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Research Article

Anatomical variations of brachial plexus: anomalous branching pattern

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ABSTRACT

Background: The brachial plexus is the plexus of nerves formed by the anterior rami of lower four cervical and the first thoracic spinal nerves with little contribution of prefix C4 and postfix T2 spinal nerve. The variations in formation, location, and courses of the cords of brachial plexus and the median nerve are not uncommon and were studied in both axillae.
Methods: The forty cadavers were studied preserved in the department of anatomy, SGRRIM and HS, Dehradun. 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: The musculocutaneous nerve communicates with the median nerve before and after piercing the coracobrachialis muscle. The lateral cord also gives the twig to the both roots of the median nerve. It also gives a branch which joined the ulnar nerve. The communication between medial root of median nerve and ulnar nerve also observed.
Conclusions: Out of 20 examined cadavers (forty upper limbs), the variations in the formation and distribution of branches of the brachial plexus were noted in nine limbs (22.5%). The both sides of the brachial plexus were inspected and it was not found bilateral variations even in a single cadaver. The knowledge of these variations may be helpful for the anatomists, radiologists, anaesthetist, neurosurgeons and orthopaedic surgeons during surgical operation of the upper limb.

Keywords: Brachial plexus, Variations, Lateral cord, Median nerve

INTRODUCTION

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.

The errors in distribution, formation, and communication between the branches may occur resulting in anatomical variations of the brachial plexus. These variations are not uncommon and are reported by many authors.[1,2] Some variations are vulnerable to damage in radical neck dissection and other surgical operations of the axilla and upper arm. On the basis of embryological development, anomalous pattern of the brachial plexus can be explained.

The growth as well as the path finding of nerve fibres towards the target is dependent upon 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. Misexpression of any of these signaling molecules can lead to abnormalities in the formation and distribution of particular nerve fibres.[3]

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.

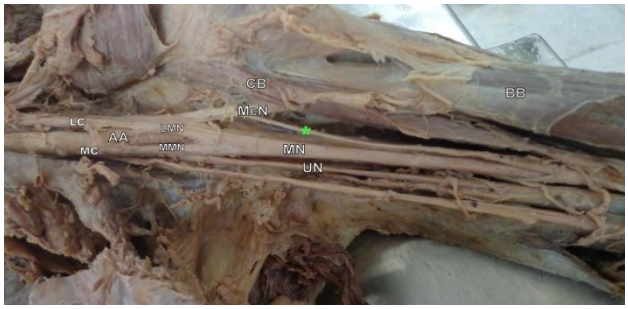
Anatomical variations of the infraclavicular part of the brachial plexus acquire clinical importance in post-traumatic evaluations and exploratory interventions of the arm for peripheral nerve repair. Some variations are vulnerable to damage in radical neck dissection and other surgical operations of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

METHODS

Our study was based on the dissection of the 60 upper limbs which belonged to 20 adult human cadavers of known sex, obtained from department of anatomy, SGRRIM and HS Dehradun, during the period between 2014 to 2016. In each cadaver, the axilla, pectoral region and arms of both the upper limbs were dissected and observed whether the variation, if any, was present unilaterally or bilaterally. 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 40 limbs (20 cadavers) we found that 31 limbs (77.5%) were normal regarding its formation and branching pattern and 22.5% limbs showed variations at different parameters. All the variations were unilateral.

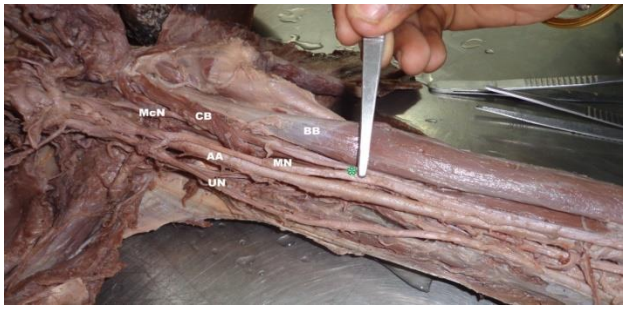


*Communicating branch; Bb - biceps brachii; Lmn: lateral root of median nerve; Mmn: medial root of median nerve; Un - ulnar nerve; Lc: lateral cord; Mc:medial cord; Aa: axillary artery.

Figure 1: Communication between musculocutaneous nerve (MCN) and median nerve (MN) before piercing the coracobrachialis muscle (CB).

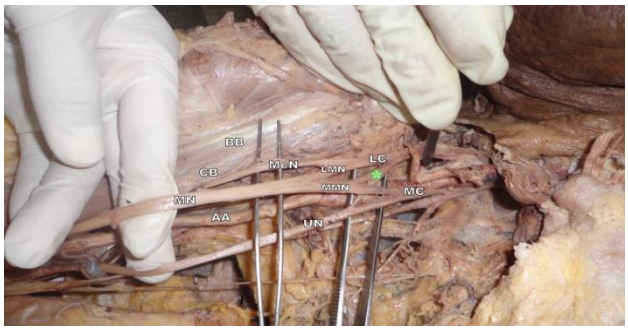
The lateral cord communicates with the medial root of median nerve and ulnar nerve both in one specimen (2.5%) on right side (Figure 3).

In 7.55% limbs it only communicates with the medial root of median nerve (Figure 4).



*Communicating branch; Bb: biceps brachii; Un: ulnar nerve.; Aa: axillary artery.

Figure 2: Communication between musculocutaneous nerve (MCN) and median nerve (MN) after piercing the coracobrachialis muscle (CB).

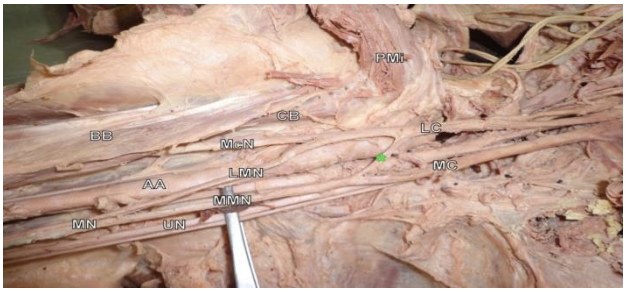


*Communicating branch; Coracobrachialis muscle (cb); Bb: biceps brachii; Lmn: lateral root of median nerve; Un: ulnar nerve; Mn: median nerve; Mcn: musculocutaneous nerve; Mc: medial cord; Aa: axillary artery.

Figure 3: Communication with lateral cord (LC) to medial root of median nerve (MMN) and ulnar nerve (UN).

In one specimen the MCN communicates with the medial root of median nerve on the left side before piercing the CB muscle (2.25%) and in other two (5.0%), it joined after piercing the CB muscle on the same side (Figure 1 and Figure 2).

In other two cases (5.0%) the medial root of median nerve joined the ulnar nerve on the left limbs (Figure 5).



*Communicating branch; Cb: coracobrachialis; Pmi: pectoralis minor; Bb:biceps brachii; Lmn: lateral root of median nerve; Un: ulnar nerve; Mn: median nerve; Mcn: musculocutaneous nerve; Mc: medial cord; Aa: axillary artery.

Figure 4: Communication between lateral cord (LC) to medial root of median nerve (MMN).

*Communicating branch; Cb – coracobrachialis; Pmi: pectoralis minor; Bb: biceps brachii; Lmn: lateral root of median nerve; Mn: median nerve; Mcn: musculocutaneous nerve; Mc: medial cord; Lc: lateral cord; Aa: axillary artery.

Figure 5: Communication between medial root of median nerve (MMN) and ulnar nerve (UN).

DISCUSSION

The brachial plexus is the nerve plexus which provide the muscular and cutaneous innervation of the upper limb. The anatomical variations in the formation and branching pattern of it have been reported earlier.[4,5]

Variations in the formation of the trunk of the brachial plexuses have also been reported by several authors. The absence of formation of superior and inferior trunk have been reported in 1% and 9% cases respectively.[6] In our study we have not seen any abnormal pattern in the formation of trunks.

In the present study all variations of the brachial plexus were observed. The musculocutaneous nerve (MCN) and the median nerve (MN) is the two major nerves which were found have numerous variations in their formation and branching pattern. Bergman et al reported that 90% of MCN arises from the lateral cord while in 2% of the cases it may arise from the MN or may be absent.[7] Le Minor explained that in the absence of MCN, the fibres of the MCN are distributed through the lateral root of MN.[8] The communication between musculocutaneous and median nerves are well documented (Yang et al., C. Priti et al.).[9,10] In our study the MCN were present in all cases but in one case it was found an unusual communication which joined the MCN to the MN before piercing the coracobrachialis (CB) muscle on the left arm. It was recorded by others in more than 20% of cases.[11,12] It were also found the MCN joined the MN after piercing the CB muscle in one case on the left side which was also reported by Ajayi et al in one case on the right side. The presence of additional root in the formation of MN has been reported by many authors.[13-15] our observations regarding these communications corroborate with the finding of C. Priti, et al, Loukas and Aqueelah.[10,16] Sunder et al also reported that MCN communicates with the median nerve in the arm.[17]

In other two cases on the right arm we found the abnormal communication arises as a single stem from the lateral cord and then after a very short course it is divided into two branches which joined with the medial root of median nerve and ulnar nerve. There are many reports regarding variations and branching pattern of brachial plexus. The incidence of formation of median nerve by two lateral roots and one medial root was described by P. Sharmila et al.[18] 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.[19,20] These concept correlates with the present study. But such type of communication is a rare finding of brachial plexus. These communications could complicate the management of regional pain syndrome because the sympathetic innervation of the upper limb is carried by the fibers of the median and ulnar nerves.[21]

In our study rather than linking of lateral cord to both median nerve and ulnar nerve we also found in one case of right limb that only the medial root of the median nerve had received a communicating channel from the lateral cord of brachial plexus. This finding correlates with study of Anju Bala et al in in 2 cases. Oluyemi et al observed an abnormal branch arising from lateral cord which communicated with the medial cord before the origin of medial root of median nerve. This does not correlate with present finding.[22,23]

In our observations in one case of left limb we found that the ulnar nerve received a communicating branch from media root of median. The communicating branches between median nerve to ulnar nerve at different levels have been mentioned earlier but this type of finding yet not been reported. The variations of the cords of brachial plexus and its terminal branches become important

during surgical exploration of the axilla and arm to avoid damage to the important nerves.[24] 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.[25]

CONCLUSION

The variations of the cords of brachial plexus and its terminal branches have been reported. The most common variations in the formation and branching pattern of musculocutaneous and the median nerve were reported. The communication between the lateral cord and ulnar nerve also has been noted. These variants are usually more prone to accidental injuries and entrapment neuropathies. Knowledge of such variations may provide additional anatomical information for the clinicians during diagnosis of unusual clinical symptoms and also become important for surgeons during surgical exploration of the axilla and arm to avoid damage to damage to these nerves.

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