Anatomic Variations of Brachial Plexus: A Cadaveric Study

Mohammad Sadegh Gholami Farashahi [1], Amir Hossein Mohammadi [1], Farid Abolhasani [1*]

1. Department of Anatomy, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.

Dr. Farid Abolhassani is Associate Professor at anatomy department of Tehran University of Medical Sciences. He received his B.Sc. in the field of Physiology and anatomy from Tehran University of Medical Sciences in 1987. Also, he completed his M.Sc. and Ph.D. degrees in the field of anatomical sciences at Tehran University of Medical Sciences in 1991 and 1996, respectively. Now, he teaches anatomy and embryology. His research fields are anatomy, embryology and reproductive medicine.

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ABSTRACT

Introduction: The brachial plexus is responsible for the innervation to the upper limb and some parts of the thorax. Variations in the branching of the brachial plexus are common and have been reported in 65.3% of the population. The variations (Atypical communication) of brachial plexus have significant clinical and surgical importance.

Methods: In this study 10 upper limbs which belonged to 5 adult human cadavers of known sex are used.

Results: In the present study, three cases (in two cadavers) of 10 cases (in five cadavers) have connections between the musculocutaneous and median nerve and seven cases are normal.

Conclusion: Knowledge about the connections between the musculocutaneous nerve and the median nerve could be very useful in surgical operations on the humerus bone and shoulder joint. So, the more information we could collect about these structures and their variations, the safer the surgical operations could be done.

1. Introduction

The brachial plexus is responsible for innervation of the upper limb and some parts of the thorax. Its roots consist of ventral rami of spinal nerves C5 to T1. Three main trunks are composed by joining these five roots together. Each one of these three trunks divides into posterior and anterior divisions.

These divisions give rise to medial, lateral and posterior cords. The axillary nerve and the radial nerve are branches of posterior cord. The medial cord gives rise to the ulnar nerve and the lateral cord gives rise to the musculocutaneous nerve (MCN). The median nerve (MN) is formed by contribution of the medial and the lateral cords together [1]. Variations (Atypical connections) in the branching of the brachial plexus are prevalent and have been reported in several literatures [2-9]. In 1955 buch Hansen declared that in 65.3% of people there are variations in structure of the brachial plexus [10].

Because of the close relationship that brachial plexus has with important anatomical structures such as axillary artery, variation in its structure has importance in clinical and surgical aspects [11]. Therefore, this study was carried out to collect more information about the brachial plexus variations. In this study we focused on communication between the MCN and the MN.

*** Corresponding Author:**
Farid Abolhassani, PhD
Address: Department of Anatomy, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.
Tel: +98 (21) 66419072
E-mail: Abolhasf@tums.ac.ir

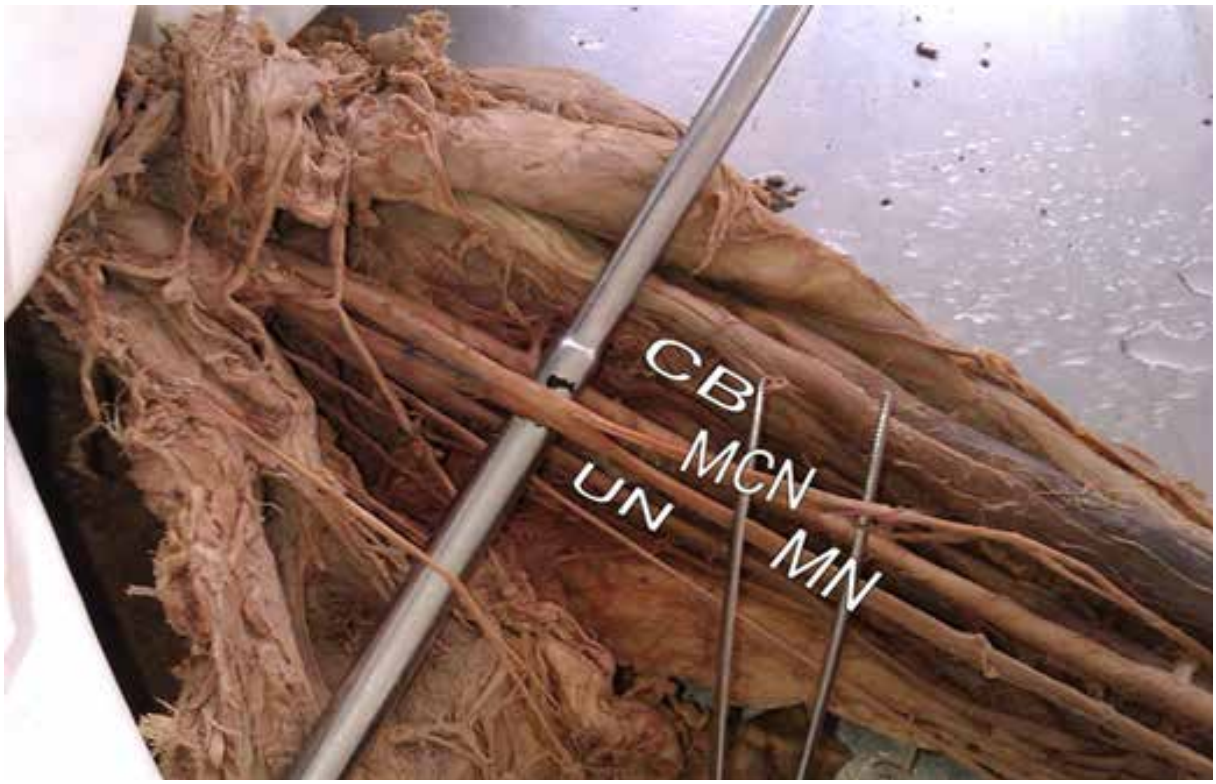

Figure 1. Brachial plexus of the first cadaver. This type of variation is seen on both sides of this cadaver. (MN: Median Nerve, MCN: Musculocutaneous Nerve, UN: Ulnar Nerve, CB: Coracobrachialis Muscle).

2. Material & Methods

The present study was performed at department of anatomy (School of medicine, Tehran University of Medical Sciences, Tehran, Iran). In this study, 10 upper limbs which belonged to five adult human cadavers of known sex were used. The brachial plexus in all upper limbs was dissected carefully.

Observations

Cadaver 1: This cadaver was female. In this cadaver, there was a bilateral variation in the brachial plexus. The MCN arises from the MN instead of the lateral cord of the brachial plexus, on the left side in distance of 75 mm and on the right side in distance of 66 mm away from the coracoid process. In the both sides, the MCN penetrates the coracobrachialis muscle (CB) in distance of 128 mm away from the coracoid process. In the both limbs, the fibers of MCN run with the fibers of the MN for 21 mm along their path. The MN was formed on the left side in distance of 54 mm and on the right side in distance of 45 mm away from the coracoid process. No other variations were seen in the path of the MN on both sides (Figure 1).

Cadaver 2: This was a male cadaver. The brachial plexus was normal on both sides. The MN was formed on the right side in distance of 45 mm and on the left side in distance of 45 mm away from the coracoid process. The MCN entered to the CB on the right side in distance of 83 mm and on the left side in distance of 105 mm away from the coracoid process.

Cadaver 3: This is a male cadaver. The brachial plexus was normal on both sides. The MN was formed on the right side in distance of 93 mm and on the left side in distance of 98 mm away from the coracoid process. The MCN entered to the CB on the right side in distance of 135 mm and on the left side in distance of 40 mm away from the coracoid process.

Cadaver 4: This cadaver was male. This cadaver had a unilateral variation on the left side. The present variation was seen in the left upper limb of the cadaver. In the left axillary fossa, the first root of the medial cord and the second root of the lateral cord were normal and joined together to form the main trunk of the MN in distance of 55 mm away from the coracoid process. The third root of the MN which was carried by the MCN leaves the MCN in distance of 30 mm before the CB, but instead of joining the MN, it entered into the CB and then came out of it and joins

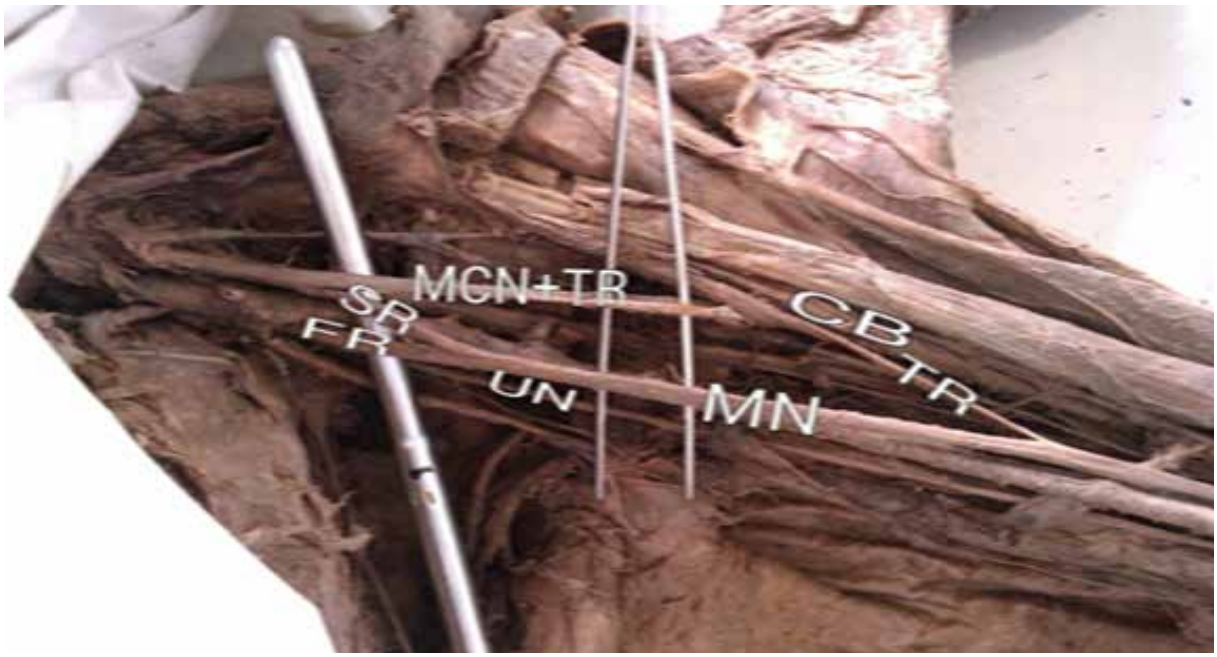

Figure 2. Brachial plexus of the fourth cadaver. In this cadaver the median nerve is formed with contribution of three roots. (MN: Median Nerve, MCN: Musculocutaneous Nerve, UN: Ulnar Nerve, CB: Coracobrachialis Muscle, FR: First Root, SR: Second Root, TR: Third Root).

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the MN in the middle of the arm. The rest of the Median nerve's path is normal. The brachial plexus on the right side is normal and has no variations. The MN was formed in distance of 50 mm away from the coracoid process and the MCN enters to the CB in distance of 65 mm away from the coracoid process (Figure 2).

Cadaver 5: This cadaver was male. The brachial plexus was normal on both sides. The MN was formed on the right side in distance of 55 mm and on the left side in distance of 40 mm away from the coracoid process. The MCN entered into the CB on the right side in distance 95 mm and on the left side in distance of 45 mm away from the coracoid process.

3. Results

In the present study, the MN was formed in different distances away from the coracoid process. In three out of 10 cases, communication between the MCN and the MN was seen and the rest of them are normal. The MCN pierces the CB in different distances away from the coracoid process. In 1990, Le Minor categorized communications between the MCN and the MN in five types: Type 1: No connections between the MCN and MN. Type 2: Some fibers of the medial root join the MCN and after a certain distance, leave it to join the trunk of MN. Type 3: Some fibers of the lateral root of MN join with the MCN and after a certain distance, leave it to join the trunk of the MN. Type 4: All fibers of the lateral root of MN and MCN unite with each other and then the MCN leaves the MN after a distance. Type 5: There is no MCN separately. The MN contains the MCN fibers [12].

In this study, both sides in the first were in type 4, one side in the fourth cadaver was type 3 and seven cases in the second, third, fourth cadavers were type 1.

Connections between the fibers of MCN and MN have been the most frequent in all the variations that have been reported about the structure of the brachial plexus [13]. Fibers of the MN were companied by the MCN and after a short distance, leave the MCN to join the main trunk (14).

Information about the connections between the MCN and the MN could be very useful in relation to surgical operations of the humerus bone and shoulder joint [15]. During the surgeries of shoulder region, the MCN must be identified and kept safe from probable injuries that could occur by pressure of the retractors which the surgeon places under the coracoid process. The muscles could get injured as well as the nerves in dislocation of the shoulder joint, grafting of the coracoid process and also arthroscopies [16].

To block the nerves of brachial plexus, the anesthetists need to have proper knowledge of such variations so they can block the specific nerve properly. Orthopedic surgeons also must be aware of such variations to prevent nerve injuries in routine and reconstructive operations of the arm. Because of the close relationship that the lateral root of MN

has with the axillary artery, compression of the axillary artery by the MN in certain postural maneuvers of the shoulder joint may lead to arterial blood insufficiency as well as the ischemic pain [17].

In the 5th week of embryonic life (days 28 to 35), the motor axons reach the base of developing limb buds [18]. By merging, these axons with each other, growth cones are formed. Growth cones form the brachial plexus in upper limb. Creation and forming of growth cones is regulated by chemoattractants and chemorepulsants in a certain gap [19]. Indeed, this stage is an argumentative reason for different variations of the brachial plexus.

4. Discussion

In this study the MN was formed in different distances away from the coracoid process, and also the MCN pierces the CB in different distances away from the coracoid process. Therefore this kind of studies are essential and could be very useful for orthopedician, Neurosurgeons, anesthetists, radiologists, general surgeons, nurses and etc. In items such as surgical operations of the humerus bone and shoulder joint, nerve blocking, plastic repair operations, diagnosing and treating post traumatic peripheral neuropathies, these structures must be identified and protected from probable injuries, so collecting information about these structures and their variations in different populations is essential.

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