Real-Time Radiographic Identification of Contrast Consistency in Modified Barium Swallow Studies: An Alternative Technique


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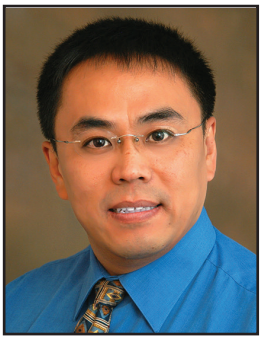
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Contrast agents of varying consistency, ranging from thin liquids to solids, are utilized in modified barium swallow (MBS) studies, typically without real-time radiographic labeling. We describe a method for identifying the contrast consistency using radiographic labels during each fluoroscopy sequence. Two cases demonstrating the utility of the radiographic labels in clinical practice are described in detail. Case 1 demonstrates placement of labels prior to each swallowing trial, enabling rapid and accurate identification of the contrast consistency administered. Case 2 demonstrates ambiguities that can occur due to absence of real-time labeling. Our labeling method is an easily implemented and cost-effective technique to promote increased accuracy. Real-time labeling of sequential MBS studies facilitate assessment on sequential studies and for different RIS/PAC systems and will reduce ambiguities and misinterpretations.

INTRODUCTION

Oropharyngeal dysphagia is a potential complication of numerous neurologic and muscular diseases including stroke, multiple sclerosis, Parkinson's disease, dementia and myositis and may also arise through structural compression such as by head and neck cancers.[1,2,3] Presently, modified barium swallow (MBS), or video fluoroscopic swallow study (VFSS), is the modality of choice in evaluating this type of dysphagia. This study utilizes different consistencies of contrast (thin liquid, nectar, honey, pudding and solids) to assess oral, pharyngeal and epiglottic dysfunction that may lead to the development of aspiration events with resulting pneumonia.[4] In current clinical practice, multiple consistencies are imaged in succession as a patient may tolerate ingestion of one consistency but not another. This information is vital for the speech language pathologist (SLP) to determine appropriate dysphagia treatment plans and to accurately prescribe nutritional recommendations in order to prevent aspiration and malnutrition.[5] Typically, identification of the administered consistency is provided verbally at the time of imaging or post-procedurally through either hand-written notes, post procedure annotations of images or, less commonly, through audio recording. Real-time radiographic labeling at the time of imaging displaying

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the consistency administered is typically absent. Despite the advantages of annotating the MBS exam to reduce ambiguity and potential miscommunications, its use is not common practice. Lack of real-time labeling by the examining radiologist may be due to perceived reductions in efficiency, increased work burden and cost of implementation. Furthermore, lack of adequate labeling for any individual study may be seen as inconsequential. With serial swallowing evaluations that are commonly performed in the setting of acute stroke to assess for neuromuscular recovery, the importance of reliable communication between the various consistencies administered becomes even more critical.

The volume of serial swallowing studies has progressively increased over the past decades due to more frequent assessments for dysphagia in patients with acute stroke, myositis and progressive neuromuscular diseases.[1] As significant improvements in swallowing function may be rapid in some patients, correct identification of improvement compared to previous studies is important in preventing unnecessary invasive interventions such as placement of a long-term percutaneous endoscopic gastrostomy (PEG) tube or nasogastric tube (NGT), or initiation of total parenteral nutrition (TPN). This further highlights the importance of a reliable radiographic labeling technique.

With more frequent indications of serial assessment, regular labeling of the contrast consistency administered will enhance interdisciplinary communication and create less ambiguity and greater ease in evaluating both retrospective and serial studies, particularly if the studies are performed by different members of the healthcare team or from outside referrals.We therefore detail an alternative technique for the examining radiologist to provide real-time radiographic identification at the time of imaging of the contrast consistency administered.

Materials and Methods

Labels denoting different contrast consistencies using radiopaque alloy letters by Pb Markers, an online company specializing in custom-made markers, were created. Each label measured approximately 2 x 1 inches and cost $10 USD to procure. The labels were then reversibly attached by Velcro pads to a painter's stick measuring 20 x 1.5 inches. One end of the painter's stick displays the contrast consistency that is administered, and the other end holds the unused labels (Figure 1). At the beginning of each consistency trial of the swallowing study, the examining radiologist passes the end of the painter's stick with the appropriate Pb label between the patient and the image intensifier. This provides radiographic identification of the contrast consistency in real-time at the time of imaging.

Figure 1. Radiographic Labels

RESULTS

Case 1. Use of Radiographic Labels in Clinical Practice

A 77-year-old woman with a history notable for gastroesophageal reflux disease and diabetes, but without history of dysphagia, undergoes an MBS study (Figure 2). Panels 2A-2D show the placement of the radiographic labels prior to administration of the contrast material. Panels 2E-2H show the pharyngeal phase of swallowing with the contrast material corresponding to the labels on the upper panel. This swallowing study revealed grossly adequate oropharyngeal swallowing function with all contrast consistencies administered, without laryngeal penetration or aspiration. Notably, without adequate labeling of each consistency, one cannot reliably distinguish the contrast consistencies from fluoroscopic appearance alone.

Case 2. Improved Efficiency with Radiographic Labeling in Serial Evaluations

A 59 year-old male, hospitalized due to severe burn, underwent an MBS study which revealed pharyngeal deficits resulting in aspiration on initial assessment. Figure 3A and B show the initial swallowing assessment

with thin and nectar liquids without any radiographic labeling at the time of imaging. A follow-up evaluation was completed one week later (Figure 3C and D). Non real-time labeling made it difficult to distinguish changes using different contrast consistencies on initial study as well as serial studies. With more frequent indications for serial assessment, as in this case study, real time labeling of contrast consistency will enhance interdisciplinary communication and create less ambiguity in evaluating both retrospective and serial studies from the same or different institutions.

DISCUSSION

We presented two cases where real-time radiographic labeling facilitated diagnostic evaluation by providing accurate and unambiguous identification of the contrast consistencies administered. Presently, the identification of the contrast consistency administered during fluoroscopy is typically provided verbally at the time of imaging between members of the healthcare team and annotated post-procedurally through hand-written, audio or digital means. Current practices may be prone to errors stemming from misinterpretations between team members at the time of imaging, and erroneous recall occurring post-procedurally due to delays in annotation.

We believe that adoption of a system in which the examining radiologist labels the contrast consistencies in real-time at the time of imaging would improve efficiency and reduce ambiguity and potential errors from miscommunication. Use of hand-written, audio or digital annotations do not always accompany the fluoroscopic images, leading to delays in assessment, particularly during retrospective reviews. It is interesting to note that some audio recordings do not become part of the patient's electronic medical record (EMR) but are stored on a separate disc or on a dysphagia work station (DWS). Lack of adequate identification of the consistencies administered may also lead to ambiguity and potentially incorrect assessments of swallowing function by the healthcare team. This can result in improper recommendations for the patient that can have disastrous consequences for the patient including aspiration pneumonia, and decreased quality of life.[4,5] Furthermore, lack of labeling may limit the utility of studies for future educational and research purposes.

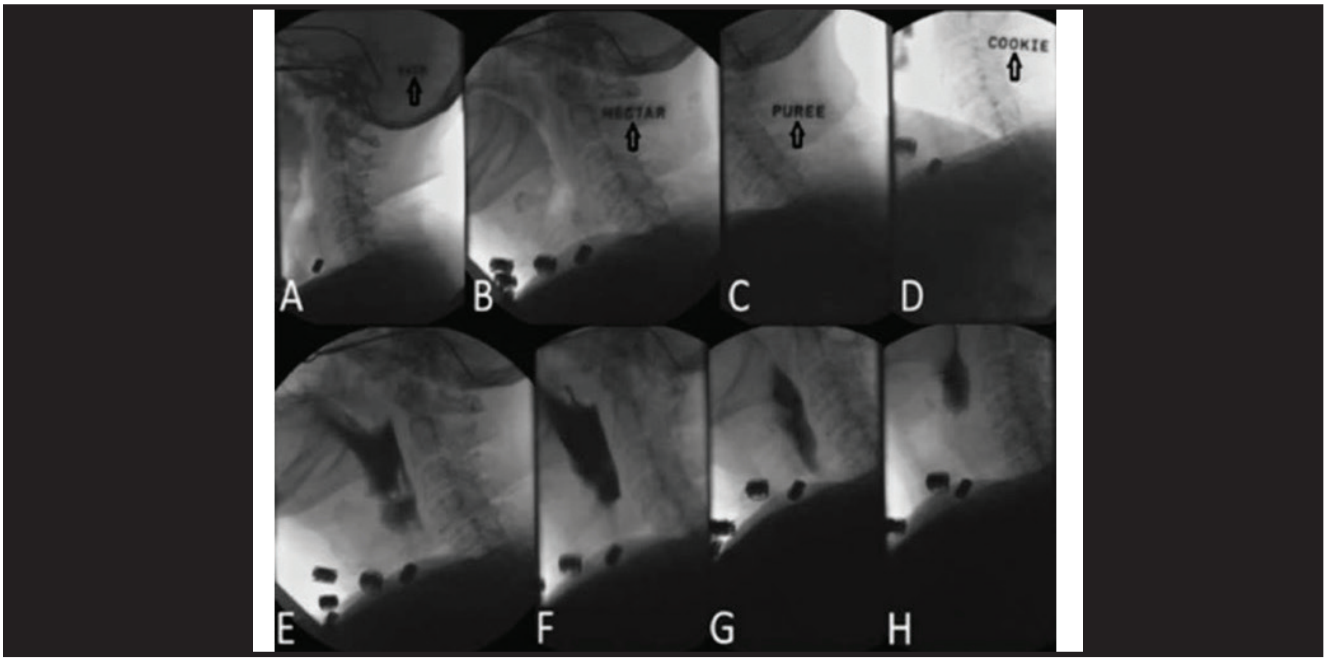

Figure 2. Radiographic Labels in Clinical Practice
Panels 2A-D show the use of radiographic labels, corresponding to thin, thick, puree, and solid consistency, respectively, prior to ingestion of contrast material in a modified barium swallowing study. Panels 2E-H show the fluoroscopic image during the pharyngeal phase of swallowing with different consistencies of contrast material, corresponding to thin, thick, puree, and solid consistency, respectively. Arrow denotes radiographic labels.

The advantage of radiographic labeling in real-time is its intrinsic inclusion into the fluoroscopic images, reducing ambiguity associated with an unlabeled MBS study.

The advantages of real time labeling of MBS studies are particularly evident in serial evaluations for dysphagia. Retrospective review of the fluoroscopic images obtained from earlier studies may also be important for proper assessment of interval changes in swallowing function of the patient. As serial evaluations may be performed by different members of the healthcare team, proper communication of the contrast consistency administered in each trial is paramount to the proper nutritional and therapeutic recommendations made by the SLP.[4] Common concerns to our method of real-time labeling includes the perception of decreased efficiency, the possibility of additional radiation exposure to the patient and operator and potential cost of constructing the radiographic labels. In our clinical practice, efficiency of the MBS studies was largely unchanged, and patients were not exposed to any significant additional radiation due to the same length of the exam. Furthermore, the operator is at no point in the direct radiation field due to the extended reach provided by the painter's stick that is carrying the radiopaque labels. In terms of costs of implementation, the materials used to assemble our radiographic labels were inexpensive and readily bought from local or online retailers.

When the initial study of our burn patient was retrospectively reviewed for assessment of interval changes, there were significant ambiguities regarding which contrast consistencies were administered with each trial as more fluoroscopic sequences were obtained than the consistencies administered. Correct pairing of the contrast consistencies with their respective fluoroscopic videos was performed only after contact between the SLP and radiologist who were present at the time of the original study. The inefficiencies and ambiguities observed in this case would have been further accentuated in patients with more numerous studies and unlabeled trials, further highlighting the importance of regular labeling technique.

Consistent identification of contrast consistency may not be routinely performed due to perceptions that labeling increased work burden and reduces efficiency,

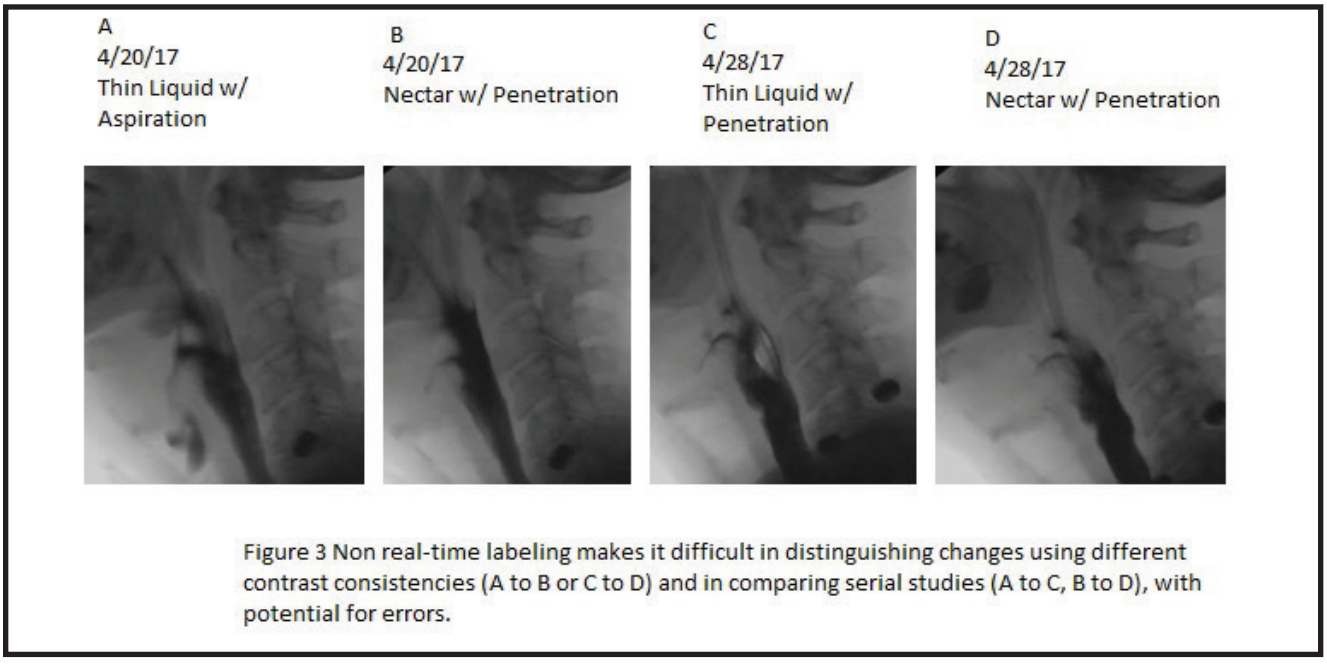

Figure 3. Improved Efficiency with Radiographic Labels in Serial Evaluations
Panels 3A-D shows a segment of the initial swallowing assessment performed with the thin consistency of barium contrast. Notably, significant laryngeal penetration and aspiration were noted, and no radiographic labels were utilized in the study.

and that lack of labeling has few adverse consequences. Implementation of our method is inexpensive and potentially may enhance communication between operators and reviewers of the examination. There are other methods that may be used to identify the contrast consistency at the time of examination, including audio recordings and annotations that are not universally utilized in current clinical practice.

CONCLUSIONS

We describe an alternative, easily implemented and cost-effective technique to provide real-time labeling of contrast consistencies administered during modified barium swallow studies. Consistent and adequate identification of contrast consistencies will reduce ambiguities stemming from poor labeling technique. Implementation of the method described above may lead to improved interdisciplinary communication, increased patient care and safety and may facilitate further education and research. A more detailed study of comparing our labeling technique with other institutions, would help validate its importance to the dysphagia patient. ■

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