A Preliminary Videofluoroscopic Investigation of Swallowing Physiology and Function in People Living with Severe Dementia

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Introduction

- Dysphagia is a commonly diagnosed condition in patients with dementia, particularly those with advanced disease progression[1], but we lack understanding of the discrete changes in swallowing physiology that are seen in this subset of the dementia population.
- We also do not understand the resulting relationship to impairments of safety and efficiency. This leads to questions surrounding optimal management approaches during late stages of the disease.
- Some studies have reported that swallowing impairments in dementia are characterized by prolonged swallow durations[2], delayed pharyngeal initiation[3], decreased epiglottic inversion[4,5], reduced hyolaryngeal movement[5,6], and inadequate clearance of the pharynx[7].
- To determine the best treatment approaches for people living with severe cognitive impairment due to dementia, we must establish a better understanding of the underlying physiological impairments.
- **Purpose: To describe the pathophysiology of dysphagia in a prospective sample of patients living with dementia with severe cognitive impairment.**

Methods

Data was collected from 9 adults (age range: 81-97; 5 female) diagnosed with dementia. Cognition was assessed using the Montreal Cognitive Assessment[8], and all scores were <11, indicating severe cognitive impairment. VFs were performed on all participants; only natural sips of thin liquid were extracted for this study and scored by blinded raters using the ASPEKT[9] method.

Raters analyzed 32 thin liquid swallows for:

- **Safety** [Penetration-Aspiration Scale (PAS)]
- **Efficiency** [Normalized Residue Ratio Scale (NRRS)]
- **Timing** [Pharyngeal Transit Time (PTT), Swallow Reaction Time (SRT), Laryngeal Vestibule Closure Reaction Time (LVCrt), Upper Esophageal Sphincter Opening Duration (UESO)]
- **Kinematics** [pharyngeal constriction]

Impairment thresholds from existing literature were used to characterize swallowing physiology and function.

Descriptive statistics were used to analyze swallow safety. Chi-square tests and Pearson's correlations were used to determine associations between swallowing physiology and function. Group means were compared to published norms using two-sample t tests.

Results

- Mean number of subswallows per bolus = 1.9±1.1
  - 52% of swallows had ≥2 subswallows per bolus
- Unsafe swallowing (PAS>2) was seen in 8 out of 9 participants and 40% of subswallows (see *Table 1*)
- Clinically significant residue was seen in most patients (83%; 20 of 32 swallows)
- Compared to published normative values for healthy older adults, we found significant differences ($p < 0.05$) in residue, pharyngeal constriction, SRT, LVCrt, and UESO (see *Table 2*)
- Chi-square tests revealed no significant associations between LVCrt and PAS [$\chi(1) = 0.625$, $p = 0.429$], nor SRT and PAS [$\chi(1) = 0.714$, $p = 0.398$].
- No associations were found between pharyngeal constriction and residue [$r = -.069$, $n = 32$, $p=0.753$]

Table 1. Frequency counts and percentages for each PAS score (n = 63).

PAS Score	Count	%
1	27	43%
2	11	17%
3	2	3%
4	1	2%
5	4	6%
6	5	8%
7	0	0%
8	13	21%

Table 2. Summary of parameters, thresholds, mean values and comparisons with healthy data.

Parameter	Measurement Event	Threshold	Mean value for healthy data	Mean value for dataset
NRRSv (vallecular)	Swallow rest frame: lowest position of the pyriform sinuses	>0.004[10]	0.002 ± 0.006[10]	0.093 ± 0.091*
NRRSp (pyriform sinus)	Swallow rest frame: lowest position of the pyriform sinuses	>0.018[10]	0.006 ± 0.040[10]	0.021 ± 0.031*
Pharyngeal constriction	Frame of maximum constriction of the pharynx	>1.2%[9]	0.9 ± 1.3%[9]	21.04 ± 17.22%*
Pharyngeal transit time	Bolus past mandible to UES closure	>270 ms[12]	820 ± 320 ms[12]	1524 ± 1590 ms
Swallow reaction time	Bolus past mandible to onset hyoid burst	>260 ms[13]	230 ± 70 ms[13]	1380 ± 1380 ms*
Laryngeal vestibule closure reaction time	Onset hyoid burst to max laryngeal vestibule approximation	>220 ms[14]	210 ± 9 ms[14]	760 ± 3044 ms*
Upper esophageal opening duration	UES opening to UES closure	<630 ms[15]	631 ± 9 ms[15]	17,260 ± 18,840 ms*

Discussion and Clinical Implications

- The current study suggests that there are clear physiologic differences between swallowing in healthy individuals and those with severe cognitive impairment associated with dementia.
- In line with previous research, aspiration is relatively uncommon whereas post-swallow residue commonly occurs[16,17]. Previous research has suggested that in this population, aspiration is most likely to occur in the presence of post-swallow residue[16].
- Of note, there appears to be increased variability in swallowing physiology in those with severe cognitive impairment associated with dementia, compared to healthy adults. This is not surprising given that the current sample is quite old, and previous studies have suggested that swallowing variability increases with age[18] and type of dementia[19].
- Future research to investigate physiologic causes of residue, other than pharyngeal constriction, in those with severe cognitive impairment associated with dementia.
- However, further work is needed to explore a greater range of food and liquid textures, and to identify additional physiological mechanisms underlying dysphagia in this population.
- It would also be beneficial to compare swallowing physiology across levels of cognitive impairment in patients living with dementia to track disease progression and determine optimal time for intervention.

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