Oropharyngeal swallowing in Parkinson’s disease: a retrospective comparison of longitudinal swallowing function

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Disclosures

• No conflicts of interest or disclosures to report
Learning Objectives:

1) To discuss the established characteristics of dysphagia in Parkinson’s disease (PD)

2) To examine the ways in which dysphagia in PD change over 1 year

3) To highlight the importance of completing annual videofluoroscopic evaluation of oropharyngeal swallowing in PD
Swallowing in Parkinson’s Disease
Dysphagia in Parkinson’s disease

- Swallowing changes can occur in the earliest stages of PD
- Widespread impairment results in swallow deficits in every stage
- Changes often go unnoticed due to corresponding sensory changes associated with PD
- Aspiration pneumonia is among the leading causes of death in PD

(Rodrigues et al., 2011; Tjaden, 2008; Van Lieshout, 2011)
**Oral Phase Impairments**

Oral phase impairments are directly and adversely impacted by bradykinesia and rigidity.

- Often the first symptom of dysphagia in PD
- Lingual pumping
- Prolonged, delayed, inefficient mastication
- Premature loss of bolus
- Piecemeal deglutition
- Oral residue

(Ali et al., 1996; Tjaden, 2008; Rodrigues et al., 2011; Van Lieshout et al., 2011)
Pharyngeal Phase Impairments

Oral impairments contribute to the onset of pharyngeal swallowing dynamics (oropharyngeal dysphagia)

- Reduced base of tongue retraction
- Impaired pharyngeal peristalsis
- Coating of the pharyngeal walls with bolus material
- Reduced laryngeal elevation and excursion
- Inadequate extent and duration of UES opening
- Incomplete or delayed timing of laryngeal vestibular closure

(Ali et al., 1996; Ertekin et al., 2002, Rodrigues et al., 2011)
Esophageal Stage

- Aperistalsis
- Delayed opening of LES
- GERD

(Castell et al., 2001; Leopold & Kagel, 1997; Nagaya et al., 1998)
• Although these features have been identified in previous studies, many of these studies have small sample sizes, are not evaluated through videofluoroscopy, and are under-described in terms of disease duration and disease severity.

• Correlation between dysphagia severity, disease duration, and disease severity remains unclear.
Aims and Hypotheses

1. Determine whether specific measures of oropharyngeal swallowing physiology exhibit significant changes over one year.

_Hypothesis:_ There will be a significant increase in oral and pharyngeal residue, increased pharyngeal transit time, and increased occurrences of laryngeal penetration or aspiration.

2. Determine whether disease duration and/or clinical staging (Hoehn & Yahr Score) impact rate of change in swallowing function in people with PD.

_Hypothesis:_ longer disease duration and higher clinical staging will be associated with a more rapid decline in swallowing function within one year.

(Hoehn & Yahr, 1967)
Methods
• Retrospective study: people with PD seen at least 2 times at University of Florida’s Center for Movement Disorders and Neurorestoration between 2011 and 2015.

• First and second videofluoroscopic swallow evaluation were one year apart (ten to fourteen months).

• 22 out of the 50 participants had DBS; of those participants, there was no change in DBS status between visits

• Exclusionary criteria: history of other neurologic disorders, head & neck cancer, COPD, severe psychological disturbance

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.00</td>
<td>87.00</td>
<td>68.94 (10.16)</td>
</tr>
<tr>
<td>UPDRS</td>
<td>10.00</td>
<td>64.00</td>
<td>30.82 (10.37)</td>
</tr>
<tr>
<td>H&amp;Y</td>
<td>1.00</td>
<td>4.00</td>
<td>2.67 (.74)</td>
</tr>
<tr>
<td>Disease Duration</td>
<td>.50</td>
<td>28.00</td>
<td>9.70 (6.38)</td>
</tr>
<tr>
<td></td>
<td>(years)</td>
<td></td>
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</table>
Swallow evaluation

• Fluoroscopic evaluation in the lateral viewing plane
• Varibar barium
• Instructions to patients:
  • Thin bolus hold: “hold in your mouth until I tell you when to swallow”
  • Sequential cup sip, thin liquid: “take two sips from a cup without moving the cup down- sip swallow, sip swallow”
  • Pudding: “hold in your mouth until I tell you when to swallow”
Scoring Tools

1. Penetration-Aspiration Scale

2. Modified Barium Swallow Impairment Profile (MBSImP)

3. Traditional Timing Measures
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 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 airway, passes below the vocal folds and no effort is made to eject

(Rosenbek et al., 1996)
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 vestibular closure
12. Pharyngeal stripping wave
13. Pharyngeal constriction
14. Pharyngoesophageal segment opening
15. Tongue base retraction
16. Pharyngeal residue
17. Esophageal clearance

(Martin-Harris, 2008)
Timing Measures

- Measures duration of stages of swallow and temporal relationships between swallow movements
- Captures incoordination in the sequence of swallow movements
- To calculate: ID frames at which swallow events occur

Physiological measures

<table>
<thead>
<tr>
<th>Timing Measure</th>
<th>Time Point 1</th>
<th>Time Point 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal Transit Time</td>
<td>Bolus head arrival in valleculae</td>
<td>Bolus tail exiting PES</td>
</tr>
<tr>
<td>Aryepiglottic Fold Closure</td>
<td>Bolus head exiting posterior nasal spine</td>
<td>Full aryepiglottic fold closure</td>
</tr>
</tbody>
</table>

(Kendall et al., 2000)
Statistics

- **Repeated measures analysis of variance (RM ANOVA)**
  - Within subjects factor: Time (visit 1 versus 2); Bolus type (thin hold, sequential, and pudding)
  - Between subjects factor: Presence of DBS leads
  - Covariate: disease duration

- **Wilcoxon signed ranks test**: used for MBSImP and P-A scores between visit 1 and visit 2

- **Pearson r correlations**: used to determine direction and strength of relationships between dependent variables
Results
Thin Bolus Hold

- Significant interaction effect for time (visit 1 vs. visit 2) and disease duration (F(8,38)=2.33; p=.038)

<table>
<thead>
<tr>
<th>Component</th>
<th>F (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal transit time</td>
<td>7.366 (1)</td>
<td>.009</td>
</tr>
<tr>
<td>Aryepiglottic closure to bolus head passing posterior nasal spine</td>
<td>15.563(1)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Pearson’s correlations:

- AEclose-B1 (time2-time1) and disease duration: (r=.501; p <.0001)
- PTT (time2-time1) and disease duration (r=.386; p = .007)
Thin Bolus Hold

Non-parametric Findings Most Severe Impairment
* Significant Decline from Year 1 to Year 2 (p<.05)
Sequential Thin
Non-parametric Findings with Most Severe Impairment
* Significant Decline from Year 1 to Year 2 (p<.05)
Discussion
Implications of the Thin Bolus Hold

The thin bolus hold showed:

- The greatest significant longitudinal decline of the three bolus types across all measures
- The only bolus types to show significant effect for timing measures and changes related to disease duration.

Explanations:

- Multi-step command that increases cognitive demand and is an unfamiliar and unnatural sequence of movements
- Highly volitional task, which requires initiation of movement to an external command
- Holding bolus requires strong lingual coordination
- Discoordination of the oral phase carries over to the pharyngeal phase
Timing Measures and Disease Duration

Thin bolus hold, which had the most significant longitudinal decline in all three measures, also demonstrated a correlation with disease duration through timing measures.

Explanations:

• At earlier disease durations, areas of physiologic change may not be acute or severe enough to be captured by timing measures.

• The functional measures, MBSImP and PAS, were able to capture markers of swallow dysfunction as a result of the milder yet widespread changes that are present early in the disease.
Clinical Relevance and Rationale

• First longitudinal study of dysphagia in PD
• Find patterns of dysfunction as disease duration increases and disease severity progresses
• Gain a better understanding of when to start screening for dysphagia
  – Cannot rely on patient reports of dysphagia because they are often asymptomatic in the early states
  – How frequently to evaluate
  – Determine when dysphagia therapy is indicated to slow rate of decline of swallowing function
• Investigate the magnitude of longitudinal changes in swallowing related outcomes over a one year time period
Implications for Swallow Evaluation and Intervention

• The current study demonstrates that there are several longitudinal changes in swallow function that occur in a one year time period across disease durations.

• This emphasizes the importance of annual VFE at the time of diagnosis to monitor swallow function as the disease progresses.

• The current study and future research will contribute to a better understanding of patterns of swallowing dysfunction throughout the course of the disease and therefore promote targeted treatment goals and regular evaluation.
Thank you!
Measures of Timing

Finding: Thin bolus hold had significant longitudinal increase in pharyngeal transit time and delay in aryepiglottic fold closure with disease duration as a covariate.

Suggests an increased risk for penetration and aspiration. Consistent with the finding that PAS longitudinally declined from visit one to visit two.

This difference not seen in sequential because it more closely approximates natural swallow, so it’s missing the volitional element/ demand for lingual control in the presence of lingual weakness.
# Inherent Differences Between Measures

*No correlation between MBSImP and timing measures.*

<table>
<thead>
<tr>
<th>Timing Measures</th>
<th>MBSImP</th>
</tr>
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<tbody>
<tr>
<td>Quantitative</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Measure of Physiology</td>
<td>Measure of function</td>
</tr>
<tr>
<td>Continuous Measure</td>
<td>Ordinal Ranking</td>
</tr>
<tr>
<td>Specific to area of physiologic</td>
<td>Not reflective of specific areas of physiologic</td>
</tr>
<tr>
<td>dysfunction</td>
<td>change- captures the result of broad deficits</td>
</tr>
</tbody>
</table>
Measures of MBSImP

<table>
<thead>
<tr>
<th>Thin Bolus Hold</th>
<th>Sequential</th>
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<tbody>
<tr>
<td>Bolus transport/ Lingual motion</td>
<td>Oral Residue</td>
</tr>
<tr>
<td>Tongue Base Retraction</td>
<td>Tongue Base Retraction</td>
</tr>
<tr>
<td>Pharyngeal Stripping Wave</td>
<td>Pharyngeal Stripping Wave</td>
</tr>
<tr>
<td>Pharyngeal Residue</td>
<td>Pharyngeal Residue</td>
</tr>
<tr>
<td>PES Opening</td>
<td>MBSImP Composite Score</td>
</tr>
<tr>
<td>Epiglottic Inversion</td>
<td></td>
</tr>
<tr>
<td>MBSImP Composite Score</td>
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**Oral:** Influenced by dopaminergic pathways, causing slow/ repetitive lingual motions

**Pharyngeal:** influenced by oral deficits

Impaired volitional components cause reflexive movements to become uncoordinated and they do not necessarily accommodate for abnormalities stemming from oral phase.
Implications for Future Research

Correlation between dysphagia severity and disease severity remains unclear

Expand longitudinal time frame beyond 1 year
Limitations

Retrospective study:
• Unable to control for participant’s participation in swallowing exercises
• Investigator did not actively participate in videofluoroscopic evaluation: ensure strict adherence to protocol of providing and reinforcing instructions to participants

Recording:
• Sequential sip was sometimes not recorded in evaluation possibly due to severity of swallow dysfunction
• Recording of swallow prematurely stopped due to prolonged nature of oropharyngeal swallow
• Anterior portion of lips and tongue not in frame, so oral transit time could not be calculated