The Effects of Core Stability Exercise on the Ability of Balance in Stroke Patients

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**Purpose**
Over the last few decades, a wide range of exercises have been shown to provide hemiplegic patients a more stable and dynamic balance. Moreover, core stability exercises for hemiplegic patients after a stroke have become increasingly significant in rehabilitation units. **Method**
This study examined the therapeutic effects of the core stability exercises on the static and dynamic balance of hemiplegic patients. A total of 10 hemiplegic patients (4 males, 6 females, age ranging from 37 to 81 years) were enrolled in this study. The subjects in the experimental group participated in the core stability exercise program consisting of a total of 12 sessions 3 times per week, over a 4-week period with each exercise lasting for approximately 15 minutes. **Result**
The static and dynamic balance by the Berg Balance Scale (BBS) and Timed Up and Go (TUG), respectively, were measured before and after the core stability exercises. A Wilcoxon signed ranks test and Mann-Whitney U test were used to compare the static and dynamic balance before and after the core stability exercises in the hemiplegic patients in each group and inter-groups, respectively. **Conclusion**
The core stability exercises were relatively effective in improving the static balance; BBS. The core stability exercises were quite effective in improving the dynamic balance; TUG (p < .05). Overall, core stability exercises are believed to be an important therapeutic method in rehabilitation programs for hemiplegic patients.

**Key words**
Core Stability Exercise, Stroke Patients.

I. Introduction
Hemiplegic patients after a stroke generally suffer impairments of sensation, motion, cognition and emotion, which restricts their basic activities of daily living (Hochstenbach et al, 1996). Neurologic deficits, such as loss of muscle power and impaired balance, are associated with the walking ability (Patterson et al., 2007). Even if hemiplegic patients show some recovery in mobility, compared to healthy adults, they can show difficulties in gait, such as slow gait speed, inappropriate energy expenditure, changed gait kinematics, lack of gait endurance, and poor stability, (Von Schroeder HP et al., 1995). Balance problems commonly occur after stroke, which have been pointed out as a critical health problem in stroke patients (Forster and Young, 1995). These problems affect the activities of daily living (ADL) significantly (Loewen SC, Anderson BA, 1990). Many studies focused not on the balance disability, which is approximately the static or dynamic sitting or standing
balance, but on the weight distribution, and postural sway (Tyson et al., 2006). Understanding the potential mechanisms that underlie the ‘natural’ balance recovery is essential for making the proper interventions to improve the balance recovery after stroke (Geurts et al., 2005). Gait training is one of the most important parts in a rehabilitation setting (Mauritz, 2004), and gait reeducation is regarded as a significant physical therapy intervention for hemiplegic patients (Lennon, 2001).

II. Method

1. Participants and Period

This study included 10 patients, the experimental and control group of 5 patients each, with hemiplegia aged 37 to 81 who were hospitalized in the Daejeon rehabilitation hospital and diagnosed with stroke resulting in hemiplegia at least in the previous 3 months, and completed the following from April 5th 2010 to April 30th 2010. The inclusion criteria were as follows:

1. Gait independently
2. No orthopedic problems on the lower limb
3. No major cognitive or perceptual problems
4. No cardiovascular problems
5. No visual problems
6. The ability to understand instructions

2. Flow Diagram

Core stability exercises have been carried out 3 times per week over a 4-week period and measured mean of Berg Balance Scale (BBS) and Timed Up and Go (TUG) before and after core stability exercises. Subjects were initially recruited 12 for this study, but 2 dropped out, one voluntarily and the other for not following the instructions from the tester.

Figure 1. Flow diagram

Balance Scale (BBS) and Timed Up and Go (TUG) before and after core stability exercises. Subjects were initially recruited 12 for this study, but 2 dropped out, one voluntarily and the other for not following the instructions from the tester.
Flow diagram of the study is given in figure 1.

3. Core stability exercises

Core stability exercises were as follows: The core stability exercises consisted of a total of 12 sessions 3 times each week over a 4-week period with each exercise lasting for approximately 15 minutes.

1) Modified breathing exercise

This exercise makes the transverse abdominis activate in that the mechanical effect of TrA contraction can control the abdominal content (Goldman et al, 1987). Figure 2 and 3 shows the procedure for the core stability exercise using modified breathing exercise.

① A patient lies down on his/her back
② Relax the patient’s muscle tone on the back of the neck.
③ Maintain both knee joints at 45 degrees of flexion and spread both knees out to the width of the pelvis.
④ Put the therapist’s hands on the patient’s abdominal area and then press slightly (Abdominal breathing).
⑤ Should be careful not to move the patient’s rib cage upward during inhaling.
⑥ Make the patient lift the abdominal area during inhaling for 5 seconds
⑦ Make the patient hold on breath for 5 seconds
⑧ Make the umbilicus move down and rostrally during exhaling for 5 seconds
⑨ Have the patient practice this three of four times and then rest.
⑩ Make the therapist’s hands move onto both lower ribs (Intercostal breathing).
⑪ Make the patient’s ribs expand during inhaling and narrow during exhaling.
⑫ Have the patient practice this three of four times and then rest.

2) Core stability exercise by using a wedge

This exercise activates TrA, internal and external oblique abdominis to stabilize the lower abdominal muscle (Urquhart and Hodges, 1998). Figures 4, 5 and 6 outline the procedure of the core stability exercise using a wedge.

① A patient lies down on his/her back
② Put a wedge below patient’s knee joints to prevent com-
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Figure 6. Contraction of transverse abdominis

pensation of the lower limbs lifting during exercising on the supine position

③ Make patient’s pelvis tilt posterior to maintain the muscle tone of the lower abdominis;

④ Maintain the length of the muscle on the back of the neck but neck not to flex it in initiation as well as middle of the exercise;

⑤ Release the muscle tone of the rhomboid muscles on the medial boarder of both scapulars to reduce the retraction of the upper limbs;

⑥ Stabilize the upper chest to induce the muscle tone of the lower abdominal muscle;

⑦ Guide both upper limbs to be protracted by holding the patient’s hands;

⑧ Make the patient move upper limb anterior and posterior several times to facilitate more the lower abdominal muscles;

⑨ Make sure not to pull the patient’s upper limbs strongly probably causing subluxation of the shoulder joints;

⑩ Guide the patient to sit up by the therapist.

4. Measurements

1) The ability of static balance Berg Balance Scale (BBS)
The BBS was created for the elderly individuals to measure balance during a performance. The BBS consists of 14 tasks on a scale from 0 to 4 for each task, with 0 indicating an inability to complete the task entirely. Scores can range from 0 to 56 (Steffen TM et al, 2002).

2) The ability of dynamic balance Timed Up & Go Test (TUG)
The way to measure the TUG is that the patients stand up from an armchair then walk a distance of 3 meter, turn, get back to the armchair, and sit down. Meanwhile the tester measures the time from the start to the end. The TUG is a test for basic mobility skill for the elderly (Steffen TM et al., 2002).

3) Data Analysis
All the data was analyzed using SPSS (Statistical Package for the Social Science) Version 12.0 for Windows. For the general characteristic of the subjects a mean and a standard deviation were used. A Wilcoxon signed ranks test and Mann-Whitney U test were used to compare the effects of the ability of static and dynamic balance before and after the core stability exercise in patients with hemiplegia in each group and inter-groups respectively. The α=0.05 level of significance was used for the statistical tests.

III. Result

1. General Characteristics of Subjects
12 subjects were initially enrolled in this study. However, 2 subjects dropped out, one voluntarily and the other for not following the instructions from the tester, respectively so that the experimental and control group contained 5 patients each. The remaining 10 subjects aged 37 to 81 included 4 males

Table. 1. General characteristics of the subjects at the baseline (N=10)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Sex</th>
<th>Age (year)</th>
<th>Paretic Side</th>
<th>Lesion of Site</th>
<th>Time Since</th>
</tr>
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<tbody>
<tr>
<td>Experimental group (N=5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>F</td>
<td>61</td>
<td>Right</td>
<td>CI (Lt MCA)</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>61</td>
<td>Left</td>
<td>S-ICH</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>66</td>
<td>Right</td>
<td>CI (Lt pons)</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>81</td>
<td>Right</td>
<td>S-ICH</td>
<td>39</td>
</tr>
<tr>
<td>Control group (N=5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>51</td>
<td>Right</td>
<td>CI (Lt MCA)</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>73</td>
<td>Left</td>
<td>CI (Rt BG)</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>77</td>
<td>Right</td>
<td>Lt periventricular</td>
<td>51</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>57</td>
<td>Right</td>
<td>CI</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>56</td>
<td>Right</td>
<td>CI (Chbl)</td>
<td>39</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>37</td>
<td>Left</td>
<td>CI (Rt. pons)</td>
<td>9</td>
</tr>
</tbody>
</table>

CI: Cerebral Infarction, BG: Basal Ganglia, Cbl: Cerebellum, MCA: Middle Cerebral Artery, S-ICH: Spontaneous Intracerebral Hemorrhage

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2. The Effects of Core Stability Exercises

1) Variations of the ability of the static and dynamic balance

The experimental group showed improvement in the BBS scores from 41.60±7.66 before the core stability exercises to 44.00±5.52 after the core stability exercises. On the other hand, the scores in the control group were improved from 47.40±6.54 before the core stability exercises to 48.20±8.70 after.

The TUG score in the experimental group was reduced significantly from 27.78±14.37 before the core stability exercises to 26.34±13.75 after (p<.05). In contrast, the score in the control group was reduced from 19.48±11.83 before the core stability exercises to 18.90±11.78 after.

Table 3 lists the individual variations of the BBS and TUG before and after the core stability exercises.

IV. Discussion

Stroke survivors suffer sensory, musculoskeletal, cognitive and perceptual insults, which impede the balance (Duncan, 1994). The balance is attenuated in hemiplegic patients (Liston and Brouwer, 1996). Hemiplegic patients show twice the postural sway as age-matched people. The normal range of the limits of stability describe the theoretical cone of 8° anteriorly, 4° posteriorly and 8° laterally to either side (Nichols, 1997). Due to the mechanical benefit of TrA contraction, it is possible to control the abdominal contents, which play a role in respiration by increasing the air flow rate during expiration (Hodges, 1999). TrA arises from the iliac crest, lower six ribs and lateral raphe of the thoracolumbar fascia, and passes medially to the linea alba (Williams et al, 1989). Contractions of the horizontal fiber in the TrA reduce the abdominal diameter with increased tension in the thoracolumbar fascia and increase the pressure in the intraabdomen. TrA is the first muscle activated. This is because the onset of TrA is evoked by the CNS, which is pre-programmed prior to moving the limb. In addition, the...
TrA activates the perturbation caused by the reactive forces on the spine to control the stability of the spine in the feedforward of a predictable disturbance (Hodges, 1999).

This study examined the effects of the core stability exercise on improving the ability of balance. Twelve subjects were initially recruited but 2 dropped out, one voluntarily and the other for not following the instructions from the tester so that the experimental and control group contained 5 patients each.

A previous study reported that a biofeedback and conventional physical therapy program improved the BBS from 45.69 before performing the exercise program to 51.54 after (Geiger et al., 2001). In this study, the mean BBS score in the experimental group increased from 41.60 before the core stability exercises to 44.00 after. In contrast, the mean BBS score in the control group increased from 47.40 before the core stability exercises to 48.20 after. These results show that the core stability exercises were relatively effective in improving the static balance of hemiplegia patients. The ranges of TUG scores have been reported for various samples of elderly people. In previous studies, the mean time of the TUG was 15 seconds in people from health fairs and senior centers (Newton, 1997). In this study, the mean TUG score in the experimental group decreased from 27.78 seconds before the core stability exercises to 26.34 seconds after (p<0.5). On the other hand, the mean TUG score in the control group decreased from 19.48 seconds before the core stability exercises to 18.90 seconds. This suggests that the core stability exercises are effective in improving the dynamic balance in hemiplegic patients. However, there is no significant difference before and after interventions in BBS and TUG between the two groups. Therefore, in both tests, there is somehow better improvement than that in the control group. In particular, the results show that core stability exercises are more helpful in improving the dynamic balance. One reason why there was no significant difference between the experimental and control group in this study might have been the time since the stroke, which means that most subjects in this study were in the chronic stage, and a period of 4 weeks for the core stability exercises was not enough time to expect large difference between them.

This study focused on the effects of the core stability exercise on the ability of balance in hemiplegic patients. In addition, the subjects were just enrolled from a definite hospital in Daejon. In addition, the subjects in both groups were a small sample size of 5 subjects in each group. Moreover, core stability exercises were performed 3 days a week, and this study did not consider the effects of other treatment methods used on the other days. Hence, the results may not be due solely to the core stability exercises. Therefore, caution should be taken when generalizing the results of this study to all hemiplegic patients.

The first hypothesis in this study was that the core stability exercises, such as modified breathing exercise and exercises using a wedge that stimulate transverse abdominis, are effective in improving the static balance in hemiplegic patients. Second hypothesis was that the core stability exercises, such as modified breathing exercise and exercises using a wedge that stimulate the transverse abdominis, are effective in improving the dynamic balance in hemiplegic patients. These results highlight the need for a further consideration of core stability exercises in a physical therapy setting to improve the static and dynamic balance of hemiplegic patients.

V. Conclusion

This study was performed over one month period from the 5th of April 2010 to the 30th of April 2010 to determine the effects of the core stability exercise on improving the ability of balance. The subjects were patients with hemiplegia from a stroke and the time since stroke was more than 3 months. The changes in the ability of balance were measured after carrying out core stability exercises over a 4-week period. Core stability exercises were relatively effective in improving the ability of static balance BBS. Core stability exercises were effective in improving the ability of dynamic balance; TUG (p<.05). These results showed that the core stability exercises are effective in improving the ability of balance in patients with hemiplegia from stroke.

Reference
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