Case Report

TRIFURCATION OF C_5 ROOT & ITS CLINICAL IMPORTANCE

Ambekar S.A.*, Dhanwate A.D.**, Diwan Chhaya V.***

ABSTRACT

Brachial plexus is a complex network of nerves, formed by ventral rami of lower four cervical and first thoracic nerves which supply the upper limb. Though its variations are common, terminal trifurcation of C5 is rare. During routine dissection in anatomy department, in an old male cadaver, multiple variations of brachial plexus were observed on the left side. It was unique with the absence of superior trunk and lateral cord. The C_5 root trifurcated terminally into suprascapular nerve, a root for musculocutaneous nerve (MCN) and posterior division for posterior cord. Musculocutaneous nerve was formed by two separate roots from C_5 and C_6. Axillary artery was intimately passing between two roots of MCN. Phrenic nerve carried fibres of the nerve to subclavius from C_5. Knowledge of these variations is important not only for anatomists but also to neurosurgeons, physicians and anaesthetists for diagnosis, planning the surgeries and avoiding the complications.

Key words – Brachial plexus, superior (upper) trunk, suprascapular nerve, musculocutaneous nerve, nerve impingement

INTRODUCTION

Normally the ventral rami of fifth, sixth, seventh, eighth cervical nerves and first thoracic nerve form the brachial plexus. These rami successively form the trunks, divisions and the cords. These cords and their branches appear in the axilla grouped around the axillary artery[1].

Though the variations of brachial plexus may not disturb normal functioning of upper limb, their knowledge is important during neurosurgery, orthopaedic procedures and anaesthesia to give the axillary block or avoid surprises during surgeries[2-5]. The present case reports uncommon variations of the brachial plexus in a male cadaver.

MATERIAL AND METHODS

During routine undergraduate dissection in department of Anatomy, variations in brachial plexus were observed in an old male cadaver on the left side. On the right side, brachial plexus was normally formed. Thorough dissection was done to expose the roots, trunks, divisions and cords. Variations were noted, photographed and labelled.

CASE REPORT

During routine undergraduate dissection in department of Anatomy, variations in brachial plexus were observed in an old male cadaver on the left side. The brachial plexus was formed by ventral rami of C_5 to T_1 roots (ph. 1,2). C_5 and C_6 failed to fuse so that the superior trunk and lateral cord were not formed. Middle and lower trunks were normal (formed by C_7 and C_8, T_1 respectively). C_5 divided terminally into two anterior and one posterior division (ph. 3).

One anterior division continued as suprascapular nerve. It reached superior border of scapula, passed beneath the transverse scapular ligament and followed its usual course to supply supraspinatous and infraspinatous.

The other anterior division formed one (lateral) root of musculocutaneous nerve (MCN), another root (medial) of MCN arose from C_6. Both roots fused to form MCN. Axillary artery passed intimately between the two roots (ph. 4).

Posterior division of the C_5 contributed to formation of posterior cord.

A branch arose from the C_5 root and joined the phrenic nerve. The fibres of nerve to subclavius were supplied through the phrenic nerve (ph. 2). Another branch arose from the same root, passed anterior to scalenus medius and divided into two, one contributed to long thoracic nerve and the other branch continued as dorsal scapular nerve. Long thoracic nerve was formed by branches from C_5, C_6 and C_7 roots (ph. 5).

C_6 divided into anterior and posterior divisions. Anterior division further divided into two branches, one formed the (medial) root of musculocutaneous nerve (MCN) (along with a root from C_5) and the other continued as lateral root of median nerve (C_5 did not contribute).

C_7 continued as middle trunk while C_8, T_1 joined to form the lower trunk. These trunks divided into anterior and posterior divisions. The anterior division of both the trunks formed a loop from which all branches of medial cord originated (ph. 3).

Posterior cord was formed by posterior divisions of C_5, C_6, middle and lower trunks. Branching pattern of posterior cord was normal.

Superior trunk was not formed as C_5 and C_6 failed to fuse. The lateral cord was absent as anterior division of C_7 did not fuse with C_5 or C_6. As a result, branches of lateral cord arose either from C_5 or C_6 or both. Only MCN received fibers from both C_5 and C_6 roots. C_7 did not contribute to MCN. Lateral root of median nerve arose from C_6 alone (ph. 6). Lateral pectoral nerve was absent and two medial pectoral nerves arose from medial cord. A variation in the formation of medial cord was also noted in the same cadaver, but only variation of C5 is discussed as the aim of this report is to focus on C_5 root and its clinical importance in absence of the superior trunk and the lateral cord.

Further course of the nerves in the limb was normal.

DISCUSSION

Variations in the branching pattern of brachial plexus are well documented in the literature. Prefixed and postfixed plexuses are mostly recorded (Hollinshead 1979)[1], (Uysal et al 2003)[6].

Uysal et al (2003)[6] examined 200 brachial plexus in human foetuses and observed that 107 plexuses had different variations. The superior trunk was not formed in 1% and inferior trunk was not formed in 9% of cases. Matejcik (2003)[5] reported a bilateral case of fusion of upper and middle trunks. Villamere (2009)[7] observed absence of superior trunk on the left side with absence of middle trunk and formation of inferior trunk by C_7, C_8 and T_1. In our case (ph1, 3), superior trunk was absent and branches of lateral cord arose either from C_5 or C_6 or both. Medial cord was formed by anterior divisions C_7, C_8 and T_1 (ph. 3) which is extremely a rare finding.

Kerr, et al (1918)[8] observed the superior trunk variation in 2 plexuses, both on the right side. In both cases, C_5 and C_6 roots were split in anterior and posterior division. Both anterior divisions joined to give origin to an "anterior superior trunk" and both posterior divisions joined to give origin to a "posterior superior trunk". These trunks joined to give origin to the superior trunk.

Singhal S. (2007)[2] mentioned about one anterior and two posterior divisions of middle and lower trunk. We observed that C_5 root trifurcated into two anterior and one posterior division. Such division of C_5 root, to the best of our knowledge, is not mentioned previously.

Shetty S. D. (2011)[3] studied variations of brachial plexus in 44 limbs and only 5 cadavers showed variations in formation of the trunks. In one cadaver middle trunk was formed by union of C_7 and C_8 roots and lower trunk was formed by T_1 root. Upper and middle trunks were fused in another specimen. One such abnormal trunk has been reported by Nayak et al (2005)[9].

In our case, C_5 fibres entered phrenic nerve to supply subclavius (ph. 2). Asli Aktan (2000)[10] noted connection between left phrenic and superior trunk. Matejcik V. (2005)[5] noted connection between phrenic and C_5 in only 2 out of 100 cases. Singhal S. (2007)[2] noted nerve to subclavius arose directly from C_5 before forming superior trunk.

Kerr[8] observed the origin of nerve to subclavius in common with a root of phrenic nerve in 24 cases out of 172 cases he studied. He also noted that nerve to subclavius alone or along with another nerve originated from only C5 in 26.5% cases.

It was observed in our case that a branch arose from the C_5 root, passed anterior to scalenus medius and divided into two, one contributed to long thoracic nerve and the other branch continued as dorsal scapular nerve. Long thoracic nerve was formed by

branches from C_5, C_6 and C_7 roots. Horwitz and Tocantins (1938)[11] reported common origin of dorsal scapular nerve with the contribution of C_5 to long thoracic nerve in 44% of cases. They also observed the rootlets of C_5 of long thoracic nerve pass through middle scalenus in 84% of cases, posterior to muscle in 2% and anterior to it in 14%.

Due to absence of superior trunk, suprascapular nerve arose from C_5 in this cadaver (ph. 3). Villamere (2009)[7] has also reported origin of this nerve from C_5 with the absence of superior trunk. Matejcik (2005)[5] noted 3 such cases out of 100 specimens. Kerr[8] found origin of suprascapular nerve from C_5 alone in fourteen cases and from anterior division of C_5 in one case. He also quoted that suprascapular nerve arose from C5 in seventeen cases.

Absence of superior trunk is discussed by few authors[6, 7] but we did not get reference about absence of lateral cord which is rare and noted in this case.

In our study, musculocutaneous (MCN) nerve arose from C_5 and C_6 by two separate roots (ph3,4) due to absence of superior trunk and lateral cord. Kerr (1918)[8] reported that in almost one third of cases musculocutaneous nerve did not receive C7 fibers. Walsh (1877)[12] reported that the MCN received fibers from C5 and C6 only in 50 of 73 cases. Ronald (2011)[13] in his encyclopaedia of anatomical variations mentioned that this nerve could be short, long or absent. After extensive search of literature, MCN arising from C_5 and C_6 by two separate roots was not found. Hence, it can be said that this is the unique case reported so far.

Axillary artery passed intimately between two roots MCN in our case. Many variations in the relationship of the axillary artery with the roots of the median nerve have been reported. The close relation of a nerve to an artery could result in its compression. Previous cases of axillary artery compression were reported in the literature.

Badawoud (2003)[14] reported two communicating branches between the lateral and medial roots of the median nerve in a close relation to the axillary artery and S. Nayak (2007)[9] observed two abnormal bands connecting medial root of median nerve with its lateral root compressing the third part of the axillary artery. Similar cases were reported by Saeed M and Rufai A (2003)[15]; Singhal S (2007)[2] and Sontakke et al (2011)[16]. They stated that axillary artery when passed intimately between two nerves may get compressed and reduce the blood supply to the upper limb.

Vollala et al (2008)[17] reported an abnormal root of median nerve coming from the lateral cord having a very close oblique course over the distal part of the axillary artery. Such variations are more prone to injury in radical neck dissection and in other surgical operations of the axilla and may result in its compression leading to ischemic pain or variable arterial insufficiency during certain postural maneuvers of the shoulder joint. It may also complicate an anterior surgical approach to the shoulder joint.

Many variations in the relationship of the axillary artery with the roots of the median nerve have been reported earliar as discussed above. Origin of Musculocutaneous nerve by two roots and its intimate relation with the axillary artery has not yet been reported, whether it will lead to any complications is again a mystery. Hence this is an unique variation focusing light on various aspects to be considered clinically and for the research.

Lateral pectoral nerve was absent and two medial pectoral nerves arose from medial cord in our case. Gupta et al (2005)[18] has reported two lateral pectoral nerves (LPN) from anterior division of upper and middle trunk instead of lateral cord. Kerr (1918)[8], Hollinshead (1958)[1] and Williams et al (1995)[19] described same origin of this nerve. Rao and Chaudhary (2001)[20] observed two cases in which LPN arose from lateral cord. S. Singhal (2007)[2] reported origin of this nerve from posterior division of upper trunk. Absence of lateral pectoral nerve is relatively rare.

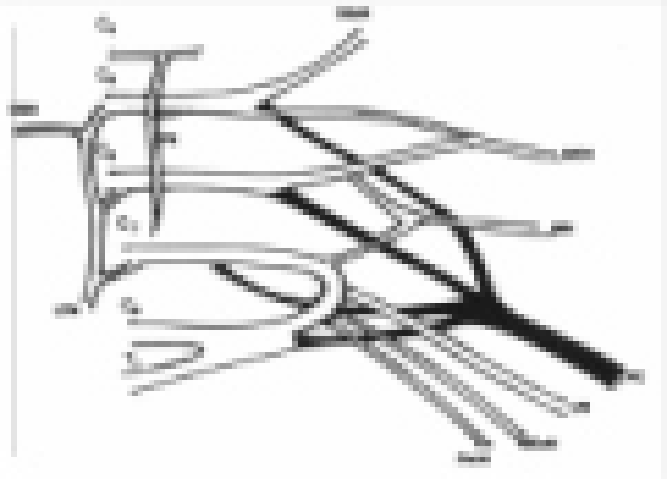
Ronald A. (2011)[13] in his encyclopaedia of median nerve, mentioned about absence of T_1 in formation of median nerve but we noted C_5 failed to contribute (ph.6) for the median nerve. Such variant formation of median nerve, to the best of our knowledge is not

yet documented in the literature.

Other branches of medial cord and posterior cord followed routine course in the limb.

CLINICAL ASPECTS

1. Variant nerves, in terms of unusual beginning, course or distribution, are usually prone for injuries and entrapment neuropathies[21].
2. Absence of the superior trunk results in full force of strain to C_5 root. So, due to traction injury of brachial plexus, a force that does not cause C_5 avulsion normally, may lead to it in absence of superior trunk[7].
3. C_5 impingement with the variations demonstrated in this case would likely cause complete supraspinatus muscle paralysis[7].
4. C_5 nerve root impingement may result in partial paralysis of the deltoid, biceps, brachialis muscles. It may also manifest by partial paralysis of wrist extensors, brachioradialis, supinator and muscles[5].
5. MCN is always spared during infraclavicular axillary block, knowledge of variations of MCN is necessary to avoid surprises during anesthesia.
6. The knowledge of variations of brachial plexus is useful for neurosurgeons for treating tumors of nerve sheaths such as schwannomas, neurofibroma and non neuronal tumors like lipoma and during orthopedic treatments of cervical spine or fractures of upper limb[9].
7. During surgical procedures of axilla and shoulder, surgeon is exposed to anatomy of neural structures and awareness of such variations may be of immense clinical help[22].
8. It also helps anesthetist in proper planning of brachial plexus blocks[23] and orthopedists for routine and reconstructive operations in arm[9].
9. The close relationship of the variant nerves with the axillary artery may result in arterial compression leading to ischemic pain or arterial insufficiency during certain postural maneuvers of the shoulder joint[15,17].
10. This kind of case may provide additional explanation for unexpected clinical symptoms that depend on different nerve courses and origins and can motivate the researchers.



Photograph 1 (ph. 1) - schematic representation of variations of brachial plexus

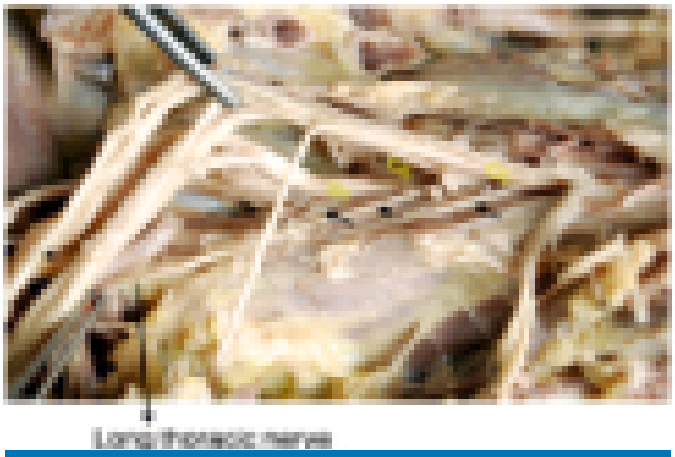
N – nerve, PN – phrenic N., SScN – suprascapular N., DSN – dorsal scapular N., LTN –long thoracic N., MCN – musculocutaneous N., MN – median N., PC – posterior cord PctN – pectoral nerves, MCuN – medial cutaneous nerve of arm and forearm UN-ulnar nerve

Photograph 2(ph. 2) – roots and formation of phrenic nerve, note the fibres of C5 joining with fibres from C^4.

photograph 3(ph. 3) - C_5 dividing in two anterior and one posterior branches also note that C_7 forming loop with C_8 and T_1

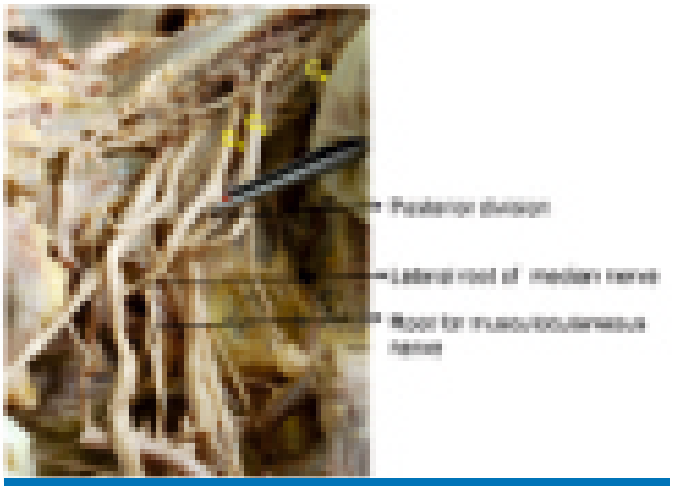
LT – Lower trunk formed by C_8 and T_1

photograph 4(ph. 4) - showing intimate relation between axillary artery and two roots of musculocutaneous nerve



photograph 5(ph. 5) – formation of long thoracic nerve, note the branches from C_5, C_6 and C_7 Picture taken after reflecting C_5, C_6 with their anterior and posterior divisions

Arrows on the roots of long thoracic nerve



Photograph 6 (ph. 6) – Note Lateral root of MN arising from C_6 only

Photograph taken after cutting axillary artery for better exposure of plexus.

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1. **Dr. Ambekar Swapna A.,**
Assistant Professor
Department of Anatomy
Government Medical College & Hospital,
Aurangabad, Maharashtra (India)

2. **Dhanwate Anant D.,**
Assistant Professor
Department of Anatomy
Government Medical College, Aurangabad,
Maharashtra (India)

3. **Diwan Chhaya V.**
Professor and Head
Department of Anatomy
Government Medical College, Aurangabad,
Maharashtra (India)