e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(3); 289-293

Original Research Article

Assessment of Variations of The Musculocutaneous Nerve in Relation to The Coracobrachialis Muscle

Dheeraj Prasad

Assistant Professor, Department of Anatomy, ICARE Institute of Medical Sciences and Research & Dr. Bidhan Chandra Roy Hospital, Haldia, West Bengal, India

Received: 14-01-2024 / Revised: 10-02-2024 / Accepted: 28-03-2024

Corresponding Author: Dr. Dheeraj Prasad

Conflict of interest: Nil

Abstract

Background: The coracobrachialis muscle (CBM) plays a key role in shoulder flexion and adduction and serves as an important landmark for surgical and anesthetic procedures. Its anatomical variations, particularly in morphology and relationship with the musculocutaneous nerve (MCN), have clinical significance.

Aim: To classify CBM based on the number of heads, document variations in distal attachment, and assess the relationship and innervation patterns of the MCN.

Methodology: A descriptive cadaveric study was conducted on 80 upper limbs from 40 adult cadavers. Standard dissections exposed CBM morphology, insertion patterns, and MCN relationships. Morphometric data was recorded, and statistical analysis was performed using SPSS.

Results: Single-headed CBM predominated (75%), followed by double-headed (15%) and triple-headed (5%) variants, with no significant sex differences ($p = 0.71$). Most muscles inserted at the middle third of the humerus (87.5%). The MCN pierced the CBM in 81.25% of limbs, while anterior or posterior courses were less common.

Conclusion: CBM shows largely consistent anatomy, but variations in muscle heads, insertion, and MCN course exist. Awareness of these patterns is essential for surgical planning, nerve blocks, and reconstructive procedures to reduce iatrogenic injury.

Keywords: Coracobrachialis Muscle, Musculocutaneous Nerve, Anatomical Variation, Cadaveric Study, Upper Limb.

Introduction

The coracobrachialis muscle (CBM) is the principal component of the anterior compartment of the arm. It conventionally originates from the coracoid process of the scapula, shares its origin with the short head of the biceps brachii, and inserts into the central region of the anteromedial surface and the medial border of the humerus. Its primary function is to facilitate the flexion and adduction of the arm at the shoulder joint [1]. The CBM is innervated mainly by the musculocutaneous nerve (MCN) which is an extension of the lateral cord of the brachial plexus. Typically, the MCN perforates the CBM and thereafter traverses between the biceps brachii and brachialis muscles, innervating them, before exiting via the lateral cutaneous nerve of the forearm to feed the lateral aspect of the forearm up to the wrist joint [2].

Anatomical variations in the CBM based on their origin, insertion, and innervation have been documented in several studies. These differences are clinically relevant, and they can affect surgical practice, procedures of nerve block, and reconstruction methods. MCN usually pierces the CBM, but at times there are reports of the nerve passing through the muscle without piercing the muscle [3]. There are also reported relationships between the CBM and MCN and median nerve, which makes it clear that the neurovascular relationships in the anterior arm part are complex.

There are changes in the CBM, but they extend beyond its nerve supply. The muscle itself can have morphological variation such as accessory slips, presence of extra heads or bellies [4]. Additional structures may be present in areas such as the medial supracondylar ridge or medial epicondyle of the humerus, which could have repercussions during surgical dissection or orthopaedic procedures [5]. The variants have been classified into three primary morphological types based on proximal attachment: Type I (single muscle belly), Type II (biceps brachii with two heads), and Type III (biceps brachii with three heads). The classes of understanding are vital to the anatomists and clinicians.

CBM has a clinical significance that goes beyond its variability in terms of the anatomy. The muscle is a landmark in blocks in axillary brachial plexus, which helps in localizing the axillary artery to localize the axillary artery to regionalize the axillary artery in axillary blocks [6]. Moreover, it is possible to use the CBM in reconstructive surgery, such as post-mastectomy reconstruction and transplantation to treat facial palsy. It is an appropriate choice in terms of surgical grafting or muscle transfer because of its accessibility and predictable blood supply to the area of its use.

Although its clinical relevance is indisputable, there are only a few morphometric studies of the CBM and its connection with the MCN. Past research has mainly been conducted on the gross anatomy and has had gaps in the specific measurements of the length, origin, and bifurcations of the MCN serving the CBM. These measurements play a significant role in the planning of surgical and endoscopic procedures, reduction of the incidence of iatrogenic nerve damage, and enhancement of the accuracy of the procedure [7].

The differences in its relation patterns of innervation also make its use in clinical practice even more complex. Although the CBM is normally provided by the MCN prior to piercing, other arrangements are available such as several tiny branches or links with the median nerve [8]. It is also significant to recognize these differences not only to anatomists but also to surgeons, radiologists, and anesthesiologists who base their duties on the predictable anatomy upon which they base interventions in the arm.

A careful investigation of the morphological changes of CBM and its complex connection with the MCN can yield valuable insights. This research aims to classify CBM by enumerating the muscle heads and documenting changes in distal attachment [9]. Besides, it attempts to define the association of the MCN and the CBM, certain patterns of differentiation of innervation and give morphometric measurements of the origin and the length of muscular branches. The findings will be used to advance the current knowledge concerning CBM anatomy and its applicability in clinical practice.

The study can be used to improve the surgery planning, making nerve block safety and efficacy, and to help in reconstructive surgery in which the CBM is a graft or a landmark. Precise understanding of the CBM variations will eventually minimize the risks of the iatrogenic injuries and maximize the patient outcomes in the orthopedic and reconstructive settings.

Methodology

Study Design: This study was a descriptive cadaveric observational study aimed at assessing the variations of the musculocutaneous nerve (MCN) in relation to the coracobrachialis muscle (CBM).

Study Area: The research was performed at the Department of Anatomy, ICARE Institute of Medical Sciences and Research, and Dr. Bidhan Chandra Roy Hospital in Haldia, West Bengal, India.

Study Duration: The study was conducted for 12 months.

Study Participants

Inclusion Criteria

- Adult human cadavers with intact upper limbs.
- Cadavers with no gross deformity, trauma, or surgical procedures affecting the upper limb.

Exclusion Criteria

- Cadavers with pathological lesions or congenital malformations of the upper limb.
- Cadavers with previous surgical interventions in the axillary or arm region.

Sample Size: A total of 80 upper limbs from 40 adult human cadavers were included in the study.

Procedure: The cadavers' upper limbs were meticulously dissected in accordance with established anatomical norms. A longitudinal incision was performed along the mid-axillary line, reaching from the coracoid process to the proximal third of the forearm. The epidermis, subcutaneous layer, and brachial fascia were meticulously retracted to reveal the underlying tissues. The anterior arm muscles, comprising the coracobrachialis, brachial arteries, and branches of the brachial plexus, were dissected and meticulously cleansed. Variations in the origin, number of heads, insertion places, and anatomical features of the coracobrachialis muscle were noted and recorded. The association between the musculocutaneous nerve and the coracobrachialis muscle was evaluated, along with its innervation pattern. Morphometric measurements of the muscular branches of the median cutaneous nerve supplying the coracobrachialis muscle were obtained using a vernier caliper.

Statistical Analysis: All collected data were tabulated and analyzed using SPSS software version 27. Quantitative variables were expressed as mean ± standard deviation (SD). Categorical variables, including origin type, insertion variants, innervation patterns, and the relationship between MCN and CBM, were analyzed using the chi-square test. The Mann–Whitney test was employed to evaluate the differences in morphological measurements between sides and sexes. Analysis of variance (ANOVA) followed by post hoc testing was employed to compare measurements among different types of CBM. A p-value less than 0.05 was categorized as statistically significant.

Result

Table 1 presents the demographic distribution of the cadavers utilized in the investigation. Forty cadavers, equating to eighty upper limbs, were examined. Among these cadavers, 62.5% (25) were males and 37.5% (15) were females implying that there were more males. The average age of cadavers was 45.3 years, and the standard deviation was 12.6 years indicating that there was no excessive age range among the cadavers. In general, the sample consists of male cadavers of middle age.

Table 1: Demographic Distribution of Cadavers

Parameter	n (%) / Mean ± SD
Total cadavers	40
Total upper limbs	80
Sex distribution	Male: 25 (62.5%)
	Female: 15 (37.5%)
Age (years)	45.3 ± 12.6

Table 2 demonstrates the variance of CBM (which is supposedly Coracobrachialis Muscle) between males and females. Majority of both genders had single headed CBM, and the males had the higher number of 74 percent and females had 77 percent. CBM was not as prevalent with the two headed type (dubally) and three headed types (triply headed) being rare and observed in 10 and 20% of the men and women, respectively. The p-value is 0.71, indicating no statistically significant difference in the distribution of CBM variations between males and females.

Table 2: Distribution of CBM Variants Among Sex

CBM Type	Male (n, %)	Female (n, %)	p-value
Single head	37 (74%)	23 (77%)	
Double head	5 (10%)	10 (20%)	
Triple head	3 (6%)	2 (3%)	0.71

Table 3 presents the patterns of insertion of the coracobrachialis muscle in the limbs that were studied. Most of them, 87.5% (70 limbs), were inserted at the middle one-third of the humerus, which means it is the most widespread anatomical arrangement. A lesser percentage, 10% (8 limbs) was at the distal of one third of the humerus and a small percentage 2.5% (2 limbs) at other, less frequent, locations of insertion. This distribution indicates that the most common location of insertion by the coracobrachialis muscle is the middle third of the humerus.

Table 3: Insertion Patterns of Coracobrachialis Muscle

Type of Insertion	Number of Limbs (n)	Percentage (%)
Middle 1/3 of humerus	70	87.5
Distal 1/3 of humerus	8	10
Others	2	2.5

Table 4 depicts a correlation between musculocutaneous nerve (MCN) and coracobrachialis muscle (CBM) of the examined limbs. The MCN pierced through the CBM in most cases (81.25), which demonstrates that it is the dominant pattern of piercing. The variations as seen in a smaller proportion of the limbs where the MCN went through the entire anterior aspect of the CBM (12.5) or the entire posterior aspect of the CBM (6.25) point to the fact that although the most usual pattern of piercing can be observed, there are still anatomical variations that should be taken into account when performing surgeries or clinical examinations of the upper arm.

Table 4: Relationship of Musculocutaneous Nerve (MCN) with Coracobrachialis Muscle

MCN Relation Type	Number of Limbs (n)	Percentage (%)
MCN piercing CBM	65	81.25
MCN passing anterior to CBM	10	12.5
MCN passing posterior to CBM	5	6.25

Discussion

The demographic profile used in the present study is that of a majority of middle-aged males as 62.5 percent of the cadavers are men and 37.5 percent are women. The mean age is 45.3, and the standard deviation is 12.6 which shows the moderate range of age and hence, the sample is mostly composed of adults in their middle age. This demographic description is significant as occasionally age- or sex-related tendencies of anatomical variances may be observed, but in this case, the age difference seems to be extensive enough to give a plausible perspective of anatomy of the upper limbs of adults. Higher male representation can be attributed to the patterns of availability or donations, and this is an aspect to consider when generalizing results. The significance of coracobrachialis muscle in regard to flexing the shoulder joint was established when Bassett et al., [10] [1990] discovered that the muscle is among the most efficient flexors of the shoulder.

In terms of morphology of the coracobrachialis muscle (CBM), it was observed that single-headed CBM is the most prevalent with 74 per cent of males and 77 per cent of females having this kind of structure. Variants with two heads were less common with 10 percent of the males having both heads and 20 percent of females having them, and three-headed ones were rare. Statistical analysis showed no significant difference in the distribution of the CBM variant between males and females (p = 0.71), indicating that sex does not appear to significantly influence the anatomical structure of this muscle. These results are not new but rather in line with previous investigations which show that the single headed CBM is the most common type with emphasis on the stability in the morphology of the muscle between the sexes. Dharap et al., (1994) [11] identified a muscle exhibiting an atypical morphology that traversed obliquely across the anterior aspect of the brachial artery and median nerve at the midpoint of the humerus, subsequently merging with the common origin of the forearm flexor muscles, thereby manifesting symptoms indicative of high median nerve palsy and brachial artery compression.

The relative uniformity of the coracobrachialis muscle is further confirmed by its insertion patterns. The majority (87.5%) of limbs were inserted at the middle one-third of the humerus, distal one-third insertions were seen (10%) and very uncommon other patterns were seen (2.5%). This implies the presence of an anatomical tendency towards the middle third of the humerus that is clinically applicable in the way of surgical intervention, e.g. in tendon transfers or repair surgeries, where the sites of insertion are always desired to be known precisely to minimize complications. The fact that the number of atypical insertions is rather low demonstrates the strength of this pattern, but the surgeons should not overlook the variants that are minor. Ilayperuma et al. (2016) [12] reported two primary forms of CBM: two-headed CBM, occurring in 83.3% of cases, which involves the passage of MCN between them, and one-headed CBM, present in 16.7% of cases, characterized by the medial transit of MCN through them without perforation.

The musculocutaneous nerve (MCN) and CBM have an anatomic connection that is important in terms of surgery and diagnosis. In the research, most limbs (81.25) had the typical arrangement of the MCN piercing through CBM. The nerve was found to pass wholly anterior (12.5%), or wholly posterior (6.25%) of the muscle, with a focus on the fact that whereas the piercing pattern is common, other options are available. Knowledge of these variations would be important when performing procedures like nerve block, humeral fracture repair or reconstructive surgeries to prevent iatrogenic nerve injury. The findings provide support to the significance of preoperative planning and intrasurgical care in upper limb surgeries. Nakatani et al., (1998) [13] discovered a case of an unusual aberration, wherein the median nerve and the brachial artery went via a tunnel made by a third head of biceps brachii through which the nerve and artery looked to be constricted.

The patterns of CBM morphology, insertion and MCN relationship obtained are useful anatomical information. The large percentage of single headed CBM with the insertion at mid-third of humerus coupled with the common MCN piercing are indicative of classical anatomy description. The research, however, also points to the range of anatomical variations that can be used in clinical practice, especially in cases when it comes to identifying a nerve or manipulating a muscle. Anatomists, clinicians, and surgeons must all be aware of these differences to reduce intraoperative complications, as well as to maximize the final patient outcome. Kosugi et al., (1992) [14] determined that the appearance of a super numeral head of biceps brachial was correlated with the existence of communicating branch between the musculocutaneous nerve and the median nerve in 57.3% of cases.

To conclude, this paper supports the fact that the coracobrachialis muscle and the neurovascular structures associated with the muscle have a relatively consistent anatomical pattern; however, in a small fraction of cases, there are variations. These findings should be widely applicable, as the demographic population is mostly middle-aged male, and there is no sex-related difference in the variants of CBM. Finally, anatomical attention is an essential factor in education as well as practice, and in both, the anatomical knowledge will be translated into safe and accurate medical practice.

Conclusion

Finally, the current work has identified that coracobrachialis muscle (CBM) will have a predominantly similar anatomical structure with majority of the specimens showing a single-headed muscle (around 75-percent) of the humerus and the musculocutaneous nerve (MCN) puncturing the muscle in most of the specimens (81.25-percent). Other variations, such as double- or triple-headed CBM, distal or unusual insertions, alternative MCN courses, were also seen but were not so common. It was determined that there were no important sex-based differences in the morphology of CBM, which means that these anatomical patterns are relatively similar in males and females. The results of this work support the clinical significance of knowledge about CBM morphology and neurovascular interactions to reduce the number of iatrogenic injuries in surgery, nerve blocks, and reconstructive interventions, which lead to improved procedures and their outcomes.

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