Variations in Innervation of Muscles in Anterior Compartment of Arm–A Cadaveric Study

ABSTRACT
Aims and Objective: Study was undertaken to observe the variation in the innervation of muscles in the front of arm. The results were compiled. Embryological basis and clinical applications of encountered variations were tried to explain with the help of available literature.

Material and Methods: Thirty upper limbs from fifteen cadavers were dissected to observe the contents of front of arm. Musculocutaneous nerve, median nerve and innervation of the muscles of front of arm were observed.

Results: Variations were observed in 13% of cases. Commonly seen variation was the absence of musculocutaneous nerve and innervation of muscles of front of arm by branches of median nerve. This variation was seen bilaterally in 3.3% of cases and unilaterally in 6.6% cases. Bilateral presence of this variation in one out of fifteen cadavers is rare finding. Variation is more common on right side as compared to the left side.

Conclusion: Bilateral absence of musculocutaneous nerve and innervation of muscles of front of arm from the branches of median nerve is a rare variation. Knowledge of such anatomical variations is of interest to the anatomist and clinician alike. Variations assume significance during surgical exploration of the axilla and can even fail nerve block of infraclavicular part of brachial plexus. Surgeons who perform procedures involving neoplasms or repairing trauma need to be aware of these variations.

INTRODUCTION
Muscles in anterior compartment of arm i.e. coracobrachialis both heads of biceps and brachialis are supplied by musculocutaneous nerve. Small lateral part of brachialis also receives branches of radial nerve. Musculocutaneous nerve is the nerve of anterior compartment of arm. It arises from lateral cord (C5,6,7) opposite the lower border of pectoralis minor. Median nerve has no muscular branch for the flexor muscles of front of arm [1].

Knowledge of normal anatomy as well as variations is important particularly to the surgeons for carrying out surgical procedures [2]. Variations of peripheral nerves are important to orthopedic surgeon, neuron physician, physiotherapists and radiologists. Such comprehension is useful in nerve grafting and neuro physiological evaluation for diagnosing peripheral neuropathies [3].

MATERIALS & METHODS
Thirty upper limbs from fifteen formalin fixed adult human cadavers were dissected to see the innervation of muscles of anterior compartment of arm. The steps of dissection were followed from Cunningham’s Manual of Practical Anatomy Vol. I [4]. The skin from pectoral region, axilla & arm was incised and superficial fascia was reflected. Deep fascia was separated to see the contents of arm. The muscles were observed for their innervation. The variations were noted and photographs were taken.

OBSERVATION
Among the 30 limbs which were dissected from 15 preserved cadavers standard textbook pattern was observed in 86.7% limbs whereas in 13.3% of the limbs variation was seen as follows [Table/Fig-1].

Variation in Innervation of Muscles in Anterior Compartment of Arm–A Cadaveric Study

<table>
<thead>
<tr>
<th>Total Number of limbs</th>
<th>Right</th>
<th>Left</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent Musculocutaneous Nerve</td>
<td>03</td>
<td>01</td>
<td>04</td>
</tr>
</tbody>
</table>

| Table/Fig-1: Absence of musculocutaneous nerve right/left limbs |

Bilateral variation was seen in one cadaver. In this musculocutaneous nerve was absent whereas median nerve had small lateral root and normal medial root in relation to the third part of the axillary artery. A small branch was seen coming from lateral root to supply coracobrachialis, later it joined median nerve after a few centimeters only. In this case rest of the flexor muscles (brachialis and biceps brachii) were innervated by median nerve [Table/Fig-2,3].

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In rest of the two cases also musculocutaneous nerve was absent whereas the formation of median nerve was seen normal after the union of two roots. Nerve to coracobrachialis was given off immediately after the union then it gave branches to biceps and brachialis. Variation was confined unilaterally to right limbs of two cadavers [Table/Fig-4].

As the roots of musculocutaneous nerve and lateral root of median nerve are same, in the absence of musculocutaneous nerve the muscles of front of arm get motor innervations by median nerve [11].

Understanding the embryologic development of the brachial plexus is important in explaining such anatomic variations. The human upper limb bud appears at about 26-27 days of embryonic life and axons of motor neurons of the spinal cord enter the limb buds during the fifth week. Formation of the brachial plexus is evident at about 34-35 days as a single radicular cone in the upper limb. Between 38th and 40th days, the major branches of the brachial plexus such as median, radial and ulnar nerves are visualized which are seen to enter the hand plate. The musculocutaneous nerve arises as an offshoot of median nerve. At about 46th-48th days, the upper limb nerve attain definitive adult pattern [12]. The need of brachial plexus arises for ease of distribution from several spinal segments and one spinal segment can be distributed to several peripheral nerves [13]. Plexus is a complex of branching, rejoining and reseparation of nerve fibres that usually happens near the root of limbs, which is axilla for the upper limb. The complex network is sometimes extending in to the arm. The roots of musculocutaneous nerve and lateral root median nerve are same, i.e. C5, C6 and C7. In the absence of musculocutaneous nerve the same root travel through the lateral root median nerve and are distributed in the muscles of the front of arm via median nerve [11]. 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 [14,15]. The variation 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 [15]. 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 postnatally [14]. 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 [16].

**DISCUSSION**

Musculocutaneous nerve is the main nerve of flexor muscle of arm that arises from lateral cord of brachial plexus in axilla. Prasada Rao [5] reported 2 cases of absence of musculocutaneous nerve whereas Ihunwo et al., [6] has reported bilaterally absence of musculocutaneous nerve. In the present study we have also observed musculocutaneous nerve absent bilaterally in one cadaver whereas unilateral absence was seen in 2 right limbs. Complete absence of musculocutaneous nerve and innervation of flexor muscles by median nerve is uncommon variation of brachial plexus [7-9] [Table/Fig-5].

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