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CLINICALLY RELEVANT MULTIPLE ANATOMICAL VARIATIONS IN THE ARM OF A SINGLE CADAVER.

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ABSTRACT

The variations in the muscles and nerves of the upper limb have been commonly reported and well documented. However, our study describes the coexistence of multiple neuromuscular variations of the arm hitherto not reported, to the best of our knowledge. During routine dissection, we observed an accessory head of coracobrachialis muscle, an additional head of biceps brachii muscle, unusual course of musculocutaneous nerve in the arm and formation of median nerve in the middle of the arm in a single male cadaver. These variations were bilateral. Knowledge of these variations is necessary to avoid complications during various procedures done in Upper Limb.

Keywords: Coracobrachialis [CB], Biceps brachil [BB], anatomical variants, musculocutaneous nerve [MCN], Median nerve [MN].

INTRODUCTION

Casser's perforated muscle i.e. coracobrachialis is a weak flexor present in the anterior compartment of the arm. It is classically described as taking its origin from the apex of the coracoid process where it blends with the medial side of the short head of biceps brachii. The muscle is inserted along the medial border of the shaft of humerus between the triceps and brachialis muscles. It is pierced by the musculocutaneous nerve [1].

The classical description of attachments of the biceps brachii muscle include: short head arising from the tip of the coracoid process of scapula and the long head arising from the supraglenoid tubercle of scapula and from the glenoidal labrum. Distally, the two bellies unite to form a common tendon which is inserted into the posterior rough part of the radial tuberosity and through the bicipital aponeurosis to the subcutaneous posterior border of ulna [2].

The musculocutaneous nerve is derived from the lateral cord of brachial plexus. It accompanies the lateral side of third part of axillary artery and pierces the coracobrachialis muscle. Then it descends downwards and laterally across the front of the arm in between the biceps brachii and brachialis muscle, supplies the flexor muscles of arm and continues downwards as the lateral cutaneous nerve of forearm [3].

The median nerve is normally formed in the axilla by the union of two roots i.e. lateral root of median nerve from lateral cord and medial root of median nerve from medial cord of brachial plexus. The two roots embrace the third part of axillary artery. It then descends downwards along the lateral side of axillary artery and upper part of brachial artery for its further course [3].

CASE REPORT

The study involved the upper limb dissection of a 50 year old male cadaver. The right and the left upper limbs of the cadaver were dissected

according to the instructions of Cunningham's manual of practical Anatomy [4] and the following observations were noted:-

The coracobrachialis muscle arose by three heads coracobrachialis1 (CB1), coracobrachialis 2 (CB2) and coracobrachialis 3(CB3) from the apex of coracoid process of scapula. The two heads of coracobrachialis 1(CB1) and coracobrachialis 2(CB2) fused to from a muscle belly which was inserted into the middle of the medial border of the shaft of humerus whereas the accessory head coracobrachialis 3(CB3) formed a thin tendon to descend downwards along the medial intermuscular septum and was inserted into the medial epicondyle of humerus. All the three heads were supplied by a common trunk formed by musculocutaneous nerve and lateral root of median nerve close to its origin in the axilla from its deep surface. [FIG.1and 2]

An additional head of Biceps brachii [BB3] took its origin from lower half of anteromedial surface of humerus just distal to the insertion of coracobrachilis muscle and fused with tendon of the long head [BB1] and short heads [BB2] of biceps brachii prior to its insertion into the posterior rough part of radial tuberosity. All the three heads were given a separate branch from musculocutaneous nerve just before it descended through the additional head of biceps brachii [BB3] and brachialis muscles. [FIG.1and 2]

The musculocutaneous nerve arose as a common trunk along with lateral root of median nerve from the lateral cord of brachial plexus in the axilla. It did not pierce the coracobrachialis and the common trunk descended downwards upto the middle of the arm. The musculocutaneous nerve then passed between the additional head of biceps brachii [BB3] and brachialis. Its further course and distribution was normal. [FIG.1and 2]

The formation of median nerve was observed close to the middle of the arm. The medial and lateral roots were long. Both the roots enclosed the additional head of coracobrachialis muscle [CB3] in between them and then joined to form the trunk of median nerve on the lateral side of brachial artery. The further course and branching pattern of median nerve was normal [FIG.1and 2]

DISCUSSION

Anomalies of the coracobrachialis muscle are common [5,6]. The reported morphological variations of the coracobrachialis muscle include accessory slips inserting into the medial epicondyle of humerus, medial supracondylar ridge, medial inter muscular septum, lesser tubercle and a supernumerary head passing over the shoulder joint [7].

The morphological variations of the muscle can be explained by comparative anatomy. During the changes in the locomotion pattern from reptiles to mammals, the adductor shoulder muscles became greatly reduced into the coracobrochialis muscle. Sontag et al [8, 17] found that coracobrachialis in some animals has three heads: brevis (profundus), medius and longus (superficialis). Some mammals such as apes and prosimians were reported to have two muscular heads. In man the two heads have fused trapping the musculocutaneous nerve between them, while the third head has become suppressed [1].

The origin of morphological variations of the coracobrachialis muscle may be explained on the basis of embryogenesis of muscles of the arm [9]. The intrinsic muscles of the upper limb differentiate insitu from the limb bud mesenchyme of the lateral plate mesoderm. At a certain stage of development, the muscle primordia within the different layers of the arm fuse to form a single muscle mass; thereafter, some muscle primordia disappear through cell death. Failure of muscle primordia to disappear during embryonic development may account for the presence of supernumerary heads of coracobrachialis muscle as reported in this case. The coexistence of these variations in our study may be the result of an abnormal embryological

formation of limb muscles, peripheral nerves and arteries.

KYOU-Jouffroy et. Al [10] described three portions in coracobrachialis muscle that originated from the coracoid process and inserted into the medial epicondyle of humerus, described as ligament of struthers (coracobrachialis longus or superficialis), humeral diaphysis (coracobrachialis medius) and humeral neck (coracobrachialis profundus or brevis). Our present study is correlated with the above description that the accessory head of coracobrachialis indeed is the coracobrachialis longus or superficialis.

The biceps brachii muscle presents a wide range of variations. Supernumerary heads of biceps brachii have been widely studied regarding their origin, insertion, size, innervation and racial differences [1, 11, 12]. The supernumerary heads of the biceps brachii muscle have been described as a part of a three, four, and five headed or even seven headed biceps brachii muscle. [13,14]. Supernumerary heads of biceps brachii muscle may arise from the articular capsule of the glenohumeral joint, lesser tubercle, coracoid process, pectoralis minor tendon, humeral shaft, tendon of pectoralis major muscle, or the crest of greater tubercle [1,7,14].

Recently Rodriquez-Niedenfuhr et al [12] studied a series of 350 arms and classified the supernumerary heads of biceps brachii into 3 different types: superior, inferomedial and inferolateral humeral heads. The inferomedial head is common and arises from the anteromedial surface of humerus just beyond the insertion of coracobrachialis and inserted into the conjoint tendon of biceps brachii [12, 13]. In the study of Vazquez et al [15], a supernumerary head arose from the lower part of anteromedial surface of humerus in continuation with the attachment of coracobrachialis. We correlated the above observations with our study and the additional head of biceps brachii in our case is inferomedial type.

Phylogenetically, the variations of the biceps brachii muscle were explained as a remnant of a "tuberculoseptate" head that together with the short and long heads is present in hylobates, but is a product of regression in humans and anthropods [16]. Sonntag [17] described the third head of the biceps brachii as a remnant of the long head of coracobrachilalis muscle, an ancestral hominoid condition; particularly in those where the additional head arose from the insertional area of the coracobrachialis muscle, as has been the case in the present study.

The reported variations of the musculocutaneous nerve include its total absence [22], its communications with the median nerve at various levels [23]. The musculocutaneous nerve not piercing the coracobrachialis and accompanying the lateral root of median nerve is also known [24], which correlates with our present study.

The median nerve as reported in literature is associated with several variations which include abnormal communications with other nerves such as musculocutaneous and ulnar nerve [18]. Variations in the formation of median nerve were reported earlier by some authors [19]. Budhiraja et al [21] studied variations in the formation of median nerve in 196 upper limbs and observed that in 17.3% of cases, the formation of median nerve was in the arm. Nayak et al [20] reported a case where median nerve was formed in the middle of the arm, lateral to the brachial artery. The above observations were also noted in our present study.

The variations of the nerves of the upper limb can be explained embryologically. The upper limb buds lie opposite to the lower five cervical and upper two thoracic segments. As soon as the buds form, the ventral rami of spinal nerves penetrate into the mesenchyme of limb bud and establish intimate contact with differentiating mesodermal condensations. The early contact between nerve and muscle is a prerequisite for their complete functional differentiation [25]. As

the guidance of the developing axons is regulated by expression of chemo-attractants and chemo-repellents in a highly coordinated site specific fashion, any alteration in signaling between mesenchymal cells of limb buds and neuronal growth cones can lead to significant variations [26].

CLINICAL SIGNIFICANCE

Knowledge of anatomical variations is of interest to the anatomist and clinician alike. All the variations mentioned in our study assume significance during radio diagnostic procedures, surgical exploration of the axilla and can even fail nerve block of infraclavicular part of brachial plexus.

The morphology of the coracobrachialis muscle is important because it is used as a flap in surgical procedures for contouring the infraclavicular area or for covering the exposed axillary vessels specifically in post mastectomy reconstructive operations [27]. The accessory head of coracobrachialis may produce compression of musculocutaneous nerve or median nerve and brachial artery as they course superficial or deep to the common attachment of the muscles. The accessory head of coracobrachialis may be a cause for subcoracoid impingement with pain and discomfort in front of shoulder [28].

The conjoint tendon of coracobrachialis is also used during stabilization treatment for recurrent dislocation of shoulder joint and as a vascularised muscle for transfer in treatment of long standing facial paralysis [29]. Acute and chronic acromioclavicular dislocations have been treated by surgical transfer of the distal 1cm of the coracoid process with the attached conjoint tendon of coracobrachialis and short head of biceps brachii to clavicle.

Variant biceps brachii may confuse a surgeon who performs procedures on the arm and may lead to iatrogenic injuries [15]. The origin of additional head of biceps brachii from shaft of humerus may cause unusual bone displacement secondary to fracture [30]. If extra heads are large enough, they may provide additional strength to biceps brachii and may increase the power of supination and flexion [15]. Kopuz et al [11] attributed the appearance of this variant to evolutionary or racial trend and origin of inferomedial head may contribute to pronation of forearm irrespective of shoulder joint position.

Aggressive weight lifting has been known to be associated with musculocutaneous palsy; this may possibly be due to entrapment of nerve under the edge of hypertrophied coracobrachialis muscle, leading to paraesthesia and weakness of elbow flexion [33].

The formation of median nerve close to the middle of the arm may lead to confusion in surgical procedures of arm and nerve block anaesthesia [21]. Entrapment of median nerve by a tendinous arch of coracobrachialis may lead to a galaxy of manifestations including sensory, motor, vasomotor and trophic changes [31].

The knowledge of nerve origin point may prove to be useful at the time of giving botulinum toxin injections for relieving spasm of the muscle [32].

CONCLUSION

The present cadaveric study was a sincere attempt to highlight the neuromuscular variations and to discuss its clinical importance which might be helpful from academic, surgical and clinical points of view. Moreover knowledge of variations in muslulocotaneous and median nerve may prove valuable in traumatology of the arm, as well as in plastic and reconstructive or repair operations.

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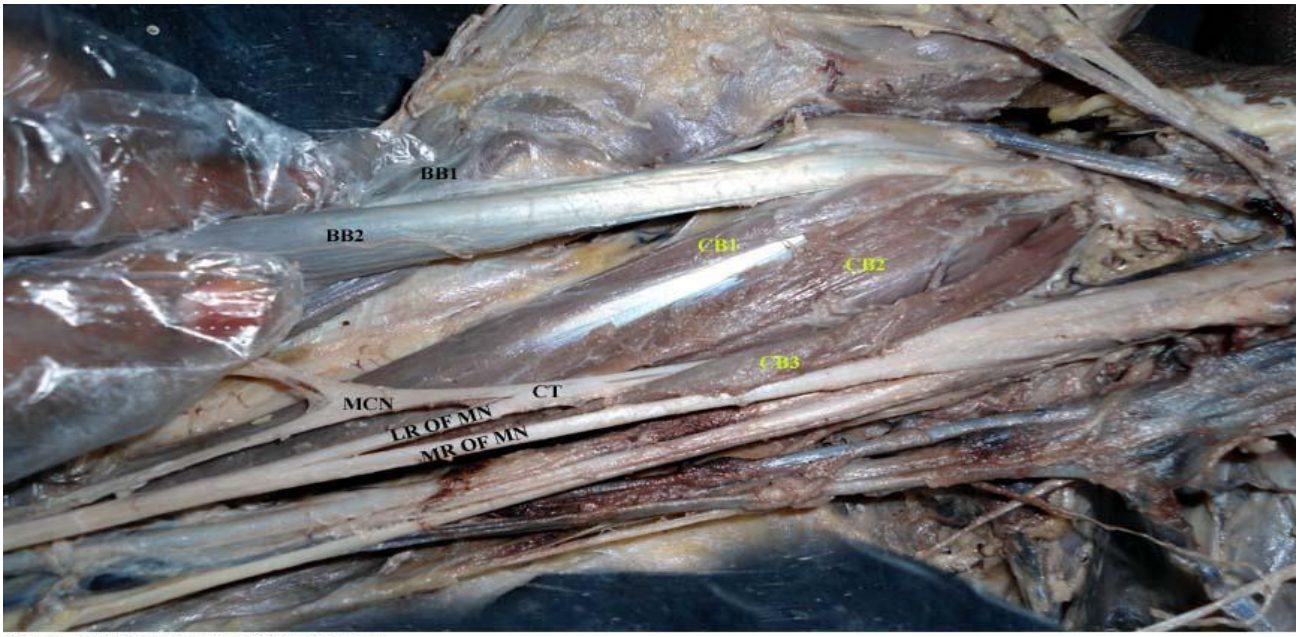

FIG 1: SHOWING RIGHT ARM OF CADAVER
CB1,CB2,CB3 - THREE HEADS OF CORACOBRACHIALIS
BB1,BB2,BB3 - THREE HEADS OF BICEPS BRACHII
CT - COMMON TRUNK
LR OF MN - LATERAL ROOT OF MEDIAN NERVE
MR OF MN - MEDIAL ROOT OF MEDIAN NERVE

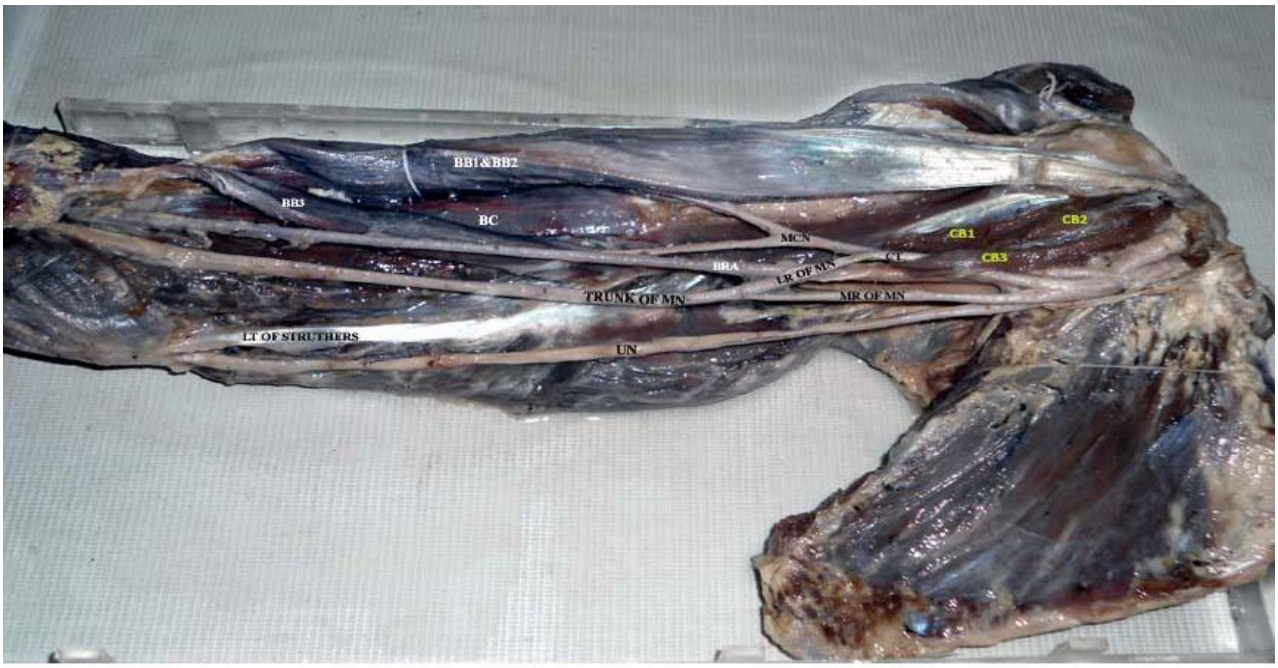

FIG 2: SHOWING RIGHT ARM OF CADAVER
CB1,CB2,CB3 - THREE HEADS OF CORACOBRACHIALIS
BB1,BB2,BB3 - THREE HEADS OF BICEPS BRACHII
BC - BRACHIALIS