

## Chapter 2

# The Videofluoroscopic Swallow Study Technique and Protocol

The videofluoroscopic swallow study (VFSS) is the current gold standard for the diagnosis and management of oropharyngeal dysphagia. It provides a comprehensive evaluation of the oral, palatal, pharyngeal, and pharyngoesophageal segments of deglutition. Other terms to describe a radiographic swallow study include the modified barium swallow, the dynamic swallow study, and the cookie swallow. The American Speech-Language-Hearing Association (ASHA) routinely uses the terminology “videofluoroscopic swallow study,” and it will likewise be used to refer to this investigation throughout this text. The VFSS does not uniformly include an evaluation of the esophageal phase of deglutition. The esophageal portion of the comprehensive swallow study will be referred to as the videofluoroscopic esophagram (VFE—Chap. 3).

Various techniques have been described to perform the VFSS. Methods differ from institution to institution; variables include the type, consistency, and quantity of contrast agent used. The swallowing clinician must be aware that variation exists among radiographic technique, equipment used, radiologic view, study capture rate, and patient position. Each of these factors has a significant contribution to the information acquired during the investigation. In order to reliably compare studies between patients and within patients pre- and post-intervention, it is essential to perform every investigation in a standardized and systematic manner. Precise and reproducible VFSS interpretation depends on this methodological approach. The protocol we use has been refined over 30 years of practice at our Center and is described in detail below.

We perform all of our studies using a properly collimated OEC Medical Systems mobile 9800 Radiographic/Fluoroscopic unit (OEC Medical Systems, Salt Lake City, UT) that provides 63 kV, 1.2 mA-type output for the full field-of-view mode (12-in. input phosphor diameter). We prefer the mobility of the C-arm to fixed fluoroscopic units (Fig. 2.1). The orbital rotation of the C-arm affords flexibility and provides the ability to study patients of various sizes at diverse angles and image projections. All studies are performed in a lead-lined room by a licensed radiology technician and speech language pathologist (SLP) and are later reviewed by a physician licensed in fluoroscopy from the Radiologic Health Branch (RHB) of the California Food, Drug, and Radiation Safety Division of the Department of Public

**Fig. 2.1** Positioning of the C-arm fluoroscopic unit during examination of a patient in the lateral fluoroscopic view. There is a disk of known diameter taped under the chin, a towel protecting the clothing from spilled barium, and a lead apron shielding the reproductive organs



Health. The studies are digitally recorded on nStream G3 HD/SD (Image Stream Medical Inc., Littleton, MA) at 30 frames per second (fps) for later slow motion playback and analysis. The nStream system is integrated with the electronic medical record (Epic Systems, Verona, Wisconsin) and can be accessed from any computer with an internet connection.

The ability to record the studies at 30 fps and review in a frame-by-frame manner is essential for precise interpretation and analysis. Studies obtained at capture rates less than 30 fps may miss significant pathology. All examinations are reviewed weekly during an interdisciplinary panel that includes SLPs, nurses, physicians, students, and dietitians.

Patients are weighed, measured, and given the validated ten-item Eating Assessment Tool (EAT-10) prior to the administration of barium and the results are documented in the EMR (Fig. 2.2). The height and weight afford calculation of the BMI, which assists with the assessment of nutritional status. The association of patient symptoms captured by the EAT-10 with VFSS findings provides essential information to assist the clinician with the development of a comprehensive treatment plan. The EAT-10 documents the level of baseline disability and is instrumental in monitoring treatment efficacy.

We use a 60% weight/volume (w/v) ratio of barium sulfate (Fig. 2.3; EZpaque, Westbury, NJ). This contrast agent has the rheological properties of a nectar thick liquid. The use of a nectar thick liquid for the VFSS has advantages and limitations. Higher density barium formulations (nectar and honey thick) are more viscous. The increased viscosity and subsequent mucosal adherence provides better visualization of subtle pathology such as webs, rings, and cricopharyngeus muscle bars that may otherwise be missed. The higher density barium is also more radiopaque and is easier to visualize under fluoroscopy. Less dense agents that behave like a thin liquid do not provide the anatomic detail nor possess the mucosal adherence of the thicker formulations. Although our protocol does not routinely utilize less dense, thinner barium for these reasons, we will, on occasion, dilute the suspension by

Eating Assessment Tool (EAT-10)  
Circle the appropriate response

To what extent are the following scenarios problematic for you?	0 = No problem    4 = Severe problem				
1. My swallowing problem has caused me to lose weight.	0	1	2	3	4
2. My swallowing problem interferes with my ability to go out for meals.	0	1	2	3	4
3. Swallowing liquids takes extra effort.	0	1	2	3	4
4. Swallowing solids takes extra effort.	0	1	2	3	4
5. Swallowing pills takes extra effort.	0	1	2	3	4
6. Swallowing is painful.	0	1	2	3	4
7. The pleasure of eating is affected by my swallowing.	0	1	2	3	4
8. When I swallow food sticks in my throat.	0	1	2	3	4
9. I cough when I eat.	0	1	2	3	4
10. Swallowing is stressful.	0	1	2	3	4
Total EAT-10					

Fig. 2.2 The ten-item Eating Assessment Tool (EAT-10)

Fig. 2.3 Sixty percent weight/volume ratio of barium sulfate (EZpaque, Westbury, NJ)



**Fig. 2.4** Boundaries of the lateral fluoroscopic view (1 lips, 2 nasopharynx, 3 cervical spine, 4 cervical esophagus). There is also an obstructing cricopharyngeus muscle bar (*red asterisk*) and a dilated pharynx (*red arrowheads*)



50% using water. Patients at risk of aspirating thin liquids will have an increased likelihood of aspirating the thinner barium formulation. The information acquired from the thinner, less dense formulation may assist with treatment recommendations but it will also have direct implications on study analysis. All of the normative data for the objective fluoroscopic measures that we use (Chap. 7) are based on use of the 60% w/v barium concentration. Altering the density of the barium will have a direct effect on deglutitive measures such as pharyngeal transit time and opening. This alteration will make the interpretation of objective fluoroscopic measures inaccurate. For this reason, we perform the majority of our VFSSs with the 60% w/v formulation. It is essential that the clinician take the density of the barium into consideration when performing and analyzing these investigations. A comprehensive investigation of the benefits and limitations of precise barium formulations has not been conducted and warrants future study. Our experience suggests that the 60% w/v formulation provides a balance between the desired rheology and the ability to provide optimal anatomic detail.

The patient is positioned in an examination chair with the fluoroscopy unit in the lateral position. The patient head position is neutral and facing forward (Fig. 2.1). Clothing, jewelry, and other artifacts that may interfere with the fluoroscopic image are removed and stored. A lead apron is placed over the patient's pelvic region to protect the reproductive organs and a towel is draped over the shoulders and lap to prevent drips of barium from getting on patient clothing. A radiopaque disk of known diameter (19 mm) is secured to the patient's chin with tape to allow for later calibration during the on screen calculation of objective fluoroscopic swallow measures (Chap. 7). The boundaries of the fluoroscopy field in the lateral view are the lips anteriorly, nasopharynx superiorly, cervical spine posteriorly, and cervical esophagus inferiorly (Fig. 2.4). The boundaries of the fluoroscopy field in the anterior-posterior (AP) view are the walls of the pharynx laterally, the nasopharynx

**Fig. 2.5** Boundaries of the anterior-posterior fluoroscopic view (1 lateral pharyngeal walls, 2 nasopharynx, 3 cervical esophagus)



superiorly, and the cervical esophagus inferiorly (Fig. 2.5). The patient is positioned upright with the spine perpendicular and the chin parallel to the floor. A standardized position is essential. Subtle variations in head tilt or position may alter swallowing biomechanics and are to be avoided unless specific maneuvers are being tested.

The study protocol proceeds in a stepwise fashion (Table 2.1). If the initial barium administration does not pose a threat to patient safety, the study proceeds to the next bolus size without a change in instruction. If swallowing function is determined to be hazardous, the protocol is modified to enhance patient safety. Compensatory maneuvers such as a chin tuck, head turn, or breath hold may be utilized. These strategies will alter swallowing biomechanics and must be noted during the interpretation of the study. If the maneuvers are unsuccessful and the further administration of barium poses too great a threat to patient safety, the study is terminated. The harm from potential barium aspiration must be weighed against the need to obtain quality information that will lead to improved patient health.

Patients are administered liquid barium boluses in precise aliquots of 1, 3, and 20 ml in the lateral fluoroscopic view. The barium is administered by syringe for the 1 and 3 ml boluses and by graduated medicine cup for the 20 ml bolus. For each bolus, the patient is instructed to hold the bolus in the oral cavity and wait. The patient is then instructed to, “swallow it all at once.” Following the liquid barium, the patient is administered a 3 ml 60% w/w barium paste bolus (E-Z-Paste; E-Z-EM, Inc.). A 60 ml liquid barium bolus is then administered by sequential straw drinking. The patient is instructed to place the straw in their mouth and drink the barium as fast as they can. The radiopaque disk is moved to a location at the level of the UES and the patient is positioned in the AP view. Liquid barium boluses of 3 and 20 ml, and a 13 mm barium tablet (Merry X-Ray Corp., San Diego, CA) are administered.

**Table 2.1** VFSS protocol

<i>Lateral fluoroscopic view</i>
1 ml 60 % w/v liquid barium
3 ml 60 % w/v liquid barium
20 ml 60 % w/v liquid barium
3 ml 60% w/w barium paste
60 ml 60 % w/v liquid barium sequential straw task
<i>Anterior–posterior fluoroscopic view</i>
3 ml 60 % w/v liquid barium
20 ml 60 % w/v liquid barium
13 mm barium tablet
<i>VFSS videofluoroscopic swallow study</i>

The AP fluoroscopic view provides important clinical information regarding the laterality of bolus flow and pharyngeal residue that cannot be obtained from the lateral projection. It also provides an important assessment of AP opening. Normative data on AP opening are available and diminished opening identifies pathology such as a stenosis or web that may be missed on the lateral study. The AP view also provides important information regarding the dimensions and location of pharyngeal (pulsion), pharyngoesophageal (Zenker), and cervical esophageal (traction) diverticuli (Fig. 2.5).

The patient is again returned to the lateral position. Speech tasks are performed to evaluate palatal competence. The patient is asked to say a repeated “k” and then “ka” to evaluate lingual-palatal and velopharyngeal competence. The patient may be asked to cough and spit to evaluate the effectiveness of clearing penetrated or aspirated barium. Asking the patient to blow against resistance may also be performed to assess asymmetries in pharyngeal wall tone.

If the etiology of the patients swallowing function is not revealed at the completion of the protocol, the patient may be administered a thin liquid bolus by diluting the barium with 50 % water. Patient-specific dysphagia complaints such as certain swallowing positions or particular foods may be studied after completion of the systematic protocol. If protective maneuvers or positioning strategies have not been evaluated then they are performed before the study is complete. Total fluoroscopy time is limited to 3 min or less.

## Suggested Reading

- Belafsky PC, Mouadeb DA, Rees CJ, Pryor JC, Postma GN, Allen J, Leonard RJ. Validity and reliability of the Eating Assessment Tool (EAT-10). *Ann Otol Rhinol Laryngol*. 2008 Dec;117(12):919–24.
- Fink TA, Ross JB. Are we testing a true thin liquid? *Dysphagia*. 2009 Sep;24(3):285–9.
- Kendall KA, Leonard RJ, McKenzie S. Airway protection: evaluation with videofluoroscopy. *Dysphagia*. 2004 Spring;19(2):65–70.
- Kendall KA, Leonard RJ, McKenzie SW. Accommodation to changes in bolus viscosity in normal deglutition: a videofluoroscopic study. *Ann Otol Rhinol Laryngol*. 2001 Nov;110(11):1059–65.

- Leonard RJ, Kendall KA, McKenzie S, Gonçalves MI, Walker A. Structural displacements in normal swallowing: a videofluoroscopic study. *Dysphagia*. 2000 Summer;15(3):146–52.
- Leonard R, Kendall C, editors. *Dysphagia assessment and treatment planning: a team approach*. 2nd edn. San Diego: Plural Publishing; 2007.
- Shaker R, Belafsky PC, Postma GN, Easterling C, editors. *Principles of deglutition: a multidisciplinary text for swallowing and its disorders*. New York: Springer; 2012.
- Shaker R, Belafsky PC, Postma GN, Easterling C, editors. *Manual of diagnostic and therapeutic techniques for disorders of deglutition*. New York: Springer; 2012.

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