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RESEARCH ARTICLE

MORPHOLOGICAL VARIATIONS AND FREQUENCY OF COMMUNICATING BRANCHES BETWEEN MUSCULOCUTANEOUS NERVE AND MEDIAN NERVE

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ABSTRACT

Introduction: In a sample of the Indian population, determine the characteristics and variance of the communication between the musculocutaneous nerve (MCN) and the median nerve (MN), and evaluate its clinical significance. The MCN is typically one of the terminal branches of the brachial plexus's lateral cord in each individual. It originates at C5, C6, and C7, the cervical ventral main rami. The biceps, coracobrachialis (CB), brachialis, and arm flexors are all innervated by the musculocutaneous nerve. It also supplies the skin on the lateral side of the forearm. **Material & Methods:** The investigation involved 40 cadaver specimens that were obtained for the First MBBS undergraduate program at Zydus Medical College and Hospital in Dahod between 2019 and 2023, spanning a 5-year period. The dissection of the arm and axilla had been carried out, and the tissues were examined and analyzed for the "existence of MCN and MN communication". **Results:** The presence of a communicating branch was detected in 11 of 80 upper limbs (11.2%), with bilateral occurrences in 3 cases (27.2%) and unilateral occurrence in 8 cases (72.7%). There was no significant variation in the side of occurrence, as per statistical analysis (p=0.30). A "communication between the MCN and the MN" was seen in 12.5% of the cases; this communication was indicated by the branch that emerged from the MCN after going through the CB (type I). Moreover, "the connection from the MN to the MCN (type II)" was found in 1.25% of the cases. In 11/80 upper limbs (13.7%), a communicating branch was discovered. With little difference in the side of incidence (p=0.30), it happened unilaterally in 8 cases (72.7%) and bilaterally in 3 cases (27.2%). In 12.5% of cases, there was "communication between the MCN and MN", with the communicative branch seen to pierce the type-I coracobrachialis before leaving the MCN. "The connection was made from the MN to MCN" (type II) in 1.25% of cases. The arm's middle third contained the majority of the communicating branch. The other significant findings that followed were determined. a) The CB is not pierced by the muscle cutaneous nerve (MCN) in 2 cases (2.5%). It is uncommon for the musculocutaneous nerve to vary in its origin, course, relation, distribution, branching pattern, termination, or connection. Stated differently, the preceding authors had recorded differences in the musculocutaneous nerve's origin and distribution. **Conclusion:** The present study's observations regarding the variation and frequency of MCN-MN communication are within the range reported in prior research, based on sample size. Understanding these MCN-MN relationships is significant for the diagnosis as well as treatment of peripheral "nerve lesions in the upper limb". In clinical practice, orthopaedic, neurologists, and anaesthesiologists value anatomical variations in the neurovascular structure of the arm. It's also crucial to keep in mind that concurrent vascular variants could exist and complicate the surgical strategy for the best possible minimally invasive surgical procedure.

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INTRODUCTION

The lateral cord of the brachial plexus is where the MCN originates in the average person. The ventral primary rami "of the cervical nerves c5, c6, c7 are source of this nerve. The MCN, which innervates the arm flexor muscles, is derived from the lateral cord.

Additionally, the lateral cord combines with the medial root of the medial cord as the lateral root of the MN at the distal margin of the pectoralis major[1].The lateral as well as medial roots, which originate from the lateral and medial cords", make up the MN. The arm flexor muscles, particularly the brachialis, CB, and biceps brachii (BB), are innervated by the MCN.

After that, the MCN continues as the forearm's lateral cutaneous, providing the skin on its lateral aspect sensory Innervation. In actuality, the lateral as well as medial roots "of the lateral and medial cord forms the MN. The "BB, CB, and brachialis are likely innervated by MCN that supplies the arm's flexors. This is most likely due "to the forearm' lateral cutaneous nerve, which starts after the MCN, supplying the skin on the lateral side of the forearm[2]. A muscle in the superomedial area of the arm is called the coracobrachialis. MCN pierces it, and the lowest part of its attachment indicates" where the humerus's nourishment foramen is located. Usually, the arm lacks the MN muscle branches. Studies indicates that the MCN exhibits variation in approximately 6.25% of cases[3], which its absence occurring in a prevalence range of 1.7% to 15%. Several reports have shown that MCN is absent and that the median nerve communicates with it[4]. The atypical branching and progression of MCN variations, as well as their relationship with the coracobrachialis, have been documented by Koizum[5]. Furthermore, the medial pectoral nerve Innervation to the axillary arch, identified as Musculo-tendinous slip. Depending on the demographic profile, the incidence of the arch can range from 0.25 to 7%. Because the arch is close to the brachial plexus, axillary vein, and axillary artery, it has various surgical implications[6]. This variation is related to multiple clinical complications, so it is important for a surgeon performing axillary surgery to be aware of it.

MATERAL AND METHODS

In a sample of 80 upper limbs—70 male and 10 female specimens—the descriptive study was conducted to evaluate the morphological variations and frequency of the communicating branches between the MCN and the MN. This investigation involved 40 cadaver specimens utilized for undergraduate medical education (First phase MBBS) over a five-year period from 2019 to 2023, conducted within the Department of Human Anatomy at Zydus Medical college and Hospital in Dahod. The axilla and the upper flexor compartment of the arm were thoroughly divided employing"a midline incision that extended from the mid-third of the clavicle to the front of the elbow. The" pectoralis major and minor emerged from their anatomical origins after the skin and superficial fascia were removed, along with the separation of the medial and lateral fascio-cutaneous flap. This procedure allowed for an in-depth examination of the vessels in the axilla and anterior arm region, as well as the terminal branches of the brachial plexus. These vessels were dissected and examined for possible connections between the MCN and the MN. A classification system suggested by Maeda et al. has been utilized to identify "the communicating branches between the MCN" of the arm and the MN, and their qualitative characteristics have been documented. There are four subtypes within Type I, which is further subdivided based on the occurrence of communication in the mid or distal third of the arm. Subtype Ia: when MCN communication entered the coracobrachialis through an intramuscular pathway. Subtype Ib: when the muscle branch of the biceps brachii exits the MCN before the communicating branches. Subtype Ic: When there is communication between the branches that supply the brachialis as well as brachii muscles. Subtype Id: following the brachialis muscle branch's emergence, the communicating branch exits. Similarly, type II with two subtypes was identified for the "occurrence of communicating branches between""the MCN and MN. Subtype IIa: The brachialis muscle branch and the biceps origin were reached by" the branch from MN. Subtype IIb: in which the brachialis branch and the communicating branch are connected. Every morphometric evaluation was recorded, and a camera was employed to take photographs of the results.

RESULTS

Of the 80 upper limbs evaluated, 11 had a communicating branch (13.7%). These branches "occurred unilaterally in 7 cases (63.6%) and bilaterally in 4 cases (36.3%), with no discernible difference in the side of incidence (p=0.30). Three were to the left and eight to the right (p=0.30). Ten (12.5%) specimens showed type I communication (figure 1), in which the MCN-MN communicating branch appeared after the MCN pierced the coracobrachialis and was obliquely connected to the" MCN. In three cases (30%), the communication originated in the intramuscular region of the MCN and went to the CB (subtype Ia). In one case (10.0%), the communication originated in the proximal segment of the MCN before the branch went to the biceps and brachialis (subtype Ib); in three specimens (40.0%), the communication originated in the "mid-segment of the MCN between the branch's emergence and the biceps and brachialis (subtype Ic); in two cases (20.1%), the communicating branch emerged from the branch to the brachialis (subtype Id"). MCN failed to pierce the coracobrachialis in two instances. The communicating branch from MN was discovered in one specimen (1.25%) "at the level of the mid-third of the arm", following an oblique trajectory, and it had been subsequently connected to the MCN (Type IIa) Figure 2.

Fig.1 – communication with the musculocutaneous and Median nerve (a) MCN – MN communication from proximal segment of musculocutaneous nerve (subtype- Ib). Anterior view of right arm. LC- lateral cord, MC- medial cord, CbM – coracobrachialis muscle, BM – biceps muscle, MCN – musculocutaneous nerve, MN – median nerve, (*) communicating branch, McNA – medial cutaneous nerve of arm. (b) MCN-MN communication, originated after the branch to the biceps brachii muscle (subtype Ic). Anterior view of left arm , DM – deltoid muscle, CbM – coracobrachialis muscle, BM – biceps muscle, MCN – musculocutaneous nerve, MN – median nerve, (**) communicating branch, McNA – medial cutaneous nerve of arm, LC- lateral cord, MC- medial cord. (c) MCN-MN communication originated from the branch to the biceps and brachialis muscle (subtype Id). Anterior view of right arm. LC- lateral cord, MC- medial cord, CbM – coracobrachialis muscle, BM – biceps muscle, MCN – musculocutaneous nerve, MN – median nerve, (*) communicating branch, BcM- brachialis muscle

Table 1. Several authors have reported varying incidences of musculocutaneous – median nerve association in different populations

Author, year	Population		Incidence n [%]		
		Sample size	MCN-MN	MN-MCN	Total
Maeda *et al*., 2009	Japanesi	453	18.8	12.8	41.5
Choi *et al*., 2002	British	276	26.4	--	26.4
Loukas *et al*., 2005	American	258	46.1	--	46.1
Venieratos *et al*., 1998	Greak	158	13.9	--	13.9
Uysal *et al*., 2009	Turkish	140	10	--	10
Budhiraja *et al*., 2011	Indian	116	20.7	--	20.7
Chiarapattanakon *et al*., 1998	Thai	112	11.6	4.4	16
Eglseder *et al*., 1997	American	108	36	--	36
Luis Ernesto Ballesteros 2015	Colombian	106	17	2.8	19.8
Kosugi *et al*., 1992	Japanese	75	54.7	--	54.7
Beheiry. 2004	Egyptian	60	5	--	5
Chitra, 2007	Indian	50	26		26
Pacha *et al*., 2005	Spanish	46	28.3	--	28.3
Krishnamurthy *et al*., 2007	Indian	44	9.1	6.8	15.9
Bhattarai *et al*., 2009	Nepalese	32	6.3	--	6.3
Guerri-Guttenberg *et al*., 2009	Argentinean	26	53.6	--	53.6
Yang *et al*., 1995	Singaporean	24	12.5	--	12.5
Kervancioglu *et al*., 2011	Turkish	20	25	--	25
Present Study	Indian	80	13.7	1	13.7

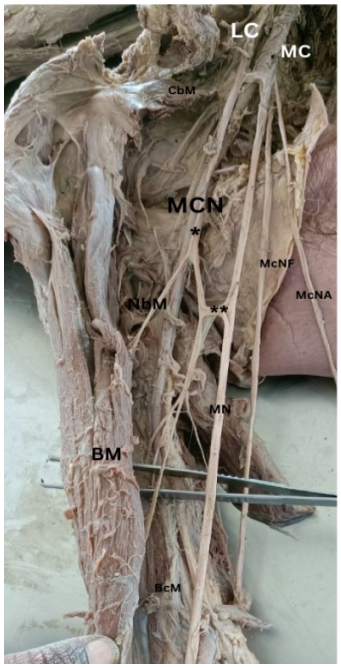

Fig. 2. Communication between the median and musculocutaneous nerves. Anterior view of left arm. LC- lateral cord, MC- medial cord, CbM – coracobrachialis muscle, BM – biceps muscle, MCN – musculocutaneous nerve, MN – median nerve, (**) communicating branch, BcM- brachialis muscle

DISCUSSION

Human embryogenesis is characterized by the somite of each myotome and dermatone maintaining its distinctive upper limb formation innervations. The paraxial mesoderm provides development to the upper limb's muscles during the 5thweek of intrauterine life[7]. The spinal nerves' axons extend toward the developing limb's mesenchyme. There are significant variations in the nerve pattern if there is any altered signaling between them. Regarding the "frequency of MCN-MN communication, our findings (13.7%) are in line with the authors' reported mid-range (17"–36%)[8].The range of 37–54.7% has been reported to contain the highest incidences[9].Numerous studies carried out in a variety of populations[10] have documented the remarkably lower prevalence of this communication (range 5–16%) (Table 1).

"The vast variability spectrum observed by different authors is probably due to a combination of variables such as sample size, methodology, and ancestral biologic traits that assess the varying manifestation of these structures in the analyzed populations. Comparably, our results agree with the literature on the dominance of the left side without statistical difference and the preference of the unilateral occurrence over the bilateral occurrence"[11, 12]. Previous research has consistently shown that there is a significant majority of one communicating branch, with a frequency of 90–93.2percent, and "two communicating branches, with a frequency of 6.8–10.7%. The presence of Type I MCN-MN communication is" described in our series. According to the majority of authors, this communication occurs 45–72% of the time and is the most common[13]. Our results are also consistent with the communicative branch that emerged from the mid-segment of the MCN (subtype Ib), which some authors[14] have identified as the most prevalent one. Our analysis did not find the communications that other studies indicated to be present prior to the MCN piercing the CbM[15]. It is most likely the result of divergent views among researchers regarding the MN formation by the lateral as well as medial fascicles. The majority of "authors only mention that the communicating branch passes from MCN to MN[16]; however, Type II communication", which can occur both directions, was discovered in our study to occur from MN to MCN in 1.2% of cases, as noted in previous studies with an incidence of 4.4–12.8%, [17]. In our study (Fig. 1), "MCN-MN communicating branch had been related to an extra head of the biceps brachii in" 3.75% of the cases; other authors have also noted this connection[18]. Recall "that 1 in 4 upper limbs evaluated may exhibit an MCN-MN communication related to an additional head of the" BB when planning surgical procedures in the arm. The MCN-MN communication must be taken into consideration when doing a "clinical examination for nerve injuries at the axilla and arm, performing surgical procedures like neuromuscular flaps or peripheral nerve repair, or even performing nerve blocks at the upper extremities in anaesthesia practice. Alterations in the" function as well as mobility of the upper extremity may be advantageous or detrimental, depending on whether the MCN or MN lesions occur close to or far from the communication branches. Clinical indications similar to those of an MN injury at the arm level can result from an MCN damage "proximal to the MCN-MN

communication, including an unpredicted weakening of the thenar and forearm flexor muscles". Moreover, the MN lesion close to the MN-MCN connection may result in a clinical presentation where the MN-innervated hand and forearm muscles remain functioning[19]. The variance among the 175 brachial plexuses was observed in only 3 cases[20].Wantanable et al. found that only 2 cases (1.4%) out of 140 upper limbs had contact between the MCN[21]. The unidentified branch of MCN that merged with MN lateral root and rejoined it is correlated with Type I and Type II in this study. The MCN originates from the brachial plexus's lateral chord and pierces the coracobrachialis muscle, giving it relatively consistent anatomical features. In contrast, Buch found in his cadaveric research that in 3-6% of cases, MCN originate from the median nerve and in 1-5% of specimens[22], from the posterior cord.

Winkelman (2016) noted that the "lateral cord innervated the CB, BB, and brachialis muscles without releasing the lateral root of the median nerve[23]. Buch estimates that 14% of instances had the MCN either not pierce the coracobrachialis muscle or not at all[24]. The current study shows 2.3% of proximal contact between the MN and the unidentified medial branch of MCN. The MN and the unidentified medial branch of MCN communicate in the current investigation, with 1.3% of the communication occurring "proximal to the CB muscle, showed evidence of MCN rejoining the MN following perforation of the CB muscle. Distal to the CB muscle is where this connection occurs. In one case, the CB was not punctured by the musculocutaneous nerve. Some factors affect how limb muscles as well as peripheral nerves grow during the embryonic stage, which might result in anatomical variants in MCN.

CONCLUSION

According to the sample, the variation and "frequency of MCN-MN communication" seen in this study falls within the range of findings from earlier studies. When diagnosing as well as treating peripheral nerve lesions that are present in the upper limb, it is important to take these MCN-MN connections into consideration. Anatomical variations of the neurovascular structure in the arm are important in clinical practice to the orthopedicians, neurologist and anesthesit. It's also important to note that concurrent vascular variants could exist and could make the surgical strategy for achieving the best results from minimally invasive surgery more difficult. Variations in MCN are important in post-traumatic evaluations, brachial plexus blocks, surgical operations, as well as "exploratory innervations of the arm for peripheral nerve restoration. Techniques for" managing and implementing radiological surgical interventions require an understanding of these distinctions.

Conflicts of interest: None

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