

Research Article

Variation in brachial plexus formation, branching pattern and relation with major vessels

G. Anwer Khan^{1,*}, Deepak Kafle², Shekhar K. Yadav¹, Om Shrestha¹, Arun Dhakal¹,
Sudeep K. Yadav¹, Ranjit Guha³

¹Department of Anatomy, ²Department of Biochemistry, Chitwan Medical College, CMC, ³Department of Anatomy, College of Medical Sciences, CMS, Bharatpur, Nepal

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*Correspondence:

Dr. G Anwer Khan,

E-mail: aanwer227@gmail.com

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ABSTRACT

Background: Anatomical variations in the formation, branching pattern and relations of the brachial plexus have been described in humans by many authors; however these have not been extensively catalogued. The aim of the study was to describe variations in brachial plexus formation, branching pattern and relation with major vessels.

Methods: This study included thorough dissection of 60 brachial plexuses which belonged to 30 cadavers (male: female ratio = 28:02) with age range of 20-60 years, obtained from the Department of Anatomy, College of Medical Sciences (CMS-TH), following standard guidelines.

Results: Out of 60 limbs dissected in present study, the variation in formation was found in 20 limbs (33.3%), out of which 12 limbs (20%) had variations in the trunk and 8 limbs (13.3%) had variations in the cord, remaining 40 limbs (66.6%) were normal in the formation of brachial plexus. Normal branching pattern of the posterior cord was encountered in 52 (86.67%) limbs, the remaining 8 (13.33%) being variants in one form or the other. The upper subscapular nerve, the thoracodorsal nerve, the lower subscapular nerve and the axillary nerve were found to arise normally in 91.66%, 96.66%, 96.66% and 98.33% of the limbs respectively.

Conclusion: The present study carried out on adult human cadavers revealed some rare variations in the formation, branching pattern and relations of the brachial plexus. These variations are of clinical significance for the surgeons, radiologists and the anesthesiologists.

Keywords: Brachial plexus, Branching pattern, Anatomical variation

INTRODUCTION

The brachial plexus, normally is formed by lower four cervical ventral rami (C5, C6, C7, C8) and greater part of the first thoracic ventral ramus (T1). It consists of roots, trunks, divisions and cords (lateral cord, medial cord and posterior cord).¹ 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. Branches of the brachial plexus are divided into supraclavicular and infraclavicular branches, supraclavicular branches are

four (dorsal scapular nerve C5, a branches to join the phrenic nerve C5, long thoracic nerve C5,C6,C7, muscular branches to longus colli and scalene) from roots and two from upper trunk (nerve to subclavius and suprascapular nerve); infraclavicular branches are three from lateral cord (lateral pectoral nerve, musculocutaneous nerve and lateral root of median nerve), five from medial cord (medial pectoral nerve, medial cutaneous nerve of forearm, medial cutaneous nerve of arm, ulnar nerve C7,C8,T1 and medial root of median nerve) and five from posterior cord (upper subscapular nerve C5,C6, thoracodorsal nerve C6,C7,C8,

lower subscapular nerve C5,C6, axillary nerve C5,C6, and radial nerve C5,C6,C7,C8,T1).²

METHODS

The study comprised of 60 upper limbs which belonged to 30 adult human cadavers of known sex [male: female ratio 28:02], obtained from mortuary of the Department of Anatomy, College of Medical Sciences and Teaching Hospital, Bharatpur, Chitwan, during the period between March 2009 to October 2012. The cadavers used in the current study were serialized from 1-30 with the suffixes ‘M’ for male, ‘F’ for female, ‘R’ for right and ‘L’ for left. Ethical approval was granted by the (Institutional Review Committee) of College of Medical Sciences and Teaching Hospital, Bharatpur, Chitwan.

The limbs of all cadavers were meticulously dissected (axilla, arm, cubital fossa, forearm and palm). The brachial plexus was dissected and exposed according to the methods described by Romanes in Cunningham’s Manual of Practical Anatomy. All its roots, trunks, divisions,

cords and branches were cleaned and the mode of their formation, branching pattern and relations with major blood vessels of upper limbs (especially axillary and brachial arteries) were observed and noted. In each cadaver, both the upper limbs were dissected to note whether the variation, if any, was present unilaterally or bilaterally. The distances were measured at different branches of posterior cord of brachial plexus from origin of the parent cord; a thread was kept along the length of that part and was marked with Indian ink at designated points. The thread which was thus marked was lifted off the dissection area and spread along a graduated metric scale to measure the length in centimeters scale. All findings with regard to the variations in the formation of trunks and cords of brachial plexus, distribution of the branches derived from the cords and anomalous relationship of trunks, cords and their branches with major blood vessels of the upper limb were documented and recorded. Statistical analysis was done wherever applicable.

RESULTS

Table 1: Showing Sidedness (right and left) of variations of brachial plexus.

Brachial plexus	Right		Left					
	Variation	Percent	Normal	Percent	Variation	Percent	Normal	Percent
Formation of Trunks	7	23.4	23	76.6	5	16.2	25	83.3
Formation of Cords	5	16.6	25	83.3	3	10	27	90
Branching pattern	5	16.6	25	83.3	5	16.5	25	83.3
Relations with blood vessels	0	0	30	100	1	3.3	29	96.6

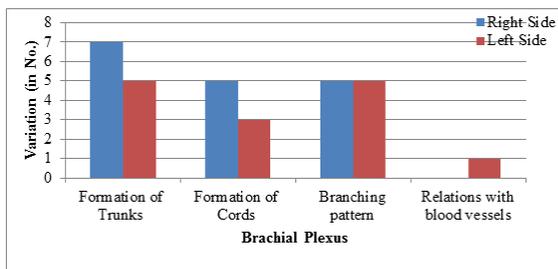


Figure 1: Showing sidedness (right and left) of variations of brachial plexus.

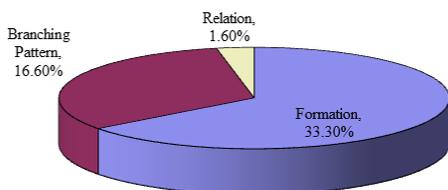


Figure 2: Showing variation (formation, branching pattern and relation) of brachial plexus.

From the experimental observation on cadaveric dissection of trunk we found that 40 limbs (66.6%) were normal regarding the formation. Among the limbs with variation 12 (20%) had variation in formation of the trunks and 8 (13.3%) had variation in formation of the cords. The majority of variations were observed in upper and middle trunks (8/12). Interestingly, 3 of the limbs had 4 trunks instead of usual 3 trunks. All these variations were noted in the left side, two in female (with approximate age of 30 & 45 years) and one in male (with approximate age of 30 years) cadavers.

From the observations after dissection of cords of the brachial plexus 1 limb, instead of having the lateral, medial and posterior cords, only two cords, anterior and posterior were present lateral to the axillary artery and the anterior cord was representing the fusion of lateral and medial cords. The variation was present in the left side of a 60 years male cadaver. Out of 3 limbs where presence of 4 trunks of brachial plexus was noted, 2 limbs (3.3%) revealed formation of the posterior cord by the union of

the posterior divisions of the Ist, IInd and IIIrd trunks (root value- C5,C6; C7; C8 respectively; as whole of the IVth trunk (T1, T2) was continuing as the anterior division only, there being no posterior division) and in 1 limb (1.6%) the posterior cord was formed by the union of the posterior divisions of all the four trunks i.e., trunks I, II, III and IV (root value- C4,5,6; C7; C8; T1,T2 respectively). The aforementioned variations were noted on left upper limbs of two female and one male cadaver. Finally, the posterior cord was formed by the posterior divisions of the upper and middle trunks in 5 limbs (8.3%), all from right male cadavers.

Similarly, variations related to the branching pattern of brachial plexus were found only in relation to posterior cord of male cadaver, branching pattern of medial and lateral cord being normal in all cadavers. The normal branching pattern of the posterior cord was encountered in 50 (83.33%) limbs in the present study, the remaining 10 (16.66%) being variants in one form or the other.

In the present study some rare variations with regard to the relations of cords of brachial plexus, median and ulnar nerves with the third part of axillary artery and brachial artery were noted in the left upper limb (1.6%) of an adult male cadaver with approximate age of 55 years. All the three cords namely lateral, medial and posterior cords of brachial plexus were noted to be lateral to the third part of the axillary artery. It was also noted that they maintained the same relation with the first and second parts of axillary artery.

The ulnar nerve was noted to arise from medial cord at a lower level than usual overlapped by the junction of medial and lateral roots of median nerve. Furthermore, ulnar nerve was lateral to brachial artery instead of descending between axillary artery and axillary vein. Infact, ulnar nerve was found to be between the brachial artery medially and median nerve laterally.

DISCUSSION

Variations in the formation and branching pattern of the brachial plexus are common and have important clinical significance. However, the concurrent presence of variant muscles and vessels in intimate relationship with such variations of the brachial plexus can further complicate the clinical picture.

Common variations in the formation of brachial plexus, prefixed and postfixed plexuses, have been well documented.³⁻⁶ Variations in the formation of the trunks of the brachial plexuses have been reported.⁶ An extensive study by Uysal et al., (2003) showed superior trunk not being formed in 1% of cases, inferior trunk not being formed in 9% of cases and formation of superior trunk by C4 and C5 roots and formation of inferior trunk by T1 and T2 roots.⁷ Satheesha Nayak et al reported absence of middle trunk and variation in the formation of upper trunk by union of C5, C6 and C7 spinal nerves.⁸

The knowledge of variations in the formation of brachial plexus is very useful for a wide variety of specialist such as anatomists, radiologists, anesthesiologists, neurosurgeons and orthopedics surgeons.⁹

In the present study, all variations related to the branching pattern of brachial plexus were found only in relation to posterior cord, branching pattern of medial and lateral cords being normal in all cadavers. Kerr¹⁰ had come across such a variant origin in 25.4% of his dissections and Fazan et al¹⁰ & Ballesteros and Ramirez¹² had come across such a variant origin in 59% and 50% of their dissections. No explanations can be given for such a wide discrepancy. Fazan et al¹¹ reported this variation to be more in males and on left side and same was found in present study also.

Normally, the three cords (medial, lateral and posterior) of brachial plexus enter the axilla and are arranged according to their names around second and third part of axillary artery. But in the first part of axillary artery the relations are different, the lateral and posterior cords lie lateral to the axillary artery whereas the medial cord lies behind the axillary artery.¹ The lateral root of median nerve (LRM) coming from the lateral cord (C5, C6, C7) of brachial plexus and medial root of median nerve (MRM) coming from the medial cord (C8, T1) of brachial plexus join to form the median nerve trunk which lies anterior to the third part of the axillary artery. Before joining the lateral root, the medial root passes obliquely in front of the third part of axillary artery. Ulnar nerve (C7, C8, and T1) is a branch of the medial cord. In the axilla the ulnar nerve descends between the third part of axillary artery and axillary vein and lies on a more posterior plane than the medial cutaneous nerve of forearm.¹ The variations in the formation, branching pattern and relation of the brachial plexus with major blood vessels of axilla and arm are common and have been reported by several investigators.^{13,10,14-18} These variations as noted in the present study can be explained on the basis of embryogenic development.

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