ROTATOR CUFF STRENGTH IN SUBJECTS WITH SHOULDER IMPINGEMENT SYNDROME COMPARED WITH THE ASYMPTOMATIC SIDE

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ABSTRACT

Objective: To evaluate the strength of internal rotation, external rotation and elevation of the shoulders of symptomatic compared with asymptomatic patients, associating muscle strength with joint function. Methods: Forty-eight individuals diagnosed with unilateral SIS were evaluated in relation to isomeric muscle strength of symptomatic and asymptomatic shoulders (using a hand-held isometric dynamometer), in addition to evaluating function using the Constant-Murley scale. The subjects were divided into 2 groups: group 1 = 35 to 49 years, group 2 = 50 to 65 years. Results: A reduction in strength of internal rotation, external rotation and elevation of the symptomatic shoulder were found, compared with the asymptomatic side ($p < 0.0001$), but there was no reduction in the strength of medial rotation in the subjects of group 1. It was observed that muscle strength is directly proportional to shoulder function, with individuals with little strength of the rotator cuff having less function. Conclusion: SIS causes decreased muscle strength of internal rotation, external rotation and elevation compared with the asymptomatic side. It also causes decreased shoulder function. The reduced function is proportional to the decrease in muscle strength of the rotator cuff. Level of evidence: level III, analytical study.

Keywords: Shoulder impingement syndrome. Rotator cuff. Muscle strength.

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INTRODUCTION

Shoulder impingement syndrome (SIS) is one of the most frequent musculoskeletal disorders of the upper limbs, considered one of the main causes of pain in the shoulder, and can lead to a decrease in the function of this joint and a reduction in quality of life.[1,2]

Initially described by Neer, SIS presents a clear relationship between the impingement phenomenon and degeneration of the rotator cuff, which during elevation of the upper limb crashes into the anteroinferior portion of the acromion, coracoacromial ligament and acromioclavicular joint, and can also injure the long head of the biceps and the subacromial bursa.[3] However, degenerative lesions of the rotator cuff also are related to the appearance of SIS. This concept was cited by Codman, in which the author describes an inadequate vascularization region in the insertion area of the supraspinatus, in which there is a limited blood supply to the subacromial bursa,[4] culminating in entesopathy due to the natural aging of the tendons. Patients that suffer from SIS present reduction of lateral rotation and elevation strength, but there are contradictions in literature regarding the reduction of internal rotation strength.[5,6]

Since patients with unilateral SIS between 50 and 59 years of age and between 60 and 69 years of age can present around 10% and 20% (respectively) of asymptomatic lesions of the contralateral RC[5], the evaluation of muscle strength of the shoulder can be an important clinical exam in the early detection of SIS on the asymptomatic side. Together with evaluation of the isometric strength of the rotator cuff, the use of specific questionnaires can help to detect shoulder joint dysfunctions, providing a precise dysfunctional diagnosis and a treatment based on functional alterations. The Constant-Murley Scale,[7] which is a specific questionnaire for evaluation of shoulder functionality, consists of objective (65%) and subjective (35%) parameters, in which the patient can reach a maximum of 100 points and

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where the higher the score, the better the function. As it is an evaluation questionnaire based on functional parameters, such as everyday activities and active range of motion, we used the Constant-Murley Scale in our study.

Accordingly, this study had the following objectives: 1) evaluate whether there is reduction of medial rotation strength in symptomatic shoulders compared to asymptomatic shoulders in subjects with unilateral SIS and 2) analyze the relation between shoulder function and rotator cuff muscle strength in patients with unilateral SIS.

METHODS

This was a cross-sectional study conducted in the Physiotherapy Sector of Irmandade da Santa Casa de Misericórdia de São Paulo (ISCMSP). The study was previously approved by the Institutional Ethics Committee, under protocol number 254/09.

Subjects

Forty-eight individuals diagnosed with SIS took part in the study. The diagnosis was based on the medical history, clinical examination and ultrasound image examination. The individuals selected for the study were of both genders, aged between 35 and 65 years with diagnosis of degree II unilateral shoulder impingement syndrome, according to criteria of Neer[8] with symptoms for more than three months. The patients were excluded from the study if they: were using steroidal or non-steroidal anti-inflammatory drugs administered orally or by infiltration seven days before the assessment; had undergone physiotherapy treatment in the last 60 days; were pregnant or patients with previous surgery on the shoulder(s) and cervical and thoracic spine; had inflammatory joint diseases (rheumatoid arthritis, lupus, gout), cervico-brachialgias, complex regional pain syndrome and calcareous tendonitis.

Procedures

The individuals were split into two groups according to age: Group 1 - individuals between 35 and 49 years (12 men and 12 women); Group 2 - individuals between 50 and 65 years (12 men and 12 women). This division into groups according to age is due to the fact that RC muscle strength decreases as the age increases.[9] The groups were also divided by gender.

Rotator cuff strength (medial and lateral rotation) and shoulder elevation were measured using a Lafayette® manual dynamometer - model 01163. To measure the strength of the medial (Figure 1) and lateral (Figure 2) rotators, the subject was positioned supine, with the shoulder abducted at 45° and at 30° of horizontal adduction (scapular plane), elbow flexed at 90° and neutral rotation, with the dynamometer positioned, respectively, above the distal radio-ulnar joint on the volar or dorsal surface and, to assess the elevation strength, the subject was kept in the seated position, shoulder at 45° of abduction and 30° of horizontal adduction, elbow extended and shoulder in neutral rotation. The dynamometer was positioned on the dorsal surface of the wrist.[10,11] (Figure 3) All measurements of strength were randomized and it was a blind evaluation, that is, the examiner did not know which were the symptomatic and the asymptomatic shoulders.

In all these strength evaluations the individuals were required to perform maximum isometric contraction. Before the test, all the individuals performed the test once to understand the correct movements, without making undesired movements, such as flexion or extension of the elbow, for example. The tests were performed twice, considering the mean between the two values obtained. These values of strength in Kg were standardized for each individual, then divided by the body mass index (BMI) and multiplied by 100.

$$Strength\ index = (Kg / BMI) \times 100$$

A pilot study was conducted previously with 10 asymptomatic individuals (20 shoulders) in the three strength evaluation condi-

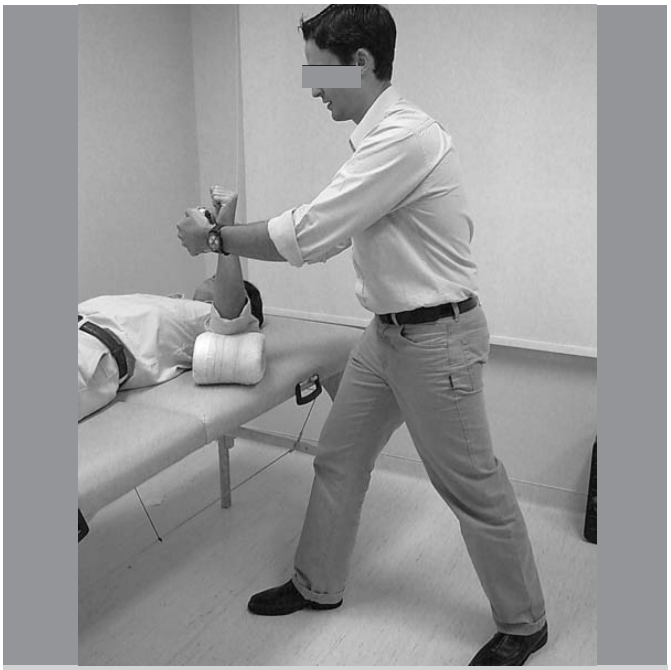

Figure 1. *Positioning of the patient and of the dynamometer for evaluation of the medial rotation strength of the shoulders.*

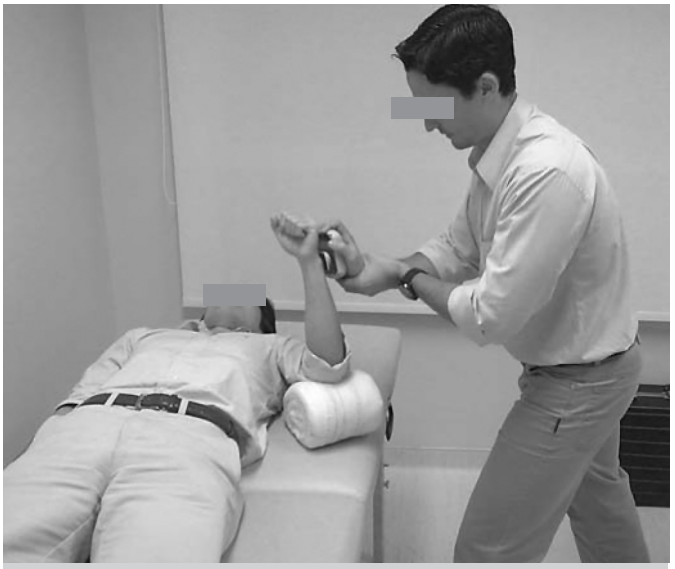

Figure 2. *Positioning of the patient and of the dynamometer for evaluation of the lateral rotation strength of the shoulders.*

Figure 3. *Positioning of the patient and of the dynamometer for evaluation of the elevation strength of the shoulders.*

tions mentioned. This was followed by an intraclass correlation coefficient (ICC) test, for analysis of muscle strength of lateral and medial rotation and elevation. Thus they encountered a value considered satisfactory for evaluation of the medial rotators (ICC= 0.65), excellent for evaluation of the lateral rotators (ICC= 0.93) and elevation (ICC= 0.88).

Data analysis

After the evaluation of all the subjects, the statistical program Graphpad Instat 3 was used for data processing. Based on the muscle strength data obtained after standardization according to the BMI, the t-test was used for dependent samples, with statistical significance when $p < 0.05$.

RESULTS

The results below are described as mean ± standard deviation.

Medial rotation strength

Group 1

The results found in the symptomatic shoulders in male individuals (n = 12) were 39.09 ± 15.28 Kg, while the result for the asymptomatic shoulders was 53.64 ± 11.95 Kg, with statistically significant difference between shoulders (p = 0.029). Among the women (n = 12) the results found in the symptomatic shoulders were 27.87 ± 10.77 Kg, while strength of 41.93 ± 11.75 Kg was observed in the asymptomatic shoulders, with statistically significant difference between both (p = 0.0002). Thus we observed that the symptomatic shoulders present on an average a reduction of 28.2% in the men and 34.6% in the women. (Table 1)

Group 2

In the older male (n = 15) individuals (50 to 65 years), the results were 36.88 ± 12.4 Kg, while in the asymptomatic shoulders we found 45.23 ± 10.88, without statistically significant difference between both (p = 0.058). In the women in this age bracket (n = 12), the results were 30.32 ± 11.7 Kg in the symptomatic shoulders and 34.82 ± 9.61 Kg (Table 1), without statistically significant difference between the groups (p = 0.314).

Table 1. *Values of medial rotation strength in the symptomatic and asymptomatic shoulders in Group 1 (35 to 49 years) and Group 2 (50 to 65 years). Values expressed in mean ± SD. *No significant difference between the symptomatic and asymptomatic shoulders; † no significant difference between the symptomatic and asymptomatic shoulders; ǂ there was significant difference between the symptomatic and asymptomatic shoulders; § there was significant difference between the groups.*

	Medial Rotation Strength in Symptomatic Shoulder	Medial Rotation Strength in Asymptomatic Shoulder	p-value
Group 1 Men (n= 12)	39.09 ± 15.28ǂ	53.64 ± 11.95ǂ	0.029
Group 1 Women (n=12)	27.87 ± 10.77§	41.93 ± 11.75§	0.0002
Group 2 Men (n= 12)	36.88 ± 12.4*	45.23 ± 10.88*	0.058
Group 2 Women (n= 12)	30.32 ± 11.7†	34.829 ± 61†	0.314

Lateral rotation strength

Group 1

In the men we observed the results of 22.57 ± 7.24 Kg in the symptomatic shoulders and 42.87 ± 13.33 in the asymptomatic shoulders, with statistically significant difference (p = 0.007). Among the women, the results were 21.74 ± 8.34 Kg in the symptomatic shoulders and 34.05 ± 10.44 in the asymptomatic shoulders, with statistically significant difference (p = 0.0004). Thus we observed an average reduction in lateral rotation strength of 48% in the symptomatic shoulders in the men and 37% in the women. (Table 2)

Group 2

As regards lateral rotation strength in the male individuals, the results in the symptomatic shoulders were 20.25 ± 5.32 Kg, and in the asymptomatic shoulders, 40.82 ± 8.65 Kg, with significant difference between groups (p < 0.0001). In the female individuals the results were 20.78 ± 5.94 Kg in the symptomatic shoulders, while in the asymptomatic shoulders we observed 27.91 ± 8.32, with significant difference between the shoulders (p = 0.0007). Therefore, we observed an average reduction in lateral rotation strength of 51% in the symptomatic shoulders of the men and 26% in the symptomatic shoulders of the women. (Table 2)

Elevation strength

Group 1

As regards elevation strength in the men, we came across the results of 26.23 ± 8.12 Kg in the symptomatic shoulders and 40.15 ± 14.02 Kg in the asymptomatic shoulders, observing statistically significant difference (p = 0.016). Among the women, the results were 20.15 ± 7.81 Kg in the symptomatic shoulders and 26.46 ± 5.93 Kg in the asymptomatic shoulders (Table 3), with significant difference between both (p = 0.0009).

Group 2

In the male individuals, the results of strength in the symptomatic shoulders were 20.65 ± 6.11 Kg, while in the asymptomatic shoulders we observed 40.55 ± 6.40 Kg, with significant

difference between the shoulders (p = 0.0001). In the women, the results of strength in the symptomatic shoulders were 18.79 ± 6.99 Kg and, in the asymptomatic shoulders, we found 22.98 ± 9.08 Kg (table 3), with statistically significant difference between the shoulders (p = 0.006).

Table 2. *Values of lateral rotation strength of the symptomatic and asymptomic shoulders in Group 1 (35 to 49 years) and Group 2 (50 to 65 years). Values expressed in mean ± SD. Statistically significant difference was found in all the groups evaluated.*

	Lateral Rotation Strength in Symptomatic Shoulder	Lateral Rotation Strength in Asymptomatic Shoulder	p-value
Group 1 Men (n= 12)	22.57 7.24	42.87 13.33	0.007
Group 1 Women (n= 12)	20.15 7.81	34.05 10.44	0.0004
Group 2 Men (n= 12)	20.25 5.32	40.82 8.65	< 0.0001
Group 2 Women (n= 12)	20.78 5.94	27.91 8.32	0.0007

Table 3. *Values of elevation strength of the symptomatic and asymptomatic shoulders in Group 1 (35 to 49 years) and Group 2 (50 to 65 years). Values expressed in mean ± SD. Statistically significant difference was found in all the groups evaluated.*

	Elevation Strength in Symptomatic Shoulder	Elevation Strength in Asymptomatic Shoulder	p-value
Group 1 Men (n= 12)	26.23 8.12	40.15 14.02	0.016
Group 1 Women (n= 12)	20.15 7.81	26.46 5.93	0.0009
Group 2 Men (n= 12)	20.65 6.11	40.55 6.40	0.0001
Group 2 Women (n= 12)	18.79 6.99	22.98 9.08	0.006

Shoulder function

Group 1

As regards function of the symptomatic shoulders in the male individuals (according to the Constant-Murley scale), the results were 45.3 ± 8.83 points (considered poor), and in the asymptomatic shoulders 94.3 ± 7.21 points, with significant difference (p = 0.002). Among the female individuals we found 45.3 ± 14.52 points (considered poor), while in the asymptomatic shoulders we found 94.35 ± 5.41 points, once again with statistically significant difference (p = 0.0005). An average reduction of 52.9% is observed in the function of the symptomatic shoulder, compared to the asymptomatic side, both for men, and for women.

Group 2

Analyzing the function of the symptomatic shoulders of the men evaluated, we found 46.9 ± 16.35 points (poor), while in the asymptomatic shoulders we found 90 ± 5.98 points, with significant difference (p = 0.0004). Among the women, the results were 56.9 ± 13.2 points (poor) in the symptomatic shoulders, and 91.9 ± 6.61 points in the asymptomatic shoulders, where we observed significant difference (p < 0.0001). Accordingly, we observed a reduction, on average, of 48% in shoulder function in the men and 39% in the women between 50 and 65 years of age.

DISCUSSION

The objective of this study was to observe whether there is a decrease in rotator cuff muscle strength in individuals with SIS, comparing symptomatic shoulders with asymptomatic shoulders. Studies show that SIS can lead to a reduction in quality of life, due to pain during work and day-to-day activities.[1,2] In our results it was possible to observe a significant decrease of medial rotation strength in the symptomatic shoulders compared to the asymptomatic shoulders only in Group 2 (50 to 65 years), made up of both genders. However, in the individuals from Group 1 (35 to 49 years) we did not find any difference in medial rotation strength between the symptomatic and asymptomatic shoulders. One explanation for this finding could be the progressive reduction of rotator cuff muscle strength that occurs naturally with aging.[8] Thus, younger individuals did not present reduction of medial rotation strength in the shoulders affected by SIS, unlike the individuals from 50 to 65 years of age. This alteration was also seen in the study by Erol et al.,[12] which revealed a deficit of medical rotation strength in the group with SIS between 26 and 52 years of age, yet without division between age brackets. In contrast, in the study by Kim et al.[5] the authors noted that individuals with SIS do not present alteration of medial rotation strength, since the most strongly impaired muscles are the supraspinatus and infraspinatus, which are external rotators.

In both evaluated groups and of both genders, we observed significant reduction of lateral rotation and elevation strength, compared to the asymptomatic shoulders. These findings are consistent with the results found in previous studies that also found greater involvement of lateral rotation[10] and elevation[6,13] strength, since SIS more often affects the supraspinatus, followed by the infraspinatus,[14,15] and these muscles are important during elevation[16] and lateral rotation of the shoulder.[17] Tyler et al.[18] observed significant reduction of lateral rotation strength in shoulders with SIS, compared to the control group. However, in this study the authors do not define which degrees of SIS were evaluated, neither do they divide the data by gender. McCabe et al.[19] also observed significant reduction of lateral rotation strength in individuals with varied rotator cuff lesion sizes. However, lateral rotation strength was measured at 90° of should abduction, unlike this study where the subjects were evaluated in the scapula plane (30° of horizontal adduction) and 45° of abduction.

There are several methods described in literature for evaluation of rotator cuff muscle strength.[6,11,12,18,19] However, to evaluate the lateral and medial rotation strengths, the patient was positioned supine, with the shoulder abducted at 45° and at 30° of horizontal adduction (scapular plane), with the elbow flexed at 90° and neutral rotation. This position is defined by literature as the best for evaluating the strength of the lateral and medial rotators in patients with shoulder impingement syndrome,[10,11] as it is a comfortable position for the patient and there is a better

length-tension ratio of the rotator cuff muscles. In the evaluation of elevation strength, and that of lateral and medial rotation, maintenance of the shoulder in the scapular plane allows the inferior capsule to remain relaxed, besides enabling maximum approximation between the humeral head and the glenoid.[10]

Analyzing the muscle strength and function data obtained in the symptomatic shoulders, in a descriptive manner it was possible to note that the reduction of muscle strength is directly related to the decrease of function, since the symptomatic joints presented scores considered poor (below 70 points) on the Constant and Murley Scale,[7] while the asymptomatic shoulders presented greater muscle strength of the entire rotator cuff and function considered excellent. MacDermid et al.[10] also observed that the reduction of rotator cuff strength in cases of SIS is directly related to the decrease in the function of this joint, besides compromising the quality of life of these patients. These data can explain the success of the conservative treatment based on strengthening of the rotator cuff in patients with Neer degree I and II SIS, showing that the improvement of lateral rotation, medial rotation and elevation muscle strength is directly proportional to the improvement of function.[20-22]

One of the limitations of this study was the fact that there was no ultrasonographic evaluation of the asymptomatic shoulders, since there may be asymptomatic lesions of the rotator cuff.[23] Kim et al.[5] showed in their studies that there are no asymptomatic lesions of the rotator cuff in individuals under 49 years of while, while from 50 to 59 and from 60 to 69 years, there is a prevalence of 10% and 20% of asymptomatic lesions, respectively. Another limitation of the study was the fact that no isokinetic evaluations were performed in addition to the isometric evaluation. However, there is evidence that isometric dynamometry is a more sensitive method than the isokinetic dynamometer to evaluate strength deficits in patients with shoulder impingement syndrome, besides presenting moderate to high inter and intra-appraiser reproducibility.[18] Prior to the start of this study, there was an evaluation of the isometric strength of 20 asymptomatic shoulders for us to discover the reliability of the examiner in charge of the obtainment of muscle strength data. Thus we observed an ICC for lateral rotation and elevation, considered excellent (0.93 and 0.88, respectively) and satisfactory for medial rotation (0.65), showing that the data obtained in our evaluation are very reliable. Moreover, the examiner in charge of the isometric force evaluation was taking part in a blind study, that is, this person did not know which were the symptomatic shoulders and the asymptomatic shoulders.

CONCLUSION

Based on the data obtained, we can conclude that the individuals from 35 to 49 years of age, of both genders, do not present reduction of medial rotation strength in the shoulders with SIS, compared to the contralateral asymptomatic shoulders. Now the subjects from 50 to 65 years of age presented reduction of medial rotation strength in the symptomatic shoulders, compared to the contralateral asymptomatic side. It was noted that the lateral rotation and elevation strengths are considerably decreased in the cases of SIS in all the age brackets evaluated, in both genders. Likewise, the reduction of rotator cuff strength, particularly of lateral and medial rotations, are directly proportional to the shoulder function, where SIS generates reduction in the strength and function of this joint.

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