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ORIGINAL ARTICLE

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Morphometric study of the nerves entering into the coracobrachialis muscle

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Abstract The nerves entering into the coracobrachialis muscle are the musculocutaneous nerve (MC) and the nerve (usually consists of several thin branches) branches to the coracobrachialis. These thin branches enter the coracobrachialis proximal to the MC. The thin branches and the MC are susceptible to injury during coracoid process transfer. The purpose of this study is (1) to reveal the number and origin of the thin branches and (2) especially to report the morphometric information about the two distances between the coracoid process and the points where the first thin branch and the MC enter the coracobrachialis. These distances were named as the "distance *T*1" and the "distance *D*," respectively. Forty-two cadaver upper extremities were used and the distance between the coracoid process and the medial epicondyle of the humerus as the "arm length" was measured. The "ratio *T*1" was calculated by dividing the distance *T*1 by the arm length. The "ratio *D*" was calculated by dividing the distance *D* by the arm length. The number of the thin branches varied between one and four. In the most common type, there were two thin branches (45%). All of the thin branches originated from the MC. The mean distance *T*1, distance *D* and arm length were found as 41.5, 62 and 304.5 mm, respectively. The mean ratio *T*1 and ratio *D* were determined as 0.13 (approximately 1/8) and 0.20 (= 1/5), respectively. The findings about the number and origin of the thin branches may contribute to the anatomy of the nerve to the coracobrachialis. The shoulder surgeon may calculate the predicted distance *T*1 and distance *D* of any upper extremity, dividing its arm length by eight and five, respectively.

Keywords Musculocutaneous nerve · Coracobrachialis muscle · Coracoid process · Anatomy · Morphometry

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Introduction

The coracobrachialis muscle (CB) arises from the tip of the coracoid process of the scapula and is inserted into the middle third of the humeral body [11, 17]. The nerve to the CB originates from the musculocutaneous nerve (MC) or from the brachial plexus near the origin of the MC [15, 16], and usually consists of several thin branches [4, 15, 16]. The MC gives off the branch to the CB before it enters the muscle [11, 17]. The nerves entering into the CB are the MC and the thin nerve branches to the CB. In this study, the main trunk of the MC was named as the "main trunk," and the thin nerve branches that enter the CB proximal to the main trunk were named as the "thin branches (TBs)" (Fig. 1a, b).

Transfer of the coracoid process to the scapular neck is used for the treatment of recurrent anterior instability of the shoulder [7]. Coracoid transfer (through the subscapularis tendon) was firstly described by Latarjet in 1954 [7]. Procedures, which include coracoid transfer, involve mobilization of the muscles attached to the coracoid process [2, 3, 7, 8]. Injury to the MC and TBs may occur during these procedures because of the applied traction to these nerves [1–3, 5, 14]. The surgeon should especially remember the entries of these nerves into the CB at a high level during these procedures [2].

In order to assist in these procedures, the purpose of this study is (1) to reveal the number and origin of the TBs, (2) especially to report the morphometric information about the two distances which take place between the coracoid process and the points where the first thin branch and the main trunk enter the CB, and (3) to compare our results with the findings of reported studies.

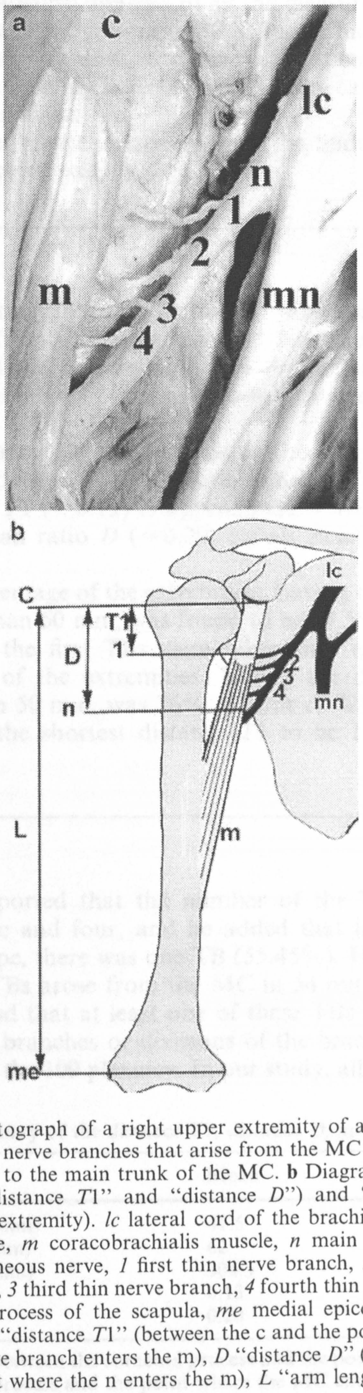

Fig. 1 **a** Photograph of a right upper extremity of a cadaver that has four thin nerve branches that arise from the MC and enter the CB proximal to the main trunk of the MC. **b** Diagram of the two distances ("distance *T*1" and "distance *D*") and "arm length" (right upper extremity). *lc* lateral cord of the brachial plexus, *mn* median nerve, *m* coracobrachialis muscle, *n* main trunk of the musculocutaneous nerve, *1* first thin nerve branch, *2* second thin nerve branch, *3* third thin nerve branch, *4* fourth thin nerve branch, *c* coracoid process of the scapula, *me* medial epicondyle of the humerus, *T1* "distance *T*1" (between the c and the point where the first thin nerve branch enters the m), *D* "distance *D*" (between the c and the point where the n enters the m), *L* "arm length" (between the c and the me)

Materials and methods

This study was carried out on the formalin fixed human cadavers of the Anatomy Department of the Istanbul Medical Faculty of Istanbul University. Forty-two upper extremities, on which no pathological findings were found in the dissection region, were dissected. All of the cadavers were Caucasian men. All of the cadavers had died because of respiratory and cardiovascular problems. Their mean age was 56.42 years (ranging from 34 to 72).

The anatomic dissections were performed while the upper extremities were abducted (approximately 30–45°). The CB, MC and TBs were exposed on each upper extremity, and the most inferior point of the lower border of the tip of the coracoid process of the scapula and the tip of the medial epicondyle of the humerus were marked. The points used for each measurement in this study were marked with the acupuncture needles (size 0.25 × 25 mm). All of the distances were measured macroscopically and manually by two experienced anatomists (AO, BB), and all of these measurements were made vertically on the coronal plane in the anatomical position. The digital calipers (model: Water and Coolant Resistant S235 caliper, manufacturer: Sylvac, manufacture country: Swiss, measuring range 300 mm, resolution 0.01 mm and maximum error 0.02 mm) were used in our measurements.

The thin branch that entered the CB at the most proximal point was named as the "first thin branch (TB)" (Fig. 1a, b). The shortest vertical distance between the coracoid process and the point where the first TB entered the CB was measured and named as the "distance *T*1" (Fig. 1b). The shortest vertical distance between the coracoid process and the point where the main trunk entered the CB was measured and named as the "distance *D*" (Fig. 1b). The shortest vertical distance between the coracoid process and the tip of the medial epicondyle of the humerus was measured as the "length of the arm" (Fig. 1b) to allow the readers to understand the size of the specimens and in addition, to find the mean ratio *T*1 and the mean ratio *D*. The distance *T*1 was divided by the arm length to find the "ratio *T*1" (ratio *T*1 = distance *T*1/arm length) for each upper extremity, and the distance *D* was divided by the arm length to find the "ratio *D*" (ratio *D* = distance *D*/arm length) for each upper extremity. Then, the mean values of these ratios *T*1 and *D* were found. Thus, these mean values of the ratios *T*1 and *D*, respectively, may be used to predict the distances *T*1 and *D* for any upper extremity whose arm length is known. This explanation can be formulated such as; the predicted distance *T*1 of any upper extremity is equal to multiplication of its arm length by the mean ratio *T*1 (predicted distance *T*1 = arm length that is measured × mean ratio *T*1), and its predicted distance *D* is equal to multiplication of its arm length by the mean ratio *D* (predicted distance *D* = arm length that is measured × mean ratio *D*).

Table 1 Classification of the extremities ($n = 42$) according to the number of the TBs of them

Number (%) of extremities having one TB	Number (%) of extremities having two TBs	Number (%) of extremities having three TBs	Number (%) of extremities having four TBs
8 (19)	19 (45)	12 (29)	3 (7)

TBs, thin nerve branches that enter the coracobrachialis proximal to the main trunk of the MC

In the statistical analysis of all the measurements, the SPSS 7.5 statistical program (SPSS Inc., Chicago, USA) for Windows was used, and the mean, standard deviation, minimum and maximum values were calculated for each measurement.

Our results were compared with the findings of previously reported studies.

Results

In all 42 extremities, the CB had no variations, the MC originated from the lateral cord of the brachial plexus and entered the CB, and the TBs originated from the MC. The number of the TBs varied between one and four (Table 1, Fig. 1a).

The distance *T*1, the distance *D*, the arm length, the ratio *T*1 and the ratio *D* are summarized in Table 2. The mean ratio *T*1 (=0.13) is approximately 1/8 (Table 2), and the mean ratio *D* (=0.20) equals exactly 1/5 (Table 2).

The percentage of the extremities, having the distance *D* shorter than 50 mm, was found to be 21.5% (9 out of 42). When the first TBs were taken into account the percentage of the extremities, having the distance *T*1 shorter than 50 mm, was 76% (32 out of 42) (Table 3). We found the shortest distance *T*1 to be 17 mm (Table 2).

Discussion

Kerr [6] reported that the number of the TBs varied between one and four, and he added that in the most common type, there was one TB (55.45%). He recorded that these TBs arose from the MC in 54 out of the 109 plexuses, and that at least one of these TBs arose from some other branches or divisions of the brachial plexus in 55 out of the 109 plexuses. In our study, all of the TBs originated from the MC, and the extremities that had two TBs were the most common type with 45% (Table 1).

Osborne et al. [12] reported that the MC perforated the CB at the level of the latissimus dorsi tendon. Latarjet et al. [9] firstly reported the distance between the coracoid process and the point where the main trunk entered the CB with range of 20–120 mm. Flatow et al. [2] stated that the distance *D* was found to be 5 cm and more, and he added that the distance *D*, which was longer than 5 cm, was accepted as the safe zone in the literature.

Linell [10] measured the distance from the acromion tip to the point where the nerve to the CB entered the muscle, and also measured the arm length from the acromion tip to the external condyle tip of the humerus. He found the ratio dividing the distance by the arm length and reported the average ratio in his study. We found our mean ratios *T*1 and *D* in the same way. However, we used the coracoid process instead of the acromion in our measurements because the CB is attached to the coracoid process.

Helfet [3] firstly suggested that the entry of the MC into the CB at a high level was clinically important. He reported a patient who developed paraesthesia after coracoid transfer procedure. Exploration showed that the MC of high entry was vulnerable at the point where the CB penetrated the subscapularis muscle. Other authors also reported that the entry at a high level had clinical relevance [1, 2, 9, 13, 14]. Flatow et al. [2] emphasized that the TBs were important during surgery. They stated that the shoulders had at least one and usually several TBs, and firstly reported the measurement data about the distance *T*1. They found the shortest distance *T*1 to be 17 mm, the mean distance *T*1 to be 31 mm and the mean distance *D* to be 56 mm. They reported the percentage of the shoulders, having the distance *D* shorter than 50 mm, as 29% (25 out of 86). When the TBs were considered; they found the

Table 2 Summary of the distance *T*1, distance *D*, arm length, ratio *T*1 and ratio *D* ($n = 42$)

Parameters	Mean	Standard deviation	Minimum	Maximum
Distance *T*1 (mm)	41.5	11.5	17	72
Distance *D* (mm)	62	14	32	104
Arm length (mm)	304.5	25	251	351.5
Ratio *T*1	0.13	0.02	0.06	0.20
Ratio *D*	0.20	0.03	0.12	0.29

Distance *T*1: between the coracoid process and the point where the first thin nerve branch enters the coracobrachialis; Distance *D*: between the coracoid process and the point where the MC enters the coracobrachialis; Arm length: between the coracoid process and the medial epicondyle of the humerus; Ratio *T*1: Distance *T*1/arm length; Ratio *D*: Distance *D*/arm length.

Table 3 Classification of the extremities (n = 42) according to the distribution of the measurements of the distance $T1$

Distance $T1$ (mm)	Number (%) of extremities
Between 17 and 19	1 (2.5)
Between 20 and 29	4 (9.5)
Between 30 and 39	16 (38)
Between 40 and 49	11 (26)
Between 50 and 72	10 (24)

Distance $T1$: between the coracoid process and the point where the first thin nerve branch enters the coracobrachialis.

percentage of the shoulders, having the distance $T1$ shorter than 50 mm, as 74% (64 out of 86).

These distances $T1$ and D are clinically important during coracoid transfer (Latarjet's procedure). The risk of injury to the MC and TBs is increased during coracoid transfer if the distances $T1$ and D of the upper extremity, which will be operated, are short. The shoulder surgeon may find the predicted distances $T1$ and D of any upper extremity using our mean ratios $T1$ and D, respectively. He may easily calculate the predicted distance D of any upper extremity dividing its arm length by five (predicted distance D = arm length of the patient/5). He may easily find the predicted distance $T1$ of any upper extremity dividing its arm length by eight (predicted distance $T1$ = arm length of the patient/8).

Conclusion

The entry of the MC into the CB at a high level is not uncommon and the extremities have at least one TB. In approximately one-fifth of the extremities, the distance D is shorter than 5 cm that was cited in the literature as the safe zone for procedures of anterior shoulder surgery. In approximately three-fourths of the extremities, the distance $T1$ is shorter than 5 cm. Therefore, the surgeon should remember these variations in levels of the entries of these nerves into the CB during these procedures. The mean ratios $T1$ and D, respectively, may be used to localize the entries of the first TB and MC into the CB during these procedures. Knowledge of the ratios would be useful for safe surgery with better outcomes in these procedures. Particularly, these ratios may be helpful for the shoulder surgeon who aims to do coracoid transfer (Latarjet's procedure) in the surgical treatment of recurrent anterior instability of the shoulder.

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