Radiation Exposure Time during MBSS: Influence of Swallowing Impairment Severity, Medical Diagnosis, Clinician Experience, and Standardized Protocol Use

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Purpose

- Determine the influence of patient swallowing impairment, medical diagnosis, and clinician experience on radiation exposure time during MBS.

- Determine whether using a standardized protocol increases radiation exposure time during MBS.
Significance and Background
Swallowing impairment and the Modified Barium Swallow Study (MBSS)

- 22% of individuals 50 years and older experience dysphagia.
- 10 million Americans are evaluated for dysphagia each year.
- Evaluation of swallowing impairment via videofluoroscopy during MBSS is critical to patient management.
- Fluoroscopic procedures involve radiation exposure.

Significance and Background
Swallowing impairment and the Modified Barium Swallow Study (MBSS)

- Radiation exposure is both natural and manmade.
- Medical procedures are responsible for 36% of total radiation exposure.
- 73% of these procedures were radiographic and fluoroscopic exams.
- Health risks: deterministic vs. stochastic
- Radiation dose measured in Sieverts (Sv)
- Risk vs. benefit: ALARA

USNRC 2011, Huda 2009, Mettler 2008
Significance and Background
Swallowing impairment and the Modified Barium Swallow Study (MBSS)

- Patient exposure during MBSS:
  - Median effective dose is 0.35 mSv

- Average annual radiation dose in US = 6.3 mSv

- NRC limits annual dose to 50 mSv over occupational dose limits.

- GOAL: Identify attributing factors and limit radiation exposure.

Moro 2006, USNRC 2011
Significance and Background

Relationship between Radiation Exposure and Fluoroscopy Time

- High correlation (85%) between fluoroscopy time and actual measurements of dose (kerma area product (KAP) values)

- Limitations of this *relative* indicator:
  - X-ray beam quantity (i.e. KAP)
  - X-ray beam quality (i.e. Half Value Layer)
  - Irradiation geometry
  - Patient physical characteristics

Moro 2006
Significance and Background

Relationship between Radiation Exposure and Fluoroscopy Time

- Radiation exposure times for MBSS range from 150s – 1080s with a median of 240s.

- This equates to effective doses between ~0.36 mSv - ~2.6 mSv with a median of ~0.67 mSv.
Significance and Background
Relationship between Radiation Exposure and Fluoroscopy Time

- These studies reported the following influences on radiation exposure time:
  - Swallowing impairment severity
  - Medical diagnosis category
  - Clinician experience
  - Standardized protocol.

Research Questions

- What are the influences of medical diagnosis, SLP experience and impairment severity on radiation exposure time?

- Does using a standardized protocol during MBSS, such as that associated with the MBSImP ©™, increase radiation exposure time?
Methods
Retrospective Chart Review

- Retrospective chart review of 739 MBSS performed at MUSC between September 2009 and September 2010.

- Information collected:
  - Fluoroscopic exposure times
  - Medical diagnosis
  - Clinician experience.

- Video obtained during:
  - continuous fluoroscopy at 30pps
  - recorded at 30fps on KayPentax Swallow Station.
Methods

Participants

- 739 adults
- 439 males and 300 females
- Age range 18-96 (mean = 59)
- Referred for MBSS by trained SLPs at the Evelyn Trammell Institute for Voice and Swallowing of South Carolina.
Method
Subset Sampling

- Randomly sampled 170 MBSSs from 739.
- N=170 yields 80% power to detect 15 sec fluoro time increase for 1 SD increase in oral total
Methods
Standardized Protocol

The MBS Impairment Profile (MBSImP™) Valid, Reliable, and Standardized Measurement

Martin-Harris et al. 2008
Methods
Standardized Protocol

- 3 integral standardized components:
  1) Training in swallowing physiology and impairment
  2) Data collection protocol
  3) Scoring and interpretation
Methods
Protocol

- 11 single swallows of standardized, commercial preparations of barium contrast agents (Varibar® E-Z-EM, Inc.)
  - Thin liquid barium (two trials of 5-ml cup sip, sequential swallows from cup)
  - Nectar-thick liquid barium (5-ml cup sip, sequential swallows from cup)
  - Honey-thick liquid barium (5 ml via spoon)
  - Pudding-thick barium (5 ml via spoon)
  - ½ Lorna Doone shortbread cookie coated with 3-ml pudding-thick barium

Martin-Harris et al. 2008
Methods

Protocol

- Lateral and Anterior-Posterior viewing planes observed.
- Esophageal clearance in upright position recorded.
- Compensatory strategies and behavioral methods elicited.
Methods
Swallowing Impairment Severity

- MBSImP©™ (standardized protocol) used for all MBSSs reviewed in this investigation.
- Defines 17 components of oral, pharyngeal, and esophageal physiology.
- Components scored using rank order severity scale based on physiologic observations from MBSS recording.

Component 6—Initiation of Pharyngeal Swallow

0 = Bolus head at posterior angle of ramus (first hyoid excursion)
1 = Bolus head at vallecular pit
2 = Bolus head at posterior laryngeal surface of epiglottis
3 = Bolus head at pit of pyriforms
4 = No appreciable initiation at any location
Methods
Swallowing Impairment Severity

- Overall impairment score of each component recorded:
  - Across all bolus volumes and consistencies
  - Based on a 3-5 point scale
  - Characterized by distinguishable observation

- Scores used to develop swallowing impairment severity

- Included oral and pharyngeal totals

Martin-Harris et al. 2008
Methods
Swallowing Impairment Severity

- **Penetration**: material that enters the larynx but does not pass below the true vocal folds.

- **Aspiration**: material that passes below the level of the vocal folds.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contrast does not enter the airway.</td>
</tr>
<tr>
<td>2</td>
<td>Contrast enters the airway, remains above the vocal folds; no residue.</td>
</tr>
<tr>
<td>3</td>
<td>Contrast remains above the vocal folds; visible residue remains.</td>
</tr>
<tr>
<td>4</td>
<td>Contrast contacts vocal folds; no residue.</td>
</tr>
<tr>
<td>5</td>
<td>Contrast contacts vocal folds; visible residue remains.</td>
</tr>
<tr>
<td>6</td>
<td>Contrast passes the glottis; no subglottic residue visible.</td>
</tr>
<tr>
<td>7</td>
<td>Contrast passes the glottis; visible subglottic residue despite patient response.</td>
</tr>
<tr>
<td>8</td>
<td>Contrast passes the glottis; visible subglottic residue; absent patient response.</td>
</tr>
</tbody>
</table>
Categorized according to medical diagnosis obtained through MBSS report:

- Neurology
- Pulmonary
- Cardiac
- ENT
- GI
- Other (e.g. phagophobia)
Methods
Clinician Experience

- Speech-Language pathologist with 1-17 years of clinical experience.

- Trained according to MBSImP©™ standards:
  - Consistently and accurately (>80%) score MBSS compared to expert clinician)

- 3 novice clinicians (0-3 months of experience)

- 7 experienced clinicians (up to 216 months experience (mean = 127)
Data and Statistical Analyses

- A one-way ANOVA was used to assess the association between fluoroscopy time and medical diagnosis.

- A two sample t-test was used to compare fluoroscopy time between experienced and novice SLPs.

- Associations between fluoroscopy time and swallowing impairment severity were assessed using simple linear regression.

- The mean and 95% confidence interval was used to evaluate the fluoroscopy time associated with the use of the MBSImP©™ data collection protocol.
Results

Does swallowing impairment severity matter? YES

*Inference for PC and PT is restricted to subpopulation of patients for whom A/P view was possible

P = <.05

Fluoroscopy time increase (sec)
## Results

### Does medical diagnosis matter? NO

<table>
<thead>
<tr>
<th>Diagnostic Category</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurology</td>
<td>1</td>
<td>7.5</td>
<td>2.94</td>
<td>2.7</td>
<td>270</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>0.4</td>
<td>7.1</td>
<td>2.88</td>
<td>2.8</td>
<td>71</td>
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<tr>
<td>Cardiac</td>
<td>0.7</td>
<td>3.8</td>
<td>2.45</td>
<td>2.6</td>
<td>8</td>
</tr>
<tr>
<td>ENT</td>
<td>0.4</td>
<td>8</td>
<td>2.86</td>
<td>2.7</td>
<td>297</td>
</tr>
<tr>
<td>GI</td>
<td>1.8</td>
<td>6</td>
<td>2.74</td>
<td>2.5</td>
<td>38</td>
</tr>
<tr>
<td>Other</td>
<td>1.1</td>
<td>7.4</td>
<td>2.87</td>
<td>2.4</td>
<td>55</td>
</tr>
</tbody>
</table>

The mean, median and range of fluoroscopy times associated with the medical diagnosis categories. \((p = 0.69)\)
Results

Does SLP experience matter? YES

- Experienced clinicians (n=497):
  - averaged **2.82** minutes
  - 95% CI = 2.72 to 2.92

- Novice clinicians (n=242):
  - averaged **3.02** minutes
  - 95% CI = 2.89 to 3.17

- **P = 0.034**
Results

Does using a standardized protocol increase time? NO

Mean radiation exposure time using MBSImP = 2.89
95% confidence interval of 2.8 to 2.97 minutes
Discussion

- Swallowing impairment severity increases fluoroscopy time.

- Medical diagnosis category did no increase fluoroscopy time.

- There was a statistically significant difference between experienced and novice clinicians.

- The thoroughness of a standardized protocol does not lead to longer radiation exposure times.
Conclusions

- Swallowing impairment severity and SLP experience impact fluoroscopy time.
  - Other factors should be considered.
  - GOAL: improve diagnostic yield while ALARA

- Medical diagnosis category does not influence fluoroscopy time.
  - We can standardize across all diagnosis categories

- Using a thorough, standardized protocol does not increase radiation exposure time.
  - Reduces need for repeat MBS
  - Improves diagnostic yield
Support and Disclosures

• NIH/NICDC R21, Respiratory Phase Training in Head and Neck Cancer, 2009-2011

• VA RR&D, Respiratory Phase Training in Dysphagic Veterans with Oropharyngeal Cancer, 2010-2013

• NIH/NIDCD K23 DC 5764, Standardization of Swallowing Assessment 2003-2009

• NIH/NIDCD R03 DC04864-01 Respiratory and Laryngeal Dynamics During Swallow, 2000-2003

• Mark and Evelyn Trammell Trust, 1993-2010

• Bracco Diagnostic, Inc., 2009-2010