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Anatomical variation of a trifid (trifurcation) lateral root origin of the median nerve

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Anatomic variations of the brachial plexus are common. Awareness of these variations is of paramount importance in clinical practice mainly in achieving best results in minimal invasive or surgical procedures. The aim of our study was to depict a case of a trifid lateral root origin of the medial nerve. This anatomical variation in the brachial plexus was encountered after dissection in upper extremities in a 90-year-old male cadaver. (Folia Morphol 2020; 79, 4: 860–862)

Key words: anatomical variations, median nerve, brachial plexus

INTRODUCTION

Anatomical variations in nerves' course and formation are quite common, especially those of the brachial plexus. It is remarkable that even half of anatomical variations in neural structures that have been described in human cadavers, arise from the brachial plexus and might be attributed to embryological development [9].

Deep knowledge of these variations is crucial in clinical practice especially for surgeons and anaesthesiologists, to avoid a neural injury or damage. For instance, this may occur in radical neck dissection and other surgical operations of the axilla or the upper arm. The results of an injury can cause severe motor and sensory complications [8].

The brachial plexus supplies either motor or sensory innervation to the upper limb. Normally it is formed by the ventral rami of C5 to C8 and Tl. The plexus arises in the neck and then crosses inferiorly over rib I. Afterwards, it enters the axillary cavity.

The median nerve (MN) arises, as known, from the plexus brachialis and is normally formed by two roots; a lateral (Lr) from the outer cord and a medial (Mr) one from the inner cord of the plexus brachialis. It receives filaments from the lower three cervical nerves as well as the first dorsal nerve. The Lr and Mr unite in a "V"-shaped formation that embraces the lower or third part of the axillary artery, to form the MN [14].

The aim of our study was to depict an anatomical variation of trifid lateral root origin of the MN. These findings were observed after dissection of a cadaver at the Department of Anatomy, School of Medicine, in National and Kapodistrian University of Athens, Greece.

MATERIALS AND METHODS

Four cadavers, of which two were males and two females, were dissected in the dissection room of the Department of Anatomy of the National and Kapodistrian University of Athens. Thiel solution was used for the embalmment and the cadavers remained then in the refrigerators (–16/–18°C) for an average 4-months interval prior to dissection.

After dissection of the upper limb for medical undergraduate students, a variation of the MN nerve was found in the right upper limb of a 94-year-old male cadaver in the Department of Anatomy, School of Medicine, in the National and Kapodistrian University of Athens Greece.

This cadaver was fixed in 10% formalin and had a medical history of septic shock. As reported, no surgical or traumatic lesions to the right upper limb

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Figure 1. Cadaveric dissection showing a trifid median nerve arising from brachial plexus; AA — axillary artery; AV — axillary vein; CB — coracobrachialis muscle; Lr1, Lr2, Lr3 — roots of median nerve; UN — ulnar nerve; MC — musculocutaneous nerve; RN — radial nerve.

were found. The anatomical specimen of the axillary region was properly cleaned.

Our dissection protocol was in accordance with Cunningham's manual [5] of practical anatomy. Both upper limbs on the right and left sides were meticulously dissected.

In this case report, the right side was found to have an anatomical variation. Finally, photographs were taken in order to depict the anatomical variation (Fig. 1).

RESULTS

During the dissection of the cadaver referred, we found a MN formed anterior-laterally of the axillary artery (the normal position) by a normal Mr and a trifid Lr. The first/outer branch of the Lr (Lr1) is the most sizeable of the three, while the inner one (Lr3) is the thinnest and resembles a precocious communicating branch between the two roots which form finally the MN (Fig. 1). This finding was observed unilaterally, *id est* only in the dexter axillary of the cadaver.

The course of the formed MN in the arm, forearm and carpal tunnel was found normal as well as its distribution in the forearm and palm. Also, the anterior interosseous nerve was cleaned and found normal. The formation, course and distribution of the rest final nerves of the right brachial plexus were found without any deviation of the normal pattern. No irregularity was identified during the dissection in the course and branches of neither the axillary, nor the brachial artery.

DISCUSSION

Cases of MN formation by more than two roots are less usual in comparison with cases of communication branches between the MC and the MN or its Lr. There also exists an embryological background of such abnormities' cause. Precisely, the upper limb buds are formed opposite to lower cervical and upper thoracic segments (C5–T2). However, it has been reported that incomplete contact of ventral primary rami of spinal nerves that enter the mesodermal buds, might lead to anatomical variations, either of the brachial plexus nerves or the MN. In addition, trophic agents that enter the circulation may be the reason of developmental anomalies or anatomical variations of peripheral nerves. A growth cone is formed at the top of axon growing to target tissue by providing molecules that are secreted by surrounding tissue. Uncontrolled expression of molecules such as N-CAM, L1 and cadherins act as transcriptional factors. Finally, these molecules and components of the extracellular matrix might have as a potential result irregular development of neural structures [2, 4].

Although there are many anatomical articles published referring to the plexus brachialis and especially the MN and variations related to its origin and course, not as much have been written for the unique type of formation, described above. The described cases of an anastomotic branch between the musculocutaneous nerve (MCN) either the MN or its Lr, and an existence of a trifid Lr or a four-root MN formation is comparatively less common. Satyanarayana et al. [12] reported in 2009 a similar case.

Such anatomical variations in the formation of the MCN and its communicating branches have been described by Le Minor in 1992. Five types of variations have been reported between the MCN and the median nerve [10].

— **type I**: no communication between the MCN and the MN The MCN penetrates the coracobrachialis muscle, as normally and divides into three branches to innervate the coracobrachialis, biceps and brachialis muscles;

— **type II**: fibres of the lateral and medial root of the MN pass through the MCN and join to the MN distally the coracobrachialis muscle;
— **type III**: the MCN arises from the lateral cord and after some distance provides communicating fibres to connect with the MN that is formed by the medial cord;
— **type IV**: fibres of the MCN and the lateral root of the MN merge together. MCN stems from the MN and then divides into branches to innervate the biceps, coracobrachialis and brachialis muscles.

Various publications report, the presence of additional root in the formation of MN [1, 6, 15]. The incidence of formation of MN by two lateral roots and one medial root has been described by Sharmila et al. [13]. Three roots forming the MN was the most frequent anatomic variation that was reported in about 36.4% (8) in left upper limb and 18.2% in right one by Mat Taib et al. [8]. MN may also be formed by four routs. Our finding is also in accordance with Budhiraja et al. [3] who found two types of variation: median nerve formed by three roots and four roots in 22.4% (44/196) and 3.57% (7/196), respectively. The median nerve was formed by two lateral roots from lateral cord and one medial root from the medial cord in six cadavers by Emamhadi et al. [7]. Sargon et al. [11] reported the formation of the median nerve by three roots in that one of the lateral cord roots was located with a very close course over the axillary artery.

It should be noted that this type of variation might increase the risk of median nerve injury in surgical operations of the axilla and may lessen the blood supply of the upper extremity by compressing the vessel due to the very close course of the second lateral root of the median nerve to the axillary artery.

CONCLUSIONS

Anatomical variations of the formation of the brachial plexus nerves and especially of the MN should be identified and recorded in order to advance the practice of medicine and the science of anatomy as well. Such variations as the one depicted, are of great significance and have a clinical or surgical impact. Anaesthesiologists that perform axillary block or surgeons that operate in the arm or the axillary cavity may cause unintentional injury to the MN. This may lead to paralysis of the anterior compartment muscles of arm (biceps brachii, brachialis, and coracobrachialis), motor disability of the elbow joint (flexion) and sensory deficiency in the lateral compartment of the forearm [16].

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