Case Study

A Variant Two Trunked Brachial Plexus with Complete Fusion of Musculocutaneous & Median Nerve – A Case Report

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ABSTRACT

Brachial plexus is a network of spinal nerves supplying the upper limb with the root value C5-T1. These roots join with each other to form three trunks viz; the upper, middle and lower by union of C5, C6; continuation of C7 and union of the C8 and T1 respectively. During the routine dissection of left upper limb of an adult male cadaver, a variant pattern of two trunked brachial plexus was encountered. The upper trunk was formed by fusion of C5, C6 & C7 roots. The C7 root instead of continuing as middle trunk, joined with roots of C5 and C6 to form upper trunk. However formation of lower trunk was normal i.e. formed by union of C8 & T1. Additionally on this side, the musculocutaneous nerve was not piercing the coracobracialis muscle & in the distal part was completely fused with median nerve. On the other (right) side, the usual normal pattern of brachial plexus was seen. A knowledge of such variations is of interest to anatomists, clinicians, anesthesiologists and especially to the surgeons. These are of immense importance during surgical exploration of axilla and arm region and also during nerve block. It also helps clinicians in proper understanding of some previously unexplained clinical symptoms. The ontogeny, phylogeny & clinical significance of the entity are discussed in detail.

Keywords: Brachial plexus, median nerve, musculocutaneous nerve, roots, trunks.

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INTRODUCTION

The brachial plexus is a major and complicated plexus of nerves at the root of the neck [1]. It begins in the lateral cervical region (posterior triangle) and extends into the axilla in the angle between the clavicle and the lower posterior border of the sternocleidomastoid [2]. It is formed by the ventral primary rami of C5, C6, C7, C8 and part of T1 spinal nerves. These roots join with each other to form three trunks viz; the upper, middle and lower by union of C5, C6; continuation of C7 and union of the C8 and T1 respectively. The three trunks divide into anterior and posterior divisions. The anterior divisions of the upper and middle trunks unite to form the lateral cord. The anterior division of the lower trunk continues as the medial cord. The posterior divisions of all the three trunks unite to form posterior cord. These cords give rise to different nerves of the upper limb.

- Musculocutaneous Nerve is one of the terminal branches of lateral cord & after piercing the coracobrachialis muscle, supplies the muscles of anterior compartment of arm i.e. coracobrachialis, biceps brachii & brachialis.
- Median Nerve is formed by the union of lateral & medial roots (branches of lateral & medial cords respectively) & supplies most of the muscles of flexor compartment of forearm. It gives no muscular branch to muscles of the arm.

In the present case, there was absence of middle trunk along with complete fusion of musculocutaneous & median nerve in distal arm. Anomalies of the cords and terminal branches of the brachial plexus are relatively common and have been well documented [3], but along with anomalies

of the roots and trunks are comparatively rare, as seen in present case. As the brachial plexus supplies cutaneous and muscular innervation to the upper limb, its anatomical variations have important clinical implications. Therefore, a knowledge of anatomy & variational patterns of brachial plexus is extremely important not only to distinguish between the lesions, involving its roots, trunks, divisions or cords [4] but also for a proper treatment of these [5], not only for a surgeon but also to the radiologists and anaesthesiologists, neurosurgeons, neurologists, vascular surgeons and orthopaedic surgeons [6,7].

The aim of reporting the present case is to contribute further to the existing knowledge of the variations in the anatomy of brachial plexus, explaining its morphological and clinical significance.

MATERIALS & METHODS

During routine dissection of the left upper limb for teaching purposes, variations in the organization of a typical brachial plexus were found in a 55-year old male cadaver in the Department of Anatomy, G.G.S. Medical College, Faridkot. The brachial plexus was dissected and exposed according to the methods as described by Romanes [8] in Cunningham's Manual of Practical Anatomy. All its roots, trunks, divisions, cords and branches were cleaned and the pattern of the formation and branching was observed.

RESULTS

The following variants of brachial plexus were encountered.

- On the left side, there were two trunks instead of the usual three. The upper trunk was formed by fusion of C5, C6 & C7 roots. The C7 root instead of continuing as middle trunk, joined with roots of C5 and C6 to form a single trunk (termed as upper trunk in this case). The lower trunk was normally formed by union of C8 & T1. Lateral cord was formed as continuation of anterior division of upper trunk (C5, C6, C7). The medial cord was formed as continuation of anterior division of lower trunk (C8, T1). The fibres of C7 were going into lateral cord as they normally go but in a different variant manner. So the root value for lateral cord was normal ie, C5, 6, 7 and that of medial cord was C8, T1. Posterior cord was formed by fusion of posterior divisions of upper (C5, 6, 7) and lower (C8, T1) trunks. Further branchings of the medial & posterior cords were normal but branches of lateral cord had a variant pattern (**Fig. 1**).
- On the left side, other variation was of lateral cord. One of the terminal branches of the lateral cord i.e. the lateral root of the median nerve was thin and the most of the fibres of the lateral cord contributed to the formation of the musculocutaneous nerve which did not pierce the coracobrachialis muscle & joined the median nerve in distal arm after supplying all the muscles of the anterior compartment of the arm i.e. coracobrachialis, biceps brachii and the brachialis (**Fig. 2**).
- On the right side, the normal pattern of brachial plexus was seen.

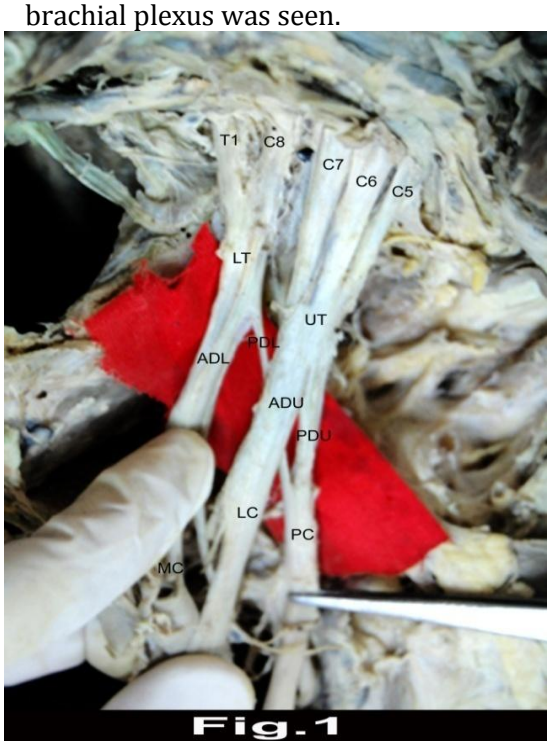

Fig.1

Legends of Fig. 1

- Upper trunk (UT) formed by C5, 6, 7; Lower trunk (LT) by C8 & T1.
- Lateral cord (LC) formed as continuation of anterior division of upper trunk (ADU).
- Medial cord (MC) formed as continuation of anterior division of lower trunk (ADL).

Posterior cord (PC) formed by union of posterior divisions of upper (PDU) and lower trunks (PDL).

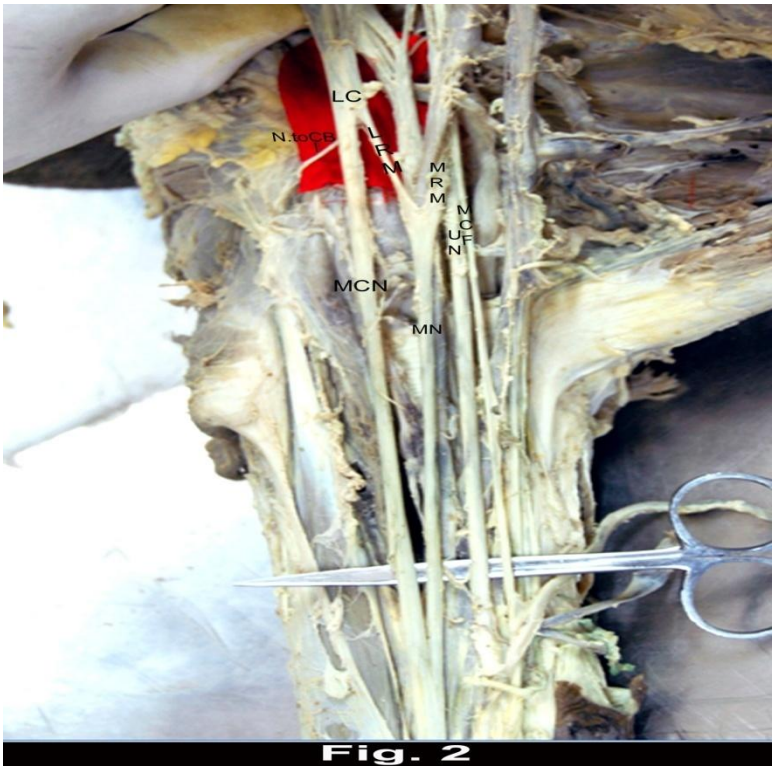

Fig. 2

Legends of Fig. 2

- LRM- lateral root of the median nerve, MCN- musculocutaneous nerve,
- N. to CB- nerve to coracobrachialis
- MRM- medial root of the median nerve, UN- ulnar nerve, MCF- medial cutaneous nerve of forearm.
- MN- median nerve
- MCN joining with MN in distal arm.

DISCUSSION

The brachial plexus variations could fail the brachial plexus loco-regional anaesthesia. In the surgical treatment of brachial plexus lesions, the surgeon must be familiar with its anatomical variations. Variations in the formation and branching pattern of brachial plexus have been documented well by many authors. Accurate knowledge of these variations other than that quoted in classical text books is important from both medical and surgical aspects.

The brachial plexus is formed by the ventral rami of C5, 6, 7, 8, and T1. These roots join with each other to form three trunks viz; the upper, middle and lower by union of C5, C6; continuation of C7 and union of the C8 and T1 respectively. Although uncommon, trunk variations have been noted in the literature. In particular, the absence of the inferior trunk characterized by the nonunion of C8 and T1 nerve roots has been reported [3, 9]. The absence of the middle trunk has also been observed, as in present case, the ventral rami of the C5, C6 and C7 nerve roots have been found to form the superior trunk at the expense of middle trunk & the lower trunk being formed by C8 and T1 [10,11]. The C7, C8 and T1 nerve roots have been shown to form the inferior trunk with the absence of the middle trunk [9].

Prakash *et al* [10] also observed that after giving two branches, that is, the suprascapular nerve and the nerve to the subclavius, the upper trunk (C5,6,7) divided into two divisions. The anterior division of the upper trunk continued as a lateral cord, while the posterior division combined with the posterior division of the lower trunk to form a posterior cord of brachial plexus. The anterior division of the lower trunk continued as a medial cord, as observed in the present case. According to him, all other parts of the brachial plexus were normal, but in present case, most of the fibres of the lateral cord contributed to the formation of the musculocutaneous nerve which did not pierce the coracobrachialis muscle & further joined the median nerve in distal arm.

Variations in the origin of the median & musculocutaneous nerve are quite common.

The commonest amongst these is the absence of musculocutaneous nerve with innervation of coracobrachialis, biceps brachii and brachialis by median nerve [12-16]. Another variation is communication between musculocutaneous nerve & median nerve. Venieratos and Anangnostopoulou [17] believed it to be the most frequent variant of this nerve where some fibres of the lateral root of the median nerve run along with the musculocutaneous nerve and after travelling some distance, leave the latter to join the ultimate destination (the median nerve). Complete fusion of musculocutaneous nerve & median nerve is not so common. In a study by Chaudhary et al [18] done on 60 limbs, the musculocutaneous nerve was seen coming as one of the terminal branches of the lateral cord in 54 (90.00%) limbs, being absent in rest of the 6 (10.00%) limbs, communicated with the median nerve through a communicating branch in other 6 (10.00%) limbs in the upper third of the upper arm. In 4 (06.66%) limbs, the musculocutaneous nerve after supplying some of the muscles of the anterior compartment of the arm fused with the median nerve. Out of these in one, it supplied the coracobrachialis; in two: coracobrachialis and biceps & in the fourth coracobrachialis, biceps & brachialis before joining the median nerve. The present case report is similar to pattern, seen in fourth case. Earlier Lang and Spinner [19] reported a complete fusion of the median and the musculocutaneous nerve. Similarly Watanabe et al [20] found 2 cases (1.4%) of fusion of musculocutaneous and median nerves among 140 upper limbs and Yang et al [21] encountered one such case out of 24 cadaveric specimens (4%).

Ontogeny:

Significant variations in the nerve patterns may be a result of the altered signalling between the mesenchymal cells and neuronal growth cones and once formed antenatally persist postnatally [22,23] or these may be due to circulatory factors at the time of fusion of the brachial plexus cords [24]**.**

The two trunked brachial plexus may be due to failure on part of radicular cone of nerves of upper limb to divide into different trunk. It may be attributed to the disproportionate display of chemoattractants and chemorepulsants as the guidance of developing axons is controlled by chemoattractants and chemorepullants.

The presence of the communications may be attributed to the random factors influencing the mechanism of formation of the limb muscles and the peripheral nerves during the embryonic life. Iwata [25] believed that the human brachial plexus appears as a single radicular cone in the upper limb bud, which divides longitudinally into ventral and the dorsal segments. The ventral segments give roots to the median and the ulnar nerves with musculocutaneous nerve arising from the median nerve. He further kept the possibility of failure of the differentiation as a cause for some of the fibres taking an aberrant course as a communicating branch. Chiarapattanakom et al [26] are of the opinion that the limb muscles develop from the mesenchyme of local origin, while axons of spinal nerves grow distally to reach the muscles and /or skin. They blamed the lack of coordination between the formation of the limb muscles and their innervation for appearance of a communicating branch.

Phylogeny Chauhan and Roy [27] strongly recommend the consideration of the phylogeny and the development of the nerves of the upper limb for the interpretation of the nerve anomalies of the arm. If we trace the phylogeny, no trunk formation is seen in amphibians, reptiles and dogs. Two trunks are formed in Marsupials and Lemurs, the two lowest roots (C8 & T1) form an inferior trunk and others (C5,6,7) a superior trunk. Similarly in Gorilla, two trunks are formed but with root value C4, 5, 6 for the first trunk and C7, 8, T1 for the second trunk [28]. Thus the present case is more close to Marsupials and Lemurs.

Considering the communication between the musculocutaneous and the median nerve as a remnant from the phylogenetic or comparative anatomical point of view and that the ontogeny recapitulates the phylogeny, Chauhan and Roy [27] feel that

the variations seen are the result of the developmental anomaly.

In dogs, the musculocutaneous nerve sends a communicating branch to the median nerve [28,29].

Clinical implications

The knowledge of variations in the formation of brachial plexus is important not only for the anatomists but also for the radiologists, anaesthesiologists, neurosurgeons and orthopaedic surgeons [30]. The awareness of the variations might also help in the surgical treatment of tumours of nerve sheaths such as schwannomas and neurofibromas & treating the non-neural tumours like lipoma. Orthopaedic procedures of the cervical spine also need a thorough knowledge of the normal and abnormal formation of brachial plexus [31].

Such a variant brachial plexus with two trunks, the upper trunk having root value C5,6,7 may give confusing clinical picture if affected by Erb's paralysis. In such cases, the injury may not remain confined to C5 or C6 only rather it may extend to C7 as well so the clinician must be familiar with such an anomaly when encountering an extended Erb's paralysis case.

CONCLUSION

The trunk variation presented in this case resulted in abnormalities of some of the terminal branches of the brachial plexus distal to the level of the cords. Therefore, it is likely that the variation would negatively affect the normal function of the upper limb although this cannot be proven with certainty. Moreover, the variation may have clinical implications during the anesthetic administration of an intrascalene nerve block.

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