Author Disclosures

Dr. Karen Hegland

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Dr. Michelle Troche

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Seth Dornisch

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Oropharyngeal swallowing in the Parkinsonian syndromes: a retrospective description and comparison

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Introduction and study aims
“Parkinsonian Syndromes”

- Ideopathic Parkinson’s disease (PD)
- Progressive supranuclear palsy (PSP)
- Multiple system atrophy (MSA)
  - Parkinsonian subtype (MSA-P), Cerebellar subtype (MSA-C), autonomic subtype (MSA-A)
- Corticobasal degeneration (CBD)

- “Atypical Parkinsonisms” or “Parkinson-plus syndromes/diseases”
  - PSP, MSA, CBD
  - Also includes dementia with Lewy bodies, but not in current study
Parkinsonian Syndromes

- Related but distinct neurodegenerative diseases
  - Clinically
    - Signs and symptoms
  - Pathophysiologically
    - Differences in type, rate, and regions of neurodegeneration
- Dysphagia is a well known sequela of these diseases
  - BUT Lacking information on:
    - Specific dysphagic characteristics
    - Comparison of severity of swallowing across the disease types

E.g., Healy, 2011; Litvan, 2005; Wenning, Gregor, & Fanciulli, 2013; Franciulli & Wenning, 2015
<table>
<thead>
<tr>
<th>Disease</th>
<th>Oral Phase</th>
<th>Pharyngeal Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>• Poor bolus control</td>
<td>• Delayed initiation of pharyngeal swallow</td>
</tr>
<tr>
<td></td>
<td>• Posterior pre-swallow spillage</td>
<td>• Incomplete PES opening</td>
</tr>
<tr>
<td></td>
<td>• Repetitive tongue pumping</td>
<td>• Post-swallow residue in valleculae and pyriform sinuses</td>
</tr>
<tr>
<td></td>
<td>• Post-swallow residue</td>
<td></td>
</tr>
<tr>
<td>PSP</td>
<td>• Uncoordinated lingual movements</td>
<td>• Delayed initiation of pharyngeal swallow</td>
</tr>
<tr>
<td></td>
<td>• Posterior pre-swallow spillage</td>
<td>• Reduced base of tongue retraction</td>
</tr>
<tr>
<td></td>
<td>• Prolonged mastication and transfer of bolus</td>
<td>• Post-swallow residue in valleculae and pyriform sinuses</td>
</tr>
<tr>
<td>MSA</td>
<td>• Delayed oral transport</td>
<td>• Reduced base of tongue retraction</td>
</tr>
<tr>
<td></td>
<td>• Compromised bolus hold</td>
<td>• Reduced speed of hyolaryngeal excursion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Incomplete PES relaxation</td>
</tr>
<tr>
<td>CBD</td>
<td>• Excessive lingual gestures</td>
<td>• Delayed initiation of pharyngeal swallow</td>
</tr>
<tr>
<td></td>
<td>• Impaired bolus transport</td>
<td>• Post-swallow residue in valleculae and pyriform sinuses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Penetration of laryngeal vestibule</td>
</tr>
</tbody>
</table>

Higo, Nito, & Tayama, 2005; Higo, Tayama, Nitou, Watanabe, & Ugawa, 2003; Higo, Tayama, Watanabe, Nitou, & Takeuchi, 2003; Johnston et al., 1997; Litvan, Sastry, & Sonies, 1997; Muller et al., 2001; Frattali & Sonies, 2000
Study Aim 1: To determine the characteristics of oropharyngeal swallowing dysfunction and pathophysiology in PD, PSP, MSA, and CBD

**Hypothesis:** There will be distinct characteristic patterns of swallowing dysfunction for each of the diseases.

- **PD** will exhibit a disproportionate degree of bradykinesia in oral bolus manipulation and delay in initiation of oropharyngeal bolus transport.
- **PSP** and **MSA-P** will exhibit disproportionate frequency of laryngeal penetration and degree of oropharyngeal residue.
- **MSA-C** will exhibit a disproportionate degree of discoordination during oral phase manipulation and lingual transfer.
- **CBD** will show greatest impairments in volitional swallow components due to cortical involvement, but be more varied in type of swallowing dysfunction demonstrated than other groups.
Study Aim 2: To determine whether the severity of oropharyngeal swallowing deficits vary between disease groups when matched for disease duration

Hypothesis: The severity of swallowing deficits, as scored with current standardized and established traditional measures, will vary according to disease type when patients are matched for disease duration.
Methods
Participant Selection

- Retrospective query of electronic medical records

- Inclusion criteria
  - MBSS
  - “probable” diagnosis confidence for PD, PSP, MSA, CBD

- Exclusion criteria
  - Hx of other neurologic disorders, head and neck cancer, chronic pulmonary disease, severe psychological disturbance

- Patients matched across groups for disease duration at time of swallow study
Patients with MBSS at UF CMDNR between Feb. 2011 and July 2015

N = 755

Patients excluded without at least a differential diagnosis of PSP, MSA, or CBD

N = 103

Patients excluded with a diagnostic confidence less than probable

N = 72

- PSP 38
- MSA 21
- CBD 13

Patients excluded with missing MBSS videofluoroscopic recording

- PSP 34
- MSA 18
- CBD 11

PSP patients excluded who did not contribute best to group matching. PD patients selected using criteria above and for best group matching

PD 18  PSP 20  MSA 18  CBD 11
Outcome Measures

- MBSS videofluoroscopic files were analyzed using three tools

1. Penetration-Aspiration Scale (PAS)
   - Rosenbek et al., 1996

2. Modified Barium Swallowing Impairment Profile (MBSImP)
   - (Martin-Harris et al., 2008)

3. Swallow timing measures
   - (Kendall et al., 2000)
Penetration-Aspiration Scale

1. Material does not enter airway

2. Material enters the airway, remains above the vocal folds, and is ejected from the airway.

3. Material enters the airway, remains above the vocal folds, and is not ejected from the airway.

4. Material enters the airway, contacts the vocal folds, and is ejected from the airway.

5. Material enters the airway, contacts the vocal folds, and is not ejected from the airway.

6. Material enters the airway, passes below the vocal folds and is ejected into the larynx or out of the airway.

7. Material enters the airway, passes below the vocal folds and is not ejected from the trachea despite effort.

8. Material enters the airway, passes below the vocal fold and no effort is made to eject.
MBSiMP

17 swallow components, each with 3-5 ordinal scoring scale values

1. Lip closure
2. Tongue control during bolus hold
3. Bolus preparation/mastication
4. Bolus transport/lingual motion
5. Oral residue
6. Initiation of pharyngeal swallow
7. Soft palate elevation
8. Laryngeal elevation
9. Anterior hyoid excursion
10. Epiglottic movement
11. Laryngeal vestibule closure
12. Pharyngeal stripping wave
13. Pharyngeal constriction
14. Pharyngoesophageal segment opening
15. Tongue base retraction
16. Pharyngeal residue
17. Esophageal clearance
Swallow timing measures

- Measured swallowing events:
  - Onset of bolus head past ramus of mandible (B1)
  - Onset of hyoid burst (H1)
  - Onset of laryngeal vestibule closure (AEStart)
  - Full laryngeal vestibule closure (AEClose)

- Durations:
  - B1_AEStart
  - B1_AEClose
  - B1_H1
Statistics

- Descriptive statistics
- To determine between group differences: Multivariate ANOVA
  - **Independent variables**: disease group (PD, MSA, PSP, CBS) and bolus type (teaspoon thin; sequential thin; pudding)
  - **Dependent variables**: MBSImp composite scores; timing measures
- Post-hoc analysis using Tukey’s HSD
- Non-parametric Kruskal-Wallace test (for ordinal variables)
  - Compare groups for differences in MBSImp **component** scores and PAS scores
Results
<table>
<thead>
<tr>
<th>Disease group</th>
<th>N</th>
<th>Disease Duration (yrs) Mean (SD)</th>
<th>Age (yrs) Mean (SD)</th>
<th>Sex</th>
<th>UPDRS Mean (SD)</th>
<th>H&amp;Y Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>11</td>
<td>4 (1.58)</td>
<td>68 (9.20)</td>
<td>4m 7f</td>
<td>43.27 (16.94)</td>
<td>4 (1-5)</td>
</tr>
<tr>
<td>MSA-P</td>
<td>8</td>
<td>4.9 (2.03)</td>
<td>75 (6.02)</td>
<td>6m 2f</td>
<td>50.13 (16.73)</td>
<td>3.5 (3-5)</td>
</tr>
<tr>
<td>MSA-G</td>
<td>10</td>
<td>4.15 (2.00)</td>
<td>69.08 (7.24)</td>
<td>7m 3f</td>
<td>33.70 (13.81)</td>
<td>2.5 (1.5-4)</td>
</tr>
<tr>
<td>PSP</td>
<td>20</td>
<td>4.2 (1.46)</td>
<td>69 (6.30)</td>
<td>6m 14f</td>
<td>43.55 (14.04)</td>
<td>3.0 (3-5)</td>
</tr>
<tr>
<td>PD</td>
<td>18</td>
<td>4.7 (2.62)</td>
<td>72 (11.82)</td>
<td>16m 2f</td>
<td>27.61 (9.40)</td>
<td>2.25 (1-4)</td>
</tr>
</tbody>
</table>

p = .949

p = .023

p = .004

p = .004
Relative severity of MBSImP components

- Same five components were found to be most severely affected across all disease types
  1. Oral residue
  2. Bolus transport / lingual motion
  3. Initiation of pharyngeal swallow
  4. Pharyngeal residue
  5. Tongue base retraction

### Table 3-1. Overall MBSImP component scores for each disease group.

<table>
<thead>
<tr>
<th>Component</th>
<th>CBD</th>
<th>MSA-P</th>
<th>PSP</th>
<th>PD</th>
<th>MSA-G</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongue control during bolus hold</td>
<td>10</td>
<td>9</td>
<td>14</td>
<td>29</td>
<td>14</td>
<td>76</td>
</tr>
<tr>
<td>Bolus transport/lingual motion</td>
<td>50</td>
<td>47</td>
<td>36</td>
<td>88</td>
<td>55</td>
<td>276</td>
</tr>
<tr>
<td>Oral residue</td>
<td>50</td>
<td>32</td>
<td>67</td>
<td>81</td>
<td>54</td>
<td>284</td>
</tr>
<tr>
<td>Initiation of pharyngeal swallow</td>
<td>40</td>
<td>43</td>
<td>54</td>
<td>85</td>
<td>48</td>
<td>270</td>
</tr>
<tr>
<td>Soft palate elevation</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Laryngeal elevation</td>
<td>19</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>6</td>
<td>56</td>
</tr>
<tr>
<td>Anterior hyoid excursion</td>
<td>17</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Epiglottic inversion</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>6</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td>Laryngeal vestibular closure</td>
<td>10</td>
<td>13</td>
<td>25</td>
<td>20</td>
<td>7</td>
<td>75</td>
</tr>
<tr>
<td>Pharyngeal stripping wave</td>
<td>8</td>
<td>2</td>
<td>20</td>
<td>14</td>
<td>5</td>
<td>49</td>
</tr>
<tr>
<td>PES opening</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>25</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>Tongue base retraction</td>
<td>32</td>
<td>20</td>
<td>21</td>
<td>68</td>
<td>34</td>
<td>175</td>
</tr>
<tr>
<td>Pharyngeal residue</td>
<td>33</td>
<td>27</td>
<td>46</td>
<td>63</td>
<td>38</td>
<td>207</td>
</tr>
</tbody>
</table>
Multivariate ANOVA

- Main effect for disease group
  \( (F(24,676)=3.213; \ p<.0001) \)
- Main effect for bolus type
  \( (F(12,334)=4.090; \ p<.001) \)
- No Interaction effect
# Post-Hoc Testing

Table 3-2. Mean differences for composite MBSImP scores and timing measures. *p < .05; **p < .01.

<table>
<thead>
<tr>
<th>Group pairing</th>
<th>MBSImP composite</th>
<th>H1-B1</th>
<th>AEstart-B1</th>
<th>AEclose-B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD-MSAP</td>
<td>-2.212</td>
<td>-3.465</td>
<td>-6.070</td>
<td>-1.413</td>
</tr>
<tr>
<td>CBD-PSP</td>
<td>2.778**</td>
<td>6.328</td>
<td>3.231</td>
<td>6.111</td>
</tr>
<tr>
<td>CBD-PD</td>
<td>-0.664</td>
<td>11.320*</td>
<td>8.819</td>
<td>11.133</td>
</tr>
<tr>
<td>CBD-MSAG</td>
<td>1.105</td>
<td>7.903</td>
<td>6.594</td>
<td>8.675</td>
</tr>
<tr>
<td>MSAP-PSP</td>
<td>4.990**</td>
<td>9.783</td>
<td>9.3001</td>
<td>7.523</td>
</tr>
<tr>
<td>MSAP-MSAG</td>
<td>3.317**</td>
<td>11.368</td>
<td>12.663</td>
<td>10.087</td>
</tr>
<tr>
<td>PSP-PD</td>
<td>-3.442**</td>
<td>5.002</td>
<td>5.587</td>
<td>5.022</td>
</tr>
<tr>
<td>PSP-MSAG</td>
<td>-1.673</td>
<td>1.585</td>
<td>3.362</td>
<td>2.564</td>
</tr>
</tbody>
</table>

1. Smaller MBSImP composite score for PSP compared to CBD, MSA-P, and PD
2. Larger MBSImP composite score for MSA-P compared to MSA-grouped
3. Longer durations between oral transit initiation and pharyngeal swallow initiation for MSA-P compared to PD
Comparing groups for differences in MBSImP component scores and PAS

### Results of the Kruskal-Wallis test for difference between groups.

<table>
<thead>
<tr>
<th>Sig.</th>
<th>MBS Composite Score</th>
<th>Penetration Aspiration score</th>
<th>Bolus transit</th>
<th>Oral residue</th>
<th>Initiation</th>
<th>Laryngeal Elevation</th>
<th>Hyoid excursion</th>
<th>Laryngeal closure</th>
<th>PES opening</th>
<th>Tongue base retraction</th>
<th>Pharyngeal Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group Mean Rank</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>134</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>130</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>CBD</strong></td>
<td><strong>109</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>128</strong></td>
<td><strong>PD</strong></td>
<td><strong>126</strong></td>
</tr>
<tr>
<td><strong>Group Mean Rank</strong></td>
<td><strong>PD</strong></td>
<td><strong>116</strong></td>
<td><strong>PD</strong></td>
<td><strong>102</strong></td>
<td><strong>PD</strong></td>
<td><strong>112</strong></td>
<td><strong>108</strong></td>
<td><strong>PD</strong></td>
<td><strong>111</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>119</strong></td>
</tr>
<tr>
<td><strong>Group Mean Rank</strong></td>
<td><strong>CBD</strong></td>
<td><strong>104</strong></td>
<td><strong>PSP</strong></td>
<td><strong>100</strong></td>
<td><strong>CBD</strong></td>
<td><strong>106</strong></td>
<td><strong>MSA-P</strong></td>
<td><strong>105</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>94</strong></td>
<td><strong>PD</strong></td>
</tr>
<tr>
<td><strong>Group Mean Rank</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>90</strong></td>
<td><strong>CBD</strong></td>
<td><strong>92</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>104</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>93</strong></td>
<td><strong>CBD</strong></td>
<td><strong>91</strong></td>
<td><strong>PSP</strong></td>
</tr>
<tr>
<td><strong>Group Mean Rank</strong></td>
<td><strong>PSP</strong></td>
<td><strong>64</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>85</strong></td>
<td><strong>PSP</strong></td>
<td><strong>80</strong></td>
<td><strong>PSP</strong></td>
<td><strong>80</strong></td>
<td><strong>MSA-G</strong></td>
<td><strong>58</strong></td>
<td><strong>PD</strong></td>
</tr>
</tbody>
</table>

*Note: The highlighted cells indicate significant differences.*
Discussion and Summary
Finding: type of swallowing impairments are similar across disease type

- Supports existing literature
- Explanation: overlap of parkinsonian features (rigidity, bradykinesia, initiation problems) are reflected in types of impairments demonstrated
  - Oral phase impairments
  - Incoordination between phases
  - Oral and pharyngeal residue

The disease processes involved result in similar types of oropharyngeal swallow dysfunction
Finding: degree of swallowing impairment varied across groups

- **MSA, and specifically MSA-P**, consistently most impaired group
- PD second most impaired group
  - Despite excluding participants later in disease process
- Explanation: degeneration of putamen results in parkinsonian signs and functional muscular decline
  - Highest and most rapid putaminal degeneration in these disease types
CBD

- Previous swallow research sparse (Frattali & Sonies 2000)

- Findings from this study challenging to characterize
  - “Splintered” profile
  - Small number of participants
  - High intragroup variation in neuropathology
    - Reflected in swallow impairment profile
  - Often overlaps with PSP

![Results of the Kruskal-Wallis test for difference between groups.](image)
Clinical Implications

- Swallowing areas most affected in the Parkinsonian syndromes are oral phase impairment, incoordination, and residue.

- Differences exist across disease groups when matched for disease duration with MSA-P being most affected.

The presence of swallowing dysfunction relatively early in the disease process may serve to distinguish MSA-P from other Parkinsonian syndromes.
Limitations and Future Directions

- Limits
  - Retrospective design
    - Control
  - Outcome measures
    - Sensitivity to nuances of dysphagia in this population

- Future Directions
  - Evaluate longitudinal progression of dysphagia in these disease types to better ID patterns of onset, rate of decline, and how these relate to other sensorimotor signs and symptoms
THANK YOU!

Questions?