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Morphological parameters of the acromion

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The purpose of this study was to record the basic morphometric values of the acromion. Forty-four pairs of dried scapulas were reviewed. Acromial shape was evaluated in relation to sex, symmetry and presence of subacromial enthesophytes and classified according to Bigliani with the following results: type I (flat): 26.1%, type II (curved): 55.6% and type III (hooked): 18.1%. There was a greater percentage of type III in men (56.2% vs. *43.7%) and type I in women (56.5%* vs. *43.4%). Acromial morphology was symmetric in 29 acromia (65.9%). Enthesophytes were most common in type III (75%). A rough inferior surface of the acromion was most frequently found in type III (81.2%). Nine other scapular osteological parameters were also measured. Many differences were noted between male and female scapulae. The great variety of morphological features is assumed to be related to rotator cuff pathology and other shoulder impairments.* (Folia Morphol 2008; 67: 255–260)

Key words: shoulder, morphometry, impingement, rotator cuff

INTRODUCTION

The acromion is related to a variety of disorders in the shoulder. To our knowledge, there are few studies in the literature which adduce a wide range of measurements to describe the various shapes and variants of this anatomical structure. The aim of this study was to record and study all the morphometric values of the acromion in a Greek population sample.

The scapular spine, originating from the posterior surface of the scapula, is extended to a powerful and flattened process situated on the border between the upper quadrant and the remaining quadrants, forming the acromion. The anterior third of the acromion, the coracoacromial ligament and the coracoid process form, as is well known, the coracoacromial arch. This arch is a relatively non-elastic structure and includes the subacromial space, 1–1.5 cm wide, which contains the subacromial bursa, the myotendinous rotator cuff and the tendon of the long head of the biceps muscle (Fig. 1).

The predominant theory for the impingement syndrome of the rotator cuff muscles (supraspinatus, infraspinatus, teres minor and infrascapularis) classifies the contributing factors as anatomical and functional. The anatomical causes include the shape and the inclination of the acromion. Bigliani and his colleagues studied 140 shoulders and classified the acromial morphology into three types: type I or flat, type II or convex and type III or hooked (Fig. 2) [1]. Since this time the Bigliani-Morrison-April morphological classification has been the dominant diagnostic tool for the impingement syndrome and rotator cuff tears.

MATERIAL AND METHODS

The study was carried out on 44 pairs of dried scapulae derived from the Osteology Collection of

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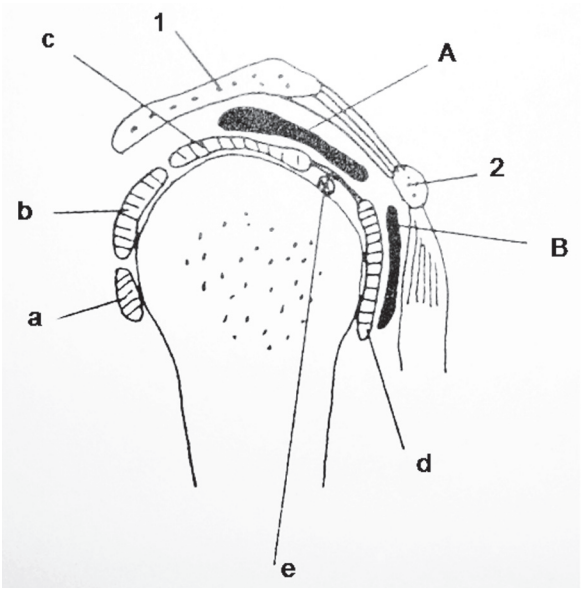

Figure 1. The subacromial space and its anatomical elements; 1 — acromion, 2 — coracoid process, a — teres minor, b — infraspinatus, c — supraspinatus, d — subscapularis, e — long head of the biceps, A — subacromial bursa, B — coracobrachial bursa.

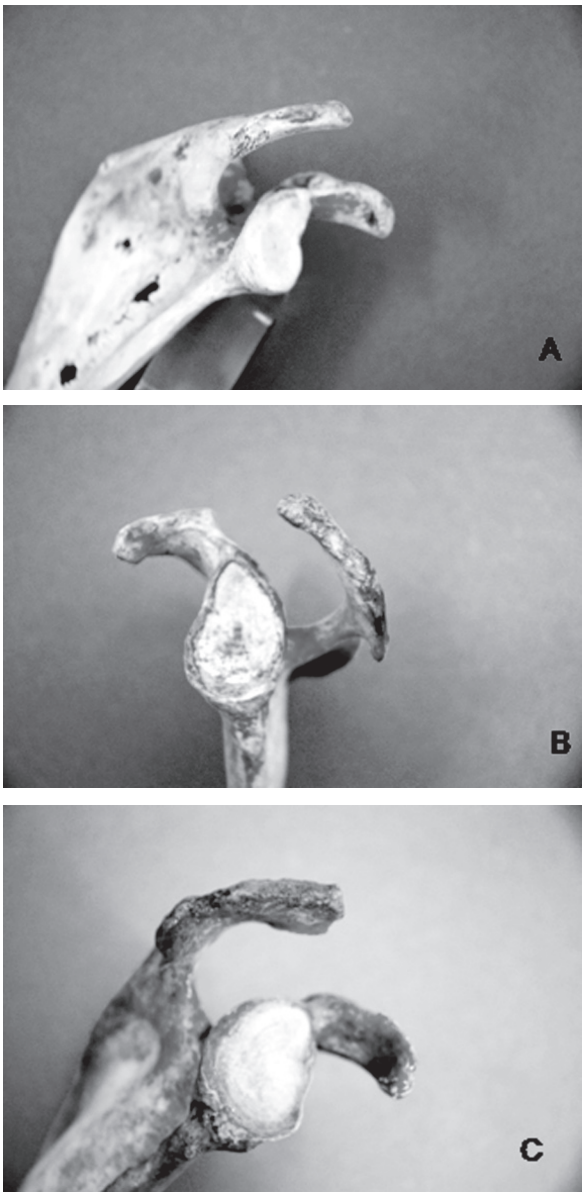

Figure 2. Classification of the acromial morphology according to Bigliani et al.; **A.** Flatted type; **B.** Convex type, **C.** Hooked type.

the Department of Anatomy at our university. The specimens were equally distributed with respect to gender. The following information was recorded: the shape of the anterior third of the acromion in relation to gender and symmetry according to the Bigliani-Morrison-April classification, the morphology of the inferior surface of the acromion (whether smooth or rough, Fig. 3) and the presence of enthesophytes. Several dimensions were measured, including the size of the scapula and the acromion, the inclination of the acromion, the inclination of the articular surface of the acromion at the sagittal plane, and the acromioglenoid and acromiocoracoid distances. The linear measurements were made with a 1 mm scaled micrometer. The measurement of the thickness of the acromion was made by a specially scaled 1 mm gauge, where this could not be achieved with a micrometer. The angular measurements were made with a goniometer.

The scapular measurements included the maximum longitudinal diameter between the superior medial and inferior angles, and the maximum transverse diameter between the medial border of the scapula, where the spine meets the body of the scapula, and the anterior lip of the glenoid (Fig. 4). The study of the dimensions of the acromion included:

— the anteroposterior length in the longitudinal axis;
— the distance between the lateral and medial borders at the midpoint of the acromioclavicular ligament insertion;
— the thickness of the acromion 1 cm posterior to the anterior border and 1 cm medially to the lateral border (Fig. 5).

The acromiocoracoid distance was measured between the coracoid process and the acromion along an imaginary line representing the midpoint of the coracoacromial ligament, while the acromioglenoidal distance was measured as the distance between the supraglenoid tubercle and the inferior surface of the acromion. The inclination of the

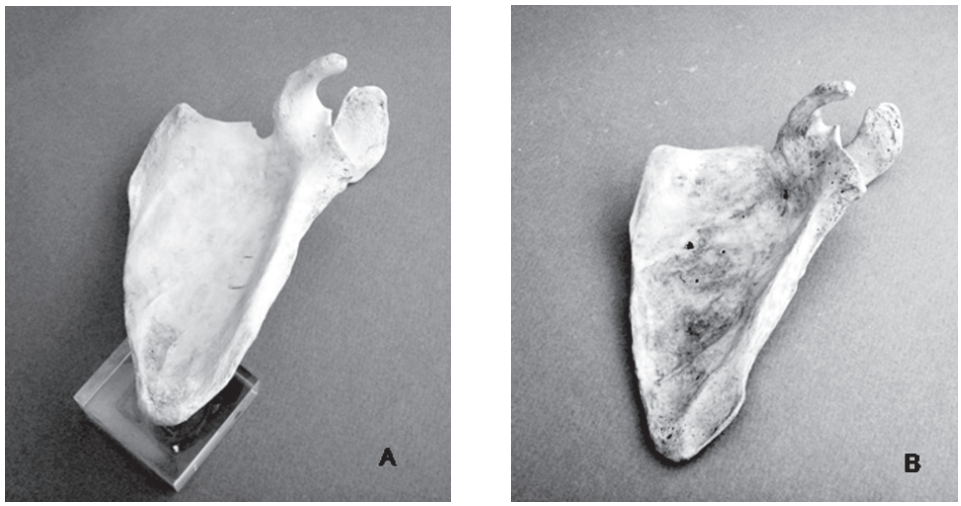

Figure 3. A. Smooth appearance; **B.** Rough appearance of the posterior third of the inferior surface of the acromion.

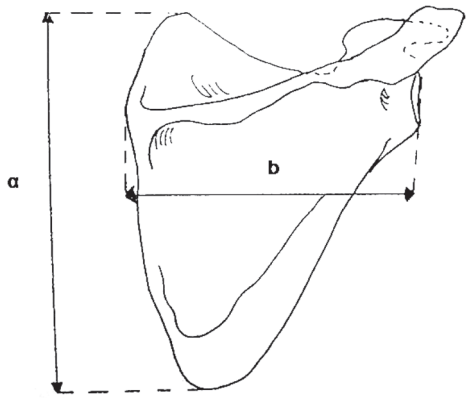

Figure 4. Determination of the maximum longitudinal diameter (a) between the superior medial and inferior angles of the scapula and (b) maximum transverse diameter, between the medial border of the scapula, in the area where the spine meets the scapular body, and the anterior lip of the glenoid.

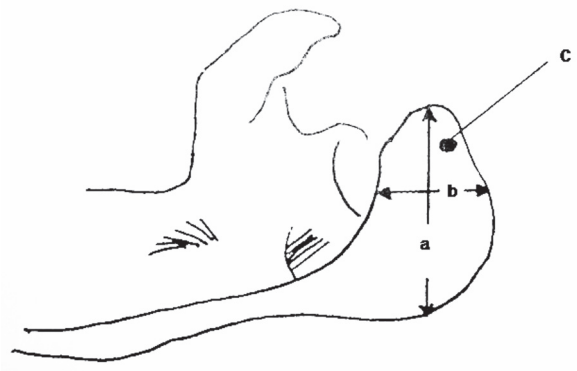

Figure 5. Determination of the dimensions of the acromion; a — sagittal length, b — distance between the medial and the lateral lip at the midpoint of the acromioclavicular ligament insertion, c — thickness measured 1 cm behind the anterior border and 1 cm medial to the lateral border).

acromion was recorded as the angle that is formed between the tangential line of the inferior surface of the acromion and the horizontal plane (Fig. 6). The inclination of the articular surface of the acromion was recorded as medial, lateral and vertical to the sagittal plane. With regard to the statistical analysis, an independent Student's t-test was used to compare quantitative variables. Statistical significance was set at 0.01.

RESULTS

According to the Bigliani-Morrison-April classification, the shape of the acromion was recorded as type I in 23 cases (26.1%), as type II in 49 (55.6%) and as type III in 16 scapulae (18.1%; Table 1). With regard to the gender distribution of each morphological type, it was noted that type I was more common in females (13 or 56.5% *vs*. 10 or 43.4%), whereas type III was more common in males (9 or 56.2%) *vs*. 7 or 43.7% in females. These results were found to be statistically significant (t-test: $p < 0.01$). The incidence of various features in the scapulae is shown in Table 2. The shape of the acromion was symmetric in 58 scapulae (65.9%), and there was no correlation between shape and gender. The presence of enthesophytes was noticed in 19 cases (21.5%), predominantly in type III acromia (12/16, 75%) and relatively frequently in the males (11/44, 25%) (statistically significant results). The morphology of the inferior surface of the anterior third of the acromion was smooth in 37 cases (42%) and rough in 51 (57.9%; Fig. 2). A prevalence of the rough inferior surface was noted in type III (13/16,

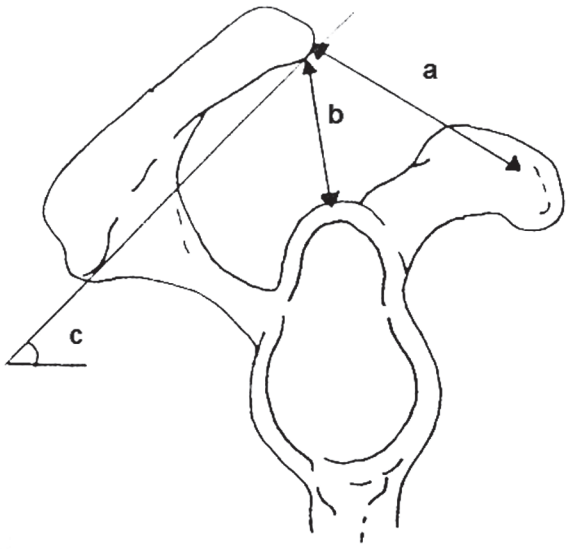

Figure 6. Determination (a) of the acromiocoracoid distance between the coracoid process and the acromion, (b) of the acromioglenoidal distance between the supraglenoid tubercle and the inferior surface of the acromion and (c) of the inclination of the acromion.

81.2%) and in males (31/44, 70.4%), the t-test showing statistical significance.

The mean values of the measurements in all the scapulae, both in males and in females, are shown in Table 3. The mean maximum longitudinal diameter of the scapula was 147.6 mm (range 129–168 mm).

Table 1. The distribution of the scapulae according to the type of acromion

Classification	Number of scapulae	Female	Male
I	23 (26.1%)	13	10
II	49 (55.6%)	23	26
III	16 (18.1%)	7	9

The same mean value in males was 154.6 mm (147–168 mm) in comparison with 140.6 mm (129–151 mm) in females. The mean value of the maximum transverse diameter of the scapula was 101.9 mm (85–115 mm). In males this value was 107.2 mm (97–115 mm), whereas in females it was 96.6 mm (85–104 mm), and these were found to be statistically significant.

The mean length of the acromion was 46.1 mm (38–55 mm), 48.3 mm (43–55 mm) in males and 43.9 mm (38–51 mm) in females. The mean width of the acromion was 22.3 mm (19–28 mm). It is important to note that there was no statistically significant difference in the mean width of the acromion as far as gender was concerned [males: 22.6 mm (22–28 mm), females: 22 mm (19–27 mm)]. The mean thickness of the acromion was 8.8 mm (7–11 mm), 9.1 mm (8–11 mm) in males and 8.5 mm (7–11 mm) for females.

Table 2. The incidence of various features in the scapulae

Shape	Symmetric: 58	Non-symmetric: 30	
Enthesophyte	Present: 19	Not present: 69	
Inferior surface of anterior 3d	Smooth: 37	Rough: 51	
Inclination	Medial: 46	Vertical: 38	Lateral: 4

Table 3. The mean values of the measurements in all scapulae, males and females

Measurement	Mean	Males	Females
Maximum longitudinal diameter [mm]	147.6 (129–168)	154.6 (147–168)	140.6 (129–151)
Maximum transverse diameter [mm]	101.9 (85–115)	107.2 (97–115)	96.6 (85–104)
Length of acromion [mm]	46.1 (38–55)	48.3 (43–55)	43.9 (38–51)
Width [mm]	22.3 (19–28)	22.6 (22–28)	22 (19–27)
Thickness [mm]	8.8 (7–11)	9.1 (8–11)	8.5 (7–11)
Acromio-coracoid distance [mm]	28.1 (21–39)	28.9 (24–39)	27.3 (21–30)
Acromio-glenoidal distance [mm]	17.7 (13–20)	17.9 (14–20)	17.5 (13–20)
Mean inclination [°]	22.7 (15–34)	24.2 (19–34)	21.2 (15–29)

The mean value of the acromiocoracoid distance was 28.1 mm (21–39 mm), 28.9 mm (24–39 mm) for males and 27.3 mm (21–30 mm) for females. The mean acromioglenoidal distance was 17.7 mm (13–20 mm) and there was no statistically significant difference in this parameter regarding gender [males 17.9 mm (14–20 mm), females 17.5 mm (13–20 mm)].

The mean inclination of the acromion was counted in degrees and found to be 22.7° (15–34°). In the male scapulae the mean inclination was 24.2° (19–34°), while that in the females was 21.2° (15–29°), which was found to be statistically significant. The inclination of the articular surface to the sagittal plane was recorded as medial in 46 cases (52.27%), vertical in 38 cases (43.18%), while in only 4 cases (4.55%) was the inclination lateral.

DISCUSSION

Many studies, especially radiological studies, have been conducted on the morphology of the acromion. Mallon et al. [12], using 28 scapulae, studied the radiographic anatomy and measured several roentgenographic parameters. These values were correlated with the pathomechanics of rotator cuff disease, total shoulder arthroplasty and recurrent shoulder dislocation. Edelson et al. [7] reported an incidence of "os acromiale" of 8.2% in a sample of 270 scapulae. Ciochon and Corrucini [4] devised two measurements, the coracoacromial projection and the height of the glenoid cavity in Hominoidea, Cercopithecoidea and Ceboidea, and showed that hominoid shoulder joints are much more mobile than cercopithecoid shoulder joints. They advocate that the coracoacromial ligament in man is a trait shared only with other hominoid apes among anthropoid primates.

The Bigliani-Morrison-April classification is widely used, dividing acromia into those of type I (flat), type II (convex) and type III (hooked). According to the literature, the incidence of each type in the population varies (I: 6–32%, II: 42–69%, III: 8.6–39%) [1, 5, 8, 10, 12, 15]. Farley et al. [9] proposed a classification which includes a fourth type of acromion, which is concave downward. This classification has not gained much acceptance, mainly owing to the very small incidence of this type of acromion (1.6––13.3%) and the absence of correlation with rotator cuff pathology [7, 13].

The clinical significance of this study rests on the causative effect of the shape of the anterior third of the acromion in relation to the impingement syndrome as well as to rotator cuff rupture. It is widely accepted that rotator cuff lesions are noticed mainly in the hooked acromia (62–66% of the cases of rotator cuff rupture involve the type III acromion) [2, 5, 6, 11]. This correlation is explained by the reduction in the dimensions of the subacromial space in the hooked acromia, which more often leads to impingement of the rotator cuff. This explanation, however, is a matter of debate. There is the question of whether the hooked shape is a congenital feature or represents a degenerative change by which type I is converted to type III in the course of time [8, 14].

There are other macroscopic changes in the anatomical elements of the region which are found in patients with rotator cuff lesions. These include thickening of the coracoacromial ligament and enthesophyte formation [6]. The impingement of the supraspinatus tendon and generally of the elements of the great humeral tubercle takes place mainly at the acromial end of the coracoacromial ligament and the anterior border of the acromion during flexion and internal rotation. The coracoacromial ligament is pulled by the great humeral tubercle, which is located over it. This explains the enthesophyte formation (pulling osteophytes) in the anterior third of the acromion in patients with chronic impingement syndrome [3]. Natsis et al. [13] claim that enthesophytes are significantly more common ($p < 0.05$) in the type III acromion, and this combination is particularly associated with subacromial impingement syndrome and rotator cuff tears. In type I and type IV acromia the incidence of enthesophytes is very small and rotator cuff tears are rare. Edelson and Taitz [6] performed various measurements in 200 scapulae and concluded that the slope and length of the acromion and the height of the arch are most closely associated with degenerative changes.

It is important to note that two morphometric elements, the width of the acromion and the acromioglenoidal distance, do not present significant differences in males and females. On the other hand, the maximum transverse diameter of the scapula and the acromial length constitute the parameters with the largest relative variation between the genders. The mean maximum transverse diameter of the scapula in men was increased by 10.97% and the acromial length was increased by 10.02%. This observation is consistent with the use of the maximum transverse diameter of the scapula as the unique skeletal index for gender determination in forensic medicine and as a discrimination ability of 91.25% [4].

The purpose of this study was to record the basic morphometric values of the acromion in a Greek population sample. We found the following scapular osteological parameters to be considerably greater in males than in females: a rough inferior surface of the anterior third of the acromion, the mean longitudinal and the mean transverse diameters of the scapula, the mean length of the acromion, the mean thickness of the acromion, the mean acromiocoracoid distance and the mean inclination of the acromion. The anatomical characteristics of the acromion are related to pathology of the rotator cuff and its treatment.

We appreciate that the clinical relevance of the dimensions of the acromion is closely related to the age of the specimens and the type of work performed by individuals (whether physical or sedentary). Unfortunately, the age of the specimens was not available and we consider this to be a drawback in the study.

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