STATIC EVALUATION OF SCAPULAR POSITIONING IN HEALTHY INDIVIDUALS

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ABSTRACT

Objective: Evaluate the static positioning of the scapula on the rib cage in healthy subjects by means of clinical and radiographic evaluation to assess inter-examiner reliability of clinical examination and verify the reliability of this evaluation method compared to the radiographic examination. Methods: We selected 30 adult individuals of both sexes with no diagnosis of shoulder pathology. The static clinical examination, following the protocol suggested by Burkhart et al, was performed repeatedly by two independent examiners, followed by the radiographic examination, which was later examined by the first evaluator. Results: 73.3% of the subjects showed positioning of the scapula considered normal. The inter-examiner reliability and that of the clinical examination in relation to radiography were considered low and very low, respectively. Conclusion: The reproducibility of the evaluation performed by Burkhart was considered satisfactory to good, while the inter-examiner reproducibility of the clinical examination and the static reproducibility of the clinical examination with radiography were considered poor to satisfactory. ***Level of Evidence III, Study of Nonconsecutive Patients.***

Keywords: Scapula. Evaluation. Radiography. Humans.

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INTRODUCTION

The essential role of the scapula is to guarantee the appropriate functionality of the upper limb, serving as a base for origin and insertion of many muscles of the shoulder complex, besides containing the acromion and the glenoid, which serves to couple the humeral head, affording stability and allowing joint mobility.[1,2]

Alterations in scapular positioning at rest and in movement, called scapular dyskinesis, are associated with various diseases of the shoulder, such as the impingement syndrome, rotator cuff tear, instabilities and adhesive capsulitis.[3,4]

Some etiological factors contribute to this scenario, such as anatomical reduction between the subacromial space, intrinsic degeneration of the tendon caused by eccentric overload, tissue ischemia, aging and alterations in the movement of the scapula and of the humerus, which leads to the impairment of the cuff muscles due to pinch in the anterior inferior portion of the acromion or in the posterior superior portion of the glenoid labrum.[4,5]

Cases of scapular dyskinesis provoke alterations in the kinematics of the glenohumeral and acromioclavicular joints and interfere in the activity of the periscapular muscles and of the rotator cuff, and can also generate pain and reduced functional capacity of the upper limb. Moreover, alterations in scapular positioning are related to several conditions that involve the glenohumeral joint, such as the impingement syndrome, rotator cuff injuries and instabilities. In this context, the evaluation of scapular positioning is an integral and essential part of the clinical practice of orthopedists, physiatrists and physiotherapists.[6-8] However, there is no consensus in the literature about the appropriate positioning of the scapula on the rib cage with the upper limbs at rest, which complicates the standardization of collected data, the comparison of published studies and the analysis of results of the proposed treatment.[2,4,5,8]

Accordingly, this study had the following objectives: to evaluate the static positioning of the scapula on the rib cage of individuals without shoulder injuries, to assess inter-examiner reliability of static clinical examination of scapular positioning on the rib cage and to verify the reproducibility of the evaluation method compared to the radiographic examination.

METHODOLOGY

This study was authorized by the Institutional Review Board of Universidade Federal de São Paulo/Hospital São Paulo in accordance with resolution CEP 0901/09.

The study subjects were adult individuals (over 18 years of age, skeletally mature), without a diagnosis of previous diseases and/or injuries involving the bilateral shoulder joint.

All the authors declare that there is no potential conflict of interest referring to this article.

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Individuals presenting rheumatological diseases, previous lesions in other joints of the upper limbs, alterations of the spinal column and cognitive deficit were excluded from the survey.
All the individuals who agreed to take part in the study received and signed the informed consent form, containing all the material information relating to the procedures applied in this study. The selected individuals were referred to the Shoulder and Elbow Outpatient Clinic of Hospital São Paulo, where the scapular positioning was evaluated according to the protocol suggested by Burkhart et al.[9]
In the evaluation, the individual was positioned upright, with arms relaxed alongside the body and trunk naked. Two examiners (examiner 1 and examiner 2), trained in and familiar with the proposed evaluation technique, were selected to carry out the evaluations. Examiner 1 marked points using stickers in the upper and lower angles, on the medial borders of both scapulae and also on the spinous process of the vertebrae (T1 to T3) located between the scapulae with the use of a universal goniometer, evaluating: (1) the difference in vertical distance, in centimeters, from the superior angle of the two scapulae; (2) the difference between the distance from the superior angle of the scapula and the line drawn over the spinous processes, bilaterally and (3) the difference in angular degrees of the medial border of the scapula and the vertical line (spine) of both scapulae, measured with the use of a goniometer with the fulcrum positioned at the inferior angle of the scapula, the fixed arm parallel to the spine and the mobile arm on the medial border of the scapula. (Figure 1) Differences greater than 1.5 cm for measurements (1) and (2); and greater than 5 degrees for measurement (3), were considered abnormal. The same examination was then repeated by the second examiner, who did not have access to the results obtained by the first examiner, so as not to interfere in the reliability of the examination.
After the clinical evaluation, a radiographic examination was requested and carried out on the same day and at the same place as the physical examination, which consisted of standardized anteroposterior view radiography of the scapula for evaluation of the static positioning of the scapula according to the measurement parameters used in the clinical examination, carried out by examiner 1.

Figure 1. Measurements taken in the static evaluation of scapular positioning. 1) Difference of the vertical distance in cm, of the superior angle of the two scapulae; 2) Difference between the distance of the superior angle of the scapula and the line drawn over the spinous processes; 3) Difference in angular degrees of the medial border of the scapula and the vertical line of both scapulae.

RESULTS

The sample was formed by 30 healthy subjects, made up of 17 (56.7%) women and 13 (43.3%) men, aged between 18 and 49 years and averaging 24.5 years (sd=7.1 years). All the subjects had the right side as dominant.
Tables 1 to 7 contain the descriptive measurements of the physical examination and radiography evaluations.
The four individuals with vertical distance of the superior angle of the two scapulae > 1.5 cm are not the same four individuals with the difference between right and left sides of the distance between the superior angle of the scapula and the midline of the spinal column > 1.5 cm. Thus, eight (26.7%) of the individuals have one of the measurements altered.
The mean value of the differences in distances between the superior angle of the scapula and the midline of the spinal column on the left side measured by examiners 1 and 2 was significantly different from 0 ($p = 0.035$), indicating larger measurements taken by examiner 2.
The mean values of the other differences were not significant in comparison to 0 ($p > 0.05$ in all the comparisons).
The ICC values for the measurements of the angle between the medial border and the vertical line of the superior angle of the scapula on the right and left sides represent poor reproducibility of the measurements. The ICC values for the measurements of the vertical distance of the superior angle of the two scapulae and of the distance between the superior angle of the scapula and the midline of the spinal column on the right and left sides represent satisfactory reproducibility of the measurements.
The mean difference of the vertical distances of the superior angle of the two scapulae measured by examiner 1 and radiography was significantly different from 0 ($p = 0.038$) indicating larger measurements taken by examiner 1.

Table 1. Vertical distance of the superior angle of the two scapulae (cm).

Measurements – n (%)	(n = 30)
0.0	2 (6.7)
0.2	2 (6.7)
0.3	4 (13.3)
0.4	1 (3.3)
0.5	3 (10.0)
0.7	2 (6.7)
0.8	2 (6.7)
0.9	3 (10.0)
1.0	6 (20.0)
1.4	1 (3.3)
1.8	1 (3.3)
1.9	2 (6.7)
3.3	1 (3.3)

N.B.: Four (13.3%) individuals with altered measurements, i.e., distance > 1.5cm.

Table 2. Measurements of the scapular positioning.

Distance between the superior angle of the scapula and the midline of the spinal column			Difference between the right and left sides	
Measurements (cm) – n (%) (n = 30)	Right side	Left side	Measurements (cm) – n (%)	(n = 30)
6.0	0 (0.0)	1 (3.3)	-1.0	1 (3.3)
6.5	0 (0.0)	2 (6.7)	-0.8	1 (3.3)
7.0	1 (3.3)	1 (3.3)	-0.7	1 (3.3)
7.5	1 (3.3)	4 (13.3)	-0.5	1 (3.3)
8.0	3 (10.0)	4 (13.3)	-0.2	1 (3.3)
8.2	2 (6.7)	0 (0.0)	-0.1	2 (6.7)
8.3	1 (3.3)	1 (3.3)	0.0	2 (6.7)
8.4	1 (3.3)	0 (0.0)	0.1	1 (3.3)
8.5	2 (6.7)	4 (13.3)	0.2	3 (10.0)
8.7	2 (6.7)	0 (0.0)	0.3	2 (6.7)
8.8	2 (6.7)	0 (0.0)	0.5	2 (6.7)
9.0	0 (0.0)	6 (20.0)	0.7	1 (3.3)
9.2	2 (6.7)	0 (0.0)	1.0	5 (16.7)
9.3	1 (3.3)	0 (0.0)	1.2	1 (3.3)
9.5	5 (16.7)	2 (6.7)	1.5	2 (6.7)
9.6	0 (0.0)	1 (3.3)	2.0	2 (6.7)
9.7	2 (6.7)	0 (0.0)	2.3	1 (3.3)
10.0	1 (3.3)	2 (6.7)	3.0	1 (3.3)
10.5	1 (3.3)	1 (3.3)		
11.0	1 (3.3)	0 (0.0)		
11.5	1 (3.3)	0 (0.0)	*N.B.: Four (13.3%) individuals with altered measurements, i.e., distance > 1.5cm*	
11.7	0 (0.0)	1 (3.3)		
12.0	1 (3.3)	0 (0.0)		

Table 3. Angle between the medial border and the vertical line of the superior angle of the scapula (º).

Measurements – n (%) (n = 30)	Right side	Left side
0.2	1 (3.3)	0 (0.0)
0.4	0 (0.0)	1 (3.3)
2.0	9 (30.0)	11 (36.7)
4.0	12 (40.0)	15 (50.0)
6.0	7 (23.3)	1 (3.3)
8.0	1 (3.3)	2 (6.7)

Table 4. Angle between the medial border and the vertical line of the superior angle of the scapula: difference between the right and left sides (°).

Measurements – n (%)	(n = 30)
-4.0	1 (3.3)
-2.0	6 (20.0)
-0.2	1 (3.3)
0.0	12 (40.0)
2.0	6 (20.0)
4.0	4 (13.3)

N.B.: No (0) individual (0%) with altered measurements, i.e. angle > 5°.

Table 5. Scapular positioning in health individuals.

Variables	Evaluation		
	Physical Examination – Examiner 1	Physical Examination – Examiner 2	Radiography
Vertical distance of the superior angle of the two scapulae (cm)			
mean (sd)	0.85 (0.69)	0.75 (0.52)	0.59 (0.38)
median	0.8	0.65	0.55
minimum – maximum	0 – 3.3	0.2 – 2.8	0 – 1.4
percentile 5%	0	0.20	0
percentile 95%	2.53	2.14	1.34
CI 95%	[0.59; 1.11]	[0.55; 0.94]	[0.44; 0.73]
Distance between the superior angle of the scapula and the midline of the spinal column – R Side (cm)			
mean (sd)	9.1 (1.1)	9.3 (1.3)	9.2 (1.2)
median	9.0	9.4	9.2
minimum – maximum	7.0 – 12.0	7.2 – 12.6	6.8 – 11.5
percentile 5%	7.3	7.2	7.1
percentile 95%	11.7	12.0	11.4
CI 95%	[8.7; 9.5]	[8.8; 9.8]	[8.8; 9.7]
Distance between the superior angle of the scapula and the midline of the spinal column – L Side (cm)			
mean (sd)	8.5 (1.2)	8.9 (1.4)	9.0 (1.3)
median	8.5	9.0	9.2
minimum – maximum	6.0 – 11.7	6.0 – 12.0	6.3 – 11.5
percentile 5%	6.3	6.3	6.4
percentile 95%	11.0	11.6	11.1
CI 95%	[8.0; 9.0]	[8.4; 9.4]	[8.5; 9.5]
Angle between the medial border and the vertical line of the superior angle of the scapula – R Side (°)			
mean (sd)	3.9 (1.8)	4.5 (1.8)	4.5 (2.7)
median	4.0	4.0	4.0
minimum – maximum	0.2 – 8.0	0.4 – 8.0	0.8 – 10.0
percentile 5%	1.2	0.7	1.5
percentile 95%	6.9	8.0	10.0
CI 95%	[3.2; 4.5]	[3.8; 5.2]	[3.5; 5.5]
Angle between the medial border and the vertical line of the superior angle of the scapula – L Side (°)			
mean (sd)	3.5 (1.7)	4.3 (2.1)	4.8 (3.2)
median	4.0	4.0	4.0
minimum – maximum	0.4 – 8.0	0.2 – 10.0	0.8 – 14.0
percentile 5%	1.3	0.9	1.5
percentile 95%	8.0	8.9	12.9
CI95%	[2.8; 4.1]	[3.5; 5.1]	[3.5; 6.0]

SD – Standard Deviation / CI – Confidence interval.

The mean difference of the distances between the superior angle of the scapula and the midline of the spinal column on the left side measured by examiner 1 and radiography was significantly different from 0 ($p = 0.011$) indicating larger measurements taken by radiography.

The mean difference of the angles between the medial border and the vertical line of the superior angle of the scapula on the left side measured by examiner 1 and radiography was significantly different from 0 ($p = 0.033$) indicating larger measurements taken by radiography. The mean values of the other differences were not significant compared to 0 ($p > 0.05$ in all the comparisons).

Table 6. Inter-examiner reliability.

Variables	Evaluation		Difference
	Physical Examination – Examiner 1	Physical Examination – Examiner 2	
Vertical distance of the superior angle of the two scapulae (cm)			
Mean (sd)	0.85 (0.69)	0.75 (0.52)	0.10 (0.56)
Comparison	p = 0.319		
Concordance	ICC = 0.73 p < 0.001 *		
Distance between the superior angle of the scapula and the midline of the spinal column – R Side (cm)			
Mean (sd)	9.1 (1.1)	9.3 (1.3)	-0.24 (0.98)
Comparison	p = 0.191		
Concordance	ICC = 0.68 p < 0.001 *		
Distance between the superior angle of the scapula and the midline of the spinal column – L Side (cm)			
Mean (sd)	8.5 (1.2)	8.9 (1.4)	-0.41 (1.02)
Comparison	p = 0.035 *		
Concordance	ICC = 0.69 p < 0.001 *		
Angle between the medial border and the vertical line of the superior angle of the scapula – R Side (°)			
Mean (sd)	3.9 (1.8)	4.5 (1.8)	-0.61 (2.25)
Comparison	p = 0.151		
Concordance	ICC = 0.38 p = 0.095		
Angle between the medial border and the vertical line of the superior angle of the scapula – L Side (°)			
Mean (sd)	3.5 (1.7)	4.3 (2.1)	-0.84 (2.54)
Comparison	p = 0.082		
Concordance	ICC = 0.20 p = 0.263		

SD – Standard Deviation / ICC - Intraclass Correlation Coefficient.

Table 7. Validity of the evaluation method.

Variables	Evaluation		Difference
	Physical Examination – Examiner 1	Radiography	
Vertical distance of the superior angle of the two scapulae (cm)			
Mean (sd)	0.85 (0.69)	0.59 (0.38)	0.26 (0.66)
Comparison	p = 0.038 *		
Concordance	ICC = 0.48 p = 0.049 *		
Distance between the superior angle of the scapula and the midline of the spinal column – R Side (cm)			
Mean (sd)	9.1 (1.1)	9.2 (1.2)	-0.14 (1.18)
Comparison	p = 0.522		
Concordance	ICC = 0.67 p = 0.002 *		
Distance between the superior angle of the scapula and the midline of the spinal column – L Side (cm)			
Mean (sd)	8.5 (1.2)	9.0 (1.3)	-0.49 (0.99)
Comparison	p = 0.011 *		
Concordance	ICC = 0.65 p < 0.001 *		
Angle between the medial border and the vertical line of the superior angle of the scapula – R Side (°)			
Mean (sd)	3.9 (1.8)	4.5 (2.7)	-0.62 (3.15)
Comparison	p = 0.291		
Concordance	ICC = 0.12 p = 0.364		
Angle between the medial border and the vertical line of the superior angle of the scapula – L Side (°)			
Mean (sd)	3.5 (1.7)	4.8 (3.2)	-1.28 (3.12)
Comparison	p = 0.033 *		
Concordance	ICC = 0.39 p = 0.074		

The ICC values for the measurements of the angle between the medial border and the vertical line of the superior angle of the scapula on the right and left sides represent poor reproducibility of the measurements.

The ICC values for the measurements of the vertical distance of the superior angle of the two scapulae and of the distance between the superior angle of the scapula and the midline of the spinal column on the right and left sides represent satisfactory reproducibility of the measurements.

DISCUSSION

So far no regulations have been drafted concerning scapular positioning in healthy individuals during rest, and there is no method with clinical application able to provide measurements related to the actual scapular kinematics. In addition, there is the absence of standardization in the nomenclature used to describe movements, planes and axes.[2,10]

In this study, the static evaluation of the scapula was based on the protocol described by Burkhart et al.,[9] considering 1.5 cm or 5° of asymmetry as the abnormality threshold in each measurement, thus classifying individuals with scapular dyskinesis.

The study subjects were 30 healthy subjects, 17 women and 13 men, aged between 18 and 49 years, and the result obtained was that 73.3% of the participants presented scapular positioning in the normal range established by Burkhart et al.[9] Inter-examiner reliability in our study was considered of poor reproducibility for the measurements of the angle between the medial border and the vertical line of the superior angle of the scapula on the right and left sides. For the measurements of the vertical distance of the superior angle of the two scapulae and of the distance between the superior angle of the scapula and the midline of the spinal column on the right and left sides, the reproducibility is satisfactory.

Nijs et al.,[2] in their study, used the test that measures the distance from the medial border of the scapula and the spinous process of the fourth thoracic vertebra, with the patient standing and with the arms relaxed and also with the patients performing active scapular retraction. The inter-examiner reliability of this test, when conducted with the shoulders relaxed, was considered very low, while the inter-examiner reliability with the test conducted with the shoulders retracted was good.

Nijs et al.[2] also conducted the test of distance between the

posterior border of the acromion and the stretcher, in which the examiner measures, with a measuring tape, the distance between the acromion and the stretcher, bilaterally, and this study obtained inter-examiner reliability considered good, yet this measurement with the patient in dorsal decubitus can influence the scapular positioning, as the stretcher would stabilize the scapula correctly, besides the fact that this position alters the effect of gravity on the scapula. Kibler[11] used the lateral scapula slide test as a means of evaluation, and its inter-examiner reliability was considered good, yet the test is questionable, as it avoids impact positions, by maintaining positions below 90º, preventing inhibition of the musculature tested. The initial interpretation of this test indicates that as is the case in our study, a difference of more than 1.5 cm between the two sides suggests the diagnosis of shoulder dysfunction, yet this difference of more than 1.5 cm between sides is frequently observed among asymptomatic individuals, corroborating the observations made in the present study and in the study by Nijs et al.,[2] Kliber[11] and Meyer et al.[12]

Due to the absence of regulations about scapular positioning in healthy individuals during rest, the present study sought by means of physical and radiographic examinations to obtain the value of normality of scapular positioning on the rib cage of healthy individuals.

In this study, 26.7 % of the participants presented scapular positioning outside the range of normality established by Burkhart et al.,[9] as well as in the studies of Nijs et al.[2] and Kibler,[11] in which even asymptomatic individuals present some type of scapular dyskinesis.[11,12]

It is worth keeping in mind that the static evaluation of scapular positioning is able to determine the presence of scapular dyskinesis, yet is not able to determine which disease this dyskinesis is associated with. In the reliability assessment of the static clinical examination compared to the radiographic examination, we obtained poor reproducibility for the measurements of the angle between the medial border of the scapula and the vertical line of the spinal column on the right and left sides, while for the measurements of the vertical distance of the superior angle of the two scapulae and of the distance between the superior angle of the scapula and the midline of the spinal column on the right and left sides we observed merely satisfactory reproducibility. We did not find excellent reproducibility in any of the measurements, demonstrating that there is a very strong probability of discordance between the measurements of the static clinical examination and of the radiography.

This study exhibited some limitations that may have influenced the results. The main limitation was in relation to the radiographic examination, which was not carried out by the same technician, and although they followed a standard protocol, there may have been changes in the angulation of the exams, thus altering their interpretation. Cote et al.[13] showed that the ideal incidence for the performance of radiography to evaluate scapular positioning is with the individual upright, forming an angle of 30º with the beam of the ray, thus parallel to the glenoid and perpendicular to the scapula. It is not possible to guarantee that all the radiographies were performed in this manner, which may hinder the identification of some scapular structures.

CONCLUSIONS

It was observed that 73.3% of the individuals presented measurements within the established pattern of normality. The inter-examiner reproducibility of the static clinical examination was considered from poor to satisfactory. The reproducibility of the static clinical examination with the radiographic examination was considered from poor to satisfactory.

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