J. Phys. Ther. Sci. 28: 2666–2669, 2016

The Journal of Physical Therapy Science

Original Article

# The effects of wall slide and sling slide exercises on scapular alignment and pain in subjects with scapular downward rotation

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**Abstract.** [Purpose] The present study was performed to evaluate the changes in the scapular alignment, pressure pain threshold and pain in subjects with scapular downward rotation after 4 weeks of wall slide exercise or sling slide exercise. [Subjects and Methods] Twenty-two subjects with scapular downward rotation participated in this study. The alignment of the scapula was measured using radiographic analysis (X-ray). Pain and pressure pain threshold were assessed using visual analogue scale and digital algometer. Patients were assessed before and after a 4 weeks of exercise. [Results] In the within-group comparison, the wall slide exercise group showed significant differences in the resting scapular alignment, pressure pain threshold, and pain after four weeks. The between-group comparison showed that there were significant differences between the wall slide group and the sling slide group after four weeks. [Conclusion] The results of this study found that the wall slide exercise may be effective at reducing pain and improving scapular alignment in subjects with scapular downward rotation.

**Key words:** Scapular downward rotation, Wall slide, Sling slide

*(This article was submitted Apr. 21, 2016, and was accepted May 31, 2016)*

## INTRODUCTION

Shoulder pain is one of the most common musculoskeletal complaints in clinical practice. In particular, abnormal alignment of the scapula is a common clinical problem[1, 2)]. Abnormal alignment provides clues about the resting length of muscles[3)]. An imbalance in scapular upward rotator muscles, such as the upper trapezius (UT), lower trapezius (LT), and serratus anterior (SA), is caused by scapular downward rotation (SDR). SDR is one of the most common scapular alignment impairments in individuals with shoulder pain[2)]. Changes in scapular alignment can potentially influence the biomechanics of the glenohumeral joint by altering tension at the cervicoscapular muscle, which may lead to shoulder impingement[4)].

Patients with SDR experience restriction of upward rotation at 60° of the scapula during shoulder abduction, and compensatory scapular elevation[2)]. Excessive UT muscle activation resulting from scapular elevation in the UT region generates myofascial trigger points that cause pressure pain[5)]. Thus, in order to treat the imbalance of scapular muscles in patients with SDR, it is necessary to use exercises which recover the normal alignment of the scapula by strengthening the scapular upward rotators and extending the scapular downward rotators[2)].

A sling is a tool that is used to provide an unstable base of support, and it widely used in clinical practice in order to increase the activity of scapular stabilizer muscles[6, 7)]. Jeong et al.[8)] measured UT, SA, and deltoid activity while healthy adults conducted push-up plus exercises on a stable base of support and an unstable base of support, such as a sling. They found that the SA and UT had higher muscle activities in a push-up plus exercise conducted on a sling[8)].

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In the wall slide exercise, the lower arms slip upward against the wall with the elbow joints flexed at 90°, the shoulder joints at 90°, and the trunk fixed in a standing position, in order to strengthen the SA[9)]. It was reported that muscle activity increased with the arms lifted by more than 90° during wall slide exercise[9)]. Nonetheless, no previous research studies have investigated the effects of a wall slide exercise performed by patients with SDR.

Therefore, the present study conducted the wall slide exercise and the sling slide exercise using an unstable base of support, with subjects with SDR, for four weeks, and examined how these exercises affected the resting scapular alignment, pressure pain threshold (PPT), and pain of the UT.

## SUBJECTS AND METHODS

Subjects whose downward rotation angle (DRA) was less than 0° in alignment during scapular rest, as determined through radiological analysis, and who had UT pain during rest for at least four weeks, were selected to participate in this study. Subjects who had experienced neurological disorders or severe musculoskeletal disease were excluded. The study subjects were 22 male university students attending Daegu University in Daegu Metropolitan City, South Korea. The subjects were fully informed of all the experimental procedures before the experiment, and they gave their voluntary informed consent before they participated in the experiment. This study was approved by the Institutional Review Board of Daegu University, in accordance with the ethical principles of the Declaration of Helsinki. Table 1 summarizes the general characteristics of the subjects.

The experiments were conducted from December 1, 2014 to February 15, 2015. The same radiographer conducted the radiography with postero-anterior projection (diagnostic X-ray, LISTEM Co., Ltd., Japan). SDR was measured from radiological images of the chest using a picture archiving and communication system (PacsPlus). The scapular DRA was calculated as follows: DRA=angle between the vertical axis from the scapular superior angle and the medial border[10, 11)]. A visual analog scale (VAS) was used to measure pain intensity pre- and post-intervention. A digital algometer was used to measure PPT pre- and post-intervention. PPT was measured by placing the measurement catheter vertically on the skin of the UT muscle belly area between the acromion and the 7th cervical vertebrae, and then gradually increasing the pressure. The intra-rater reliability for the digital algometer measurements using the intra-class correlation coefficient (ICC) was reported as 0.90[12)]. The subjects were randomly assigned to one of two groups. For random assignment, cards numbered from one to 22 were placed in a sealed box and each of the subjects selected one card. When the card number was odd, the subject was placed in the wall slide exercise group (N=11) and when the card number was even, the subject was placed in the sling slide exercise group (N=11).

The subjects performed the specified exercise three times each week, for a total of four weeks. The subjects performed three sets of exercises with 10 repetitions per set during the first week of the program. During the second week, the subjects performed three sets of exercises with 15 repetitions per set. During the third week, the subject performed three sets of exercises with 20 repetitions per set. During the fourth week, they performed three sets of exercises with 25 repetitions per set. The resting time between each set was two minutes. Before performing each exercise, the subjects in both groups engaged in stretching of the shortened downward rotators. In order to stretch the downward rotators, the subjects assumed a quadruped position as a starting position, with the hip joints and knee joints at 90° of flexion, the shoulder joints at 90° of flexion, the elbow joints fully extended, and the head in a neutral position. Then, the subjects further flexed the hip joints and the shoulder joints conducting backward rocking, applying downward rotator stretching. During stretching, the subjects maintained the last position of the backward rocking for 10 seconds, and then slowly returned to the original position. Stretching was performed for a total of three sets, with 10 repetitions per set. The resting time between each set was two minutes.

For the wall slide exercise, the subjects stood in front of the wall, spread both feet shoulder width apart, flexed their shoulder and elbow joints at 90°, and placed the ulnar border in contact with the wall. The subjects were instructed to slide upward while pushing their forearms against the wall. In addition, the exercise was conducted until the shoulder joints were maximally flexed and the trunk was maintained in a straight line without compensatory action. At the point of maximal shoulder flexion, the subjects maintained the position for 10 seconds, and then slowly returned to the original position.

For the sling slide exercise, the subjects stood straight with both feet spread at shoulder width. The sling suspension point was located vertically above the shoulder joint, and the sling height was adjusted to the height of the elbow joints. Then, with the elbow joints flexed at 90°, the sling was slipped over the ulnar border and the weight was supported by the forearms in the starting position. From the starting position, the body was brought forward, and the exercise was conducted until the subjects' shoulder joints reached maximal flexion. The trunk was maintained in a straight line without compensatory action. At the point of maximal shoulder flexion, the subjects maintained the position for 10 seconds, and then slowly returned to the original position. In each exercise group, the scapular alignment and PPT and pain were measured in the same way after four weeks.

SPSS version 18.0 was used for all statistical analyses. Prior to analysis, the data normality was tested using the Shapiro-Wilk test. The paired t-test was used to compare pre- and post-intervention data within each group, and the independent t-test was used to compare the wall slide and sling slide exercise groups. The significance level was chosen 0.05.

**Table 1.** General characteristics of the subjects

| Group | DRS | |
|---|---|---|
| | Wall (N=11) | Sling (N=11) |
| Age (years) | 24.7 ± 3.5[a] | 25.4 ± 3.8 |
| Height (cm) | 172.8 ± 3.9 | 174.8 ± 4.0 |
| Weight (kg) | 71.6 ± 4.4 | 73.0 ± 4.3 |
| DRA (°) | −3.28 ± 0.92 | −3.05 ± 0.93 |
| VAS | 3.45 ± 0.93 | 3.00 ± 0.77 |
| PPT | 7.05 ± 1.46 | 7.66 ± 1.07 |
| DRS side (Rt/Lt) | 8/3 | 7/4 |

[a]Mean ± SD, DRA: downward rotation angle, VAS: visual analog scale, PPT: pain pressure threshold, DRS: downward rotation syndrome

**Table 2.** Comparison of changes between pre- and post-intervention, and between groups

| Variable | group | pre- | post- |
|---|---|---|---|
| Alignment (°) | WS | −3.28 ± 0.93 | −1.46 ± 0.84* |
| | SS | −3.04 ± 0.92 | −3.18 ± 1.01[a] |
| PPT ($N/cm^2$) | WS | 7.04 ± 1.46 | 10.06 ± 1.20* |
| | SS | 7.66 ± 1.07 | 6.51 ± 1.30[a] |
| Pain | WS | 3.45 ± 0.93 | 1.27 ± 0.78* |
| | SS | 3.00 ± 0.77 | 3.63 ± 0.92[a] |

*Significant difference from pre-test, p<0.05, [a]Significant difference in the changes of the two groups, p<0.05, WS: wall slide, SS: sling slide, PPT: pressure pain threshold. Values are presented as the mean ± SD.

## RESULTS

In the within-group comparison, the wall slide exercise group showed significant differences in the resting scapular alignment, PPT, and pain after four weeks ($p<0.05$). On the other hand, there were no significant differences in the sling slide exercise group ($p>0.05$). The between-group comparison showed that there were significant differences between the wall slide group and the sling slide group after four weeks of exercise ($p<0.05$) (Table 2).

## DISCUSSION

Restoring normal alignment of the scapula requires recovery of the normal length of the upward and downward scapular rotators[13]. Cools et al. reported that exercises helped strengthen weakened muscles, and stretching was conducive to shortened muscles[14]. In the present study, resting alignment of the scapula was measured using X-ray images. A significant decrease in the scapular DRA at rest was found only in the group that conducted the wall slide exercise for four weeks, and, in the between-group comparison, the wall slide exercise group's DRA was significantly decreased compared to the sling slide exercise group. This indicates that the SA muscle was strengthened through the wall slide exercise, and stretching of the downward rotators through the quadruped position also had an effect. Therefore, the wall slide exercise accompanied by downward rotator stretching for four weeks recovered muscular imbalance, and is conducive to recovery of normal alignment of the scapula. In contrast, the sling slide exercise group showed no significant difference in alignment of the scapula after four weeks. This strongly suggests that the sling slide exercise does not greatly contribute to SA muscle activity.

Patients with SDR complain of UT pain[15]. Andrade et al.[16] reported that the UT tenderness threshold of subjects with downward scapular alignment was lower than that of those with normal scapular alignment. They demonstrated that this was because UT is in continuous passive tension when the muscles are lengthened due to a depressed or downward rotated scapula. In the present study, two separate groups respectively performed the wall slide exercise and the sling slide exercise for four weeks. The PPT of UT significantly increased in the wall slide exercise group, and in the between-group comparison, the PPT of UT was significantly higher in the wall slide exercise group than in the sling slide exercise group. This finding was consistent with decreased SDR, and because of stretching of the downward rotators and strengthening of the upward rotators, downward rotation of the scapula decreased, reducing passive tension of the UT and increasing the tenderness threshold.

Changes in the tension of the neck and shoulder muscles resulting from SDR greatly contribute to decreases in shoulder pain and functional disability[15]. Pain in the UT area triggers continuous eccentric contraction of the UT resulting from muscle weakening of SA, thereby contributing to scapular upward rotation and traction of the muscles, contributing to SDR; consequently, muscular strain may be suspected[2]. In addition, the shortening of the levator scapulae muscle in subjects with SDR may trigger severe pressure on the disc and facet joints through the cervical vertebra[17]. In the present study, only the wall slide exercise group reported a significant decrease in pain after four weeks, and the wall slide exercise group's pain was significantly less than that of the sling slide exercise group. It is assumed that the pain decreased because a reduction in SDR decreased the load on the UT, thereby decreasing muscular strain of the UT, and, as the levator scapulae muscle was stretched, the pressure force of the disc and the spur joint decreased. Ha et al.[18] found that the UT pain of subjects with SDR syndrome was decreased by passive scapular elevation performed by a therapist, which supports the result of the present study.

The present study had a few limitations. First, the subjects with SDR were young males and the study only included 22 participants, thus it is difficult to generalize its results. Second, this study failed to collect and quantify kinematic data of the scapula. Third, a 4-week exercise program was conducted to evaluate the exercise treatment effects, but long-term and periodic follow-up evaluations after the training were not taken into account. Future research needs to study the long-term effects of the exercise treatment on subjects with SDR, with differing age groups, taking the above limitations into consideration by conducting follows-up on a long-term basis.

The results of this study may provide a foundation for understanding the effects of the wall slide exercise in SDR patients. In conclusion, the wall slide exercise can be used effectively for symptomatic or asymptomatic patients with SDR in clinical practice.

## REFERENCES


1) Lim JY, Kim TH, Lee JS: Reliability of measuring the passive range of shoulder horizontal adduction using a smartphone in the supine versus the side-lying position. J Phys Ther Sci, 2015, 27: 3119–3122. [Medline] [CrossRef]
2) Sahrmann S: Diagnosis and treatment of movement impairment syndromes. St. Louis: Mosby, 2002, pp 193–198.
3) Caldwell C, Sahrmann S, Van Dillen L: Use of a movement system impairment diagnosis for physical therapy in the management of a patient with shoulder pain. J Orthop Sports Phys Ther, 2007, 37: 551–563. [Medline] [CrossRef]
4) Lewis JS, Wright C, Green A: Subacromial impingement syndrome: the effect of changing posture on shoulder range of movement. J Orthop Sports Phys Ther, 2005, 35: 72–87. [Medline] [CrossRef]
5) Gerwin RD: Classification, epidemiology, and natural history of myofascial pain syndrome. Curr Pain Headache Rep, 2001, 5: 412–420. [Medline] [CrossRef]
6) Kim ER, Oh JS, Yoo WG: Effect of vibration frequency on serratus anterior muscle activity during performance of the push-up plus with a redcord sling. J Phys Ther Sci, 2014, 26: 1275–1276. [Medline] [CrossRef]
7) Maeo S, Chou T, Yamamoto M, et al.: Muscular activities during sling- and ground-based push-up exercise. BMC Res Notes, 2014, 7: 192. [Medline] [CrossRef]
8) Jeong SY, Chung SH, Shim JH: Comparison of upper trapezius, anterior deltoid, and serratus anterior muscle activity during push-up plus exercise on Slings and a Stable Surface. J Phys Ther Sci, 2014, 26: 937–939. [Medline] [CrossRef]
9) Hardwick DH, Beebe JA, McDonnell MK, et al.: A comparison of serratus anterior muscle activation during a wall slide exercise and other traditional exercises. J Orthop Sports Phys Ther, 2006, 36: 903–910. [Medline] [CrossRef]
10) Akel I, Pekmezci M, Hayran M, et al.: Evaluation of shoulder balance in the normal adolescent population and its correlation with radiological parameters. Eur Spine J, 2008, 17: 348–354. [Medline] [CrossRef]
11) Sobush DC, Simoneau GG, Dietz KE, et al.: The lennie test for measuring scapular position in healthy young adult females: a reliability and validity study. J Orthop Sports Phys Ther, 1996, 23: 39–50. [Medline] [CrossRef]
12) Nussbaum EL, Downes L: Reliability of clinical pressure-pain algometric measurements obtained on consecutive days. Phys Ther, 1998, 78: 160–169. [Medline]
13) Choi WJ, Cynn HS, Lee CH, et al.: Shrug exercises combined with shoulder abduction improve scapular upward rotator activity and scapular alignment in subjects with scapular downward rotation impairment. J Electromyogr Kinesiol, 2015, 25: 363–370. [Medline] [CrossRef]
14) Cools AM, Witvrouw EE, Declercq GA, et al.: Evaluation of isokinetic force production and associated muscle activity in the scapular rotators during a protraction-retraction movement in overhead athletes with impingement symptoms. Br J Sports Med, 2004, 38: 64–68. [Medline] [CrossRef]
15) Van Dillen LR, McDonnell MK, Susco TM, et al.: The immediate effect of passive scapular elevation on symptoms with active neck rotation in patients with neck pain. Clin J Pain, 2007, 23: 641–647. [Medline] [CrossRef]
16) Andrade GT, Azevedo DC, De Assis Lorentz I, et al.: Influence of scapular position on cervical rotation range of motion. J Orthop Sports Phys Ther, 2008, 38: 668–673. [Medline] [CrossRef]
17) Szeto GP, Straker L, Raine S: A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. Appl Ergon, 2002, 33: 75–84. [Medline] [CrossRef]
18) Ha SM, Kwon OY, Yi CH, et al.: Effects of passive correction of scapular position on pain, proprioception, and range of motion in neck-pain patients with bilateral scapular downward-rotation syndrome. Man Ther, 2011, 16: 585–589. [Medline] [CrossRef]