International Journal of GEOMATE, March, 2020, Vol.18, Issue 67, pp. 188-194
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2020.67.5545
Special Issue on Science, Engineering and Environment

IMMEDIATE EFFECTS OF ARM SWING EXERCISE THERAPY ON SHOULDER RANGE OF MOTION AND FORWARD HEAD POSTURE: A PILOT STUDY IN YOUNG ADULTS

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ABSTRACT: People who work in offices for a long time tend to have poor posture and a decreased range of motion throughout the body. This could lead to chronic neck and shoulder pain if not corrected. Shuai Shou Gong, a version of Arm Swing Exercise (ASE), has been developed and practiced by some Chinese people for over one thousand years to maintain physical well-being. Its beneficial effects on posture and range of motion had not yet been verified. The purpose of this study was to preliminarily examine the immediate effects of ASE on shoulder range of motion (ROM) and occiput-wall distance (OWD) in young adults. The before-after study design was used in fifteen healthy office workers (6 males, 9 females), aged 20-40 years, who participated in the study. The shoulder ROM and OWD of the participants were measured before and immediately after a 10-minute session of supervised ASE. A paired-sample t-test was used to estimate the mean changes in the outcome. Results in this study revealed that shoulder ROM was increased in all directions ($P < 0.05$) while the OWD was decreased ($P < 0.05$) after the 10-minute session. However, a postural assessment method using a mobile application (PostureScreen) could not demonstrate a significant improvement. In conclusion, ASE have provided immediate improvements on shoulder ROM and forward head posture as indicated by a decreased OWD. Further research using a randomized controlled trial is needed.

Keywords: Arm Swing Exercise, Shoulder Range of Motion, Occiput-wall Distance, Posture

1. INTRODUCTION

Arm Swing Exercise (ASE) is a type of traditional Chinese QiGong which has been practiced by Chinese people for ages to maintain both physical and mental wellbeing. ASE first appeared in the book of Dharma Yi Jin Jing more than a thousand years ago [1]. The performance of ASE consists of a series of rhythmic arm swinging and body swaying back-and-forth, while on the fifth swing the participants slightly bend their knees and dip down twice. ASE normally lasts for 5-15 minutes depending upon the health conditions of the performers. It has been classified as a low-intensity exercise, based on approximately 23% of the maximum VO_2 and 45% of the maximum HR (HR Max) during the exercise [2]. Based on traditional Chinese medicine, ASE may facilitate the circulation of Qi, the internal energy [3], throughout the whole body, since Qi nourishes the internal organs and helps recovery from illnesses and provides positive effects for health [4].

Performing ASE training quickly and repeatedly stimulates the muscles, improves the transmission rate of nerve transmissions across synapses, improves tonic reflexes that cause the muscle to contract and increases muscular activity [5]. ASE is beneficial for increasing muscle strength and balance stability [6]. Since rapid vibration stimulates the receptors in the joints, muscles, ligaments, activation reflection, and proprioception circuit, improves the sensory function of upper limbs and promotes neuromuscular recovery [7], ASE may provide accurate coordination of space and time between sensory center and muscle proprioception [8]. Thus, it may facilitate good postural control in standing posture.

Theoretically, repeatedly swinging the arms may stimulate the nerves, tendons, and muscles surrounding the shoulder joint [9]. When the arms are swinging, the latissimus dorsi muscle and the gluteus maximus that is connected by the superficial layer of the lumbar fascia, can transfer the forces and rotate the torso [9]. In previous studies, ASE training has been shown to have a protective effect on vascular complications by improving blood glucose control and improving oxidative stress through exercise [11]. Exercise capacity and oxygen consumption in overweight and normal-weight sedentary young adults improved through ASE [11]. ASE was also found to improve the pulmonary functions in type 2 diabetes mellitus (T2DM) patients [12].

Nowadays, there is an increase in the number of people who work in offices for an extended time. This can lead to poor posture and a decreased range of motion throughout the body because of tiredness and muscle tightness resulting in chronic neck and shoulder pain. Since the effects of ASE on improving the shoulder range of motion and standing posture had not been verified, this study aimed to preliminarily examine the immediate effects of ASE on shoulder range of motion (ROM) and Occiput-Wall Distance (OWD) in office-working people. It is anticipated that ASE could increase ROM of the shoulder joints and improve forward head posture which may result in relieving muscle tightness and prevention of postural neck pain.

2. METHODOLOGY

2.1 Study Design and Participants

The study takes place after approval from the Ethical Committee of Khon Kaen University (ID: HE612355). This pilot study employed a before-after research design. Healthy people aged between 20-40 years who met the inclusion criteria were recruited. Fifteen participants (6 males, 9 females), aged 28.8 ±7.03 years, were included. Their mean height, weight, and BMI (Body Mass Index) were 162.62 ±7.08cm, 65.95±14.72 kg, 25.07 ±4.52 kg/m^2, respectively. Exclusion criteria were based on reviewing past medical records. Participants with a pre-existing medical condition with contra-indication to exercise were excluded. Before and immediately after the experimental intervention, the evaluation parameters of the young adults were investigated to explore the immediate effect of ASE on posture and the active range of motion of the shoulder joints. The whole process of the study is presented in the following flowchart (Fig. 1).

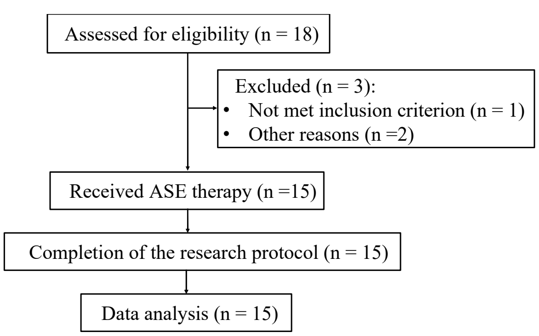

Fig.1 Flowchart of the study process

2.2 Arm Swing Exercise Intervention

The ASE training was performed in a research room with proper light and ventilation where the room temperature was set at 25°C. Participants were told to wear a suitable cotton T-shirt and shorts. The ASE protocol consisted of 3 minutes of warm-up and active stretching of the main muscle groups of the body， such as splenius capitis splenius cervicis, deltoids, triceps brachialis, and biceps. Then the participants performed a 10-minute session of ASE as guided by a prerecorded videotape. Finally, the session ended with a 3-minute cool-down. All of the procedures of ASE were guided by an exercise coach using a metronome to control the rhythm.

2.3 Arm Swing Exercise Protocol

The participants stood with their feet apart about shoulder width. The arms were actively raised to shoulder-height with comfortably straightened fingers. While their trunk and neck were kept upright, their arms swung back and forth naturally following the preset tempo of the metronome. Breathing through their nose, they breathed in during the upswing and breathed out on the downswing. Each set of ASE consisted of five arm-swings, where the action from 1 to 4 was the same (Fig. 2A). However, on the fifth swing, the participants slightly bent their knees and dipped down twice (Fig. 2B). Then they were back to the starting position. The participants were encouraged to swing their arms rhythmically in a relaxed manner [4].

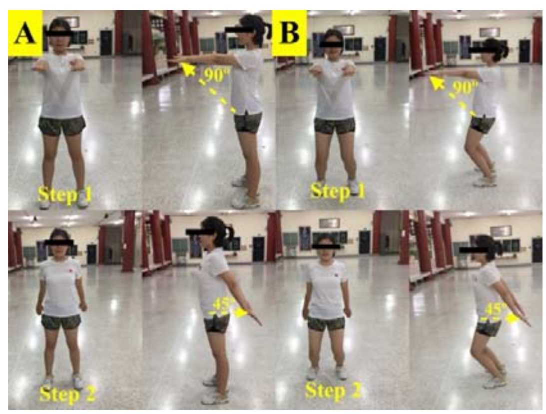

Fig.2 Single set of ASE performance consisted of the first four swings with knees extended (A) in the standing position and the fifth swing (B) with slightly bent knees.

3. OUTCOME MEASURES

3.1 Shoulder Range of Motion

Active shoulder ROM was defined as the range of motion where participants could move their shoulders to the end of each of the cardinal planes while maintaining a neutral thorax (no compensatory movement of the trunk) [13]. A standard goniometry of shoulder joint ROM was measured by a licensed physical therapist (the examiner). The examiner asked the participants to lay supine on a massage bed to measure ROM to minimize the compensatory movement of the thorax during the measurement [14]. Movements in shoulder flexion, abduction, medial (internal) rotation, lateral (external) rotation and extension were measured bilaterally [15]. The first four directions were measured in the supine lying position. Only the shoulder extension was measured when the participants were in the prone lying position. Three consecutive measurements were made in each direction, after which the average was used.

3.2 Occiput-Wall Distance

The distance between occiput and wall in standing position was measured by the examiner. OWD has been used to determine the amount of kyphotic posture [16]. The flexed posture defined by OWD is also associated with increased posterior chest convexity [16]. OWD has been widely used in epidemiological studies, although it cannot replace the clinical measures of highly accurate kyphosis deformity such as Cobb's Angle [17]. However, it could be used as a screening tool for early detection of forwarding neck posture and possible weakness of posterior neck muscles in non-disabled elderly people [18]. The examiner used a ruler to measure the distance between the protuberance of the 7th cervical spinous process and the wall as the participants stood up erect where the heels, sacrum, and upper back were positioned against the wall [19].

3.3 Posture

Posture was defined as the rotation and straight position of adjacent body segments and its direction relative to gravity [20]. The proper alignment of the body's segments so that the least amount of energy is required to maintain the desired position is the ideal posture. The whole-body posture was also observed in the current study to check whether ASE might affect it. The examiner used the PostureScreen Mobile application program to take the participants' photos in front view, right side view, back view, and left side view [21]. Through the taken photos of the standing body, the average of lateral postural displacements was determined. Previous studies had shown that this mobile application program had high reliability and validity. Inter-rater reliability was good to excellent for all translations and a range of 0.71 to 0.99 for the intra-rater reliability [18].

3.4 Heart Rate

HR was measured to monitor the exercise intensity of the participants while doing the ASE. The examiner used the Jumper JPD-500A pulse oximeter to measure the heart rate of participants. The heart rate was measured before exercise, during exercise (at the 5-minute mark), and immediately after the exercise.

3.5 Data Collection

The trained examiner measured all before and after exercise data in the laboratory where the intervention occurred in the same sequence. Data of shoulder ROM, OWD and posture were collected twice, whereas heart rate was collected three times. The average of them was taken for data analysis.

3.6 Data Analysis

SPSS 26.0 was used to process and analyze all data. Paired-sample T-test was used to compare the means of before and after the intervention. The level of significance was set at $p < 0.05$.

4. RESULTS

4.1 Shoulder ROM#

Shoulder ROM increased in all directions when participants finished 10-minutes of ASE. Based on changes from baseline to intervention, the significant improvement was shown in shoulder flexion, medial rotation, lateral rotation, and extension ($p < 0.05$) (Table 1).

Fig. 3 and 4 showed the mean shoulder flexion and shoulder medial rotation measurements presented in the box plot format. The results showed a positively skewed distribution. According to the results, there was a significant improvement in shoulder range of motion after ASE. When the arm was swinging back and forth, the arm swung forward to 90 degrees and backward to 45 degrees. Increased shoulder range of motion was achieved by repeatedly stimulating shoulder muscles and joints [33].

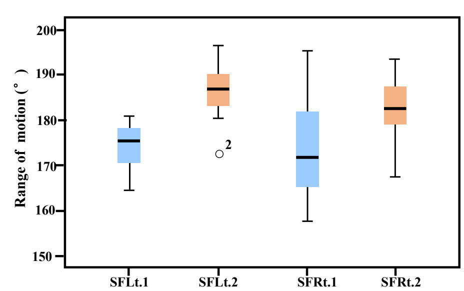

Fig.3 Shoulder flexion
Abbreviations: SFLt.1 means shoulder flexion before exercise (left); SFLt.2 means shoulder flexion after exercise (left); SFRt.1 means shoulder flexion before exercise (right); SFRt.2 means shoulder flexion after exercise (right)

Table 1. Pre-ASE and Post-ASE values of the shoulder range of motion

Shoulder range of motion (°)	Pre-ASE Mean±SD	Post-ASE Mean±SD	95% Conf. Interval	*p*-value
Left side				
Flexion	173.86±4.67	186.33± 6.44	(-16.71 to -8.21)	0.001*
Abduction	184.33±13.97	191.13±16.75	(-15.82 to 2.22)	0.129
Medial rotation	80.06±8.49	96.73±13.29	(-25.31 to -8.01)	0.001*
Lateral rotation	82.33±8.47	95.20±10.11	(-18.62 to -7.10)	0.001*
Extension	38.40± 15.22	57.86±19.85	(26.30 to -12.62)	0.001*
Right side				
Flexion	173.40±10.83	182.40±7.02	(-14.81 to -3.18)	0.001*
Abduction	181.70±12.63	195.93±14.93	(-20.99 to -7.67)	0.001*
Medial rotation	80.00±7.66	92.46±12.19	(-18.18 to -6.74)	0.001*
Lateral rotation	86.06±11.77	96.86±8.91	(-15.42 to -6.17)	0.001*
Extension	35.80±15.22	53.40±18.78	(-24.16 to -11.03)	0.001*

Note: Pre-ASE means pre-Arm Swing Exercise; Post-ASE means post-Arm Swing Exercise.
Values are means ± standard deviation, P value (2-tailed). *$P<0.05$

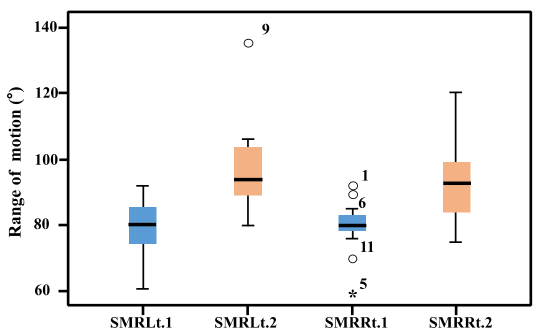

Fig.4 Shoulder Medial Rotation
Abbreviations: SMRLt.1: Shoulder Medial Rotation before exercise (left); SMRLt.2: Shoulder Medial Rotation after exercise (left); SMRRt.1: Shoulder f Medial Rotation before exercise (right); SMRRt.2: Shoulder Medial Rotation after exercise (right)

4.2 Occiput-wall distance (OWD)

The mean measurements of OWD before the ASE was 4.93±1.40 cm and after the ASE the median measurement was 3.63±1.23 cm (Fig.5). OWD was decreased by 1.30±1.00 cm after the ASE ($p<0.05$). This decrease in OWD indicated that the kyphotic posture of the participants decreased.

4.3 Heart Rate (HR)

Before ASE the mean HR was 79±11.60) beats per minute (bpm), during exercise (at the 5-minute mark) the mean HR was 93± 16.19 bpm, and after ASE, the mean HR was 103±18.81 bpm. ASE of a previous study was found as a low-moderate intensity traditional Chinese QiGong [19]. The result from the HR monitoring in the current study has confirmed that the intensity of this observed ASE was low-moderate.

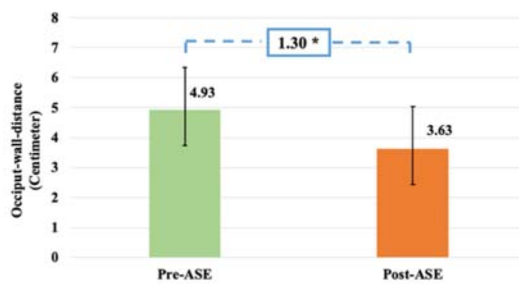

Fig.5 Occiput-wall distance between Pre-ASE and Post-ASE

4.4 Posture

Through PostureScreen analysis, average lateral postural displacements of participants were measured. The results showed no significant difference in the average lateral postural displacements of participants ($p>0.05$).

5. DISCUSSION

This study aimed to preliminarily examine the immediate effects of ASE on shoulder range of motion (ROM) and posture after a session of 10-minute of ASE. The study found that shoulder ROM increased immediately in all directions. An explanation could be that repeated movements of the shoulder joints during ASE many have actively mobilized soft tissues around the joints including muscles of the rotator cuff and shoulder girdles. Besides, ASE induced an increased local temperature of the soft tissues around the shoulder which resulted in increasing tissue extensibility when they were heated. Thus, when active ROM of the shoulder movements was performed during the measurement after the ASE, the ROM was found to have increased in all directions as a result of lower resistance than before ASE.

These results were also in line with other previous studies using different types of exercise. One study reported that regular exercise is an important factor in maintaining the shoulder range of motion of older women. Women between the ages of 50 and 71 who participated in regular exercise (twice a week) improved and/or maintained a shoulder range of motion [24]. Pilates exercises were effective in improving shoulder abduction and external rotation ROM [25]. Traditional Chinese Qigong training among breast cancer patients effectively increased shoulder muscle strength, shoulder range of motion and was associated with better functional wellbeing [26].

Clinical observation has shown that posterior shoulder tightness lead to a variety of kinematic changes, such as decreased shoulder rotation, horizontal adduction, abduction, flexion, and increased external rotation. During ASE, the posterior shoulder, acromioclavicular joints, biceps, trapezius, and deltoid were fully mobilized [33].

The results of this study also demonstrate that ASE therapy may provide immediate improvements in OWD in young adults as indicated by a significant decrease in OWD after ASE. OWD is a quick and simple method for the evaluation of kyphosis and also an effective way to assess posture [28]. Long-term ASE training in the future may improve OWD more effectively and decrease kyphotic posture.

During ASE the body was performed in an upright posture where head and shoulders move backward, chest moved forward, feet shoulder-width apart. Exercise in this posture allowed the entire core muscles to be activated. If ASE was done correctly, it improved the participant's core muscle control, effectively promoting the participant's core strength, core endurance, and it mobilized the spinal joints [29]. Therefore, ASE in the current study provided benefits to the participant's posture by a decrease in OWD. It helped activate many major core and limb muscles, for example, splenius capitis and splenius cervicis, deltoids, triceps, brachialis, biceps and core muscles, such as erector spinae, multifidus, gluteus maximus and rectus femoris [30]. Theoretically, regular training with ASE should provide the strength and endurance of these muscles as well as maintaining good posture and preventing neck pain.

A 10-minute training did not significantly improve participants' whole-body standing posture as detected by the Postural Screen application program. Probably the changes in whole-body posture have been compensated by many axial joints and core muscles. It may require long-term and regular ASE training to affect the improvement in whole-body posture. Besides, the participants in this pilot study were healthy young adults having no significant postural problems such that no changes could be observed after a single session of ASE.

A targeted exercise program (10-week trial) was found to improve posture adjustments associated with forwarding head posture [30]. The formation of human posture is a long-term development, therefore correcting a person's established posture or posture may also require a long process [32], [33]. To detect a significant change in whole-body posture, a randomized controlled trial on the effect of ASE on posture is needed in the future.

We acknowledge that our research design has some limitations. First, the physiological mechanism of ASE in this study cannot be fully explained since we did not investigate some relevant physiological effects such as muscle activities and local tissue temperature. Secondly, we employed a single group study design to preliminary explore the immediate effects of ASE on shoulder ROM and posture. The definite effects of ASE could not be known without a control group. Thus, a randomized controlled trial should be conducted to verify these effects.

6. CONCLUSIONS

Based on the results of this study, we concluded that ASE may provide immediate improvements on shoulder ROM and forward head posture as indicated by a decreased OWD. A 10-minute training did not significantly improve participants' whole-body posture. Long-term study and regular ASE training are challenged to maximize its benefits including improvement in whole-body posture. Further research using a randomized controlled trial is needed.

7. ACKNOWLEDGMENTS

We would like to thank the Faculty of Associated Medical Sciences, the research center in Back Neck and Other Joint Pain Research Group, Research and Training Center for Enhancing Quality of Life of Working-Age People and the Khon Kaen University for financially supporting this project.

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