THE EFFECTS OF MUSCLE TRAINING ON GAIT CHARACTERISTICS IN CHILDREN WITH DOWN SYNDROME

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INTRODUCTION

Patients with Down syndrome are characterized by a unique facial profile and medical complications such as heart problems, leukemia, obesity, and impaired kinesthesia. Specifically, excessive joint flexibility and weak muscles require special attention. Weak muscles cause flat-footed contact with no heel-strike, excessive abduction of the leg in the swing phase of the gait, and abnormal knee and hip flexion throughout the gait cycle (Parker, et al., 1986). Previous studies have reported increased muscle strength as a result of strength training in Down syndrome patients (Sayers, et al., 1996; Weber & French, 1988). It was suggested that training programs with exercises designed to strengthen the muscles in relatively short period time should improve the efficiency of the locomotion system (Neuman, et al., 1989). The purpose of this study was to investigate the effects of an 8-week muscle training program on the muscular fitness and gait characteristics in children with Down syndrome.

METHODS

Eight Korean male Down syndrome children (age: 12.0 ± 0.9 yrs; height: 134.9 ± 9.7 cm; mass: 34.4 ± 8.4 kg) with no history of heart problems participated in this study. Informed consents were obtained prior to the pre-test with the approvals of the primary care physicians. In both pre- and post-tests, the peak torque, work, and the average power of the knee flexors and extensors were measured using a Cybex 770 Isokinetic System at two different angular velocities: 60 deg/s and 180 deg/s. All isokinetic data were normalized to the body mass. Three-dimensional motion analyses were performed to obtain the maximum medio-lateral and vertical sway of the body center of mass (CM), toe-out, and the ankle, knee, and hip joint angles before and after the training. An AMTI force plate was used to measure the vertical and anteroposterior ground reaction forces simultaneously.

The muscle training program was composed of four leg exercises (squat, leg curl, leg extension, and toe raise) and two abdominal and back muscle exercises (sit-up and toe-raise), 3 sessions a week, 3 sets of 10-15 RM per session, for 8 weeks. The load was gradually increased, by 5 % at a time, to keep it within the 10-15 RM range. Sit-up and the hyperextension exercise were repeated until the onset of the fatigue (3 sets). The order of the exercises was randomly arranged to prevent excessive build-up of fatigue in a particular muscle group.

Repeated-measure ANOVAs were performed to see the changes in the dependent variables \((\alpha = .05)\).

RESULTS AND DISCUSSION

All isokinetic variables (the peak torque, work, and the mean power) showed significant
increases (p < .05) in response to the training (Table 1). The medio-lateral CM oscillation decreased significantly showing more stable gait. The post-test ML CM sway values were similar to that of the normal gait (5 cm). Toe-out revealed a significant decrease with the feet placed closer to the gait progression line with decreased external rotation (Table 2). The knee joint angle decreased significantly throughout the gait cycle, showing more flexed positions after the training (Table 2). The hip joint angle showed a significant decrease at foot-strike, meaning a more extended position.

The ground reaction force pattern was characterized by a wide spectrum of individual differences. In some participants, however, post-training vertical force patterns similar to the normal pattern were observed.

**SUMMARY**

The outcome of the 8-week muscle training program were:

1) increased muscle torque, work, and power,
2) increased postural stability with smaller medio-lateral sway of the body CM and less toe-out during the gait cycle, and
3) more upright body posture with increased hip joint angle and decreased knee joint angle.

**REFERENCES**


**TABLE 1:** Summary of the changes in the isokinetic data (Mean ± SD; p < .05).

<table>
<thead>
<tr>
<th></th>
<th>Peak Torque (N·m)</th>
<th>Work (J)</th>
<th>Mean Power (W/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flexor</td>
<td>Extensor</td>
<td>Flexor</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>9.1±11.5</td>
<td>30.9±13.1</td>
<td>4.8±2.8</td>
</tr>
<tr>
<td>Post-Test</td>
<td>18.0±7.9</td>
<td>38.6±9.9</td>
<td>14.0±10.7</td>
</tr>
</tbody>
</table>

**TABLE 2:** Summary of the changes in the kinematic data (Mean ± SD; p < .05).

<table>
<thead>
<tr>
<th></th>
<th>M-L CM Sway (cm)</th>
<th>Toe-out at Foot-strike (deg)</th>
<th>Knee Angle at Foot-strike (deg)</th>
<th>Knee Angle at Toe-off (deg)</th>
<th>Hip Angle at Foot-Strike (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>12.8±4.3</td>
<td>8.0±8.2</td>
<td>159.0±4.6</td>
<td>137.7±6.4</td>
<td>153.2±4.0</td>
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<tr>
<td>Post-Test</td>
<td>3.6±1.4</td>
<td>1.4±6.3</td>
<td>155.8±4.4</td>
<td>129.4±7.0</td>
<td>146.7±7.1</td>
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</tbody>
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