



A STUDY TO EVALUATE THE VARIATIONS IN BRACHIAL PLEXUS & ITS CORRELATES AS OBSERVED AMONG ADULT MALE & FEMALE CADAVERS OF TEACHING INSTITUTES .

Anatomy

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ABSTRACT

BACKGROUND AND OBJECTIVES: The brachial plexus is a complex network of nerves that innervates the upper limbs & since its origin in the neck throughout its course in the axillary region. It also has close relationship to important anatomic structures what makes it an easy target of a sort of variations and provides its clinical and surgical importance. The purpose of the present study was to describe the brachial plexus anatomical variations in origin and respective branches.

METHODS: After approval , Thirty adult cadavers separated into sex had their brachial plexuses evaluated. The origins of the dorsal scapular, long thoracic, suprascapular, subscapular, thoracodorsal, medial pectoral and lateral pectoral nerves were studied along with the origins of the phrenic and accessory phrenic nerves. Variations of the trunks, divisions , cords & origin of terminal branches were also studied.

RESULTS: Our results showed that the phrenic nerve had a complete origin from the plexus in 20% of the cases. In this way, a lesion of the brachial plexus roots could result in diaphragm palsy. The long thoracic nerve pierced the scalenus medius muscle in 64% of our cases. Another observation was that the posterior cord was formed by the posterior divisions of the superior and middle trunks in 10% plexuses. In these cases, the axillary and the radial nerves may not receive fibers from C7 and C8, as usually described.

CONCLUSIONS: The plexuses studied did not show that sex or side of the body had much (if any) influence upon the presence of variations. An attempt has been made to know the possible variations of the brachial plexus as it is important for anaesthesiologist , Surgeons , Radiologists & Orthopaedicians to have knowledge of the variations & to be kept in mind, during anesthetic and surgical procedures.

KEYWORDS

Variations , Brachial Plexus , Nerve Branches, Cadavers

INTRODUCTION

The brachial plexus is responsible for innervation of the upper limb and some parts of the thorax. Its roots consist of ventral rami of spinal nerves C5 to T1. The brachial plexus (BP) consists of a network of nerves whose function is to provide the motor, sensory and sympathetic innervation of the upper limb. At the brachial plexus, nerve fibers are routed from different levels of the spinal cord to enter one of the terminal nerves that supply the upper limb. Thus errors in distribution may occur that are corrected distally in the arm, forearm or hand, resulting in anatomical variations of the plexus¹.

Variations (Atypical connections) in the branching of the brachial plexus are prevalent and have been reported in several literatures. Anatomical variations in the pattern of the BP are due to abnormal formation in the development of the trunks, divisions or cords. Some variations are vulnerable to damage in radical neck dissection and other surgical operations of the axilla and upper arm². Also, a very close course of an unusual brachial plexus branch with the axillary artery may lessen the blood supply of the upper extremity by compressing the vessel³.

Because of the close relationship that brachial plexus has with important anatomical structures such as axillary artery, variation in its structure has importance in clinical and surgical aspects. The purpose of the present study was to describe its anatomical variations in origin and respective branches, and to correlate these variations with sex, color of the subjects and side of the body. Therefore, this study was carried out to collect more information about the brachial plexus variations.

METHODOLOGY

After Approval from respective departments of nearby 3 Medical Colleges Including JLN Medical College, A total of 30 embalmed human cadavers (10 from each medical institute) of both sexes (24 males and 6 females) in a total of 60 upper extremities were studied (30 from each side). The age of death ranged from 30 to 82 years and all specimens were fixed in 10% formaldehyde solution. The upper limbs have been partially dissected by the medical students during the previous years and, the authors did further dissections under magnification, with the aid of a surgical microscope. A classic brachial plexus was defined when the superior trunk was formed by the union of

C5 and C6 roots, the middle trunk was the continuation of C7 root and the inferior trunk was formed by the union of C8 and T1 roots^{4,5}. The terminal branches of the brachial plexus were considered as being the axillary, radial, ulnar, median and musculocutaneous nerves. From the supraclavicular part, the origins of the dorsal scapular, long thoracic, suprascapular, subscapular, thoracodorsal, medial pectoral and lateral pectoral nerves were studied. The origins of the phrenic and accessory phrenic nerves were also evaluated. From the infraclavicular part, the origins of the medial brachial cutaneous and the medial antebrachial cutaneous nerves were studied. Variations of the trunks, divisions , cords along with the origin of the terminal branches. The obtained results are of a descriptive order and data are presented as absolute numbers and percentages

RESULTS

From the 60 upper extremities evaluated, 72% showed normal origin of the brachial plexus. 23% were prefixed in origin, rest plexuses were postfixed in origin, being all from male cadavers, 2 on the right and 1 on the left side.

20% phrenic nerves originated entirely from the brachial plexus in 9 male and 2 female cadavers , 72% on the right and 28% on the left sides . An accessory phrenic nerve was present on 12 plexuses, 50% on each side, in 9 male and 3 female cadavers. When the nerves arising from the roots of the brachial plexus were evaluated (60 in total) , 46 plexuses presented the dorsal scapular branch, 27% of which were completely out of the middle scalene muscle during their course.

73% dorsal scapular nerves had an intramuscular course in 26 male and 7 female plexuses. The long thoracic nerve was formed by C5 and C6 in 34% , by C5, C6 and C7 in 45% and by C6 and C7 in 16% of the cases. No female cadavers presented a long thoracic nerve . The long thoracic nerve pierced the middle scalene muscle in 64% of the cases. Variation on the superior trunk was present in 2 plexuses, both on the right side. In both cases, C5 and C6 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.

The middle trunk received a communicating branch from C8 on the left side in one male cadaver and a communicating branch from the inferior trunk on the right side in one male cadaver. The posterior cord was formed by the posterior divisions of the superior and middle trunks on 10% plexuses, all from male cadavers.

From the terminal branches of the brachial plexus, the axillary and the musculocutaneous nerves were not variable in origin. In 4 male cadavers (1 on the right and 3 on the left side), the musculocutaneous nerve, after piercing the coracobrachialis muscle, gave off a communicating branch to the median nerve, which was normal in its origin. The radial nerve received a communicating branch from the inferior trunk in 7 % cases , all in male cadavers, 3 on the right and 1 on the left side. The ulnar nerve received a communicating branch from the lateral cord in 30% cases.

The median nerve was formed by 2 lateral roots and 1 medial root (from the medial cord) in 52% cases, . In 4 cases, one of the two lateral roots came from the anterior division of the middle trunk and 1 from the lateral cord. On the other cases, the two lateral roots came from the lateral cord of the plexus. 7% median nerves were formed distally, in the arm.

DISCUSSION

Knowledge of variations in anatomy is important to anatomists, radiologists, anaesthesiologists and surgeons, and has gained more importance due to the wide use and reliance on computer imaging in diagnostic medicine. Also, the presence of anatomic variations of the peripheral nervous system is often used to explain unexpected clinical signs and symptoms. Descriptions of nerve variations are useful in clinical/surgical practice since an anatomical variation can be the cause of a nerve palsy syndrome due to a different relation of a nerve and a related muscle. In most of these cases, surgery can lead to a rapid recovery of nerve function⁶. Although a brachial plexus injury during neck surgery is a rare condition, especially due to its protection by a dense layer of deep cervical fascia surrounding the scalenus muscles and also the protection of its roots between the scalenus anterior and scalenus medius muscle, anatomical variations of the brachial plexus may render it vulnerable to injury during routine surgical neck dissection⁷. In our observations, the dorsal scapular branch was completely out of the scalenus medius muscle during its course in 27%, being vulnerable to injury in neck surgical procedures. Also, because of the relatively large number of prefixed plexuses , the phrenic nerve originated entirely from the plexus in 20% of the cases. An injury to the plexus in the neck, in these cases, could result in unexplained diaphragm palsy.

Kerr⁸ extensively revised the anatomy of the brachial plexus in man and, classified this anatomical structure into 3 groups and 7 sub-groups. Although most of the variations reported in that study were also present in ours, with some differences in the percentages (probably due to the large number of cases studied in that study), some variations remained to be described. In observations, we found a middle trunk which received a communicating branch from C8 what could be an indicative that the musculocutaneous nerve may receive fibers also from C8, what has not been previously reported. Another observation from our material is that the posterior cord from 5 plexuses was formed by the posterior divisions of the superior and middle trunks. This observation is suggestive that, in some cases, the axillary and the radial nerves may not receive fibers from C7 and C8, as usually described. The origin of the suprascapular nerve from C5 is mentioned by Tountas and Bergman¹ and was present in some of our cases. The origin of the upper subscapular nerve from the axillary nerve and the origin of the lower subscapular nerve from the thoracodorsal nerve were also not described before.

The presence of communicating branches between the terminal branches of the brachial plexus was relatively common in our material. The existence of communicating branches may be of importance in the evaluation of unexplained sensory loss after trauma or surgical intervention in a particular area⁹.

The absence of the musculocutaneous nerve was described by LeMinor¹⁰ and by Nakatani and Tanaka^{11,12} and in all these cases, the lateral cord pierced the coracobrachialis muscle and innervated the anterior muscles of the arm. In our series, none of the brachial plexuses presented such variation. The formation of the median nerve by three roots was described by Sargon et al.³ on a male cadaver. In this case, the

authors reported the presence of two roots coming from the lateral cord, one of them with a very close course over the axillary artery. The same variation was present in our material and one must be aware that this kind of variation is more prone to injury in surgical operations of the axilla and that, the very close course of the second lateral root of the median nerve to the axillary artery may lessen the blood supply of the upper extremity by compressing the vessel³.

Although some differences were present in our material, a pattern of variations for sex, or side of the body was not evident. As also described by Kerr⁸, the plexuses studied did not show that sex or side of the body had much if any influence upon the presence of variations.

CONCLUSION:

We concluded that the the plexuses studied did not show that sex or side of the body had much (if any) influence upon the presence of variations. An attempt has been made to know the possible variations of the brachial plexus as it is important for anaesthesiologist , Surgeons , Radiologists & Orthopaedics to have knowledge of the variations & to be kept in mind, during anaesthetic and surgical procedures.

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REFERENCES :

1. Tountas CP, Bergman RA. Anatomic Variations of the Upper Extremity. Churchill Livingstone, New York, 1993.
2. Uzun A, Seeling LL Jr. A Variation in the Formation of the Median Nerve: Communicating Branch Between the Musculocutaneous and Median Nerves in Man. *Folia Morphol* 2002; 60: 99-101.
3. Sargon MF, Uslu SS, Celik HH, AkÅit D. A Variation of the Median Nerve at the Level of the Brachial Plexus. *Bull Assoc Anat* 1995; 79: 25-6.
4. Agur AMR. Grant's Atlas of Anatomy. 9th Ed. Baltimore: Williams & Wilkins, 1991.
5. Harry WG, Bennett JDC, Guha SC. Scapular Muscles and the Brachial Plexus: Anatomical Variations and Their Clinical Significance. *Clin Anat* 1997; 10: 250-2.
6. Megele R. Anterior Interosseus Nerve Syndrome with Atypical Nerve Course in Relation to the Pronator Teres. *Acta Neurochir* 1988; 91: 144-6.
7. Gacek RR. Neck Dissection Injury of a Brachial Plexus Anatomical Variant. *Arch Otolaryngol Head Neck Surg* 1990; 116: 356-8.
8. Kerr AT. The Brachial Plexus of Nerves in Man, the Variations in its Formation and Branches. *Am J Anat* 1918; 23: 285-395.
9. Hoogbergen MM, Kauer JM. An Unusual Ulnar Nerve-Median Nerve Communicating Branch. *J Anat* 1992; 181: 513-6.
10. LeMinor JM. A Rare Variation of the Median Nerve and Musculocutaneous Nerve in Man. *Arch Anat Histol Embryol* 1990; 73: 33-42.
11. Nakatani T, Tanaka S. Absence of the Musculocutaneous Nerve with Innervation of Coracobrachialis, Biceps Brachii, Brachialis and the Lateral Border of the Forearm by Branches from the Lateral Cord of the Brachial Plexus. *J Anat* 1997; 191: 459-60.
12. Nakatani T, Tanaka S. Two Rare Anomalies of the Brachial Plexus. *J Anat* 1998; 192: 303-4.