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Original Article

Effect of the lumbar stability exercise on the height difference between shoulders and range of motion in older adults

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Abstract. [Purpose] The purpose of this study was to investigate the effect of the lumbar stability exercise on the range of motion (ROM) and height difference of the shoulder and to provide basic data to prevent musculoskeletal disorders for improvement of the quality of life of older adults. [Participants and Methods] Twenty older adults without musculoskeletal problems were divided into the lumbar stability exercise group and the passive upper arm exercise group and performed exercise for 30 minutes, 3 times a week for 5 weeks. The shoulder flexion, abduction, extension, and height difference between shoulders were measured. A paired t-test was applied for comparative analysis of data before and after exercise in both groups. [Results] In the lumbar stability exercise group, the shoulder flexion, abduction and height difference were significantly different. In the passive upper arm exercise group, the abduction was significantly different. [Conclusion] Since it was proved that the height difference and range of motion of shoulder are improved when the lumbar stability exercise is indirectly carried out without directly doing shoulder exercise, it is suggested that the lumbar stability exercise is strongly recommended for clinical uses to improve functions in older adults.

Key words: Lumbar stability exercise, Shoulder range of motion (ROM), Shoulder height difference

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INTRODUCTION

As the musculoskeletal system is degenerated in elderly adults, muscle atrophy occurs upon calcification of ligaments and tendons, decrease in muscle fiber size, increase in muscle collagen content and increase in fat[1)]. In addition, as degeneration progresses, all the functions and range of motion of joints are decreased, muscle weakness and chronic pain occur and reduce mobility of the body to raise dependance on medical treatment. The limits of movement or pains in the shoulder joint greatly affects every phase of one's life[2)]. Since older adults frequently suffer gastro intestinal or cardiovascular side effects and there is a concern about drug abuse and misuse, safe nonpharmacological intervention which can be applied for a long time is necessary for older adults with shoulder pains[3)]. For older adults, aerobic exercises such as walking, stair climbing, biking, playing gateball and swimming and low intensity exercises such as gymnastics for improving flexibility[4)]. Exercises for older adults should not be restricted by place, equipment or costs to continue participation in exercise and should consist of easy exercises that the elderly can follow[5)]. The lumbar stability exercise is a typical example of the exercise considering the convenience of older adults, not imposing physical or financial burden and easily carried out only with a mat or a blanket without specific exercise equipment or goods[6)]. The lumbar stability exercise can enhance muscle strength, flexibility, endurance, and correct the posture by controlling the tension of the lumbar spine, pelvis, and hip muscles that maintain spine stability,

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and has the advantage of being less limited in place, time, and cost[7]. In addition, the lumbar stability exercise is based on the theory that the activity of the muscles that form the core of the body contributes to overall stability. The lumbar stability exercise works on the segments from the basal area (the area near the proximal body) to the distal area (the area farther from the body) and gives effect through motions from small and delicate actions to various large actions[8]. In a study that identified the effects of lumbar stability exercise, it was reported that lumbar stability exercise was effective in lumbar muscle strength, lower extremity strength, and range of motion[9, 10]. The abdominal muscles composed of the external oblique, rectus abdominis, transverse abdominis, and internal oblique are particularly involved in the movement of the distal area as well as the basal area[11]. In addition, the transverse abdominis is a muscle that provides stability to the trunk by increasing the tension of the thoracolumbar fascia, which contributes to the stability of the spine and pelvis[12]. The lumbar stability exercise is an exercise method for coordinated contraction of the core and strengthening of stabilizer muscles. Especially, older adults show prominent weaking of trunk muscles compared to lower extremity muscles. It was reported that this can greatly affect the movement and balance[13]. In a previous study, 4 weeks of lumbar stability exercise was effective in improving upper extremity function, movement, balance, and motion for stroke patients[14]. It was reported that the lower back stabilization exercise of stroke patients for 8 weeks was effective in wrist, elbow and shoulder joint[15]. Although study on exercises for improving lower extremity function among the decreased physical functions of the elderly has been conducted in various and steady ways[16], study for improving upper extremity function is lacking. However, upper extremity function is also a very important factor in the daily life of the older adults and it is necessary to study on exercise program for upper extremity functions. As in the previous study, there have been many studies on the elderly with stroke. This study was conducted by applying lumbar stability exercise to the elderly without musculoskeletal diseases to improve physical functions and flexibility that decrease upon degeneration due to aging. The purpose is to investigate the effect of the lumbar stability exercise on the range of motion and height difference of the shoulder joint without doing direct shoulder exercise and to provide base data for improving the quality of life of the elderly by preventing musculoskeletal disorders.

PARTICIPANTS AND METHODS

For the participants of this study, 20 older adults over the age of 60 living in the D City and registered in N Nursing Home were selected. The willing participants were selected after being well-informed of the purpose and procedure of this study through an information session according to the ethical principles of Declaration of Helsinki. The participants were randomly divided into 10 participants of lumbar stability exercise group and 10 participants of passive upper arm exercise group. The lumbar stability exercise group consists of 6 males and 4 females with average age of 67.2 ± 3.0, average height of 167.8 ± 5.5 cm, and average weight of 52.2 ± 7.9 kg. The passive upper arm exercise group consists of 6 males and 4 females with average age of 68.1 ± 2.0, average height of 165.4 ± 6.0 cm and average weight of 54.1 ± 7.2 kg (Table 1). The participants were required to be those who could communicate, those who had not undergone shoulder surgery within the last 6 months, and those who spontaneously agreed to participate in the study[17].

The range of motion of the shoulder joint was measured and evaluated by using a digital goniometer (East Angle, Meloq AB, Stockholm, Sweden). The ranges of motion of the right shoulder joint of the participants were repeatedly measured three times for flexion, abduction and extension before and after exercise under the guidance of the therapist and then averaged. There was 30 second break between measurement. The angle between the shoulder joints was measured by aligning the shoulder peak with the center line of the humerus as the axis in an upright posture so that the spine does not bend forward or backward. In order to minimize the effect of the order of measurement, the order of joint angle measurement was randomly selected. The active joint range of motion (AROM) was measured in the range immediately before joint angle limitation occurred[18].

The shoulder height difference test was conducted by using a motion analyzer (UIN care, Seoul, Korea) and measuring in the front posture in tight clothes and shorts. It was measured 2 times before lumbar stability exercise and 5 weeks after the exercise. The measurement was conducted by screen positioning, calibration, participant information input, body marker attachment and then posture measurement in order. For the front posture measurement, the center of the body and the shoulder height difference were analyzed. In the test of height difference between both side shoulders, markers were attached to the left Acrominal processes (AC) and right acromial processes, and the height difference of the left (Lt) and right (Rt) acromial

Table 1. General characteristics of the participants

	Lumbar stability exercise group (n=10)	Passive shoulder exercise group (n=10)
Age (years)	67.2 ± 3.0	68.1 ± 2.0
Height (cm)	167.8 ± 5.5	165.4 ± 6.0
Weight (kg)	52.2 ± 7.9	54.1 ± 7.2
Body mass index (kg/m^2)	18.54 ± 5.7	19.78 ± 7.4

All values are mean ± standard deviation (SD).

processes were compared. If the right side (AC)- left side (AC) was "+", the result was Rt-Up, and if it was "−", the result was Lt-Up[19].

The beginner's course of lumbar stability exercise was modified for elder patients to perform[20]. The lumbar stability exercise group was directed guided by a therapist in the entire course. The therapist demonstrated and provided training so that the participants could fully understand, and the therapist directly corrected their mistakes and assisted them. The exercise was carried out for a total of 30 minutes, including a 10 minute intermission break, 3 times a week for 5 weeks. The exercise was performed by two patients at a time.

The passive upper arm exercise was performed by using an arm and leg exercise machine (SE-1000, Siheung, Korea). The patient was seated and did exercise by holding and rotating the pedals with both hands under the assistance of a therapist. According to the patient's condition, the resistance stage was selected from stage 1 to 10 gradually, and the total exercise time was set to 30 minutes and independently performed 3 times a week for 5 weeks.

The normality of the variables was verified by performing Shaprio–Wilks test was performed to verify, and as a result, the normality was satisfied. The paired t-test was used to compare the participants result values before and after the intervention. SPSS statistics version 20.0 was used for analysis of the collected measured values, and $p<0.05$ was set to verify the statistical significance level.

RESULTS

In the lumbar stability exercise group, the range of motion of the shoulder joint flexion was 141.3 ± 11.0° before exercise and 160.2 ± 8.9° after exercise for 5 weeks, which was significantly increased ($p<0.05$). In the passive upper arm exercise group, the ROM of shoulder joint flexion was 139.6 ± 15.2° before exercise and 141.5 ± 9.3° after 5 weeks, which was not significantly different ($p>0.05$) (Table 2).

In the lumbar stability exercise group, the range of motion of the shoulder joint abduction was 141.8 ± 22.1° before exercise and 165.5 ± 47.5° after exercise for 5 weeks, which was significantly increased ($p<0.05$). In the passive upper arm exercise group, the ROM of shoulder joint abduction was 145.5 ± 17.4° before exercise and 162.7 ± 19.1° after 5 weeks, which was significantly increased ($p<0.05$) (Table 2).

In the lumbar stability exercise group, the range of motion of the shoulder joint extension was 30.12 ± 3.1° before exercise and 31.12 ± 2.5° after exercise for 5 weeks, which was not significantly different ($p>0.05$). In the passive upper arm exercise group, the ROM of shoulder joint extension was 31.33 ± 4.4° before exercise and 31.51 ± 4.1° after 5 weeks, which was not significantly different ($p>0.05$) (Table 2).

In the lumbar stability exercise group, the shoulder height difference was 1.38 ± 0.67 before exercise and 0.75 ± 0.32 after exercise for 5 weeks, which was not significantly decreased ($p>0.05$). In the passive upper arm exercise group, the shoulder height difference was 1.25 ± 0.68 before exercise and 1.22 ± 0.13 after exercise for 5 weeks, which was not significantly different ($p>0.05$) (Table 2) (Fig. 1).

DISCUSSION

As the result of this study, the range of motion of joint was significantly increased in the lumbar stability exercise group. It is considered that this result came from the increase in the balance ability and stability of the body by keeping balance of the upper and lower body through the treatment of lumbar stability exercise which strengthens the core muscle, the part where all strength and movement occurs in the center of the human body[21]. In the group that performed the lumbar stability exercise, the ranges of motion of joint for flexion and abduction were significantly increased ($p<0.05$). This result was consistent with the results of a study that conducted lower trunk stability strengthening exercises for hemiplegic patients, showing that lower trunk stability enhancement increased the active range of motion of the upper extremity[22]. This is considered to be the

Table 2. Comparison of shoulder range of motion and height difference before and after exercise (°) (N=20)

Item	Group	Pre test	Post test
Shoulder flexion	LSE*	141.3 ± 11.0	160.2 ± 8.9
	PUE	139.6 ± 15.2	141.5 ± 9.3
Shoulder abduction	LSE*	141.8 ± 22.1	165.5 ± 47.5
	PUE*	145.5 ± 17.4	162.7 ± 19.1
Shoulder extension	LSE	30.12 ± 3.1	31.12 ± 2.5
	PUE	31.33 ± 4.4	31.51 ± 4.1
height difference	LSE*	1.38 ± 0.67	0.75 ± 0.32
	PUE	1.25 ± 0.68	1.23 ± 0.13

*$p<0.05$.
LSE: lumbar stability exercise; PUE: passive upper arm exercise.

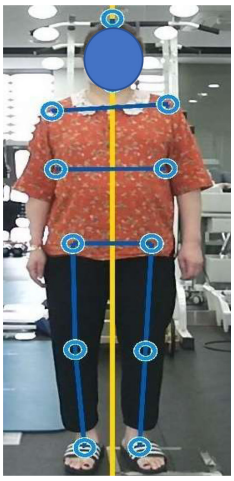

Fig. 1. Shoulder height difference.

result of the strengthening of the lumbar muscle strength which increases the shoulder joint stability and is applied to protect damaged tissued to normalizes the ROM of joint[23]. This increase in the range of motion of joint is consistent with the result of the previous study in which the lower trunk stability exercise of stroke patient has an effect on increase in the function and balance ability of the upper extremity decreased due to stroke[15], and the trunk stability exercise has an effect of improving the balance and function of the stroke patients' upper extremity[14]. It is suggested that the balance was improved by trunk stability exercise and it provides the trunk stability so that the pain and function of the upper extremity were improved. In this study, as the result of evaluating the effect of passive upper arm exercise which is generally performed in case of the limit in the range of motion of shoulder joint, only the range of motion of joint abduction was significantly increased when the ROM of joint before and after the exercise were compared. In the shoulder height difference, the lumbar stability exercise group showed a statistically significant difference as the height difference decreased ($p<0.05$), and the passive upper arm exercise group had no statistical significance ($p>0.05$). The shoulder joint is a complex structure with mobility, and static and dynamic stability are provided by the harmonious movement of the rotator cuff muscles, joint capsule, and ligaments[24]. It is related to the abnormal position of the static scapula, scapular dyskinesis which is loss of dynamic control of scapula, impingement syndrome, rotator cuff dysfunction and various shoulder disorders such as instability[25]. Lister et al.'s study[26], found that the trunk muscle strengthening exercise affects the upper, middle and lower trapezius muscles around the shoulder joint which are related to the movement of upper extremity. It is considered that the lumbar stability exercise had an effect on the range of motion and height difference of the shoulder joint by affecting the peripheral area of the shoulder joint. One of the most important changes that occur with aging is that the difficulty in maintaining attention on tasks continues to increase, and there is a limit to improving flexibility in the elderly because flexibility decreases with aging. Such decrease in flexibility, cognition and concentration due to aging is a cause of difficulty in independent and continuous participation in exercise, and thus they could not perform accurate exercise, which is considered to be the cause of lower effect in the passive upper arm exercise group. Since the participants of this study was limited to the older adults registered in some nursing homes, it was not sufficient to generalize to all the older adults and the proportion of male among all the participants was relatively high. For future research, it is necessary to correct the impact of the gender when selecting participant by considering the gender feature. In addition, although it was recommended that participants in the study not do other exercise during the study period, there was the possibility that other exercise was performed, and the drug they were taking due to a chronic disease was not controlled. Although the exercise intervention period was limited to a short period of about 5 weeks, it has significance in that lumbar stability exercise therapy and passive upper arm exercise therapy were selected as groups for comparison for 5 weeks and the effect of lumbar stability exercise was examined. Summarizing the above results, it was found that lumbar stability exercise had a positive effect by identification of the improvement in shoulder height difference and in the range of motion of the shoulder joint in the elderly. The lumbar stability exercise is recommended for clinical use to improve the function and range of motion of shoulder of the elderly in the future.

Conflict of interest

There are no conflicts of interest relevant to this article.

REFFERNCES

1) Costic RS, Jari R, Rodosky MW, et al.: Joint compression alters the kinematics and loading patterns of the intact and capsule-transected AC joint. J Orthop Res, 2003, 21: 379–385. [Medline] [CrossRef]
2) van den Dolder PA, Roberts DL: A trial into the effectiveness of soft tissue massage in the treatment of shoulder pain. Aust J Physiother, 2003, 49: 183–188. [Medline] [CrossRef]
3) Dentino A, Medina R, Steinberg E: Pain in the elderly: identification, evaluation, and management of older adults with pain complaints and pain-related symptoms. Prim Care, 2017, 44: 519–528. [Medline] [CrossRef]
4) Sung KW: Content analysis of exercise programs for the elderly in Korean and foreign articles. J Korean Acad Community Health Nurs, 2007, 18: 56–68.
5) Mikesky AE, Topp R, Wigglesworth JK, et al.: Efficacy of a home-based training program for older adults using elastic tubing. Eur J Appl Physiol Occup Physiol, 1994, 69: 316–320. [Medline] [CrossRef]
6) You YY, Kim HS: Comparing the effects on elderly women of bearing weights and lumbar stabilization using lumbar muscle exercises. J Kor Soc Phys Ther, 2010, 22: 17–23.
7) Karatas M, Cetin N, Bayramoglu M, et al.: Trunk muscle strength in relation to balance and functional disability in unihemispheric stroke patients. Am J Phys Med Rehabil, 2004, 83: 81–87. [Medline] [CrossRef]
8) Kim JS, Ju MY, Bae SS: The effect of dynamic lumbar stabilization exercise on low back pain patients. J Korean Soc Phys Ther, 2001, 13: 495–507.
9) Hwang BJ, Kim JW: Effects of lumbar stabilization exercise on lumbar and lower extremity strength of the elderly women. J Korean Soc Phys Med, 2011, 6: 267–275.
10) Jung YW, Bae SS: The effects of lumbar stabilizing exercise on the functional recovery and the range of motion of low back pain patients J Korean Soc. Phys Ther, 2004, 16: 157–182.
11) Shaghayegh Fard B, Ahmadi A, Maroufi N, et al.: Evaluation of forward head posture in sitting and standing positions. Eur Spine J, 2016, 25: 3577–3582. [Medline] [CrossRef]
12) Barry CM, Kestell G, Gillan M, et al.: Sensory nerve fibers containing calcitonin gene-related peptide in gastrocnemius, latissimus dorsi and erector spinae muscles and thoracolumbar fascia in mice. Neuroscience, 2015, 291: 106–117. [Medline] [CrossRef]
13) Hicks GE, Simonsick EM, Harris TB, et al.: Trunk muscle composition as a predictor of reduced functional capacity in the health, aging and body composition study: the moderating role of back pain. J Gerontol A Biol Sci Med Sci, 2005, 60: 1420–1424. [Medline] [CrossRef]
14) An SY: The effect of core stability exercise on function of upper extremities and activities daily of living in patients with stroke [dissertation]. Yongin: Yongin University, 2009.
15) Koh MH: The effect of core stability exercise on the paretic upper extremity function and standing balance in the patients with stroke [dissertation]. Yongin: Yongin University, 2012.
16) Lee KJ, Lee SW, Lee SW, et al.: The effect of low extremity strengthening enhanced gait mat training on unstable surface on gait parameter and low extremity strength in elderly. J Spec Edu Rehab Sci, 2011, 50: 419–435.
17) Han SH, Han MA, Ryu SY, et al.: The effects of lumbar stabilization exercise on pain and range of motion in the shoulder. Korean J Health Promot, 2015, 15: 24–30. [CrossRef]
18) Gajdosik RL, Bohannon RW: Clinical measurement of range of motion. Review of goniometry emphasizing reliability and validity. Phys Ther, 1987, 67: 1867–1872. [Medline] [CrossRef]
19) Han GS, Lee JB, Song YJ: The effect of lumbar stabilization exercise on postural balance, shoulder gradient and forward head posture in college students. Korean J Sport Sci, 2017, 26: 1081–1091. [CrossRef]
20) Brill PW: The core program, 1st ed. New York: Bantam Books, 2002.
21) Nuzzo JL, McCaulley GO, Cormie P, et al.: Trunk muscle activity during stability ball and free weight exercises. J Strength Cond Res, 2008, 22: 95–102. [Medline] [CrossRef]
22) Kim MS: The effect of upper extremity movement of a core stability strength exercise in patient with hemiplegia [dissertation]. Yongin: Yongin University, 2005.
23) Song JM, Kim SM: The effect of trunk stability exercise on balance and gait in stroke patients. J Korean Soc Phys Med, 2010, 5: 413–420.
24) Thomas SJ, Swanik KA, Swanik C, et al.: Glenohumeral rotation and scapular position adaptations after a single high school female sports season. J Athl Train, 2009, 44: 230–237. [Medline] [CrossRef]
25) Lukasiewicz AC, McClure P, Michener L, et al.: Comparison of 3-dimensional scapular position and orientation between subjects with and without shoulder impingement. J Orthop Sports Phys Ther, 1999, 29: 574–583, discussion 584–586. [Medline] [CrossRef]
26) Lister JL, Del Rossi G, Ma F, et al.: Scapular stabilizer activity during Bodyblade, cuff weights, and Thera-Band use. J Sport Rehabil, 2007, 16: 50–67. [Medline] [CrossRef]