EFFECT OF BODY-BLADE EXERCISES ON CRANIO-VERTEBRAL ANGLE AND PAIN IN INDIVIDUALS WITH FORWARD HEAD POSTURE

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ABSTRACT

Background: Forward head posture (FHP) is one of the most common postural deviations that are usually associated with disability. This posture impairs proper biomechanical loading and, in the long run, may result in cervical spondylosis. Individuals with FHP always presents with pain and persistence of neck discomfort. Active vibration exercises using the Body-blade can produce muscle contractions by stimulation of the muscle spindles. The goal of this study was to compare between the effect of Body-blade exercises and the traditional treatment on cranio-vertebral angle (CVA) and neck pain in individuals with FHP.

Results: There was a significant increase in CVA and pain after treatment in group receiving the combined treatment (Body-blade plus traditional treatment) compared to the increase in CVA after treatment in traditional group (p= 0.017), There was a significant decrease in pain after treatment in the Body-blade group compared to the decrease in pain after treatment in traditional group (p= 0.000).

Conclusion: Adding Body-blade exercises to traditional treatment in rehabilitation of individuals with FHP will be of great value in improvement of CVA and neck pain. Keywords: Body-blade, Forward head posture, pain, active vibration

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Key words: Body-Blade, Exercises, Forward Head Posture.

I. BACKGROUND

Forward head posture (FHP) is considered one of the most common postural problems among youth and middle-aged [1] [2]. FHP is frequently observed among the general population due to the involuntary maintenance of the head in a forward head position for long time during the occupational usage of new technology as computers and smart-phones [3] [4] [5]. FHP was reported to cause musculoskeletal disorders such as upper crossed syndrome (UCS), which is associated with lordosis of the lower cervical vertebrae, in addition to kyphosis of the upper thoracic vertebrae [6] [7]. Individuals with FHP often complain of neck and shoulder pain [8].

The pain and the change in the muscle length caused by FHP decreases cervical position sense [9]. Proprioceptive afferent input from neck muscles are important in postural control. Forward head posture can reduce proprioceptive information from neck muscles and contribute to postural control problems especially in patients with neck pain [10]. FHP was described as UCS which is caused by poor sitting posture for long periods [11]. This improper posture can weaken deep neck flexors and scapular retractors such as the lower fibers of trapezius and rhomboids and decreases muscle length of the upper fibers of trapezius, levator scapulae, pectoralis major, and pectoralis...
minor [12]. Most of individuals with FHP suffer from neck pain and inability to work efficiently [13]. Also there is high incidence and maintenance of neck pain, inter-scapular pain and headache in individuals with FHP, and a great correlation was detected between FHP and disability [14] [15].

The treatment strategies to improve neck pain and forward head posture may include; electrotherapeutic modalities as transcutaneous electrical nerve stimulation (TENS), ultrasound waves, therapeutic exercises, joint mobilization exercises, and manipulation [16]. Corrective exercise was reported to be one of the interventional methods for treatment of FHP, including stretching, strengthening, and movement control exercises [17] [18]. It was reported that active vibration can increase the power and strength of the shoulder and scapular muscles [19].

Specific stimulators, vibration platforms, oscillation poles, or blades can be used to apply active vibration directly to muscles and tendons [20] [21]. Oscillation pole training, unlike other methods of vibration training, uses a low frequency of roughly 4.5 Hz, and can cause muscle contractions [22] [23] by stimulating muscles physiologically and impacting muscle spindles [24] [25]. Oscillation exercise was considered to be effective in developing the physical capacity of the shoulder, and it was also found to be useful in strengthening of the shoulder stabilizing muscles [26].

The Body-blade is a reactive dynamic tool that introduces oscillatory resistance according to the force applied to it. The points of the Body-blade start to oscillate after a few fast shakes, providing a vibratory stimulus that the muscles will resist, requiring up to 270 contractions per minute [27] [23]. Body-blade rehabilitation differs from standard resistance training, such as that with free weights, as it can be done with or without joint mobility. The Body-blade can be moved in various locations and movement patterns once it has been oscillated. Body-blade can be retained in a static position for a long time since it oscillates or dynamically moved across the various shoulder and elbow ranges of motion [28]. Although using the Body-blade is an open kinetic exercise, the resistive vibration stimulus creates resistance from the distal to the proximal body segments, facilitating proprioceptive sense through co- and eccentric contractions in a similar way to that in a closed kinetic exercise [29].

II. METHODOLOGY

This study which is a double-blinded randomized controlled trial (One examiner made the assessment, and another investigator was responsible for application of the treatment procedures, and both the investigators, and the participants were blinded) was conducted between December of 2020 and June of 2021. Forty-two adult participants, of both genders with mild to moderate FHP participated in the study. Their age was from 25 to 35 years. They all match inclusion criteria. This study was conducted at Mansheyet El Bakry General Hospital, Heliopolis, Cairo, Egypt.

Sample size calculation was based on power analysis done; calculating the effect size using change of CVA, the primary outcome of a previous study [30], using G*power software. Power set to (0.8) and significance level to (0.05).

Participants were included if they had FHP of both genders, age range from 20-35 years [31], and with CVA less than 52 degrees [32]. Individuals were excluded if they had a previous diagnosis of a musculoskeletal system disease over the last 6 months, severely unstable spine, osteoporosis or vascular disease [32] or if with cervical or shoulder neurological movement disorder [33]. The protocol of this study was approved by the ethical committee of the Faculty of Physical Therapy, Cairo University, Egypt (No: P.T.REC/012/003040). The clinical trial registration number is NCT04743427.

After inclusion in the study, every participant signed an informed consent and then, all participants were randomly assigned into two groups (control and study group) using opaque, sealed envelopes, each containing the name of one of the groups. The CVA was measured in AutoCAD 2007 after taking a photo for each participant. The pain intensity was recorded by the visual analogue scale (VAS), which was a horizontal line of 10 cm long with no pain at one end and the worst pain at the other end. All were recorded before and after the treatment.

III. PROCEDURES:

The sample were divided into two groups (twenty-one each); Study group (Body-blade) (BB) group in which participants received the traditional treatment, in addition to exercises with the Body-blade and Control group (Traditional therapy group) in which participants received the traditional treatment. Each participant will be
evaluated and tested individually before and after 6 weeks of treatment. Treatment is conducted through 3 sessions per week.

For selection:
A digital camera (Canon power shot A1200 HD) for taking photos for the participants, and measurement of CVA by AutoCAD 2007 for Forward head assessment [34], Figure (1).

For evaluation:
1. A digital camera (Canon power shot A1200 HD) for taking photos for the participants, and measurement of CVA by AutoCAD 2007 for Forward head assessment, Figure (1) [34]. A digital imaging technique was utilized to assess head and neck posture in the standing position from a sagittal view to determine FHP (Photogrammetry). A digital camera (Canon Power shot A1200 HD) was positioned on a stationary base at a distance of 1.5 meters, with no rotation or tilt. The camera's height was set to the level of the subject's shoulder [35]. To normalize the head and neck posture of subjects, a self-balanced position was adopted; each participant was requested to move his/her head and neck into full flexion and extension, then progressively lower the range of motion to stop movement and retain the head and neck in the neutral position [36]. The angle between the seventh cervical spine and the appendage tragus of the ear horizon line (CVA) was marked by the markers. AutoCAD 2007 was used to complete this task [34], Figure (1).

2. Visual Analogue Scale (VAS) for measuring pain intensity level as a secondary outcome to abnormal posture. The visual analogue scale is valid and reliable [38] [37]. The VAS is a self-reported scale which consists of horizontal line usually 10 centimeters long (100 mm) presented at the extremes by two verbal descriptors referring to the pain level [39]. Because there are no gradations on the visual analogue scale, it is thought to be more sensitive than scales with intermediate markers [40]. Participants were asked to tick the line next to the point that best described their suffering [41].

For intervention:
The treatment protocol was 18 treatment sessions (3 sessions per week) for 6 weeks for the 2 groups [30].

A- Study group (BB group):
Participants assigned to the study group (BB group) were treated with the same as in the control group, in addition to active vibration exercises by the Body-blade. The Body-blade (Classic, Mad Dogg Athletics, USA), an elastic pole exercise instrument with a length of 122 cm, a weight of 0.68 kg, and a width of 4.3 cm, is based on oscillatory/vibration motions used in training. The Body-blade works by rapidly changing directions at a low-frequency rhythm of approximately 4.5 Hz (cycles per second) [27] [23]. Rehabilitation programs using Body-blade exercise showed an effective improvement in individuals with FHP [30].

The participant gripped the rubber grip in the middle of the Blade-shaped pole and shook it, causing vibrations at both ends of the pole with a constant frequency and velocity. The participants stood with their feet shoulder-width apart and their knees slightly flexed in an anatomic posture [30].

Three exercises were performed in random order (Three sets of, 3-minute exercise and 5-minute break), i.e., each of the three exercises was performed 1 minute in each set [30].

Exercise task (I); Grabbing the center of the pole with both hands with shoulder joint flexed to 180° in overhead position and oscillation exercise in the sagittal plane [30], Figure (2).

Exercise task (II); Grabbing the center of the pole with both hands with shoulder joint flexed to 90° and oscillation exercise in the transverse plane [28], Figure (3).

The first two exercises were performed as below:
First three weeks: in upward and down ward movement to emphasize more on the flexibility of the muscles [32].
Last three weeks: sustain the vibration in each of the two certain positions to emphasize more on the strength of the muscles [30].
Exercise task (III); Grabbing the center of the pole with both hands with both of the arms behind the back and oscillation exercise in the sagittal plane, [42] Figure (4).

**B-Control group (Traditional therapy group):**

Participants assigned to the control group (Traditional training group) were treated with 20-minute hot pack, three active exercises: (a) chin tucks in supine lying with the head in contact with the floor, (b) active Standing Shoulder pull back [12], and (c) scapular plane shoulder elevation [43] (3 sets of 10 repetitions for all the 3 exercises), and a self stretch for the upper trapezius muscle; participants sat in a chair with one arm holding it, and laterally tilted their heads to the opposite side with the other hand pressing the head to maximize the lateral stretch. The participant held the stretch for (15-30 seconds) (2-4 repetitions) [44].

**IV. DATA ANALYSIS**

Unpaired T test was conducted for comparison of subject characteristics and CVA and pain between groups (Body-blade and traditional groups).

Paired t test was conducted for comparison of dependent variables (CVA and pain) before and after treatment within subjects in each group.

Unpaired t test was conducted for comparison of changes in dependent variables (CVA and pain) before and after treatment between subjects (Body-blade and traditional groups).

The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

**V. RESULTS**

1. **Comparison of the mean of Subject characteristics in both groups:**

   Table 1 showed the subject characteristics of both groups (Body-blade) (A) and traditional group (B). There was no significant difference between groups regarding age ($p=0.39$), weight ($p=0.38$) and height ($p=0.28$) (Table 1, Diagram 1).

2. **Comparison of the mean of the dependent variables between Body-blade group (A) and traditional group (B) (pretreatment):**

   There was no significant difference between groups regarding CVA and pain ($p=0.65$), ($p=0.15$), ($p=0.1$) and ($p=0.31$). (Table 2, Diagram 2).

3. **Comparison of the median values of CVA and Pain between Body-blade group (A) and traditional group (B) (posttreatment):**

   There was a significant increase in CVA and pain in both groups after treatment ($p=0.000$) (Table 3 and Diagram 3).

4. **Comparison of changes in dependent variables between group A and B:**

   There was a significant increase in CVA after treatment in Body-blade group compared to the increase in CVA after treatment in traditional group ($p=0.017$), There was a significant decrease in pain after treatment in Body-blade group compared to the decrease in pain after treatment in traditional group ($p=0.000$). (Table 4 and Diagram 4).

**VI. DISCUSSION:**

The purpose of the current study was to compare between the effects of Body-blade exercises and the traditional treatment on CVA and neck pain in individuals with forward head posture. Results showed that although pain and FHP improved in both the groups, there was a significant increase in CVA and significant decrease in VAS in the group receiving both the traditional physical therapy, and the Body-blade, in comparison with the group receiving the traditional physical therapy alone.
It was demonstrated that a shift in the cervical spine's sagittal plane alignment might cause abnormal loads and strains, accelerating degenerative changes in the muscles, ligaments, bony structures, and neural components [45], and that any treatment aiming to restore the normal cervical curve and posture will improve neck discomfort, and sense of positioning [46]. It was reported that using active vibration by Body-blade in patients with FHP can improve the CVA in patients with FHP due to its effect on the activity of the scapular stabilizer muscles, shoulder stability, proprioception and thus neck posture [30]. Also, in a recent study accomplished by Kim et al. [47], who reported that there was a significant increase in CVA in the group using the Body-blade than the control group. It becomes clear that the global muscle strengthening, proprioceptive feedback, nerve root control induced by the Body-blade exercises improved scapular stability and controlled the activity of the shoulder and scapular muscles, and so improved neck posture. Active vibration with flexi bar was found to be useful for pain reduction in low back pain patients [48], and also in a study conducted by [32], reduction of pain was obvious after using flexi bar exercises in patients with FHP. Also there was a significant reduction in the shoulder pain and disability index (SPADI) and the numeric pain rating scale (NPRS) after training with the Body-blade in individuals complaining of pain and shoulder instability [49] which support our results. On the other hand, it was reported by [50], that local vibration intervention did not affect balance, power, or self-reported pain but they explained that those results were because of the instrument used; which was a large drum that has a large contact area. So using Body-blade or flexi bar is seemed to be more effective in inducing positive changes in pain and function.

One of the main problems of patients with neck pain is that the alteration of cervical proprioception leads to the disturbance of cervical sensorimotor control [51]. Furthermore, the improper proprioceptive input can trigger the increased and prolonged reflex activation of neck muscles, which may lead to neck pain over time, thus forming a dangerous circle [52]. It was declared by [51], that most of the current studies recommend training on different aspects of sensorimotor function, particularly retraining aimed at improving proprioception and muscle coordination in the neck; It was found that, after a rehabilitation program based on eye—head coupling exercises aimed to improve proprioception in the neck, they found that the ability to reposition the head after rotation was significantly improved, and the neck pain was significantly reduced [53]. Also the same results occurred when a group of patients with neck pain used proprioceptive training [54]. In addition, the decrease in CVA and cervical flexion were considered to be important risk factors for the occurrence of pain in the cervical region [55]. So improvement of neck proprioception seems to have an important role in pain reduction and improvement of neck posture.

Vibration exercise was helpful for pain relief by stimulating the proprioceptive sense and activating nerve fibers [26]. Active vibration exercise using the Body-blade generates 4.5 Hz of strong vibration stimulus, which can reduce pain by simultaneous activity in low-threshold receptors (Aβ -fibers) and the release of the Inhibitory neurotransmitters (e.g., GABA), and thus decreases mechanical hyperalgesia [56] [57]. So it is considered that active vibration exercise using Body- blade can improve proprioception of neck, decrease load on the posterior cervical structure, stimulate nerve fibers, and thus decrease the neck pain of patients with the forward head posture.

Limitations:
Because to government curfew decisions, the size of the sample was impacted by the Corona issue, and also for personal and religious reasons, female participants refused to record their sessions on video tape for the sake of documentation. In addition, several individuals were unable to complete the treatment program due to a variety of factors and were thus removed from the study.

VII. CONCLUSION:
The active vibration stimulus such that generated by the Body-blade could significantly relieve pain and increase CVA in individuals with FHP. So, the combination of Body-blade exercises with the traditional treatment could be an effective method to improve disability and deformity caused by FHP.

REFERENCES:

www.turkjphysiotherrehabil.org


### TABLES

**Table 1:** Comparison of the mean of demographic data (age, weight and height) between group A and B:

<table>
<thead>
<tr>
<th></th>
<th>Group A Body-blade (21)</th>
<th>Group B Traditional (21)</th>
<th>MD</th>
<th>t- value</th>
<th>p- value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.33 ± 2.83</td>
<td>25.43 ± 3.57</td>
<td>-1.09</td>
<td>-1.1</td>
<td>0.39</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>76.33 ± 12.78</td>
<td>75.48 ± 11.84</td>
<td>0.86</td>
<td>0.23</td>
<td>0.38</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.33 ± 9.41</td>
<td>167.48 ± 7.34</td>
<td>3.86</td>
<td>1.48</td>
<td>0.28</td>
</tr>
</tbody>
</table>

\( \bar{x} \), Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value.

Diagram (1): Comparison of participants characteristics between groups.
Table 2: Comparison of the mean of dependent variables (pretreatment) between group A and B:

<table>
<thead>
<tr>
<th></th>
<th>Group A (Body-blade) (21)</th>
<th>Group B (Traditional) (21)</th>
<th>MD</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA (degrees)</td>
<td>43.67 ± 5.49</td>
<td>42.57±5.38</td>
<td>1.19</td>
<td>0.71</td>
<td>0.65</td>
</tr>
<tr>
<td>Pain</td>
<td>5.5 ± 1.7</td>
<td>4.6±2.3</td>
<td>0.9</td>
<td>1.44</td>
<td>0.15</td>
</tr>
</tbody>
</table>

=x, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value.

Table 3: Comparison of the mean CVA and Pain between group A and B (pretreatment and posttreatment):

<table>
<thead>
<tr>
<th></th>
<th>Group A (Body-blade) (21)</th>
<th>Group B (Traditional) (21)</th>
<th>t value</th>
<th>P value</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA (degrees)</td>
<td>43.67 ± 5.49</td>
<td>49.9±5.57</td>
<td>-12.95</td>
<td>0.000*</td>
<td>-13.89</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pain</td>
<td>5.5 ± 1.7</td>
<td>1.4 ± 1.2</td>
<td>12.95</td>
<td>0.000*</td>
<td>8.1</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

=x, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value.
Diagram (3): Comparison of the dependent variables recording (CVA and pain) before and after treatment between groups.

Table 4: Comparison of changes in dependent variables between group A and B

<table>
<thead>
<tr>
<th></th>
<th>Group A Body-blade (21)</th>
<th>Group B Traditional (21)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA (degrees)</td>
<td>6.24 ± 2.18</td>
<td>2.9±1.09</td>
<td>6.47</td>
<td>0.017*</td>
</tr>
<tr>
<td>Pain</td>
<td>-3.95 ± 1.69</td>
<td>-1.24±0.7</td>
<td>-6.81</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

ȳ, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value.

Diagram (4): Comparison of changes in dependent variables between group A and B

FIGURE HEADINGS

Figure (1): CVA measurement in AutoCAD 2007
Figure (2): Exercise task (I)
Figure (3): Exercise task (II)
Figure (4): Exercise task (III)