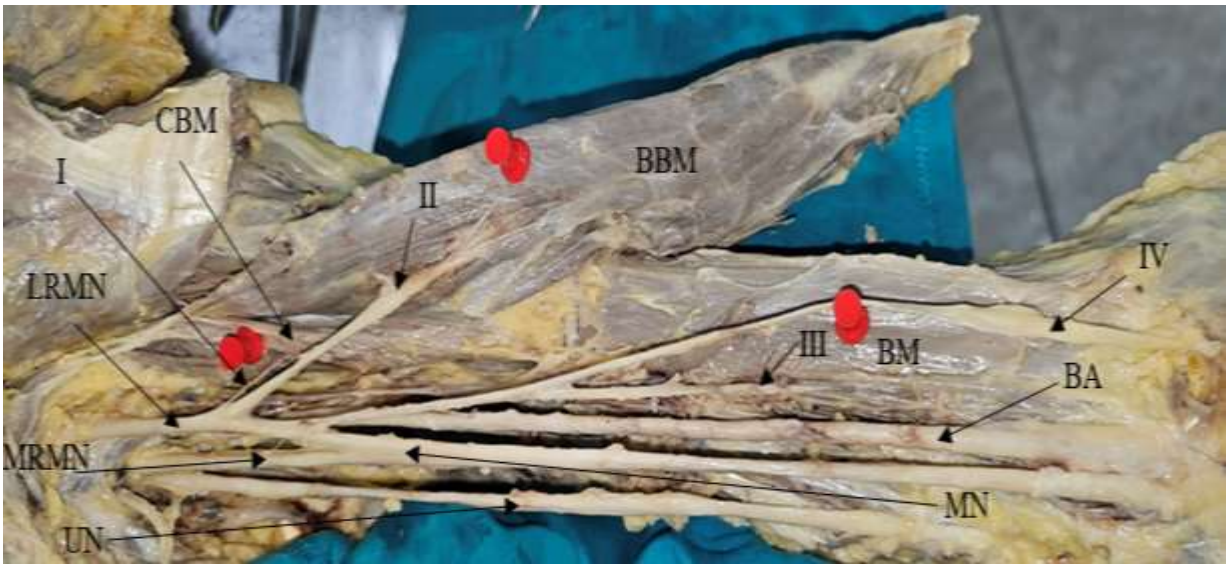

Figure 1. Left axilla showing absence of the musculocutaneous nerve with muscular branches arising from the lateral root of the median nerve. The muscles of the anterior compartment of the arm receive direct branches from the lateral root of the median nerve.

I – Branch to the coracobrachialis muscle

II – Branch to the biceps brachii muscle

III – Branch to the brachialis muscle

IV – Lateral cutaneous nerve of the forearm

CBM – Coracobrachialis muscle

BBM – Biceps brachii muscle

BM – Brachialis muscle

LRMN – Lateral root of the median nerve

MRMN – Medial root of the median nerve

MN – Median nerve

UN – Ulnar nerve

BA – Brachial artery

Figure 2. Dissection of the right axilla showing a normally formed musculocutaneous nerve with an additional communicating branch to the median nerve.

LRMN – Lateral root of the median nerve

MRMN – Medial root of the median nerve

AA – Axillary artery

MCN – Musculocutaneous nerve

AB – Additional communicating branch

MN – Median nerve

CBM – Coracobrachialis muscle

3. DISCUSSION

Anatomical variations of the brachial plexus are well documented in both cadaveric and clinical studies. Among these, variations involving the musculocutaneous nerve (MCN) and its relationship with the median nerve are of particular importance due to their direct clinical implications. While communication between the musculocutaneous and median nerves is relatively common, a complete absence of the musculocutaneous nerve is considered a rare anatomical variation. In such cases, the median nerve assumes both motor and sensory functions normally attributed to the musculocutaneous nerve [10].

The embryological basis of these variations can be explained by the developmental processes occurring during early limb formation. The ventral rami of cervical spinal nerves extend into the developing limb bud and establish connections with differentiating muscle masses. Any disruption or alteration in the migration, fusion, or distribution of these nerve fibers may result in atypical neural arrangements, including absence or substitution of peripheral nerves [5].

Several classification systems have been proposed to describe variations in the musculocutaneous nerve. Le Minor described five types of relationships between the musculocutaneous and median nerves, with Type V representing the complete absence of the musculocutaneous nerve, where all fibers are incorporated into the median nerve [13]. The present case corresponds to this category, as no independent musculocutaneous nerve trunk was identified.

Venieratos and Anagnostopoulou further classified these variations based on the relationship of the musculocutaneous nerve with the coracobrachialis muscle, noting that the nerve may not pierce the muscle or may be entirely absent [14]. In addition, Choi et al. demonstrated that although communication between the musculocutaneous and median nerves is relatively frequent, a complete absence of the musculocutaneous nerve remains uncommon [15]. Guerri-Guttenberg and Ingolotti emphasized that such variations represent persistence of primitive embryological patterns, contributing to the wide spectrum of anatomical diversity observed in the brachial plexus [16].

Cadaveric studies have consistently demonstrated variability in the branching pattern of

the musculocutaneous nerve. Bhojak et al. reported atypical branching patterns, including direct muscular supply from adjacent nerves [6]. Lalit et al. further described variations within the flexor compartment of the arm, highlighting differences in nerve–muscle relationships [7]. These findings support the observation in the present study, where muscular branches arise directly from the lateral root of the median nerve rather than from a distinct musculocutaneous nerve.

Table 1: A comparative overview of Previously reported findings is presented in Table 1.

Author (Year)	Study Type	Key Finding	Pattern of Innervation	Clinical Relevance
Le Minor (1990) [13]	Anatomical classification	Five types of the median nerve relationship	Type V: Complete absence of MCN	Important for nerve transfer and surgical planning
Venieratos & Anagnostopoulou (1998) [14]	Cadaveric study	MCN variation based on the coracobrachialis relation	MCN may be absent or not pierce the muscle	Alters anatomical landmarks
Choi et al. (2002) [15]	Cadaveric study	Communication patterns analyzed	Communication is common; absence is rare	Important in anesthesia and diagnosis
Guerri-Guttenberg & Ingolotti (2009) [16]	Review	Classification of MCN variations	Fusion with the median nerve is possible	Reflects embryological persistence
Bhojak et al. (2014) [6]	Cadaveric study	Atypical MCN branching	Direct muscular supply variations	Surgical relevance
Lalit et al. (2022) [7]	Cadaveric study	Variations in the flexor compartment	Altered branching patterns	Impacts of reconstructive surgery
Hunter & Zdilla (2021) [9]	Systematic review	Absence of MCN	Median nerve substitutes function	Important in nerve injury diagnosis
Borthakur et al. (2024) [10]	Case report	Unilateral absence of MCN	The median nerve supplies the anterior arm muscles	Closely comparable to the present case
Present study	Cadaveric case	Complete absence of MCN	Branches from the lateral root of the median nerve supply all anterior muscles; continuation as the lateral cutaneous nerve of the forearm	High clinical relevance

The present case closely resembles the findings reported by Borthakur et al. [10], who described a unilateral absence of the musculocutaneous nerve in which the median nerve supplied the coracobrachialis, biceps brachii, and brachialis muscles, and aligns with Type V of Le Minor's classification [13]. However, the present case demonstrates a more anatomically precise pattern, in that three independent muscular branches arise from the lateral root of the median nerve before its union with the medial root, rather than from the formed median nerve trunk itself. This proximal origin from the lateral root is a distinguishing feature not consistently described in earlier reports. Furthermore, in the present case, the branch supplying the brachialis muscle continued distally as the lateral cutaneous nerve of the forearm, effectively replacing the entire functional course of the musculocutaneous nerve, including both its motor and sensory components. This continuity of the brachialis branch into the lateral cutaneous nerve of the forearm is consistent with the findings of Hunter and Zdilla [9], who documented that the median nerve assumes full functional substitution when the musculocutaneous nerve is absent. Compared with the classification by Venieratos and Anagnostopoulou [14], who categorized variations based on the relationship of the musculocutaneous nerve with the coracobrachialis muscle, the present case represents the most extreme form of variation, wherein no independent musculocutaneous nerve trunk is identifiable at any point in its expected course. Similarly, while Choi et al. [15] noted that communication between the musculocutaneous and median nerves is relatively common, the complete absence observed in the present case is acknowledged as uncommon in their series, further underscoring the rarity of this anatomical finding.

From a clinical perspective, such variations are highly significant. Surgeons operating in the axillary and upper arm regions rely on predictable anatomical landmarks for safe tissue dissection and nerve identification. The absence of the musculocutaneous nerve may lead to misidentification of neural structures, thereby increasing the risk of iatrogenic injury. In particular, during axillary lymph node dissection, surgical repair of the biceps brachii tendon, or coracobrachialis muscle release, the surgeon may inadvertently damage the variant muscular branches arising from the lateral root of the median nerve, mistaking them for expendable connective tissue or minor vascular tributaries. The proximal origin of these branches from the lateral root, before the formation of the median nerve trunk, makes them especially vulnerable during dissection in the axillary region. Additionally, during nerve transfer surgeries aimed at restoring elbow flexion following brachial plexus injuries, preoperative awareness of this variant is critical. If the musculocutaneous nerve is

targeted as a recipient nerve and is found to be absent, the surgical plan must be adapted accordingly to identify the functionally equivalent branches from the lateral root of the median nerve [12]. Similarly, anesthesiologists performing brachial plexus blocks may encounter incomplete or altered anesthesia due to unexpected nerve distribution patterns [11]. Standard axillary brachial plexus block techniques target the musculocutaneous nerve as a distinct structure within the axillary sheath. In cases such as the present one, where no independent musculocutaneous nerve is present, the injection at the expected site of the musculocutaneous nerve would be ineffective. The variant branches, arising proximally from the lateral root, may not be adequately covered by a conventional axillary approach, potentially resulting in incomplete motor and sensory blockade of the anterior arm. Ultrasound-guided techniques may help identify the variant branching pattern in such cases, though the unusual origin of these branches from the lateral root before median nerve formation may still pose a challenge to accurate identification intraoperatively.

Neurologically, this variation may alter the presentation of nerve injuries. Under normal conditions, injury to the musculocutaneous nerve results in weakness of elbow flexion and sensory loss over the lateral forearm. However, in the absence of this nerve, similar deficits may arise following proximal median nerve injury, potentially leading to diagnostic confusion. This highlights the importance of considering anatomical variations during clinical evaluation and interpretation of nerve conduction studies [12].

In contrast to more commonly reported cases in which the musculocutaneous nerve communicates with the median nerve, the present study demonstrates a complete absence of the musculocutaneous nerve, with full functional substitution by the median nerve. This represents a rare but clinically relevant variation.

Overall, this case's findings contribute to the existing body of knowledge on brachial plexus variations. Awareness of such patterns is essential for clinicians involved in upper-limb surgical, anesthetic, and diagnostic procedures, as it may improve procedural safety and diagnostic accuracy.

4. CONCLUSION

This case report describes a rare anatomical variation characterized by the complete absence of the musculocutaneous nerve. The anterior compartment muscles of the arm receive direct innervation from branches of the lateral root of the median nerve. In this variation, the branch supplying the brachialis muscle continued distally as the lateral cutaneous nerve of the forearm.

Recognition of such variations is important for clinicians involved in upper-limb surgical, anesthetic, and diagnostic procedures. Awareness of atypical neural patterns can help reduce the risk of iatrogenic nerve injury during axillary or upper-arm surgeries, improve the effectiveness of regional anesthesia techniques, and assist in the accurate interpretation of neurological investigations. Continued documentation of these variations contributes to a better understanding of brachial plexus anatomy and its clinical significance.

Ethical Approval and Informed Consent: The cadaver used in this study was obtained through the institutional body donation program of the Medical University of the Americas. The donor had provided prior written informed consent for the use of the body for medical education and scientific research, including post-mortem anatomical investigations.

According to institutional and national guidelines governing cadaver-based anatomical research, formal ethical approval was not required for this study.

Funding Information: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest: The author declares that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments: The author expresses sincere gratitude to the body donor and their family for their invaluable contribution to medical science. Their selfless donation has made this study possible and continues to support advancements in anatomical knowledge and clinical practice.

The author also acknowledges the institutional support provided by the Medical University of the Americas during the conduct of this study.

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