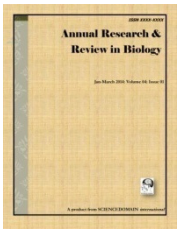

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Study of the Anatomical Variations of the Median Nerve in Human Fetuses

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Authors' contributions

This work was carried out in collaboration between all authors. Author FPR co-designed the study, managed the literature search and proof read the first draft manuscript. Authors ATSL and ATFB managed the analyses of the study. Author JAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Introduction: The median nerve is one of the most important terminal branches of the brachial plexus. Anatomical variations in the formation of the median nerve are common and have been reported by several authors.
Objective: The aim of this study was to analyze the anatomical variations of the median nerve in cadavers of human fetuses, from its origin to the formation of the median nerve.
Materials and Methods: Twenty-five fixed human fetuses (50 upper limbs) were dissected by planes with conventional technique and classic instrumentation.
Results: The frequency of variation in formation of the median nerve was 28%. The more frequent anatomical variations were: a communicant branch between the median and the

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musculocutaneous nerves (10%) and a lateral cord which gave rise to a couple of lateral branches to formation of the median nerve (8%).
Conclusions: Anatomical variations of the median nerve and its roots described in this study confirm the frequent occurrence of these variations in the brachial plexus neuroanatomy. An unusual variation during the formation of median nerve was also described. The significance of such variations are relevant to surgeons, anesthetists and clinicians in the management of surgical exploration of the axilla, in the clinical investigations and in the nerve blocks procedures of the brachial plexus.

Keywords: Brachial plexus; gross anatomy; median nerve; musculocutaneous nerve; anatomical variations; peripheral nerves.

1. INTRODUCTION

The median nerve (MN) is functionally one of the most important terminal branches of the brachial plexus [1]. It innervates the flexor muscles located in the anterior region of the forearm except the flexor carpi ulnar and the ulnar head of the flexor digitorum profundus. On hand, it innervates the external lumbricóides (I and II) and the muscles of the thenar eminence with the exception of the adductor pollicis and the deep head of the short flexor of the thumb. Its sensory innervation is limited to hand. [2,3]

The MN arises from the brachial plexus and is formed in the axilla by the union of a lateral root from the lateral cord (C5, C6) and a medial root from the medial cord (C8,T1). The two roots unite at the lower margin of the pectoralis minor muscle [1,3-5]. Behind of the pectoralis minor muscle, the lateral cord divides into two terminal branches: one, the musculocutaneous nerve (MCN), goes sideward; the other continues the course of this cord as lateral root of the MN.. The lateral cord often provides a contribution to the ulnar nerve, usually located behind the roots of the MN. The medial cord divides into two terminal branches: the ulnar nerve, posteromedial to the axillary artery; and the medial root of the MN, which goes anteriorly to the axillary artery to join with the lateral root and form the MN, lateral or anterolaterally to the axillary artery [2]. The MN gives no branch to innervate the muscles of the arm. [6]

Variations of the brachial plexus and its terminal branches are often described.[6,8,9]Anatomical variations in formation of the MN are common and have been reported by several authors.[3,4,6-20,23] Communication between the MCN and the MN nerve is the most common and frequent variation observed between the branches of brachial plexus. The presence of such anatomical variations of terminal branches of the brachial plexus has relevant neurophysiological, clinical and surgical implications [5,6,16-22,23-28]. On the other hand, evidences concerning bilateral variations in the MN formation are quite rare. [24]Other studies have also emphasized the syntopy variations of the MN related to axillary artery, [29-32], showing that the traditional view of the anatomy of MN is not always true [33].

The aim of this present study was to analyze the anatomical variations of MN in cadavers of human fetuses, from its origin to formation.

2. MATERIALS AND METHODS

We studied 50 brachial plexuses from 25 human male fetuses, whose cause of death was not available. At visual inspection fetuses had no gross congenital malformations and plexuses were apparently intact. All the fetuses were obtained from the laboratory of Anatomy of Tiradentes of the University and Federal University of Sergipe and were fixed in a solution offormalinto10%. The study was conducted according with the ethical standards of the Ethics in Research of the Federal University of Sergipe and approved under protocol Nº CAAE 1497.0.000.107.

The dissection was performed without the aid of optical instruments and followed the anatomical plans. The dissection was initiated by the anterior surface of the elbow joint, followed medially through the arm and shoulder area, to the origin of the brachial plexus in the cervical region. The median nerve was identified and a detailed observation of the fascicles of the brachial plexus as well as of the roots that formed the median nerve and the terminal branches of the brachial plexus was made. Each observed variation of the median nerve was identified, photographed and recorded, taking into account gender, level and side of the upper limb.

3. RESULTS

We found anatomical variations in the formation of the MN in 14 (28%) of the 50 dissected brachial plexus, distributed as follows: 8 to left and 6 to sided right limbs

The most common variations of the MN were: a communicant branch between the MN and the MCN in 5 (10%) of the plexus (Fig. 1); a lateral cord which gave rise to a couple of lateral branches to the formation of the MN in four (8%), (Fig. 2). In the latter case, two plexus belonged to the same fetus.

In six brachial plexus, one variation for each of them occurred. These variations were:

(1) The medial cord provided two medial roots to the MN, while the lateral root was formed by the anterior division of the middle trunk (Fig. 3);
(2) Each cord (medial and lateral) gave rise to two roots that were destined to the formation of MN, so that it was formed by four roots, two medial and two lateral;
(3) The MN gave rise to the MCN;
(4) The lateral root of the MN was formed by the anterior divisions of the middle trunk and the C8 root of the brachial plexus, respectively;
(5) The MN was formed by three roots: a lateral one, which was a direct continuation of the lateral cord; a medial one, which proceeded from the medial cord, and a third root emerging directly from the anterior division of the upper trunk of the brachial plexus (Fig. 4);
(6) The two roots of the MN originated from the medial cord and the axillary artery crossed the brachial plexus between these two roots. In one of the plexus there was a direct communication between the MN and the MCN (Fig. 5).

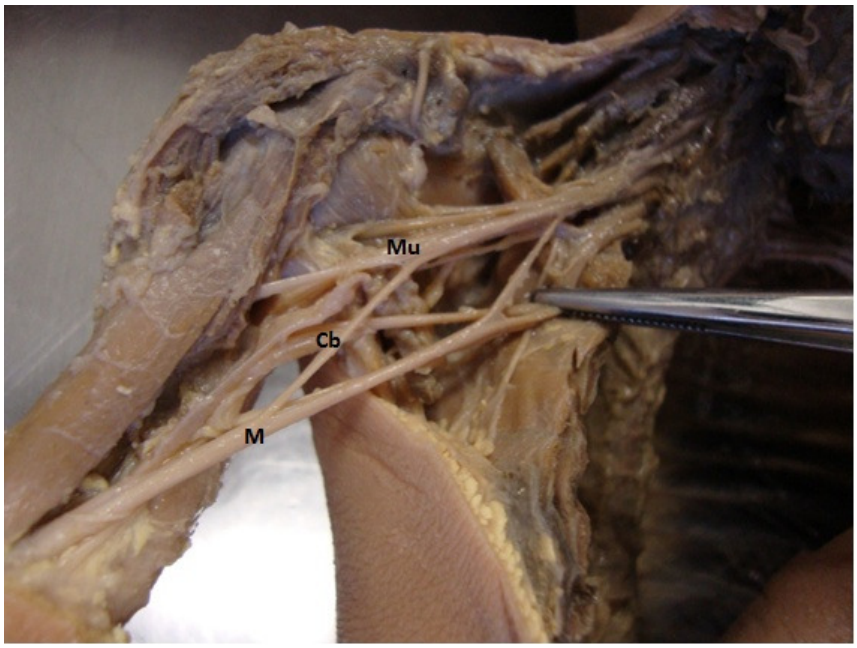

Fig. 1. Communicant branch (Cb) between the median (M) and the musculocutaneous (Mu) nerves

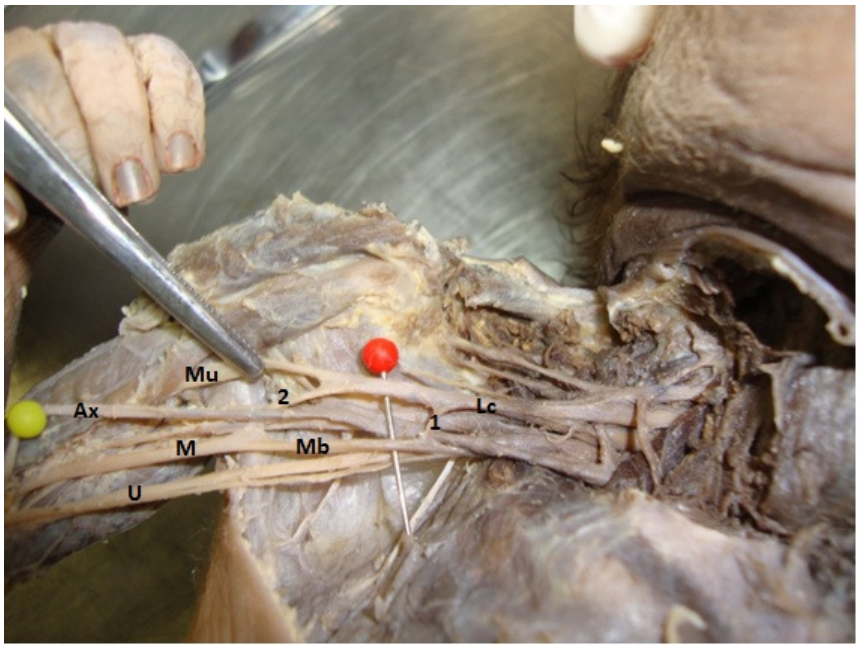

Fig. 2. The lateral cord (Lc) gave rise to two lateral branches (1 and 2) to the formation of the median nerve (M). Ax = Axillary artery; Mu = Musculocutaneous nerve; U = Ulnar nerve; Mb = Medial branch of the median nerve

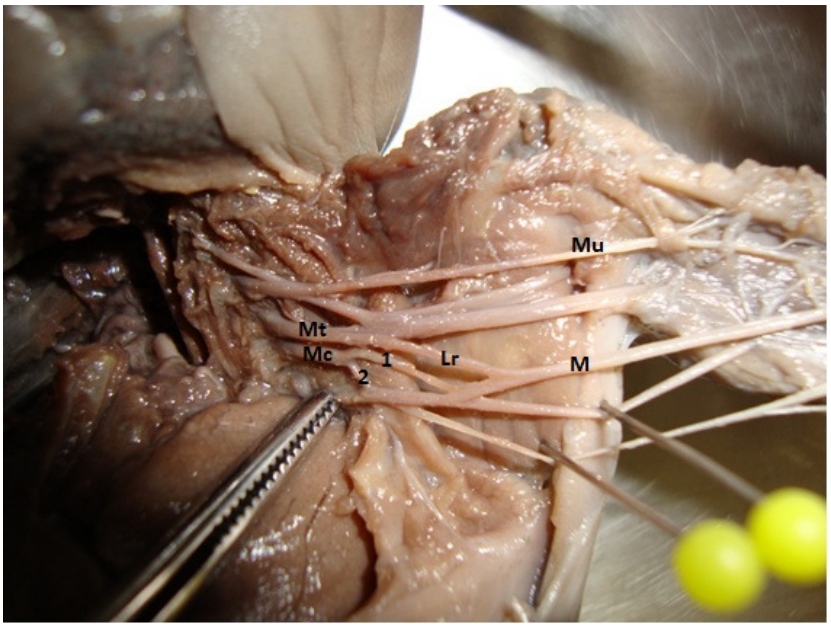

Fig. 3. The medial cord (Mc) provided two medial roots (1 and 2) to the median nerve (M), whereas the lateral root (Lr) was formed by the anterior division of the middle trunk (Mt). Mu = Musculocutaneous nerve

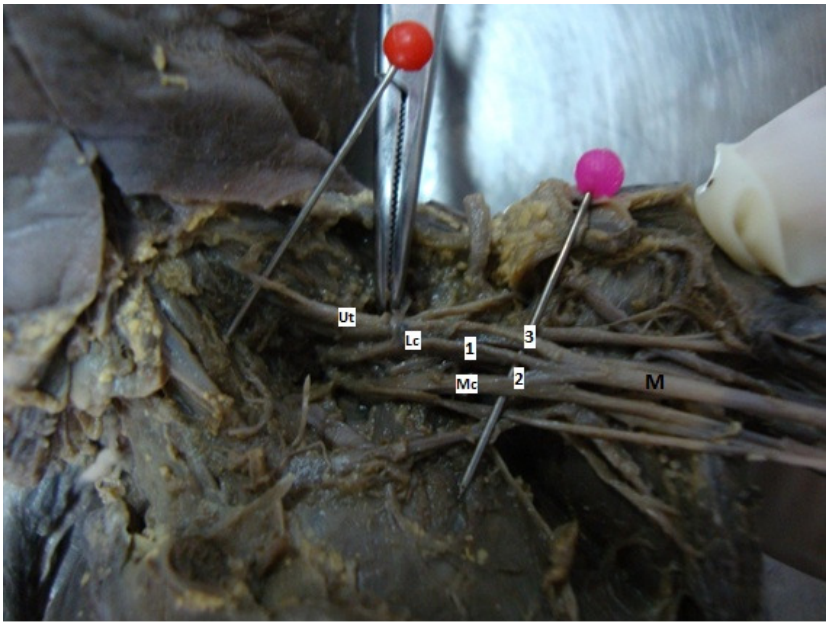

Fig. 4. Median nerve (M) formed by three roots: a lateral (1), which was a direct continuation of the lateral cord (Lc); a medial (2), which proceeded from the medial cord (Mc), and a third root (3) emerging directly from the anterior division of the upper trunk (Ut)

Fig. 5. Two roots (1 and 2) of the median (M) nerve originated from the medial cord; the axillary artery (Ax) crossing the plexus between these two roots; communication (C) between median and musculocutaneous (Mu) nerves

4. DISCUSSION

The communications between the MN and the MCN are the most common anatomical variations of the terminal branches of the brachial plexus.[23,25-28,34] Moreover, we emphasize the different formation of the median nerve and its topography related to the axillary artery and brachial artery, the biceps brachii and brachialis muscles as well as the level and the height of the arm .[6,13,25-27,30,35-38] Other investigations reported anatomical variations in the formation of the MN at 48.46%,[6]; 33.63%,[8]; 49.42%,[27], depening on the study. In the present study these variations occurred in 28% of cases. Although all our fetuses were male authors like [8,9,26,27] not have given significance to sexual dimorphism upon the occurrence of these anatomical variations of the MN. Kuar and Singla [26] found a slight predominance of the occurrence of communication between MN and the MCN, in the right limb. We found a similar finding.

Previous reports of Sawant et al. [28] and Kuar and Singla [26] showed an incidence of communication between the MN and the MCN of 30% and 11.7%, respectively. These studies have shown, according to the literature, a frequency of occurrence of such variation ranging from 1.4 to 63.5% and 1.4 to 33.3 respectively. Chitra [5] found the communication in 26% of cases, whereas Uysal et al. [39] in 10% and Aktan et al. [40], 10.4%. The occurrence of10% of communications between the MN and the MCN we found in this study seems close to the findings reported by Uysal et al. [39] and Aktan et al [40]. The MCN and the lateral root of the MN have in common the ventral branch of the spinal nerves that emerges from cervical roots (C5, C6, and C7). It can be hypothesized that this anatomical aspect could explain the occurrence of the communication between the MN and the MCN in approximately one third of the individuals.

In the current study, an occurrence of 12% of the NM formed by three branches has been found: in four dissected plexus (8%), the additional branch originated from the lateral cord; in one plexus (2%) from the medial cord; and in one (2%) from the anterior division of the middle trunk of the brachial plexus. Another plexus exhibited four of these branches: two originated from the lateral cord and two from medial cord. Some cases reported in literature described similar variations. Kouli et al. [24] and Das and Paul [4] described an additional lateral root in formation of the MN. Other studies found the presence of the additional lateral root in association with communication between the MN and the MCN within the same plexus [16,31,41,42]. In the present study, we found a similar association, Chauhan and Roy [13] described a third root that originated from the MCN, a finding that was not observed in the present cases.

In one plexus (2%), it was found the MCN as a division from the MN, instead of to originate from the lateral cord directly. This was also observed by Budhiraja et al. [6] in 11.2% of the upper extremities explored.

We did not find similar cases in the literature for the following variations: the lateral root of the MN originated from the anterior division of the middle trunk and the anterior division from the eighth cervical nerve root of the brachial plexus.

The anatomical variations of NM have been highlighted within the context of their clinical significance. In this sense we can emphasize its importance in preventing undesirable surgical outcomes [43]; clinical diagnosis [36]; orthopedic surgeries in the neck of the humerus and the MN lesions in the axilla or arm [28]; surgical exploration of the axilla and brachial plexus block [6]; traumatics shoulder injuries and especially in the dissection of axillary lymph nodes in cases of breast cancer [23].

5. CONCLUSION

The present study showed that communication between the MN and the MSN occurred only in 10% of dissected brachial plexus .Among the different possible anatomical variations of the MN, we observed an unusual one where the nerve roots had their origin from the medial anterior division of the middle trunk and the lateral of the eighth cervical roots of the brachial plexus. We highlight the significance of these variations for clinical diagnosis or surgical procedures in case of injury to the MN and MCN or during anesthetic procedures of the brachial plexus nerves.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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