Effects of Core Stability Training on Postural Control Ability and Respiratory Function in Chronic Stroke Patients

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Abstract. The purpose of this study was to examine the effects of the core stability training on postural control ability and respiratory function in chronic stroke patient. Experimental group (n=15) received core stability training. Control group (n=15) received general exercise. We measured maintenance and change of posture, balance and coordination ability with postural assessment scale for stroke (PASS) and trunk impairment scale (TIS). The respiratory functions were measured forced vital capacity (FVC), forced expiratory volume at one second (FEV₁) with spirometer. After training, the PASS and TIS scores was significantly improved in experimental group (p<.05), and the experimental group showed significantly difference from control group (p<.05). In respiratory function test, experimental group more significantly increased than before (p<.05), and showed significantly difference from control group (p<.05). The results of this study showed that the core stability training may be appropriate for improving the trunk stability and respiratory function in chronic stroke patients.

Keywords: Core Stability Training, Postural Control Ability, Respiratory Function, Stroke

1 Introduction

Stroke causes blood supply problems that occur after the brain has completed normal growth and development. This disease becomes the cause of considerable morbidity and mortality worldwide [1]. In general, stroke patients experience weakening of muscles on the affected side [2]. In particular, the weakening of trunk muscles moves the center of gravity backward, thereby causing thoracic bending. As this disturbs proper postural control by reducing the activation of abdominal muscles [3], it can become the primary cause of reduced balance and gait abilities [4]. The weakening of trunk muscles in stroke patients also affects their primary and secondary respiratory muscles [5]. Therefore, it causes functional respiratory disorders which limit physical activities [6]. Damage to the motor cortex and the pyramidal tract due to a stroke leads to motor control disorders and co-contraction of trunk muscles due to abnormal
levels of muscle tension and voluntary movement. As a result, the coordination and motor performance of respiratory muscles are impaired [7]. Thus, when planning the treatment for stroke patients, tests on their postural control ability and respiratory function should be considered as important factors to evaluate their functional abilities and determine their treatment and prognosis.

Intervention programs to improve the postural control ability and respiratory function of stroke patients should focus on improving trunk stability. Trunk stability depends on coordinated activities of multiple trunk muscles, and therefore, these muscles should contract in a concerted manner to secure stability [8]. Trunk stabilization training maximizes spinal movement and stability by stretching and strengthening the trunk muscles repeatedly [9]. Verheyden et al. [10] suggested that selective trunk stabilization exercises should be added to traditional exercise therapies to improve balance after a stroke.

The purpose of this study was to evaluate the effects of trunk stabilization training, with a focus on strengthening trunk muscles, on the postural control and respiratory function of stroke patients. Then, based on the results, the study intends to support the effectiveness of trunk stabilization training for stroke patients.

2 Subjects and Methods

2.1 Subjects

The present study choose 30 subjects who consented study participation after hearing the objective of the study among those who chronic stroke patients treated the rehabilitation hospital located in Jinju city in Korea. Experimental group (EG; n=15) received core stability training for abdominal muscle strength. Control group (CG; n=15) received general exercise for increase balance ability.

Table 1. General characteristics of each group

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender (M/F)</th>
<th>Age (year)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>MMSE-K (score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG</td>
<td>10/5</td>
<td>61.45±4.56</td>
<td>64.83±11.46</td>
<td>165.73±9.64</td>
<td>27.07±3.85</td>
</tr>
<tr>
<td>CG</td>
<td>9/6</td>
<td>62.85±3.21</td>
<td>61.03±9.86</td>
<td>162.23±7.96</td>
<td>28.86±4.76</td>
</tr>
</tbody>
</table>

2.2 Training Program

The present used training program that it is based on trunk stability training program developed by Kim [11]. Each programs were performed 30 min, 4 times a week for a period of 8 weeks. Core stability training (CST) is a therapeutic program to train abdominal muscle strength. General exercise (GE) is a therapeutic program to increase balance ability and symmetry.
Table 2. Core stability training and general exercise program

<table>
<thead>
<tr>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CST</td>
</tr>
<tr>
<td>1. Abdomen retract to back (Supine, knee joint 70–90 flex) Hold 5, 10, 15, 20 sec</td>
</tr>
<tr>
<td>2. Upper part of the back lifting (Supine, knee joint 70–90 flex) Hold 5, 10, 15, 20 sec</td>
</tr>
<tr>
<td>3. Low limb elevation and rotation (Supine knee joint 70–90 flex) Hold 5, 10, 15, 20 sec</td>
</tr>
<tr>
<td>GE</td>
</tr>
<tr>
<td>1. Lateral weight shifting to affected side (Standing, Hip &amp; knee joint extend)</td>
</tr>
<tr>
<td>2. Lifting unaffected side leg on board (Standing, Hip &amp; knee joint extend)</td>
</tr>
<tr>
<td>3. Anterior and Posterior weight shifting (Standing, Hip &amp; knee joint extended)</td>
</tr>
</tbody>
</table>

2.3 Outcome Assessment

To observe postural control changes, we measured maintenance and change of posture, balance and coordination ability with postural assessment scale for stroke (PASS) and trunk impairment scale (TIS). The respiratory functions were measured forced vital capacity (FVC), forced expiratory volume at one second (FEV₁) with spirometer (micro Lab MK8 Spirometer, CareFusion 232 Ltd, UK).

2.4 Statistical Method

For the statistical analysis of this study, SPSS 12.0 ver. for window® was used. The results of all experiments were expressed as a mean and standard deviation. Independent t-test was used for the comparison between experimental group and a control group. The comparison on postural control ability and respiratory function change of value paired t-test was used for the comparative verification on pre and post of training programs in each group. If 'p' value is less than 0.05, statistical significance level was used.

3 Result

3.1 Changes of Postural Control Ability

The PASS and TIS test revealed that both group showed increased. The experimental group showed significantly different between pre and post in PASS and TIS (p<.05), and control group showed significantly different between pre and post in TIS (p<.05). The experimental group showed significantly different from control group at post in TIS (p<.01) (Table. 3).
Table 3. Changes of Postural Control Ability in each group (score)

<table>
<thead>
<tr>
<th></th>
<th>Experimental group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>PASS</td>
<td>28.93±2.02</td>
<td>32.01±1.81**</td>
</tr>
<tr>
<td>TIS</td>
<td>13.47±2.55</td>
<td>18.13±2.06*</td>
</tr>
</tbody>
</table>

All values showed mean ± SD
Test by paired t-test (‘; p<.05, **; p<.01)
Test by independent t-test (‘; p<.05, ##; p<.01)

3.2 Changes of Respiratory Function

The FVC and FEV1 test revealed that both group showed increased. The experimental group showed significantly different between pre and post in FVC and FEV1 (p<.05). The experimental group showed significantly different from control group at post in FVC and FEV1 (p<.05) (Table 4).

Table 4. Changes of Respiratory function in each group (liter)

<table>
<thead>
<tr>
<th></th>
<th>Experimental group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>FVC</td>
<td>2.01±0.29</td>
<td>2.56±0.33*</td>
</tr>
<tr>
<td>FEV1</td>
<td>1.64±0.19**</td>
<td>1.90±0.40***</td>
</tr>
</tbody>
</table>

All values showed mean ± SD
Test by paired t-test (‘; p<.05, **; p<.01)
Test by independent t-test (‘; p<.05, ##; p<.01)

4 Discussion

Recent studies have focused on the postural control ability and respiratory function of chronic stroke patients because reduction in the motor control ability of muscles involved in breathing, due to the weakening of trunk muscles on the affected side, has been known to be associated with declines in thoracic movement and strength of respiratory muscles [12]. Since the 1990s, core stabilization training has been implemented as a therapeutic intervention to reduce pain and increase abdominal and lumbar stability, particularly for patients with chronic lumbar pain. In recent years, it has been suggested as an intervention to strengthen the trunk muscles of stroke patients. Marshall and Murphy [13] reported that trunk stabilization training alleviates the imbalance of muscles necessary for postural maintenance by activating abdominal muscles and small vertebral muscles in a coordinated and simultaneous manner.

Considering these findings, this study evaluated an eight-week trunk stabilization training program as a method for strengthening the trunk muscles of chronic stroke patients intensively, and then analyzed its outcome by comparing the results with
those of a general exercise therapy program aimed at improving balance and symmetry.

The result of postural control ability test, PASS and TIS test revealed that both group showed increased. The experimental group showed significantly different from control group at post in TIS ($p<.01$). This suggests that both core stability training and general exercise therapy may have positive effects on improving the postural control ability of chronic stroke patients. Control group may have improved postural control ability by inducing balance increases through stretching the whole body and increasing symmetry. As the patients in experimental group strengthened their abdominal and lumbar muscles intensively, they were able to strengthen the trunk muscles and improve the control of selective muscle movements. As a result, this group may have shown an overall higher level of postural control ability compared to the control group. In a previous study, Verheyden [10] implemented a five-week trunk exercise program in 33 stroke patients, and reported that the test group showed a statistically significant level of improvement in postural control ability compared to the control group that received general exercise therapy. Saey et al. [14] also reported in their study that trunk exercises were more effective than general exercise therapy for stroke patients in terms of postural control ability, balance, and motor skills. Their findings support the results of this study.

The result of respiratory function test, FVC and FEV$_1$ test revealed that both group showed increased. The experimental group showed significantly different from control group at post in FVC and FEV$_1$ ($p<.05$). The above results may illustrate that core stability training also has positive effects on the respiratory function of chronic stroke patients by improving their postural control. Bach et al. [15] supported the interpretation of the results of this study by arguing that abdominal and lumbar strengthening exercises improve expiratory function and thoracic expansion, thereby increasing forced expiratory volume. Lung capacity and forced expiratory volume are closely associated with the strength of respiratory muscles.

This study showed that an eight-week core stability training program applied in chronic stroke patients had positive effects on their postural control ability and respiratory function. In particular, core stability training was demonstrated to contribute further to improving balance, postural stability, and lung capacity, compared to general exercise therapy. A comprehensive review of the above results suggests that when physical therapists aim to improve the postural control and respiratory function of chronic stroke patients, core stability training performed to strengthen trunk muscles through direct interaction with patient increases therapeutic efficiency and effects.

5 Conclusion

This study confirmed that an eight-week core stability training program was more effective than a general exercise therapy program in improving the postural control ability and respiratory function of chronic stroke patients. Therefore, the results of this study are likely to become essential information showing the effectiveness of core stability training for the rehabilitation of chronic stroke patients in clinical practice.
References