

Background

- Reducing the X-ray pulse rate during MBSSs is a common method used with the intent of minimizing radiation exposure¹.
- When the pulse rate is reduced, the temporal resolution (number of unique images to capture swallowing impairment) is also reduced.
- Many aspects of swallowing are brief and unlikely to be visualized during MBSS where pulse rates of 15 or less are used.
- The reduction in temporal resolution poses a significant risk to diagnostic accuracy as it reduces our ability to identify swallow impairment and impacts clinical care based on the MBSS¹.
- The As Low As Reasonably Achievable (ALARA) principle, that guides medical uses of radiation, indicates that clinically-important diagnostic accuracy should not be compromised due to stochastic-risk related radiation concerns.

Objective

- Determine the influence of pulse rates of 15 or less on the visualization of swallow physiology via MBSS.
- Determine which aspects of swallow physiology and which bolus types (bolus volume/viscosity) are most sensitive to degraded temporal resolution.

Hypothesis

- We hypothesized that the reduction of temporal resolution, associated with reducing the pulse rate, impairs clinician judgments of clinically meaningful aspects of swallowing physiology.
- We hypothesized that the reduction of temporal resolution would impact visualization for all bolus types.

Methods

- We selected MBSSs from 200 patients routinely undergoing MBSS as standard of care.
- MBSSs were conducted at 30pps using the MBSImP standardized administration protocol² & recorded at 30 fps.
- We used a stratified sampling method to ensure that the 200 MBSSs included represented the full range of swallowing impairments (etiology, type, and severity).
- Recordings were down-sampled from 30pps to 15, 7.5, and 4pps (per methods previously reported).
- Recordings were de-identified for rater blinding.
- SLPs, trained and proven reliable using the MBSImP scoring methodology², scored the MBSImP components and PAS for each individual swallow using the research scoring protocol.
- Each recording (200 x 4 pulse rates) was scored by 2 SLPs and 20% of recordings were repeated to assess inter- and intra-rater reliability.
- We analyzed the data to determine the impact of pulse rate on specific physiological swallowing impairments and on bolus type.
- Scores were considered:
 - Not impacted** = greater than 80% agreement across raters
 - Mildly impacted** = 80% or less agreement across a subset of raters
 - Moderately impacted** = 80% or less agreement across all raters
 - Moderately-severely impacted** = 70% agreement or less across a subset of raters
 - Severely impacted** = 70% or less agreement across all raters

Results

Impact of Pulse Rate on Visualization of Swallowing Physiology			
	30 vs 15	30 vs 7.5	30 vs 4
Lip Closure	Mod/Sev	Mod/Sev	Severe
Tongue Control During Bolus Hold	Moderate	Moderate	Mod/Sev
Bolus Preparation/Mastication	Mod/Sev	Severe	Severe
Bolus Transport/Lingual Motion	Moderate	Mod/Sev	Severe
Oral Residue	Mild	Mild	Moderate
Initiation of Pharyngeal Swallow	Severe	Severe	Severe
Soft Palate Elevation	Not Impacted	Not Impacted	Not Impacted
Laryngeal Elevation	Mild	Moderate	Severe
Anterior Hyoid Excursion	Moderate	Moderate	Severe
Epiglottic Movement	Not Impacted	Mild	Mod/Sev
Laryngeal Vestibular Closure	Not Impacted	Not Impacted	Moderate
Pharyngeal Stripping Wave	Moderate	Severe	Severe
Pharyngeal Contraction	Not Impacted	Mild	Mod/Sev
Pharyngeal Segment Opening	Mild	Moderate	Severe
Tongue Base Retraction	Mild	Moderate	Severe
Pharyngeal Residue	Not Impacted	Moderate	Moderate
Esophageal Clearance (upright)	Moderate	Mod/Sev	Severe
PAS	Moderate	Moderate	Severe

Results

- 8 of 17 components (47%) were moderately or severely impacted by when assessed at a pulse rate of 15.
- 12 of 17 components (70%) were moderately or severely impacted by when assessed at a pulse rate of 7.5.
- 16 of 17 components (94%) were moderately or severely impacted by when assessed at a pulse rate of 4.
- PAS was moderately to severely impacted by pulse rate modifications.

Impact of Pulse Rate by Bolus Type			
	30 vs 15	30 vs 7.5	30 vs 4
Tsp Thin	Moderate	Moderate	Severe
Seq Thin	Moderate	Moderate	Severe
Cup Thin	Moderate	Moderate	Severe
Tsp Nectar	Mild	Moderate	Severe
Seq Nectar	Moderate	Moderate	Severe
Cup Nectar	Mild	Moderate	Severe
Honey	Mild	Moderate	Severe
Pudding	Mild	Moderate	Severe
Cookie	Mild	Moderate	Severe

Conclusions

- We have demonstrated that reducing the pulse rate impacts the evaluation of key aspects of swallowing physiology.
- We have also demonstrated that this impact occurs across bolus types and, therefore, pulse rate should not be reduced for any trial type during an MBSS.
- These results, paired with our knowledge of the low cancer risks associated with MBSSs in adults³, supports the clinical use of a pulsed X-ray of 30pps.

References

- Bonilha, H. S., Blair, J., Carnes, B., Huda, W., Humphries, K., McGrattan, K., Michel, Y., & Martin-Harris, B. (2013). Preliminary investigation of the effect of pulse rate on judgments of swallowing impairment and treatment recommendations. *Dysphagia*, 28(4), 528–538.
- Martin-Harris, B., Brodsky, M. B., Michel, Y., Castell, D. O., Schleicher, M., Sandidge, J., Maxwell, R., & Blair, J. (2008). MBS measurement tool for swallow impairment—MBSImp: establishing a standard. *Dysphagia*, 23(4), 392–405.
- Bonilha, H.S., Huda, W., Wilmskoetter, J., Martin-Harris, B., & Tipnis, S.V. (2019). Radiation risks to adult patients undergoing modified barium swallow studies. *Dysphagia*, 34(6), 922-929.

