Anatomical study of Variations of Median Nerve and Musculocutaneous Nerve in the Arm

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Abstract

Background: The variations related to the median nerve and musculocutaneous nerve are relatively less common. The variations may have potential clinical implications especially during surgeries and nerve blocks.

Materials and Method: The routine dissection of 50 adult cadavers including 42 males and 8 females in the Department of Anatomy during undergraduate training was carried out to detect the variations in the structure, formation and relation of Median nerve and musculocutaneous nerve.

Results and Findings: There was a variation observed in the formation of median nerve in three adult cadavers. In three male cadaver, there was unilateral variation in the formation of the median nerve by more than two roots . However, in each of these cadavers the distribution of the median nerve was normal in arm, forearm and palm. There was normal pattern of formation, relation and course of Median nerve in rest of the cadavers. Absence of musculocutaneous nerve, and nerve not piercing coracobrachialis, and communication between median and musculocutaneous nerve was found. Photographs of abnormalities were taken for proper documentation of the variations.

Conclusion: These variations have been explained by some embryological flats available. These variations of formation of median nerve are clinically important for physicians, surgeons and anesthetists because symptoms of median nerve compression due to these variations are often confused with radiculopathy and carpal tunnel syndrome. The knowledge of variations of musculocutaneous nerve is important to the surgeons and anesthetists’ for carrying out surgical procedures and nerve blocks in axilla and arm.

Key Words: Median nerve, Musculocutaneous nerve, Brachial plexus variations.

Introduction

The median nerve is formed by the union of medial root from medial cord( C8, T1) and lateral root from lateral cord(C5-C7) of brachial plexus anterior or lateral to the third part of Axillary artery.

In the arm the nerve passes at first lateral to brachial artery crosses to the medial side from front of it descending down to the cubital fossa. No branches of median nerve are found in the arm.11

Similarly Musculocutaneous nerve is a branch of lateral cord pierce the coracobrachialis and gives branches which supplies all the muscles of arm.

In close to the cubital fossa, it lies lateral to the biceps tendon and anteriorly to the brachialis muscle that becomes known as the lateral antebraclial cutaneous nerve (or the lateral cutaneous nerve of forearm) which supplies common sense of the skin in anterolateral region of the forearms as far distally as the base of the thenar eminence1.
The MCN entrapment is rare. It can occur due to an inadequate positioning of the arm during sleep because the CbM and BM act as anchor points for MCN. If this situation coexists with a communicating branch where a part of MN passes through CbM, the clinical signs could be similar to those found in MN neuropathy in the hand. The diagnosis of MCN-MN communication in this clinical presentation by electromyographic methods could prevent unnecessary releases of the carpal tunnel.

The knowledge of anatomical variations of these nerves is important as these nerves could be injured during surgical procedures and because variation may explain unusual clinical symptoms.7

The present study is aimed at assessing the variations of median and musculocutaneous nerves in the arm and their clinical correlations.

Materials and Method

The present study was conducted on 50 limb (42 male and 8 female) specimen during routine dissection for MBBS students. The Axilla and Arm were dissected in the anatomy department of the JSS Medical College, Mysuru, India, over a period of 2 years. The cadavers were embalmed and preserved in a weak formalin solution. The infraclavicular part of the brachial plexus was dissected according to the guidelines of the Cunningham’s manual of Practical Anatomy. During the dissection, the variations of Median nerve, Musculocutaneous nerve in the arm were noted, the normal pattern, as well as variations from the normal pattern, were noted and photographed. The number of the variations was noted and the result was tabulated using a regular statistics method. Any variations from normal was noted and tabulated (►Table 1).

Results

1) Formation of the median nerve by three roots was seen in 1 out of 50 specimen. Out of the three roots of median nerve, two roots was given by the lateral cord of the brachial plexus and one root was given by the medial cord of brachial plexus as seen in ►Figure 1.

2) Absence of the musculocutaneous nerve was seen in 1 out of 50 specimen. In the absence of the musculocutaneous nerve, the muscles of the anterior compartment of the arm were innervated by the branch coming from median nerve as seen in ►Figure 2. This variation comes under type v as described by Li Minor (1990).
3) Communication between the median and the musculocutaneous nerves was seen in 2 specimens out of 50. The communication was in the middle of the arm, as seen in Figure 3. This variation comes under type II according to Li Minor (1990).

4) Musculocutaneous nerve was arising normally from the lateral cord traversing between coracobrachialis and biceps brachii, then between biceps brachii and brachialis supplying all three muscles. Here the variation noted was musculocutaneous nerve not piercing coracobrachialis seen in 1 out of 50 specimen. It is one of the very rare variation found. Figure 4 (MCN- musculocutaneous nerve, MN- median nerve, Br- brachialis muscle)
TABLE NO 1: Showing all the variations observed

<table>
<thead>
<tr>
<th>Specimen No</th>
<th>Variation observed</th>
<th>No of Variation, n=50</th>
<th>Percentage of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Formation of the median nerve by three roots</td>
<td>3</td>
<td>6%</td>
</tr>
<tr>
<td>2</td>
<td>Absence of the musculocutaneous nerve</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>3</td>
<td>Communication between the median and the musculocutaneous nerves</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>4</td>
<td>Musculocutaneous nerve not piercing coracobrachialis</td>
<td>1</td>
<td>2%</td>
</tr>
</tbody>
</table>

TABLE NO 2: Comparision between the previous studies

<table>
<thead>
<tr>
<th>Author</th>
<th>year</th>
<th>Sample size</th>
<th>Absent MCN</th>
<th>Innervation by Median Nerve</th>
<th>Communication between median nerve and MCN</th>
<th>MCN not piercing Coracobrachialis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Shashank M J</td>
<td>2014</td>
<td>40</td>
<td>5%</td>
<td>Present in the arm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Abhilasha Priya</td>
<td>2019</td>
<td>60</td>
<td>5%</td>
<td>Present in the arm</td>
<td>13.33%</td>
<td>-</td>
</tr>
<tr>
<td>Virendra Budhiraja</td>
<td>2011</td>
<td>116</td>
<td>11.2%</td>
<td>Present in the arm</td>
<td>20.7%</td>
<td>-</td>
</tr>
</tbody>
</table>

Cont... TABLE NO 2: Comparision between the previous studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Sample Size</th>
<th>Percentage (Roots)</th>
<th>Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amrita Bharati</td>
<td>2015</td>
<td>10</td>
<td>-</td>
<td>Formation from 3 roots- 2%</td>
</tr>
<tr>
<td>K Lakshmi Kumar</td>
<td>2015</td>
<td>106</td>
<td>-</td>
<td>Formation 3 roots- 26.41%, 4roots- 1.88%</td>
</tr>
<tr>
<td>Parminder Kaur</td>
<td>2014</td>
<td>30</td>
<td>13.2%</td>
<td>Present in the arm</td>
</tr>
<tr>
<td>Present study</td>
<td>2019</td>
<td>50</td>
<td>2%</td>
<td>Formation 3 roots- 6%</td>
</tr>
</tbody>
</table>

Discussion

Variations of the lateral cord are not rare and have been reported by many authors in the past as seen in table 2. On the basis of embryological development, anomalous pattern of the median nerve and musculocutaneous nerve can be explained. The upper limb buds lie opposite the lower five cervical and upper two thoracic segments. As soon as the buds form, the ventral primary rami of the spinal nerve penetrate into the mesenchyme of limb bud. Immediately, the nerves enter the limb bud and they establish intimate contact with the differentiating mesodermal condensations. The early contact between nerve and muscle cells is a pre-requisite for their complete functional differentiation. The growth as well as the path finding of nerve fibres towards the target is dependent on concentration gradient of a group of cell surface receptors in the environment. Several signaling molecules and transcription factors have been identified, which induce the differentiation of the dorsal and ventral motor horn cells. Misexpressions of any of these signaling molecules can lead to abnormalities in the formation and distribution of particular nerve fibres.

At the infraclavicular level, the lateral fascicle of the brachial plexus usually bifurcates giving origin to the musculocutaneous nerve (MCN) and the lateral root of the median nerve (MN). However, during the embryological development process it is possible that bundles of fibers corresponding to the MN initially run together with bundles of fibers of the MCN. The MN recovers the fibers required to perform its motor and sensorial functions in the upper extremity, only when the bundles of fibers were connected with their nerve of origin (MN) at the proximal or mid-thirds of the arm. Although with low frequency, fibers of the MCN have also been seen to initially run along of the MN and later reestablish their configuration through a communicating branch. The incidence of the MCN-MN communication has been reported in diverse population groups with a wide variability between 2.1 and 63.5%. The majority of the studies only report the MCN-MN communication. Maeda et al. and Chiarapattanakom et al. have reported an occurrence of 3–6.8% for the communication from the MN to the MCN. Information about the prevalence of side of MCN-MN communication is low. Few studies report predominance of the left side and of the unilateral expression of this communicating branch. Several ways to classify this communicating branch have been proposed by the wide variability in its expression. Knowledge of the existence of the MCN-MN communication in the arm is clinically important.

Communications between MN and MCN have been described to the five types:

- **Type I** - There is no communication between median nerve and musculocutaneous nerve.
- **Type II** - Some fibres of lateral root of median...
nerve pass through musculocutaneous nerve and join median nerve in the middle of the arm.

- Type III- All the fibres of lateral root of median nerve pass along musculocutaneous nerve and after some distance leave it to form the lateral root of the median nerve.
- Type IV- Musculocutaneous nerve joins the lateral root of median nerve and after some distance the musculocutaneous nerve arises from the median nerve.
- Type V- Musculocutaneous nerve is absent and entire fibres of musculocutaneous nerve pass through lateral root of median nerve to median nerve. The fibres to the muscles supplied by musculocutaneous nerve branch out directly from the median nerve.

Classification of variations of the median nerve and the musculocutaneous nerve according to Le Minor (1990). CBM: Position of the coracobrachialis muscle; CB: coracobrachialis ramus (nerve); BB: Biceps brachii ramus; B: Brachialis ramus; LR: Lateral root forming the median nerve; MR: medial root forming the median nerve; LC: lateral cord; MR: medial cord; MCN: Musculocutaneous nerve; MN: median nerve; UN: ulnar nerve.

In the present study, formation of the median nerve by three roots was noted in 3 out of 50 cases (6%). In all of these cases, two roots were coming from the lateral cord, and one root from the medial cord. In one case, there was also communication between the median and the musculocutaneous nerves. A similar case of formation of the median nerve by three roots was described by Anju Bala in 26.41% and Amrita Bharti in 2% cases. K Lakshmi Kumari has reported median nerve which is formed by 4 roots in 1.88%.

Dr Shashank M J, Abhilasha Priya, Virendra Budhiraja, Parminder Kaur, Charushila D Shinde have observed absence of Musculocutaneous nerve in 5%, 5%, 11.2%, 13.2% cases respectively. Whereas in our study it was found to be 2%.

Arian Azimi found a variation in which lateral cord was giving off MCN which was small and thin and needed to be looked carefully to find it in the macroscopic dissection, then the lateral root continued as the lateral root of median nerve innervating the muscles of arm.

Communication between Median and Musculocutaneous nerve after piercing or without piercing coracobrachialis muscle is quite common compared to other variations as per the results of previous studies (by Virendra Budhiraja, Abhilasha Priya, Hamid Tayefi Nasrabadi). The same is been tabulated in Table No 2.

Musculocutaneous nerve not piercing Coracobrachialis without communication with median nerve is one of the rare variation, which we found in our present study.

The MCN injury proximal to the MCN-MN communication can lead to an unexpected weakness of the forearm flexor muscles and thenar muscles with clinical signs like seen in a MN injury at the level of the
arm. Furthermore, the MN injury proximal to the MN-MCN communication can lead to a clinical presentation characterized by functional preservation of forearm and hand muscles innervated by MN. In the peripheral nerve surgery, especially in nerve transfers techniques, a good knowledge of the MCN-MN communications is required.

**Conclusion**

The MCN has been successfully used as a receiver nerve to the recovery of elbow flexion. Furthermore, the MCN motor branch to BrM has been used as donor to anterior interosseous nerve and posterior interosseous nerve for the treatment of lower brachial plexus injuries as well as in the treatment of tetraplegic patients.

The high median nerve entrapment symptoms may be used in differential diagnosis of unexplained clinical symptoms like sensory loss, pain, wakefulness and paresis. The knowledge of such rare median nerve variations is thus important for anatomists, anesthetists, radiologists and surgeons.

The knowledge of such variations is of much interest to Anatomists and Surgeons. Anatomical variations are significant during exploration of axilla and arm surgeries involving neoplasms and other vascular masses.

**Conflict of Interest:** No

**Ethical Clearance:** Has been taken from the ethical committee, JSSMC, Mysuru

**Source of Funding:** Self

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