IJAE
Vol. 119, n. 3: 232-240, 2014
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Research Article – Basic and Applied Anatomy

Median ulnar nerves communication in the forearm: a study with autopsy material

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Submitted March 6, 2014; accepted revised June 19, 2014

Abstract

The incidence of median-ulnar communication in the forearm presents variability in different population groups. The aim of this study was to determine the incidence and morphologic expression of the median-ulnar communication in a sample of the Colombian population. One hundred and eight forearms of autopsy material at the National Institute of Forensic Medicine of Bucaramanga, Colombia were studied. Using an approach of the flexor compartment of forearm the median and ulnar nerves were dissected and the communications between these two structures were characterized. The communicating branch occurred in 28 (25.9%) forearms. It occurred unilaterally in 12 specimens and bilaterally in 8, with statistically significant difference (P=0.01). The communication between the anterior interosseous and ulnar nerves was most frequent, observed in 13 (46.4%) forearms. The length of the communicating branch was 56.9±8.3 mm. The distance of the proximal and distal points of the communicating branch to the bi-epicondylar line was 59.6±15.4 mm and 102.7±23.5 mm respectively. The length of the forearm was 269.8±15.9 mm. A projection of the communicating branch from the upper third to the mid-third of the forearm was observed. The incidence of the median-ulnar communication in the present study is in the high rank reported in the literature; there is an agreement with prior studies in finding more numerous communicating branches in the right forearm. The median-ulnar communication should be taken into account for surgical approach of the forearm.

Key words

Median nerve, ulnar nerve, communicating branch, forearm, nerve transfer.

Introduction

The communication between the median and ulnar nerves (MUC) at the level of the forearm was first described by Martin in 1763 and later by Gruber in 1870; this anatomic variation is called Martin-Gruber's communication to honour these two anatomists. This morphologic expression is characterized by the presence of a communicating branch that emerges at the level of the cubital fossa, from the main trunk of the median nerve or from one of its branches, more particularly the anterior interosseous nerve; it crosses between the flexor digitorum superficialis muscle and the flexor digitorum profundus muscle, finally joining the ulnar nerve. Thus, the usual innervation pattern of the intrinsic muscles of the hand is modified (Nakashima, 1993; Shu et al., 1999).

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http://www.fupress.com/ijae
DOI: 10.13128/IJAE-15546

The incidence of the MUC varies between 10-30%. There is little controversy on the laterality relation of the MUC. Some studies report its predominant occurring at the right side (Nakashima, 1993; Shu et al., 1999; Prates et al., 2003; Sarikcioglu et al., 2003), whereas some others report either bilateral or left side dominance (Rodriguez-Niedenfur et al., 2002; Kazakoz et al., 2005; Lee et al., 2005).

Studies conducted with cadaver specimens describe the MUC as originating at the proximal level of the forearm (Nakashima, 1993; Taams, 1997; Shu et al., 1999; Kazakos et al., 2005; Lee et al., 2005); it ends by joining the ulnar nerve at a variable distance from the medial epicondyle of the humerus (Taams, 1997; Kazakos et al., 2005). The length of the communicating branch is 25-74 mm (Taams, 1997; Rodriguez-Niedenfur et al., 2002).

Concerning the characterization of the anatomic expression of the MUC, several classifications based on the origin of the communicating branch have been presented: From the median nerve, from the anterior interosseous nerve, or from the branch of the flexor digitorum profundus muscle (Rodriguez-Niedenfur et al., 2002; Kazakos et al., 2005).

The clinical significance of the MUC resides in that the injuries of the median nerve proximally to the emergence of the communicating branch affect the motor function of the intrinsic muscles of the hand, a circumstance that is not observed when the injury occurs distally to the emergence of the nerve branch. Additionally, a communicating branch with an intramuscular course may be the subject of compression, and cause a clinical picture difficult to understand (Brandsma et al., 1986; Shu et al., 1999; Rodriguez-Niedenfur et al., 2002).

Taking into account that the ethnic factor is decisive for the emergence of diverse morphological expressions and the absence of this type of information from the Mestizo population, which is predominant in Latin America, this study on fresh cadaveric material with the purpose of obtaining our own reference information is relevant

Materials and methods

This study assessed the frequency and morphologic characteristics of the MUC in 108 forearms of fresh unclaimed cadaver specimens, autopsied at the National Institute of Forensic Medicine of Bucaramanga, Colombia. The sample met the following inclusion criteria: Adult males pertaining to the mestizo racial group (a breed of white hispanics and natives), with no evidence of direct trauma or pathologies involving the forearm, and who were not subjected to forensic investigation.

The flexor compartment of the forearm was approached using a midline incision made from the bi-epicondylar line to the distal flexure of the wrist, involving skin, subcutaneous tissue, fascia, releasing of the pronator teres, and dissection of the muscular and vascular components of the cubital fossa. The median nerve and ulnar nerve were identified and the existence of communicating branches between them was verified, recording their morphologic traits - according to the classification proposed by Rodriguez-Niedenfur et al. (2002a) - as pattern I, when there was a single communicating branch, and pattern II when there were two branches. Also, Rodriguez-Niedenfur et al. (2002a) divided pattern I in three types: type Ia when the communication emerges from the branch of the median nerve to the superficial forearm flexor muscles, type Ib when the communication was between the origin of the branch to the superficial forearm flexors and the origin of the anterior interosseous nerve, type Ic when the communication arose from the anterior interosseous nerve. In our study, we adopted this further sub-classification and added type Id, for cases where the communicating branch arose from the branch of the flexor digitorum profundus muscle. The distance of the proximal and distal points of the communicating branches, as well as their lengths, were measured with respect to the bi-epicondylar line. The length of the forearm was measured from the bi-epicondylar line of the elbow to the line bi-styloid in the wrist.

All morphometric assessments were made with a digital caliper (Mitotuyo®) and the findings were photographed with a digital camera. All findings were digitized in Excel tables and the statistical analyses were carried out with the Epi-Info 3.5.4 program. Nominal variables are described with ratios, while continuous variables are described with mean and standard deviation. Statistical evidences were tested with the chi square ($\chi 2$) test and Student t test accepting an alpha error of up to 5%. A p-value < 0.05 was therefore considered as significant.

Results

An MUC was observed at the level of the forearm in 28 (25.9%) specimens studied: 15 cases (53.6%) on the right side and 13 (46.4%) on the left side, with non-significant difference between sides (P= 0.31). Occurrence was unilateral in 12 cases and bilateral in 8 cases, this difference being statistically significant. (P= 0.01).

Only specimens with a single communicating branch (pattern I) were found. Type Ic (Fig. 1) was the most frequent one, being observed in 13 (46.4%) forearms, with the presence of a communicating branch between the anterior interosseous nerve and the ulnar nerve in 7 cases on the right side and in 6 on the left side; in its oblique path the communicating branch ran along the ulnar vessels. Type Id was found in 10 cases (35.7%) (Fig. 2). Communication type Ia, originating from the branch for the superficial forearm flexor muscles, and more specifically, from the branch for the flexor carpi radialis muscle, with a path over the flexor digitorum profundus muscle prior to its connection to the ulnar nerve, was observed in 4 specimens (14.3%) (Fig. 3). Type Ib, i.e., direct communication from the median nerve to the ulnar nerve (Fig. 4), was found in one forearm (3.6%).

The distance from the proximal point of emergence of the communicating branch to the bi-epicondylar line was 59.6 ± 15.4 mm (right side: 59.9 ± 17.6 mm; left side 59 ± 12.6 mm), whereas the distance from its distal point to the above-described reference landmark was 102.7 mm ± 23.5 mm (right side 103.6 ± 18.4 mm, and contralateral 101.5 ± 29.8 mm) without significant difference between sides (P= 0.13).

The length of the communicating branch was 56.9 ± 18.3 mm, corresponding to 57.6 ± 21.4 mm on the right side, and 56.1 ± 13.9 mm on the left side, with non-statistically significant difference (P=0.92). The length of the forearm, measured from the bi-epicondylar line of the elbow to the bi-styloid line in the wrist, was 269.8 ±15.9 mm. The usual location of the communicating branch, with an oblique course, was between the lower segment of the upper third and the upper segment of the mid third of the forearm.

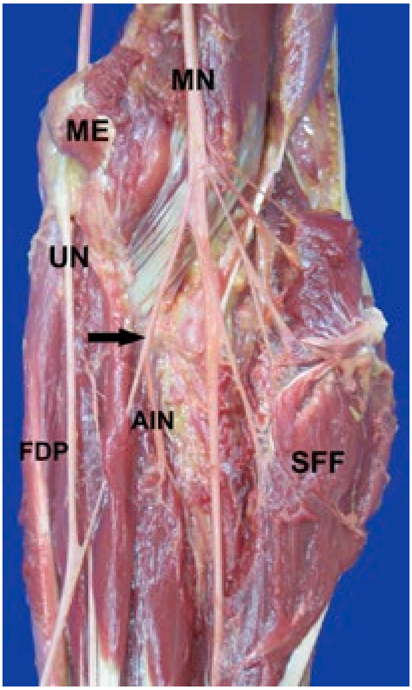

Figure 1 – Anterior view of the left cubital fossa. Median-ulnar nerves communication type Ia. MN, Median nerve; UN, Ulnar nerve; FCR, Flexor Carpi Radialis muscle; Arrow, Communicating branch; FDP, Flexor digitorum profundus muscle.

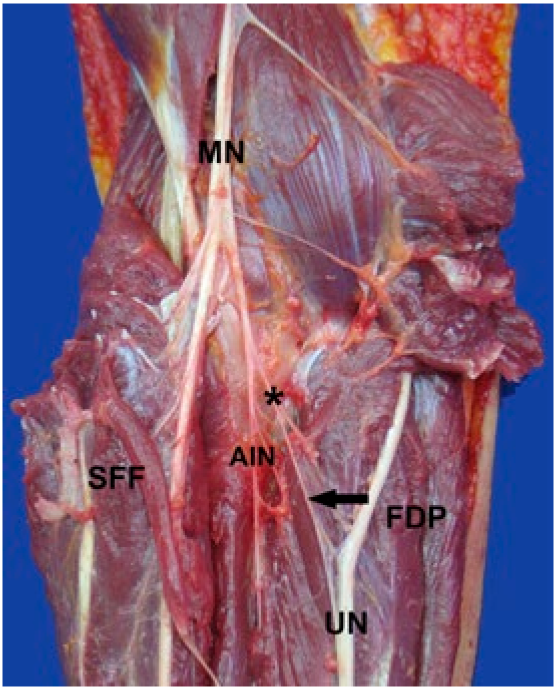

Figure 2 – Anterior view of the right cubital fossa. Median-ulnar nerves communication type Ib. MN, Median nerve; UN, Ulnar nerve; Arrow, Communicating branch; SFF, Superficial forearm flexor muscles; FDP, Flexor digitorum profundus muscle.

Discussion

Within a wide spectrum of variability, the frequency of MUC observed in our study (25.9%) is in the high rank (25.9 - 39.3%) as reported by Lee et al. (2005) and some other authors (Amoiridis, 1992; Erdem et al., 2002). Medium rank incidence has been reported within a range of 13.6 - 23.6% (Nakashima, 1993; Shu et al., 1999; Rodriguez-Niedenfur et al., 2002a,b; Hodzic et al., 2011). Of note is the low incidence of this communicating branch, in the range 7.8-12.5%, reported in several studies (Almeida et al., 1999; Prates et al., 2003; Sarikcioglu et al., 2003; Kazakos et al., 2005; Felippe et al., 2012). The divergence in the incidence reported by diverse authors is probably the result of multiple factors such as sample size, methodology and the ancestral biologic characteristics that determine the variable expression of these structures in the population groups evaluated.

There is controversy on the relation of laterality of the MUC. Taams et al. (1997) and Prates et al. (2003) did not find significant differences between sides, whereas our study found a right dominance, in agreement with the reports by Shu et al. (1999)

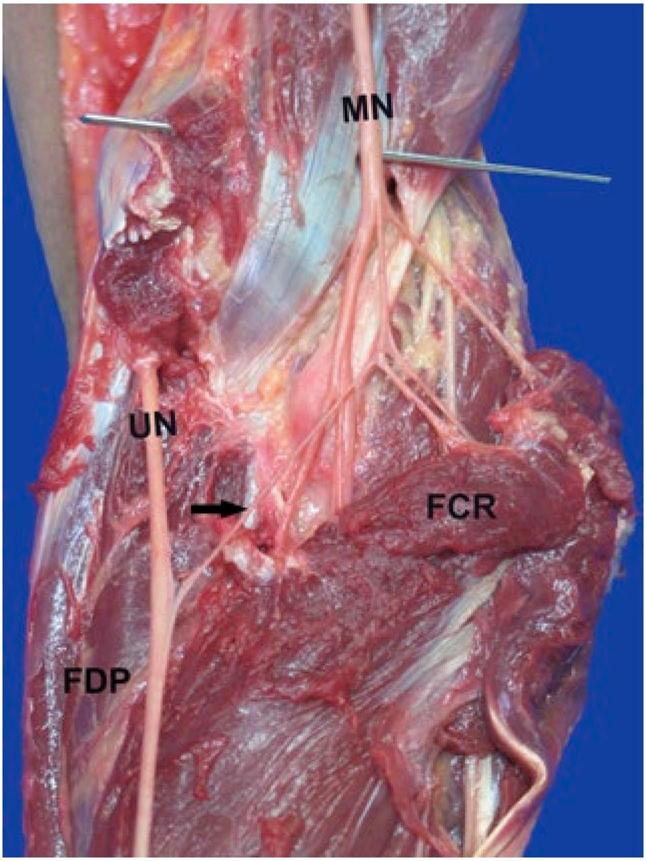

Figure 3 – Anterior view of the left forearm. Median-ulnar nerves communication type Ic. MN, Median nerve; UN, Ulnar nerve; AIN, Anterior interosseous nerve; Arrow, Communicating branch; SFF, Superficial forearm flexor muscles; FDP, Flexor digitorum profundus muscle; ME, Medial Epicondyle.

and other authors (Sarikcioglu et al., 2003; Prates et al., 2003 Kazakos et al., 2005; Felippe et al., 2012); Rodriguez- Niedenfur et al.(2002a).Some other authors (Almeida et al., 1999; Lee et al., 2005; Hodzic et al., 2011)reported a left dominance, whereas Kimura et al. (1976) reported a majority of bilateral cases (68%). There is consensus with respect to the lack of significant difference between genders (Taams, 1997; Erdem et al., 2002; Rodriguez-Niedenfur et al., 2002a; Prates et al., 2003; Kazakos et al., 2005; Lee et al., 2005).

Our findings are consistent with most previous studies reporting the presence of a single communicating branch (Srinivasan and Rhodes, 1981; Taams, 1997; Almeida et al., 1999;; Prates et al., 2003; Kazakos et al., 2005). The MUC type Ic between the anterior interousseous nerve and the ulnar nerve is reported with a high incidence in diverse population groups (Nakashima, 1993; Shu et al., 1999; Rodriguez-Niedenfur et al., 2002a; Kazakos et al., 2005; Lee et al., 2005).Our finding (46.4%) is in the mid-

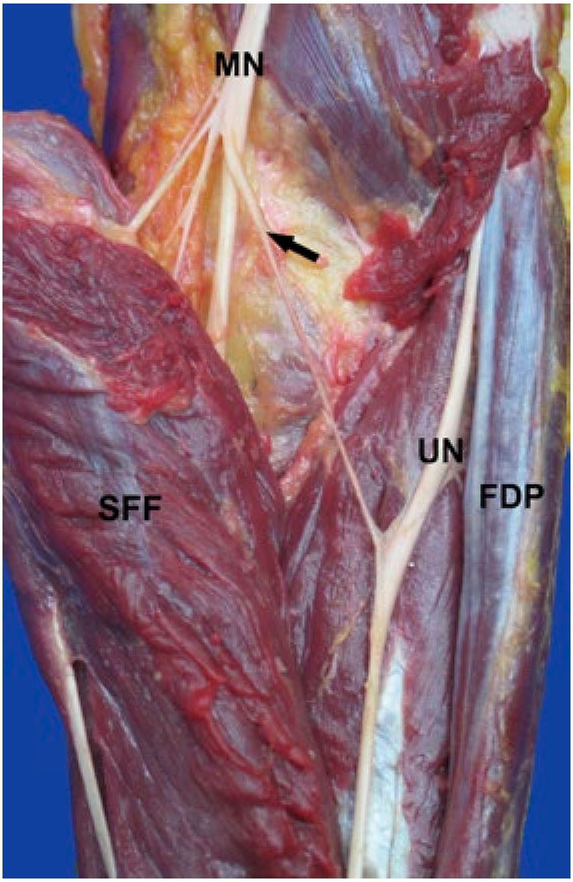

Figure 4 – Anterior view of the right cubital fossa. Median-ulnar nerves communication type Id. MN, Median nerve; UN, Ulnar nerve; AIN, Anterior interosseous nerve; Arrow, Communicating branch; FDP, Flexor digitorum profundus muscle; asterisks, Flexor digitorum profundus motor branch.

rank that has been reported to date in the literature. While type Ia was found in our series in 14.8% cases, it has not been reported in several papers (Nakashima, 1993; Almeida et al., 1999; Shu et al., 1999; Prates et al., 2003) (Table 1). The disagreement between different authors with respect to the anatomic categorization of the MUC is expressed in the inclusion in some classifications of the branches derived from the flexor digitorum profundus or the flexor digitorum sublimis muscles. Including the branch of the flexor digitorum profundus muscle as a site of origin for the communication generates controversy, because this is a branch of the anterior interosseous nerve and therefore it should be considered in the category that includes the origin of the MUC in anterior interosseous nerve (Lee et al., 2005). Our study, in agreement with some others (Almeida et al., 1999; Lee et al., 2005), has considered an additional type the communicating branch derived from the flexor digitorum profundus muscle because this connection originates from some of the motor branches for the flexor digitorum profundus muscle emitted by the anterior interosseous nerve, behaving as an independent structure that should be classified separately.

The MUC that emerges from the branch for the flexor muscles, originating in the medial epicondyle of the humerus, was found in 14.8% cases in our study and in a range of 6 - 47.3% in some other works (Srinivasan and Rhodes, 1981;Taams, 1997; Rodriguez-Niedenfur et al., 2002a); it should be taken into account in surgical nerve transfer procedures that use the flexor carpi radialis motor branch as donor to motor branches of the radial nerve for the management of wrist drop (Ray and Mackinnon, 2011). This procedure could result in iatrogenic lesions compromising the function of the intrinsic muscles innervated by ulnar nerve in the hand when the MUC is present.

The distances of the proximal and distal points of the MUC to the bi-epicondylar line found in our work (59.6 mm and 102.7 mm respectively) are in the upper rank of measures indicated in prior studies (Taams, 1997; Kazakos et al., 2005; Lee et al., 2005). Similarly, in our series with a length of the forearm of 269.8 mm, the most common location of the communicating branch was between the lower segment of the upper third and the upper segment of the mid third, slightly distal to the location described by most reports (Taams, 1997; Kazakos et al., 2005; Lee et al., 2005). Our measurement of the length of the communicating branch (56.9 mm) occupies the mid rank of the 25-74 mm range indicated in the few works conducting this particular morphometric evaluation (Taams, 1997; Rodriguez-Niedenfur et al., 2002a).

Knowledge of the existence of communicating branches should be taken into account for a correct clinical assessment of the upper extremity and in surgical approaches involving the upper and mid thirds of the forearm. Proximal injuries of the ulnar nerve could go unnoticed, because distal communication between these and the median nerve would enrich the fibers of the distal segment of the ulnar nerve; similarly, compression neuropathies of the communicating branch could differ clinically from what is described in classic texts that do not take into consideration the presence of the communicating branch, thus leading the examiner to confusion and to clinical mistakes (Brandsma et al., 1986; Shu et al., 1999; Rodriguez-Niedenfur et al., 2002a).

Some publications have analyzed the possible causes of the presence of the MUC, Crutchfield and Gutmann (1980) reported the relationship between genetic aspects and the presence of the communicating branch in members of the same family, which could suggest the influence of a hereditary factor of the autosomal dominant type. Srinivasan and Rhodes (1981) have also proposed a genetic influence on the incidence of the MUC, because the examination of fetuses with congenital defects has found that all fetuses with trisomy 21 present this anatomic variation bilaterally.

For the correct diagnosis of peripheral neuropathies of the upper extremity it is important to know the forms of presentation and topography of the MUC. These should be taken into account to differentiate a partial from a total injury of these nerve structures. On the other hand, the MUC can cause an alteration in the clinical signs, mainly in patients presenting simultaneously that communication and pronator syndrome, which may include changes in the pattern of innervation of the muscles and in the sensorial distribution of the hand, thus generating signs and symptoms that differ from those found in routine clinical practice (Shafic et al., 2009; Felippe et al., 2012). On the other hand, the presentation of MUC may be favourable in the presence of severe ulnar nerve entrapment at the elbow with limited compromise of intrinsic hand muscles that are innervated by ulnar nerve. In these cases, electrophysiological and ultrasonographic studies may be helpful for the correct diagnosis of these lesions (Cho et al., 2013).

Acknowledgements

We would like to recognize the National Institute of Forensic Medicine, Northeastern Colombian region, for supplying the anatomical pieces used in this study.

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