



Original Article

The effects of shoulder stabilization exercises and pectoralis minor stretching on balance and maximal shoulder muscle strength of healthy young adults with round shoulder posture

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Abstract. [Purpose] The purpose of this study was to analyze the effects of pectoralis minor stretching and shoulder strengthening with an elastic band on balance and maximal shoulder muscle strength in young adults with rounded shoulder posture. [Subjects and Methods] Nineteen subjects with rounded shoulder posture were randomly divided into 2 groups: a shoulder stabilization exercise group and a stretching exercise group. The groups performed each exercise for 40 minutes, 3 times a week, for 4 weeks. Static balance (eyes open and closed), dynamic balance (the limits of stability in 4 directions) and shoulder muscle strength in 5 directions were measured before and after the exercises. [Results] The stretching exercise demonstrated a significant difference between the pre- and post-exercise in the static balance with eyes closed and extension and horizontal abduction strength while the stabilization exercise demonstrated significant difference in the left and right directions between the pre- and post-exercise of the dynamic balance and flexion strength. The stabilization exercise demonstrated significant differences shown in the flexion between the pre- and post-test. [Conclusion] The shoulder stabilization and stretching exercises improved the static balance, dynamic balance, and muscle strength.

Key words : Balance, Round shoulder posture, Stabilization exercise

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INTRODUCTION

The function and stability of many joints that make up the shoulder joint are crucial to daily life¹⁾. Having the greatest range of movement out of all the joints in the human body, the complicated nature and wide range of mobility of the shoulder makes this joint vulnerable to injury of the bone, muscle, tendon, ligament, and bursa from excessive movement^{2, 3)}. In modern society, musculoskeletal abnormality and pain are increasing due to repetitive work and bad work posture.

The rounded shoulder posture (RSP) appears to be one of the most common structural anomalies of the shoulder complex and involves the increased anterior tilt of the cervical vertebra and the posterior tilt of the upper thoracic vertebra, which causes the shoulder to protrude, turn downwards, and tilt anteriorly⁴⁻⁶⁾. Exercise impairment syndrome, which results from RSP, causes pain in certain areas, increases or decreases the joint's range of motion, and encourages movements to be made in the easiest direction, even if they are outside of the normal range, which applies stress to certain areas or causes muscle atrophy due to the compensatory movement⁴⁾. Failure of the head alignment with longitudinal axis⁷⁻⁹⁾ can lead to further malalignments such as rounded shoulders and thoracic kyphosis^{7, 10, 11)} for compensation^{7, 12)}. Forward head posture, RSP, and increased thoracic kyphosis could be in any combination⁷⁾. When the thoracic kyphosis is increased, anterior longitudinal

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ligament and upper abdominal muscles are shortened and the anterior part of vertebral bodies is compressed, leading to increases in intradiscal pressures^{7, 13}). This condition could cause poor respiratory function^{7, 14}) and poor balance^{7, 15}). Balance involves maintaining the center of gravity within the supporting surface, and it requires muscle strength and activity¹⁶). Pain that evolves from structural change affects joint sensory, influencing abnormalities in the proprioceptive senses and postural balance^{7, 17}). Posture is defined by the relative positioning of the body parts within a space^{18,19}), and it is an essential element of normal balance^{18, 20}).

One of the various causes of RSP is the shortening of the pectoralis minor^{6, 21, 22}). The pectoralis minor originates from the three to five ribs near the sternocostal junction and inserts into the coracoid process of the scapula. The muscle elongates during the extension of the arm and aids in the upward rotation, external rotation, and posterior tilting of the scapula²¹). The pectoralis minor shortens due to adaptation and through the restriction of the full scapular motion, exhibiting less total excursion, relative to the longer muscles^{21, 23, 24}). The treatment of a protracted shoulder commonly involves the strengthening of the rotator cuff and scapular stabilizers, as well as the stretching of the anterior musculature, such as the pectoralis minor²⁵⁻²⁸).

Shoulder stabilization exercises are the most widely used form of treatment to correct RSP²¹). These exercises are designed to fix the shoulder to the chest cavity in a neutral position through interaction of the muscles that construct the shoulder. The interaction of the muscles around the shoulder joint, which connects the upper extremities to the torso²⁹), allows the shoulder bones to be situated between ribs two through seven^{30, 31}). Stabilization exercises include an elastic band exercises and stretching exercises are performed in cases in which there is a shortening of the muscles, and they are effective in repositioning the shoulder and lengthening the pectoralis minor^{4, 6, 32-34}). Elastic band exercises are performed when there is muscular weakness, and they are effective in enhancing the function of postural control³⁵). In previous studies, it was reported that elastic band exercises were effective in improving shoulder strength, endurance, flexibility, and range of motion in patients who had suffered shoulder injuries³⁶).

If improper posture is sustained for a prolonged period, it may cause upper crossed syndrome, simultaneously weakening the rhomboid, serratus anterior, and lower trapezius muscles, which are all deep, cervical flexors. Furthermore, the pectoralis major, pectoralis minor, and upper trapezius muscles may shorten; due to muscular shortening and weakening, pain may result in the head, temporo-mandibular joint, cervical vertebra, thoracic vertebra, shoulder, and arm^{37, 38}). There are many studies that have investigated the structural deformation of the upper extremities, including abnormalities such as RSP and forward head posture, and many of these studies comparatively analyze the individual effects of each exercise or pain. Also, there are more studies pertaining to the balance of the lower limbs than to the upper limbs. The purpose of this study was to investigate the combined effect of stretching exercises on the shortened pectoralis major and stabilization exercises utilizing an elastic band on the balance and maximal shoulder muscle strength of the upper trapezius, pectoralis major, and posterior deltoid muscles in individuals with RSP.

SUBJECTS AND METHODS

Originally, the subjects of this study were 20 students with RSP, currently enrolled in “N” University. One subject had to leave the study due to personal reasons; therefore, the final number of subjects was 19 (Table 1). The subjects were confirmed to have RSP through an examination in which they were instructed to lie supine, resulting in a measurement that exceeded 2.5 cm between the table’s surface and their shoulder peaks^{32, 37}). Before participating in this study, the subjects were thoroughly briefed on the nature of the study and were confirmed to have fully understood all aspects of the study. In addition, a voluntary written consent was obtained from each subject. Individuals who, in the past year, had received medical attention for their neck, shoulder, or lower back, suffered from a structural disorder related to the spine, had any neurological deficits, osteoarthritis, or rheumatoid arthritis, and who had performed any muscle strengthening exercises for the neck, shoulder, or arm in the last six months were excluded from this study.

In order to identify the general characteristics of the subjects, a body composition analyzer (InBody 720, Biospace Co., Ltd., Seoul, Republic of Korea) was used. In order to measure the subjects’ shoulder height, the standard type of vernier calipers (Vernier calipers, Coms, China) were used. In addition, a computerized balance platform (BT4, HUR Labs Oy, Tampere, Finland) was used. In order to measure isometric strength, a functional rehab system (PRIMUS RS, BTE Tech., Hanover, MD, USA) was used. The TheraBand colored blue (HYSNAL Synthetic Rubber Sheeting, Hygenic, Akron, Ohio, USA) were used for shoulder stabilization exercise.

Prior to the study, in order to confirm the presence of RSP, the subjects’ shoulder height was measured. The subjects were asked to lie down in a supine position, after which the distance between the table surface and the posterior surface of their shoulder peak was measured. The standard, vernier caliper tool used had 1 mm increments, with 20 total increments and the smallest possible measurement being 1/20 mm. For the evaluation of RSP with or without symptoms, and solely based on shoulder placement, this device has a high degree of reliability (ICC_{3, 1} = 0.88–0.93)^{39, 40}). Both pre- and post-exercise,

Table 1. General characteristics of subjects (n=19)

Characteristics	Stabilization (n=9)	Stretching (n=10)
Age (years)	20.7 (1.6)	21.1 (0.9)
Height (cm)	167.7 (7.3)	161.9 (7.1)
Weight (kg)	67.1 (17.7)	62.1 (9.6)

Expressed as mean (standard deviation).

*p<0.05.

Table 2. Exercise program

Exercise	Program	Time (min)
Warm-up	Neck, wrist, pelvic, knee, and ankle stretching and rotation	5
Main	Stretching exercise on pectoralis minor Right arm resting overhead on the floor with lower trunk rotated and knees fallen to the left in a hooklying position with both knees flexed. Repeat the other side. Both arms resting overhead on the floor with lower trunk rotated to the left in a supine position with the right knee flexed. Repeat the other side. Both arms and armpits resting close on the floor in quadruped position.	15
	Strengthening exercise with the elastic band Resisted shoulder external rotation with a band from 45 degrees to 60 degrees with elbows flexed in 90 degrees. Resisted “rowing” shoulder extension with elbow flexion with a band fixed on feet in long sitting position. Resisted “rowing” shoulder extension with elbow flexion towards abdomen with a band fixed on feet in mini squat position.	15
Cool-down	Neck, wrist, and ankle rotation Breathing exercise	5

**Fig. 1.** Shoulder strengthening exercise.

the data was collected three times, and the average was calculated. The same examiner performed all the evaluations.

The subjects were randomly divided into two groups, the shoulder stabilization exercise group and the stretching exercise only group, with 10 subjects in each group. Both groups performed their respective exercises 3 times a week, with each session lasting 40 minutes, for a total of 4 weeks. Each exercise program consisted of a 5-minute warm-up exercise, a 30-minute main exercise, and a 5-minute concluding exercise (Table 2) (Figs. 1, 2). With respect to the stabilization exercise group, the warm-up and concluding exercises consisted of stretching, and the main exercise consisted of 15 minutes of shoulder strengthening exercises and 15 minutes of shoulder stretching exercises on pectoralis minor muscle. With respect to the stretching only group, all aspects of the exercise program consisted of stretching exercises⁴⁾. The main exercise was repeated 10 times in a set of 10 seconds and the rest time was 2-minutes between the sets⁴¹⁾.

The one-leg stance test, with eyes both open and closed, was used to measure the subjects' static balance. The subjects were barefoot and stood on one leg on the computerized balance platform⁴²⁾ for 30 seconds⁴³⁾. During the measurement, the subjects were instructed to flex their lifted leg 30° and to maintain their stability as much as possible⁴⁴⁾. The measured static balance parameter was C90 area; area (mm²) of the smallest ellipse containing 90% of the center of pressure point⁴⁵⁾. In order to measure the subjects' dynamic balance, the limits of stability (LOS) was used. The subjects were instructed to stay aligned with the primary axis of motion and to use their ankle joint in order to keep their body within the straight line, without moving their feet. Also, the subjects were instructed to shift their body weight as quickly and directly as possible, following the appearance of the target on the monitor. The direction of each target was randomly displayed once for a total of eight seconds⁴⁶⁾. The target placement took into consideration the conversion of the angular motion of leaning toward the linear movement of the center of gravity that appeared on the screen⁴⁷⁾. The measured directions included forward, backward, left, and right.

A functional rehab system was used in order to measure the subjects' shoulder flexion, extension, abduction, horizontal

**Fig. 2.** Shoulder Stretching exercise on pectoralis minor.

Table 3. Between groups difference maximal shoulder muscle strength after exercise

Variables	Group	Post-Pre
C90 area with eyes open (mm ²)	Stabilization	23.67 (188.57)
	Stretching	-11.45 (381.12)
C90 area with eyes closed (mm ²)	Stabilization	-1,090.48 (2.44)
	Stretching	-1,002.79 (868.28)
Forward (degrees)	Stabilization	-3.92 (14.19)
	Stretching	0.75 (0.94)
Backward (degrees)	Stabilization	0.32 (1.91)
	Stretching	0.06 (1.26)
Left (degrees)	Stabilization	1.58 (1.68)
	Stretching	0.26 (1.06)
Right (degrees)	Stabilization	1.01 (0.70)
	Stretching	1.05 (1.59)

Expressed as mean (standard deviation).

*p<0.05.

abduction, and horizontal adduction strength. The horizontal abduction and horizontal adduction strength was measured with the humerus in an adducted state²²). During the measurement process, in order to ensure the exertion of the subjects' maximal muscle strength, verbal encouragement was given to them.

The SPSS Version 20.0 for Windows was used to complete the statistical analysis of the data collected in this study. In order to confirm normal distribution, the Kolmogorov–Smirnov test was used. In addition, Levene's F-test was used in order to verify homogeneity. In order to compare the change in balance and maximal shoulder muscle strength between the groups, an independent t-test was conducted. In order to compare the change in balance and maximal shoulder muscle strength within each group, a paired t-test was conducted. The statistical significance was set as $\alpha=0.05$.

RESULTS

Comparison of balance between the groups showed no significant changes within all the variables. Comparison of balance between the two groups revealed that, within the stabilization exercise group, the LOS for both the left and right directions experienced a significant increase. For the stretching exercise group, C90 area with eyes closed experienced a significant decrease, and the LOS forward direction showed a significant increase (Tables 3, 4).

The maximal shoulder muscle strength between these groups showed no significant changes in any of the variables. Overall, the stabilization exercise group displayed a significant increase in the maximal flexion strength, whereas the stretching exercise group demonstrated a significant increase in muscle extension and horizontal abduction (Tables 5, 6).

DISCUSSION

RSP causes pain in the cervical and thoracic vertebra and upper thoracic⁴⁻⁶), and it reduces the posterior tilt, upward rotation, and lifting of the scapula in the extension of the arm^{6, 21, 22}). In this study, the elastic band was used as a part of the combined shoulder strengthening and shoulder stretching exercises for young adults with RSP in order to observe the effects of shoulder stabilization exercises on balance and muscle strength.

Upon comparison of the change in balance between the two groups, there appeared no significant differences. Regarding the internal comparison of balance within the shoulder stabilization exercise group, a significant increase in the left and right directions of the LOS was observed. In the stretching exercise group, the C90 area with the eyes closed was significantly reduced, and the forward direction of the LOS increased significantly. In a previous study, cervical changes such as forward head posture might be associated with changes in balance, the study found that there was a negative relationship between a forward head posture and a more anterior center of gravity had balance scores¹⁷). The young participants with RSP performed scapular posterior tilt exercise, pectoralis minor stretching, and shoulder brace. The study concluded that pectoralis minor stretching exercise and a shoulder brace might help correct RSP and restore the pectoralis minor length⁴⁸). The adolescents with forward head and protracted shoulder posture were instructed to perform resistance and stretching exercises for 16 weeks. The results of this study showed that, in the intervention group, the subjects' cervical and shoulder angles increased significantly. It was reported that the shoulder angle was often involved with protraction, anterior tilting, and the internal rotation of the scapula, as well as tightness of the pectoralis minor muscle²⁵). The shortening of the pectoralis minor has similar altered scapular kinematics, often resulting in subacromial impingement. This association may enhance scapular kinematics through the stretching of the pectoralis minor, and it may also aid the maintenance of shoulder impingement²¹).

Table 4. Within group change in static and dynamic balance

Variables	Group	Pre-test	Post-test
C90 area with eyes open (mm)	Stabilization	705.40 (322.64)	729.06 (352.37)
	Stretching	585.11 (367.73)	573.66 (276.39)
C90 area with eyes closed (mm)	Stabilization	729.08 (352.37)	2,773.94 (2.18)
	Stretching	2,536.74 (800.98)	1,533.95 (513.03)*
Forward (degrees)	Stabilization	10.02 (13.87)	6.10 (1.59)
	Stretching	5.16 (1.09)	5.91 (0.69)*
Backward (degrees)	Stabilization	4.39 (1.36)	4.71 (1.31)
	Stretching	4.35 (0.84)	6.42 (1.34)
Left (degrees)	Stabilization	5.87 (1.28)	7.45 (0.71)*
	Stretching	7.34 (0.96)	7.60 (1.00)
Right (degrees)	Stabilization	6.53 (1.01)	7.54 (0.95)*
	Stretching	6.42 (1.34)	7.48 (0.74)

Expressed as mean (standard deviation).

*p<0.05.

Table 5. Between groups difference in static and dynamic balance (N)

Variables	Group	Post-Pre (Δ Values)
Flexion	Stabilization	1.30 (1.68)
	Stretching	0.71 (1.49)
Extension	Stabilization	0.65 (2.29)
	Stretching	1.00 (1.33)
Abduction	Stabilization	0.65 (1.67)
	Stretching	0.65 (1.50)
Horizontal abduction	Stabilization	0.84 (2.02)
	Stretching	0.84 (0.71)
Horizontal adduction	Stabilization	0.70 (1.66)
	Stretching	0.26 (1.16)

Expressed as mean (standard deviation).

*p<0.05.

Table 6. Within group change in shoulder muscle strength (N)

Variables	Group	Pre-test	Post-test
Flexion	Stabilization	8.20 (2.13)	9.50 (0.95)*
	Stretching	6.99 (2.48)	7.70 (1.83)
Extension	Stabilization	7.04 (2.46)	7.70 (1.58)
	Stretching	6.56 (1.98)	7.56 (1.75)*
Abduction	Stabilization	7.53 (2.44)	8.18 (1.25)
	Stretching	6.75 (2.27)	7.40 (2.21)
Horizontal abduction	Stabilization	7.27 (2.61)	8.12 (1.11)
	Stretching	7.40 (1.96)	8.24 (1.42)*
Horizontal adduction	Stabilization	8.44 (3.25)	9.14 (2.51)
	Stretching	7.61 (1.80)	7.87 (1.11)

Expressed as mean (standard deviation).

*p<0.05.

In a study that included individuals both with and without shoulder pain, a 6-week pectoralis minor stretching protocol was conducted, and, for the group experiencing shoulder pain, it was reported that the function of their upper limbs increased significantly. For the healthy group, the scapular anterior tilt at 90° of flexion also increased significantly. The length of the pectoralis minor for both groups did not demonstrate any significant changes⁴⁹. A previous study reported that there is a significant decrease in RSP through the application of pectoralis minor stretching exercises and scapular, posterior tilting exercises for individuals with RSP¹⁶. In swimming athletes with forward shoulder posture, a 6-week stretching and strengthening exercise program group, using the elastic band, showed a significantly decreased distance between the wall and acromion in the subjects' resting posture than what was observed in the normal swim training activity⁴¹. Upon examination of the effect that fatigue has on the sensory input of the levator scapula muscles in healthy adults, it was found that, without vision, cervical muscular fatigue increased the center of the foot pressure displacement. This effect became more pronounced when the somatosensation was reduced by the use of a foam surface. As a result, it was reported that the availability of vision inhibited the effects of instability for some subjects⁵⁰. In a study conducted with healthy male adults, isometric contractions were applied to the subjects' cervical extensors. This study reported that the subjects' balance was influenced by the increase of maximal isometric contractions of the cervical extensors⁵¹.

In the current study, the shoulder stabilization group experienced a significant increase in the left and right directions of the LOS. In the stretching exercise group, there was a significant decrease when the eyes were closed; also, there was a significant increase in the LOS of the forward direction in this group. These results are thought to have been caused by improved muscle strength and reduced the RSP symptom, which resulted from the performance of the stabilization exercise and the stretching exercise. The shoulder stabilization exercise and pectoralis minor stretching exercises are thought to have enhanced the shoulder and scapular movement, as well as to have improved the scapular kinematics. There was an association between forward head posture, RSP, and increased thoracic kyphosis⁷. So, the stabilization exercise and the stretching exercise also improved thoracic alignment by decreasing RSP and changing positively the scapular kinematic mechanism. As such, improved body alignment and changed center of gravity would have aided in improving the postural control ability and, consequentially, their balance. However, in the current study, the shoulder stabilization group significantly improved dynamic balance although the stretching group significantly improved both static and dynamic balance. These results showed that the stretching exercise had more effect on the RSP than stabilization exercise because the RSP is more responsible for the shortening of the anterior muscle, the pectoralis minor muscle, than the weakening of the posterior muscle of shoulder. Thus, the stretching exercise had which was performed longer and alone had more positive effect on the RSP than the shoulder stabilization exercise which was combined with the strengthening and stretching exercise.

In this study, comparison of the changes in the maximal shoulder muscle strength between the two groups showed no significant differences. However, comparison within the groups revealed that there was a significant increase in flexion within the stabilization exercise group. In the stretching exercise group, there was a significant increase in both extension and horizontal abduction.

In a previous study that was conducted on individuals with forward head posture, stretching exercises for the pectoralis muscle and resistance strengthening exercises for the scapular retractors and elevators, glenohumeral abductors, and external rotators were performed three times a week for six weeks. This study's post-intervention analysis revealed no changes in the subjects' resting scapular posture. However, the muscle strength of the subjects' horizontal abductors, internal rotators, and external rotators showed significant increases²². In a study conducted with healthy adults, the subjects were divided into a pectoralis minor soft tissue and self-stretching experimental group and a placebo touch and pectoralis major self-stretching control group. The experimental and control groups both displayed reduced RSP during the post-intervention analysis. It was also reported that there was an increase in the lower trapezius muscle strength³⁹. Individuals with both forward head posture and RSP symptoms were instructed to perform strengthening exercises for their deep cervical flexors and shoulder retractors, as well as stretching exercises for their cervical extensors and pectoral muscles, using the elastic band for 10 weeks. The results of this study revealed that there were significant differences in the range of motion and postural measurement of the exercise group and the control group. Furthermore, in the exercise group, it was reported that there was a significant difference between the pre- and post-intervention measurements⁹. Also, the application of rubber band strength training exercises to athletes displayed an increase in the external rotator peak torque, which implies that strength training improves the muscle strength and balance of the external rotator⁵².

Comparison of the maximal shoulder muscle strength in this study revealed that the flexion of the stabilization exercise group and the extension and horizontal abduction of the stretching exercise group experienced significant increases. These results may be attributed to the enhancement of muscle strength and balance of the flexor, extensor, and horizontal abductor muscles through the performance of stabilization and stretching exercises. Consequently, the improved muscular strength and balance would have reduced the subjects' RSP.

One limitation of this study is that it is difficult to generalize the results of this study that involved only 19 subjects. Also, only adults with no other disorders, aside from RSP, were selected for this study. Future studies should involve an increased number of subjects, as well as a more varied selection of disorders.

This study examined the effects of a 4-week shoulder stabilization exercise program that combined a pectoralis minor stretching exercise and a stabilization exercise that used an elastic band to improve the balance and maximal shoulder muscle strength in individuals with RSP. The comparison of balance within the groups, based on exercise, demonstrated that, in

the stabilization exercise group, a more positive impact was made on the subjects' dynamic balance, while in the stretching exercise group, both the patients' static and dynamic balance were positively affected. The comparison of maximal shoulder muscle strength within the groups, based on exercise, revealed that both the stabilization and stretching exercise groups experienced significant increases in maximal shoulder muscle strength. The stabilization and stretching exercises are not only thought to improve RSP, but to improve balance and maximal shoulder muscle strength as well. This study will be useful for future research on RSP or other cervical disorders.

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Conflict of interest

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