

Subacromial space in adult patients with thoracic hyperkyphosis and in healthy volunteers

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Abstract The assumption that subacromial space decreases in patients with thoracic hyperkyphosis arises from sporadic and personal observations. The purpose of this study was to compare width of subacromial space calculated on radiographs and CT scans of a high number of patients with thoracic hyperkyphosis that registered on exams of healthy volunteers. We measured the subacromial space, using Petersson's method, on radiographs of 47 patients with idiopathic or acquired thoracic hyperkyphosis and of 175 healthy shoulder volunteers. Both groups were further distinguished considering gender and age. Females with hyperkyphosis were also divided in two subgroups: those with a kyphotic curve of less (24 patients) or more (19 patients) than 50°, respectively. Subacromial space of all patients and of 21 volunteers was also evaluated using CT. Acromio-humeral space was less wide in patients with hyperkyphosis with respect to coeval volunteers of the same gender; in females and in subjects older than 60. Subacromial width of females with hyperkyphosis whose curve was more than 50° was significantly narrower ($p < 0.05$) than that measured on radiograms or CT scans

of females with a less severe spinal deformity. Decrease of subacromial space may be attributed to less posterior tilting of the scapula and to dyskinesia of the scapular movement. Scapular malposition causes an anomalous orientation of the acromion that may contribute to subacromial impingement. Patients with thoracic hyperkyphosis greater than 50° had a subacromial space narrower than that measured in patients with a less severe kyphosis. This suggests that subacromial width is directly related to severity of thoracic kyphosis. Because hyperkyphosis of patients with osteoporotic vertebral fractures may worsen over the time, subacromial decompression could give only temporary shoulder pain relief.

Keywords Subacromial impingement · Thoracic hyperkyphosis · Scapulothoracic dyskinesia

Introduction

Many causes have been considered responsible for subacromial impingement syndrome. They have been reassumed as intrinsic (intratendinous) and extrinsic (extratendinous). These factors can be further distinguished as primary or secondary. The former directly causes the impingement and a secondary aetiology is the result of another process, such as instability or neurological injury [1].

Despite the huge quantity of papers on subacromial impingement, the relationship with malposition of the scapula, as a consequence of thoracic hyperkyphosis, has not been fully elucidated.

In a masterly review, Bigliani and Levine [1] have listed the primary extrinsic causes of impingement syndrome; however, thoracic hyperkyphosis is not cited. To our knowledge, only sporadic studies have considered thoracic hyper-

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kyphosis as a cause of subacromial impingement. Matsen and Craig [2] observed that stretched and weakened scapular and midthoracic kyphosis are common companions of subacromial primary extrinsic syndrome and stated that the pathological spatial orientation of the scapula, owing to thoracic kyphosis, may decrease the subacromial space. Celli et al. [3] have verified that, in patients with midthoracic hyperkyphosis, the great tuberosity passes precociously under the acromion (40°) during the forward flexion; therefore they have hypothesised that in patients older than 50 years old, hyperkyphosis may be considered a cause of subacromial impingement. Grimsby and Gray [4] stated that in patients with forward head, rounded shoulders and increased thoracic kyphosis, the scapula rotates forward and downward, depressing the acromial process and changing the direction of the glenoid fossa. Therefore, as the patient attempts to elevate the arm, the supraspinatus tendon may become impinged against the anterior portion of the acromion. On the contrary, Lewis et al. [5] have determined the forward head and the forward shoulder posture by calculating some angles between fixed points on the dominant and painful side of asymptomatic subjects and patients affected by subacromial impingement syndrome, respectively. They have concluded that a clear relationship between posture and subacromial width does not exist. Considering the lack of knowledge and contradictory results, we have measured, on X-ray films and CT scans, the subacromial space in a considerable number of patients with dorsal hyperkyphosis and compared the results with those from volunteers without shoulder pain, radiographic signs of shoulder instability or a well known pathological condition responsible for subacromial impingement syndrome.

Materials and methods

The 78 patients with idiopathic (11) or acquired (67) thoracic kyphosis $>40^\circ$ (according to the Cobb's method) [6] examined at our departments from 2002 to 2004, were requested to undergo radiographic evaluation of the right shoulder. Eight did not accept. Of the remaining 70 patients, 11 were excluded from the study because of chronic shoulder pain. All the others were X-rayed, using a true AP view (standing) with the arm in neutral rotation and with a 20° caudal tilt and an axillary view. The subacromial space was measured, in the true AP view, from the dense cortical bone marking the inferior aspect of the acromion at a point directly above the humeral head and recorded as the smallest distance between this point and the articular cortex of the humeral head, as suggested by Petersson and Redlund-Johnell [7]. Magnification was estimated as 11%. Another 4 and 8 patients were excluded, respectively, because the superimposition of the scapular spine did not

permit a good visualisation of the subacromial space or because radiographs showed: AC (Acromion-Clavicular) or acromial spurs (4), calcific tendinitis (2), os acromiale (1) or signs of gleno-humeral instability (1). The remaining 47 patients (4 M, mean age 60 years; 43 F, mean age 67 years) represent the studied group. The most representative group, represented by females with hyperkyphosis, was also divided in two subgroups: that whose kyphotic curve was less (24 patients) or more (19 patients) than 50° , respectively.

One hundred and seventy-five healthy volunteers (71 M, mean age 63 years; 104 F, mean age 64 years) without shoulder pathologies were recruited as the control group. Subjects were provided with information booklets explaining the aim of the study and informed consent documents were signed before participation. To evaluate whether a decrease in the subacromial space with increasing age was registered, we divided studied and control groups into two categories constituted by people younger and older than 60 years of age. All patients with hyperkyphosis and 16 volunteers were submitted to right shoulder CT evaluation too, in order to verify X-ray measurement reliability.

Conventional statistical methods were used. *p* values lower than 0.05 were considered statistically significant.

Results

Results obtained from measurements performed on X-ray radiographs are summarised in Table 1. Subacromial space was 8.25 ± 3.59 mm (AV \pm SD) and 9.52 ± 1.80 mm, respectively in 4 and 71 males with and without hyperkyphosis ($p > 0.05$); while in female groups the values were 7.13 ± 2.40 mm (43 patients) and 8.99 ± 1.60 mm (104 volunteers) ($p < 0.05$). Subacromial width was 10.0 ± 1.0 mm and 9.76 ± 1.80 mm respectively in 3 patients and 51 volunteers of masculine gender and younger than 60 ($p > 0.05$). Corresponding values, calculated on radiographs of males older than 60, were 5.1 mm (1 patient) and 8.90 ± 1.77 mm (20 volunteers) ($p > 0.05$). Acromio-humeral space measured on radiographs of 13 and 78 females, respectively with and without hyperkyphosis and younger than 60, was 8.53 ± 1.56 mm and 9.14 ± 1.56 mm ($p > 0.05$); corresponding values obtained from females older than 60 were 6.53 ± 2.50 mm (30 patients) and 8.53 ± 1.92 (26 volunteers) ($p < 0.05$). Reliability of measurements performed on X-ray radiographs has been confirmed by CT scans; in fact, considering magnification consequent to X-ray exam, differences were not statistically significant.

Subacromial width of females with hyperkyphosis whose curve was more than 50° was significantly less (6.71 ± 1.20 mm) ($p < 0.05$) than that measured on radiographs or CT scans of females with a less severe spinal deformity (7.98 ± 2.12 mm) (Fig. 1).

Table 1 Acromio-humeral distance (expressed in millimetres) in volunteers without and in patients with thoracic hyperkyphosis

X-ray radiograms	Females						Males					
	Without			With			Without			With		
	No.	AVG	SD±	No.	AVG	SD±	No.	AVG	SD±	No.	AVG	SD±
Total	104	8.99	1.60	43	7.13	2.40	71	9.52	1.80	4	8.25	3.59
Years<60	78	9.14	1.56	13	8.53	1.56	51	9.76	1.80	3	10.0	1.00
Years>60	26	8.53	1.92	30	6.53	2.5	20	8.90	1.77	1	5.10	–
CT scans												
Total	17	7.99	1.80	43	6.29	1.70	4	8.60	1.90	4	7.20	2.7

**Fig. 1a, b** Patients with thoracic hyperkyphosis, respectively lesser and greater than 50°. Acromio-humeral space width decrease is directly related to severity of thoracic kyphosis

Discussion

It is well known that scapula contributes to the function of the shoulder in a number of ways. It provides an anatomic and kinematic link between trunk and upper limb and a stable socket for the articulation of the humeral head and creates adequate space for the clearance of the rotator cuff during forward flexion [8]. Burkhart et al. [9] have frequently observed a malposition of the scapula in the dominant throwing shoulder and have named this condition SICK syndrome (Scapular malposition, Inferior medial border prominence, Coracoid pain and malposition, and dysKinesis of the scapular movement). This malposition has been attributed to muscle activation disturbances that produce altered kinematics of the scapula upon dynamic use. Patients with SICK syndrome have been seen to have impingement-like symptoms due to the anteroinferior angulation of the acromion caused by scapular protraction. Warner et al. [2], using a modification of the standard technique of Moiré topographic analysis in asymptomatic subjects and in patients with impingement syndrome, have observed a scapulothoracic asymmetry, respectively, in 14% and 57%. Rubin and

Kibler [10] reported that postural dysfunction is frequently associated with a dyskinesia, and so with an asynchronism, of the scapula and considered primary subacromial impingement a cause of scapular dyskinesia. Ludewing and Cook [8] have observed that excessive scapular protraction is associated with an antetilting of the acromion responsible for subacromial impingement syndrome. Lukaszewicz et al. [11] have noticed that patients with impingement syndrome had approximately 10° less posterior tilting compared with asymptomatic subjects. Subacromial space of our patients with hyperkyphosis was narrower than that of controls. Gender and age did not influence this result. It is plausible that narrowness of the subacromial space may be attributed to the less posterior tilting of the scapula. This hypothesis is supported by Kebaetse and coworkers' study [12]. Authors have observed that patients with a slouched posture have less posterior tilt and less upward rotation of the scapula with respect to trunk-erect subjects; and that this anomalous orientation of the acromion may create a bony block that causes, or contributes to, impingement pathology with repetitive overhead activity.

Our data have confirmed Petersson's method. Mean CT measure was slightly less than that calculated on X-ray radiographs. This could be due to the fact that the CT exam was performed with the patient in the supine position; therefore the superior limb did not suffer from gravity effect. Another possible explanation might be that hyperkyphosis may slightly decrease in the supine position, thus decreasing antetilting. Imaging also confirmed that subacromial space is wider in males than in females and decreases with increasing age.

Our patients with thoracic hyperkyphosis greater than 50° had a subacromial space lesser than that measured in patients with a less severe kyphosis. This suggests that subacromial width is directly related to severity of thoracic kyphosis. Since over time hyperkyphosis of patients with osteoporotic vertebral fractures may make it worse, because new vertebral fractures may occur, subacromial decompression could give only temporary shoulder pain relief.

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