Effects of horizontal- and vertical-vibration exercises using a blade on the balance ability of patient with hemiplegic

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Abstract. [Purpose] This study aimed to compare the effects of horizontal-vibration with those of vertical-vibration training on the balance and gait of patients with stroke. [Subjects and Methods] A sample population of 20 subjects was randomly divided into 2 groups: the horizontal-vibration group and the vertical-vibration group. We evaluated the Berg Balance Scale (BBS) score, Timed Up-and-Go (TUG) test results, and 10-meter Walk Test (10MWT) results at 3 times points: before the training, 3 weeks after the training, and 6 weeks after the training. [Results] The BBS score, TUG test result, and 10MWT result differed significantly among the subjects in the vertical-vibration group. However, only the BBS score differed significantly among the subjects in the horizontal-vibration group. [Conclusion] The vibration training used in this study heightened the activity of the trunk muscles and improved balance ability of the patients. In particular, we recommend the vertical-vibration training because dynamic movements such as gait improved the balance ability through activation of the trunk stabilizer muscles.

Key words: Stroke, Vibration, Balance

INTRODUCTION

General problems after a stroke include weakening of the muscles strength and loss of abdominal muscle elasticity and sensation. Such problems can restrict daily activities such as maintenance of balance and gait1). In addition, balance abnormalities trigger social problems, such as falls and difficulty in the maintenance of independence.

The ultimate goal of stroke rehabilitation is to reduce the dependence on others for daily activities, and balance ability is important for the attainment of this goal2). Akuthota and Nadler3) noted that the core muscles act as a unit, similar to muscle corsets and stabilize the body, particularly the spine, regardless of the movement of the 4 extremities. These muscles also maintain postural alignment and dynamic posture equilibrium during functional activities.

Exercises using a Blade (Mad Dogg Athletics, USA) enables type I and type II muscle strengthening exercises. Such strengthening exercises enable the body to move against gravity and stabilize the deep muscles of the body, and thereby support the body and prepare it for rigorous movements. In addition, exercises using a Blade enables continuous working of the muscles, improving muscle endurance, and thereby enables long-distance movement at a high speed through improvement of the muscle strength, balance, and coordination ability4).

Many researchers have shown that the combination of vibration training and other treatments is effective for balance ability5, 6) and have applied repetitive sensation stimuli and vibration training during rehabilitation of patients with cerebral palsy and scoliosis7). However, research on the application of vibration training for the rehabilitation of patients with stroke is lacking. Therefore, this study examined the effects of vibration training on the balance and gait ability of patients with stroke.
SUBJECTS AND METHODS

Twenty patients with hemiplegia who had been diagnosed with a stroke ≥6 months before the study on the basis of the results of computed tomography or magnetic resonance imaging were enrolled in this study. The inclusion criteria were as follows: ability to understand and follow the researcher’s directions and a Mini-Mental State Examination-Korea score of ≥24 points. The purpose of the study was explained to the subjects, and their consent for participation was obtained. The subjects signed an informed consent form. This study was approved by the institutional review board of Daegu University.

The subjects, comprising 5 men and 15 women, were randomly and equally assigned to a horizontal-vibration group and a vertical-vibration group. Their average ± standard deviation age was 73.46 ± 3.94 years. Nine subjects showed left-sided paresis, whereas 11 subjects showed right-sided paresis. Their average duration since they first sustained a stroke was 18.11 ± 13.04 months. The subjects’ average height was 163.9 ± 6.11 cm, and their average weight was 57.93 ± 7.83 kg. The 2 groups did not differ significantly in terms of their general characteristics (p > 0.05).

Both the groups received basic exercise treatment 3 times per week for 6 weeks. Each training treatment comprised vibration for 10 s repeated 10 times per set for 10 sets, in total.

The Blade was used as the training tool. The Blade is frequently used to stabilize the core and may be applied for multiple types of motions. It is used to increase muscle strength, improve body stabilization, and increase muscle endurance.

The subjects in the vertical-vibration group held the Blade vertically with 1 hand and moved it to the right and left side, whereas those in the horizontal-vibration group held the Blade horizontally with 1 hand and moved it upward and downward.

For the measurement of balance, the Berg Balance Scale (BBS) score, Timed Up-and-Go test (TUG) results, and 10-meter Walk Test (10MWT) results were obtained. Each measurement was recorded at 3 times points: before the training, 3 weeks after the training, and 6 weeks after the training.

The BBS objectively evaluates the static balance ability and dynamic balance ability and may be divided into 3 areas: sitting, standing, and postural changes. It is a highly valid tool for patients with stroke. The TUG test measures functional mobility and movement ability. For this test, each subject was seated on a chair. The time taken for the subjects to stand up once signaled to do so, turn at the 3-m turning point in front of them and then sit down on the chair again, was measured. The 10MWT measures gait speed during a 10-m walk in a straight line. The 10MWT result can be used as a measure of mobility in patients with stroke, and its validity and reliability have been verified.

For the statistical analyses, PASW Statistics 18.0 for Windows was used. For within-group comparisons, repeated analysis of variance was used. An independent t-test was employed to compare the differences between the groups. The statistical significance level was set at p = 0.05.

RESULTS

The BBS measurement significantly differed among the subjects in each group (p < 0.05). The TUG test and 10MWT results significantly differed among the subjects in the vertical-vibration training (p < 0.05). At each time points, the BBS score, TUG test result, and 10MWT result did not differ significantly between the 2 groups (p > 0.05) (Table 1).

DISCUSSION

Horizontal- and vertical-vibration exercises using the Blade were performed by our study patients 3 times per week for 6 weeks. Marigold et al.8) observed that patients with hemiplegia experience a loss of sense of balance and encounter problems with postural sway, which is potentially debilitating because trunk stability plays an important role in the maintenance of balance.

Table 1. Comparison of BBS, TUG, and 10MWT

<table>
<thead>
<tr>
<th></th>
<th>0 week</th>
<th>3 weeks</th>
<th>6 weeks</th>
<th>Differences between the groups</th>
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</thead>
<tbody>
<tr>
<td><strong>BBS (score)</strong></td>
<td></td>
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<tr>
<td>Group A</td>
<td>42.7±8.07</td>
<td>47.4±6.83*</td>
<td>49.6±5.89*</td>
<td>0.53</td>
</tr>
<tr>
<td>Group B</td>
<td>44.5±6.22</td>
<td>48.9±4.82*</td>
<td>51±3.65*</td>
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<tr>
<td><strong>TUG (sec)</strong></td>
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<tr>
<td>Group A</td>
<td>23.5±9.98</td>
<td>21.1±8.63</td>
<td>20.6±8.8*</td>
<td>0.85</td>
</tr>
<tr>
<td>Group B</td>
<td>23.7±17.61</td>
<td>18.8±11.31</td>
<td>19.6±13.75</td>
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<tr>
<td><strong>10MWT (cm)</strong></td>
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<tr>
<td>Group A</td>
<td>21.3±11.02</td>
<td>18.8±8.52*</td>
<td>16.8±6.59*</td>
<td>0.9</td>
</tr>
<tr>
<td>Group B</td>
<td>19.6±12.55</td>
<td>18.4±14.29</td>
<td>17.4±13.9</td>
<td></td>
</tr>
</tbody>
</table>

Group A: vertical-vibration group; Group B: horizontal-vibration group; BBS: Berg Balance Scale; TUG: Timed Up-and-Go test; 10MWT: 10-m Walking Test
*p < 0.05
Many studies have concluded that activation of the trunk muscles improves balance\(^9,^{10}\), and in the present study, the BBS score of the subjects in both our study groups increased. Moreside et al.\(^{11}\) measured the activities of multiple trunk muscles by using electromyography while the subjects performed horizontal-vibration exercises with both the hands and vertical-vibration exercises with 1 hand. The results showed that the activities of the internal oblique abdominal muscle and external oblique abdominal muscle were the highest when the subjects performed the vertical-vibration exercises with 1 hand. In addition, a study by Daniel et al.\(^{12}\) in which the muscle activity was measured when the subjects performed horizontal and vertical exercises using the Blade while seated, found that the differences in the muscle activity according to posture were unremarkable, but the differences in the muscle activity according to the vibration direction were remarkable. During vertical-vibration exercises, the activities of the internal oblique abdominal muscle and external oblique abdominal muscle were the highest, whereas during horizontal-vibration exercises, the activity of the erector spinae muscle, latissimus dorsi muscle, and rectus abdominis muscle were the highest. These results suggest that vibration training heightens the activity of the trunk muscles and improves balance ability.

Ress et al.\(^5\) noted that vibration training was effective for the improvement of muscle strength and functional movement of the lower extremities, and Pollock\(^{13}\) observed that vibration training for 8 weeks was effective for gait improvement. In the present study, a change in the TUG test and 10MWT results was observed in the vertical-vibration group. Vertical vibration affects the adductor muscle, and the muscle of the chest, back, shoulder and hip joints, and the entire upper and lower extremities, and creates muscle stability during rotation\(^4\). Sung\(^{14}\) reported that trunk stability was achieved by anticipatory movements through pelvic movement and trunk adjustment ability. Stevens et al.\(^{15}\) observed that the external oblique abdominal muscle maintains spinal neutrality against gravity during movement. In the present study, a significant difference in all of the 3 measurements was observed in only the vertical-vibration group, and the reason for this difference may be that dynamic movement such as gait improved balance ability through activation of the trunk stabilizer muscles. The results of the present study verified that training using the Blade positively affected the subjects’ balance and gait, and thus, it can be considered an efficient treatment method to improve balance ability of patients with stroke. Further studies in a larger sample size are necessary.

REFERENCES