한국전문물리치료학회지 2012년 19권 4호
Phys Ther Kor. Vol. 19 No. 4 2012

Effects of 6-Week Self-Scapular Upward Rotation Exercise on Downward Pulling Tension in Subjects With Scapular Downward Rotation Syndrome

Sung-min Ha[1], PhD, PT, Oh-yun Kwon[2], PhD, PT, Kyue-nam Park[3], MSc, PT
[1]Laboratory of Kinetic Ergocise based on Movement Analysis,
[2]Dept. of Physical Therapy, College of Health Science, Yonsei University,
Dept. of Ergonomic Therapy, The Graduate School of Health Science, Yonsei University,
[3]Dept. of Physical Therapy, The Graduate School, Yonsei University

Abstract

The purpose of this study was to investigate the quantitative data of downward pulling tension in subjects with scapular downward rotation syndrome (SDRS) before and after 6-week self scapular upward rotation exercise (SURE) program. Eleven subjects with bilateral SDRS. The downward pulling tension(DPT) was measured digital tension-meter. The tension force data were collected using a surface electromyography before and after a 6-week self-scapular SURE program. The significance of difference between pre- and post-program was assessed using a paired t-test, with the level of significance set at α=.05. The results showed that significant differences between pre- and post-SURE program were found for DPT ($p<.05$). These findings suggest that 6-week self SURE program is effective for reducing DPT in subjects with SDRS. Additionally, our DPT measurement can be useful for maintaining shoulder position and providing quantitative data between pre- and post-SURE program during passive correction of scapular position test.

[Sung-min Ha, Oh-yun Kwon, Kyue-nam Park. Effects of 6-Week Scapular Upward Rotation Exercise on Downward Pulling Tension in Subjects With Scapular Downward Rotation Syndrome. Phys Ther Kor. 2012;19(4):32-37.]

Key Words: Downward pulling tension; Scapular downward rotation syndrome; Scapular upward rotation exercise.

Introduction

Prolonged periods in the scapular downward rotated (SDR) position may increase downward pulling tension (DPT) by changing shoulder girdle muscle's stiffness (infraspinatus, latissimus dorsi, levator scapula, rhomboid, subscapularis, teres major, and teres minor) (Sahrmann, 2002). Additionally, a change in the direction of glenoid fossa displacement in patients with SDR can increase DPT as well as downward subluxation of the glenohumeral joint (Basmajian and Bazant, 1959). These biomechanical changes of the scapulae are a source of pain, dysfunction, and range of motion (ROM) limitation in the neck-shoulder region (Lewis et al, 2005).

Previous studies have suggested that modifying the scapular position is useful to reduce mechanical stress or pain by decreasing muscle's tension, which improve ROM in the neck, neck pain, and proprioception (Andrade et al, 2008; Azevedo et al, 2008; Ha et al, 2011; McDonell et al, 2005). In addition, axio-scapular muscles stiffness through 6-week

Corresponding author: Oh-yun Kwon kwonoy@yonsei.ac.kr

self-scapular upward rotation exercise (SURE) program has been shown to improve scapular and clavicular alignment and increase the strength of scapular upward rotator muscles in subject with scapular downward rotation syndrome (SDRS) (Ha, 2012).

In the clinical field, the passive correction of scapular position test (PCSPT) is commonly used to determine the effects of DPT in subjects with neck-shoulder complaints (Magee, 1997; Sahrmann, 2010). When assessing cervical rotation ROM, examination of cervical motion with and without upper limb support would provide information about the contribution of the upper limbs to the patient's clinical presentation. If the upper limbs are related to the patient's restriction or symptoms, it may be useful to have the patient perform cervical rotation exercises with the arms supported (Magee, 1997; Sahrmann, 2010). PCSPT or modifying scapular alignment using manual is considered the key test to confirm whether neck pain is related with abnormal scapular alignment (Magee, 1997; Sahrmann, 2010; Van Dillen et al, 2007). PCSPT using manual cannot be applied for a long period of time nor constant shoulder girdle position (Sahrmann, 2010; Ha et al, 2011).

In previous studies, DPT measurements have typically been performed manually by an examiner with no quantitative data being provided before and after the therapeutic intervention. This has a limited that explains the links between neck pain and abnormal scapular alignment. Thus, the present study was conducted to investigate quantitative DPT data in subjects with SDRS before and after 6-week self-SURE program. We hypothesized that DPT would differ between pre- and post-SURE program.

Methods

Subjects

Eleven subjects with bilateral SDRS (4 male and 7 female) were recruited from university populations (a total of 22 SDRS sides). The inclusion criteria used for subject selection were based on the literature (Caldwell et al, 2007; Ha et al, 2011; Ha, 2012; Sahrmann, 2002): (1) the scapulae are downwardly rotated with visual appraisal; (2) the clavicle appears to be horizontal or the acromioclavicular joint is lower than the sternoclavicular joint with visual appraisal; (3) the vertebral borders of the scapulae are less than 3 inches from the spine as measured with a tape measure. Subjects with cervical spinal fractures, neck-rotation ROM of <20°, radiating pain to an upper extremity, or a history of unresolved cancer were excluded. Prior to the study, the principal investigator explained all procedures to the subjects, and all subjects signed an informed consent form which is approved by the Yonsei University Wonju Campus Human Studies Committee. Subject's characteristics are presented in Table 1.

Measurement Instruments

A digital tension-meter (DTM)[1)] using linear force measurement load cell was used to measure downward tension (Figure 1A). The tension force data were collected using a Noraxon TeleMyo 2400T and MyoResearch Master Edition 1.06 XP software (Noraxon Inc., Scottsdale, AZ, U.S.A.). The sampling

Table 1. General characteristics of the subjects (N=11)

	Mean±SD	Range
Age (yrs)	23.0±2.6	23~32
Height (㎝)	166.0±6.6	153~175
Weight (㎏)	57.5±9.7	45~75

1) digital tension-meter, Noraxon Inc., Scottsdale, AZ, U.S.A.

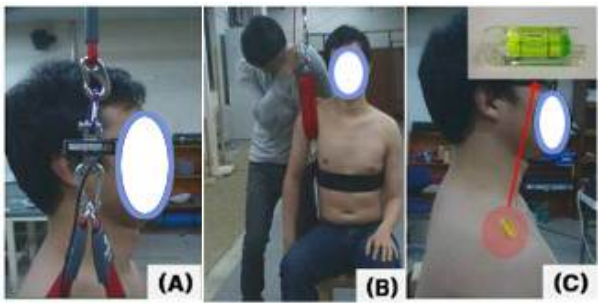

Figure 1. Downward pulling tension measurement apparatus (A: Digital tension meter, B: Suspension and trunk fixation equipment, C: Water-based horizontal level).

rate was 1000 ㎐, and the DTM was calibrated before testing using a 1 ㎏ dumbbell.

Scapular Upward Rotation Exercise

During SURE instruction, subjects were asked to stand with their back against the wall, with wall contact from head to buttock, and with feet shoulder width apart. In the starting position, the radial border of the forearms and lateral side of the humerus were in contact with the wall, and the shoulder was abducted 90° with the elbow flexed 90°. The subjects were instructed to slide their arms up the wall. The sliding movement ended when the shoulder reached 180° of abduction. Subjects were then instructed to maintain the arm position for 10 seconds (Figure 2). The subjects were informed that the exercises may induce muscle fatigue but should not cause increased shoulder pain. Subjects were instructed to perform SURE three days per week.

The 6-week self-SURE program was divided into two sections (the first section with non-resistive SURE during weeks 1-3 and the second section with resistive SURE using a thera-band during weeks 4-6) (Figure 2). During the 6-week self-SURE program, subjects were asked to perform three sets of 10 repetitions during the first week, progress to three sets of 15 repetitions during each session in the second week, and complete three sets of 20 repetitions during the third week. After completing three sets of 20 repetitions for three consecutive sessions, subjects were evaluated whether they were pain-free

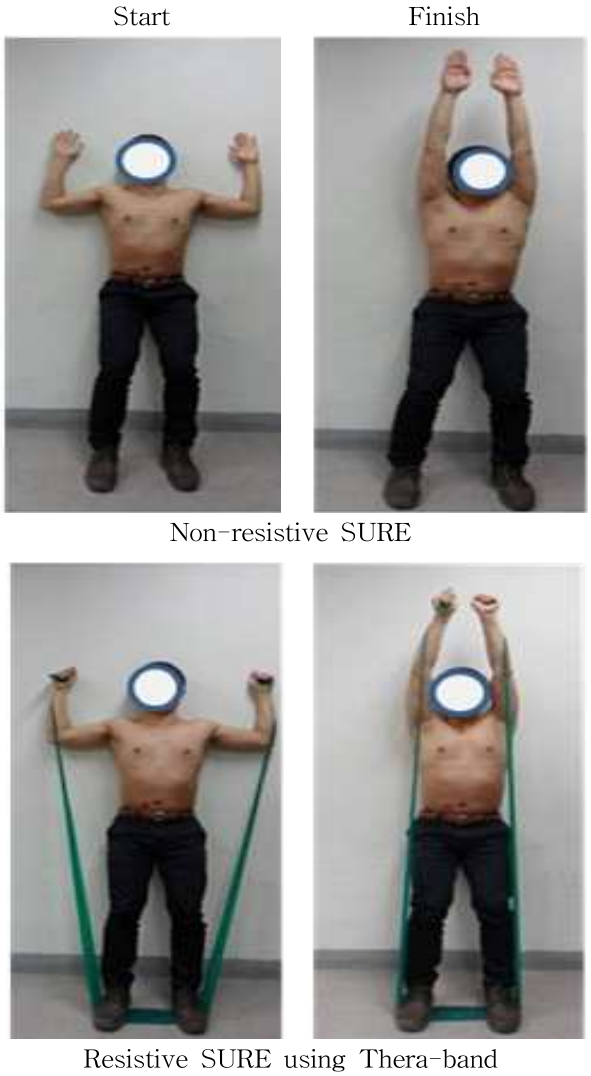

Figure 2. Scapular upward rotation exercise (SURE: scapular upward rotation exercise).

and had achieved full active ROM. All subjects who were pain-free in full active ROM were prescribed self-SURE.

After the first section of the 6-week self-SURE program (i.e. at the beginning of the fourth week), subjects were allowed to progress to the second section. The low level of tension of the thera-band was controlled by a concentric exercise phase that did not cause excessive loading for activated muscles and joint pain. To fix the thera-band, the thera-band was placed under subject's both mid-foot. The level of thera-band tension was increased by shortening

the thera-band as much as could be tolerated without discomfort or pain while maintaining the exercise performance instructed by the physical therapist. If subjects felt or complained of pain during the resistive SURE using thera-band, they were instructed to lengthen the thera-band. Subjects were asked to perform resistive SURE using thera-band for three sets of 10 repetitions during each session in the fourth week, progress to three sets of 15 repetitions in the fifth week, and complete three sets of 20 repetitions in the sixth week.

Procedures

All subjects were evaluated for study inclusion/exclusion at the initial visit. To measure the DPT by upper extremity weight, subjects were asked to sit upright on a chair with their feet on the floor and looking straight ahead. To prevent compensatory trunk movement, the subject's trunk was fastened to the back of the chair using a Velcro strap as described by Wang et al (2005) (Figure 1B). As described by Ha et al (2011), the examiner passively lifted one side of the subject's one side shoulder girdle using a suspended device until the shoulder level become horizontal. A water-based horizontal level was used to confirm a horizontal shoulder level. Next, DPT by upper extremity weight was measured (Figure 1C) with the mean of three trials being calculated. All measurements were performed both at the time of entry into the study (pre-SURE program) and at follow-up (post-SURE program).

Following the initial measurement, the subjects received instruction in a 6-week self-SURE program by a licensed physical therapist with 9 years of clinical experience in the evaluation and treatment of musculoskeletal disorders. Each subjects received written/pictorial instructions, a video file for home reference during the self-SURE program, and a daily exercise log to monitor compliance with the exercise program. All subjects received a 1 hour training session at the initial visit. The subjects were asked to perform a 6-week self-SURE program. The subjects returned 1 week after the initial session for a review of the home self-SURE program, and questions regarding the exercise regime were answered by the physical therapist. At 4 weeks, the therapist checked to determine whether subjects clearly understood the self-SURE program or whether they were having any difficulty performing the exercise regime. Every week, subjects were contacted by telephone to monitor compliance, discuss any problems, and ensure proper progression of self-SURE program at home. At the post-program visit, subjects rated their exercise compliance during the 6-week self-SURE program using a numerical rating scale ranging from 0 to 100%.

Statistical Analysis

The data are expressed as the means±standard deviations. Kolmogorov-Smirnov Z-test were performed to assess whether continuous data approximated a normal distribution. The paired t-test was used to test for significant differences between pre- and post-SURE program measurements. The level of statistical significance was set at α=.05. The statistical package for the Social Sciences for ver. 18.0 (SPSS, Inc., Chicago, IL, U.S.A.) was used for statistical analysis.

Results

Downward Pulling Tension

All of the continuous variables were found to approximate a normal distribution (Kolmogorov-Smirnov Z-test, $p>.05$). The amounts of DPT values are presented in Table 2. As can be seen, DPT decreased significantly in the post-program, compared to pre-program ($p<.05$).

Discussion

Prolonged periods in the SDR position can lead to

Table 2. Pre- and post-SURE program differences in downward pulling tension (N=22 SDRS[a] side)

	Pre-program	Post-program	t	p
DPT[b] (㎏)	66.91±21.57	47.07±16.35	6.12	<.05

[a]scapular downward rotation syndrome, [b]downward pulling tension.

changes in the length of scapular muscles and the biomechanics of the neck-shoulder region (Van Dillen et al, 2007). To solve these problems, the self-SURE program intervention has been suggested to restore optimal muscle length and strength for normal upper extremity function (Ha, 2012; Ludewig and Borstad, 2003; Sahrmann, 2002). Previous studies have investigated a self-questionnaire (pain and disability), ROM, muscle strength, and alignment before and after the therapeutic intervention (Andrade et al, 2008; Azevedo et al, 2008; Ha et al, 2011; Ha, 2012; McDonell et al, 2005). However, no prior studies have examined the effects of program on DPT in subjects with SDRS. Thus, the purpose of our study was to investigate the effect of a 6-week self-SURE program on DPT in subject with SDRS. To our knowledge, this is the first study to investigate the effect of a 6-week self-SURE program on DPT in subjects with SDRS.

Our results demonstrated that the 6-week self-SURE program significantly decrease DPT ($p<.05$), therefore, our hypothesis suggested. A possible explanation for the significant decrease between pre- and post-SURE program may be a change inmuscle stiffness. Although we did not directly measure the change of muscle stiffness, the 6-week self-SURE program lead to stretch shortened scapular downward rotators as well as strength lengthened scapular upward rotators. The improper positioning of the scapulae as in SDR may cause stretch weakness of the scapular upward rotator muscles by elongating them beyond the neutral physiological resting position (Sahrmann, 2002). Stretched scapular upward rotator muscle can not maintain a normal scapular position in subjects with SDR, which can lead to excessive DPT. The DPT due to subject's prolonged SDR position was considered to contribute to the prolonged compressive loading of posterior cervical structures by way of transfer of the weight of the upper extremities to the cervical region through the attachments of the cervicoscapular muscles (levator scapulae and upper trapezius) (McDonell et al, 2005). The 6-week self-SURE program may have induced correction of the anatomic muscle length adaptation and changed the relative muscle flexibility of the shortened scapular downward rotator muscles (levator scapulae, and rhomboid), leading to the decreased DPT. Therefore, the 6-week self-SURE program can be recommended for correcting scapular downward rotator muscles stiffness or reducing DPT in subjects with SDRS.

In the clinical field, the PCSPT is performed manually by an examiner (Magee, 1997; Sahrmann, 2010; Van Dillen et al, 2007). Compared to PCSPT by therapist's hands, our DPT measuremnt can provides constant shoulder position during PCSPT and quantitative data of DPT (Ha et al, 2011; Sahrmann, 2010). The present study demonstrated that PCSPT using a DPT device is effective for maintaining shoulder position and providing quantitative data between pre- and post-SURE program.

There are some limitations in our study. First, because study had not control group, generalizations are limited. Further study is needed to determine the effects of 6-week self-SURE program in subjects with normal scapular alignment. Second, our results cannot be generalized to other populations because our subjects were young and had no pain. Thus, further research is needed to investigate the effects of self-SURE program in subjects from different age groups and individuals with neck-shoulder pain.

Conclusion

The effects of the 6-weeks self-SURE program on DPT were examined in subjects with SDRS. Our re-

sults demonstrated that 6-week self-SURE program showed significant differences in DPT between pre- and post self-SURE program. The findings of our study provide evidence for the effectiveness of self-SURE in subjects with SDRS.

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This article was received September 18, 2012, was reviewed September 18, 2012, and was accepted October 28, 2012.