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The morphometry of the coracoid process – its aetiologic role in subcoracoid impingement syndrome

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Abstract Anatomical morphometric studies of the coracoid process and coraco-glenoid space were carried out on 204 dry scapulae. No statistically significant correlations were found between length, or thickness of the coracoid process, prominence of the coracoid tip, coracoid slope, coraco-glenoid distance, or position of the coracoid tip with respect to the uppermost point of the glenoid. These anatomical characteristics were independent of the dimensions of the scapulae. Three configurations of the coraco-glenoid space were identified. Type I configuration was found in 45% of scapulae and Type II and Type III, in 34% and 21% of specimens, respectively. The lowest value of the coraco-glenoid distance were seen in Type I scapulae. Morphometric characteristics which might predispose to subcoracoid impingement were found in 4% of Type I scapulae. A total of 27 scapulae, nine with each type of configuration were submitted to CT scanning. Scapulae with a Type I configuration were found to have low values for the coraco-glenoid angle and coracoid overlap, which are known to be associated with a short coraco-humeral distance. Subjects with a Type I configuration, and severe narrowing of the coraco-glenoid space, appear to be predisposed to coraco-humeral impingement. These morphometric characteristics may be easily evaluated on CT scans.

Résumé Des études d'anatomie morphométrique du processus coraco ont été menées sur 204 omoplates sèches. Aucune corrélation statistiquement significative n'a été trouvée entre la longueur, ou l'épaisseur, du processus coraco, la proéminence du point coraco, la pente coraco, la distance coracogléno et la position du point coraco par rapport au sommet de la gléno. Ces caractéristiques sont indépendantes des dimensions de l'omoplate. Trois configurations de l'espace coracogléno ont été identifiées: Type I, Type II et Type III. Les caractéristiques morphometriques qui peuvent prédisposer à une friction subcoraco ont été trouvées sur 4% des omoplates avec une configuration de Type I. Un total de 27 omoplates, 9 de chaque type de configuration, a été soumis à une tomographie osseuse. Les omoplates du premier type de configuration présentent un angle coracogleno de faible valeur, ce qui est connu pour être associé avec une distance coracohumerale faible. Les sujets présentant une configuration de premier type et un sévère rétrécissement de l'espace coracogleno, apparaissent être prédisposés à une friction coracohumérale. Ces caractéristiques morphométriques peuvent aisément être évaluées par tomographie osseuse.

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Introduction

Gerber et al. [4] described the aetiology of sub-coracoid impingement. Few patients had idiopathic impingement, which appeared to be caused by a long coracoid process projecting more laterally than normal. Coracoid impingement was reported in seven patients, all of whom underwent surgical excision of the coracoid tip [2]. In spite of these reports, many shoulder surgeons, including Codman [1], have expressed doubt about the existence of this idiopathic syndrome.

We performed an anatomical morphometric study on a large number of coracoid processes in dry scapulae and a CT morphometric study on some of the specimens. The aim was to determine if anatomical variations of the coracoid process might predispose to the idiopathic impingement syndrome.

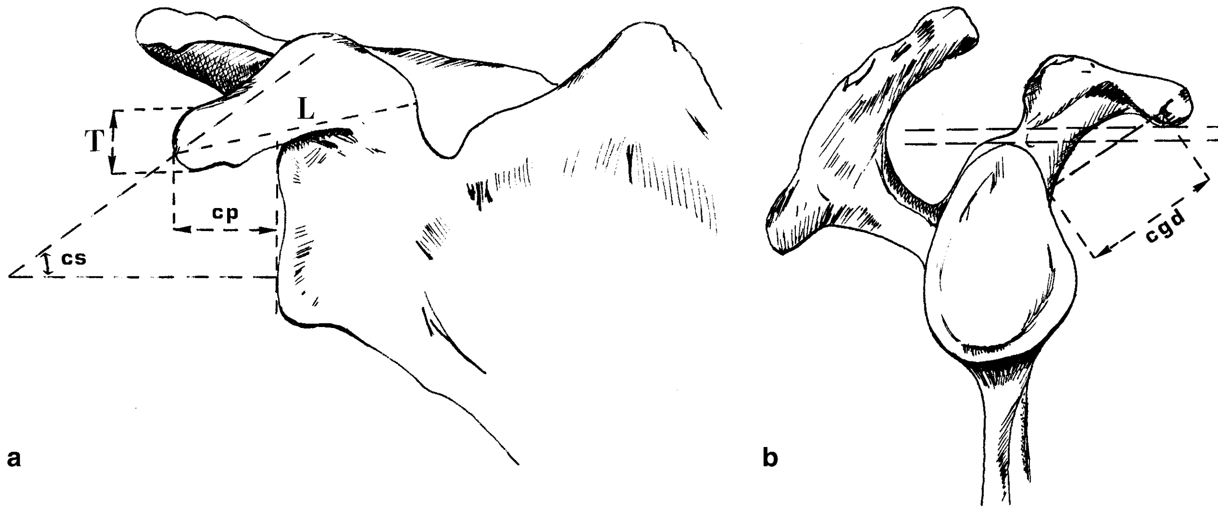

Fig. 1a, b Drawings showing the measurements performed. **a** *L*, coracoid length; *T*, coracoid thickness; *cp*, prominence of the coracoid tip beyond the plane of the glenoid; *cs*, coracoid slope (according to Edelson and Taitz [3]). **b** *cgd*, distance between the lateral border of the coracoid tip and the nearest point of the anterosuperior margin of the glenoid; *d*, distance between the horizontal plane tangent to the lowermost point of the coracoid tip and the horizontal plane tangent to the uppermost point of the glenoid

Material and method

204 scapulae (76 right and 128 left) were entered into the study; most (82%) were from cadavers with a presumed age between 30 and 60 years. Sixty-eight pairs of scapulae were from the same skeletons. None of the scapulae showed degenerative changes of the coracoid process.

The measurements shown in Figs. 1a,b were performed. Statistical analysis was performed to investigate the relationship between variables; the R^2-coefficient was also calculated.

A total of 27 randomly selected scapulae among those whose glenoid retroversion ranged from 11° to 14°, nine for each of the three types of configuration of coraco-glenoid space, were studied by computerized tomography. Since for every 1° of change in glenoid retroversion there is a change of 0.37 mm in coraco-humeral distance [5], a 3° range yields minimal variations in the measurements. Each scapula was placed in the same position as it is in vivo at CT examination of the shoulder; ie, as if the humerus were at the side and the forearm under the lumbar spine. The coraco-glenoid angle and the coracoid overlap were measured according to the method of Gerber et al. [5]. The coraco-glenoid angle is formed by: the line originating from the anterior glenoid rim and running tangentially to the most prominent part of the tip of the coracoid; and the line passing through the anterior and posterior glenoid rims. The coracoid overlap represents the distance by which the coracoid process overlaps the plane of the glenoid fossa.

Results

Three groups of scapulae were arbitrarily identified, based on the height to width ratio: Group I (ratio 1.18–1.34), Group II (ratio 1.35–1.50) and Group III (ratio 1.51–1.75). Group I included 52% of scapulae, Group II, 44% and Group III, 4%.

The mean, extreme values and standard deviations of L, T, cp, cs and d are reported in Table 1. The different positions of the coracoid tip with respect to the uppermost point of the glenoid fossa are shown in Fig. 2a, b.

Three types of configurations of the coraco-glenoid space were identified. In Type I this space had a “round bracket” configuration (Fig. 3a), whereas in Type II and III it had the shape of a “square bracket” (Fig. 3b) and a “fish hook” (Fig. 3c), respectively. Type I configuration was observed in 45% of scapulae, and Type II and III configuration in 34% and 21% of specimens, respectively. The three types of configuration were equally distributed in the scapulae of Group I, II and III. The shortest coraco-glenoid distance was found in Type I configuration (mean value 15.7 mm) compared with Type II and Type III (whose mean values are 16.9 mm and 16.0 mm respectively). Only 4% of the specimens with Type I configuration were found to have the following characteristics, which affect the width of the coraco-humeral space: T>8.2 mm; cp>16.6 mm; cgd<14.5 mm; cs>30°. Each of these values was obtained by taking the mean value plus or minus the standard deviation of each variable.

Table 1 Extreme values, average and standard deviations of coracoid length and thickness; coracoid prominence; coraco-glenoid distance; coracoid slope; distance between the coracoid tip and the uppermost point of the glenoid fossa (*L* coracoid length; *T* coracoid thickness; *cp* coracoid prominence; *cgd* coraco-glenoid distance; *cs* coracoid slope (measured according to Edelson and Taitz [3]); *d* distance between the coracoid tip and the uppermost point of the glenoid fossa; *S.d.* standard deviation)

	L (mm)	T (mm)	cp (mm)	cgd (mm)	cs (degrees)	d (mm)
Max	50	10.2	22	22.1	42	12
Min	31	5	11	11.8	19	0.5
Average	38.15	7.19	14.62	16.23	25.57	7.11
S.d.	3.97	1.04	1.96	1.7	4.71	1.23

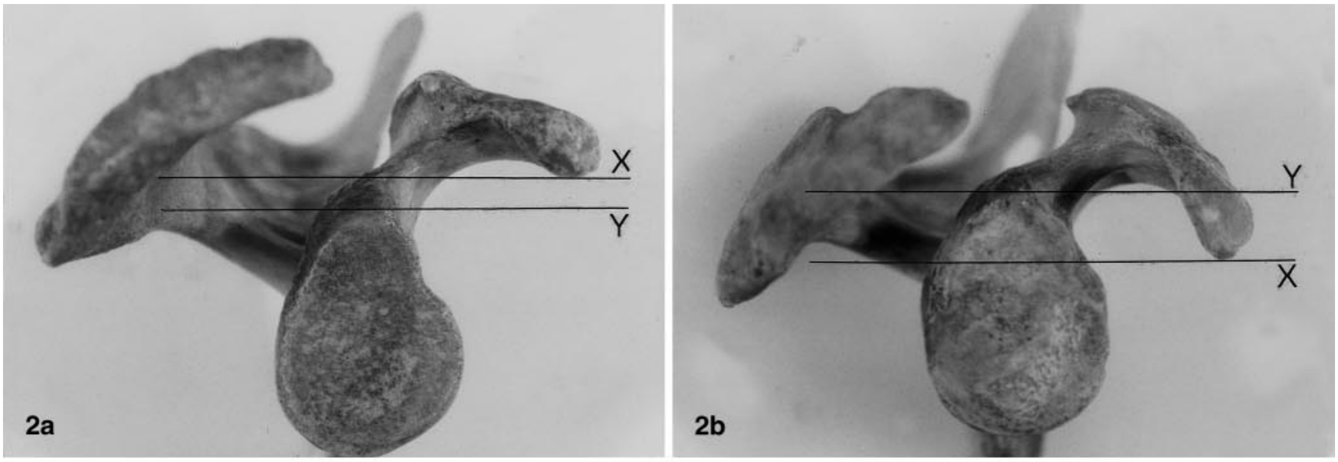

Fig. 2 Photographs showing the different position of the coracoid tip with respect to the uppermost point of the glenoid fossa in two scapulae. In the scapula of the Fig. 2a the *horizontal line* tangent to the caudal margin of the coracoid tip (X) is situated cranially (maximum 3 mm), and in the scapula of the Fig. 2b caudally (maximum 12 mm), compared with the *horizontal line* tangent to the cranial end of the glenoid (Y)

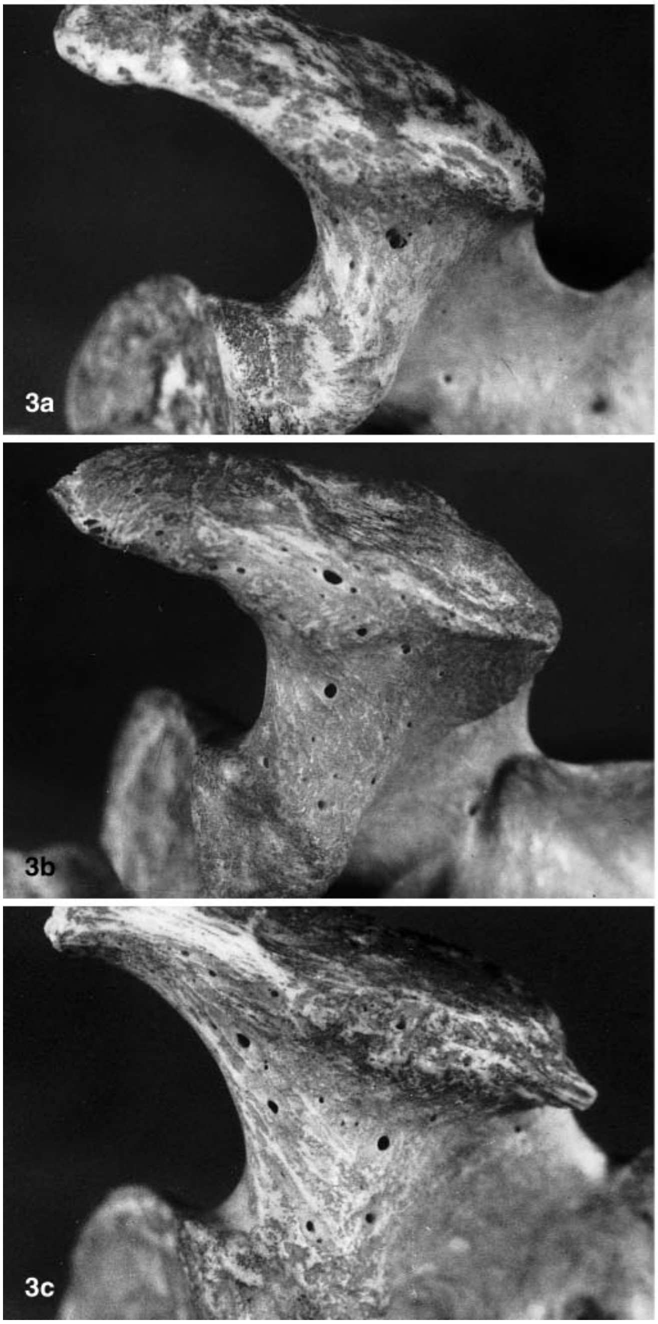

Fig. 3a–c Configurations of the arch-like space delimited by the anterosuperior border of the glenoid and the posterolateral margin of the coracoid process. **a** Type I configuration; **b** Type II configuration; **c** Type III configuration

The values for L, T, cp, cgd, cs and d of the coracoid process were found to be independent of the dimensions of the scapulae.

No correlations emerged between the anatomical characteristics of the coracoid process and the presence of degenerative changes of the acromion. Statistical analysis showed no correlations among the variables.

The supplementary CT study showed that the mean value of the coraco-glenoid angle was 146.4° in Type I scapulae and 151.1° and 151.3° in the specimens with Type II or Type III configuration (Table 2). The mean coracoid overlap in the three types of scapulae was, respectively, 8.7 mm, 11.2 mm and 10.7 mm (Table 2).

Discussion

The subcoracoid space is occupied in vivo by several soft tissue structures, such as the articular capsule of the gleno-humeral joint, the subscapularis tendon and the subacromial bursa. The thickness of these tissues may vary, but variations are small and do not affect the width of the subcoracoid space, unless there is local pathology. The shape and size of this space depend on its limiting skeletal structures [6,8]. Therefore, anatomical morphometric studies of these structures may provide information as to the aetiology of the subcoracoid impingement syndrome. To elucidate the possible aetiological role of scapular morphometry in idiopathic coraco-humeral impingement, we examined dry scapulae with an age range similar to that of patients presenting with the clinical syndrome [2]. Gender, and side of the scapulae were not

Table 2 Mean values of coraco-glenoid angle, coracoid overlap, and retroversion angle (*cga* coraco-glenoid angle (degrees); *co* coracoid overlap (mm); *ra* retroversion angle (degrees); *var* variance; *avg* average)

Type I			Type II			Type III		
cga (var)	co (var)	ra	cga (var)	co (var)	ra	cga (var)	co (var)	ra
146.2 (0.2)	6.8 (0.2)	12	151.8 (0.2)	10.2 (0.2)	11	153.6 (0.3)	10 (0.0)	12
142.8 (0.2)	9.2 (0.2)	12	147.6 (0.3)	12 (0.0)	12	150.2 (0.2)	10 (0.0)	13
145 (0.0)	8 (0.0)	12	154.2 (0.2)	10.8 (0.2)	12	154.4 (0.3)	11.8 (0.2)	13
145.2 (0.2)	10 (0.0)	11	151 (0.0)	9 (0.0)	14	152.2 (0.2)	12 (0.0)	13
146.4 (0.8)	11.1 (0.1)	14	155.2 (0.2)	11.2 (0.2)	12	150 (0.0)	10 (0.0)	13
147.2 (0.2)	8.2 (0.2)	12	152 (0.0)	13.9 (0.1)	13	153.6 (0.8)	9.2 (0.2)	12
150.2 (0.2)	10 (0.0)	12	150.8 (0.7)	11 (0.0)	12	149.6 (0.3)	10 (0.0)	11
145.2 (0.2)	7.2 (0.2)	13	149.4 (0.8)	13.4 (0.8)	12	150 (0.0)	12.8 (0.2)	12
149.4 (0.3)	8 (0.0)	13	147.6 (0.8)	9.2 (0.2)	14	148.4 (0.8)	10.8 (0.2)	14
avg: 146.4	avg: 8.7	avg: 12.3	avg: 151.1	avg: 11.2	avg: 12.4	avg: 151.3	avg: 10.7	avg: 12.6

taken into account, since these factors do not appear to influence the anatomical features of the coracoid process [5].

We found no significant correlations among length or thickness of the coracoid process, coraco-glenoid distance, coracoid slope and prominence of the coracoid tip beyond the anterior edge of the glenoid. Furthermore, no correlations were found between these anatomical features and the dimensions of the whole scapula as revealed by the length-width ratio. Since the anatomical characteristics, which were found to be extremely variable, cannot be precisely evaluated on radiographs of the shoulder, no information on the dimensions of the coracohumeral space can be obtained by radiographic studies.

The anterosuperior border of the glenoid and the posterolateral margin of the coracoid process enclose an arch-like space of varying shape. We found that this space may have three configurations and presents the shortest dimensions in the Type I scapulae. Furthermore, the scapulae with this configuration were found to have, on CT, the lowest mean values of the coraco-glenoid angle and coracoid overlap. It has been shown that values of these parameters are related to the width of the coraco-humeral space, since the latter are found to be small in the presence of small coraco-glenoid angles and small coracoid overlap [5]. Therefore, Type I configuration implies a short coraco-humeral distance. Measurements of the coraco-glenoid space on standard CT scans, which are much easier than measurements of the coraco-glenoid angle and coracoid overlap, may identify subjects with a narrow coraco-humeral space. This information, however, is not sufficient to diagnose idiopathic subcoracoid impingement. In fact, in 4% of Type I scapulae, other anatomical characteristics were present predisposing to narrowing of the coraco-humeral space, and this is a higher figure than the incidence of the clinical syndrome. It is thus conceivable that constitutional anomalies (e.g. prominence of the lesser tuberosity) or pathological conditions of the local soft tissues or bony structures (ganglia or calcification of the subscapularis tendon, or superior migration of the humeral head) [4,7] should also be present for the clinical syndrome to develop.

Severe degenerative changes of the coracoid pillar were not observed in our skeletons, even when the acromion showed anterior spurs or a pseudoarticular surface for the humeral head. This suggests that the coracoid process is not involved in, or affected by, subacromial impingement. Furthermore, degenerative changes have not been observed in patients with subcoracoid impingement [2].

In conclusion, our study suggests that subjects who are at risk of developing an idiopathic subcoracoid impingement syndrome are those showing a Type I configuration, associated with severe narrowing of the coracoglenoid space. The morphometric characteristics of this space may be easily evaluated on standard CT scans of the shoulder.

References

1. Codman EA (1984) The shoulder: rupture of the supraspinatus and other lesions in or about the subacromial bursa. Krieger, Malabar, Florida
2. Dines DM, Warren RF, Inglis AE, Pavlov H (1990) The coracoid impingement syndrome. J Bone Joint Surg [Br] 72: 314–316
3. Edelson JG, Taitz C (1992) Anatomy of the coraco-acromial arch. Relation to degeneration of the acromion. J Bone Joint Surg [Br] 74: 589–594
4. Gerber C, Terrier F, Ganz R (1985) The role of the coracoid process in the chronic impingement syndrome. J Bone Joint Surg [Br] 67: 703–708
5. Gerber C, Terrier F, Zehnder R, Ganz R (1987) The subcoracoid space. An anatomic study. Clin Orthop 215: 132–138
6. Goldthwait JE (1909) An anatomic and mechanical study of the shoulder-joint, explaining many of the cases of painful shoulder, many of the recurrent dislocations and many of the cases of brachial neuralgias or neuritis. Am J Orthop Surg 6: 579–606
7. Ko JY, Shih CH, Chen WJ, Yamamoto R (1994) Coracoid impingement caused by a ganglion from the subscapularis tendon. J Bone Joint Surg [Am] 76: 1709–1711
8. Meyer AW (1937) Chronic functional lesions of shoulder. Arch Surg 35:646–674