



Bilateral variations of brachial plexus involving the median nerve and lateral cord: An anatomical case study with clinical implications

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CASE REPORT

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ABSTRACT

During the routine dissection of upper limbs of a Caucasian male cadaver, variations were observed in the brachial plexus. In the right extremity, the lateral cord was piercing the coracobrachialis muscle. The musculocutaneous nerve and lateral root of the median nerve were observed to be branching inferior to the lower attachment of coracobrachialis muscle. The left extremity exhibited the passage of the median nerve through the flat tendon of the coracobrachialis muscle near its distal insertion into the medial surface of the body of humerus. A variation in the course and branching of the nerve might lead to variant or dual innervation of a muscle and, if inappropriately compressed, could result in a distal neuropathy. Identification of these variants of brachial plexus plays an especially important role in both clinical diagnosis and surgical practice.

Key Words

Brachial plexus; Lateral cord; Coracobrachialis; Median nerve

What this study adds:

1. What is known about this subject?

The study reports a bilateral anatomical variation in the brachial plexus observed in a single cadaver.

2. What is the key finding of this report?

This report reviews the morphological variants of the human brachial plexus.

3. What are the implications for future practice?

The report emphasizes the clinical implications of the brachial plexus variations, raising the awareness of such variations in brachial plexus morphology. Clinicians and anatomists need to be aware of such variations as they are relevant to clinical practice for some procedures (e.g. nerve block).

Background

The brachial plexus is formed by the ventral rami of roots C5–8, T1. It supplies both motor and sensory innervation for the upper limb as well as to extrinsic muscles of the thorax. The musculocutaneous nerve and median nerve are both derivatives of the lateral cord of the brachial plexus and give rise to the musculocutaneous nerve (C5,6,7), that courses lateral to the brachial artery. Proximally, the musculocutaneous nerve normally pierces and innervates the coracobrachialis muscle before continuing between the biceps brachii lying superficially and brachialis muscle, situated deeper.¹ In more than 20 per cent of arms, instead of penetrating the coracobrachialis, the musculocutaneous nerve continues with the median nerve before subsequently dividing at various levels.^{2,3} Distally, the musculocutaneous nerve traverses the elbow in lateral relation to the biceps tendon before forming the lateral cutaneous nerve of forearm.

Figure 1: Right arm of the cadaver showing the variant lateral cord, which was piercing (∟) the coracobrachialis muscle



The median nerve was embedded in the fascia of the brachialis muscle (∟) before entering the cubital fossa. (CB-coracobrachialis; LC-lateral cord; MC-medial cord; MR- medial root of median nerve; LR-lateral root of median nerve; UN-ulnar nerve; BB-biceps brachii; MSC- musculocutaneous; MN-median nerve; MCNF-medial cutaneous nerve of the forearm; B-brachialis).

The median nerve is formed by the merging of branches from the lateral and medial cords and is comprised of fibers from all root levels (C5–T1). This union occurs in the axilla, from which the median nerve will descend lateral to the brachial artery and anterior to brachialis to the distal

third of the upper arm, where it crosses medial to the brachial artery before entering the cubital fossa. Running deep to the bicipital aponeurosis, the median nerve continues down the forearm providing primary innervation to the flexor compartment along with the intrinsic muscles of the hand, including the muscles of the thenar eminence and the lumbricals of the lateral two digits.

The majority of the cutaneous innervation supplied by the median nerve can be found on the palmar aspect of the hand: the lateral palm and lateral three-and-a-half digits. The remaining cutaneous innervation supplies the dorsum of the hand: the lateral three-and-a-half distal phalanges.^{1,4} Variations have been reported in the literature about the arrangement of both the median and musculocutaneous nerves. Some include: communicating branches between the two nerves,⁵ multiple cords forming the median nerve,⁶ and the entrapment of the median nerve by the arching tendon of the coracobrachialis.⁷ In the present report, variations were observed bilaterally in a cadaver. We discuss the morphology of these variations and the clinical implications are emphasized.

Case details

This case of bilateral variation in the brachial plexus was found in an embalmed elderly male cadaver whose precise age was unknown. Anomalies were discovered during a routine dissection in the Department of Anatomy at the American

University of Antigua College of Medicine, West Indies, within the academic year of 2012–13. While dissecting the right upper limb, it was observed that the lateral cord of brachial plexus passed through the coracobrachialis muscle (Figure 1) prior to its bifurcation into the musculocutaneous nerve and the lateral root of the median nerve. The lateral cord of brachial plexus was piercing the coracobrachialis muscle about 11.4 cm away from the acromion process of the scapula. The medial root of the medial cord, travelling to adjoin with the lateral root to fuse and form the median nerve, was abnormally long. Furthermore, the median nerve was found to be embedded in the fascia of the brachialis muscle (Figure 1) before entering the cubital fossa.

During the dissection of the left upper limb, it was observed that although the majority of the structures were in their correct anatomical positions, a variation was noted by which the median nerve pierced the distal tendon of the coracobrachialis muscle (Figure 2) near its insertion onto the medial surface of the body of the humerus. Distally, the

Figure 2: Left arm of the cadaver showing the variant median nerve, which was piercing (⊥) the distal tendon of coracobrachialis muscle



(CB-coracobrachialis; CBT-coracobrachialis tendon; LC-lateral cord; MR- medial root of median nerve; LR-lateral root of median nerve; UN-ulnar nerve; BB-biceps brachii; MCN- musculocutaneous nerve; MN-median nerve; MCNF-medial cutaneous nerve of the forearm)

median nerve maintained a normal tract into the cubital fossa. The musculocutaneous nerve was piercing the coracobrachialis muscle about 14 cm away from the acromion process of the scapula. The distance between acromion process and median nerve which was observed piercing the distal part of coracobrachialis was 19 cm.

Discussion

Morphological variation of the lateral cord of the brachial plexus, the median and musculocutaneous nerves, and the coracobrachialis, altogether in a single person is not common. The significance of variations observed in the present study relate to the possible clinical implications. Concerning the right arm, given that the lateral cord penetrates the coracobrachialis muscle rather than solely the musculocutaneous nerve, we can speculate that the motor and sensory innervation to the coracobrachialis may be derived from the lateral cord itself.⁸ By understanding the anatomical position of the coracobrachialis in relation to the glenohumeral joint, conjecture may be placed on the vulnerability of the lateral cord, passing through the coracobrachialis muscle in this case, being susceptible to injury when the coracobrachialis is acted upon by retractors used in arthroscopic shoulder reconstructive surgery.⁹ Furthermore, given the variant route travelled by the lateral cord, nerve blocks in the upper arm may be compromised.¹⁰ For example, in outpatient hand surgery using a mid-humeral approach, all four major nerves are able to be selectively

blocked.¹¹ With the more distal formation of the median nerve, localisation and administration of sufficient analgesia may be compromised.¹⁰ In the event of trauma or varying pathology to the right arm inclusive of the coracobrachialis muscle, sensory information derived from the anterolateral portion of the hand may be compromised. In the same respect, motor innervation to the flexor antebrachial region as well as the aforementioned intrinsic muscles of the hand might be affected. In particular to females, post mastectomy, this anatomical knowledge is important in using the coracobrachialis to rectify any defects that have arisen.^{9,12} The coracobrachialis is often used in the flap surgeries of mastectomy. During the post mastectomy, the deformities in the infraclavicular region and the axilla are filled by using the coracobrachialis flap. For taking the coracobrachialis flap, the anatomical knowledge and its morphological variants are crucial to the surgeon. During this plastic surgery, the structures piercing the coracobrachialis muscle are prone for the injuries particularly if there is an unnoticed anatomical variation.

In regard to the left arm, resulting pathology may arise from the median nerve lying entrapped within the tendon of the coracobrachialis muscle. This position enables the possible compression of the nerve during muscle operation. Understanding the physiology of the coracobrachialis tendon in this case further clarifies this



theory.⁷ Being a passive tension structure, the mechanical function of coracobrachialis muscle is not due to an accompanying metabolic process, the tendon of coracobrachialis responds to the action of its muscle by stretching or relaxing with each contraction.¹³ The coracobrachialis muscle is a dynamic stabiliser of the glenohumeral joint, it also functions to weakly adduct and flex the arm.¹⁴ Engaging in weight lifting and activities that increase the force generated by the coracobrachialis will translate that tension and stretch to the distal tendon.¹³ The resulting compression of the median nerve from this tendon could produce loss of sensory and motor innervations previously discussed.⁷

Although the aetiology of these variations in nerve formation is not fully understood, theories have been developed to provide possible explanations. Research¹⁵ has found that cell signalling mechanisms during embryological development could play a role. During the fifth week of development, as axons of spinal nerves grow distally to initiate contact with limb bud mesenchyme, improper signalling can alter the proper formation of this peripheral nerve plexus.¹⁶ Factors guiding nerve growth are chemo-attractants and repellents which ultimately direct cell processes for appropriate tissue formation.^{2,6} An additional theory is that cell adhesion contributes to the growth and direction of a nerve. Specifically, transcription factors such as neural cell adhesion molecule (N-CAM), L1, and cadherins are believed to play a role in axonal growth.¹⁷ Further research into the embryological basis of nerve formation may assist with future identification of these anomalies.

The variations reported in the present study are of potential interest to surgeons, clinicians, and researchers. Ultimately, knowledge of these variations is of key significance to clinicians and surgeons for the potential benefit of their patients. The use of sonographic investigation to screen for these variations could prove helpful in providing more effective nerve blocks, in addition to discerning a differential diagnosis for clinical presentations.¹⁸

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PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.