

# Cadaveric Study of Supraclavicular Part of Brachial Plexus

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## ABSTRACT

**Introduction:** Brachial plexus is network of nerves present in the neck and axilla supplying the upper limb. It is formed by the ventral rami of lower four cervical and first thoracic nerves. Surgical intervention in axilla, root of neck, brachial plexus block, orthopaedic surgeries in shoulder region requires detailed knowledge of anatomy of the brachial plexus and its variations.

**Aim:** To note for any variations in the supraclavicular part of brachial plexus.

**Materials and Methods:** The study was carried on 30 adult cadavers (60 upper limbs) in the Department of Anatomy, Kasturba Medical College, Manipal. Posterior triangle were dissected and any variations in roots, trunks and divisions of brachial plexus were noted and photographed.

**Results:** Out of 60 upper limbs, in 57 there was normal formation of brachial plexus. In one cadaver there was bilateral absence of middle trunk and lower trunk was formed by C7, C8 and T1. Upper and lower trunks formed a single cord instead of forming divisions and gave all the branches of brachial plexus. In one another cadaver on the right side formation of trunks were normal but lower trunk did not divide into anterior and posterior divisions instead continued down as medial cord and gave all the branches of medial cord. In the same cadaver posterior cord was formed by posterior division of upper and middle trunk only.

**Conclusion:** Knowledge of these variations of the brachial plexus has clinical significance especially in prevention of injuries to these nerves in surgical interventions of the axilla, neck and arm. Therefore, the present study will be of importance to surgeons, anaesthetists and radiologists.

**Keywords:** Axilla, Brachial Plexus Block, Cervical Nerves, Thoracic Nerves

## INTRODUCTION

The brachial plexus is a system of connected nerve fibres which supplies nerves to the upper limb and is formed by the ventral rami of lower four cervical and the first thoracic nerves (C5, C6, C7, C8, T1). If there is contribution from C4, the plexus is called prefixed whereas, if T2 is giving contribution in plexus formation it is called post fixed type of brachial plexus [1].

The brachial plexus consists of roots, trunks, divisions and cords. Supraclavicular part of brachial plexus consists of roots, trunks and divisions. The ventral rami of C5, C6, C7, C8 and T1 forms the roots. C5 and C6 forms upper trunk, C7 continues as middle trunk and C8 and T1 forms lower trunk. Branches from the roots are dorsal scapular nerve and long thoracic nerve and branches from the trunks are nerve to subclavius and suprascapular nerve. Each trunk divides into anterior and posterior divisions. Anterior divisions of upper and middle trunk unite to form the lateral cord. Anterior division of lower trunk forms the medial cord. Posterior division of upper, middle and lower trunk forms the posterior cord [1]. The cords

are named according to their relationship with the second part of the axillary artery. The cords and their branches form the infraclavicular part of the brachial plexus. Branches from the lateral cord are lateral pectoral nerve, musculocutaneous nerve and lateral root of median nerve. From the medial cord the branches are medial pectoral nerve, medial cutaneous nerve of arm, medial cutaneous nerve of forearm, medial root of median nerve and ulnar nerve. Posterior cord branches are upper and lower subscapular nerve, thoraco-dorsal nerve, axillary nerve and radial nerve [1].

The anatomical variations of these nerves are very common thus making clinical interventions in the region difficult. The knowledge of anatomical variations in this region helps in clinical interventions which are usually performed in this region including anaesthetic blocks, surgical approaches, treating nerve compressions caused by tumour or trauma.

## MATERIALS AND METHODS

The present study was a descriptive study conducted on 60 upper limbs dissected in the department of Anatomy,

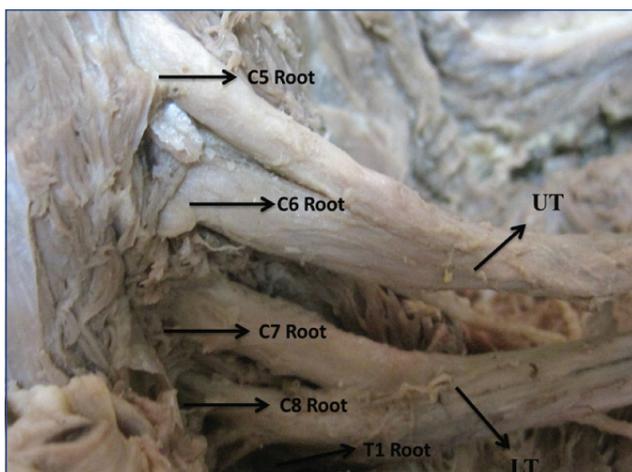
Kasturba Medical college, Manipal, Karnataka over a period of two years from January 2014 to March 2016. Institutional Ethical Clearance was obtained before conducting the study. The cadavers were embalmed and preserved in weak formalin solution. All normal cadavers were included in the study and Cadavers with traumatic lesion or with any surgery done in neck and axilla were excluded. The posterior triangle of neck was dissected according to the guidelines of Cunningham's manual of Practical Anatomy [2]. Skin, superficial fascia and platysma are removed. Boundaries of the posterior triangle were defined. The floor muscles were identified. The trunk of the brachial plexus was noted between scalenus medius and anterior. All its root, trunk, division and cord were cleaned. Formation of the trunks was noted and also other branches from the roots were observed. The divisions of each trunk and also the formation of the cord were observed [2]. Photographs were taken by the digital camera under good lighting. Results were obtained and percentage of cadavers with any variations was calculated.

## RESULTS

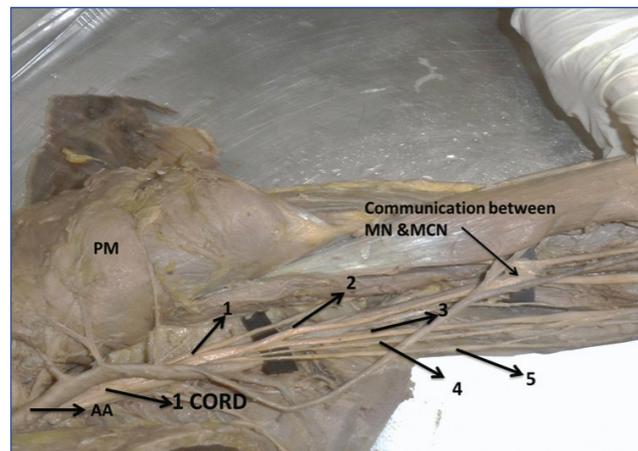
In the present study normal formation of brachial plexus was observed in 57 upper limb specimens out of 60. No pre-fixed and post-fixed brachial plexus were observed. Variations were observed in three upper limbs out of 60 (5%).

In two upper limbs, there was absence of middle trunk (3.3%). Lower trunk was formed by ventral rami of C7, C8 and T1 in both the cases [Table/Fig-1]. When traced down the two trunks fused to form a single cord which in radiating manner gave all the branches of the brachial plexus [Table/Fig-2].

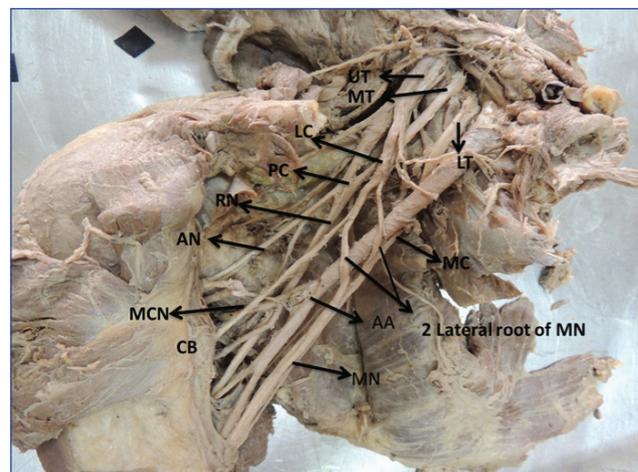
In one upper limb (1.66%), formation of trunks was normal but when traced down lower trunk did not divide into anterior and posterior divisions instead continued down as medial cord giving all the branches of the medial cord. The posterior cord was formed from posterior divisions of upper and middle trunk [Table/Fig-3].



**[Table/Fig-1]:** Absence of middle trunk; formation of lower trunk by C7, C8, T1 nerve roots.  
UT: Upper Trunk, LT: Lower Trunk



**[Table/Fig-2]:** One cord radiating branches, 1-musculocutaneous nerve, 2-median nerve, 3-ulnar nerve, 4-medial cutaneous nerve of arm, 5-medial cutaneous nerve of forearm, AA- Axillary Artery, PM- Pectoralis Major.



**[Table/Fig-3]:** Posterior cord formed by posterior division of upper and middle trunk.  
lower trunk with only anterior division forming the medial cord, UT: Upper Trunk, MT: Middle Trunk, LT: lower Trunk, PC: Posterior Cord, MC: Median Nerve, CB: Coracobrachialis

## DISCUSSION

Variations in pattern of Brachial plexus are due to abnormal formation in the development of trunks, divisions and cords. In the present study, normal formation and branching pattern of brachial plexus were observed in 95% cases. Variations were observed in three out of 60 cadavers (5%). With the recent advances, general anaesthesia for the upper limb surgery is not used much instead a regional anaesthesia like supraclavicular nerve block of brachial plexus is preferred. The success of such block depends on the detailed knowledge of the anatomy of brachial plexus in term of formation and its branching pattern. The present study provides knowledge regarding these and is helpful to the surgeons and anaesthetists operating in this area. Surgical intervention in

the neck and axilla, nerve block, treatment of neuropathy and nerve compression requires detailed anatomical knowledge of the brachial plexus. The brachial plexus has a complex anatomical structure originating in neck and extending in axilla. It has close association with important anatomical structures. Therefore thorough knowledge of formation of brachial plexus is necessary for surgical exploration of axilla and arm, cervical rib correction, nerve block, neurosurgical procedure of cervical spine and prosthetic implant procedure etc. The brachial plexus injury can be due to trauma, compression of nerves, shoulder dislocation, patients during anaesthetic block. Nerve injuries can be classified as neuropaxia, axontomesis and neurotemesis. These can cause various degrees of paresthesias, paresis or paralysis [3].

Mchonde GJ et al., reported bilateral multiple variations of roots, trunks, cords and branches of brachial plexus [4]. They found that C7-C8 joined to form middle trunk and lower trunk was formed only by T1. Upper trunk was formed by C5-C6 roots. The upper and middle trunks subdivided into anterior and posterior divisions but lower trunk did not divide and descended as solitary cord. Posterior cord was formed by posterior divisions of upper and middle trunk. Lateral cord was formed by anterior divisions of upper and middle trunks. Medial cord was formed by the lower trunk [4]. In the present study there was similar variation seen but there was difference in the formation of the trunks. The upper trunk was formed by C5-C6 roots, middle trunk by C7 roots and lower trunk by C8-T1. The upper and middle trunks subdivided into anterior and posterior divisions but lower trunk continued as a single cord. Lateral cord was formed by anterior divisions of upper and middle trunks and Posterior cord by posterior divisions of upper and middle trunks. Medial cord was formed by the lower trunk.

Vishwanathan U et al., reported bilateral single cord of brachial plexus in an adult female cadaver [5]. On the left side, the upper trunk was formed by C4, C5 and C6 the C7 formed the middle cord, and lower trunk was formed by C8 and T1. They united to form a single cord. On the right side, upper trunk was formed by C5 and C6 which divided into anterior and posterior divisions. C7, C8 and T1 roots united to form the lower trunk. Middle trunk was absent. The anterior and posterior divisions of upper trunk united with the lower trunk to form a single cord. This single cord gave rise to all the branches of the brachial plexus [5]. In the present study, there were two similar cases seen with the formation of single cord. But in both cases there was bilateral absence of middle trunk and single cord was formed by joining of upper and middle trunks. C5 and C6 root formed the upper trunk and C7, C8 and T1 formed lower trunk on both the sides. These trunks did not divide into divisions but instead formed a single cord which gave all the branches of the brachial plexus.

Aggarwal A et al., reported four cases of single cord formation out of 90 upper limb specimen (4.4%). In cases 1 and 2, the upper trunk (fused C5 and C6 roots), C7, C8, and T1 roots united to form the single cord, which descended deep to the clavicle to enter into the axilla [6]. In case 3 (left side), formation of upper, middle, and lower trunks followed the usual pattern. After the suprascapular nerve emerged from the upper trunk, the trunk divided into anterior and posterior divisions. The middle and lower trunks, without dividing, directly fused with two divisions of the upper trunk, resulting in the formation of an 8-mm-long single cylindrical cord. In case 4 (right side), following normal upper, middle, and lower trunk formation, the three trunks directly fused to form a single cord. In all cases, the fused cord was lying superior to the subclavian artery in the posterior triangle of the neck, and anterolateral to the axillary artery while descending deep into the clavicle, and was finally lateral to the artery in the axilla. In the present study, presence of single cord was seen in two cases out of 60 (3.33%)

Sannes DH et al., suggested that development of the peripheral nerve is influenced by expression of chemo-attractants and chemo-repulsants in a site specific pattern [7]. Variations in the brachial plexus in its formation and branching pattern can be attributed to the evolutionary evidence. Lower vertebrates differ from humans in the formation of the brachial plexus. In amphibians, reptiles and dogs there is no formation of trunks from the roots. Two trunks are being formed from roots in gorillas [8]. Clinical implications of common single cord are not certain as this variation is not very common. However, it is likely that any supraclavicular brachial plexus injuries in such individuals would have serious clinical manifestations as all branches are coming from single cord [5].

Khan GA et al., in his study on supraclavicular part of brachial plexus observed formation of four trunks in three limbs out of 60 [9]. In the present study no limb with four trunks was noted. Absence of middle trunk and formation of upper trunk by ventral rami of C5, C6 and C7 and lower trunk by C8 and T1 was noted in one limb. In the present study similar findings was observed in both limbs of a cadaver and when traced down they formed a single cord.

Nayak S et al., reported absence of middle trunk and formation of upper trunk by C5, C6, C7 [10]. In the present study one case of bilateral absence of middle trunk was observed but the formation of upper trunk was normal. Lower trunk was formed by C7, C8, T1. Uysal II et al., reported absence of upper trunk in 1% cases and absence of lower trunk in 9% cases [11]. However, in the present study upper trunk and lower trunk was present in all the cases. In a dissected upper limb there was bilateral absence of middle trunk and lower trunk was formed by C7, C8, T1.

Singh R et al., reported an anomalous single cord after fusion of all the three trunks without splitting into anterior and

posterior divisions [12]. In the present study, there was bilateral absence of middle trunks in one of the dissected cadaver with the presence of a single cord which was formed by upper and lower trunks. The presence of a single cord makes the brachial plexus more complex with more chances of injury during any surgical interventions. Hasan M et al., also reported a single cord of brachial plexus in 1964 [13].

Havaladar PP et al., reported absence of middle trunk with presence of two trunks [14]. The Upper Trunk (UT) was formed by C5 and C6 roots and the Lower Trunk (LT) was formed by C7, C8 and T1. Anterior divisions of UT and LT formed a superior cord whereas the posterior divisions formed the inferior cord. Both cords were lateral to axillary artery. Branches of medial cord and lateral cord were given by the superior cord and the branches of lateral cord were given by the inferior cord. Sweekritha et al., also reported same findings in a male cadaver during routine dissection for undergraduate students [15]. Jamuna M et al., also reported a case with two cords similar to the above two case reports [16]. In the present study absence of middle trunk was reported bilaterally but no such formations of superior cord and inferior cord was noted. It is observed that most of the reported case of single cord was from India.

## CONCLUSION

Knowledge of these variations of the brachial plexus has clinical significance especially in prevention of injuries to these nerves in surgical interventions of the neck and axilla. The knowledge of these variations can help neurophysicians to understand the weakness of specific pattern in relation to nerve damage and is important for interpretation of results of nerve conduction studies. It is also essential for physiotherapists in performing electrotherapy. Knowledge of variations is also useful in nerve grafting and in neurophysiological evaluation in case of peripheral nerve injury so anatomical knowledge of these variations are important for radiologists, surgeons and neurologists and even for anatomists during routine dissection.

## LIMITATION

Infraclavicular part of the brachial plexus was not studied simultaneously.

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