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INFLUENCE OF THE ANTERIOR SHOULDER MUSCULATURE STRETCHING ON SCAPULAR KINEMATICS

[1]Paula Maria Ferreira Camarini, [2]Helga Tatiana Tucci, [3]Kevin J McQuade, and [4]Anamaria Siriani de Oliveira
[1]Master in Science from Post-Graduation Program in Functional Performance and Rehabilitation, Ribeirão Preto School of Medicine, University of São Paulo, Brazil
Email: paula_camarini@yahoo.com.br
[2]Professor, Department of Human Movement Science, Federal University of São Paulo, Santos, Brazil;
[3] Associate Professor, Department of Rehabilitation Medicine, School of Medicine, University of Washington, Seattle, USA
[4] Associate Professor, Department of Biomechanics, Medicine and Rehabilitation of Locomotor Apparatus, Ribeirão Preto School of Medicine, University of São Paulo, Ribeirão Preto, Brazil

SUMMARY
The aim of the study was to determine the effect of anterior shoulder musculature stretching on scapular kinematics. Healthy subjects with a clinical diagnosis of pectoralis minor shortening were evaluated before and after 4 and 8 weeks of a stretching program. There were no clinically meaningful differences in the rotations of scapula relative to the thorax between pre and post intervention evaluations. The results suggests that stretching of anterior musculature alone does not alter the habitual scapular motion that occurs during the arm elevation in different planes.

INTRODUCTION
The adequate scapular motion is important to shoulder's function. Pectoralis minor muscle shortening may be one of the factors that may cause alterations on scapular kinematics. A previous study [1] showed that individuals with short pectoralis minor present less posterior tilt and more scapular internal rotation than long pectoralis minor subjects. This movement alteration is similar to those presented by individuals with shoulder dysfunction [4]. From this point, shortening of pectoralis minor may be a risk factor for shoulder impingement symptoms. Pectoralis minor stretching is recommended, however no previous studies have evaluated the isolated effect of this intervention on scapular kinematics. Thus the aim of this study was to determine the effect of anterior shoulder musculature stretching on scapular kinematics of subjects with short pectoralis minor. The hypothesis tested was whether after the intervention, subjects would show more posterior tilt, upward rotation and less internal rotation of scapula during the elevation of the arm.

METHODS
Twenty seven volunteers were submitted to scapular kinematics evaluation. According to past studies [1,4], twenty-five subjects would be necessary to detect clinically meaningful angular differences of 5°, with a sample power of 80% and significance level of 0.05. This difference is believed to be similar to anatomical changes of the acromial slope in subjects with rotator cuff pathology [1]. Inclusion criteria included: age between 20 and 40 years, absence of shoulder dysfunction, normal glenohumeral motion and pectoralis minor muscle shortening. Pectoralis minor shortening was considered present when, with the subject lying in supine, the distance between the treatment table and the posterior aspect of the acromion greater than 2.54 cm [2]. Exclusion criteria were presence of impingement symptoms, ROM limitation, spine misalignment, trauma or orthopedic dysfunction in shoulder, cervical or thoracic spine. The study was approved by the Ethics Committee of the Clinic's Hospital of the Ribeirão Preto Medical School of the University of São Paulo.

Anterior shoulder musculature supervised stretching program was composed of 3 exercises of static stretching, carried out 3 times per week, lasting 8 weeks. Each session consisted of three 30 second repetitions. The total daily load of stretching was twice the recommend by ACMS.

A electromagnetic tracking device was used to measure 3D scapular kinematics. The evaluations were carried out before and after 4 and 8 weeks of an anterior shoulder musculature stretching program. Kinematic data collections were done with at least one day interval from the last stretching session to avoid the stretching transient effects on the viscoelastic muscle properties. The scapular movements relative to the thorax were evaluated during humeral elevation in frontal, sagittal and scapular planes of elevation. Volunteers repeated three times the paced elevation of arm in each plane to be tracked. Mean values of anterior-posterior tilt, medial-external rotation and upward-downward rotation of scapula were took at humeral elevation angles of 30°, 60°, 90°, 120° and maximal.

The analysis of scapular movements relative to the thorax was made using Euler angle rotation sequence of YX'Z'' and for the humeral movements relative to the thorax the sequence used was XZ'Y''[3]. The linear mixed effect model analysis was used to compare between the pre and post 4 and 8 weeks of the study intervention. Level of significance was set at 5%.

RESULTS AND DISCUSSION
Twenty five volunteers completed the fourth week evaluation. They presented mean age of 21.9 (±3,02) years. Twenty four subjects were females. Only twelve volunteers completed the eighth week evaluation.

At the 4 week kinematic evaluation, it was observed that the scapula is more posterior tilted at 90° and 120° of humeral elevation on frontal plane and at 120° and maximal

elevation on scapular plane. However, none of these differences were greater than 5°, that is considered a clinical meaningful difference. After 8 weeks of stretching program, contrary to the expected, the scapula presented less upward rotation during the scapular plane elevation, at maximal elevation in frontal plane and at 30°, 60° and maximal elevation in sagittal plane. Also contrary to our hypothesis, the scapula showed more internal rotation at 90° of elevation on sagittal plane (figure 1). However, with the exception of the less upward rotation at the maximal elevation in scapular plane and 30° and 60° on sagittal plane, the differences between pre and post eight weeks of stretching also were below 5°. Pectoralis minor is antagonist to the muscles responsible for posterior tilt, external rotation and upward rotation, which was of the reasons it was expected that after its stretching, more posterior tilt, upward rotation and less internal rotation would be observed. Borstad & Ludewig [1] showed that individuals with shortening of pectoralis minor presented less posterior tilt and more internal rotation when compared with individuals with long pectoralis minor. Nevertheless, comparison with this study is limited because the criteria used by Borstad & Ludewig [1] to classify volunteers as "short pectoralis minor" was the linear distance between 4th rib and coracoid process.

A possible explanation to the results obtained in the present study may be related to a variety of muscles that can influence scapula motion beyond the passive tension of the pectoralis minor. Although, when relative short that muscle has potential to constrain scapular movements, active tension generate from contractions in other scapulothoracic muscles could create less posterior tilt and more scapular internal rotation. Future studies should describe the effects of adding motor control training isolated or in combination to the stretching and strengthening exercises for posterior scapulothoracic muscles in the scapular kinematics.

CONCLUSIONS

According to the results of this study, the stretching program could not change scapula movements in healthy individuals with pectoralis minor shortening.

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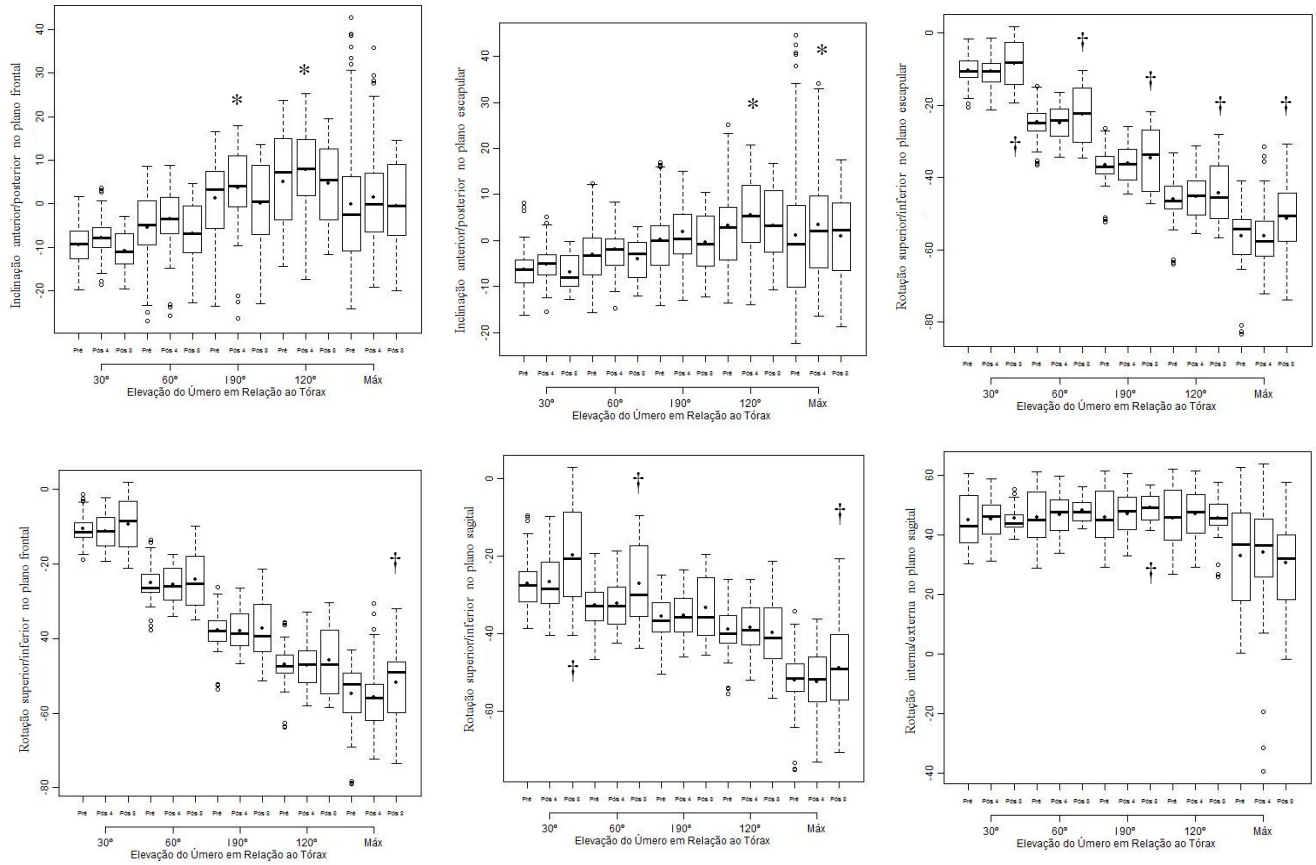

Figure 1. angular measures of each scapular variable relative to the thorax during humeral elevation in each plane of movement.

*Indicates significant difference between pre and post 4 weeks of intervention

†Indicates significant difference between pre and post 8 weeks of intervention