Original Article

Indian Journal of Anatomy
Volume 6 Number 2, April - June 2017
DOI: http://dx.doi.org/10.21088/ija.2320.0022.6217.4

Study of Variations of Median Nerve in the Arm: Its Embryological and Clinical Correlation

Rohini M.*, Prajakta Kishve**

Abstract

Musculocutaneous nerve is the nerve of front of arm. It is one of the terminal branches of lateral cord of brachial plexus.This nerve is responsible for innervation of flexor compartment of arm and for cutaneous innervation on lateral surface of forearm. Median nerve is formed by the union of lateral and medial roots respectively arising from lateral and medial cords. Median nerve does not give any branch in the arm. The aim of this study is to find out the prevalence of variations of the median nerve in the arm with respect to its branching pattern and distribution as well as its possible communication with the musculocutaneous nerve. 30 arms pertaining to 15 preserved human cadavers, ranging in age from 35 to 70 years, were dissected in anatomy dissection hall in a private medical college. In two limbs out of 30 (6.7%) the lateral root of median nerve gave off muscular branches to the coracobrachialis, brachialis as well as biceps brachii muscle. The trunk of median nerve gave lateral cutaneous nerve of forearm which is usually a continuation of musculocutaneous nerve. Concomitantly the musculocutaneous nerve was absent. Knowledge of such anatomical variations is of interest to the anatomists and clinicians. These observations should be considered when a high median nerve paralysis is shown to originate in the axilla or proximal arm in a patient presenting with weakness of forearm flexion and supination. Similarly, it can explain weakness of the arm flexor muscles in thoracic outlet syndrome with median nerve affection.

Keywords: Brachial Plexus; Lateral Cord; Median Nerve; Musculocutaneous Nerve; Variations.

Introduction

Variations in the distribution of peripheral nerves constitute a potentially important clinical and surgical issue. The median nerve (MN) is formed anterior or anterolateral to axillary artery by the union of its two roots. The lateral root of MN is the largest branch of the lateral cord of brachial plexus (BP)(C5,6,7) while the medial root arises from the medial cord (C8,T1) and crosses in front of the axillary artery (AA) to join the lateral root. After joining of both roots the MN descends anterior to the AA and upper part of brachial artery (BA) to reach the medial aspect of BA in the distal half of the arm. It gives off vascular branches to the BA and usually a branch to pronator teres, a variable distance proximal to the elbow joint [1].

The musculocutaneous nerve (MCN) arises from the lateral cord (C5–7), opposite the lower border of pectoralis minor. It pierces coracobrachialis (CB) and descends laterally between biceps brachii (BB) and brachialis (BR) to the lateral side of the arm. Just below the elbow it pierces the deep fascia lateral to the tendon of BB, and continues as the lateral cutaneous nerve of the forearm (LCNF). Its absence has been described previously but its real prevalence is unknown [2].

Variations of the peripheral nerves and their abnormal communications are a clinically important consideration. Patnaik et al [3] reported that the anterolateral surgical approach to the humerus described by Henry [4] was superior to the posterior

Author's Affiliation: *Assistant Professor, Department of Anatomy, MNR Medical College and Hospital, Sangareddy (Telangana), India. **Professor and Head, Department of Anatomy, Maheshwara Medical College and Hospital, Chitkul, Patancheru (Telangana), India.

Corresponding Author: Rohini Motwani, Assistant Professor, Department of Anatomy, MNR Medical College and Hospital, Sangareddy, Telangana 502285.
E-mail: rohinimotwani@gmail.com

Received | 23.01.2017, **Accepted** | 30.01.2017

approach described by Berger and Backwalter.[5] Thus a thorough knowledge of the possible variations of the MN and MCN, both branches of the BP, can be of the utmost importance in routine surgery where such branches can be injured.

The main aim of this study is to know the anatomical variations of the MNin arm with special reference to its branches, distribution and possible communications with other nerves, namely the musculocutaneous and / or ulnar nerves (UN) in the arms of preserved human cadavers.

Materials and Methods

Thirty arms pertaining to 15 preserved human cadavers, ranging in age from 35 to 70 years, were dissected in anatomy dissection hall in a private medical college during undergraduate teaching.The cadavers were embalmed using 4% formaldehyde solution and preserved in weak formalin. The axilla and arm regions of both the upper limbs were dissected according to the guidelines of Cunningham's manual. The MN was studied with reference to its abnormal branches, distribution and communication with other nerves especially the MCN and / or UN. Variations found were photographed.

Results

During dissection of front of the right arm of 60 years old male cadaver we observed MN giving muscular branches to the muscles of the front of the arm.A branch was seen to arise wqfrom the lateral root of the median nerve (LRMN) at about 6cmsproximal to the union of the two roots of the MN and 8 cms distal to the acromion process.This branch was divided into two branches and was piercing the CB muscle to supply it (Figure.1).A second branch arose from the LRMN 10 cms distal to the acromion process. It passed downwards and laterally deep to the BB muscle entered the muscle belly 14 cms distal to the acromian process. Third branch arose from the trunk of the median nerve (TMN) 16 cms distal to the acromian process.It passed downwards and laterally between the BB and BR muscles, divided into 2 branches and entered the BR muscle (Branch to Brachialis: BBR) about 18 cms distal to the acromian process. Another branch arose from the TMN in common with BBR which passed downwards and laterally in between BB and BR and pierced deep fascia 2 cms proximal to the lateral epicondyle of the humerus and continued as LCNF. After giving these branches MN was running in between BB and BR, then medial to tendon of BB and entered cubital fossa (Figure.1). The MCN was absent.There was no any variation in the left arm of the cadaver and there were no vascular anomalies on either side.

In a 70 years old female cadaver, another variation of branching pattern of MN was observed in left arm.A

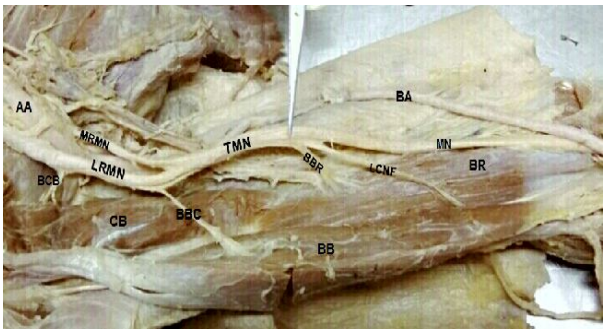

Fig. 1: A photograph of the anterior aspect of the right arm in an adult human cadaver. The biceps brachii muscle (BB) is reflected laterally. AA: Axillary artery, BR: Brachialis, MN: Median nerve, MRMN: Medial root of median nerve, LRMN: Lateral root of median nerve, TMN: Trunk of median nerve, BCB: Branch to coracobrachialis, BBC: Branch to biceps brachii, BBR: Branch to brachialis, LCNF: Lateral cutaneous nerve of forearm.

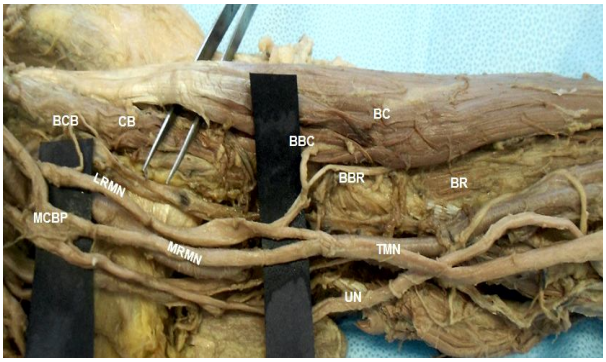

Fig. 2: A photograph of the anterior aspect of the left arm in an adult human cadaver. MCBP: Medial cord of brachial plexus, UN: Ulnar nerve, BR: Brachialis, MN: Median nerve, MRMN: Medial root of median nerve, LRMN: Lateral root of median nerve, TMN: Trunk of median nerve, BCB: Branch to coracobrachialis, BBC: Branch to biceps brachii, BBR: Branch to brachialis.

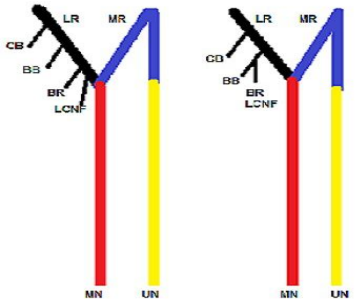

Fig. 3 (A,B): Diagrammatic illustration of median nerve (MN) variation in present study.LR: Lateral Root of median nerve, MR: Medial root of median nerve, CB: Nerve to coracobrachialis, BB; Nerve to Biceps brachii, BR: Nerve to brachialis, LCNF: Lateral cutaneous nerve of forearm.

branch was seen to arise from the LRMN at about 8cmsproximal to the union of the two roots of the MN and 8 cms distal to the acromion process. This branch was running upwards and laterally and piercing the CB muscle to supply it (Figure 2). A second branch arose from the LRMN 14 cms distal to the acromion process or just proximal to the union of two roots of the MN. It passed downwards and laterally and divided into two branches. One was piercing the BB muscle and another one entered the arm deep to the BB muscle, then in between BB and BR to supply the BR muscle and then continued as LCNF (Figure 2). There was no any branch arising from the TMN in the arm. The MCN was absent. The right arm of the cadaver was without any variation and there were no vascular anomalies on either side. No any communicating branches observed in any arm.

The knowledge of the variations of the course and distribution of the lateral cord of brachial plexus is important while performing neurotization of brachial plexus lesions, shoulder arthroscopy by anterior glenohumeral portal and shoulder reconstructive surgery so that these structures can be identified and protected [6].

Further medical concerns related with these variations include, anaesthetic blocks, surgical approaches, interpreting tumour or traumatic nerve compressions having unexplained clinical symptoms. There is also possibility of injury to the muscular branches of MN in arm by surgeons as usually it does not give branches in the arm. Surgeons who perform procedures involving neoplasm or repairing trauma need to be aware of these variations

Discussion

Anatomical variations of the nerves should be of concern to the clinicians while performing some procedures. In our study we found variation of median nerve of arm in two limbs out of 30 (6.7%). In the past many variations have been described regarding the course of MCN and MN. Le Minor (1992) described five types of variations [7]:

- Type 1: there are no communicating fibres between the musculocutaneous and the median nerves. The musculocutaneous nerve pierces the coracobrachialis muscle and innervates the coracobrachialis, biceps brachii and brachialis muscles.
- Type 2: although some fibres of the medial root of the median nerve unite with the lateral root of the median nerve to form the median nerve, some leave to run within the musculocutaneous nerve and after some distance leave it to join their proper trunk.
- Type 3: the lateral root of the median nerve runs into the musculocutaneous nerve and, after some distance, leaves it to join its proper trunk.
- Type 4: the fibres of the musculocutaneous nerve unite with the lateral root of the median nerve and, after some distance, emanate from the median nerve.
- Type 5: the musculocutaneous nerve is absent. Its fibres run within the median nerve along its course. In the study conducted by Kerr [8] on 75 brachial plexuses, the Type 5 variation was found in 3 cases (1.7%). However, a communicating branch between the two nerves was observed in 18 cases (24%).

Venieratos and Anagnostopoulou (1998) [9] also described three different types of communication between Musculocutaneous and Median nerve in relation to Coracobrachialis

Type 1: Communication between Musculocutaneous and Median nerve is proximal to the entrance of Musculocutaneous into Coracobrachialis.

Type 2: Communication between the two nerves is distal to the muscle.

Type 3: Neither the nerve nor its communicating branch pierced the muscle.

In our study type 5 variation is observed according to Lee Minor's classification, the MCN was absent and muscular branches in front of the arm were arising from MN in 2 out of 30 limbs (6.7%). No any communicating branches observed in the present case study (Figure 3 A,B). So our study did not coincide with any of Venieratos's classification. Nakataniet al. [10] observed absence of the musculocutaneous nerve with innervation of the coracobrachialis, biceps brachii and brachialis muscles and the lateral border of the forearm by branches from the lateral cord of the brachial plexus. Although variations reported in the present study conformed to Type 5, the coracobrachialis muscle was supplied by a branch from the lateral cord of the brachial plexus and not from the median nerve. Ihunwoet al. [11] reported absence of the musculocutaneous nerve bilaterally in a male cadaver where the flexors of the arm were suppliedby branches from the median nerve. Similarly, Gumusburun and Adiguzel [12] reported bilateral absence of the musculocutaneous nerve in a 72-year-old female cadaver where the median nerve supplied the biceps brachii and brachialis muscles and also gave off the lateral cutaneous nerve of the

forearm. Sud and Sharma [13] reported a case of absence of the musculocutaneous nerve with innervation of the coracobrachialis and biceps brachii via the median nerve. The lateral cutaneous nerve of the forearm originated from the median nerve and gave off a muscular branch to the brachialis muscle. Prasada and Chaudhary [14] reported two cases of absence of the musculocutaneous nerve out of 24 upper limbs dissected (8%). The median nerve took over the area of supply of the musculocutaneous nerve by giving off both muscular and sensory branches. Knowledge of such variation has clinical importance especially in post-traumatic evaluations and peripheral nerve repair.

Embryological Correlation

These variations can be explained embryologically. The upper limb buds lie opposite to the lower five cervical and upper two thoracic segments. As soon as buds form, the ventral primary rami of the spinal nerves penetrate into the mesenchyme of limb bud and establish intimate contact with differentiating mesodermal condensations. The early contact between nerve and muscle cell is a prerequisite for their complete functional differentiation [15,16]. The variations could arise from circulatory factors at the time of fusion of brachial plexus cord. In human, the forelimb muscles develop from the mesenchyme of the para-axial mesoderm during fifth week of embryonic life [16]. The axon of spinal nerve grows distally to reach the limb bud mesenchyme. The peripheral process of the motor and sensory neurons grows in the mesenchyme in different directions. Once formed, any developmental differences would obviously persist post-natally [16]. As the guidance of the developing axons is regulated by expression of chemo-attractants and chemo-repellants in a highly coordinated site specific fashion, any alteration in signaling between mesenchymal cells and neuronal growth cones can lead to significant variations [17].

Conclusions

Knowledge of such anatomical variations is of interest to the anatomist and clinicians. These observations should be considered when a high median nerve paralysis is shown to originate in the axilla or proximal arm in a patient presenting with weakness of forearm flexion and supination. Similarly, it can explain weakness of the arm flexor muscles in thoracic outlet syndrome with median nerve affection.

There is also possibility of injury to the muscular branches of median nerve in arm by surgeons as usually median nerve does not give branches in arm.Surgeons who perform procedures involving neoplasm or repairing trauma need to be aware of these variations.

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