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# Anatomical Variations in Brachial Plexus Formation and Branching Pattern in Adult Cadavers

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## Abstract

**Background and Aims:** Variation in the formation of brachial plexus (BP) during its course, branches and distribution is of great interest for all the clinicians. The aim of present study was to find variations in the formation of brachial plexus (BP) during its course, branches and distribution.

**Methods:** This study included thorough and careful dissection of 30 brachial plexuses which belonged to 15 cadavers, obtained from the Department of Anatomy, SKIMS Medical College, following all standard guidelines. The age and sex of the cadavers were not taken into consideration. The upper limbs were examined for the abnormal formation and union of branches of brachial plexus.

**Results:** Nine limbs (30%) limbs in our study showed variations in brachial plexus at different parameters. The median nerve was showing 2 lateral and 1 medial roots with absent musculocuteneous nerve. Median nerve was giving branch to coracobrachials muscle. Median nerve was formed by single lateral root with absent medial root. In 2 limbs, the radial nerve was arising from two roots. Communicating branch was seen between musculocuteneous nerve and median nerve. Similarly, double communication between median nerve and ulner was seen and in another limb communicating branch of ulner nerve to radial nerve was seen.

**Conclusion:** Our study revealed some rare variations in the formation, branching pattern and relations of the brachial plexus. The knowledge of these variations may be helpful for the anatomists, radiologists, anesthetist, neurosurgeons and orthopedic surgeons during surgical operation of the upper limb.
**Keywords:** Brachial plexus, variations, Median nerve

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## INTRODUCTION

A good knowledge of human anatomy of brachial plexus (BP) is very important in elective surgical procedures. Anatomical variations in brachial plexus are very common. More than 50% of anatomical variations in cadaveric studies of human neural system have been reported to belong to the brachial plexus [1,2, 3] and it is believed due to abnormal formation in the development of the trunks, divisions or cords and can be explained through neuronal growth cones.[4] Any alterations in the signaling between the mesenchymal cells and the neuronal growth cones or the circulatory factors at the time of development of the BP can lead to significant variations. Dissection of cadavers has demonstrated seven major configurations of the brachial plexus, none having more than 57% representation. [5] Intra-individual variations also exist and right and left anatomical asymmetry was found in 61% of cadavers.

Brachial plexus is a network of nerves which innervates the muscles of the back and the upper limb. It is formed by the ventral rami of C5, C6, C7, C8 and T1 spinal nerves. They are located behind Scalenus anterior and medius muscles of neck. Sometimes C4 roots joins with C5, when plexus is called pre-fixed type. On occasions T2 roots joins with T1 with disappearance of C4 roots; this forms the post-fixed type of plexus.

The anterior divisions of the upper and middle trunks unite to form the lateral cord, and the anterior division of the inferior trunk continues as a medial cord. Ulnar nerve (C7, C8, and T1) is a branch of medial cord. In the axilla the ulnar nerve descends between the third part of axillary artery and axillary vein. The median nerve (MN) is formed by the union of lateral and medial roots from lateral and medial cord of BP respectively and both the roots were present lateral to the axillary artery. It then courses downwards in front of the arm. The ulnar nerve from the medial cord was found to be lateral to the axillary artery and then it crossed the axillary artery from lateral to medial and further it coursed down medial to the brachial artery.

The musculocutaneous nerve arises from the lateral cord of the brachial plexus, passes inferolaterally and pierces coracobrachialis muscle before lying between biceps brachii and brachialis muscles. It was observed that instead of piercing the coracobrachialis, the musculocutaneous nerve continues the median nerve before dividing at various levels.

In present study we observed the gross variations in the formations and branching pattern of the brachial plexus. In this regard, variation in the formation of brachial plexus (BP) during its course, branches and distribution is of great interest for all the clinicians.

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Anatomical variations of the infraclavicular part of the brachial plexus acquire clinical importance in post-traumatic evaluations and exploratory interventions of the arm for peripheral nerve repair. Some variations are vulnerable to damage in radical neck dissection and other surgical operations of the axilla and upper arm.

## METHODS

The study was conducted at multiple places along SKIMS Medical College, in which we explored 30 BP of 15 cadavers. All cadavers were fresh and were fully formalinated. Cadavers with previous surgical history were excluded from the study. It was a routine dissection of upper limb axilla and brachial plexus for MBBS students in SKIMS Medical College. The skin and superficial fascia was reflected and various muscles were seen. All these structures were reflected to visualize the branching pattern of brachial plexus. . All the variations in the formation of trunks and cords of brachial plexus and distribution of the branches were noted and the photographs were taken with the help of digital camera.

## RESULTS

From the observation on cadaveric dissection of 30 limbs (15 cadavers) we found that 21 limbs (70%) were normal regarding its formation and branching pattern and 9 limbs (20) limbs showed variations at different parameters.
In 3 (10%) limbs, the median nerve was showing 2 lateral and 1 medial roots with absent musculocuteneous nerve (Figure 1 and 2). Median nerve was giving branch to coracobrachials muscle.

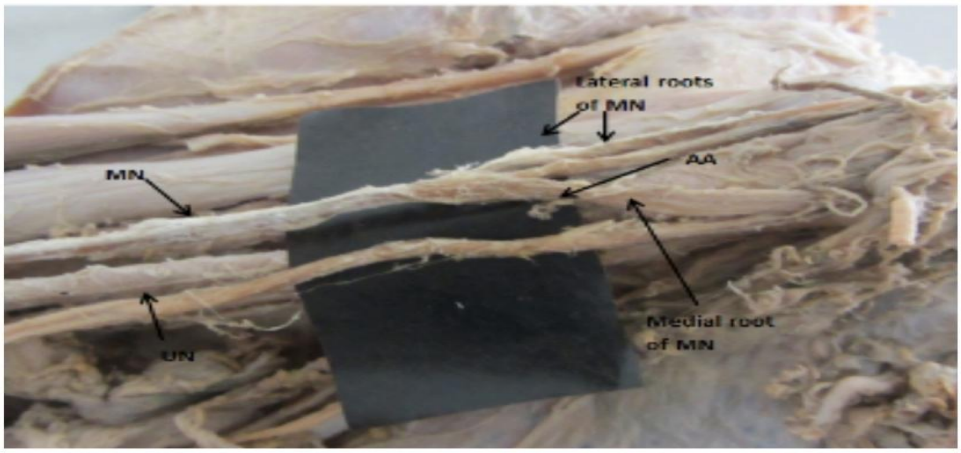


**Figure 1= Showing 2 lateral and 1 medial root of median nerve with absent musculocuteneous nerve ( MN=median nerve, UN=ulner nerve, AA=axillary artery)**

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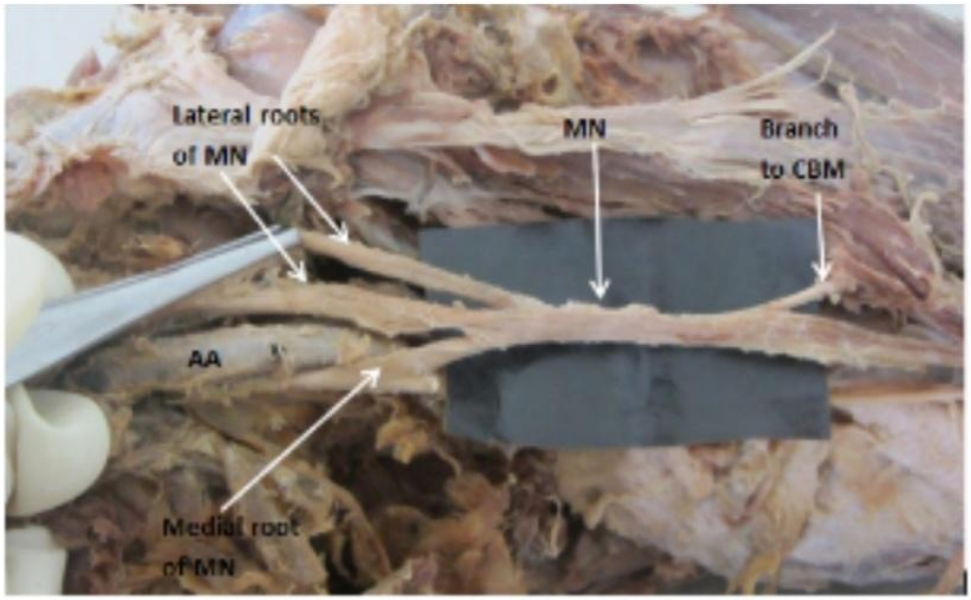


**Figure 2: Showing 2 lateral amd 1 medial root of median nerve with absent musculocuteneous nerve. Median nerve giving branch to coracobrachials muscle(CBM). ( MN=median nerve, UN=ulner nerve, AA=axillary artery)**

In 2 (6.6%) limbs cadaver, median nerve was formed by single lateral root with absent medial root bilaterally (figure 3).

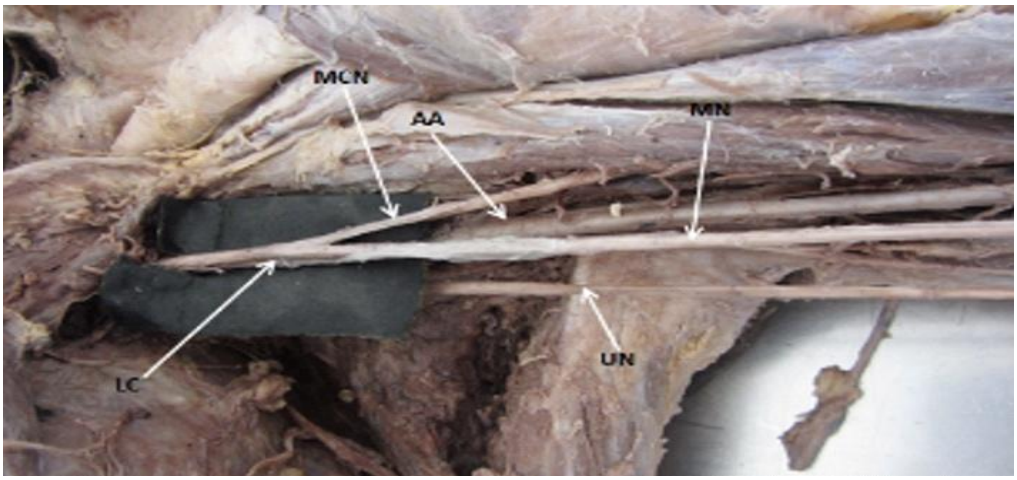


**Figure 3: Showing single lateral root of median nerve with absent medial root.**

(MN=median nerve, UN=ulner nerve, AA=axillary artery, MCN=musculocuteneous nerve, LC= lateral cord )

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In 2 limbs (6.6%) specimen, the radial nerve was arising from two roots. Upper root formed by posterior division of upper trunk and lower root was formed by union of posterior division of middle and lower trunk unilaterally. Axillary nerve arising from posterior division of upper trunk (figure 4).


**Figure 4: Showing radial nerve arising from two roots. Upper root formed by posterior division of upper trunk and lower root was formed by union of posterior division of middle and lower trunk.Axillary nerve arising from posterior division of upper trunk. ( MN=median nerve, UN=ulner nerve,RN=radial nerve,**
UT=upper trunk,MT=middle trunk,PD=posterior division, LT=lower trunk )

In one limb, communication was seen between musculocuteneous nerve and median nerve (figure 5). These findings were seen unilaterally. Two roots of median nerve were joining medial to third part of axillary artery. Similarly, double communication between median nerve and ulner was seen (figure7) and in another limb communication of ulner nerve to radial nerve was seen (figure 6).

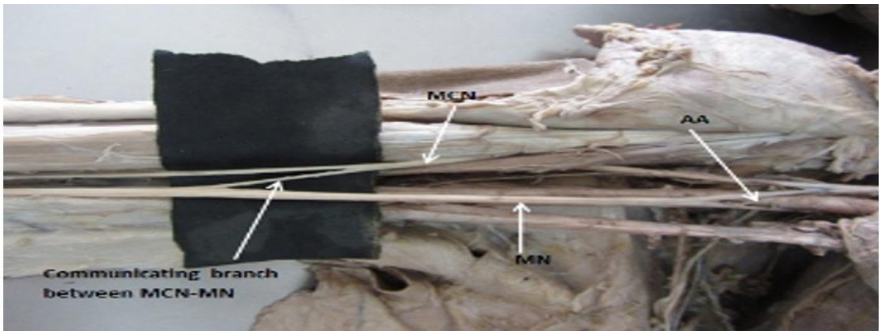


**Figure 5: showing communicating branch between Musculocuteneous nerve (MCN) and Medial nerve (MN)**

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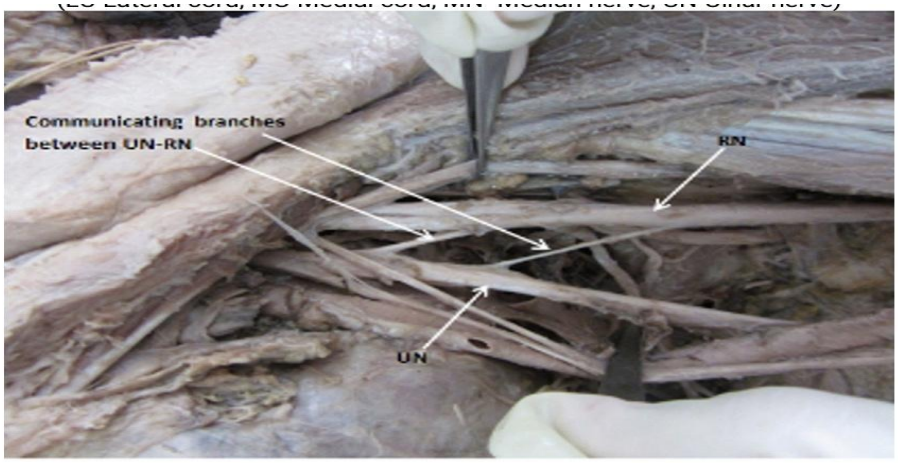


**Figure 6: Showing communicating branch between ulner nerve (UN) and radial nerve.( RN)**

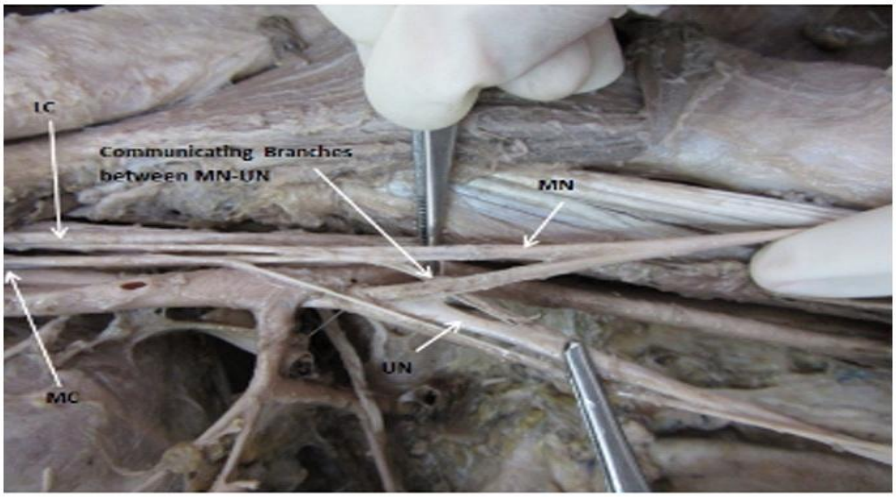


**Figure 7: Showing double communication between ulner nerve (UN) and medial nerve(MN)**

## Discussion

Nervous system is very much essential for the survival of an individual. Thorough anatomic knowledge of the nerves is essential for assessing the functional loss and planned reconstructive surgeries. The brachial plexus lesions may occur following trauma, compression of nerves, shoulder dislocation, intraoperative nerve damages, and traumatic delivery in infants and malposition of the patient during general anaesthesia. The knowledge of brachial plexus and its variations is important for

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anatomist, radiologist, anesthesiologist and surgeons; it has also gained importance in diagnosis due to extensive use of imaging techniques.

In the present study, we observed variations in Musculocutaneous and median nerve in their formation and branching pattern. Similar type of variations were observed by Bergman et al., with 90% of musculocuteneous nerve (MCN) arises from the lateral cord while in 2% of the cases it may arise from the medial nerve (MN) or may be absent.[6] Le Minor in another similar type of cadaver study of brachial plexus, explained that in the absence of MCN, the fibres of the MCN are distributed through the lateral root of MN.[7]

In present study, we found communication between musculocuteneous nerve and median nerve. Two roots of median nerve were joining medial to third part of axillary artery. Similarly, double communication between median nerve and ulner nerve were also seen. in another limb communication of ulner nerve to radial nerve was also found. These type of communication between musculocutaneous and median nerves are well documented by Yang et al. and C. Priti et al .[8,9] Similar type of communication also reported by C. Priti, et al, Loukas and Aqueelah.[9,10] Sunder et al. also reported that MCN communicates with the median nerve in the arm.[11]

The incidence of formation of median nerve by two lateral roots and one medial root was described by P. Sharmila et al.[12] It was documented that C7 root of ulnar nerve arises from lateral cord either through roots of median nerve or as a lateral root of ulnar nerve in axilla.[13,14] These concept correlates with the present study. But such type of communication is a rare finding of brachial plexus.

The communicating branches between median nerve to ulnar nerve and medial nerve to radial nerve at different levels have been mentioned earlier but this type of finding yet not been reported.[15] The existence of communicating branches may be of importance in the evaluation of unexplained sensory loss after trauma or surgical intervention in a particular area.[16]

In conclusion, Nervous system is very much essential for the survival of an individual. Thorough anatomic knowledge of the nerves is essential for assessing the functional loss and planned reconstructive surgeries. So it is important to be aware of the variations seen in brachial plexus and knowledge of these variations is important for neurologists, orthopaedicians, anesthesiologist and traumatologists as these may give rise to variable clinical picture depending upon the variations present.

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