Purpose: Despite the emphasis on using evidence-based practice for patient care, as clinicians, we sometimes find that there is insufficient evidence to support our clinical practices. One example of this is the “contentious” inclusion of routine, standardized visualization of the esophagus during modified barium swallow studies (MBSSs). This review sought to investigate the evidence for inclusion of routine esophageal visualization during the MBSS, a practice that is supported by the long-established interrelationship between all aspects of the oral, pharyngeal, and esophageal swallowing continuum.

Method: Searches were conducted in PubMed, Scopus, and CINAHL databases. Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines were followed to identify articles that met prespecified inclusion and exclusion terms.

Results: Five articles were included in this review, which identified that esophageal findings were present in 48.67% of those participants whose MBSS included esophageal visualization.

Conclusion: This review supports a standardized, validated, reliable visualization protocol of the esophagus during the MBSS as a critical component to the accurate diagnosis and formulation of treatment recommendations for patients with swallowing disorders.

Disordered swallowing, or dysphagia, affects approximately 15 million Americans with an additional 1 million diagnosed each year (Carnaby & Harenberg, 2013), costing over 540 billion dollars annually in government spending (Altman et al., 2010). The Modified Barium Swallow Study (MBSS) is considered the gold standard for the evaluation of swallowing as it allows for multiplane videofluoroscopic imaging (Martin-Harris & Jones, 2008) of the swallowing continuum. However, there is a lack of agreement regarding the inclusion of routine visualization of the esophagus by speech-language pathologists (SLPs) during the MBSS. Visualization of the esophagus is supported by the known interrelationship between all aspects of the swallowing continuum and the knowledge that a disturbance in any part of the swallowing continuum can cause a disruption in any or all aspects of swallowing (Gullung et al., 2012; Triadafilopoulos et al., 1992). Therefore, the assessment of swallow function (or dysfunction) with the MBSS may be incomplete without visualization of the esophagus. If an MBSS is completed without consideration of the esophagus, the deficit may not indicate the primary nature of the disorder if oropharyngeal abnormalities are being caused by esophageal function.

For over 30 years, historic expert opinion has supported the interrelationship of all aspects of the swallowing continuum. Jones et al. (1985) stated that coexisting dysfunction of the pharynx and esophagus is so common that the “complete swallowing chain should be examined in all patients with dysphagia.” Triadafilopoulos et al. (1992) specified that the oral, pharyngeal, and esophageal aspects of the swallowing continuum “operate as an integrated system and that dysfunction in any of these anatomic and functional components leads to adaptive or compensatory changes in the other.” Gullung et al. (2012) described a “functional interrelationship” between oral, pharyngeal, and esophageal aspects of the swallow and further highlighted the “importance of thorough pharyngoesophageal examination for dysphagia symptoms,” advocating for the use of esophageal visualization under fluoroscopy using the Modified Barium Swallow Impairment Profile (MBSImP; Martin-Harris et al., 2008) protocol. It is growing increasingly...
The diagnosis and management of swallowing disorders is divided among SLPs, otolaryngologists, and gastroenterologists. These specialties may be at odds with different, often incompatible, diagnostics, treatments, and terminology. This divided diagnostic and treatment process further perpetuates the view of swallowing as occurring in discrete phases. Due to these arbitrary divisions of the swallowing continuum, no single medical specialty, or test, fully evaluates the continuum as a whole. This is contrary to the known interconnectedness of the swallowing continuum (Jones et al., 2019, 2015; O’Rourke et al., 2014; Watts et al., 2019).

To understand the current evidence for the visualization of the esophagus during an MBSS, we conducted a systematic review of the literature. The objective of this study was to identify the scientific evidence that supports the visualization of the esophagus as part of the MBSS. Specifically, we sought to synthesize the current information regarding the use of esophageal visualization to improve diagnostic accuracy during an MBSS. Despite historic expert opinion on the interconnectedness of all aspects of the swallow, there is a need to discern the extent of the scientific support for the clinical utility of the addition of routine, systematic visualization of the entire length of the esophagus as part of the MBSS to assess the whole swallowing continuum. We could find no such synthesis of the literature. Furthermore, review of the current literature may help inform best practices for all of those health care specialties that work in the field of dysphagia (e.g., SLPs, radiologists, otolaryngologists, gastroenterologists, pulmonologists, neurologists, and more).

Method

Protocol

Methods of the analysis and inclusion criteria were outlined in advance of the review and are documented in sections below. The guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (Moher et al., 2009) were followed.

Eligibility Criteria

Peer-reviewed journal articles on the topic of normal or disordered swallowing with specific regard for radiographic, fluoroscopic findings in the oropharynx and/or in the esophagus were considered.

Information Sources

The authors identified articles by searching electronic databases, scanning reference lists of articles, conference papers, and publications in print. Search limitations included English language publications, humans, and adults 18 years or older. No limit was placed on publication date with publication years ranging from 1947 to 2019: PubMed (1966–June 2020), SCOPUS (1947–June 2020), and CINAHL (1948–June 2020). This literature search was completed on June 19, 2020.

Search


Study Selection

Following the completion of the initial search, duplicates were excluded. The remaining articles were screened (titles and abstracts) for inclusion in the review in a standardized manner, based on the following keywords: (“swallowing”/“deglutition disorder”/“swallowing disorder”/“dysphagia” and or “radiology”/“radiographic”/“fluoroscopy”/“fluoroscopic”/“barium swallow”/“modified barium swallow” and/or “diagnostic imaging”). At least one key word was required to be present to be considered for the study. If there was insufficient information during the screening process, the article moved on to the next stage of review (e.g., from title/abstract search to full-text review) to determine if any exclusion/inclusion criteria were met. Any studies that did not meet these criteria did not undergo further review. Any articles that were based solely on the evaluation of reflux; only consisted of esophageal examination or visualization in isolation without examination or inclusion of oropharyngeal findings; or studies that only included a full esophagram and not a screening, follow-through, or visualization were excluded.

The remaining studies were then subjected to a full-text screening by a reviewer (E. L. R.), with a second reviewer (H. S. B.) assessing 20% of those articles to limit the contribution of bias. There was an initial 82% agreement between raters with an end agreement on 100% of the articles included after discussion. Any articles that did not meet the inclusion criteria were not included in
the review. The references of all included articles were reviewed to determine if there were any that met the inclusion/exclusion criteria.

**Data Collection Process and Data Items**

The data from the remaining articles was extracted and reviewed by two raters, and disagreements between the two primary raters was resolved by discussion and re-review. Information was extracted based on the following categories.

1. General information from the publication (author name(s), publication year)
2. Participant demographics
   a. Participant information (sample size, population)
   b. Demographics of study participants (age, sex distribution)
   c. Etiology, symptom, and/or referral source
3. Protocol
   a. Bolus type, volume, and viscosity (product names provided as applicable)
   b. Participant positioning during visualization
4. Technical parameters of fluoroscopy
   a. Equipment: description provided as well as recording device(s) if reported
   b. Frame rate reported

**Study Quality Assessment**

Risk of bias in the studies included for review was assessed by the Downs and Black scale (Downs & Black, 1998). The ordinal and binary responses were coded, and inter- and/or intrarater reliability was assessed. Level of evidence was evaluated using the “Assessing the Evidence” Guidelines by the American Speech-Language-Hearing Association (ASHA, 2004a), based off of the Scottish Intercollegiate Guidelines Network (2002), which provides a hierarchy for level of evidence. All studies were evaluated by two independent raters, and disagreements were subject to discussion until a consensus could be reached.

**Summary Measures of Esophageal Findings**

The relative risk for accurate diagnosis was the primary measure of intervention (esophageal visualization) effect. The mean value of those participants identified with esophageal dysfunction or disorder when esophageal visualization was performed was calculated.

**Compliance With Ethical Standards**

There are no conflicts of interest to disclose. There were no human subjects directly involved in this study, and, therefore, there was no informed consent.

**Results**

**Participant Demographics**

Of the 3,221 total articles identified through the search, five articles (Gullung et al., 2012; Madhavan et al., 2015; Miles et al., 2015; Ortiz et al., 2019; Watts et al., 2019) met our inclusion criteria (see Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow chart, Figure 1). Of the five studies selected for review; none were randomized controlled trials. The studies included 111–307 participants. Mean age for all groups was 62.69 years with ages ranging from 15 to 95 years. Sex was distributed as approximately 46.76% females and 53.24% males. One article (Miles et al., 2015) reported etiology for all participants, including neurologic diseases, otolaryngology primary (e.g., head and neck cancer), and dysphagia primary (any type). See Table 1 for details.

**Protocol**

Other than the Gullung et al. (2012) study, which employed the MBSImP (Martin-Harris et al., 2008), no standardized, validated, and reliable protocols were utilized. For those studies that included stimuli for the esophageal visualization, the barium contrasts ranged from Varibar (Gullung et al., 2012; Madhavan et al., 2015), 40% w/v (Watts et al., 2019) to 100% w/v (Miles et al., 2015). A 13-mm barium tablet was included in three (60%) studies for the purpose of esophageal visualization (Madhavan et al., 2015; Miles et al., 2015; Watts et al., 2019). A single study (Madhavan et al., 2015) included an unmasticated marshmallow in their esophageal visualization protocol. When specifications for participant positioning was included (Gullung et al., 2012; Madhavan et al., 2015; Miles et al., 2015; Watts et al., 2019), participant positioning was similar across studies: The oropharynx was examined in the lateral plane, and the esophagus was viewed in the A–P projection. Miles et al. (2015) specified that patients were standing whenever possible, and Madhavan et al. (2015) specified that all participants were standing.

**Technical Parameters of Fluoroscopy**

Technical parameters of the fluoroscopy study and subsequent recording may impact the identification of esophageal abnormality. Two (40%) of the five studies reported the equipment used (Miles et al., 2015; Watts et al., 2019). No studies reported the recording technology, and only two studies (Miles et al., 2015; Watts et al., 2019) reported the recording medium: USB and digital, respectively. None of the studies reported pulse rate while two (40%) studies reported frame rate: 29.98 (Watts et al., 2019) to 30 (Miles et al., 2015) frames per second. Main sources of variability included the different protocols used, including different types of barium stimuli, and the technical aspects of the procedure.
Study Quality Assessment

The studies were assessed for bias using the Downs and Black (1998) checklist for measuring study quality with scores ranging from 6 to 14. See Appendix A. Level of the evidence assessment was completed using the Scottish Intercollegiate Guidelines Network methodology checklist for studies of diagnostic accuracy with studies qualifying as either acceptable or of high quality. See Appendix B.

Summary Measures of Esophageal Findings

When esophageal visualization is completed during videofluoroscopic swallowing assessment (MBSS), esophageal findings were identified in 48.67% (457/939) of participants (range: 26%–69.5%). See Table 2 for summary findings. This percentage reflects the “pass–fail” nature of a bolus follow-through when visualizing the esophagus indicating any esophageal abnormalities (including anatomic/structural, as well as gross physiologic findings [e.g., impression for dysmotility, increased esophageal transit time]).

Discussion
Detection of Esophageal Abnormality During Visualization

Esophageal abnormality was identified in an average of 48.67% of participants when visualization of the esophagus was included in MBSSs. This finding reinforces the historic stance of the important interrelationship between
<table>
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<tr>
<th>Authors</th>
<th>Participants</th>
<th>Demographics</th>
<th>Etiology/ Symptoms/ Referral Source</th>
<th>Protocol</th>
<th>Participant Positioning</th>
<th>Equipment</th>
<th>Frame rate</th>
<th>SIGN Assessment of Evidence&lt;sup&gt;a&lt;/sup&gt;</th>
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<tr>
<td>Gullung et al. (2012)</td>
<td>164 participants</td>
<td>Mean age 58 (range: 21–94), 75% female</td>
<td>Primary complaint was dysphagia (59%), review included those ICD-9 codes for oral, oropharyngeal, and pharyngoesophageal types. Other diagnoses included choking sensation (15%), globus (11%), regurgitation or reflux (6%), aspiration pneumonia (4%), odynophagia (4%), and chronic cough (1%).</td>
<td>MBSimP protocol consisting of 11 swallows of various consistencies (Varibar), Esophageal clearance (Component 17) evaluated in the upright position with one 5-ml nectar-thick bolus and one 5-ml pudding bolus</td>
<td>Upright: lateral projection for imaging of oropharynx and in the A–P projection for imaging of the pharynx and esophagus</td>
<td>Not reported</td>
<td>Not reported</td>
<td>High quality</td>
</tr>
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<td>Madhavan et al. (2015)</td>
<td>141 participants</td>
<td>Mean age 61.46 (range not reported), 37.59% female</td>
<td>All participants complained of globus sensation</td>
<td>Participants self-regulated bolus sizes of thin, nectar-thick, pudding Varibar, unmasticated marshmallow coated with contrast, and a 13-mm barium tablet</td>
<td>Lateral plane for the oropharyngeal imaging and the A–P plane for imaging of the esophagus in the standing position</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Miles et al. (2015)</td>
<td>111 participants</td>
<td>Mean age 71 (range: 20–95), 54% female</td>
<td>36 participants with neurologic diagnoses. 37 participants with dysphagia of unknown cause, 28 participants with primary otolaryngology diagnosis, 10 participants in “other” (e.g., unwell elderly) category</td>
<td>1 ml, 3 ml, and 20 ml of thin barium (EZ-Paque, EZ-EM), half a cup of thin barium via straw for oropharyngeal imaging. 20-ml bolus drunk consecutively and 13-mm barium tablet</td>
<td>Lateral plane for the oropharyngeal imaging and A–P projection while participant is upright, standing whenever possible for imaging of the esophagus</td>
<td>Videofluoroscope (Toshiba, Japan) and recorded on a USB drive with timing information was superimposed in 100ths of a second using a Horita VS-50 Video Stopwatch</td>
<td>30 frames per second</td>
<td>High quality</td>
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<sup>a</sup>SIGN assessment of evidence
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<th>Authors</th>
<th>Participant information</th>
<th>Demographics</th>
<th>Etiology/ symptoms/ referral source</th>
<th>Protocol</th>
<th>Participant positioning</th>
<th>Equipment</th>
<th>Frame rate</th>
<th>SiGN assessment of evidence&lt;sup&gt;a&lt;/sup&gt;</th>
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<tr>
<td>Ortiz et al. (2019)</td>
<td>216 participants</td>
<td>Mean age 63 (range not reported), 17% female</td>
<td>All participants reported globus pharyngeal sensation. Diagnosis reported for 99 participants: 6 neurodegenerative conditions, 22 with cancer history, 8 with Barrett’s esophagus, 63 with extraesophageal reflux. Referral sources reported for 79 participants: 55 from gastroenterology, 24 from otolaryngology.</td>
<td>Functional items assessed for oral, pharyngeal, pharyngoesophageal, and esophageal follow through listed. No materials were listed.</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Phillips BV Endura fluoroscopic C-arm unit (GE OEC 8800 Digital Mobile C-Arm system type 718074), recorded using the Digital Swallowing Workstation (Model 7120; Pentax)</td>
<td>29.98 frames per second</td>
</tr>
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<td>Watts et al. (2019)</td>
<td>307 participants</td>
<td>Mean age 60.5 (range: 15–95), 54% female</td>
<td>Referral sources included: otolaryngology, pulmonology, neurology, gastroenterology, internal medicine, allergy, and rheumatology. Esophageal portion only: ¼ graham cracker with 5-cc barium paste (Varibar), a 13-mm barium tablet, two large swallows of barium (EZ-Paque; volume self-regulated).</td>
<td>Upright in the lateral and A–P projections for oropharyngeal imaging and in the A–P projection for esophageal imaging</td>
<td>Not reported</td>
<td>Not reported</td>
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the oral, pharyngeal, and esophageal aspects of swallowing (Jones et al., 1985; Triadafilopoulo et al., 1992) and stresses the need to include esophageal visualization during the MBSS. Although esophageal visualization is not sensitive to all esophageal abnormalities, the inclusion of the esophagus during the MBSS can be an important first step and is likely to improve the accurate referral of patients for further esophageal testing, as appropriate. While visualizing the esophagus during the MBSS appears to provide important information for patient care, it is critical to acknowledge that we do not yet have an understanding of how esophageal function abnormalities visualized during the MBSS relate to esophageal function abnormalities assessed by the gold standards for the assessment of esophageal function.

### Variability in the Visualization of the Esophagus

The main sources of variability across the five articles in this review can be reduced to two categories where there was a lack of consistency in (a) the visualization protocol including variations in the barium stimuli used, and (b) the technical aspects of the procedure.

The esophageal visualization protocols varied across the five studies included in this review. Barium stimuli used in the various esophageal visualizations ranged significantly, when reported. It is worthy to note that the type of barium sulfate used in imaging is important not only for reproducibility but also for accuracy. Varibar (barium sulfate) is the only contrast specifically formulated for the dynamic imaging of the oropharynx (Bracco Diagnostics, 2016). Standardized barium preparation for MBSS (Martin-Harris, 2015) is critical since not only viscosities but also results are reproducible across studies, sites, and clinicians. However, the barium sulfate formulated for MBSS (Varibar) is not the contrast developed for imaging of the esophagus or other gastrointestinal structures. It is critical to acknowledge that products for the esophagus (e.g., E-Z-Paque, E-Z-EM) are formulated to coat gastrointestinal structures, whereas Varibar was created to result in minimal coating (Bracco Diagnostics, 2016). The presence of residue in the oropharynx for the purpose of the MBSS is symptomatic of deficit in the context of Varibar stimuli and may be asymptomatic in the context of bariums intended for gastrointestinal assessment. Varibar, however, may prove to be useful in the visualization of the esophagus as this may allow for fluoroscopic imaging of the esophagus for those patients who aspirate, or may have other limitations that preclude an esophagram (barium swallow). Notably, only three of five studies (Madhavan et al., 2015; Miles et al., 2015; Watts et al., 2019) specified the use of a barium tablet in their visualization protocol.

While two (40%) of five studies reported frame rate, no studies reported pulse rate. According to Bonilha, Blair et al. (2013), the discrepancies in pulse rates when comparing 15 pulses per second (pps) to 30 pps result in differences in consistency recommendations, treatment interventions, as well as the prognosis for returning to regular consistency solids and liquids for physiological impairments of swallowing. All studies using fluoroscopy should report the pulse rate and frame rate so that the validity of the study can be assessed by the reader. The method of recording the study for off-line evaluation also varied across the studies. Equipment, when reported, varied as did the recording mechanisms: USB (Miles et al., 2015) versus digital (Watts et al., 2019). Recording equipment was specified in two (40%) of five of the studies while none of the studies specified of the file type (e.g., MPEG, AVI). This variability across studies results in a general reduced ability to compare findings across all three studies.

Ultimately, this review demonstrates that the research in this area does not utilize a single standardized, reliable, and validated protocol (including stimuli, method of presentation, order of presentation, positioning, and recording). To this effect, in 1985, Jones et al. (1985) outlined a full protocol for dynamic imaging of the oral, pharyngeal, and esophageal aspects of the swallow following the full bolus trajectory. While this protocol was standardized, it does not have published reliability or validity data to support its use. The Madhavan et al. (2015), Miles et al. (2015), and Watts et al. (2019) studies did outline standardized protocols; however, only the MBSImP used by Gullung et al. (2012) is a standardized, validated, reliable visualization of the esophagus, which is done in the anterior–posterior plane with nectar and pudding consistencies (Martin-Harris et al., 2008).

Two aspects of the MBSS may enhance esophageal visualization. One aspect is the use of a 13-mm barium tablet. One difference between the protocols is that only three studies (Madhavan et al., 2015; Miles et al., 2015; Watts et al., 2019) used a 13-mm barium tablet, which is particularly useful, since it is sized to retain at any point in the esophagus that is pathologically narrowed. Allen et al. (2012) found that the addition of a 13-mm barium tablet demonstrated enhanced sensitivity in their esophageal screening protocol, improving from 63% to 71% when compared to a full esophagram. Only the Madhavan et al. (2015) study utilized a solid for the esophageal portion of the MBSS using an unmasticated marshmallow. Additionally, temporal measures for esophageal transit time may be valuable to the interpretation of esophageal visualization, as the literature has identified differences

### Table 2. Summary results for abnormal esophageal findings detected with an esophageal screen.

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<tr>
<td>Any primary esophageal abnormality</td>
<td>63.41%</td>
<td>69.5%</td>
<td>68%</td>
<td>45.83%</td>
<td>26%</td>
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across age groups (Miles et al., 2019, 2016) and variations in health versus disease (Miles et al., 2019). Future assessment of the impact of including a barium tablet and the consideration of temporal measures on the sensitivity and specificity of esophageal visualization would be beneficial.

**Clinical Implications**

The results of this systematic review indicate that visualization of the esophagus should routinely occur during an MBSS. The current limitations to the immediate clinical utility of these findings include (a) issues related to SLP scope of practice, (b) radiology requirements, and (c) patient factors.

Incorporating nondiagnostic visualization of the esophagus falls within the scope of practice for SLPs according to both the American College of Radiology (ACR, 2017) as well as ASHA (ASHA, 2003, 2004b). According to the ACR, the MBSS includes the assessment of “all phases of swallowing from the preparatory oral phase through the oral transfer phase and pharyngeal phase [and] The esophageal phase may be assessed on other swallows.” However, the ACR specifies that evaluation of the esophagus for diagnostic purposes requires an esophagram (ACR, 2017). ASHA guidelines for videofluoroscopic swallowing function by SLPs include the “screening of esophageal motility and gastroesophageal reflux” (ASHA, 2004b).

Incorporating esophageal visualization into the SLP practice has been shown to be feasible and that it can provide clinically relevant information. Miles (2017) found that, after completing a 1-day course on the esophagus, SLPs were able to achieve substantial (kappa = 0.61–0.80) interrater agreement for the need to refer to other services/specialties, judgments of the presence of stasis and bolus redirection, and perfect agreement (kappa = 1.0) for the rating of bolus transport time. Additionally, the MBSImP protocol training demonstrates an 80% or greater inter- and intrarater accuracy across all components, including esophageal visualization (Martin-Harris et al., 2008). Allen et al. (2012) found that esophageal visualization with a single 20-ml bolus of liquid Barium (E-Z-Paque) had a sensitivity of 63% and specificity of 100% when compared to findings from a full esophagram. Furthermore, Gullung et al. (2012) found that Component 17 of the MBSImP (Martin-Harris et al., 2008; esophageal clearance) had a sensitivity of 80% and a specificity of 48% when compared to high-resolution esophageal manometry with or without multichannel intraluminal impedance (HRM +/- MII).

Visualizing the esophagus in a standardized manner is a critical aspect of the evaluation of dysphagia and can also provide information about esophageal consequences of voluntary (believed to be ameliorative) oropharyngeal, laryngeal, and/or respiratory maneuvers. Using high-resolution manometry, O’Rourke et al. (2014) found that the Mendelson maneuver has the potential to create temporary esophageal outflow obstruction related to pan-pressure of the esophagus and reduced esophageal peristalsis, whereas an effortful swallow may improve esophageal peristalsis. The latter conclusion echoes an earlier study by Lever et al. (2007). A second swallow and rapid swallows, whether cued or volitional, both result in deglutitive inhibition that halts esophageal peristalsis (Hightower, 1955; Sifrim & Jafari, 2012, Tutuian et al., 2004). Narrowed focus on the oropharynx (and a primary concern for prandial aspiration) may blind clinicians to postprandial considerations of the esophagus. Thickening liquids to compensate for altered oropharyngeal physiology may also have unintended consequences for esophageal function (Jou et al., 2009; Miles et al., 2016). While these interventions may address oropharyngeal concerns, their esophageal manifestations must also be considered. A focus on compensatory strategies or exercises to improve oral or pharyngeal aspects of the swallow, as should be standard in the MBSS, should consider the consequences (positive or negative) for all aspects of the swallowing continuum (oral, pharyngeal, esophageal) as observable during fluoroscopy.

Radiologists may be hesitant to follow the bolus through the esophagus as they are obligated to comment on any findings and may be concerned regarding false negatives. Missed pathology in the esophagus is likely the primary concern; however, the positive predictive value of identifying esophageal carcinoma via a double contrast esophagram is 86%. Mediastinal tumors are identified via computed tomography in 52%–89% of cases (Iyer & Dubrow, 2004). These statistics indicate that the preferred diagnostic imaging studies also carry the risk of unidentified pathology.

To mitigate the risk, the radiologist’s dictated report should include language to clarify the limited nature of the esophageal visualization during an MBSS. Furthermore, the hesitation to visualize the esophagus may also reflect the perpetuation of the myth that swallowing occurs in distinct “phases.” Levine and Rubesin (2017) state that the “arbitrary division between speech pathologists assessing the oral phases of swallowing and radiologists assessing the esophageal phase violates the basic tenet that swallowing begins at the lips in the oral cavity and ends when barium reaches the stomach.” In fact, the collaboration between the SLP and the radiologist can only yield improved overall assessment. As Ott et al. (1990) state, “close cooperation between the [SLP] and radiologist better defines the specific swallowing problems, avoids inadvertent aspiration of large amounts of contrast material, and best directs proper management of the patient.” However, it should be noted that, as Miles et al. (2015) stated, SLPs are not esophageal diagnosticians. Thus, the inclusion of esophageal visualization for the purpose of bolus follow-through is not intended to be utilized as a thorough diagnostic assessment of the esophagus, rather a tool to enhance the understanding of the biomechanically interdependent aspects of the swallowing continuum and to inform the need for referral to other medical specialists, as applicable.

Concerns regarding additional radiation exposure related to the addition of esophageal visualization may arise under the As Low As Reasonably Achievable (Nuclear Regulatory Commission Regulations, 2007) principle of radiation safety, where efforts should be made to reduce
radiation exposure. However, Bonilha et al. (2019) identified that the exposure to adults in MBSS examinations is minimal and outweighs the risk of not imagining or inappropriately reducing the pulse rate to reduce radiation risk. The additional time associated with esophageal visualization should not be a critical decision-making point for clinicians, as the average length of an MBSS using the MBSImP protocol, including esophageal visualization, is 2.9 min (Bonilha, Humphries, et al., 2013), which is well below the recommended limits (Martin-Harris & Jones, 2008). It is critical to highlight that the esophageal visualization does not and should not be advocated for in lieu of the traditional esophagram or upper gastrointestinal series, which are distinct and separate assessments from the MBSS.

As is typical with other clinical aspects of the MBSS, the clinician must use best judgment as to the needs of the patient. This critical thinking extends to the determination to move forward with different consistencies, to trial compensatory strategies and/or maneuvers, or to terminate the exam for safety reasons. In addition, this clinical decision making, too, should extend to visualizing the esophagus and the determination of the appropriate consistencies to use. Many of the presenting symptoms for esophageal dysphagia are with solids or pills. While the MBSImP uses nectar-thick liquid and pudding Varibar (barium) for the esophageal visualization component, the protocol is designed for clinicians to add clinically relevant trials (to develop an informed treatment plan). Ultimately, clinicians must consider the patient’s health and the benefit of the information to be gained when determining whether to proceed with the esophageal portion of the examination. It should be acknowledged that not all patients will be able to undergo an esophageal visualization due to patient tolerance: body habits, presence of and amount of aspiration, as well as the patient’s ability to readily or reasonably alter position.

**Implication of Omitting Esophageal Visualization**

Esophageal clearance was abnormal in 63.4% of participants in the Gullung et al. (2012) study, and 82% of patients with abnormal esophageal findings also had atypical findings for the onset of the pharyngeal swallow. Miles et al. (2015) found a statistically significant relationship where 90% of patients with esophageal abnormalities also had reduced maximal pharyngeal esophageal segment opening duration. Furthermore, 50% of participants with prolonged esophageal transit also had oral abnormalities, though acknowledged to be only significant in a subset of participants. Esophageal abnormalities were the most common finding in the Miles et al. (2015) study and, most importantly, without the esophageal visualization, 33% of abnormalities in the esophagus would have gone undetected and another 33% would have been inaccurately treated as oropharyngeal dysphagia. Watts et al. (2019) found that 26% of their participants had an esophageal abnormality that would have gone undetected without esophageal visualization. Thus, current literature indicates that visualizing the esophagus during an MBSS is likely to impact at least a quarter of the patients undergoing MBSSs. Additionally, symptom localization lacks accuracy with esophageal visualization. Madhavan et al. (2015) found that 69.5% of their participants presenting with globus had a primary esophageal deficit. Ortiz et al. (2019) found that, in their participants, all of whom presented with globus, 45.83% had a primary dysfunction of the esophageal body, and 72.2% had abnormalities of the pharyngoesophageal segment providing further evidence for the need to consider swallowing as a continuum to achieve an accurate diagnosis.

The results of the review highlight that some oropharyngeal findings may correlate with co-occurring or primary esophageal dysphagia. Some pharyngeal or pharyngoesophageal segment findings may be indicative of esophageal dysphagia. For example, finding cricopharyngeal prominence (bar) during the MBSS is a clinical sign that may indicate esophageal deficit. Miles et al.’s (2015) findings support the historic opinion of Jones et al. (1985) that, with the identification of a prominent cricopharyngeus, “intensive examination of the esophagus and a search for signs of compensation or decompensation in the pharynx should be undertaken.” If an esophageal component is suspected or indicated per patient symptoms, esophageal visualization should always be completed, or attempted, during the MBSS. It should be noted that there may be instances where the deficit is isolated to a single aspect of swallowing; however, given that all of the available assessment methods used for swallowing fail to assess the continuum as a whole, we cannot rule this in or out.

Limitations include the small number of articles in this review, reflective of the necessary exclusion criteria. Only one study (Gullung et al., 2012) included a reference to provide sensitivity and specificity when measured against a standard high-resolution manometry with impedance. Gullung et al. (2012) was the only study to utilize a standardized, validated, and reliable protocol with the MBSImP. The majority (4/5) of the studies in this review were retrospective, highlighting a gap in the research for prospective randomly controlled trials for true comparison between groups with and without esophageal visualization.

In conclusion, the findings from this literature review support the utility of standardized esophageal visualization practices as a critical component to the MBSS. If the esophagus is excluded in the diagnosis and treatment of swallowing disorders, we will miss not only the esophageal findings but also the nuances of the physiologic inter-relationship between the oral, pharyngeal, and esophageal aspects of the swallow. Diagnostic and treatment recommendations are likely to be impacted, perhaps even negatively, if those recommendations result in unnecessary interventions having missed the primary deficit by omission of esophageal visualization. Furthermore, some compensations and/or exercises prescribed to address oropharyngeal deficit have been shown to have a negative impact on esophageal function (O’Rourke et al., 2014). By omitting the esophagus, our diagnoses invariably default to oropharyngeal: Altering food and/or liquid consistencies or...
recommendations for oropharyngeal dysphagia-focused exercises would be futile if the primary culprit for the deficits lies below the cricopharyngeus (or any other arbitrary boundary). Swallowing is indeed a continuum of anatomic and biomechanically contiguous events and should be evaluated and treated as such.

References
Appendix A

Scottish Intercollegiate Guidelines Network: Checklist for Studies of Diagnostic Accuracy (SIGN, 2006)

<table>
<thead>
<tr>
<th>Authors (year)</th>
<th>Domain 1</th>
<th>Domain 2</th>
<th>Domain 3</th>
<th>Domain 4</th>
<th>Domain 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gullung et al. (2012)</td>
<td>Y Y Y Y Y Y N Y Y Y Y N Y Y</td>
<td>high quality</td>
<td>directly applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madhavan et al. (2015)</td>
<td>Y Y Y Y * * Y Y * Y Y Y N</td>
<td>acceptable</td>
<td>some indirectness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miles et al. (2015)</td>
<td>Y Y Y Y Y N Y Y Y Y Y Y Y</td>
<td>high quality</td>
<td>directly applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ortiz et al. (2019)</td>
<td>Y Y Y Y * * Y Y * Y Y Y N</td>
<td>acceptable</td>
<td>some indirectness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watts et al. (2019)</td>
<td>Y Y Y Y N Y Y Y Y Y Y Y</td>
<td>high quality</td>
<td>directly applicable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Y = yes; N = no; * = not applicable.

Appendix B

Downs and Black (1998) Checklist

| First author (year) | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 QUALITY: |
|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Gullung et al. (2012) | 1 1 0 1 0 0 0 1 0 0 1 0 0 0 0 1 1 1 0 1 0 0 0 1 0 1 1 1 1 1 |
| Madhavan et al. (2015) | 1 1 1 1 0 1 0 0 0 0 0 0 1 0 0 1 1 1 0 1 0 1 0 0 0 0 0 1 0 1 1 |
| Miles et al. (2015) | 1 1 1 1 0 1 0 0 0 1 1 0 1 0 0 1 0 1 1 1 0 0 0 0 0 0 1 0 1 0 1 |
| Ortiz et al. (2019) | 1 1 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 |
| Watts et al. (2019) | 1 0 1 0 1 0 0 0 0 0 0 1 0 0 1 1 1 1 1 0 1 1 0 0 1 0 1 0 1 |

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