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Research Paper: Immediate Effects of Whole Body Vibration on Rounded Shoulder Posture

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ABSTRACT

Introduction: The present study aimed to determine the immediate effects of Whole Body Vibration (WBV) on Rounded Shoulder Posture (RSP) in healthy women.

Materials and Methods: Thirty female students aged between 18 to 30 years with RSP participated in this study. First, the examiner measured the RSP (in supine position), Pectoralis Minor Length (PML) and Total Scapular Distance (TSD). Then, the subjects performed 5 sets of 1-min WBV (frequency=30 Hz, amplitude=5 mm) with 1 min rest between each set. After intervention, the examiner immediately measured the above mentioned variables. The paired t test was used for data analysis.

Results: The analysis showed that WBV significantly decreased the supine measurement of RSP (P<0.001) and TSD (P=0.03) and increased PML (P <0.001).

Conclusion: It seems that WBV had immediate effect on postural correction of rounded shoulder posture in the study subjects.

1. Introduction

The habitual slouched postural common in activities of daily living can be brought on by, or lead to, Rounded Shoulder Posture (RSP) [1], which is characterized by protracted, downwardly rotated, and anteriorly tipped scapula position. RSP has been known as a predisposing cause of upper quarter pain [2]. In RSP, shoulder is placed anterior to the plumb line and scapular position changes [3] leading to muscle imbalance, deficiency of scapulohumeral rhythm and finally shoulder impingement, bursitis, tendinitis, shoulder pain and instability [4-6]. Because of high prevalence of RSP especially in modern societies [7], proper treatment of this problem is necessary for prevention of further complications.

There are different exercise regimes for RSP such as strengthening of lengthened muscles, scapular stabilizers, stretching of shorten muscles especially pectoral muscles, and soft tissue mobilization [8].

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Whole-Body Vibration (WBV) is a new method introduced since the last decade [9]. Vibration is an oscillatory motion. WBV exercise devices render vibrations across a range of frequencies (15–60 Hz) and displacements (<1 mm to 10 mm) [9]. Nowadays, WBV devices are commercially available and typically apply low-frequency and low-amplitude vibration. Acute alteration in motor output due to WBV are most often associated with neural factors like higher sensitivity of the primary muscle spindle (Ia) afferent fibers, resulting in facilitation of homonymous alpha motor neurons. The last, in turn, may lead to more motor unit recruitment, increased firing frequency, and or improved synchronization, followed by higher background muscle activity and force (tonic vibration reflex) [10]. So far, several studies have been conducted on the effects of WBV on the strength, power, muscle flexibility, bone density, hormonal changes, joint proprioception, and postural control.

Pectoralis minor adaptive shortening has been implicated as a mechanism for RSP [11]. However, some studies have been demonstrated the positive effects of WBV on muscle flexibility [12, 13]. Also in this posture, the scapular stabilizer muscles especially middle trapezius is weak, and some studies showed that WBV can increase its strength, for example Delecluse et al. reported that WBV for 2 minutes would result in increased strength of knee extensors [14]. Another study reported the improvement of lumbosacral proprioception after one session of WBV compared to the control group [15]. Change in scapular position imposed prolonged stress on muscle and joint structure and may even damage proprioceptive muscle function [16]. It seems that WBV can be useful for treatment of this abnormal posture with its effects on joint position sense and proprioception of shoulder girdles muscles. According to the previous studies, WBV is effective on improvement of proprioception, strength and flexibility of muscles [12-15]. Also, we know that with improvement of proprioception of shoulder girdle and flexibility of pectoral muscles and stronger stabilizer muscles of scapula, it is possible to correct or improve RSP. Therefore, the present study aimed to examine the immediate effects of WBV on some parameters of RSP.

2. Materials and Methods

Study design

The present study is an interventional research with before and after design and non-probability sampling. According to the pilot study, the sample size was estimated as 26 people. However, in order to increase the power of study, 30 female students aged between 18 to 30 years were enrolled in this study. Statistical population included all female students of Rehabilitation School of Tehran University of Medical Sciences (TUMS). Participants were included if they had RSP measurement in supine position>1 inch (the distance between the posterior aspect of the acromion and the exam table) [17].

The inclusion criteria were as follows: being 18 to 30 years old, having RSP based RSP measurement in supine position, having a moderate level of physical activity, lacking any cardiovascular problem.

The exclusion criteria were as follows: being pregnant, having untreated wounds, joint or artificial limb; suffering from diseases such as diabetes, epilepsy, acute thrombosis, acute migraine, acute infectious conditions, and tumor; having history of neurological diseases like vestibular disease, stroke, kidney or bladder stones, and finally reporting history of back problems such as herniated disk and deformities like scoliosis. All the subjects were right-handed and measurements were done on their right shoulders. Prior to study participation, all subjects signed an informed consent form approved by Ethics Committee of TUMS.

Measurements

RSP was measured in supine position and then PML and TSD. Supine measurement of RSP is the distance between the posterior aspect of the lateral acromion process and the exam table in the supine position [18]. An investigator marks the posterior aspect of the lateral acromion process while the subject is in the supine position, with the shoulder in neutral position to avoid measurement variations due to humeral rotation [19]. The investigator then measures the distance from the table to the posterior aspect of the lateral acromion process by using a straight ruler and records the value in inches [20] (Figure 1).

Figure 1. Supine measurement of RSP: the distance between the posterior aspect of the lateral acromion process and the exam table

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Figure 2. Pectoralis minor length measurement between the inferomedial aspect of the coracoid process and the caudal edge of the fourth rib at the sternum

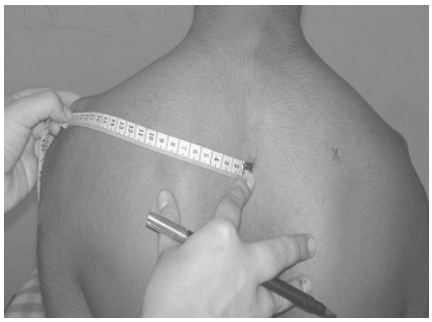

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Figure 3. Total scapular distance between the inferior angle of the acromion and the spinous process of the third thoracic vertebrae

PML is the distance from the inferomedial aspect of the coracoid process to the caudal edge of the fourth rib at the sternum [21] (Figure 2). The investigator marks the distance between the inferomedial aspect of the coracoid process and the caudal edge of the fourth rib at the sternum while the subject stands in a relaxed position [19]; then records the distance between the two marked points in inches with a tapeline [21].

TSD is the distance between the inferior angle of the acromion and the spinous process of the third thoracic vertebrae [22]. The investigator marks the distance between the inferior angle of the acromion and the spinous process of the third thoracic vertebrae while the subject stands in a relaxed position [22], and records the distance between the two marked points in inches with a tapeline. RSP, PML and TSD were measured before and immediately after the intervention (Figure 3).

Intervention protocol

The whole WBV platform used in this study was the Whole Body Vibration (Power Plate, USA). Subjects were placed in a modified push-up position [23], put their hands in the middle of the platform, shoulder width apart, elbows slightly flexed, and their lower extremities were supported by kneeling on the floor (Figure 4). Vibration protocol included 5 sets of 60 s duration, at 5 mm amplitude and 30 Hz frequency, with a rest period of 60 s between sets [24]. The subjects were reminded kneeling but upright and detached from the platform between sets.

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Figure 4. Experimental set up for vibration training in modified push up position

Data analysis

The SPSS (version 22.0) was used to conduct statistical analysis. The paired t test was done to compare differences in supine measurement of RSP, PML and TSD, before and immediately after the intervention. The P was considered as 0.05 for all data analysis.

3. Results

Table 1 presents demographic characteristics of the participants. Table 2 presents the pre-intervention and post-intervention measurements. At first, the normal distribution of variables was investigated using Kolmogorov-Smirnov test and all variables had normal distribution. In order to examine the effectiveness of WBV on RSP, the paired t test was used for data analysis. The supine measurement of RSP decreased significantly after WBV ($P<0.05$). The PML showed a significant increase after WBV ($P<0.05$). The TSD increased significantly after WBV ($P<0.05$).

4. Discussion

Based on the study results, supine measurement of RSP, PML and TSD might be immediately improved following application of five sets of 60 s of WBV (frequency=30 Hz, amplitude=5 mm). Accordingly, this study showed WBV might be effective on immediate correction of RSP.

Table 1. Demographic characteristics of the study participants (n=30)

Demographic Variable	Mean±SD	Min	Max
Age (y)	25.93±2.49	21	35
Height (cm)	161.97±4.36	154	174
Weight (kg)	57.26±6.12	48	71
BMI (kg/m^2)	21.85±2.46	18.07	27.64

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Table 2. Comparison of supine measurement of RSP, PML and TSD before and after WBV (n=30)

Variable	Mean±SD		P
	Pre-Intervention	Post-Intervention	
Supine measurement of RSP (inch)	1.72±0.2	1.55±0.23	<0.001
PML (inch)	6.19±0.35	6.39±0.34	<0.001
TSD (inch)	7.63±0.35	7.49±0.41	0.003

Abbreviations: RSP: Rounded Shoulder Posture; PML: Pectoralis Minor Length; TSD: Total Scapular Distance JMR

Several effects of WBV have been reported in various studies. Priplata et al. reported that WBV is one of the most powerful methods for stimulating proprioception, which can have long-term effects on the posture of healthy people [25]. Information about the proprioceptive system is transmitted to CNS by muscle spindles, Golgi tendon organs, and joint afferents. This study showed that applying WBV in a modified push-up position may stimulate this system in muscles and joints of the shoulder girdle, which relatively improves the supine measurement of RSP after the vibration. Also, Fontana et al. study showed that low frequency WBV in intervention group can improve significantly the lumbosacral proprioception (about 39%) compared with the control group [15].

The WBV has several mechanisms for increasing muscle strength. One of the most important mechanisms is the stimulation of sensory receptors, and especially the primary endings of muscle spindles (Ia afferent fibers). Stimulation of these receptors facilitates activation of α motor neurons, which causes muscle reflexes. This causes a tonic contraction of the muscle called the tonic reflex of the vibrations [26]. Other mechanisms, such as improving the coordination and hypothesis of muscle tuning have been discussed, too [9, 27]. Hypothesis of improved coordination states that WBV can increase the prolonged duration of maximum agonist muscle activity and decrease the activity of antagonistic muscles, which improves muscle coordination. WBV generates waves simultaneously to the muscles, which does not seem to accurately divide the muscles into distinct groups of agonists and antagonists. However, it seems possible to reduce the TSD indicating increasing the activity of the scapular stabilizer muscles and also increasing the PML may be related to the hypothesis of improving muscle coordination.

Most of the studies conducted on the effects of WBV on flexibility have focused on the lower extremity, e.g., Despina et al. compared the effects of WBV and 5 special exercises on the flexibility of lower limbs. Individuals participated in two sessions of the study; they underwent the WBV platform in the first session (frequency= 30 Hz, amplitude=2 mm), and then performed 5 special exercises in the next session. The study findings showed that WBV was able to immediately improve the flexibility of lower limbs of subjects better than the training program alone [13]. In another study by Gerodimos et al., following the immediate use of WBV, the improved limb muscle flexibility was shown in the Sit and Reach Flexibility test. The researchers also mentioned that the best effects on flexibility are usually achieved with low frequencies of 15 to 30 Hz and amplitudes of 4 to 8 mm, which is also used in the present study with a frequency of 30 Hz and amplitude of 5 mm. Therefore, it is not unlikely that increasing PML following 5 sets of 60 s WBV can be caused by improved flexibility [28].

Based on the study results, significant differences were seen in mean values of supine measurement of RSP, PML and TSD immediately after applying 5 set of 60 s

of WBV (frequency=30 Hz, amplitude=5 mm) with rest intervals of 60 s between sets, indicating improvement of these parameters. Therefore, WBV may be effective as a modality for immediate improvement of RSP.

One of the study limitations was the absence of the control group. The present study only investigated the immediate effects of WBV on RSP and further studies can accomplish on short and long term effects of WBV on RSP or another postural impairments.

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Conflict of Interest

The authors declared no conflicts of interest.

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