The Effects of Trunk Stabilization Exercises using a Sling on Motor Development and Balance in Infant with Development Disability

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Abstract. Recently, trunk stabilization exercise using a sling has been investigated in a number of studies. But there has been no cases applied to infants. This study was to confirm the effects of trunk stabilization using a sling exercise on motor development and balance in infant with development disability. Seventeen individuals participated in three testing session: GMFM, AIMS, ECAB. The intervention consisted of twice a week for 40 min each time in six weeks. After the intervention, motor development and balance was significant increase (p<.05). Also, when balance increased, motor maturity could be significantly improved. The sling exercise for trunk stabilization will be utilized in an effective way to improve the balance and motor development of the young infants with developmental disability. It may refer to a starting point for further study in the future.

Keywords: sling exercise, motor development, balance, development disability

1 Introduction

Cerebral palsy (CP) is a non-progressive disease including neurologic disorder or developmental disability [1]. Infants with CP had weak control of their trunk as primary damage. As a result, the secondary compensatory mechanism of other muscles occurs to maintain stability of posture [2]. Various biomechanical problems caused by compensatory mechanism make it difficult for the head and trunk to be controlled in sitting and standing, and thereby make the problem with balance ability [3]. Therefore, stability of trunk posture is considered important, it lead to the child's activity and participation restrictions [4]. To improve trunk stability of young infants with CP, the studies on the enhancement of the trunk by hippotherapy [5], horseback riding [6], Swiss ball exercise [7] have verified the effects of the therapeutic exercise. Among the intervention methods for trunk stabilization, a sling exercises is able to make easy

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trunk stability exercise, and to facilitate the control of nervous system of the limbs [8]. As a result, it can enhance deep muscles involved in stability, maintain co-contraction of trunk muscles, and thereby improve postural stability [9]. Previous study used the sling exercise was applied to CP who can walk independently in order for trunk stability, not only the balance, but also weight bearing and shift were improved [10]. Recently, many studies on sling based stability exercise have been conducted with adults, stroke patients and orthopedic patients. However, there is no case study on the application of sling exercise to young infants, and especially no study has been conducted on motor development. This study aims to investigate sling based trunk stability exercise influences the motor development and balance in infant with development disability. [11]

2 Methods

2.1 Subjects

Seventeen infants with developmental disability who were taking rehabilitation center for child development in Seoul. They were infants of the parents who understood the purpose of this study and agreed on the participation. The inclusion criteria were: 1) less than 36 months; 2) stages in which they had developmental disability prior to independent standing and walking (GMFCS III-IV). The exclusion criteria were use of respiratory apparatus three months prior to the study period, and intake of drugs for seizure and convulsion.

2.2 Outcome measure

The motor development of all subjects was measured with Gross Motor Function Measurement (GMFM) and Alberta Infant Motor Scale (AIMS), balance was measured with Early Clinical Assessment of Balance (ECAB). For gross motor function, GMFM-88 was used. Lying, rolling, sitting, crawling and kneeling were measured. For motor maturity, AIMS was used to evaluate prone (21 items), supine (9 items), sitting (12 items), and standing (16 items). For balance, ECAB was used to evaluate the items in the categories of the control of the head and trunk (36 points) and of the control in sitting and standing postures (64 points).

2.3 Procedure

As the sling equipment for training, the auxiliary device of Redcord plus Extra (Redcord mini extra, Norway) was used. Support plate was directly made (Figure 1).

Flexion-extension of the trunk, the subjects were start with sitting and kneeling posture began, keep the postures 5 seconds to maintain co-contraction of trunk muscles, and pulling motion. Lateral flexion of the trunk, they began with side-sitting posture
by supporting one side of the upper limbs and rotated the trunk to lateral flexion with the use of both arms. Rotation of the trunk, they began with small kneeling posture and extended the trunk. After that, their active pulling reaction was maintained. For balance training in sitting, they were move forward and backward to maintain equilibrium reaction of the head and trunk. Crawling posture, assistive device was attached to the trunk in order to reduce loading. The exercise performed 40 minutes per session and twice a week during six weeks. The exercise was taken in the sequence of trunk flexion-extension, lateral flexion, rotation, sitting, and crawling. The study design was approved by the Sahmyook University Institutional Review Board.

Fig. 1. Support plate

2.4 Data analysis

All statistical analyses were performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Data are presented as the mean and standard deviation as indicated in the text and tables. The general characteristics of the subjects were evaluated using descriptive statistics, and the Shapiro-Wilk test was used to assess the normal distribution. To look into the correlation between motor development function and balance, Pearson's correlation coefficient was used. The significance level was p<0.5.

3 Results

Seventeen infants (average age 17.71 years) participated in this study. The characteristics of the subjects are presented in Table 1.

Scores for dimension of the GMFM, AIMS was significantly increased (p<0.05) (Table 2). Balance was also significantly improved (p<0.05) (Table 2). And GMFM and AIMS had definitely positive correlation with each other (r=0.541, p<0.05) (Table 3).
### Table 1. Baseline demographic characteristics of subjects

<table>
<thead>
<tr>
<th>Trunk stabilization exercises with sling (n=17)</th>
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</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>17.71</td>
<td>±1.00</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>9.46</td>
<td>±1.79</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>75.89</td>
<td>±8.16</td>
</tr>
<tr>
<td>GMFCS (score)</td>
<td>III(8)/IV(7)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Values are presented as mean ± SD. GMFCS = gross motor function classification system.

### Table 2. Change of motor development, motor maturity, and balance

<table>
<thead>
<tr>
<th>Motor development</th>
<th>Trunk stabilization exercises with sling (n=17)</th>
<th>t(p)</th>
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</thead>
<tbody>
<tr>
<td>GMFM(score)</td>
<td>Pre-test: 101.00 ± 15.80</td>
<td></td>
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<tr>
<td></td>
<td>Post-test: 141.77 ± 18.77</td>
<td></td>
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<tr>
<td></td>
<td>Changes: 40.76 ± 10.23</td>
<td>16.437(.000)</td>
</tr>
<tr>
<td>AIMS(score)</td>
<td>Pre-test: 35.18 ± 4.41</td>
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<tr>
<td></td>
<td>Post-test: 44.77 ± 5.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Changes: 9.59 ± 2.74</td>
<td>14.428(.000)</td>
</tr>
<tr>
<td>ECAB(score)</td>
<td>Pre-test: 24.74 ± 4.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-test: 34.41 ± 4.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Changes: 9.68 ± 2.90</td>
<td>13.762(.000)</td>
</tr>
</tbody>
</table>

Note. Values are presented as mean ± SD. GMFM = gross motor function measurement. AIMS = Alberta infant motor scale, ECAB = early clinical assessment of balance.

### Table 3. Correlation between motor development and balance

<table>
<thead>
<tr>
<th></th>
<th>GMFM</th>
<th>AIMS</th>
<th>ECAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMFM</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIMS</td>
<td>.541*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ECAB</td>
<td>.417</td>
<td>.553*</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. GMFM = gross motor function measurement. AIMS = Alberta infant motor scale, ECAB = early clinical assessment of balance.

*p<.05.
4 Discussion

The goal of a rehabilitation program for infants with CP is often based on an ability to regain neuromuscular control of the trunk stability. In this study, trunk stabilization had significant effect on gross motor function (p< .05). In particular, the item B (sitting) and C (crawling and kneeling) were higher than in others. The results supported our hypothesis that performing the closed-kinetic chain was improved stability of proximal area and the support ability of limbs to maintain righting reaction and protective extension reaction. Moreover, the co-contraction of agonist and antagonists has been facilitated joint stability and proprioceptive sense, and then improved gross motor function. Motor maturity was also significant improved (p< .05), in particular sitting and standing posture. Generally, sling based trunk stability exercise activated deep muscles through sensory-motor training necessary for keeping joint stability, and thereby increased motor maturity [12], which is consistent with the present study's results. In this study, the balance was significantly improved (p< .05). In particular, in the category 1 (neck and trunk) was posture control in sitting and standing. Sling based trunk stability exercise on unstable surface may result in functional improvement and increased stability, and it may stimulate proprioceptive sense input in neurological terms. By using such measurement tools as AIMS and ECAB through the universal GMFM, it was possible to make early evaluations of young infants and find the applicability of the qualitative analysis. It is difficult to generalize the study results in the points that there is no previous study on development and that this study didn’t analyze the effectiveness in comparison with control group. Nevertheless, many studies have been conducted on the effect of sling based trunk stabilization exercise, there was no case of applying it to young infants in previous studies.

5 Conclusions

The results of present studies demonstrated the effectiveness and the importance of sling including trunk stabilization exercise. It is expected that effective method to improve the motor development and balance ability of young infants with developmental disability. This study is meaningful and is considered to be the start point of future research.

References