Effects of Oral-Motor Exercise on Tongue Strength and Dysarthria

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INTRODUCTION

Parkinson’s disease (PD): idiopathic, degenerative, neurological Abbruzzese et al. (2009) due to a loss of dopaminergic neurons in the substantia nigra. The motor symptoms, include bradykinesia, resting tremor, and muscle rigidity.

Exercise has been found to improve function and counteract the degenerative nature of PD (Carroll, 1992).

Potential benefits of exercise on swallowing and speech intelligibility in individuals with PD (Robbins et al., 2008; Sapir, Spielman, Ramig, Story, & Fox, 2007).

Oral-motor exercises have been found useful in improving tongue strength, mass, and swallowing ability and quality of life (Robbins et al., 2005; Robbins et al., 2008)

Unfortunately, minimal research objectively documents the effects of oral-motor exercise on tongue strength and clinical markers of dysarthria in individuals with PD.
PURPOSE OF THE INVESTIGATION AND HYPOTHESIS

To determine the effects of a structured oral-motor exercise program using the *Ora-Light System* (Kapitex Healthcare, 2004) on tongue strength and dysarthria in individuals with PD.

Hypothesis:

Oral-motor exercises based on principles of motor learning and neural plasticity will increase tongue strength and function.

These increases will improve tongue strength measurements and decrease severity scores on a standardized assessment of dysarthria in individuals with PD.
EXPERIMENTAL DESIGN, SETTING, AND PARTICIPANTS

Design:  Pre-test/post-test experimental design

Setting:  All intervention and assessment sessions were conducted at a nursing home, an assisted living facility, and Illinois State University’s Speech and Hearing Clinic

Participants:  7 (4 males, 3 females), ages ranged from 54-92 years.

• Using medical records, observations, and 5-point severity scale developed by Hoehn and Yahr (1967) for determining stages of PD, it was determined that 5 of the participants were in the advanced or late stage of PD (Stage 5), and 2 participants were classified as Stage 4.

All participants displayed two or more of the following symptoms of PD: bradykinesia, resting tremor, muscle rigidity, hypokinetic speech, decreased vocal intensity/volume, masked facies, reported difficulty swallowing, and poor muscle strength.
INDEPENDENT VARIABLE

- The *Ora-Light System* (Kapitex Healthcare, 2004) is a structured oral-motor exercise system.

- Designed to strengthen the musculature of the tongue, lips, and cheeks to facilitate neuromuscular coordination and competency for speech and swallowing.

- The exercise tools have activating shapes and textures on the handle and palatal portions to provide increased sensory feedback.

- Standardized protocol was used as described in the manual that accompanied the tools.
INDEPENDENT AND DEPENDENT VARIABLES

**Independent:**

*Ora-Light oral-motor exercise system* (Kapitex Healthcare, 2004) implemented 2 days per week, 30 minutes per day for 12 weeks.

**Dependent:**

Pre- and Post-Intervention assessments:
- Measurements of tongue strength using the Iowa Oral Performance Instrument (IOPI) (Luschei, 2008)
RESULTS

• Because of the small number of participants in the sample, non-parametric analysis of data was used.

• The Wilcoxon signed-rank test was used to determine significance levels of pre and post-test scores for individual subtests of the FDA-2 (7 sub-sections-Reflex, Respiration, Lips, Palate, Laryngeal, Tongue, and Intelligibility-with 26 sub-tests) and the IOPI™ assessments.

• The Wilcoxon signed-rank test is a non-parametric, statistical hypothesis test used to compare repeated measurements on a single sample.
### FDA-2 Means and p-values

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pre-test mean</th>
<th>Post-test mean</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>4.43</td>
<td>5.86</td>
<td>.102</td>
</tr>
<tr>
<td>Swallow</td>
<td>5.14</td>
<td>7.14</td>
<td>.084</td>
</tr>
<tr>
<td>Drool</td>
<td>5.86</td>
<td>6.57</td>
<td>.492</td>
</tr>
<tr>
<td>Respiration at rest</td>
<td>7.00</td>
<td>7.14</td>
<td>.705</td>
</tr>
<tr>
<td>Respiration in speech</td>
<td>3.57</td>
<td>5.29</td>
<td>.078</td>
</tr>
<tr>
<td>Lips at rest</td>
<td>7.29</td>
<td>8.00</td>
<td>.180</td>
</tr>
<tr>
<td>Lips spread</td>
<td>5.29</td>
<td>7.71</td>
<td>.131</td>
</tr>
<tr>
<td>Lips seal</td>
<td>3.14</td>
<td>7.29</td>
<td>.027*</td>
</tr>
<tr>
<td>Lips alternate</td>
<td>3.57</td>
<td>6.43</td>
<td>.041*</td>
</tr>
<tr>
<td>Lips in speech</td>
<td>5.43</td>
<td>6.86</td>
<td>.102</td>
</tr>
<tr>
<td>Palate fluids</td>
<td>6.71</td>
<td>8.00</td>
<td>.180</td>
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<tr>
<td>Palate maintenance</td>
<td>4.86</td>
<td>7.14</td>
<td>.043*</td>
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<tr>
<td>Palate in speech</td>
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<td>7.14</td>
<td>.024*</td>
</tr>
<tr>
<td>Larynx time</td>
<td>3.71</td>
<td>6.57</td>
<td>.041*</td>
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<tr>
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<tr>
<td>Larynx volume</td>
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<td>6.00</td>
<td>.026*</td>
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<tr>
<td>Larynx speech</td>
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<td>.194</td>
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<tr>
<td>Tongue at rest</td>
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<td>6.57</td>
<td>.083</td>
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<tr>
<td>Tongue protrusion</td>
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<tr>
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<td>.059</td>
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<tr>
<td>Tongue lateral</td>
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<tr>
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<td>.109</td>
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<tr>
<td>Tongue in speech</td>
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<td>6.29</td>
<td>.059</td>
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<tr>
<td>Intelligibility: words</td>
<td>3.14</td>
<td>6.86</td>
<td>.046*</td>
</tr>
<tr>
<td>Intelligibility: sentences</td>
<td>3.71</td>
<td>6.71</td>
<td>.025*</td>
</tr>
<tr>
<td>Intelligibility: conversation</td>
<td>4.43</td>
<td>6.00</td>
<td>.039*</td>
</tr>
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</table>
**IOWA ORAL PRESSURE INSTRUMENT MEANS AND P-VALUE**

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>p-value</th>
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<tr>
<td>IOPI tongue strength</td>
<td>14.29</td>
<td>27.71</td>
<td>.028*</td>
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<tr>
<td>measurement</td>
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</table>

Note:*Significant at the p<0.05 level
DISCUSSION

Lips:

• Two subtests involving the lips (alternate movements and seal) evidenced statistically significant gains. According to the literature, weakness in the lips has been specifically documented for individuals with PD (Netsell, Daniel, & Celesia, 1975).

• Lip movements are commonly involved in both speech and swallowing, but the effects of these increases are not known.

Velum:

• Significant gains were documented for both the maintenance of the soft palate, and the function of the soft palate during speech as measured subjectively by velar elevation during phonation on the FDA-2.

• Although there was not a tool or exercise using the Ora-Light Oral-Motor Exercise System© (Kapitex Healthcare, 2004) that was specifically designed to strengthen the soft palate via direct physical contact or specific resistance tasks, the speech tasks completed during the intervention may have indirectly stimulated the soft palate by requiring loud production of high pressure sounds /p^, t^, and k^/. 
DISCUSSION

Voice:

• A significant improvement was measured in the ability of participants to sustain phonation and increase perceived laryngeal loudness. This may have been due to the instruction that the researchers gave to participants, which was to give their best effort during all exercises, use their loudest voice possible for consonant-vowel productions.

• The increased effort during vocal productions may have led to improvements in these areas.

Speech Intelligibility:

• Significant improvements were documented in perceived speech intelligibility during single word, sentence, and connected conversational speech tasks.

• The improvements in intelligibility following the Ora-Light Oral-Motor Exercise System® intervention may indicate a need for further research between oral-motor exercise and speech intelligibility in patients with PD. What is not known, unfortunately, is whether the noted gains in intelligibility were related to improvements in articulation, vocal loudness or clarity, or some other factor related to speech intelligibility.
DISCUSSION

Tongue Strength:

• Participants also exhibited an increase in overall tongue strength as measured by the IOPI™ (Blaise Medical) following the intervention.

• This is promising as previous research (Nagaya et al., 2000) has reported improvements in swallowing following an oral-motor exercise program aimed at strengthening the tongue.

• Robbins et al. (2005) also found that lingual exercises aimed at increasing pressure generation can aid in restoring lingual mass and strength in healthy adults exhibiting age-related declines.

Further research documenting specific speech and swallowing outcomes related to increased tongue strength is needed.
APPLICATION OF PRINCIPLES OF NEURAL PLASTICITY AND MOTOR LEARNING THEORY

• Results of this investigation appear to be in agreement with recent theories of neural plasticity (Clark, 2003; Kleim & Jones, 2008; Robbins et al., 2008) that indicate that the human brain constantly changes its neural circuitry to adapt to new experiences and allow functional changes to occur.

• Thus, individuals with neurological impairments such as PD may benefit from exercise because of the potential for neural plasticity in the brain.


