

Original communication**CONCURRENT VARIATIONS IN THE FORMATION OF LATERAL CORD AND MEDIAN NERVE OF BRACHIAL PLEXUS****Virendra Budhiraja, Rakhi Rastogi***Department of Anatomy, L.N. Medical College, Bhopal, India***RESUMEN**

El cordón lateral y el nervio mediano se asocian a variaciones. Observamos variaciones simultáneas en la formación del cordón lateral y nervio mediano en treinta y dos cadáveres fijados en formol. En 29,6% de extremidades superiores el cordón lateral se formó por la división anterior del tronco superior solamente. En el 21,8% de estos casos la división anterior del tronco medio formó dos raíces adicionales para el nervio mediano y en 7,8% de los casos la división anterior del tronco medio se unió con la raíz medial del nervio mediano. En el 14% de las extremidades superiores no se formó la parte superior del tronco y el cordón lateral se formó por la unión de la división anterior de las raíces C5, C6 y C7. En 6.2% de esos casos donde no se formó la parte superior del tronco, el nervio mediano recibió una raíz adicional del cordón lateral. Creemos que el conocimiento previo de estas variaciones anatómicas es de interés para el anatomista y médico por igual. Los cirujanos que realizan procedimientos que implican neoplasias o reparar traumatismos necesitan ser conscientes de estas variaciones.

Palabras clave: *variaciones anatómicas; cordón lateral; nervio mediano.*

ABSTRACT

Lateral cord and median nerve are associated with variations. We observed concurrent variations in the formation of lateral cord and median nerve in thirty two formalin fixed cadavers. In 29.6% upper limbs Lateral cord was formed by anterior division of upper trunk only. In 21.8% of these cases the anterior division of middle trunk formed two additional roots for the median nerve and in 7.8% cases anterior division of middle trunk joined with medial root of median nerve. In 14% upper limbs the upper trunk was not formed and the

lateral cord was formed by union of anterior division of C₅, C₆ and C₇ roots. In 6.2% of such cases where upper trunk was not formed, the median nerve received an additional root from lateral cord. We believe that prior knowledge of such anatomical variations is of interest to the anatomist and clinician alike. Surgeons who perform procedures involving neoplasms or repairing trauma need to be aware of these variations.

Key words: *Anatomical variations; Lateral cord; Median nerve*

INTRODUCTION

The brachial plexus (BP) is a major and complicated plexus at the root of neck. It is formed by the union of the ventral rami of inferior four cervical (C₅-C₈) and first thoracic (T₁) nerves. Upon exit from the intervertebral foramina, the ventral rami of C₅ and C₆ cervical nerves unite to form upper trunk. Ventral ramus of C₇ nerve continues as the middle trunk and the ventral rami of C₈ and T₁ nerves unite to form the lower trunk. Each trunk bifurcates into anterior and posterior divisions. The anterior division of upper and middle trunk forms the lateral cord (LC).

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The anterior division of lower trunk continues as the medial cord. The posterior divisions of all three trunks unite to form posterior cord (Snell, 2004; Standing et al, 2005). Normally the LC after giving the lateral pectoral nerve divides into musculocutaneous nerve and lateral root of the median nerve (MN). The lateral root then joins the medial root from the medial cord to form the median nerve (Venieratos and Anagnostopoulou, 1998). Understanding of the anatomical variations of the BP is important for diagnosing unexplained clinical cases during surgical procedures to the neck and axillary region. It also facilitates the anesthesia in that region

(Orebaugh and Williams, 2009; Sassoli Fazan et al, 2003; Loukas et al, 2008).

MATERIAL AND METHOD

Thirty two formalin fixed cadavers (sixty four upper limbs) obtained from Anatomy department of L.N. Medical College constitute the material for study. During routine dissection of root of neck and axilla, various muscles were reflected to note the variations in the formation of lateral cord and median nerve of brachial plexus.

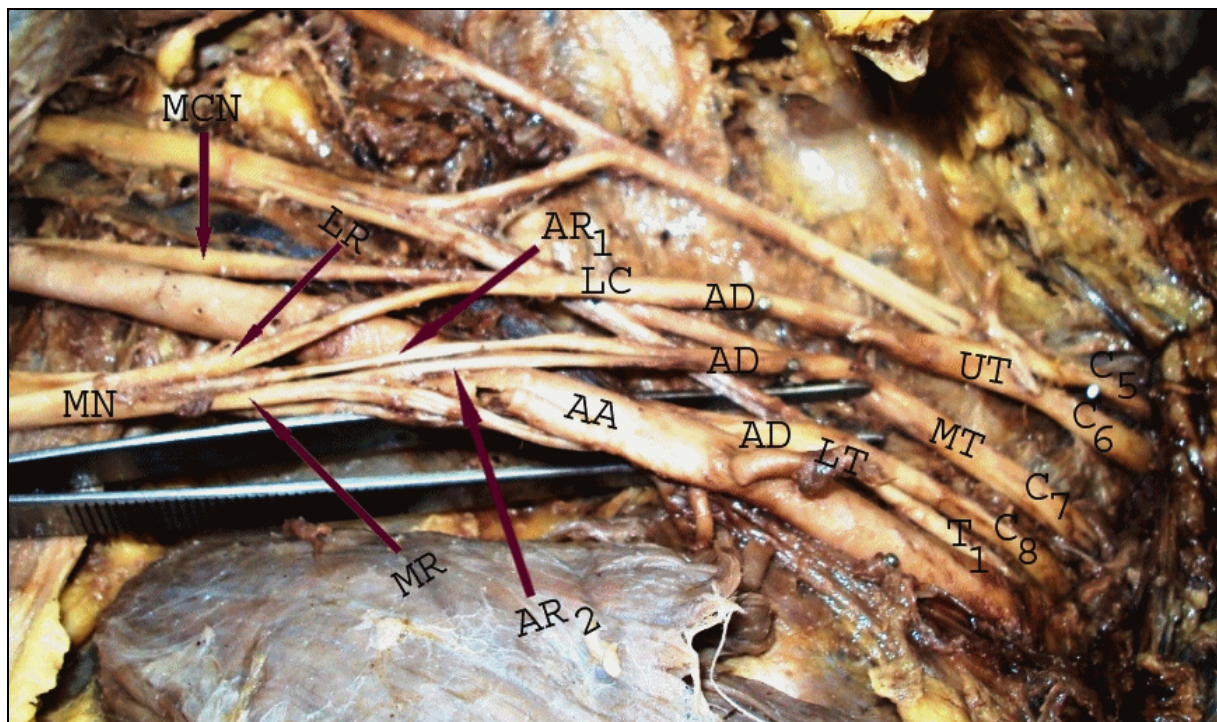


Figure 1- Showed Lateral cord of brachial plexus formed by anterior division of upper trunk. Anterior division of middle trunk provides two additional roots for median nerve. C₅, C₆, C₇, C₈, T₁- roots of brachial plexus, UT-upper trunk, MT-middle trunk, LT-lower trunk, AD- anterior divisions of upper, middle and lower trunks, AA-axillary artery, LC-lateral cord, AR₁- first additional root, AR₂-second additional root, LR-lateral root, MR-medial root, MN-median nerve, MCN- musculocutaneous nerve.

RESULTS

We observed formation and branching pattern of LC in thirty two formalin fixed cadavers (sixty four upper limbs). In thirty six (56.2%) upper limbs LC showed usual formation by union of anterior division of upper and middle trunk. In nineteen (29.6%) upper limbs LC was formed by anterior

division of upper trunk only (Fig. 1, Fig. 2). In fourteen (21.8%) of these cases the anterior division of middle trunk formed two additional roots for the MN (Fig. 1) and in five (7.8%) cases anterior division of middle trunk joined with medial root of median nerve (Fig. 2). In nine (14%) upper limbs the upper trunk was not formed. In these cases the LC was formed by

union of anterior division of C₅, C₆ and C₇ roots (Fig. 3). In four (6.2%) of such cases where upper trunk was not formed the MN received an additional root from lateral cord (Fig. 3). In five

(7.8%) upper limbs MN formation was normal by lateral and medial root even in absence of upper trunk.

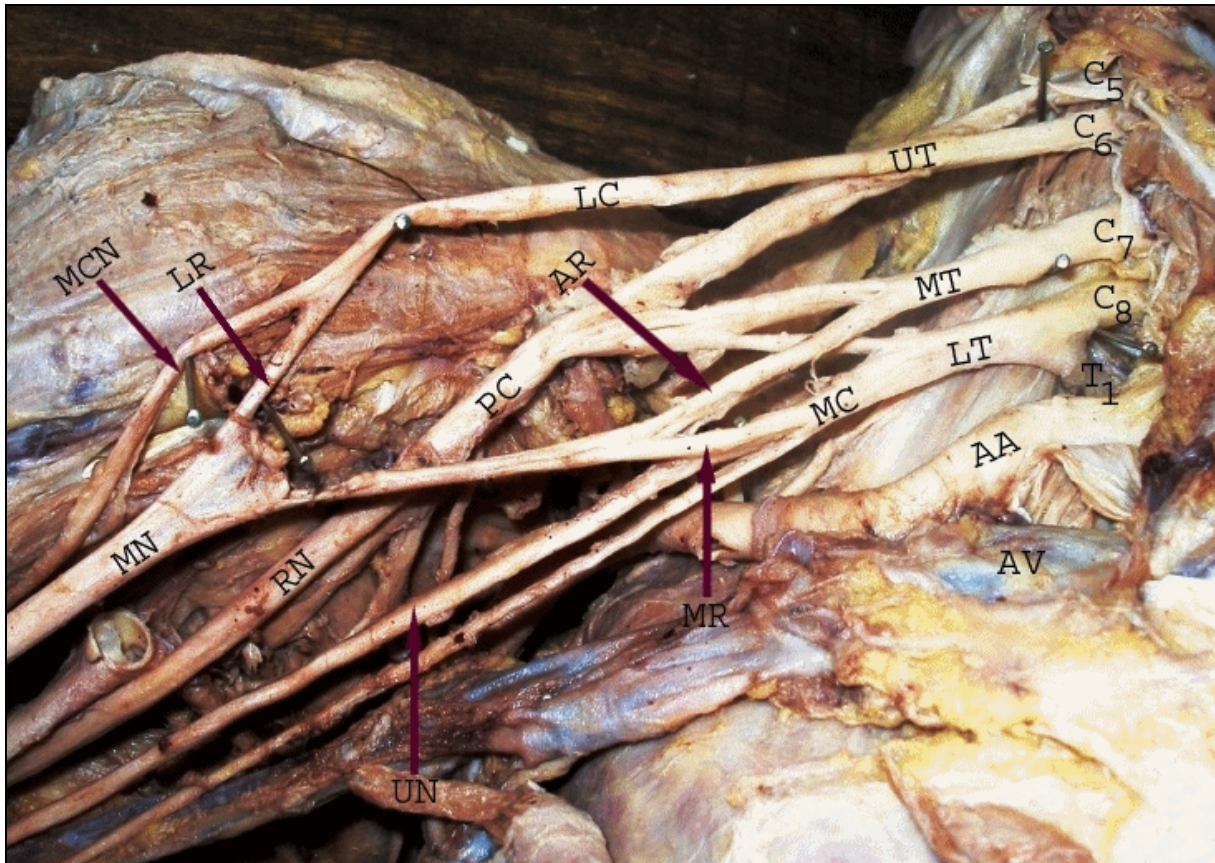


Figure 2- Shown- Lateral cord of brachial plexus was formed by anterior division of upper trunk. Anterior division of middle trunk forms additional root for median nerve and joins the medial root. C₅, C₆, C₇, C₈, T₁- roots of brachial plexus, UT-upper trunk, MT-middle trunk, LT-lower trunk, AA-axillary artery, AA- axillary vein, LC-lateral cord, PC- posterior cord, AR- additional root, LR-lateral root, MR-medial root, MN-median nerve, RN- radial nerve, UN- ulnar nerve, MCN- musculocutaneous nerve.

DISCUSSION

The knowledge of variations in the formation, course and branching of the lateral cord of brachial plexus assumes importance while performing shoulder arthroscopy and shoulder reconstructive surgeries (Chitra, 2007). Uzun and Bilgic (1999) in their study on one hundred and thirty brachial plexus observed that in four brachial plexus, LC was formed by continuation of anterior division of upper trunk alone. In the present study we also observed formation of the LC by continuation of anterior division of upper trunk alone in 29.6% cases (Fig.1).

Matejcik (2003) described in three cases and Villamere et al (2009) and Singla et al, (2011) in their case reports did not find formation of upper trunk. In these cases C₅ and C₆ root united with that of C₇ root to form LC. In our study upper trunk was not formed in 14% cases (Fig.3). The LC was formed by union of anterior division of C₅, C₆ and C₇ roots. The brachial plexus without upper trunk may increase the chance of nerve root avulsion due to downward traction injury (Stevens, 1988).

These variations can be correlated embryologically. Position and width of a limb bud determines its innervation. Limb bud is supplied

by nerves of region where it is implanted. Segregation of the developing structure within the limb directs growing nerve fibers (axons) and determines their grouping into bundles leading to formation of roots and trunks (Keibel et al, 1912). As the expression of chemoattractants and chemorepulsants regulates the growing nerve fibers (axons) in a highly coordinated site specific fashion, any alterations in signaling between the mesenchymal cells and neuronal growth cones can lead to significant variations (Sannes et al, 2000). In the present study non formation of

upper trunk appears to be a result of over expression of chemo attractants/repulsants, leading to separation of the C₅ and the C₆ roots. Miller (1932) in different vertebrates observed the pattern of roots, trunks, cords and branches of brachial plexus. He reported no trunk formation in amphibians, reptiles and dogs. In our study 14% cases showed absence of the upper trunk (Fig. 3). These cases partially fit into this category of amphibians, reptiles and dogs indicating ontogeny repeats phylogeny.



Figure 3- Shown- lateral cord of brachial plexus was formed by anterior division of C₅, C₆ and C₇ roots in the absence of upper trunk. C₅, C₆, C₇, C₈, T₁- roots of brachial plexus, LT-lower trunk, AA- axillary artery, LC-lateral cord, PC- posterior cord, LR-lateral root, MR-medial root, AR- additional root, MN-median nerve, MCN- musculocutaneous nerve.

Median nerve is associated with several variations which include communication with musculocutaneous nerve (Chauhan and Roy, 2002), splitting of the median nerve (Sundaram et al, 2008) and unusual innervations of the flexor muscles of arm (Nayak, 2007). Variations in the

MN formation with an additional root that arose from LC were also reported earlier (Pais et al, 2010; Sontakke et al, 2011). In the present study we observed variations in the formation of MN in concurrence with unusual formation of lateral cord. In our study in 21.8% cases anterior

division of middle trunk provides additional roots to the MN (Fig.1). In 7.8% cases anterior division of middle trunk joins with medial root of median nerve to provide C₇ fibers to MN (Fig.2).

We believe that prior knowledge of such anatomical variations of lateral cord and median nerve is of interest to the anatomist and clinician. Variations assume significance during surgical exploration of the axilla and can even lead to failure of nerve block of the infraclavicular part of brachial plexus. Surgeons who perform procedures involving neoplasm or repairing trauma needs to be aware of these variations.

REFERENCES

- Chauhan R, Roy TS.* 2002. Communication between median and musculocutaneous nerve-A case report. *J Anat Soc India* 51: 72-5.
- Chitra R.* 2007. Various types of inter-communications between musculocutaneous and median nerve-A analytical study. *Ann Indian Acad Neurol* 10: 100-4.
- Keibel NZ, Mall FP.* 1912. Nerves of the arm and leg In: Keibel NZ editor. 1st ed. *Manual of human embryology.* Philadelphia: J.B. Lippincott, 122-8.
- Loukas M, Tubbs RS, Stewart D.* 2008. An abnormal variation of the brachial plexus with potential clinical significance. *West Indian Med J* 57: 403-5.
- Matejcek V.* 2003. Aberrant formation and clinical picture of brachial plexus from the point of view of a neurosurgeon. *Bratisl Lek Listy* 104: 291-9.
- Millar RA.* 1932. Comparative studies upon the morphology and the distributions of the brachial plexus. *Am J Anat* 54: 143-75.
- Nayak S.* 2007. Absence of musculocutaneous nerve associated with clinically important variations in the formation, course and distribution of median nerve. *Neuroanatomy* 6: 49-50.
- Orebaugh SL, Williams BA.* 2009. Brachial plexus anatomy: normal and variant. *Scientific World Journal* 9: 300-12.
- Pais D, Casal D, Santos A, O'neill JG.* 2010. A variation in the origin of median nerve associated with unusual origin of the deep brachial artery. *J Morphol Sci* 27: 35-8.
- Sannes HD, Reh TA, Harris WA.* 2000. Development of nervous system. In; *Axon growth and guidance.* New York: Academic press, 189-97.
- Sassoli Fazan VP, Sc Souza Amadeu A, Caleffi AL, Rodrigues Filho OA.* 2003. Brachial plexus variations in its formation and main branches. *Acta Cir Bras* 18: 14-8.
- Singla RK, Mahajan R, Sharma R, Sharma T.* 2011. Bilateral non-formation of upper trunk of the brachial plexus with a unilateral communication between the musculocutaneous nerve and the median nerve: A case report. *J Clin Diag Research* 5: 1637-40.
- Snell RS.* 2004. *Clinical anatomy by regions.* 7th ed. Canada: Lippincott Williams and Wilkins.
- Sontakke BR, Tarnekar AM, Waghmare JE, Ingole IV.* 2011. An unusual case of an asymmetrical formation and distribution of median nerve. *Int J Anat Var* 4: 57-60.
- Standring S, Berkowitz BKB, Hackney CM, Ruskell IGL.* 2005. *Gray's Anatomy, The anatomical basis of clinical practice.* 39th ed. New York: Churchill and Livingstone.
- Stevens JH.* 1988. Brachial plexus paralysis. *Clin Orthop Relat Res* 237:4-8.
- Sundaram SM, Kumar MSJ, Sethupathi BB, Nayak S, Krishnamurthy A.* 2008. Split median nerve with variation in its common digital branch. *Neuroanatomy* 7: 15-6.
- Uzun A, Bilgic S.* 1999. Some variations in the formation of the brachial plexus in infants. *Tr J of Med Sci* 29: 573-7.
- Venieratos D, Anagnostopoulou S.* 1998. Classification of communications between the musculocutaneous and median nerve. *Clin Anat* 11: 327-31.
- Villamere J, Goodwin S, Hincke M, Jalani A.* 2009. A brachial plexus variation characterized by the absence of the superior trunk. *Neuroanatomy* 8: 4-6.