Interpretation of Videofluoroscopic Swallow Studies of Infants and Children

A study guide to improve diagnostic skills and treatment planning

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## Interpretation of Videofluoroscopic Swallow Studies of Infants and Children

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Chapter I

Introduction

This eCourse’s manual and videos were developed to give you an opportunity to gain experience in reading radiographic swallow studies in order to improve and test your skills with infants and children. Northern Speech Services has another eCourse with videos and manual available that focuses on reading radiographic studies of adults (author: Jeri A. Logemann, PhD).

This eCourse contains 25 swallowing studies that include the entire examination so that you can be aware of the process that this author used for each child. Most exams were completed with infants and young children. A few studies are included with older children who demonstrate findings that are pertinent for pediatric focused speech-language pathologists (SLPs) to recognize and incorporate into management decisions.

The primary goals of this eCourse’s videos and manual are to provide you opportunities to increase your experience to:

1. Identify anatomy and read the study in relation to normal physiologic function for safety of oral feeding appropriate for the patient’s age and developmental skill levels overall. Note: We are limited in normalcy data for “typical” infants and children, since it is difficult to obtain Institutional Review Board approval for radiographic studies in normal infants and children;

2. Identify swallowing disorders in relation to patient’s age & developmental skills;

3. Determine the effects of those disorders in relation to presence of aspiration, laryngeal penetration, timing of pharyngeal swallow initiation, and pharyngeal residue;
4. determine alterations during the examination that may be useful in management decisions (keeping in mind that findings in this study make up just a small piece of the diagnostic and management puzzle); and

5. make recommendations for management decisions that are likely to be multi-factorial.

The videos should give you experience in identifying swallowing disorders or problems, in recognizing the effects of the problems that include aspiration and residue, and in making alterations or adjustments during the examination to determine a basis for development of a therapeutic intervention plan. You will also gain experience in making recommendations regarding the patient’s need for swallowing therapy, or swallowing and feeding therapy, and other types of intervention that may be appropriate. You will be challenged to make prognoses regarding safety or appropriateness of total oral feeding, partial oral feeding, and in some instances non-oral feeding. You will decide under what circumstances taste practice may be encouraged and when/why further evaluation may be needed.

How to Use This Manual

Read Section II (Anatomy and physiology: Basis for reading x-ray swallow studies) before you look at any of the video studies. This manual is organized so that you will “read” the x-ray study. Your first step should be to identify the anatomy. Then concentrate on the physiology as you describe the swallowing process and define “normal” findings and/or the disorder(s) for each examination. You may find it helpful to use the work sheet sample at the end of this section so you can do your review in a systematic way. Then make decisions regarding management options, which are typically not clear cut. You may find it helpful to review the history and reason(s) for referral so
that you can consider both short and long term prognoses for oral feeding over time with an appreciation for the “whole picture.”

Recommendations for each patient may include (1) the need for and appropriateness of therapy by SLP, (2) specific guidelines related to route for nutrition and hydration; need for nutrition guidelines (per dietitian); position and posture changes; alterations of food related to texture, temperature, taste, etc.; utensil changes; changes in feeding schedule and pacing; oral sensorimotor program with food; nonnutritive oral sensorimotor program with tube feeds to meet nutrition and hydration, (3) need for referral to other professionals or for further diagnostic workup, and (4) follow-up plans.

When you have finished making your observations and decisions, continue to the next page and read through the section containing Dr. Arvedson’s report of findings in terms of normalcy and nature of the swallowing disorder, interpretations, and recommendations. Findings from some studies are reported by phase of swallowing with any texture variations noted within the description of each phase (bolus formation, oral transit, pharyngeal phase initiation, pharyngeal phase, and upper esophageal phase). In other cases, the findings are reported by texture of food or consistency of liquid with the phase related findings under each heading of food texture or liquid consistency.

You may not agree with every point made, but that does not necessarily make your decision wrong. These processes should allow you to use the manual and videos as a test for yourself and as a learning tool. You will become much more skilled if you will force yourself to view the video and make your own decisions before referring to the author’s statements. The videos cover infants and children with a range of ages and problems. Given the nature of variables in infants and children, some of the examinations
are of higher quality than others, which also reflects the multiple factors to be considered when working with infants and children who do not follow verbal directions, who cannot be fully prepared for the examination, who often become wary and in some instances scared in the radiology suite, and are likely to be moving targets for the radiologist who is trying to cone appropriately to get and keep the oral and pharyngeal structures in view. At the same time, although it is desirable to keep the orbits of the eyes out of the field, this is not always possible. Challenges abound. Standardization is lacking. Efficacy data are needed. Intra- and inter-rater reliability and validity data are also needed. However, all persons carrying out video swallow studies must know the anatomy and physiology of the swallowing mechanism.

This manual could be written only with the extensive input from all the infants and children whose videoswallow findings are shared with readers. The parents and caregivers have often developed strategies for feeding their children through their wonderful insights into all aspects of their lives. To all of them, I owe a deep debt of gratitude. I also extend a huge thank you to my colleague and friend, Maureen Lefton-Greif, PhD, who helped to stretch my mind and my problem solving skills as we wrote *Pediatric Videofluoroscopic Swallow Studies: A professional manual with caregiver guidelines*. She continues to challenge and inspire me in both clinical and research focuses with these high risk infants and children.
Chapter II

Anatomy and Physiology Basis for Reading X-rays

Anatomy Pertinent for Swallowing

This manual focuses on information that will relate to reading and interpreting x-ray studies of infants and young children. Clinicians involved in radiographic swallow studies need to have a thorough understanding of similarities and differences in anatomic relationships of structures for infants and young children compared to older children and adults. A brief overview of anatomic structures that relate to swallowing function follows. Specific identifiable anatomic landmarks that can be noted on the radiographic images are found in Chapter IV.

**Nose.** Infants are often described as obligate nose breathers. Thus, any significant degree of obstruction in the nasal cavity or nasopharynx is likely to have a negative impact on an infant’s ability to coordinate sucking, swallowing, and breathing for efficient oral feeding. Elevation and retraction of the soft palate are necessary to prevent food and liquid from entering into the nasopharynx and nasal cavity. Although embryology will not be discussed here, all clinicians are urged to study embryologic development of the head and neck structures.

**Mouth.** Anatomy of the mouth of a term infant is distinctly different from that of an adult. The primary attributes of the infant’s mouth are:

1. Tongue fills the oral cavity and is almost entirely positioned in the mouth. Muscles aiding in tongue elevation to contain a bolus include digastric, genioglossus, geniohyoid, and mylohyoid.
2. A relatively small mandible makes the tongue seem oversized for its space for all infants. Note: there are some medical diagnoses in which the small and retracted mandible is a primary anatomic based cause of airway obstruction and in turn may have a negative impact on sucking and swallowing.

3. In term infants, sucking pads that are defined by the buccinator and masseter muscles help to stabilize the cheeks,. In preterm infants, the sucking pads are not fully developed, which results in a high probability of at least some degree of sucking difficulty. Note: You will observe cheeks during clinical examination, but the sucking pads are not seen in a lateral view on VFSS.

4. Lips are defined by the orbicularis oris muscle and surrounding soft tissue. Lips turn outward partially in a “fish lips” posture to enclose a nipple such that the inner portion approximates the nipple. This position is important to enable the pars villosa, an inner ridge of specialized mucosa consisting of an arrangement of fine villi, to facilitate the lip seal around the nipple (Bosma, 1986).

Pharynx.

1. Three anatomic areas make up the pharynx: nasopharynx, oropharynx, and hypopharynx.

   a. The nasopharynx extends from the nasal choanae (paired openings between the nasal cavity and the nasopharynx) to the elevated and retracted soft palate. Eustachian tubes originate in this area. In the newborn infant, the pharynx follows a gentle curve from the nasopharynx down into the hypopharynx. The adenoid (pharyngeal tonsil) may be seen on the posterior pharyngeal wall at about the level where the soft palate retracts.
b. Young infants do not have a true oropharynx. The oropharynx becomes defined over time. As a child grows and develops, the angle between the nasopharynx and oropharynx gradually changes until in adulthood it reaches 90 degrees. Palatine (faucial) tonsils lie within the oropharynx. The palatine tonsils are paired collections of lymphoid tissue bounded anteriorly by the palatoglossus muscle (anterior tonsillar pillar) and the palatopharyngeus muscle (posterior tonsillar pillar). The lingual tonsil resides in the tongue base. Superficial bands of lymphoid tissue connect these four masses of tonsil tissue (palatine tonsils, adenoid [pharyngeal tonsil], and lingual tonsil) that can be seen on videofluoroscopy.

c. The hypopharynx is the inferior portion of the pharynx that extends from the tip of the epiglottis down to the cricopharyngeus muscle (pharyngoesophageal segment [PES]). Lateral and posterior walls of the hypopharynx are supported by the middle and inferior constrictors. The anterior wall of the hypopharynx is the larynx.

2. Walls of pharynx consist of three overlapping muscle groups.

a. Superior, medial (middle), and inferior pharyngeal constrictors are striated muscle fibers arising from the median raphe in the midline of the posterior pharyngeal wall.

b. Inferior constrictor is the most external – oblique fibers end where the horizontal fibers of the cricopharyngeus muscle begin

c. Superior constrictor is the most medial (Donner, Bosma, & Robertson, 1985)

3. Extrinsic support muscles of the tongue make up the dorsal and lateral walls of the pharynx
4. Pyriform sinuses are the spaces formed between the lateral insertion of the inferior constrictors and the lateral walls of the thyroid cartilage. The pyriform sinuses end inferiorly at the cricopharyngeus muscle, which divides the pharynx and the esophagus.

**Larynx**

1. Differences between the infant larynx and the adult larynx include
   
   a. The infant larynx is superiorly and anteriorly positioned closer to the base of the tongue than the adult larynx.
   
   b. The arytenoids and corniculate cartilages are relatively large with thick fascia and submucosa around them.
   
   c. Total arytenoid mass is large compared to the entire laryngeal opening.
   
   d. Length of vocal folds and ventricle is small in relation to the internal diameters of the thyroid and cricoid cartilages (Bosma, 1985).
   
   e. Nasal breathing is facilitated by the small oral cavity and close proximity of tongue, soft palate, and pharynx with the larynx. This anatomic configuration may aid in a structural defense mechanism to enhance airway protection during the first three months of life. It does not permit sucking, swallowing, and breathing to occur simultaneously.

2. Changes in structure over time

   a. The infant larynx is located approximately 7 to 9 cm from the nares (Gryboski, 1965).
   
   b. Mouth breathing in addition to nose breathing is typically seen after the first three to four months of life. At the same time sucking pads disappear and the neck begins to elongate.
c. Laryngeal vestibule enlarges in relation to the arytenoid mass as the head and neck grow. Oral cavity enlarges around the tongue. Upper pharynx enlarges in relation to the soft palate (Bosma, 1985).

d. Larynx gradually descends over time. By age five years, the lower border of the cricoid cartilage is at the level of the sixth cervical vertebra (C6). By age 15 to 20 years of age, the lower border of the cricoid cartilage reaches C7. It continues to lower slightly with age (Wind, 1970).

3. The larynx and trachea are suspended in the neck between the hyoid bone superiorly and the sternum inferiorly.

   a. Young infants have primarily an anteriorly directed excursion of the larynx during swallowing, rather than the elevation that is described for adults (and older children).

   b. The hyoid bone serves as a support for the tongue base, which rests on it.

4. Structures of the larynx involved in airway protection include the epiglottis, paired arytenoid cartilages, and the two pairs of vocal folds (ventricular or false and true).

   a. Epiglottis: the least critical structure as noted by reports of swallowing without aspiration with congenital absence of the epiglottis (Reyes, Arnold, & Brooks, 1994) and surgically removed epiglottis, e.g., epiglottectomy in decerebrated cats (Medda, Kern, Ren et al., 2003). The flattened lingual surface acts to direct food laterally into the pyriform sinuses. The epiglottis is most inverted when the tongue base makes complete contact with the pharyngeal wall (Ardran & Kemp, 1952; Logemann, Kahrilas, Cheng et al., 1992). This movement can be seen on VFSS. Food and liquid are directed away from the midline and the laryngeal inlet.
b. Arytenoid cartilages and aryepiglottic folds, along with cuneiform and corniculate cartilages, move medially to protect the larynx from penetration.

c. False (ventricular) vocal folds primarily aid in regulating expiration of air from the lower respiratory tract (Sasaki & Isaacson, 1988).

d. True vocal folds do not resist expired air. They prevent inspired air and foreign material from entering the larynx. The space that is formed between the false and true vocal folds is the laryngeal vestibule that can usually be seen in the lateral view most clearly before any barium contrast is introduced. Unilateral (or bilateral) vocal fold paralysis may be a factor in pediatric patients following various cardiac surgeries, likely related to injury to the recurrent laryngeal nerve (Khariwala, Lee, & Koltai, 2005).

5. Neuroanatomy of the larynx is another important area of knowledge for clinicians involved in reading and interpreting x-ray swallow studies given the critical role the larynx plays for airway protection in the process of swallowing.

a. The recurrent laryngeal nerve (RLN) is primary for innervation of muscles involved in sphincteric closure of the upper airway.

b. Innervation of the laryngeal protective and respiratory functions is centrally located in the brain stem. Control relies on fine sensory and motor innervation to that region. Sensory innervation to supraglottic and glottic areas is provided by the internal branch of the superior laryngeal nerve (SLN), which is a branch of the vagus nerve (CN 10). The RLN provides sensory innervation to the subglottic mucosa. The most densely innervated area of the larynx appears to be the posterior part of the true vocal folds and the superior surface of the epiglottis (Sasaki & Isaacson, 1988).
c. Chemical and thermal receptors, which are sensitive to a variety of stimuli, are also found in the supraglottic larynx. Other afferent receptors in the larynx include joint, aortic, baroreceptors, and stretch receptors. The impulses are interpreted at the brain-stem level in the tractus solitarius.

d. The ipsilateral RLNs innervate all intrinsic muscles of the larynx, except the cricothyroid muscles (innervated by external branch of SLN). The interarytenoid muscles are the only ones receiving bilateral innervation from RLNs.

e. Intrinsic muscle action: All muscles are involved in adduction except the posterior cricoarytenoid muscles, which are the only abductors of the vocal folds. Brain-stem control is within the nucleus ambiguous.

6. Anatomic changes in larynx when nerve paralysis occurs

   a. SLN: lateral cricoarytenoid muscle rotates the posterior laryngeal commissure to the paralyzed side giving an appearance of asymmetry or tilt to the larynx.

   b. RLN: paramedian position of the vocal fold on the paralyzed side due to unopposed adductor action of the ipsilateral cricothyroid muscle, which is innervated by an intact external branch of the SLN.

Esophagus.

1. Esophagus is a muscular tube lined with mucosa that propels food from hypopharynx to the stomach extending from pharynx at the cricoid cartilage to the stomach at the level of the eleventh vertebral body. Sphincters at top and bottom of esophagus are normally in tonic contraction and keep the esophagus closed between swallows (Derkay & Schechter, 1998).
a. Identifiable at four weeks gestation. By the fifth month of gestation, the longitudinal and circular muscle layers of the upper esophagus are fully striated.

b. Located approximately 7 to 9 cm from the nares in infants at the same level as the larynx (Gryboski, 1965). Diameter at birth is 5 mm and length is approximately 11 cm. Length increases at a rate of approximately 0.65 cm per year until it reaches 24 to 30 cm in adults (Weaver, 1991). The lateral diameter reaches 33 mm narrowing to 19 mm in the anteroposterior plane in adults (Clark, 1993).

c. Elastic tissue containing a few fibromuscular bands joins the esophagus to the trachea ventrally. Loose connective tissue connects it to the spinal column dorsally (Perlman & Christensen, 1997).

2. Upper esophageal sphincter (UES), also known as the pharyngoesophageal segment (PES), contains the cricopharyngeal muscle, which is the major muscle of the UES. The UES/PES forms the junction between the hypopharynx and the esophagus. It includes fibers of the inferior pharyngeal constrictor and circular muscle fibers of the proximal cervical esophagus. The UES/PES surrounds the uppermost esophagus at the level of the cricoid cartilage. Mucosa above the CP muscle is thin and easily injured, e.g., perforation by foreign body.

a. The UES is fully functional in the neonatal period. It varies between 5 and 10 mm in length in the neonate up to 20 mm to 40 mm in adults. The width of the cricopharyngeal muscle itself is only 1 cm in adults.

b. The PES is closed between swallows and prevents air from filling the esophagus at rest. It corresponds to an area of high pressure identified by intraluminal manometry (Donner, Bosma, & Robertson, 1985).
3. The lining of the esophagus is stratified squamous epithelium with five distinct histologic layers: mucosa, lamina propria, muscularis mucosae, submucosa, and muscularis propria (Geboes & Desmet, 1978). Three anatomic regions:
   a. Cervical segment contains striated muscle that allows a bolus to move quickly.
   b. Thoracic segment crosses at the tracheal bifurcation or carina (at level of T5) to left mainstem and contains smooth muscle. A bolus moves more slowly through this segment than through the cervical segment.
   c. Abdominal segment extends from the diaphragm to gastroesophageal junction and is usually only 1.5 cm in length in adults (Clark, 1993). This portion of the esophagus is surrounded by negative intrathoracic pressure. Bolus flow speed may be influenced by differing pressure gradients.
4. Lower esophageal sphincter (LES) is a high-pressure zone between the esophagus and the stomach. The LES prevents reflux of gastric contents into the lower esophagus and relaxes during swallowing to allow fluid or food to pass into the stomach. Length of the LES gradually increases with age: approximately 1 cm in infants less than three months, 1.6 cm in infants less than one year, and 2 to 4 cm in adults (Kahrilas et al. 1988; Moroz, Espinoza, Cumming et al., 1976).
5. Relationship of esophagus to other structures
   a. In neck, esophagus lies anterior to cervical vertebrae, posterior to trachea, and between carotid arteries.
   b. Recurrent laryngeal nerves are on either side of the esophagus in the tracheoesophageal groove.
c. Posterior mediastinum has structures important to breathing and swallowing: left main stem bronchus, aortic arch, pericardium, nerves and blood vessels to esophagus.

6. Four layers in wall of esophagus: mucosa (stratified squamous, continuous with epithelium in pharynx), submucosa, muscularis, and adventitia.

7. Intrinsic muscles: in outer longitudinal layer and inner circular layer. Posterior and lateral portions of longitudinal muscle encircle inner muscle layer in a spiral pattern.

a. Upper third of esophagus is made up of striated muscle similar to pharyngeal constrictors. Pharynx and proximal esophagus are the only regions in the body where there is involuntary neural control to striated muscles.

b. Sympathetic and parasympathetic fibers innervate the esophagus. Cricopharyngeus muscle appears to be primarily under parasympathetic control.

Physiology Pertinent for Swallowing

Swallowing requires a highly complex and integrated sensorimotor system. Swallowing is one of the most complex functions that humans carry out with several anatomic areas involved for voluntary and involuntary components. Simultaneous inhibition of respiration is required during a critical time in the process. Neuromuscular coordination depends on the central nervous system, the brain stem, afferent sensory input, motor responses, and the enteric nervous system.

The need for integration of multiple normal functions adds complications to the act of swallowing, e.g., chewing and swallowing, chewing and respiration, and the pharyngeal phase of swallowing with respiration. These functions with the entire act of swallowing are controlled by pattern generators in the brain stem that are modulated by the cerebral cortex and by sensory input (Miller, 1999). Miller’s work provides an
excellent basis for gaining knowledge regarding the neurophysiology of swallowing (e.g., Miller, 1999; Miller, Bieger, & Conklin, 1997).

The swallowing phases will be described in an outline that relates directly to the form used for reviewing VFSS findings (oral preparatory or bolus formation, oral transit, pharyngeal phase initiation [or trigger], pharyngeal, and upper esophageal phases of swallowing). The focus will be on identification of bolus movement and problem areas that can be identified on the video findings. It is important to remember the status of neural innervation (i.e., voluntary or involuntary) in the respective phases of swallowing. Problem areas will be described for each phase of swallowing at the end of this description of the phases of swallowing.

1. **Oral Preparatory Phase (Bolus Formation Phase)**
   
   a. Voluntary neural control
   
   b. Includes getting food into the mouth which usually requires assistance in infants and young children, variable duration.
   
   c. Airway remains open. Nasal breathing continues.
   
   d. Minimal segment of infant nipple feeding – latch and initiation of sucking.
   
   e. The more chewing required, the longer the duration. Muscles of mastication are modulated by mechanoreceptors in the tongue, teeth, hard palate, and soft palate through brain stem integrative pathways.
   
   f. Liquid is usually held in oral cavity for less than 2 seconds
   
   g. Lip closure is critical for effective bolus formation (often problematic with neurologic damage)
h. Tongue elevates and the bolus is held in central groove of tongue with aid of intrinsic muscles while lateral borders of tongue abut the hard palate.
   i. Buccinator muscles help infant to generate suction and help children to hold food between the teeth.
   j. Soft palate remains low and rests against tongue base, which prevents the bolus from getting into the pharynx too early. Contraction of palatoglossus muscle innervated by CNX actively lowers the soft palate.

2. **Oral Phase**
   a. Voluntary neural control.
   b. Airway remains open. Nasal breathing continues.
   c. Begins with posterior propulsion of the bolus by the tongue – ends with onset (trigger) of pharyngeal swallow. Styloglossus muscle is primary in elevation and posterior movement of tongue.
   d. As the bolus is propelled into the pharynx, the soft palate elevates and retracts against the posterior pharyngeal wall to seal the nasopharynx and prevent nasopharyngeal penetration (reflux or regurgitation).
   e. Sensory input and feedback: Critical for normal swallowing. Sensors include mechanoreceptors, pain receptors, proprioceptive receptors, chemical receptors, and special receptors for taste, smell, and temperature. According to Miller (1999), water is perceived differently than other liquids.

3. **Pharyngeal phase trigger**
   a. Location of pharyngeal trigger: Recent evidence suggests that the “point” of the trigger may be more variable in normal adults than previously thought, likely from
anterior tonsillar pillars or faucial arches as traditionally described (e.g., Fujiu et al. 1994), base of tongue, and valleculae in “normal” persons. Changes with aging have been described by Stephen and colleagues (2005). It is likely that this variability holds for children as well, but there are no data currently. Sequential swallows in healthy young adults are often produced with the onset (trigger) of the pharyngeal swallow occurring when the bolus is inferior to the valleculae (Daniels & Foundas, 2001). Young adults have been shown to achieve complete supraglottic closure after liquid boluses have arrived at the upper esophageal sphincter, but never greater than 0.1 second later (Kendall, Leonard, & McKenzie, 2004). Any material held in the hypopharynx longer than 0.1 second would be considered a delayed onset (trigger) of pharyngeal swallow.

b. Duration does not vary by texture and is about 0.5 second (Dodds, Logemann, & Stewart, 1990; Dodds, Stewart, & Logemann, 1990). Voluntary initiation of a swallow is mandated with food or liquid in the oral cavity. Swallowing of saliva may be initiated more automatically and is supported by the fact that swallowing of saliva continues during sleep, although at a significantly reduced rate.

4. Pharyngeal phase

a. Potential for aspiration is greatest in this phase.

b. Tongue base propulsion (retraction) is greatest in this phase.

c. No interruption of posterior bolus movement occurs with normal swallowing.

Several elements are involved in the pharyngeal swallow (e.g., Cook, Dodds, Dantas et al, 1989; Kahrilas, 1993):

i. Elevation and retraction of soft palate to close off nasopharynx (levator veli palatine, tensor veli palatine, and palatopharyngeus muscles)
ii. Anterior superior laryngeal displacement with obliteration of laryngeal
vestibule (mylohyoid, geniohyoid, digastric, stylohyoid, stylopharyngeus,
salpingopharyngeus, and thyrohyoid muscles) and laryngeal closure at levels of epiglottis
and true vocal folds (thyroarytenoid, aryepiglottic and oblique arytenoids muscles)
(Logemann, Kahrilas, Cheng et al., 1992)

iii. Opening of cricopharyngeal segment (UES) to allow passage of the
bolus into the esophagus (Jacob et al, 1989).

iv. Bolus propulsion by tongue (e.g., Wein, Bockler, & Klajman, 1991)
and pharyngeal clearance (pharyngeal constrictors and elevators) (Kahrilas et al. 1992).
In adults, duration of pharyngeal constrictor contraction varies from 400 to 700 msec
(Ardran and Kemp, 1951). Pharyngeal constrictors propagate a bolus at a rate of 9 to 25
cm/sec in adults (Dodds 1989). Mean pharyngeal transit time is reported to be 0.60 +/-
0.10 sec (range 0.46 to 0.89 sec) in young “normal” infants (Newman et al. 1991).

Two types of pharyngeal contractions occur to move a bolus through the pharynx
to the esophagus. The pharynx shortens in the vertical direction decreasing the distance a
bolus travels through the pharynx. This pharyngeal shortening obliterates the laryngeal
vestibule and shortens the pyriform sinuses that prevent the bolus from getting caught in
those recesses. Second, a propulsive contractile wave is generated by activation of
pharyngeal constrictors in a fixed rostrocaudal sequence, which occludes the pharyngeal
lumen behind the bolus as it moves downward. Residue is cleared by this contraction and
moved toward the esophagus. The bolus usually divides as it moves through the pharynx
with half the bolus moving through pyriform sinuses at each side of the pharynx, and then
the two portions rejoin above the level of the opening into the esophagus. The swallow
ready bolus is transported from the oral and pharyngeal regions into the cervical esophagus with no interruption of posterior bolus and with airway protection to prevent aspiration.

**Cough:** Cough is a primary protective function of the larynx during deglutition and at other times. The cough response provides backup protection when primary airway protection mechanisms fail. The cough is a response mediated in the brainstem to protect the airway from foreign matter. This response is triggered by sensitive receptors stimulated by CNX in the larynx, the subglottic space in the trachea, and in the lower airway near the carina. When those receptors are stimulated, the glottis is closed to be followed by an explosive cough in most individuals. However, it is not unusual that young infants do not cough in response to aspiration events, especially in the first month or two of life. Only 25% of preterm infants and 25% to 50% of term infants have a well-functioning cough reflex (Loughlin & Lefton-Greif, 1994). By one month of age, 90% of children have a well-developed cough reflex (Holinger & Sanders, 1991). Normal young adults have been shown to have spillover of barium contrast into the laryngeal vestibule (penetration), but without aspiration, if airway closure is maintained throughout the swallow (e.g., Shaker et al. 1990).

5. **Upper (Cervical) Esophageal phase**
   a. Opening (relaxation) of the UES begins when the larynx is pulled forward and upward by the genioglossus and suspensory muscles. The UES is pulled open by traction of the hyoid while the arytenoids move against the base of the epiglottis to seal the entry to the airway. The blade of the epiglottis is not critical for safe swallowing (e.g., Medda et al., 2003; Reyes et al., 1994). Timing of events is important. Bolus size is a factor in
the dynamics of UES function. The UES shows increased opening diameter and prolonged interval of sphincter relaxation with larger boluses (Schechter, 1990). An automatic peristaltic wave carries the bolus to the stomach (not a focus for reading and interpreting VFSS for the purposes of this course). See a variety of sources for normal physiology of pharyngeal and esophageal function to include Hiss & Huckabee, 2005; Kim, McCullough, & Asp, 2005.

b. There are differences between discrete swallows with a time delay before the next swallow compared to consecutive swallows, e.g., when infants take a bottle or a child drinks consecutive swallows of liquid. For discrete swallows, the esophageal phase follows each separate pharyngeal phase of swallowing. With consecutive swallows, the esophageal phase is inhibited if a second pharyngeal swallow occurs when the bolus is still in the striated muscle segment of the esophagus. If the bolus from the first swallow is still in the striated muscle segment of the esophagus, the esophageal phase is immediately and completely inhibited. If the bolus from the first swallow is in the smooth muscle segment of the esophagus when a second swallow occurs, the initial bolus will progress for several seconds before dissipating. The final swallow in a series is followed by a single normal peristaltic wave that clears the esophagus in infants and adults (Clark, 1993).
Chapter III

The Videofluoroscopic Swallow Study

The videofluoroscopic swallow study (VFSS) is a dynamic radiographic swallowing examination that allows for real time two-dimension visualization of the oral, pharyngeal, and cervical esophageal phases of swallowing. The standard view is in the lateral projection. An anteroposterior projection is useful when there are suspicions of any asymmetry, particularly in the pharyngeal phase of swallowing. There are several terms used to describe the videofluoroscopic assessment of swallowing function. These include, but are not limited to, modified barium swallow (MBS), oral pharyngeal motility study (OPMS), videofluorographic examination of swallowing (VFE), three-phase swallowing study, rehabilitation swallow study, and cookie swallow. For our purposes, the term VFSS is preferred and will be used throughout this manual.

Videofluoroscopy (VF) is a generic term that describes the pairing of fluoroscopic imaging techniques with video recording capabilities in a radiology suite. This examination becomes important when professionals need specific information regarding physiologic function focused on pharyngeal phase for persons with swallowing difficulties. The primary purpose of the VFSS is to define pharyngeal physiology of swallowing, and the interaction with oral and upper esophageal function, not simply to determine whether a person aspirates. When aspiration is defined in relation to physiology to determine reason(s) for the aspiration, it is critical that further descriptions are made that relate to the timing of aspiration (before, during, or after swallows) and whether the aspiration is texture specific. It is also important to state whether the aspiration occurs on only one swallow of one texture out of a number of swallows,
whether there are multiple aspiration events, and whether the person responds (or not) to the aspiration event.

In infants, pharyngeal swallow initiation may occur when a liquid bolus accumulates in the space between the tongue and the soft palate or when a bolus accumulates in the valleculae. Interpretation of possible delayed initiation of pharyngeal swallow would depend on how long the bolus is contained in the valleculae prior to movement through the pharynx as well as why the bolus got into the valleculae. Reasons could include, but are not limited to, a true delayed swallow or reduced bolus control noted by limited/poor tongue action with material passively spilling over the tongue into the pharynx. If material is seen in the valleculae only very briefly, the swallow may not be delayed. Data are needed to delineate normal vs abnormal timing in evidence based ways. Findings should be reviewed and decisions for management made in light of the entire child to include pulmonary, neurodevelopmental, and GI tract status.

Once liquid is extracted from the nipple, oral transit has begun. There is not a true bolus formation process for nipple feeding, although the latch to a nipple and suck initiation can be considered an abbreviated bolus formation process. Once infants and children advance to spoon feeding and cup drinking, the bolus formation/oral preparation is more similar to the adult process.

Efficient “normal” infants taking nipple feeds either at the breast or by bottle latch on to the nipple and use a 1:1 suck:swallow sequencing. Some infants may suck 2 to 3 times per swallow and still be considered functional oral feeders. Infants produce a number of suck and swallow sequences before they pause to take a breath. This “burst-pause” pattern for bottle feeding is what infants use in the fluoroscopy suite. When an
infant who is an exclusive breast feeder is referred for a VFSS, the study would have to be completed with pumped breast milk presented via nipple and bottle. Given the examination requires barium contrast material, an infant cannot be tested at the breast. The viscosity of breast milk is different from that of formulas. In simplistic terms, the breast milk is thinner than formulas, which means that the flow rate through an artificial nipple is likely to be higher/faster with the breast milk than any infant formula. Thus, caution must be used in interpretation of findings since pharyngeal incoordination or aspiration could result from the lack of experience with a nipple and bottle as well as the difference in expression of the liquid from the container (i.e., breast vs bottle).

Children who are ready to begin transition feeding, which is usually at about six month developmental skill levels, are used to being seated for eating and drinking. The fluoroscopic procedure can be related somewhat more closely to a meal, but this examination never replicates typical feeding times for any individual. Use of chewable food must be considered carefully in light of developmental expectations. This examination is not intended to have a major focus on chewing/bolus formation, although clinicians may find it useful to visualize action of lips, jaw, tongue, and palate with some children for at least one presentation of a food that requires some degree of mastication. Findings must be interpreted in light of medical/surgical and developmental history, current health status, clinical observations, and overall needs of the child in relation to parent concerns.

It is important for persons interpreting videofluoroscopic swallow studies to realize that normal persons occasionally demonstrate transient penetration into the
laryngeal vestibule above the level of the true vocal folds without aspiration (Shaker et al. 1990). The airway closure must be maintained throughout the swallow.

**Procedural Sequence**

The procedure for infants and children is less predictable than it is for adults because of the multiple issues described above. In general, SLPs are encouraged to follow the principles delineated by Logemann (1993) that include boluses representing a variety of sizes, starting with a very small volume of the thinnest liquid planned, moving systematically to larger boluses and to thicker material. If aspiration occurs on thin liquid, there may be less damage to the developing lungs than thicker food. The thin liquid will not block the airway as thicker food may do. The examination requires careful planning in order to maximize the information obtained and to minimize the radiation exposure time. Procedural considerations are discussed in detail in Arvedson and Lefton-Greif (1998). All readers are urged to familiarize themselves with the multiple issues that make the “on line” decisions during the examination such a critical factor in pediatric care. Remember, the examination should not be stopped at the first sign of aspiration. The clinician must make decisions at that point for testing of therapeutic interventions under fluoroscopy so that appropriate information is obtained to enable the most useful management decisions.

Cooperation is less predictable in young children for some of the reasons described earlier. In those instances, the clinician may want to start with the texture and volume that are considered to be of greatest concern. Two-to-three swallows may be all that will be obtained. For other children, the clinician may want to start with the food or
liquid that is considered to be the most acceptable to the child, according to parents, and move to those boluses that are considered non-preferred.

The number of boluses presented will vary from patient to patient depending on the status of the patient, the nature of the swallowing dysfunction, and the cooperation of the child. Multiple considerations for alterations during the examination include: Typical and optimal positioning, textures and bolus sizes, utensils (e.g., nipples, cups, spoons), and maneuvers in selected patients. The interventions that can be introduced during x-ray for infants and young children whose cognitive/language skills are such that they cannot follow verbal directions and or carry out maneuvers are limited. Interventions under fluoroscopy typically can be more extensive with children and adults who are expected to follow through independently. The video is reviewed with parents immediately following the examination. Recommendations are described in Chapter VI.

The VFSS is not necessary with every infant and child with a feeding and swallowing problem, particularly if a clinical examination and history are consistent with minimal to no pharyngeal issues. Bolus formation and oral problems can often be delineated well in a clinical examination. However, there are patients who may require a VFSS to rule out a pharyngeal problem so that a vigorous approach can be made for oral disorders. It is also true that children with neurologic deficits may be silent aspirators and have pharyngeal phase problems that cannot be ruled out strictly by the clinical observation. Clinicians are again reminded that the recommendations for a VFSS should be based on the need to define the physiology of swallowing, not whether a patient aspirates. Clinicians must always stress the need to identify the swallowing deficits so that optimal management decisions can be made. The primary goal for all infants and
children is adequate nutrition/hydration for growth. Oral feeding is also a major goal, but not at the expense of pulmonary health and nutrition. Thus, the VFSS findings can aid in determination of strategies to facilitate oral feeding to whatever extent possible.
Chapter IV

Orientation to the Radiographic Image

The review of the VFSS for infants and children is based on the same principles as with adults (Logemann, 1993). Orient yourself to the lateral image. First, identify the hyoid bone. The placement of the hyoid is high in the neck and it has limited calcification in infants. This makes it more difficult to identify in young infants than in older children and adults. The hyoid is just inferior and posterior at the lower edge of the mandible. It sometimes seems nearly occluded by the mandible. Next, identify the epiglottis posterior to the hyoid. It is a long cartilage extending from tongue base down into the thyroid cartilage. The epiglottis is attached to the thyroid cartilage by a ligament. Third, note the airway entrance inferior to the epiglottis. As you look lower on a lateral view, the larynx may be seen and below that is the trachea. In a true lateral view the laryngeal inlet is often clear with true vocal folds at the inferior border and the false vocal folds at the superior border. The valleculae are anterior to the upper portion of the epiglottis. The base of the tongue is the vertical portion of the tongue that is in the pharynx (sometimes called the pharyngeal tongue) extending from the lowest part of the valleculae up toward the curved oral tongue. The tip of the uvula is at the level where the tongue base separates from the portion of the tongue in the oral cavity (also called the oral tongue). Fourth, identify adenoid and determine whether it is impinging on the nasal airway. Are tonsils visible? Lingual tonsils appear as a grayish mass along the tongue base and may seem to fill the valleculae. Palatine tonsils may be seen as a grayish bulge at the junction of the tongue and soft palate. If you have any question about tonsil size and possible effect on
bolus transit, plan to get an anterior-posterior view that will be more definitive than the lateral view.

The tongue in the oral cavity functions in multiple ways to facilitate bolus formation and oral transit. It is active during sucking in infants who are nipple feeding. Efficient infant nipple feeding is characterized by a stripping action to the tongue to extract liquid from a nipple. The oral tongue accepts food placed on it by a spoon, moves it to the teeth when chewing is needed, or uses a kind of mashing movement for other types of food, mixes food with saliva, and assists in collecting the chewed food to get it back at mid-tongue and “swallow-ready.” The oral tongue initiates posterior movement for at least a part of the bolus, depending on size and viscosity (texture), which is the beginning of oral transit. Typically, the thicker or pastier the food is, the smaller the portion of the bolus is swallowed in a single swallow. The base of tongue is the primary pressure generator in the pharynx regardless of age. The base of tongue is activated as the tail of the bolus reaches it (Logemann, 1998). If the base of tongue is activated too early to contact the anteriorly moving pharyngeal wall, part of the bolus may be squeezed back into the mouth or up into the nasal passage rather than being propelled down into the esophagus. As bolus volume increases, base of tongue activity with pharyngeal wall motion occurs later in the swallow of normal adults. Similar findings are expected in individuals with swallow disorders across the age spectrum.

An anterior-posterior view is not used routinely with infants and children. This view is considered when there is a suspicion of asymmetry related to soft palate, larynx, and pharynx with pharyngeal phase disorders. Etiologies, such as, stroke, brain tumor, vocal fold paralysis, and any other central or peripheral nervous system diagnosis that
may include unilateral effects. In addition, the view permits visualization of palatine tonsils. This image of the oral cavity and pharynx has different landmarks from the lateral view. With the head in a midline neutral posture, one can make out the surface of the tongue when it holds a bolus and begins to move the bolus posteriorly, but not the entire oral cavity. This view shows the inward movement of the lateral pharyngeal walls. As the bolus moves posteriorly into the valleculae, one can make out the scalloped shaped valleculae and visualize whether the bolus is moved symmetrically or whether there is a greater portion of the bolus moving down one side compared to the other. The shape of the valleculae results from the hyoepiglottic ligament holding the epiglottis to the hyoid bone. The base of tongue propels the bolus from the valleculae through the pharynx to enter the esophagus through the upper esophageal sphincter. There are no data for infants and young children regarding the frequency with which the bolus divides equally as it moves through the pharynx versus those who may move the bolus down one side of the pharynx.

Problems include the need to hyperextend the neck to move the mandible out of the way and the close proximity of the face to the imager. Children often become frightened when that change is made. With hyperextension of the neck, possibility of aspiration may be increased if trigger of the pharyngeal swallow is even slightly delayed. It can be difficult to image children with poor head control and children fed by bottle as the barium contrast in the bottle may block the view of the structures of interest (Arvedson & Lefton-Greif, 1998).
Chapter V
Selecting and Introducing Modifications to Assist Treatment Recommendations

The videofluoroscopic swallow study provides dynamic imaging of the physiology of swallowing. It also permits visualization of changes when modifications are made under fluoroscopy. Selection of modifications is important so that the exposure time to radiation can be kept to a minimum for all persons undergoing a radiographic examination. Currently, there is no standard protocol for pediatric swallow studies. Arvedson and Lefton-Greif (1998) presented principles and issues with infants and children with procedural guidelines. However, a standard evidence based protocol is needed. In the meantime, all clinicians are urged to consider modifications on the basis of strong knowledge of anatomy, physiology, and development. This section will discuss issues with infants, children in transition feeding stages and beyond, and older children.

Infants

Modifications may be made in position, viscosity or texture, temperature, and techniques of presentation (e.g., nipple, syringe, tubing).

Position: The examination is usually started with the infant in a “typical” feeding position. Modifications are most likely to involve moving the infant either more or less upright. Infants may be positioned in side-lying on the table if that is their typical position. One has to be extraordinarily careful in interpreting findings if an infant has been strictly breast-fed, because of positioning differences and the fact that there is no artificial nipple that duplicates a breast nipple. The viscosity of breast milk is different
from infant formulas. This difference complicates the interpretation of sucking-swallowing-breathing sequencing with breast milk by bottle/nipple.

**Viscosity/texture:** Infants showing incoordination of suck/swallow/respiratory sequencing and aspiration before trigger of pharyngeal swallows on the first series of swallows can be presented with thicker liquid. Changes in viscosity should be made in small steps, since it is desirable that infants consume the thinnest liquid possible to assist in optimizing hydration, as well as nutrition. Thickened liquids are not appropriate for all infants with delayed swallowing, particularly for those who have residue in the hypopharynx following swallows with thin liquid and do not clear with a spontaneous follow-up swallow. Infants with poor sucking skills or decreased endurance may have more difficulty with thickened liquids than with thin liquids. Thickened liquid may increase the risk for aspiration on residue after swallows. In order for infants to extract thickened liquid from a nipple, it usually has to be enlarged by a slit or a cross-cut, which must be done very carefully so that the flow does not become too fast and can “flood” the infant resulting in increased risk for aspiration. There are no fixed “recipes” for thickening, but 1 T. rice cereal per 60 cc thin liquid is often considered typical. Some infants may tolerate only 1 ½ tsp. rice cereal per 60 cc thin liquid. It must be noted that all thin liquids are not the same. Not only are expressed breast milk and standard infant formulas different in viscosity, they do not thicken in the same way. In fact, expressed breast milk with rice cereal does not retain the consistency even for a few minutes that is noted upon mixing. Thus, it is usually not feasible to make recommendations for thickening breast milk. Consider other modifications that may facilitate efficient flow so that the infant can continue to breast-feed (see Chapter VI).
**Temperature:** Changing the temperature of liquid may be a therapeutic consideration, particularly if it has been chilled. It has been suggested that chilled formula is a kind of thermal stimulation for infants (Wolf and Glass, 1992). These authors suggest that chilled formula will encourage quicker swallows, but data are needed as there are no evidence-based outcomes. One must exercise caution. Questions arise as to effect of cold formula on young infants’ digestive systems and whether there may be a shift in threshold of responses to repeated stimulation with chilled liquid.

**Techniques of presentation:** Infants who have incoordinated sucking, swallowing, and breathing present dilemmas to the speech-language pathologist in the radiology suite. A syringe or spoon may be used to introduce 1-2 cc liquid into the oral cavity. However, the ensuing swallow would not reflect a sucking and swallowing sequence. A nipple gavage method is another possible modification in which a catheter is fed through the hole in a nipple, which is then fixed to the mouth with tape or held in place with a clamp held by the feeder (Marquis and Pressman, 1995). Small amount of liquid is initially introduced via syringe, which may stimulate sucking by the infant. If sucking is not initiated, liquid can continue to be given by syringe. Others have suggested alternating nipple with liquid and barium contrast with a pacifier (Fox 1990). Extreme caution is urged as radiation time is likely to be increased with these techniques.

Infants demonstrating poor saliva management are clearly not safe for oral feeding. Management of saliva needs to be delineated. A couple drops of thin liquid can be placed on the tongue to mix with saliva. The clinician can observe tongue action, laryngeal movements, airway protective mechanisms, and cricopharyngeal opening and closing. Secretions in pyriform sinuses may overflow into the laryngeal vestibule.
Children in Transition Feeding Stages and Beyond

Typically these children range in developmental ages from about 6 months to 36 months. It is important that developmental skill levels are used as the basis for decision making by the SLP and other professionals, not chronologic ages or even corrected ages for children born prematurely. Note: by 24 months of age, adjusted or corrected ages are no longer used. These children have added other textures to their diets and usually have been weaned from nipple and bottles for their liquids. Modifications during the radiographic swallow study include posture/position changes, self-feeding, texture variations, chewable food, and sampling over time. Older children who can follow verbal directions may be appropriate for voluntary swallowing maneuvers as described by Logemann (2006).

Posture/position changes: Children with neurologic deficits that include reduced head support may do safer swallowing when their position is changed to a slight tilt back from the standard 90 degree upright posture so that they do not have to work hard to maintain the head midline. Data are needed to provide evidence for or against a wide range of intervention processes.

Other postural changes, such as chin down that narrows the airway entrance and pushes the tongue base posteriorly, may be included for children beyond infancy. This change has been shown to improve airway protection and potentially improve tongue base contact to the posterior pharyngeal wall in adults (Shanahan et al, 1993; Welch et al, 1993). In cases of unilateral paralyses or pareses and aspiration during a swallow, head
turned to the damaged side or head rotated to damaged side with chin down may be tested in the radiology suite (Logemann et al., 1989). In instances of residue spread throughout the pharynx because of reduced pharyngeal contraction, lying down on one side may eliminate the gravity effect on the pharyngeal swallow. Head rotation has been suggested with cricopharyngeal dysfunction with residue in the pyriform sinuses since the rotation will pull the cricoid cartilage away from the posterior pharyngeal wall that in turn reduces resting pressure in criciopharyngeal sphincter (Logemann et al, 1989).

**Self-feeding:** A more efficient examination with shortest possible radiation time is accomplished when a feeder presents food and liquid to a child. The goal is not to measure self-feeding skills. However, when the clinic observations and parent reports reveal differences between assisted and self-feeding in timing of swallow production or risks for aspiration, it may be helpful to allow the child to do self-feeding for a few boluses.

**Texture variations:** The order of liquid and food presentations should proceed from small bolus of thin liquid to larger boluses of thin liquid to thicker and possibly chewable foods. However, when parents report that if you give the child liquid first, he will refuse the spoon feeding, you probably will start with a pudding like food via spoon, or even chewable food (if you know you need to observe swallowing of solid food). One must be prepared for difficulties in interpretation if there is residue in the pharynx with the thicker food. The residue will make it difficult or impossible to define the physiology of liquid swallows. No reports of data-based research are available to date for standardization of bolus size and composition for infants and children. Standardization is lacking for changes in viscosity (Garcia, Chambers, Matta, & Clark, 2005; Steele, Van Lieshout, &
Goff, 2003). Children with tracheostomy who are reported to require increased suction following ingestion of certain foods or liquids should be assessed with a sample of those foods (Arvedson, Brodsky, & Christiansen, 2002).

**Chewable food:** This examination is not focused on chewing skills, although for some children it is useful to observe one or two boluses of chewable food. One needs to be careful in selection of solid food and also in adding the barium contrast. If a pudding consistency is used, for example as a filler between two crackers or in an Oreo™, one needs to be careful to keep the coating minimal, just enough to provide the contrast but not enough to make the food a mixed texture. The process of alternating sides of placement of a bolus can be rehearsed prior to the examination so that fluoroscopy time is not increased. It is useful to delineate pharyngeal motility and possible risks for aspiration on whatever textures the child takes so that management decisions can be made regarding best consistencies of food for children with neurologic deficits, particularly cerebral palsy, who cannot chew efficiently (Croft, 1992).

**Sampling over time:** For children who appear to fatigue or become disorganized as the meal progresses, it may be helpful to sample swallows at the beginning of a meal, turn off the fluoroscopy unit with the child and caregiver continuing the meal, and then observe several swallows near the end of the meal. This feeding interval may take place in the radiology suite if available or the meal can be completed near by with the child brought back into the radiology suite for the final sampling. Parents of these kinds of children typically report that they start out well and then meal times become prolonged with signs of increasing difficulty as the meal progresses. This procedure can also be used with infants with nipple feeding, with the fluoroscopy unit turned off after a series of sucks.
and swallows. One drawback is that if the infant has an aspiration event while the unit is
turned off, one would not know when or why that event occurred.

**Older Children (Three Years and Up)**

Protocols and modifications during the radiographic study are more similar to
those used with adults than with infants and young children. There may be differences
because many of these children have had feeding and swallowing deficits since birth, in
contrast to older children and adults who have had normal development preceding an
insult that left them with swallowing deficits. These children are likely to have positive
prognoses to improve swallowing with therapeutic alterations and maneuvers that have
been described most completely with adult populations (e.g., Logemann, 1998). Only
minor modifications in approach would be anticipated. It must be remembered that
dietary needs differ in children up to adolescence compared to adults. Children need to
continue to grow and gain weight through adolescence. Nutrition guidance is important
for children. Modifications in the radiology suite are similar to those described above for
children in transition feeding and beyond.

Primary goals of the VFSS are:

- to delineate the physiology and function of swallowing,
- to make modifications during the examination that can help determine what food and
  liquid each individual can eat and drink, even if in very small quantities for practice and
  pleasure, and
- to make specific guidelines for meal time effectiveness and safety as well as for
  therapy strategies to meet nutrition and hydration needs and to maintain pulmonary
  stability.
In order to select the modifications during the examination, the SLP must have a good understanding of the patient’s underlying diagnosis (etiology) and implications for possible findings, be able to read and interpret the findings “on line” immediately, and introduce appropriate modifications. The easy part is to carry out an initial sequence of swallows. The challenge is to make the decisions quickly and effectively to get the best information in the shortest time possible for each individual and to interpret the findings and to make optimal recommendations for follow-up management.
Chapter VI

Making Recommendations

It is important to remember that the VFSS is just “one piece of the puzzle” and must be interpreted along with other information in the child’s history, medical/surgical status, clinical observations, and parent reports. The prognosis for oral feeding gains is more likely to be related closely to the underlying diagnosis and etiology of the feeding and swallowing problems than it is to the specific findings during one radiographic examination.

The SLP needs to answer the question: is the child safe for oral feeding? If the answer is “yes,” the next consideration is whether modifications are needed in the current diet, whether the child is a total oral feeder or whether tube feeding supplements are needed.

Decisions regarding recommendations may be made in the following areas of intervention that include, but are not limited to (Arvedson & Lefton-Greif, 1998, p. 146):

1. Route for nutrition and hydration
2. Nutrition guidelines per dietitian
3. Position and posture changes
4. Alterations of food (e.g., texture, temperature, taste)
5. Utensil changes
6. Changes in feeding schedule and pacing
7. Oral sensorimotor program with food
8. Nonnutritive oral sensorimotor program
It is not within the scope of this manual to provide major resources for intervention. The reader is encouraged to review multiple sources for further information as well as to seek mentoring and continuing educational opportunities in order to meet the needs of each individual child and family. These recommendations are made in most comprehensive ways in the context of an interdisciplinary team of professionals working closely with parents and other primary caregivers.

It appears that there are wide variations across medical settings and even among clinicians within a medical setting regarding recommendations when a patient demonstrates penetration and/or aspiration during the examination. There are no evidenced based reports to provide guidance when one observes multiple events of laryngeal penetration, particularly in young infants doing nipple feeding. It is not unusual to see barium contrast on the underside of the upper portion of the epiglottis while infants are making consecutive suck and swallow sequences. The penetration typically occurs just prior to trigger of swallows. Barium contrast is cleared from the pharynx upon completion of each swallow. This may be a “normal” phenomenon, but data are lacking. It is not unusual for SLPs to recommend thickened liquid when they find penetration with regular formulas. Caution is urged because of the concerns related to need for adequate fluids for hydration. Data are available to indicate that the frequency of penetration increases with age in normal individuals (Daggett et al., in press) but there are no data for infants and young children. Children producing consecutive swallows of liquid from a variety of cups may show the same kind of pattern with “high” laryngeal penetration. If there is no deep penetration into the laryngeal vestibule, these children may be appropriate for continuing their intake with thin liquid. Close monitoring of pulmonary
status is advised for all children, particularly those who have shown any level of risk for aspiration with oral feeding.

What about aspiration events? There is no evidence to suggest that trace aspiration on thin liquid occasionally during a video swallow study is a reason to make a person a non-oral feeder, or even to make any adjustments that would include thickened liquids. On the other hand, there is no evidence that suggests how much aspiration of what liquid or food can be tolerated by an individual for how long until chronic pulmonary problems may become obvious. The infant’s or child’s medical diagnoses, pulmonary status, neurologic status, and potential for global developmental gains all must be considered in decision making following the radiographic study.

There are times when the best recommendation after a radiographic swallow study is to refer the patient to another specialist, usually following consultation with the child’s parents and primary physician. Remember that a stable airway and adequate nutrition are the primary needs for all children. A stable airway is a necessary prerequisite for oral feeding. All recommendations must support nutrition and hydration needs for all children, especially during the first two years of life. Oral sensorimotor intervention is a common recommendation made along with suggestions for changes in position/posture, texture, taste, and temperature. SLPs are urged to seek evidence based practice information, which is limited, or to collect data in ways that can contribute to the evidence base.

Recommendations need to be stated at the end of the report in ways that make the rationale clear and relate to the physiologically based findings. The anticipated outcomes should be stated as well.
Consideration for re-evaluation should be noted. If no follow-up evaluation is anticipated, that should be stated clearly. Children showing silent aspiration will likely need re-evaluation, particularly if a goal includes increased volume of oral feeding. In cases of progressive neurologic diagnoses, re-evaluation will be needed because of possible regression in coming months, e.g., a patient with Rett Syndrome who has penetration with no aspiration may develop aspiration in the future.
Chapter VII

Report Writing

A report must be written or dictated following the VFSS. It will describe the findings related to normalcy or swallowing disorders. The underlying physiologic reasons for the findings need to be stated as clearly as possible. One may not always be able to state a direct cause and effect, but statements can be made that describe a finding and relate it to a physiologic reason for which the finding would be logical. For example, “residue in the valleculae was noted, consistent with reduced tongue base retraction.” Any therapeutic modifications with effects must be described. Recommendations may include texture changes, mealtime guidelines, oral feeding and swallowing therapy, suggested referrals to other professionals, and considerations for re-evaluation if appropriate.

Reports should be concise and describe the swallowing physiology in language that can be understood by professionals and parents who are not experts in swallowing. The impressions and recommendations need to be clear and stated in ways that focus toward functional outcomes. Checklists are usually not helpful to referring physicians and to parents. Narrative reports are more useful, but one must be careful not to use professional jargon and technical terms that are not familiar to others. When technical terms are necessary, a brief operational definition is usually helpful to readers. The information included for each infant and child actually makes up the report, although an outline form is used for manual whereas a narrative form would be used in the report.

The report does not need to include a description of each individual swallow, especially when most infants and children are observed with more consecutive swallows.
than for discrete single swallows. A description of the overall pattern of swallowing physiology and abnormalities is most useful. Reports may begin with a brief history and current feeding status as in the outline in this manual. Descriptions need to include information regarding bolus formation, oral transit, initiation or trigger of pharyngeal swallow, pharyngeal phase, and upper esophageal phase of swallowing. Descriptions also need to note texture or food specific information, particularly as some swallowing disorders may be texture specific. Although data are lacking for VFSS descriptions of “normal” swallowing in pediatrics, when swallowing appears “normal” and “functional”, the report should state that impression. For example, “findings are interpreted as normal for all textures. There was no difficulty noted in bolus formation, no delay in trigger of a pharyngeal swallow, no residue in the pharynx between swallows, and no difficulty with material moving through the upper esophageal sphincter.” Results do not lead to “pass” or “fail”. Statements that relate to normalcy or abnormality are needed. Each report should also comment on a patient’s sensory awareness of residue or aspiration. For example, “the infant made no response to multiple aspiration events just prior to trigger of pharyngeal swallows while sucking and swallowing.”

Modifications or treatment procedures introduced during the examination should be described with a comment about effectiveness (or lack of effectiveness). Reports should be written/dictated immediately in the inpatient acute care setting so that it is available to those caring for the patient. Outpatient reports should be completed within 24 hours except for unusual circumstances, so they are made available to referring sources and others who will be following up with the child. A phone call to a referring physician
is usually appreciated and provides opportunity for some education about the results of the examination and to answer any questions.
Chapter VIII

Guidance to Parents and Other Caregivers

The best way to begin discussions with parents and other caregivers is to review the video findings with them immediately upon completion of the examination. Visual images aid in helping families understand the problems, particularly useful when a child is an eager feeder and shows no overt signs of laryngeal penetration or aspiration. For example, parents typically have “aha” moments when they see barium contrast in the airway and listen to the audio, which makes it very clear that the child did not cough in response to aspiration. It is also helpful for parents to gain insights into positive aspects of the child’s swallowing, since that is a starting point for making a prognosis for changes in coming months, need for specific types of therapeutic intervention, changes in textures or other aspects of diet, and in some instances, why oral experiences must be kept to minimal tastes, at least in the near future.

Appropriate follow-up plans can be made before families leave the radiology suite. These plans may range from no intervention needed to a clinical session to be scheduled within a week or two or for therapy follow-up through other resources, for example, Birth-to-Three program SLPs (who often accompany the family to the study), school based SLPs, or rehabilitation agencies. For families who live a considerable distance from the setting in which the examination was completed, communication will be needed with appropriate professionals closer to home for families. It is vital that pertinent information is obtained during the examination so clinicians can make pertinent appropriate recommendations that will allow whatever oral feeding is safe,
developmentally appropriate, and non-stressful while assuring that all children receive adequate nutrition and hydration.
Chapter IX

Patient Reports and Videos for Training

The videos accompanying this manual contain 25 videofluoroscopic swallow studies. A complete study is included for each patient, so that you gain experience in reading, interpreting, and making decisions with the study as completed by this clinician. It is not unusual to reflect on a study after it is completed and note ways in which the study could have been carried out more efficiently or with better information. However, hindsight does not always match the processes in the “real world”. It is likely that readers of this manual may take exception to some of the interpretations and recommendations, but it is hoped that experience will be gained in ways that will enhance patient care.

In this section of the manual, you will read background demographic information and procedural information in outline form for each separate patient’s examination. Then you will review the video. Make notes of what you observe on the video that will include any structural or physiologic abnormalities. You may find it helpful to copy the worksheet that is at the end of this section and use it as you review each patient. Write down your recommendations before you turn the page to compare with the outline in the manual (which is not the format typically used for report writing). You may want to go back and review the VFSS. You may find it helpful to write your own report for each patient in whatever format you find most useful or that your department/institution recommends.

These videos are meant to demonstrate a number of different swallowing scenarios and disorders to give you the opportunity to practice reading the videofluoroscopic study. The biggest challenges tend to be with the youngest infants or
children with significantly delayed or disordered development overall. It is hoped that you will enjoy improving your skills with this project.
### Videofluoroscopic Swallow Study (VFSS)

**Children’s Hospital of Wisconsin**

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**Present Diet & Feeding Method**

<table>
<thead>
<tr>
<th>Patient Status:</th>
<th>Alert</th>
<th>Active, not crying</th>
<th>Crying</th>
<th>Lethargic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway Status:</td>
<td>No problem</td>
<td>URI or congestion</td>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O²</td>
<td>Suction Needs</td>
<td>Monitors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>(+/- valve)</td>
<td>Ventilator dependent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Seating:**

- MAMA Chair
- Tumbleform
- Other

**Pt. Position**

- Upright
- Semi upright
- Reclining < 30º
- Other

**Image view**

- Lateral
- Anteroposterior
- Oblique

**Food Presenter**

- Caregiver
- Clinician
- Patient
- Other

**Utensils**

- Bottle
- Nipple
- Pacifier
- Syringe
- Spoon
- Cup
- Straw

**Textures**

- Liquid
- Very thin (VT)
- Thin (TL)
- Nectar (N)
- Honey (H)
- Puree
- Smooth (SP)
- Lumpy (LP)
- Solid
- Mashed (M)
- Chewable (C)

### RADIOGRAPHIC SIGN

<table>
<thead>
<tr>
<th>Bolus Formation * delivery mode</th>
<th>SWALLOWING DISORDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of food or liquid out mouth, Can’t hold food in mouth anteriorly</td>
<td>↓ lip closure</td>
</tr>
<tr>
<td>Material in anterior sulcus</td>
<td>↓ lip tension or tone</td>
</tr>
<tr>
<td>Material in lateral sulcus</td>
<td>↓ buccal tension or tone</td>
</tr>
<tr>
<td>Limited tongue movement</td>
<td></td>
</tr>
<tr>
<td>Material pushed out with tongue</td>
<td>Tongue thrust, reduced tongue control</td>
</tr>
<tr>
<td>Jaw grading inappropriate</td>
<td></td>
</tr>
<tr>
<td>Limited/immature chewing</td>
<td></td>
</tr>
<tr>
<td>&gt;3 sucks per swallow (nipple)</td>
<td>↓ sucking strength/coordination</td>
</tr>
<tr>
<td>Gag</td>
<td>Heightened sensation, behavioral</td>
</tr>
</tbody>
</table>

### Oral Transit

- Searching tongue movements
- Forward tongue to move bolus
- Material remains in anterior sulcus
- Material remains in lateral sulcus
- Material remains on floor of mouth
- Material remains on tongue
- Material remains on hard palate
- Limited tongue movement (A-P)
- Tongue-palate contact incomplete
- Piecemeal (mult.swal/bolus)
- Delayed oral transit time (>3 sec)

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### Pharyngeal Phase Initiation

| Material in valleculae pre-initiation | If brief, no delay in pharyngeal initiation |
| Material in pyriform sinuses pre-initiation | Delayed pharyngeal initiation |
| Material in/on tonsil tissue | Tonsils blocking bolus transit, delayed pharyngeal initiation |
| Material on PPW | Delayed pharyngeal initiation |

#### Pharyngeal Phase

**SWALLOWING DISORDER**

| Nasopharyngeal penetration | ↓ velopharyngeal closure, ↓ UES opening |
| Penetration to underside epiglottis | Incoordination, ↓ pharyngeal contraction |
| Penetration to laryngeal vestibule | ↓ airway closure |
| Penetration/Aspiration (P/A Score) | ↓ airway closure |
| Aspiration before swallow | Delayed pharyngeal initiation, incoordination, weakness |
| Aspiration during swallow | Vocal fold paralysis/paresis, incoordination |
| Aspiration after swallow | ↓ pharyngeal contractions, ↓ UES opening, timing deficit |

- Productive spontaneous cough
- Nonproductive, delayed cough
- No cough (silent)
- Eliminated (ejected, squeezed out)

| Coating of pharyngeal wall after swallow | ↓ tongue base retraction, ↓ pharyngeal contraction |
| Residue along tongue base | ↓ tongue base retraction, ↓ pharyngeal contraction, ↓ UES AP opening diameter |
| Residue in valleculae | ↓ tongue base retraction, ↓ pharyngeal contraction, ↓ UES AP opening diameter |
| Residue in pyriform sinuses | ↓ tongue base retraction, ↓ pharyngeal contraction, ↓ UES AP opening diameter |
| Residue posterior pharyngeal wall | ↓ tongue base retraction, ↓ pharyngeal contraction, ↓ UES AP opening diameter |
| Residue in tonsil tissue | ↓ tongue base retraction, ↓ pharyngeal contraction, ↓ UES AP opening diameter, interference by tonsils |
| Residue cleared with next swallow | |
| Residue not cleared | |

### Upper Esophageal Phase

| Slow bolus passage through UES | UES prominence, ↓ UES AP opening diameter; reduced pharyngeal pressures may contribute |
| Residual on/in UES | Structural abnormality or ↓ UES AP opening diameter |
| Retrograde bolus movement from esophagus to pharynx | Esophageal dysmotility, Structural abnormality |
| Retrograde bolus movement from lower esophagus to upper esophagus | Esophageal dysmotility, Structural abnormality |

* Delivery mode: B=Bottle  C=Cup  SC=Spout Cup (+/- valve)  S=Spoon  SY=Syringe

**Findings Summary re Aspiration:**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Yes:</td>
<td></td>
</tr>
<tr>
<td>very thin liquid</td>
<td>smooth puree</td>
</tr>
<tr>
<td>thin</td>
<td>lumpy puree</td>
</tr>
<tr>
<td>nectar</td>
<td>mashed</td>
</tr>
<tr>
<td>honey</td>
<td>chewable</td>
</tr>
</tbody>
</table>

JCA/CHW/Feeding/VFSSform10/31/06
References


Patient #1 (JA)
I. Demographic information
   A. Age: 6 months
   B. Diagnoses: Intrauterine heroin exposure, with foster family. Apnea monitor at home. Global developmental delays, in Birth to Three services.
   C. Previous testing: Upper gastrointestinal study (UGI) – “nonobstructive upper GI with gastroesophageal reflux (GER).”
   D. Reason for referral: Vomiting during feedings and apart from feedings (projectile at times), some choking and coughing with nipple feeding
   E. Current feeding: Pregestimil formula at 20 cal/oz. Thickened feeds have not reduced vomiting. Started spoon feeding with natural cereal from health food store. Weight gain in recent weeks – had been losing weight at times in past. Infant is doing better since he is less irritable.
   F. Medication: Zantac; off morphine in prior 3 weeks – less irritable.

II. VFSS Procedure
   A. Position: Lateral view, nearly upright
   B. State: Awake, alert, cooing vocalizations, and appropriate fussing to indicate hunger - alert and responsive throughout examination.
   D. Therapeutic alterations: Alter consistency to improve suck:swallow ratio

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:

A. Regular formula (Pregistimil) with standard nipple as used at home:
   1. Started sucking immediately
   2. Suck:swallow varied from 1:1, usually 2-4 sucks per swallow
   3. Delayed swallow initiation noted by liquid into pyriform sinuses most times before initiation of pharyngeal swallow
   4. Aspiration at initiation of pharyngeal swallow 17, 20, 23 (large amount), 24, and 25 – nipple out, aspiration at initiation of final swallow 26. Delayed cough only after swallow 25. He did not clear airway. He fussed when nipple was taken out, wanted nipple back. He calmed when he resumed sucking
   5. Second series of suck/swallows. Aspiration just prior to and during swallow 3, 6, 7, and 11 – nipple out after swallow 10, residual in valleculae & pyriform sinuses – aspirated on the residue prior to the final swallow. No cough at all with that series.
   6. Penetration to underside of superior portion of epiglottis (first at swallow 12 and noted with a number of swallows after that), Cleared upon completion of the swallow, except at end when he aspirated after nipple was taken out of his mouth
   7. Material moved into and through upper esophageal sphincter with no signs of any problems.
   8. Note: infant was eager, fussed when nipple was taken out, calmed when the nipple was presented again

B. Nectar consistency formula (thickened with rice cereal via standard nipple)
   1. Immediate initiation of sucking
   2. Multiple sucks per swallow, slower transit as infant appeared to work harder to extract the liquid from the nipple. Liquid seen in pyriform sinuses prior to initiation of pharyngeal swallow. Total of 17 swallows
   3. Aspiration just prior to and during swallows 10, 15, 16, 17.
   4. Nasopharyngeal reflux/penetration noted near end of series.
   5. Barium contrast was seen on tongue and superior soft palate at end of study

C. Thin rice cereal by spoon
   1. Number of swallows: 5
   2. Material was seen under the tongue and to valleculae at times as he was initiating bolus formation prior to trigger of pharyngeal swallow
   3. Nasopharyngeal reflux one time near end of spoon feeding
   4. Palate intact
   5. No aspiration or laryngeal penetration with thin puree.
   6. No residue in the pharynx after swallows, only on posterior tongue.

D. All textures: Upper esophageal sphincter opened promptly and adequately, with no difficulty moving material through the upper esophageal sphincter (UES).

IV. Interpretation/Impression

6-month-old infant demonstrated oral and pharyngeal phase incoordination while sucking regular formula and thickened liquid via nipple with multiple events of silent aspiration prior to and during swallows consistent with delayed trigger of pharyngeal swallow. He produced a delayed and weak cough at times, but did not
clear airway. Occasional nasopharyngeal penetration (reflux) was noted as part of the pharyngeal incoordination. He was eager to take his bottle and fussed when it was taken away from him. He appears ready for spoon feeding practice – no aspiration, penetration, or residue following swallows of puree via spoon.

V. Prognosis: Questionable for full oral feeding to meet nutrition needs and to maintain pulmonary health. Can he continue as a total oral feeder with close monitoring?

VI. Recommendations – Short Term
   A. Call pediatrician to discuss findings and recommendations to maximize nutrition/hydration and safety of oral feeding.
   B. Continue bottle feeding to meet nutrition needs. Monitor flow rate. Parent will adjust nipple or consistency of formula (may thicken just enough to get 1:1 suck:swallow ratio).
   C. Follow up in Feeding Clinic to manage GI tract issues, monitor respiratory status, make nutrition guidelines, and facilitate efficient timing and coordination of sucking and swallowing in a comprehensive, coordinated way. Note: CT scan of chest was completed per gastroenterologist – essentially normal.
   D. Continue Birth to Three services. SLP is asked to call me at parent request.
CASE #2 (PH)

I. Demographic information
   A. Age: 6 years 8 months
   B. Diagnoses: Multiple congenital anomalies with an undiagnosed genetic disorder, delivered at 33 weeks gestation with intrauterine growth retardation (IUGR), Grade 2 intraventricular hemorrhage. Bilateral optic nerve atrophy. Hearing within normal limits – frequent ear infections, multiple sets of ventilating tubes. He fed fairly well orally until he had pneumonia and empyema (pus in pleural space) at 5 years of age, followed by severe esophagitis. Gastrostomy tube with fundoplication – No oral feeding (not per oral – NPO) so esophagus could heal.
   C. Developmental status: Cognition and receptive language at age level – regular school program; expressive language and speech motor production mildly delayed; motor skills significantly delayed – uses a walker for short distances, but does not walk independently. Fine motor skills show some delays. Visual deficits.
   D. Reason for referral: Concerns related to limited weight gain, swallowing difficulties, and gastrointestinal (GI) tract problems. Child is ill frequently. Frequent ear and sinus infections, has had 3 sets of ventilating tubes. Question of large adenoid and tonsils.
   E. Current feeding: Gastrostomy tube (GT) feeds overnight (3 cans Pediasure) and oral feeding during the day (2 cans of Pediasure and small volume smooth food, e.g., smooth yogurt, pudding, and applesauce). Parent report of feedings – He uses water to wash down food. He gags with all solid food.
   F. Medications: Prevacid, Singulair, MiraLax, Nebulizer as needed.

II. VFSS Procedure
   A. Position: Lateral view, upright in Multiple Application Multiple Articulation (MAMA) chair, neutral midline head posture; at physician request, esophageal transit was examined for solids. Posterior-anterior (PA) view for visualization of palatine tonsils.
   B. State: Awake and alert, cooperative.
   C. Oral peripheral examination: Intact oral structures, lips closed at rest, Tongue protrusion and lateralization appeared effortful, but he did follow directions. He had more jaw movement laterally than tongue movement.
   D. Therapeutic alterations: Posture and consistency of food and liquid

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
   A. Thin liquid: Pediasure by straw
      1. Liquid: 7 swallows in first sequence of sucking and swallowing, 4 swallows in second, and 3 swallows in third sequence.
      2. Bolus formation: **Good lip closure around straw, immediate sucking, no delay in initiating oral transit and pharyngeal swallow, mildly reduced tongue propulsion**
      3. **Lack of tongue base contact to the posterior pharyngeal wall** related to reduced tongue base propulsion and reduced pharyngeal contractions
      4. No nasopharyngeal penetration/reflux
      5. **Aspiration occurred after swallows on residue** — no cough
      6. **Penetration to underside of the superior portion of the epiglottis occasionally, no deeper— never cleared barium contrast from the pharynx**
      7. **Pharyngeal residue** in valleculae and pyriform sinuses
      8. **Upper esophageal sphincter opened promptly** and adequately, no difficulty in material moving through the UES.
   B. Smooth puree: Pudding by spoon
      1. Very small bite, **bolus formation inefficient, multiple swallows per bolus**
      2. Held food in oral cavity for **slight delay in initiating tongue action** to form a bolus; material held in oral cavity between swallows
      3. **Residue noted in valleculae and pyriform sinuses** after swallows
      4. **Trace aspiration after swallows from residue in pyriform sinuses; no cough, did not clear airway**
      5. **No laryngeal penetration**
      6. **No nasopharyngeal penetration/reflux**
      7. **Upper esophageal sphincter opened promptly and adequately**, with no difficulty in material moving through the UES.
      8. **Esophageal transit time appeared slow with delay at the level of the fundoplication**. Retrograde transit could be seen. Material did clear through the fundoplication (Radiologist reports on esophageal function in more detail).

IV. Interpretation/Impression
   A. Intermittent silent aspiration throughout study, primarily after swallows due to residue in pyriform sinuses that spilled into the open airway. Residue was consistent with reduced posterior tongue propulsion, reduced tongue base retraction, and reduced pharyngeal contractions. Not appropriate for total oral feeding to meet nutrition needs.
   B. Finding of mild to moderately enlarged tonsils – should not be an interfering factor for oral feeding.

V. Prognosis – Guarded for total oral feeding adequate to meet nutrition and hydration needs, at least in the near future. The lack of cough is of concern because there is no sign to parents when an aspiration event occurs. In the short run, focus on improving growth with tube feedings. Make sure oral feeding is pleasurable.

VI. Recommendations
   A. Increase tube feedings per dietitian and physician to boost weight gain.
B. Maximize oral feeding with liquid via straw – chin down posture with effortful swallow. Consider thickened liquid by open cup for practice.

C. Keep meal and snack times to 10-15 minutes, nothing between meals except water in small amounts, if he is thirsty. Supplement by tube rest of the Pediasure that the child does not drink within the allocated time. Better to keep volumes small in light of the esophageal function and aspiration findings.

D. SLP to work with spoon feeding so that spoon can be placed on the tongue at mid tongue to encourage increased tongue function. Chewing can be added later. Speech motor focuses are important to improve communication skills.

E. Close monitoring of respiratory status. Follow with Feeding Clinic.
CASE #3 (SS)

I. Demographic Information
   A. Age: 5 years 2 months
   B. Diagnoses: 49XXXXY syndrome, asthma and allergy signs/symptoms.
   C. Developmental status: Significant expressive language delay – essentially non-verbal with sign language; speech primarily vowel sounds and no consonants
   D. Reason for referral: Referred by gastroenterologist because of risk for aspiration in light of asthma diagnosis and history of gastroesophageal reflux.
   E. Current feeding: Total oral feeding
   F. Parent report of feedings: He likes to feed himself table food – slow with solids that require definite chewing.
   G. Medications: Multiple meds in medical chart

II. VFSS Procedure
   A. Position: MAMA chair, lateral view, upright
   B. State: Alert, communicated primarily by gestures
   C. Oral peripheral examination: Intact oral structures, no structural basis for swallowing problem
   D. Therapeutic alterations: None
   E. Child participation: Alert and cooperative throughout examination

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:

A. Spoon feeding (smooth puree applesauce, meat and vegetable mixture, and fruit cocktail)
   1. Lip closure around spoon and spout cup
   2. Immediate initiation of tongue action
   3. **3-4 swallows per bolus** with material usually held in oral cavity between swallows
   4. **Material seen in valleculae briefly** prior to initiating pharyngeal swallow for all textures; fruit cocktail 1 time in pyriform sinuses prior to initiation of pharyngeal swallow
   5. **No nasopharyngeal reflux**
   6. **No laryngeal penetration**
   7. **No aspiration**
   8. **No residue in pyriform sinuses; trace coating noted on tongue and in valleculae after swallows** – cleared with the next swallow

B. Thin liquid via valved spout cup (regular milk)
   1. Consecutive swallows for total of 24 swallows
   2. **Most swallows with no delay** in moving through pharynx; midway through the sequences, child paused and material was seen in pyriform sinuses, with a slight delay in initiating a pharyngeal swallow two times
   3. **Penetration to underside of tip of epiglottis just prior to and during some swallows; no deeper penetration**
   4. **No nasopharyngeal reflux**
   5. **No aspiration**
   6. **No residue in valleculae and pyriform sinuses**

C. All textures: **Upper esophageal sphincter opened promptly and adequately**, no difficulty in material moving through the UES.

IV. Interpretation/Impression

A. Safe for oral feeding – essentially normal

B. Penetration to the under side of the superior portion of the epiglottis with consecutive swallows of liquid should not place him at risk for aspiration issues while eating and drinking

V. Prognosis - Long term total oral feeding: Should be positive providing overall neurodevelopmental gains continue.

VI. Recommendations:

A. Continue to maximize nutrition at mealtimes with food and liquid that child handles efficiently. Easily dissolvable chewable food likely is best. Tough to chew food should be reserved for therapy or in very small quantity at meal time for practice for just a few minutes.

B. Parent will monitor posture for cup drinking – maintain midline position.

C. No specific follow-up anticipated. I will be available to assist with recommendations for chewing skills if needed in coming months.

D. Continue therapies in school focusing on communication and language.

E. Return to physicians as recommended.

F. Parent will call with questions or concerns.
CASE #4 (DY)

I. Demographic information
   A. Age: 19 months, severe developmental delay (motor skills less than 4 month levels; communication 3-4 months, with emerging skills to 6 month levels).
   B. Diagnosis: Hypoxic ischemic encephalopathy (HIE), seizure disorder, aspiration pneumonia 3 months prior to examination.
   C. Previous testing: None available.
   D. Reason for referral: History of aspiration pneumonia, persistent coughing with liquids, wet and gurgly voice quality after drinking milk.
   E. Current feeding: Total oral feedings of whole milk by nipple and bottle, smooth purees by spoon, some mashed food. Parent reports – He spits out table food. Snores loudly when sleeping.
   F. Medication: Phenobarbital, Depakote

II. VFSS Procedure
   A. Position: Lateral view, nearly upright in MAMA chair, neutral midline head posture, no head tilt back.
   B. State: Awake and alert, kicking legs and moving arms; mouth open at times with tongue protruding between teeth, suckle motions noted.
   C. Oral peripheral examination: Intact oral structures. Voice quality appropriate – no gurgly voice during this study.
   D. Therapeutic alterations: Midline posture

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
   A. Mashed meat mixture and pudding by spoon
      1. **Bolus formation inefficient, multiple swallows per bolus**
      2. Held food in oral cavity between swallows
      3. Two bites of meat mixture – 4 swallows on first, 3 swallows for second bite.
         Two bites of pudding – 3 swallows on first bite, and 2 swallows second.
      4. Material in valleculae and pyriform sinuses briefly one time, only **mild delay in trigger of pharyngeal swallow**.
      5. **No residue after swallows**
      6. **No laryngeal penetration or aspiration**
      7. **No nasopharyngeal penetration or reflux**
      8. Upper esophageal sphincter opened promptly and adequately, **no difficulty in material moving through the UES**.
   B. Whole milk by nipple
      1. Total of 38 swallows; **usually 2-3 sucks per swallow**
      2. Occasionally material in valleculae and pyriform sinuses prior to initiation of a pharyngeal swallow; **usually no delay in trigger of pharyngeal swallow**
      3. **Trace penetration to underside of tip of epiglottis** at times, no deeper.
      4. **No nasopharyngeal reflux**
      5. **No aspiration**
      6. **No pharyngeal residue**
      7. Upper esophageal sphincter opened promptly and adequately, with **no difficulty in material moving through the UES**.
   C. Adenoid pad appeared to impinge on nasal airway; **2-3 mm gap between adenoid pad and soft palate**.

IV. Interpretation/Impression
   A. Essentially functional swallowing for all textures tested. Appropriate for continued oral feeding to meet nutrition needs.
   B. Primary finding of enlarged adenoid, consistent with snoring report by parent

V. Prognosis – Good for total oral feeding adequate to meet nutrition and hydration needs providing overall development continues and gastroesophageal reflux is well managed.

VI. Recommendations – Short Term
   A. Continue oral feeding with developmentally appropriate food and liquid (chewable food not expected)
   B. Important to be aware of developmental skill levels in setting expectations for advance of textures. Cup drinking with thickened liquid may become appropriate in coming months, with gradually thinning as child demonstrates coordination.
   C. Posture and position are important factors. All feeders should be consistent.
   D. Consider referral to pediatric otolaryngologist for airway examination.
CASE #5 (KK)

I. Demographic information
   A. Age: 4 years 7 months
   B. Diagnoses: Seizure disorder – onset at 9 months following normal development to that time. Grand mal seizure lasts 1-2 minutes every week or two. Global developmental delays (current levels of function approximately 18 months, including language).
   C. Previous testing: None available re feeding/swallowing, followed by Neurology.
   D. Reason for referral: Risks for aspiration
   E. Current feeding: Total oral feeding with pureed food and thin liquid by water bottle and spout cup. She occasionally eats popcorn, crepes with caviar, bread, fruit, pretzels, and crackers. She had been on ketogenic diet at 3 years of age – lost her appetite and reduced PO intake – switched back to regular diet.
   F. Medication: Multiple seizure medications - see medical chart.

II. VFSS Procedure
   A. Position: Lateral view, upright in MAMA chair, neutral midline head posture, no head tilt back
   B. State: Alert and cooperative with video in background to facilitate participation.
   C. Textures: Popcorn, apple juice by spout cup, and homemade pureed mixture by spoon.
   D. Oral peripheral examination: Symmetrical facial features, mouth open at rest – appeared to be mouth breathing, tongue slightly protruded between teeth.
   E. Therapeutic alterations: Midline posture, encouraged lip closure, A-P view for tonsils and adenoid visualization

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
A. Popcorn (soybean puff) and homemade pureed mixture by spoon
   1. **Bolus formation inefficient**, maximal cueing to initiate movements
   2. Held food in anterior and lateral sulci with **tongue retracted, limited anterior-posterior tongue movement**
   3. Material remained in anterior sulcus and on tongue, also on palate. **Multiple swallows to clear oral cavity.**
   4. Material in valleculae, not pyriform sinuses – **no delay in pharyngeal trigger.**
   5. **No laryngeal penetration or aspiration; no nasopharyngeal penetration or reflux**
   6. **Residue in valleculae with popcorn**, cleared with next swallow; **puree residue not cleared by end of examination.**
   7. Upper esophageal sphincter opened promptly and adequately, **no difficulty in material moving through the UES.**
B. Apple juice by spout cup
   1. **Bolus formation functional**
   2. Material in valleculae and pyriform sinuses prior to trigger of a pharyngeal swallow – **slight delay in pharyngeal trigger**
   3. **Trace penetration to underside of tip of epiglottis** at times, no deeper.
   4. **No nasopharyngeal reflux**
   5. **No aspiration**
   6. **No pharyngeal residue after swallows**
   7. Upper esophageal sphincter opened promptly and adequately, with **no difficulty in material moving through the UES.**
C. Enlarged tonsils and adenoid – PA view estimated **palatine tonsils filling approximately 90% of airway.**

IV. Interpretation/Impression
A. Essentially safe and functional skills for drinking thin liquid and eating smooth pureed foods. Appropriate for continued oral feeding to meet nutrition needs.
B. Slow initiation of oral transit with smooth pureed food; frequent cueing needed.
C. Immature chewing skills
D. Enlarged tonsils and adenoid may be factor in limited chewable food

V. Prognosis – Regression in oral feeding skills likely related to seizure disorder, overall neurodevelopmental status, behavioral factors, and oral sensorimotor skills. Prognosis does appear positive for gains to improve efficiency and expand food textures with appropriate intervention.

VI. Recommendations – Short Term
A. Continue oral feeding with developmentally appropriate food and liquid, per nutrition recommendations by dietitian.
B. Spoon feeding: place spoon on tongue with small amount of food (size of Hershey’s kiss). Encourage active lip movement to clear the spoon.
C. Easily dissolvable solid food is good for chewing practice.
D. Referral to ENT clinic for airway examination re enlarged tonsils and adenoid.
E. Resume oral sensorimotor and feeding therapy with SLP.
F. Call with further questions and concerns. Follow with Feeding Clinic.
Case #6 (ZJ)

I. Demographic information
   A. Age: 7 months, term infant, birth weight = 6 lb 13 oz.
   B. Diagnosis: Pierre Robin sequence (micrognathia, glossoptosis, and airway obstruction) with posterior cleft palate; s/p mandibular distraction osteogenesis (MDO).
   C. Previous testing: VFSS at 3 months revealed multiple events of silent aspiration just prior to and during swallows while using a Haberman feeder – NG tube fed at that time shortly after MDO. G-tube was placed. Infant was limited to 60 ml orally and rest of feeding by tube. Second examination was done 3 weeks later when parents reported that infant fussed significantly when they stopped the oral feeding. He seemed to be doing better by observation. However, multiple episodes of silent aspiration were noted. He continued to feed eagerly via Haberman feeder with small volume. Feeding team evaluation 6 weeks prior to this exam: focus on spoon feeding practice rather than liquid.
   D. Reason for referral: Child appears to be doing better per parents, who want to increase volume of oral feeding if possible.
   E. Current feeding: Nipple feeding of formula maximum 60 ml per oral feeding by Haberman feeder, rest by GT. Beginning spoon feeding practice.
   F. Medication: None

II. VFSS Procedure
   A. Position: lateral view, nearly upright in Tumbleform seat
   B. State: awake, alert, eager to feed, responsive throughout exam
   C. Oral peripheral examination: Normal structures, except for posterior cleft palate (not repaired), very mild micrognathia.
   D. Therapeutic alterations: cup trial

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
A. Regular formula via Haberman feeder presented by father:
   1. **Initiated sucking readily, but limited tongue action, variable efficiency** 1:1 to 5:1 suck:swallow
   2. Number of swallows: 27 (18, brief pause, and 9 additional swallows)
   3. Liquid seen in **valleculae and pyriform sinuses** briefly prior to initiation of pharyngeal swallow indicating **minimal delay**
   4. **Nasopharyngeal penetration** (expected with posterior cleft palate)
   5. **No aspiration**
   6. **No residue in pharynx after swallows**
B. Smooth puree (Stage 2 baby food green beans by spoon for 6 swallows -limited experience)
   1. **Inefficient initiation of bolus formation** (some leakage out mouth, material in anterior sulcus for several seconds, slow initiation of tongue action)
   2. Material into valleculae and at times into pyriform sinuses, **minimal delay in initiating a swallow**
   3. **Nasopharyngeal penetration**
   4. **Silent trace aspiration event 1 time at the initiation of a pharyngeal swallow** related to delay in initiation of pharyngeal swallow with material seen just below level of vocal folds, which **appeared to be “squeezed out” upon completion of the swallow.** No barium contrast was seen in trachea as the study progressed
   5. **Trace residual on posterior tongue and occasionally to valleculae**
   6. **Pharyngeal contractions appeared borderline to mildly reduced**
C. Thickened liquid by cup (rice cereal in formula)
   1. Small amount each time – 14 swallows
   2. **Less delay in bolus formation**
   3. **No delay in initiation of pharyngeal phase**
   4. **No aspiration**
   5. **No residue in pharynx, just on tongue**
D. Upper esophageal sphincter opened promptly and adequately for all textures, with **no difficulty in material moving through the UES.**

IV. Interpretation/Impression
A. Significant gains in coordination of oral and pharyngeal phases of swallowing, especially for formula by Haberman feeder, with no aspiration on that consistency.
B. The one trace and silent aspiration event with pureed food likely is related to a mild timing deficit. The fact that he expelled the aspirated material from the airway upon completion of the swallow is encouraging for gains to continue for safe oral feeding.
C. Safe to increase volume of formula taken orally in small steps gradually. Goal is total oral feeding.
D. He was eager to eat and drink.

V. Prognosis – Good for gradual increase in oral feeding in coming weeks. Long range for total oral feeding adequate to meet nutrition and hydration needs appears positive and will relate closely to overall neurodevelopmental progress.
VI. Recommendations
   A. Parents will increase the volume of formula in small increments. They will increase the next feeding by 15 cc. If no obvious problem for at least 4 feeds, they will increase by the same amount. Tube feeds will be decreased by the same amount as oral feeding increases.
   B. Spoon feeding for practice about 10 minutes 3 times per day, per specific techniques demonstrated, practiced by parent, and discussed.
   C. Cup drinking practice can be initiated in the near future – open cup with milk shake or fruit slush consistencies with gradual transition to drinking thin liquid (as demonstrated and discussed)
   D. Birth-to-Three evaluation is in process.
   E. Return to Feeding Clinic within 6-8 weeks. Follow up with other physicians.
CASE #7 (AC)

I. Demographic information
   A. Age: Nearly 3 months, term delivery, birth weight = 6 lb 10 oz
   B. Diagnoses: Tetrasomy 18p, developmental delay – in Birth-to-Three services with gains noted in past few weeks.
   C. Previous testing: First VFSS while inpatient in first week of life with no aspiration, basically normal with fatigue noted as study progressed. By 2 weeks, repeat VFSS revealed multiple episodes of silent aspiration at initiation of pharyngeal swallows with thin and thickened liquid by nipple. UGI was normal. pH probe showed significant gastroesophageal reflux. Magnetic resonance imaging (MRI) of head was normal. Genetics workup in progress.
   D. Reason for referral: Feeding difficulties since birth, poor weight gain, and history of silent aspiration. Can she increase volume of oral feeding?
   E. Current feeding: Nasogastric (NG) tube feedings of Enfamil AR formula 24 cal/oz over 18 hours per day with slight increase in volume gradually over time. Parents stated that she handles those feeds with no emesis. They have been offering 10 ml formula via standard nipple 1-2 times per day. Infant has been taking that small volume without obvious signs for aspiration.
   F. Medication: Zantac

II. VFSS Procedure
   A. Position: Lateral view, semi-upright in Tumbleform seat
   B. State: Awake, alert, and responsive throughout examination
   C. Oral peripheral examination: Intact oral structures
   D. Therapeutic alterations (NG tube was left in place – had she shown aspiration or other pharyngeal phase problems, it would have been removed for additional swallows).

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Enfamil AR nectar consistency via standard nipple (presented by father)
   1. Variable efficiency - **suck:swallow ratio varied from 2-3:1 up to 6:1**
   2. Once she initiated posterior tongue action in the sucking process, liquid moved through the pharynx with liquid seen only briefly in the valleculae and at times in pyriform sinuses – minimal delay in pharyngeal trigger.
   3. Laryngeal penetration just to underside of tip of epiglottis noted occasionally, cleared with completion of the swallow.
   4. **No aspiration**
   5. Trace residue in valleculae, pyriform sinuses, and on posterior tongue

B. Thin consistency formula via standard nipple
   1. Improved efficiency: **1-2 sucks per swallow**
   2. Less material in valleculae and pyriform sinuses prior to pharyngeal swallow initiation; improved clearance of pharynx
   3. Laryngeal penetration to underside of epiglottis more frequent than with thicker liquid; cleared pharynx upon completion of the swallow.
   4. **Minimal residue in pharynx, cleared with next swallow**

C. Upper esophageal sphincter opened promptly and adequately, with no difficulty in moving thin and thickened liquid through the UES.

IV. Interpretation/Impression
A. Gains in recent months re improved sucking strength and coordination of sucking, swallowing, and breathing. No aspiration noted. Gains noted in other developmental domains. Efficiency for regular formula was better than with thickened liquid. Efficiency is important – we don’t want her to expend so much effort sucking and swallowing that she will not take appropriate volume.

B. Safe for at least small volume oral nipple feeds, with gradual increase in volume over time. She should not be at obvious risk for aspiration while feeding orally

V. Prognosis – Good for total oral feeding adequate to meet nutrition and hydration needs via nipple feeds at least for the next 2-3 months. By 6 months of age or equivalent developmental skill levels, she should be ready for spoon feeding providing gains continue similarly to the past few weeks.

VI. Recommendations
A. Continue NG tube feeding and oral feeding with thin liquid (maximize nutrition and hydration with liquid that is handled most efficiently). Monitor closely for flow rate to make sure she is efficient, while not getting too much liquid too fast.

B. Gradually increase the oral feeding and off set tube feeding in a direct trade-off, per dietitian.

C. Mid-line neutral posture is important to minimize risk for aspiration while she drinks thin liquid.

D. Continue Birth-to-Three program services. SLP is encouraged to call me at parent request for further information and mutual problem solving.

E. I will continue to monitor status for oral sensorimotor skills and feeding with the Feeding Clinic. Further recommendations will be made pending changes in the next few weeks.
CASE #8 (BB)

I. Demographic information
   A. Age: nearly 7 weeks, term delivery, birth weight = 7 lb
   B. Diagnosis: “Normal infant”, except for frequent choking episodes.
   C. Previous testing: UGI - normal
   D. Reason for referral: Feeding difficulties and reflux
   E. Current feeding: Enfamil Gentle Ease formula with Avent nipple and bottle system has reduced choking, according to parent. Constipation is problem.
   F. Medication: Axid for reflux

II. VFSS Procedure
   A. Position: Lateral view, semi-upright in Tumbleform seat appropriate for nipple feeding
   B. State: Awake, alert, and responsive throughout examination
   C. Oral peripheral examination: Intact oral structures
   D. Therapeutic alterations: None

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings: Regular formula by nipple with Avent nipple for 25 swallows, fluoroscopy unit turned off as infant took about 20 cc, 15 additional swallows when unit was turned back on- presented by mother.

A. Bolus formation
   1. Immediate initiation of sucking, varied from **1:1 to 4:1 suck:swallow**
   2. **Typically 2 sucks per swallow, essentially within normal limits**
B. Oral Transit – **functional**, within normal limits
C. Pharyngeal phase initiation
   1. **Liquid in valleculae prior to initiation of most pharyngeal swallows**, most common when she produced multiple sucks per swallow
   2. **Liquid in pyriform sinuses prior to some swallows, indicating a mild delay in pharyngeal phase initiation**
D. Pharyngeal phase
   1. **No aspiration or laryngeal penetration**
   2. **No nasopharyngeal penetration**
   3. **No residue in pharynx after swallows**
E. Upper esophageal phase - Material entered into and moved through the upper esophageal sphincter with **no problem**

IV. Interpretation/Impression
A. Functional suck, swallow, and respiratory coordination
B. No aspiration or penetration events
C. Safe to continue nipple feeds with no specific intervention needed.

V. Prognosis – Good for total oral feeding adequate to meet nutrition and hydration needs via nipple feeds with adequate management of reflux and appropriate developmental skills.

VI. Recommendations
A. Continue oral feeding with regular formula consistency and nipple/bottle. Monitor closely for flow rate to make sure infant is efficient, while not getting too much liquid too fast. Goal is 1:1 or 2:1 suck to swallow ratio
B. Hold infant nearly upright with good support to keep her trunk, neck, and head in a neutral midline posture
C. Parent will call with questions or concerns.
D. If gains do not occur as anticipated in the next several weeks, a clinical feeding evaluation can be scheduled so that more specific recommendations can be made.
CASE #9 (DA)

I. Demographic information
   A. Age: 16 months, term delivery, birth weight = 6 lb.
   B. Diagnosis: Probable autosomal dominant microphthalmial-anophthalmia syndrome, per Genetics. Developmental delay with low tone (normal development for first 3 months, then slowed – currently mild global developmental delays), visual deficits.
   C. Previous testing: UGI - normal.
   D. Reason for referral: Gurgly wet sounds while he is eating and drinking at times. SLP has noted high palate.
   E. Current feeding: Total oral feedings – Pediasure and water by spout cup with valve, smooth food by spoon, and some chewable food (e.g., small pieces of hot dog, fruit, and crackers). Parent stated that chunky foods are harder for child, which is not surprising given developmental skill levels.
   F. Medication: See medical chart.

II. VFSS Procedure
   A. Position: Lateral view, upright in MAMA chair
   B. State: Awake and alert, cooperative most of the time. He got slightly fussy at one point and calmed down – no gurgly voice quality noted during the examination
   C. Oral peripheral examination: Essentially intact oral structures. High palate should not be a major interfering factor for oral feeding.
   D. Textures: Father presented Pediasure via spout cup, pudding via spoon, Jello via spoon, water by spout cup
   E. Therapeutic alterations: Water by open cup to get a bigger volume to “stress” him

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
A. Bolus formation
   1. **Slow to initiate tongue action** to form a bolus for all food and liquid
   2. Liquid - **closed lips around the spout**, but seemed to work hard to get the liquid out with **2-3 sucks per swallow** via spout cup
   3. Pureed – **only minimal loss out of mouth, somewhat slow to initiate tongue action**
B. Oral transit - **Appropriate for all boluses** once posterior tongue propulsion was initiated. **Thicker food remained on tongue that required 2-3 swallows per bolus**
C. Initiation of pharyngeal phase
   1. **Material in valleculae prior to initiation for most boluses**, but held so briefly that he had **no major delay** in initiating a pharyngeal phase.
   2. **Occasionally material was seen in pyriform sinuses**, primarily noted when he got fussy.
D. Pharyngeal phase
   1. Essentially **functional timing, coordination, and strength**
   2. **No aspiration or laryngeal penetration**
   3. **No nasopharyngeal penetration**
   4. **No residue in pharynx after any swallows**
E. Upper esophageal phase - **Material entered into and moved through the upper esophageal sphincter with no problem**
   Structures: **Adenoid pad – no negative impact on nasal airway**
   **Tonsils – evident but not interfering with swallow** (Note: Snores at night)

IV. Interpretation/Impression
A. Essentially functional pharyngeal phase swallowing for all textures tested.
B. No aspiration or laryngeal penetration with any texture
C. Mild inefficiency in bolus formation with mild delay in initiating tongue action

V. Prognosis – Short term prognosis appears positive for total oral feeding adequate to meet nutrition and hydration needs. Long term prognosis for total oral feeding is likely to relate closely to overall neurodevelopmental skill development.

VI. Recommendations – Short Term
A. Continue oral feeding with developmentally appropriate food and liquid (not expected to handle chewable food efficiently – avoid “tough to chew” solids for at least the next several months)
B. Important to be aware of developmental skill levels in setting expectations for advance of textures. Gradually expand textures in small steps.
C. Meal times should take no more than 30 minutes on a regular basis.
D. If gains do not occur as anticipated, a clinical feeding evaluation will be scheduled so that more specific recommendations can be made.
E. Continue therapy services.
CASE #10 (AB)

I. Demographic information
   A. Age: 6 months (adjusted at about 4 1/2 months), delivered at 33-34 weeks, small for gestational age (SGA).
   B. Diagnoses: Prenatal cocaine exposure, mild to moderate persistent asthma, possible airway malacia, No major developmental concerns at this time
   C. Previous testing: UGI reported normal two weeks prior to this examination
   D. Reason for referral: Risk for aspiration with oral feeding; history of “barky cough”
   E. Current feeding: Total oral feeding with thickened formula (4 oz formula, 1 oz rice cereal) by bottle/nipple + spoon feeding. Adoptive parent reported less coughing since thickened formula. Constipation is a problem.
   F. Medications: Prevacid, Albuterol, Flovent

II. VFSS Procedure
   A. Position: Lateral view, nearly upright on Tumbleform seat
   B. State: Awake and alert, no fussing
   C. Oral peripheral mechanism: Intact oral structures. Voice within normal limits
   D. Therapeutic alterations: Varied liquid consistencies

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings (Food and liquid presented by adoptive mother)
   A. **Thickened formula** (4 oz formula/1 oz rice cereal) with bottle and nipple used at home in previous 2 weeks
      1. **Efficient suck:swallow ratio of 1:1** with appropriate burst and pause patterns. 19 sucks and swallows, with **liquid seen briefly in valleculae before 2 swallows only and no real delay**. Fluoroscopy unit turned off for 3 minutes, on for 5 additional sequences
      2. **No nasopharyngeal penetration**
      3. **No laryngeal penetration or aspiration**
      4. **Pharynx cleared with every swallow**
   B. **Regular formula** by standard hospital nipple
      1. **Flow rate faster** than thickened liquid
      2. **Material in valleculae and pyriform sinuses prior to some swallows**
      3. **Penetration to underside of superior portion of epiglottis** at initiation of pharyngeal swallows
      4. **Trace silent aspiration at initiation of pharyngeal swallow 2 times**, **material squeezed out of airway**; no barium contrast seen below level of vocal folds as study progressed.
      5. **Coughed after nipple was removed. No barium contrast noted in pharynx or airway** at the time.
   C. **Smooth puree** (stage 2 baby food by spoon)
      1. **Suckle pattern with tongue**; slow in closing lips around the spoon. Once he closed lips around spoon, he initiated posterior tongue action.
      2. **No delay in oral transit**
      3. **No delay in initiating pharyngeal swallows**
      4. **No laryngeal penetration or aspiration**
      5. **No nasopharyngeal penetration**
      6. **No residue in pharynx following swallows**
      7. **Residue on tongue, cleared with follow-up swallow**
   D. **Upper esophageal sphincter opened promptly and adequately**; no difficulty in material moving through the UES for all textures

IV. Interpretation
   A. Efficient suck, swallow, and breathing sequencing for nectar-consistency liquid by nipple (4:1, 4 oz formula:1 oz rice cereal).
   B. Increased risk for aspiration with regular formula and standard nipple due to faster flow and more difficulty in initiating a swallow in a timely way (2 aspiration events, barium contrast cleared out of the airway)
   C. Appropriate for spoon feeding practice

V. Prognosis
   A. Positive for successful oral feeding with thickened liquid in short run
   B. Positive for regular formula in long term closely related to neurodevelopment gains in coming months

VI. Recommendations
   A. Use thickened liquid (1 oz rice cereal with 4 oz. formula), with gradual thinning of formula in small steps until regular formula is handled with appropriate efficiency (may also help constipation). Feeders will monitor flow rate closely.
B. Spoon feeding practice 2-3 times per day for 10 minutes; no emphasis on increasing volume, but emphasis on pleasurable practice. Gains expected as developmentally appropriate.
C. Return to Pulmonology Clinic as recommended
D. If gains do not continue as anticipated, infant will be scheduled for clinic evaluation to make specific recommendations to facilitate safe and efficient oral feeding.
CASE #11 (JS – no audio, quivery artifact, but useful for decision making with this diagnosis)

I. Demographic information
   A. Age: 3 years 8 months
   B. Diagnosis: Spinal muscular atrophy (SMA) Type II, hereditary disorder in which nerve cells in the spinal cord and brain stem degenerate, causing progressive muscle weakness and wasting. Inheritance is usually autosomal recessive (not sex-linked trait). In Type II, weakness develops by age 6 months. Most children are confined to a wheelchair by age 2-3 years. Disorder is often fatal in early life because of respiratory problems, but some children survive with permanent weakness that stays stable for prolonged periods. JS has intact cognition & language skills – motor deficits consistent with diagnosis
   C. Previous testing: Not available
   D. Reason for referral: Risk for aspiration and limited chewing of solid food
   E. Current feeding: Total PO – Child drinks Pediasure and eats a variety of textures, although limited food choices. Favorite is chicken nuggets; eats yogurt; likes chocolate milk. Parent reports that child likes to feed himself, gets fatigued as meal progresses. Meal times up to 1 hour. OT focuses on self-feeding.
   F. Medication: None

II. VFSS Procedure
   A. Position: Lateral view, upright
   B. State: Alert, appropriate verbal communication, somewhat shy, cooperative and responsive
   C. Oral peripheral mechanism: Intact structures; speech intelligible; voice with clear phonation, fading at ends of phrases
   D. Therapeutic alterations: varied texture trials

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
   A. Liquid via straw (apple juice and chocolate milk)
      1. Started sucking immediately
      2. **Functional bolus formation**
      3. **Posterior tongue propulsion mildly reduced**
      4. Liquid seen in valleculae and briefly in pyriform sinuses prior to initiating pharyngeal swallow – 17 swallows of juice and 14 swallows of chocolate milk
      5. **No nasopharyngeal penetration**
      6. **Laryngeal penetration to underside of superior portion of epiglottis one time** near end of sequence of swallows of chocolate milk.
      7. **No aspiration**
      8. **Residue in valleculae and pyriform sinuses – never cleared**
   B. Smooth puree via spoon (yogurt)
      1. **Slow to initiate tongue action** for bolus formation
      2. Total: 3 bites of yogurt and 3 swallows per bite
      3. **Posterior tongue propulsion mildly reduced**
      4. **No nasopharyngeal penetration**
      5. **Barium contrast on tongue and in valleculae between swallows**
      6. **No laryngeal penetration or aspiration**
      7. **Residue in valleculae and pyriform sinuses – never cleared**
   C. Chewable food - chicken nugget
      1. Two bites, **3 swallows per bite**
      2. **Prolonged chewing** – mouth opened and closed rhythmically, at best vertical munching and more tongue mashing than true chewing
      3. **No nasopharyngeal penetration**
      4. **No laryngeal penetration or aspiration**
      5. **Residue in the pharynx** (valleculae, pyriform sinuses, and posterior pharyngeal wall)
      6. **Verbal request at end of examination to “swallow again” did not result in clearance of residue**
   D. All textures: **Upper esophageal sphincter opened promptly and adequately**, with no difficulty in material moving through the UES.

IV. Interpretation/Impression
   A. Safe for oral feeding to continue in short run, fatigue likely as meal progresses, especially with food that requires increased chewing
   B. No aspiration or nasopharyngeal penetration, encouraging for continued PO
   C. Mild delay in initiation of swallow as noted by laryngeal penetration just prior to pharyngeal trigger with consecutive swallows of liquid – likely some risk for aspiration with liquids as fatigue becomes a factor
   D. Reduced posterior tongue propulsion, incomplete base of tongue contact to posterior pharyngeal wall, and reduced pharyngeal contractions resulted in residue in pharynx, which adds to risk for aspiration over duration of a meal

V. Prognosis
   A. Progressive muscle weakness and wasting will occur in coming months/years
   B. Expect increased effort making chewing more difficult over time
C. Swallowing of all textures is likely to become more difficult as disease progresses
D. Risk for aspiration will likely increase over time

VI. Recommendations – Short Term
A. Maximize nutrition via liquid and food not requiring chewing (or at most minimal chewing) at mealtimes. Focus on a combination of self-feeding and assisted feeding to keep meal times to about 20 minutes to a maximum of 30 minutes, and snack times about 10-15 minutes.
B. Allow small amounts of easily dissolvable chewable food – his favorites
   1. A few bites at beginning of meal or at end
   2. Snack times can include chewable food – easily dissolvable
C. Self-feeding and chewing practice should be a focus in therapy and at snack times, less during meal times when efficiency is important
D. Follow up with clinical feeding evaluation and dietitian consultation. Call for further information and assistance.
CASE #12 (AA)

I. Demographic information
   A. Age: 8 years. Delivered at 27 weeks’ gestation due to placenta abruption – 4 months in NICU.
   B. Diagnosis: Bronchopulmonary dysplasia resolved; PDA (closed spontaneously); motor skill deficits. Cognition & language intact.
   C. Previous testing: Previous VFSS at age 5 years revealed aspiration on thin liquids. Recommendation was for nectar consistency liquids. Two months prior to this examination, clinical feeding evaluation revealed immature chewing skills, although child was taking regular table food. School personnel have continued to offer nectar liquids, but parents have been giving her thin liquids.
   D. Reason for referral: Question of safety for oral feeding and readiness to increase volume and expand textures in child with long term GT feedings and history of silent aspiration on thin liquids. Parents reported snoring when child is asleep.
   E. Current feeding: GT feeds + table foods and thin liquid at home.
   F. Medication: None

II. VFSS Procedure
   A. Position: Lateral view, upright
   B. State: Cooperative and responsive
   C. Textures: Apple juice by spoon 1 time followed by independent drinking from open cup (4 single sips, no sequential swallows, which is typical at home), one bite applesauce for 2 swallows, and 1 bite sausage with 3 swallows.
   D. Therapeutic alterations: Varied texture trials, verbal requests to child to make quick sequential swallows of liquid.

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
   1. Held **food in anterior oral cavity several seconds** – material seen in anterior and lateral sulci. **Liquid was seen under tongue**
   2. **Slow to initiate tongue action** to form a bolus
   3. **Immature chewing skills** for solid – combination of **tongue mashing and vertical munching**
B. Oral transit
   1. Essentially **within normal limits**
   2. **Material remained on tongue between swallows for some boluses**
C. Pharyngeal phase initiation
   1. **Material in valleculae briefly prior to initiation of swallow, only occasionally to pyriform sinuses**
   2. **Minimal delay** in initiating pharyngeal swallows **at times**
D. Pharyngeal phase
   1. **Penetration to underside of superior portion of epiglottis** at initiation of pharyngeal phase **with big gulps of liquid**, no deeper penetration
   2. **No aspiration**
   3. **No nasopharyngeal penetration**
   4. **Cleared pharynx with most swallows. At times, residue was seen on tongue base and in valleculae. Trace coating with thicker barium contrast at top of upper esophageal sphincter. Pharynx cleared with additional dry swallow.**
E. Upper esophageal phase: **UES opened promptly and adequately**, with no difficulty in material moving through the UES.
Structures: **Tonsils visible, not interfering with bolus transit. Adenoid pad not enlarged**

IV. Interpretation/Impression
A. Improved function over previous VFSS, particularly for timing and coordination in swallowing very thin liquid. No aspiration.
B. Safe for oral feeding to include very thin liquids.
C. Immature chewing skills – ok for relatively soft and easily chewable food.

V. Prognosis: Positive for gains to continue in coming months with gradual expansion of textures and close monitoring of timing for liquids. Long term prognosis relates most closely to overall neurodevelopmental status.

VI. Recommendations – Short Term
A. Maximize nutrition with food and liquid that child handles efficiently. Gradually decrease G-tube feeds as she drinks more of her formula and eats more foods. Dietitian and physician will direct that portion of plan.
B. At school, child should be able to drink liquid by open cup without thickening. Supervision in lunchroom should continue as appropriate for children of her age and developmental skill levels.
C. Guidelines have been given for ways to facilitate improved chewing skills. She also needs to learn to take consecutive swallows of liquid. New skills can be a focus in therapy and at snack time.
D. Follow up with clinical intervention as needed. Call for further information and assistance.
CASE #13 (WH)

I. Demographic information
   A. Age: 6 years. 26-weeks gestation, 485 grams, intrauterine growth retardation (IUGR),
   B. Diagnoses: Grade 1 germinal matrix bleed, bilateral optic nerve atrophy and nystagmus. Mild global developmental delays - he is ambulatory and communicates via speech.
   C. Previous testing: Brain MRI – white matter atrophy, foreshortening of corpus colossum, atrophic optic nerves, and shallow sella with hypoplastic pituitary gland. Genetic and metabolic workups reported normal. VFSS at another institution 3 ½ years ago was reported normal (no video or report available).
   D. Reason for referral: Feeding team referral with concerns related to “how to get him feeding orally and eventually to get rid of the G-tube.”
   E. Current feeding: G-tube with Nissen fundoplication for past 3 years 9 months, NG tube feeding prior. Compleat pediatric formula by tube for nutrition and hydration needs. Small volume oral feeding includes yogurt and pudding as primary foods. He nibbles on chips, cookies, other salty or sour food, but no true chewing and swallowing of solid food. He takes single sips of liquid by straw or cup
   F. Medications: Albuterol, Flovent, Carbatrol (Allergic to Motrin)

II. VFSS Procedure
   A. Position: Lateral view, upright
   B. State: Alert and cooperative; self feeding with mother presenting food and liquid
   C. Oral peripheral examination: Intact oral structures; slightly short lingual frenulum did not interfere with tongue mobility; lips closed at rest to indicate nasal breathing; voice quality appropriate; speech readily intelligible
   D. Textures: Orange juice via straw, smooth pudding (1 bite for 2 swallows), 1 bite lumpy pudding, additional swallows of orange juice by straw
   E. Therapeutic alterations: Facilitation to “swallow quicker” and take consecutive swallows of liquid.

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
   1. **Significantly delayed initiation of tongue action, particularly for liquid.**
      He held liquid in oral cavity for up to 20 seconds before he moved liquid posteriorly over his tongue.
   2. **Pudding held in oral cavity for shorter time.**
B. Oral transit
   1. Once posterior tongue propulsion was initiated, material moved posteriorly over tongue with **no major delay**
C. Initiation of pharyngeal swallow
   1. **Minimally delayed initiation** with material in valleculae briefly, but only occasionally in pyriform sinuses
   2. Liquid: **One aspiration event noted at point of initiation of pharyngeal swallow on the 8th swallow of thin liquid.** He coughed immediately and cleared the airway. He produced another swallow and cleared the pharynx completely.
D. Pharyngeal phase
   1. **Pharyngeal contractions appeared functional**
   2. **Trace coating of puree on posterior tongue and posterior pharyngeal wall**
   3. **Pharynx cleared with additional swallow**
E. Upper esophageal phase
   1. **Material moved into and through the UES with no sign of problems**
   2. **Trace coating of barium contrast on upper esophageal sphincter - cleared with the following swallow** – did not appear problematic in terms of safety for swallowing.

IV. Interpretation/Impression
A. Appears safe for oral feeding without obvious risks for aspiration issues, even though he had one aspiration event at initiation of one swallow of liquid as he was being urged to increase volume and to take consecutive swallows. He had been taking single sips of liquid.
B. Immediate cough and clearance of airway were encouraging for safe oral feeding.
C. The prolonged holding of liquid in the oral cavity has a negative impact on the timing of swallows of liquid.

V. **Prognosis** – Long term prognosis for significant increase in oral feeding is positive, especially if he can improve efficiency for taking liquid.

VI. Recommendations
A. In short run, continue to maximize nutrition and hydration with G-tube feeds per dietitian and gastroenterologist.
B. Structured meal and snack times with intervention related to chewing and to taking consecutive swallows of liquid (child was seen for a few sessions with guidance to his parents before returning home out of state).
C. Weaning from G-tube feedings appears feasible that may require intensive inpatient behavior focused intervention
D. School therapists to call me at parent request.
E. Follow with Feeding, Swallowing, and Nutrition Center.
CASE #14. (TP)
I. Demographic information
   A. Age: 9 months (7 months adjusted age).
   B. Diagnoses: 31 weeks gestation, white matter disease, and periventricular leukomalacia (PVL). Developmental delays – overall at about 4 month levels
   C. Previous testing: UGI 2 weeks prior, normal motility and no gastroesophageal reflux (GER)
   D. Reason for referral: Possible risk for aspiration with oral feeding
   E. Current feeding: Alimentum formula thickened with rice cereal (3 to 1 ratio), tricut nipple, spoon-feeding
   F. Medications: Prilosec, Baclofen, and Kristalose (constipation)
II. VFSS Procedure
   A. Position: Tumbleform seat on MAMA chair: lateral view, nearly upright
   B. State: Awake and alert, no fussing.
   C. Peripheral oral examination: Intact oral structures, frequent drooling
   D. Textures: Puree – thin (2 presentations by spoon), thicker smooth puree (2 presentations by spoon), thickened liquid formula for 24 swallows, regular formula 23 swallows in sequence, fluoroscopy unit turned off, back on for 12 more swallows. Father presented food and liquid
   E. Therapeutic alterations: Varied consistencies

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings

A. Bolus formation
1. **Inefficient oral skills for spoon feeding expected for developmental levels of 4 months; suckle pattern, spillage.** No difference with thin/thicker puree.
2. Sucking: **non-nutritive pattern of 2 sucks per sec at first, then better flow, usually 2-3 sucks per swallow indicating mild inefficiency.** Similar for thin and thicker liquid – took longer to get into sequential pattern with thin liquid

B. Oral transit
1. **No significant delay**
2. **Material in lateral sulcus and some remaining on tongue**
3. **Piecemeal deglutition with puree – 2-3 swallows per bolus**

C. Pharyngeal phase initiation
1. **Mild delay with all textures**
2. **Material in valleculae with all textures, and at times to pyriform sinuses**

D. Pharyngeal phase
1. **No delay in transit with spoon feeding**
2. **Puree: Residue on posterior tongue and in valleculae with trace coating in pyriform sinuses. Cleared with additional swallow**
3. **Liquid – occasional nasopharyngeal penetration (3 times)**
4. **Liquid – Intermittent penetration to underside of superior portion of epiglottis, cleared with each swallow. Similar thin and thickened liquid**
5. **Liquid residue posterior tongue, valleculae, and only occasionally to pyriform sinuses.**

E. Upper esophageal phase: **Upper esophageal sphincter opened promptly and adequately:** no difficulty in material moving through the UES.

IV. Interpretation

A. Mildly reduced pharyngeal contractions resulted in residue
B. Nipple feeding appeared appropriate and functional for developmental skill levels
C. Not yet ready for spoon feeding at 4-month developmental levels, although practice may be considered, but not for major volume of oral feeding.

V. Prognosis

A. Positive for successful oral feeding, primarily bottle feeding in the short run.
B. Positive for expansion of textures over coming months as appropriate for neurodevelopment skill levels in coming months

VI. Recommendations

A. Continue bottle feeds with Alimentum formula, gradually thinning liquid in small changes to work toward a goal toward thin liquid by bottle.
B. Spoon feeding practice 2-3 times per day for 5-10 minutes; no emphasis on increasing volume, but emphasis on pleasurable practice. Gains expected as developmentally appropriate
C. Return to physicians as recommended
D. If gains do not continue as anticipated, infant will be scheduled for clinic evaluation to make additional specific recommendations.
CASE #15 (TH)

I. Demographic information
   A. Age: nearly 2 years
   B. Diagnoses: Down Syndrome, Ventral Septal Defect (surgery at age 11 months), low tone, developmental delays, and long history of feeding problems
   C. Previous testing: Sinus workup through ENT, on medication for left middle ear infection, and cardiac testing
   D. Reason for referral: Increased respiratory issues, including sinus problems, that appear to some degree feeding related.
   E. Current feeding: Total oral feeder – bottle and spoon feeding
   F. Medications: See medical chart.

II. VFSS Procedure
   A. Position: Upright, lateral view
   B. State: Alert, socially interactive, and cooperative
   C. Oral peripheral examination: Down facies, no basic structural basis for swallowing problem, although low tone is a factor in feeding function. Voice quality reflected appropriate phonation, pitch, and volume. Speech productions were primarily vowels.
   C. Textures: Thin liquid (consecutive swallows of milk plus Polycose via nipple), thicker liquid (consecutive swallows of milk plus cereal by nipple), puree (one bite of Stage 2 baby food), and bottle feeding of thickened liquid (consecutive swallows). Mother presented food and liquid to him
   D. Therapeutic alterations: Varied liquid consistencies

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
   1. **Mildly inefficient sucking for all consistencies of liquid** – 2 to 4 sucks per swallow. As liquid became thicker, he did not increase number of sucks per swallow
   2. **Fussy with spoon feeding**, accepted only one bite – inefficiency related to fussiness.
B. Oral transit
   1. Once posterior tongue propulsion was initiated, **material moved posteriorly over tongue with no major delay**
C. Pharyngeal phase initiation
   1. **No delay in initiation of swallow with puree bolus**
   2. **With nipple feeding, material was seen in valleculae and usually to pyriform sinuses as he made multiple sucks before initiating a swallow**
D. Pharyngeal phase
   1. **Laryngeal penetration just prior to and during pharyngeal swallow related to multiple sucks per swallow**
   2. **Intermittent silent trace aspiration with all liquid consistencies, more frequent with thinner liquids and only, ejected from just below the level of the vocal folds**
   3. **Trace coating after swallows in valleculae and pyriform sinuses, and occasionally on posterior pharyngeal wall**
E. Upper esophageal phase
   1. **Material moved into and through the UES with no signs of delay or any other problem**
   Structures: **Palatine tonsils noted deep in pharynx**, but not appearing to restrict airway or interfere with bolus flow

IV. Interpretation/Impression
A. Multiple events of trace and silent aspiration as he was drinking liquid from a nipple.
B. He appeared safer with thickened liquid (nectar consistency) than with thinner liquid. He had fewer trace aspiration events. Inefficient sucking continues of concern with 2-4 sucks per swallow typical.
C. Although observation with pureed food was limited, timing and coordination appeared functional.
D. Tonsils did not appear to have a negative impact on swallowing.

V. Prognosis
Long term prognosis for significant increase in oral feeding is positive, especially if he can improve efficiency for taking liquid.

VI. Recommendations
A. Thickened liquid (1 ounce rice cereal in 4 ounces formula) with toddler formula per dietitian and gastroenterologist. Parent will monitor flow rate closely – goal is 1 suck per swallow
B. Continue to maximize spoon-feeding for boosting caloric intake since child demonstrated more efficient swallowing than with liquid and thus likely less risk for aspiration.
C. Parent will call with questions. Follow up with clinical evaluation
D. Continue Birth-to-Three therapies. SLP is asked to call me at parent request for further information and mutual problem solving.
E. Follow with Feeding, Swallowing, and Nutrition Center.
CASE #16 (LM)

I. Demographic information
   A. Age: 3 years
   B. Diagnoses: Bilateral pneumothorax at birth, laryngotracheal malacia (severe), s/p bilateral supraglottoplasty, s/p adenoidectomy, severe GER with Nissen fundoplication that has been redone. No developmental delays. Language skills age appropriate. Speech about 80-90% intelligible to unfamiliar listener.
   C. Previous testing: Silent aspiration on VFSS – most recent exam 18 months ago - aspiration with multiple consistencies. Recommendations included small volume oral trials with limited textures.
   D. Reason for referral: Since oral skills have improved in recent months, is he safe to increase volume PO? No recent upper respiratory infections or pneumonia – one bout of croup two weeks prior to this exam
   E. Current feeding: GT feeds, with limited oral feeding for practice
   F. Medications: See medical chart.

II. VFSS Procedure
   A. Position: Upright, lateral view
   B. State: Alert, socially interactive, and cooperative
   C. Textures: Very thin liquid (apple juice by spoon, straw, open cup), 1 pineapple chunk, smooth puree (3 bites yogurt via spoon), 1 bite peanut butter and jelly sandwich, thin liquid (Pediasure by open cup for 5 swallows). Mother presented food and liquid to him
   D. Therapeutic alterations: Varied liquid consistencies

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
   A. Bolus formation
      1. **Liquid held in anterior oral cavity for several seconds before he initiated tongue action to form a bolus, then usually single sips.**
      2. **Immature and prolonged chewing for pineapple chunk and sandwich.**
   B. Oral transit
      1. **Appropriate for all textures**
   C. Pharyngeal phase initiation
      1. **Material in valleculae for all textures prior to initiation of pharyngeal swallow, but in most instances essentially no delay.**
      2. **Very thin liquid by spoon and straw was seen in pyriform sinuses with only minimal delay in initiation of pharyngeal swallow**
   D. Pharyngeal phase
      1. **Laryngeal penetration to the laryngeal vestibule 1 time at the point of initiation of pharyngeal swallow with very thin liquid by straw, and 2 times to the underside of the superior portion of the epiglottis during consecutive swallows of apple juice and Pediasure by open cup. He cleared the pharynx upon completion of each swallow.**
      2. **Residue on posterior tongue following some swallows and in valleculae with smooth puree – cleared with the next swallow.**
   E. Upper esophageal phase
      1. **Material moved into and through the UES with no signs of delay or any other problem**

**Structures:** **No evidence of enlarged tonsils or adenoid.**

Note: Child coughed and cleared his throat after exam was completed. He was still in the seat. Radiologist turned unit back on – no barium contrast in pyriform sinuses or in laryngeal vestibule, none in trachea. Trace residue was seen on posterior tongue and in valleculae. Child cleared pharynx while fluoroscopy unit was on.

IV. Interpretation/Impression
   A. Only brief penetration to laryngeal vestibule occurred occasionally while child drank very thin liquid (straw drinking) and 2 times with the open cup. Material was cleared (ejected/squeezed out) upon completion of the swallow, showing significant improvement over prior exams
   B. He appears safe to continue oral feeding and increase PO volumes with goal of weaning from GT feeds
   C. Immature chewing skills are not surprising given limited PO intake in past.

V. Prognosis – Long term prognosis for significant increase in oral feeding is positive and will relate closely to his overall neurodevelopmental status, as well as cardiopulmonary status. Goal of total oral feeding should be realistic over time.

VI. Recommendations
   A. In short run, continue to meet nutrition needs via GT feeds per dietitian and gastroenterologist.
   B. Oral feeding at family meal times prior to GT feeds. Close monitoring of head position for midline posture to eliminate tilting head back resulting in neck
hyperextension. Encourage consecutive swallows of liquid. Put a small amount of liquid in cup at one time, so he can “make it empty.”

C. Parent will bring 3-day food record to next gastroenterology clinic appt.

D. Feeding team clinic will be available to assist with a plan for weaning from tube feedings. Pulmonary health is most important – discussion will include pulmonologist and otolaryngologist with feeding team.

E. Continue speech-language pathology services with focuses on speech production and on oral skills for timing of swallows with liquid and for chewing practice. SLP is asked to call me at parent request for further information and mutual problem solving.
CASE #17 (TS)

I. Demographic information
   A. Age: Nearly 4 months
   B. Diagnosis: Down Syndrome, meconium aspiration at delivery, cardiac anomalies to include a large patent ductus arteriosus, pulmonary artery hypertension, and significant dilatation of the right ventricle. Cardiologist reported no evidence of any residual heart disease at 3 months of age.
   C. Previous testing: UGI at 3 months – normal. She is in Birth-to-Three services, with testing showing function at close to age level expectations, per parent
   D. Reason for referral: Per gastroenterologist - Question possible aspiration risks with bottle feeding in infant who has shown interest in increasing oral feeding volume.
   E. Current feeding: Gastrostomy tube that was placed while she was in a NICU at another hospital + nipple feeding. Parent stated that infant chokes as she gets started feeding and occasionally during the feeding. Weight gain is appropriate.
   F. Medication: None

II. VFSS Procedure
   A. Position: Lateral view, semi-upright in Tumbleform seat appropriate for nipple feeding.
   B. State: Awake and alert, fussing appropriately to indicate hunger.
   C. Oral peripheral examination: Down facies with intact oral structures; tongue was frequently held behind lips, although protruding slightly between lips at times. Nasal breathing was noted with occasionally snortiness. No obvious palatal deficits. Voice quality was appropriate re pitch, phonation, and volume.
   D. Textures: Infant’s mother presented regular formula via nipple used at home (short preemie nipple for 16 swallows, fluoro unit turned off for approximately 1 minute, then on to observe 4 additional swallows), standard hospital nipple (16 swallows observed), and thin rice cereal by spoon (6 swallows for 2 presentations).
   E. Therapeutic alterations: Nipple change.

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings

A. Bolus formation
   1. Infant took **a few seconds to get organized** to get nipple into her mouth and to latch on the nipple. She typically produced **2 sucks per swallow with her nipple**. She **improved efficiency with standard nipple for 1 suck per swallow frequently**. She **coughed one time after 3 or 4 swallows with standard nipple, but no barium contrast in pharynx at that time**. She was **markedly inefficient in forming a bolus with cereal by spoon** – not surprising as this was a new experience and developmentally she is not really ready for spoon feeding.

B. Oral transit
   1. **No problem**

C. Pharyngeal phase initiation
   1. **Minimal delay**: With her short preemie nipple, liquid was seen in valleculae and into pyriform sinuses prior to initiation of pharyngeal swallow.
   2. **No delay with standard nipple or puree by spoon**; With standard nipple, more timely trigger of pharyngeal swallow. No delay with puree by spoon.

D. Pharyngeal phase
   1. **No aspiration, no laryngeal penetration, no nasopharyngeal reflux**.
   2. **No residue in pharyngeal recesses following any swallow**

E. Upper esophageal phase
   1. **No problem**
   Structures: No evidence of enlarged tonsils or adenoid.

IV. Interpretation/Impression (This examination demonstrates significant differences in efficiency between two different types of nipples and emphasizes importance of a nipple that is placed far enough into the oral cavity so that tongue “stripping” can be accomplished readily).

A. Essentially functional nipple feeding with no aspiration or laryngeal penetration with nipple feeding or with spoon feeding.
B. Significantly improved efficiency with standard nipple that allowed her to “strip” the nipple better than with a short nipple
C. Spoon feeding practice does not need to be major focus until she gets closer to 6 months of age with commensurate skill levels.

V. Prognosis – Positive for total oral feeding in near future as efficiency is improved.

VI. Recommendations

A. Maximize nutrition and hydration with nipple feeding + GT supplement as currently being done. Parent will test with the standard nipple and let me know how the feedings go in the next few days. She will not push to increase volume of oral feeding but to improve efficiency. Likely volume will increase as efficiency improves. It is as important that this infant does not get too much liquid too fast as it is for her to work too hard.
B. Keep oral feeding times to about 20 minutes and no more than 30 minutes.
C. Continue Birth-to-Three services. SLP is asked to call me for further information and for mutual problem solving.
D. No follow-up appointment is being scheduled, unless gains do not occur as
anticipated. Parent will call with questions. Clinical evaluation can be scheduled
if needed.
E. Return to pediatric gastroenterologist and other physicians as recommended.
CASE #18 (TB)

I. Demographic information
   A. Age: Nearly 10 months of age
   B. Diagnoses: Torticollis, with gains noted per physical therapy. Fractured clavicle during delivery with birth weight 10 pounds, 8 ounces at term. He did not latch adequately for breast feeding. He has been bottle fed without difficulty. Feeding difficulties have been noted since spoon feeding. No developmental concerns.
   C. Previous testing: UGI - normal
   D. Reason for referral: Parents concerned about stress signs in child as he makes multiple swallows particularly noted with spoon feeding. His “eyes water” and he looks stressed as he makes multiple swallows with every bite of food. Per referral from gastroenterologist, there was question of possible upper esophageal sphincter dysfunction.
   E. Current feeding: Total oral feeding to include Alimentum formula since 8 weeks of age, primarily by bottle. He takes smooth baby food by spoon. He has been given opportunity for finger feeding, but just “sucks on a cracker,” but no biting or chewing yet.
   F. Medications: None

II. VFSS Procedure
   A. Position: Upright, lateral view. He tended to turn his head toward one side.
   B. State: Alert and cooperative, eager to eat.
   C. Oral peripheral examination: Intact oral structures. He was sucking on a Nuk type pacifier. Babbled appropriately with consonant-vowel combination. Voice quality was characterized by appropriate phonation, pitch, and volume.
   D. Textures: Child’s mother presented formula by bottle for 16 swallows, Stage 2 baby food fruit by spoon, Stage 3 sweet potato by spoon, Stage 2 fruit with crushed cookie to make a lumpy purr by spoon, nectar consistency juice by open cup.
   E. Therapeutic alterations: Texture and consistency, as well as bolus size changes.

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
   A. Bottle drinking
      1. **Immediate initiation of sucking on nipple used at home (Playtex type nurser)** with multiple sucks per swallow, from 3 to 5 or 6 times per swallow. Tongue appeared to be held in a retracted position, resulting in **inefficient sucking**.
      2. **Once he initiated posterior tongue propulsion, he had no delay in triggering a pharyngeal swallow and no signs of pharyngeal problem.**
      3. **No difficulty in moving liquid into and through the UES.**
   B. Pureed food by spoon
      1. **Suckle pattern used on the spoon**, with multiple suckles before he moved material posteriorly with his tongue.
      2. Trigger of pharyngeal phase: He appeared to continue to suckle as he moved the food over his tongue. As he triggered a pharyngeal swallow, **significant incoordination was noted with material moving up into the nasopharynx as part of the bolus was propelled through the UES. At times part of the bolus was propelled back into the oral cavity.**
      3. **Pharyngeal phase incoordination was evident in multiple ways. Residue was seen on posterior tongue, tongue base, in valleculae, in pyriform sinuses, and at times on the posterior pharyngeal wall. He typically cleared the pharynx following 2-3 swallows per bite of food.**
      4. **Less residue was seen with thicker, lumpier food.** He appeared to improve transit through the pharynx with less nasopharyngeal penetration and improved tongue base retraction. **Some swallows appeared essentially normal.**
      5. **No problem directly related to UES opening.**
   C. Nectar by open cup
      1. **With a small amount in the oral cavity, he showed essentially normal oral, pharyngeal, and upper esophageal function.**
      2. With bigger quantity, he showed some coordination deficits, but less than with the spoon feeding. He cleared the pharynx with an additional swallow.
      3. Material moved into and through the UES with no problem
IV. Interpretation/Impression
   A. Nipple feeding was characterized by inefficient sucking, but with no pharyngeal or upper esophageal swallowing problem.
   B. Spoon feeding: characterized by inefficient bolus formation, resulting in inefficient pharyngeal phase with nasopharyngeal penetration and residue between swallows, but with clearance following multiple swallows.
V. Prognosis – Prognosis for gains with oral feeding appears positive with modifications in spoon feeding to improve bolus formation and in turn swallowing.
VI. Recommendations
   A. Continue to maximize nutrition with nipple feeding of formula.
   B. Consider transition to pacifier that has longer nipple and similar shape to nipple used for feeding. Given his developmental status, he is likely to transition to cup within the next few months. The pacifier use can be minimized.

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C. Cup drinking practice techniques were demonstrated and printed guidelines sent home with parents – open cup with the pureed food thinned to fruit slush or milk shake consistency as means to alter the suckling patterns on spoon. (Practice was done immediately after the video swallow study while in the radiographic suite).

D. Introduction of easily dissolvable finger foods appears appropriate.

E. Spoon feeding: Use thicker, lumpier textures in smaller volume per bite to give opportunity to move the bolus over the tongue and swallow entire bolus with one swallow. Parents will call to report status within a week or two.

F. If child does not make major changes, clinical feeding appointment will be scheduled so that more specific demonstration with guidelines can be given to parents. This child should not require any ongoing therapeutic intervention.
CASE #19 (CL)
I. Demographic information
   A. Age: 8 ½ months (twin is normal)
   B. Diagnoses: Chromosomal anomaly, chromosome 4, monosomy distal 4q, s/p gastrostomy tube. Mild developmental delays
   C. Previous testing: VFSS at a different institution reported to show silent aspiration
   D. Reason for referral: History of silent aspiration and upper esophageal sphincter deficits; define pharyngeal physiology along with upper esophageal function.
   E. Current feeding: PO + NG tube feeds. Infant is eager to eat. Parents report that child usually fusses when oral feeding is stopped to indicate that he wants more.
   F. Medication: Prevacid
II. VFSS Procedure (Study completed in conjunction with esophageal manometry)
   A. Position: Lateral view, nearly upright in Tumbleform seat appropriate for nipple feeding.
   B. State: Alert, eager to eat, cooperative, and responsive
   C. Oral peripheral examination – Intact oral structures, occasional gurgly voice quality noted consistent with pooling of secretions, primarily vowel sounds. Voice quality – appropriate phonation, pitch, and volume
   D. Textures: Bottle feeding only - formula with rice cereal to nectar consistency via standard nipple as he has been taking at home – presented by mother
   E. Therapeutic alterations: No specific changes – considerations will be made pending manometry measures

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
   A. Bolus formation
      1. Immediate latch on nipple with **functional sucking usually 1 suck per swallow and at times 2 to 3 sucks per swallow**
      2. **Posterior tongue propulsion only mildly reduced**
   B. Oral transit
      1. **No problem**
   C. Pharyngeal phase initiation
      1. **Minimal delay** in initiating pharyngeal swallow; liquid in valleculae and in pyriform sinuses very briefly
   D. Pharyngeal phase
      1. **Pharyngeal contractions appeared mildly reduced**
      2. **Tongue base retraction reduced**
      2. **Nasopharyngeal penetration intermittent**
      3. **Residue increased as study continued** – valleculae, pyriform sinuses, and posterior pharyngeal wall
      4. **Aspiration intermittent with no response** – primarily on residue post-swallows and/or as he was initiating the next swallow in the sequences of sucking and swallowing – usually rated “trace”. He cleared the pharynx with additional swallows.
   E. Upper esophageal phase
      1. **Reduced opening of upper esophageal sphincter, Cricopharyngeal bar prominent.**
   F. Manometry revealed reduced pharyngeal compression with incomplete relaxation of upper esophageal sphincter.

IV. Impression/Interpretation
   A. Not safe for total oral feeding
   B. Coordination deficits related closely to reduced tongue base retraction, reduced pharyngeal contractions, and reduced opening of UES

V. Prognosis – Guarded for total oral feeding in the near future. It is difficult to predict long term prognosis – likely to relate closely to overall neurodevelopmental changes in light of his underlying diagnosis.

VI. Recommendations – (short term)
   A. Continue NG tube feeds to maximize nutrition and hydration
   B. Nipple feeding in small volumes given infant’s significant interest in oral feeding and basically stable pulmonary status, maximum of 15 ml per feed, if infant is calm and appears well coordinated.
   C. Discuss possible management strategies with physicians: consideration for Botox, esophageal dilatation, and possible PEG to maximize nutrition.
   D. Continue therapies with Birth-to-Three program with SLP focusing on communication. Monitor oral feeding status – oral skills are functional at this time.
   E. Return to Feeding Clinic for follow-up to include monitoring of oral skills to assist in facilitating age appropriate oral feeding safely.
CASE #20 (CL – repeat examination of Case 19 one year later)

I. Demographic information
   A. Age: 22 months (twin is normal)
   B. Diagnoses: Chromosomal anomaly, chromosome 4, monosomy distal 4q, s/p gastrostomy tube, s/p botox injections into upper esophageal sphincter, s/p esophageal dilatation. Developmental status: Continues in Birth to 3 therapy services with OT 2 times per month, PT 1 time per week, and speech-language pathology intervention weekly for language and for feeding. Using signs, consonant-vowel combinations increasing, speech imitation skills improving.
   C. Previous testing: Manometry revealed reduced pharyngeal pressures with incomplete relaxation of upper esophageal sphincter. Botox injection into UES + esophageal dilatation
   D. Reason for referral: Delineate pharyngeal phase function in child with history of silent aspiration on previous swallow studies and upper esophageal sphincter deficits.
   E. Current feeding: Total oral feeding; water via GT each day per dietitian. Parent reports that child loves to eat and fusses when oral feeding is stopped. He communicates that he wants more.
   F. Medication: None

II. VFSS Procedure
   A. Position: Lateral view, upright
   B. State: Alert and cooperative
   C. Oral peripheral examination: No change – intact oral structures. Voice quality was age appropriate with clear phonation. Child was communicating primarily by signs - signing “eat” on his way into the radiology suite with his father
   D. Textures: Very thin liquid (water by spoon), thickened formula by bottle (as he has been taking at home), thickened liquid by spout cup as taking at home, applesauce by spoon, and water by spout cup. Father presented food and liquid.
   E. Therapeutic alterations: Vary textures

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
1. **No problem.** Functional for thin and thickened liquid by spoon, spout cup, and bottle, as well as applesauce by spoon. He closed his lips around the spoon readily.

B. Oral transit
1. Once posterior tongue propulsion was initiated, material moved posteriorly over tongue with **no delay**.

C. Initiation of pharyngeal swallow
1. **No delay** - Occasionally material was seen in valleculae briefly prior to initiation of a pharyngeal swallow, primarily very thin liquid by spoon.
2. Material was not seen in pyriform sinuses prior to pharyngeal swallow initiation.

D. Pharyngeal phase
1. **Mild incoordination related to airway protection and upper esophageal sphincter opening.**
2. **Penetration to underside of superior portion of epiglottis was noted with consecutive swallows of thickened and thin liquid by bottle and by spout cup. At times penetration was deeper into laryngeal vestibule no cough.**
3. **Trace silent aspiration events were noted just prior to and during swallows of thickened liquid by spout cup, one time with the nipple/bottle, and also with slightly greater volume of very thin liquid by spout cup.**
   Note: child has not been taking the thinnest liquid by spout cup.
4. **No aspiration with pureed food by spoon**
5. Trace silent aspiration events were noted just prior to and during swallows of thickened liquid by spout cup, one time with the nipple/bottle, and also with slightly greater volume of very thin liquid by spout cup.
   Note: child has not been taking the thinnest liquid by spout cup.
6. **Residue in valleculae at times and occasionally in pyriform sinuses. He cleared residue with follow-up swallow most times.**

E. Upper esophageal phase
1. **UES appeared to open, but not sufficient and not long enough to clear each bolus into the esophagus part of the time. At other times, the bolus went through the UES adequately. Cricopharyngeal bar continued evident as noted in the past,** but did not appear to be interfering with bolus transit through upper esophagus.
   Structures: no evidence of enlarged tonsils or adenoid.

IV. Interpretation
A. Although significantly improved compared to past studies, occasional aspiration events noted, likely related to continued reduced tongue base retraction and reduced pharyngeal constrictor contractions.
B. Coordination deficits are also related closely to reduced opening of UES and premature closure.
C. No aspiration with pureed food, likely at least in part because of controlled bolus size as well as the thicker texture.

V. Prognosis – Becomes more positive for long term goal of total oral feeding with adequate fluid intake to meet nutrition and hydration needs. However, it is not yet possible to state the time frame or the course of additional interventions that may be needed.
VI. Recommendations
   A. Continue oral feeding with close monitoring of pulmonary status.
   B. Follow nutrition guidelines per dietitian and gastroenterologist.
   C. Independent finger feeding is appropriate with only a few pieces accessible at a time. Otherwise this child tends to stuff too much into his mouth at one time. Parents can add a few more pieces once child clears the oral cavity.
   D. Given no real difference in aspiration events with thin vs thickened liquid, gradual thinning of liquid can be done in very small steps so that timing of swallow can be functional and safe.
   E. Continue Birth to Three services. SLP is encouraged to call at parent request for updates and mutual problem solving.
   F. We will continue to follow with Feeding, Swallowing and Nutrition Center.
CASE #21 (NA)
I. Demographic information
   A. Age: 4 months, term delivery, no pre-natal problems
   B. Diagnoses: Food allergies, multiple hospitalizations for bronchiolitis, mild development delays (in Birth-to-Three services)
   C. Previous testing: UGI at 2 months – “normal swallowing with frequent GER, normal anatomy”
   D. Reason for referral: Possible risk for aspiration with oral feeding and gurgly voice quality
   E. Current feeding: Total PO on Neocate formula.
   F. Medication: Zantac
II. VFSS Procedure
   A. Position: Lateral view, semi-upright in Tumbleform seat (support appropriate for nipple feeding).
   B. State: Bright-eyed and alert. He was eager to feed and cooperative.
   C. Oral peripheral mechanism: Intact oral structures; voice quality with appropriate phonation, pitch, and volume noted in crying.
   D. Textures: Bottle with nipple used at home with his regular formula presented by mother)
   E. Therapeutic alterations: Position change to side lying.

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
   1. **Immediate initiation of sucking**, frequently with **multiple sucks per swallow ranging from 1:1 suck:swallow up to 4-5 sucks per swallow**, usually **2-3 sucks per swallow**, indicating **mild inefficiency**
B. Oral transit
   1. **No problem**
C. Pharyngeal phase initiation
   1. **At times, no delay** primarily when he was doing a **1:1 suck:swallow sequence**.
   2. **At other times, liquid was seen in valleculae and only occasionally into pyriform sinuses prior to pharyngeal swallow initiation**, indicating a **mild delay**
D. Pharyngeal phase
   1. **Penetration to laryngeal vestibule** when he was **inefficient with multiple sucks per swallow**
   2. **Aspiration to underside of vocal folds just prior to initiation of a pharyngeal swallow, with no response**. Material appeared to be **squeezed out (expelled) with subsequent swallows – no evidence of barium contrast in trachea at end of examination**. Total of 76 swallows observed in first sequence. During **latter part of that sequence**, he appeared to be **sucking but not extracting liquid from the nipple**.
   3. Fluoroscopic unit was turned off – approx 10 ml – unit back on, and **no barium contrast seen in trachea**
   4. Observed for another 14 swallows – total approximately 35 ml.
   5. **Trace residue in valleculae at times and only a coating in pyriform sinuses occasionally**. Overall, very little residue was seen in pharynx. He **cleared the residue with the next swallow**
E. Upper esophageal phase
   1. **No problem**
      Structures: No evidence of enlarged tonsils or adenoid.
IV. Interpretation/Impression
A. One trace silent aspiration event at point of initiation of pharyngeal swallow, material squeezed out (expelled) as he made subsequent swallows.
B. Basically functional, although with mildly inefficient sucking with a ratio ranging from 1:1 suck:swallow to 5:1 suck:swallow.
C. Appears safe to continue oral feeding; reflux and frequent emesis may have more impact on airway than occasional aspiration during oral feeding
V. Prognosis – Positive for safe oral feeding adequate to meet nutrition and hydration needs via nipple feeds
VI. Recommendations
A. Continue nipple feeding with close monitoring of sucking and swallowing efficiency. (Described to parent and demonstrated with infant after exam was completed).
B. Hold in a well supported nearly upright position. Feedings should take no longer than 25 minutes to a maximum of 30 minutes.
C. SLP in Birth-to-Three services is encouraged to call at parent request. Infant is not likely to require therapies for much longer since he seems to be meeting developmental milestones.

D. Parent will call with questions.

E. No follow-up appointment is being scheduled. If gains do not occur as anticipated, a clinical evaluation can be scheduled in conjunction with GI clinic where child is seen by gastroenterologist and a dietitian.
CASE #22 (NG)

I. Demographic information

A. Age: nearly 2 years, low tone, basically healthy with one ear infection, and no upper respiratory problems

B. Diagnoses: Canavan’s disease. Constipation is a problem. Significant global developmental delays; in Birth-to-Three services with PT, OT, SLP, neurodevelopmental therapist (NDT) and dietary consultant. She is not yet sitting independently, variable in ability to maintain head in midline posture. Vocalizations are primarily vowel sounds; receptive and expressive language delays.

C. Previous testing: Routine outpatient EEG at 9 months of age – normal in awake, drowsy, and sleep states per report. UGI – 1 week prior to this VFSS – report stated gastroesophageal reflux, delayed gastric emptying, otherwise unremarkable – no aspiration noted.

D. Reason for referral: Referred by pediatric neurologist with need to define pharyngeal phase of swallowing and determine whether she may be a silent aspirator. Parental primary concerns relate to lack of weight gain in the past several months.

E. Current feeding: Total oral feeder – liquid via spout cup and spoon feeding. Mealtimes usually take 30-45 minutes. Parents said that she likes to eat and they “could feed her essentially all day long.”

F. Medications: PhosLo

II. VFSS Procedure

A. Position: Lateral view, semi-upright at about 75 degrees as used at home, Tumbleform seat on MAMA chair.

B. State: Alert, eager to eat, and cooperative.


D. Textures: Puree (Stage 2 baby food), thin liquid by spout cup (no valve, juice and milk mixture), nectar consistency liquid by open cup. Mother presented food and liquid.


Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.

**III. Findings**

**A. Bolus formation**

1. Accepted food and liquid readily, some **delay in initiating tongue action** to form a bolus, particularly with spoon-feeding. She did **not close her lips around a spoon**, resulting in some loss of food out her mouth. **Material remained on tongue** as she was forming a bolus.
2. **Liquid – less loss out her mouth with spout cup than with food.** New experience with thickened liquid via open cup – less accepting
3. **Immature lip and tongue action** – not unexpected for her developmental skill levels overall.

**B. Oral transit**

1. Once posterior tongue propulsion was initiated, material moved posteriorly over tongue with **no major delay**
2. **Material remained on the tongue with each presentation of pureed food, thus multiple swallows per bolus.** She cleared the oral cavity more efficiently with liquid by **spout cup** than she did the pureed food.

**C. Pharyngeal phase initiation**

1. **Pureed boluses were seen in valleculae prior to trigger of pharyngeal swallow, only minimal delay.** Similar findings with thickened liquid by **open cup**
2. **Thin liquid was seen in valleculae and in pyriform sinuses prior to triggering pharyngeal swallow – delayed as he made multiple sucks before triggering a swallow**

**D. Pharyngeal phase**

1. **Puree – variable efficiency, best with spoon-feeding of smooth pureed food – no pharyngeal penetration or aspiration.** Trace residue on tongue and in valleculae, with trace coating in pyriform sinuses following swallows.
2. **Very thin liquid – consecutive swallows by spout cup** were characterized by frequent laryngeal penetration to underside of the superior surface of epiglottis, also nasopharyngeal penetration at times. Silent aspiration noted just prior to the initiation of the 19th swallow with a second trace aspiration immediately following – likely closely related to the delayed initiation with material in pyriform sinuses before she initiated a swallow. Lack of cough is of some concern. **Barium coating was seen on tongue base in and valleculae after swallows of thin liquid.**
3. **Note:** She did a **prolonged sequence of consecutive swallows of liquid with essentially functional timing and coordination.**
4. **Thickened liquid – more coordinated than with thin liquid.** No nasopharyngeal penetration and only occasional penetration to underside of epiglottis, no aspiration, and only trace coating in pharynx following swallows of nectar consistency.

**E. Upper esophageal phase**

**Material moved into and through the UES with no problem**

**Structures:** **No enlarged tonsils or adenoid**
IV. Interpretation/Impression
   A. Silent trace aspiration just 2 times while making consecutive swallows of thin liquid via spout cup (no valve), with other sequences showing appropriate efficiency and no aspiration.
   B. She was eager to eat and drink. She appeared more coordinated in initiating pharyngeal swallows with thickened liquid than for thin liquid.
   C. Spoon-feeding of smooth purees and maximizing liquid intake appear appropriate for striving toward adequate weight gain.

V. Prognosis – Short term prognosis appears positive for continued oral feeding with developmentally appropriate food and liquid, along with gradual expanding of textures per developmental skill levels. A primary concern relates to whether this child can take sufficient amounts of the right kinds of food and liquid to gain weight adequately to continue as a total oral feeder. Long term prognosis for total oral feeding is likely to relate closely to her neurodevelopmental gains in coming months per underlying Canavan’s disease

VI. Recommendations
   A. Continue oral feeding with no major changes in textures for the next few weeks at least. Regular meal and snack times are encouraged, with feeding times 30 minutes or less. Eliminate grazing patterns – should facilitate hunger.
   B. Continue to maximize spoon-feeding – follow techniques demonstrated during the clinic evaluation.
   C. Encourage liquid by spout cup. Open cup drinking can be used for practice – start with fruit slush or milk shake consistencies and gradually thin the liquid as child improves her coordination. Printed handouts will be sent with parent copy of report.
   D. Finger foods should be limited to snack or therapy times, or at the end of meal times so as not to interfere with caloric intake. It is important to consider global developmental skill levels when making estimates related to oral feeding skills.
   E. Parent will call with questions. Follow up with clinical evaluation and consider Feeding, Swallowing and Nutrition clinic so that comprehensive coordinated recommendations can be made.
   F. Continue Birth-to-Three therapies. SLP in encouraged to call me at parent request.
CASE #23 (KS)

I. Demographic information

A. Age: 5 years 3 months (child first presented to Feeding Clinic at this age)
B. Diagnoses: Rare genetic disorder – Ring22 with Q13 deletion. Severe global developmental delays – functioning at about 3 to 6 month levels. Multiple surgeries for tracheoesophageal fistula, nephrectomy, surgery for tethered cord, gastrostomy, cardiac surgery, and she was hospitalized 9 months prior to this appointment for a kidney infection and shortly after that time she underwent a tonsillectomy and adenoidectomy. Health has been stable in recent months, except for a recent urinary tract infection (UTI). She has had a total of 19 surgeries.
C. Previous testing: No report from any VFSS was available.
D. Reason for referral: Questions relate to potential for increasing volume of oral feeding with guidelines needed for school. Parent stated that she would like for her daughter to eat and drink whatever she can without stress and without health problems.
E. Current feeding: G-tube feedings over night. During the day, she takes from 1 oz up to 3-4 oz Pediasure with a large Nuk type nipple and bottle. She is fed again in a short time if she does not take much. About 3 years ago, this child was taking some soft foods to include pudding, applesauce, and baby food, but she has regressed. Current feeding does not appear pleasurable, but a chore. No weight gain in past year.
F. Medications: Prevacid, Ditropin, Singulair, and Pulmicort.

II. VFSS Procedure

A. Position: Lateral view, MAMA chair tilted back because of reduced head control, per grandparent report as used at home.
B. State: Awake and cooperative.
C. Oral-peripheral examination: Oral structures intact.
D. Textures: Pediasure via her NUK nipple and thin rice cereal by spoon. Grandmother presented food and liquid to her
E. Therapeutic alterations: Position and texture

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings
A. Bolus formation
   1. **Liquid**: Inefficient sucking characterized by rapid tongue movements in a non-nutritive pattern with the nipple – several sucks were needed before she extracted enough liquid to produce a swallow.
   2. She opened her mouth for the spoon, but she did not close her lips around the spoon immediately. Material was seen in anterior sulcus for several seconds prior to limited tongue movement to form a bolus.
B. Oral transit
   1. Once she extracted enough **liquid from the nipple**, she moved it over the tongue **without obvious delay**
   2. The **thicker food remained on the tongue** – strength seemed reduced for **posterior tongue propulsion**
C. Initiation of pharyngeal swallow
   1. **Mild delay in initiation of pharyngeal phase of swallowing with significantly reduced pharyngeal contractions, resulting in lack of clearance of pharynx.**
D. Pharyngeal phase
   1. **Multiple episodes of aspiration, primarily on residue as material spilled into open airway following swallows, also during pharyngeal swallows related to timing problems and reduced muscle strength. She never coughed – never cleared barium contrast from airway.**
   2. **Residue built up on posterior tongue, in valleculae, in pyriform sinuses and on posterior pharyngeal wall as feeding progressed.**
   3. **No nasopharyngeal penetration**
E. Upper esophageal phase
   1. **Material moved into and through the UES with no problem**
      Structures: no evidence of enlarged tonsils or adenoid.

IV. Interpretation/Impression
A. The multiple episodes of silent aspiration are of concern. They were not texture specific. They appeared most closely related to marked hypotonia, reduced head control, and significant oral and pharyngeal phase swallowing problems
B. Given developmental level less than six month skills, she is not expected to take chewable food or even to do much spoon feeding.
C. Nipple/bottle feeding is appropriate for developmental skill levels, but with aspiration episodes and potential chronic lung disease, she does not appear safe to increase volume of oral intake.

V. Prognosis – Prognosis for total oral feeding to meet nutrition and hydration needs appears guarded. At most, small volume oral feeding can be considered, but it must be nonstressful to this child and not jeopardize her pulmonary status.

VI. Recommendations
A. Continue to maximize nutrition and hydration with GT feeds, increasing the tube feeds while reducing the oral feeding expectations.
B. The bottle can be offered for short period at regular feeding times so that she gets some practice – no longer than 10 minutes. She must be actively participating in terms of sucking and swallowing, or the feeding should be stopped even sooner,
also if there are any signs of stress. Tube feeding supplement can be given at each feeding time, per MD and dietitian.

C. Tastes of strong flavored juice on a spoon may be appropriate since that amount would be less than her own saliva. This practice may be best in therapy, not at meal times.

D. CT scan of chest will be done in near future, per MD in feeding clinic.

E. Therapists from school can call me at parent request for mutual problem solving. In the short run, there will be no attempt to increase oral feeding at school.

F. We will continue to follow this child with her family at feeding clinic, with additional recommendations pending changes in coming months.
CASE #24 (JA: Case 1 – follow-up repeat VFSS)

I. Demographic information
   A. Age: 17 months - Global developmental delays - Birth to Three services; language skills estimated at about 9 months for receptive language and 8 months for expressive language. Gains noted in recent months.
   B. Diagnosis: Intrauterine heroin exposure and parent recently learned that methamphetamine had also been used by birth mother during her pregnancy. Child is now adopted by family he has been with since newborn period.
   C. Previous testing: Before 6 months of age, UGI – “nonobstructive upper GI with GER.” VFSS at 6 months had revealed multiple events of silent aspiration prior to and during swallows consistent with delayed initiation of pharyngeal swallow. He produced a delayed and weak cough at times, but did not clear airway. Occasional nasopharyngeal penetration (reflux) was noted as part of the pharyngeal incoordination. CT Scan of chest had revealed no signs of pulmonary damage – oral feedings were continued with close follow-up and monitoring of pulmonary status (See case 1)
   D. Reason for referral: Given history of silent aspiration, need to define pharyngeal physiology to determine safety for oral feeding and advance of textures. Parents stated child gets congested fairly frequently and spikes high fevers at times. No recent pulmonary issues.
   E. Current feeding: Primarily Pediasure by bottle and small amounts by valved spout cup. He takes some pureed food (smooth and slightly lumpy) by spoon. He is not yet taking solid chewable food.
   F. Medication: Zantac

II. VFSS Procedure
   A. Position: Lateral view, upright in MAMA chair
   B. State: Awake, alert, cooperative, and socially interactive – smiling and vocalizing, but no real word attempts.
   C. Oral peripheral examination: Intact oral structures.
   D. Textures: Smooth puree (applesauce by spoon for 3 bites), lumpy puree (crushed graham cracker in applesauce by spoon for 2 presentations), Pediasure by spout cup (valve taken out since he did not get much with valve), Pediasure via bottle with nipple used at home), and a few more swallows of Pediasure by spout cup, no valve. Parent presented food and liquid.
   E. Therapeutic alterations: Alter textures; cup to compare with bottle for Pediasure

Make notes in this space with your observations regarding structures, findings, signs of swallowing disorders, and your recommendations. Then compare your notes with the description of the VFSS findings, impressions, and recommendations on the next page. You may want to copy the worksheet at the end of this section and use it with your review of each examination.
III. Findings:
   A. Bolus formation
      1. Puree: Accepted spoon, held food in oral cavity for a few seconds before initiating tongue action, then no deficits
      2. Liquid – Never produced any significant number of consecutive swallows with spout cup or bottle. At most with bottle, he sucked 2-3 times, swallowed, and took the nipple out of his mouth, then sucked 2-3 times with the longest sequence 4 sucks and swallows
      3. Tilted head back with neck hyperextended with the valved cup and to lesser extent with bottle. No gag, cough, or choke.
   B. Oral transit
      1. Once posterior tongue propulsion was initiated, material moved posteriorly over tongue with no major delay
   C. Pharyngeal phase initiation
      1. Pureed food and liquid were seen in valleculae very briefly prior to initiation of pharyngeal swallow
      2. At times, liquid was seen very briefly in pyriform sinuses prior to initiating pharyngeal swallow. With nipple, when he produced multiple sucks per swallow, more likely to have mild delay
   D. Pharyngeal phase
      1. No aspiration with any texture. Occasional penetration to underside of superior portion of epiglottis just prior to initiation of pharyngeal swallows with consecutive swallows of thin liquid. Penetration was never deeper.
      2. Trace residue on posterior tongue, occasionally to valleculae and to pyriform sinuses, the latter only with smooth pureed food.
      3. He cleared the pharynx with a follow-up dry swallow.
      4. No nasopharyngeal penetration
   E. Upper esophageal phase
      Material moved into and through the UES with no problem
   Structures: Adenoid pad was evident, but not interfering with nasal airway. No indication of enlarged tonsils.

IV. Interpretation/Impression
   JA, now 17 months of age, with primary history of prenatal multiple drug exposure, has demonstrated gains in swallow timing and coordination since the previous examination at 6 months of age. No aspiration was noted, with laryngeal penetration only to underside of superior portion of epiglottis. Hyperextension of the neck appeared to be a contributing factor for material seen in valleculae and pyriform sinuses prior to initiation of pharyngeal swallow. Trace residue was cleared with the next swallow. He appears safe to continue oral feeding with no texture restrictions.

V. Prognosis: Positive for oral feeding to meet nutrition needs and to maintain pulmonary health. Expansion of textures should occur as developmentally appropriate.
VI. Recommendations – Short Term
   A. Continue to maximize nutrition with Pediasure by spout cup with continued weaning from bottle.
   B. Expand textures as child demonstrates that he can handle without gagging, gradually making food lumpier and pastier. Work toward soft chewable food (e.g., strips of soft banana and cooked baby carrots) and easily dissolvable solids with placement on molar surfaces, alternating sides.
   C. Return to Feeding Clinic with clinical oral sensorimotor and feeding evaluation with typical food in a typical meal time setting so that more specific recommendations can be made to advance oral skills as developmentally appropriate in safest ways possible to minimize risks for aspiration with oral feeding.
   D. Continue Birth to Three services with SLP focusing on communication skills and oral skills for advancing textures, also monitoring position for midline posture while child is drinking liquid. SLP is asked to call me at parent request for further information and mutual problem solving.
   E. Return to other physicians as recommended.
CASE #25 (KJ)

I. Demographic information
   A. Age: 17 months (adjusted at 14 months); 25 weeks gestation, birth weight = 600 grams.
   B. Diagnoses: Prematurity, necrotizing enterocolitis s/p colostomy, cholestasis, patent ductus arteriosus (PDA) s/p ligation, Grade 3 intraventricular hemorrhage, retinopathy of prematurity, small aortic thrombus that resolved, central apnea, total lung atelectasis by chest x-ray, s/p hernia surgery and ostomy closure. Child has global developmental delays. Birth-to-Three therapies. – babbling, but no real words.
   C. Previous testing: First VFSS at 6 months (3 months adjusted) – NG tube feedings at that time. Findings: minimal silent aspiration during some swallows, trace coating in pharynx after swallows. VFSS repeated at 11 months – intermittent aspiration before and during swallows of liquid, no aspiration with spoon feeding, although laryngeal penetration 1 time. Recommendations had included nutrition needs to be met non-orally, with oral tastes for practice.
   D. Reason for referral: Given history of silent aspiration, need to define pharyngeal physiology to determine safety for oral feeding and advance of textures for this child who has been showing interest to increase volume of oral feeding. No recent pulmonary issues, except RSV one month prior to this examination.
   E. Current feeding: GT feeds for nutrition. He takes small volume smooth pureed food by spoon, and often acts like he wants more, according to parent. He is not yet taking solid chewable food. Parent has not been giving liquid.
   F. Medications: Zantac, Pulmicort, Zithromax, Singulair, and Atrovent

II. VFSS Procedure
   A. Position: Lateral view, upright in MAMA chair
   B. State: Awake, alert, responsive, and cooperative – smiling and vocalizing, but no real word attempts. Voice quality still breathy and dysphonic, but with increase in phonation and volume in recent months compared to previously.
   C. Textures: Parent presented food and liquid in the following order - Smooth puree (Stage 2 baby food sweet potatoes for 3 presentations by spoon), thickened liquid by spoon 2 times, open cup (smooth puree thinned slightly with water for a few sips); thicker puree by spoon (2 presentations).
   D. Therapeutic alterations: Alter textures and cup vs bottle for Pediasure.

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III. Findings:
A. Bolus formation
   1. Slow to initiate tongue action for all textures, but once he closed lips and
      initiated tongue action, he had no problem forming a bolus.
B. Oral transit
   1. Once posterior tongue propulsion was initiated, material moved posteriorly
      over tongue with no delay. Material was seen on the tongue with all
      textures after and between swallows – piecemeal deglutition. Tongue
      action appeared mildly reduced in anteroposterior direction
C. Pharyngeal phase initiation
   1. Material was seen in valleculae for all textures prior to initiation of
      pharyngeal swallow
   2. At times, material was seen very briefly in pyriform sinuses prior to
      initiating pharyngeal swallow. Mild delay in pharyngeal phase initiation
      persists
D. Pharyngeal phase
   1. Penetration was noted to underside of superior portion of epiglottis at
      times.
   2. Primary finding – multiple events of aspiration with all textures, indicative
      of regression in the past several months. The aspiration occurred primarily
      just prior to and at the initiation of the pharyngeal swallow. Aspiration
      became more frequent as the session progressed. He continued receptive to
      the food and liquid. There was no cough until the final swallow of thicker
      puree when he produced a delayed cough that did not clear the airway.
   3. Occasionally child seemed to “squeeze” material out of the airway, but
      not consistently.
   4. No nasopharyngeal penetration
E. Upper esophageal phase
   Material moved into and through the UES with no problem
   Structures: No signs of enlarged adenoid or tonsils

IV. Interpretation/Impression
   Child, now 17 months of age (adjusted to 14 months), with primary history of
   prematurity and extremely low birth weight (600 g), has demonstrated regression,
   rather than improvement, in swallow timing and coordination since the previous
   examination at 11 months of age. At this time, he does not appear safe to take
   even the volume of oral feedings that he has been doing. Multiple events of silent
   aspiration were noted, usually just prior to and at the initiation of pharyngeal
   swallows. Occasionally he seemed to squeeze material out of the airway with the
   first couple swallows of a specific texture. Slow gains are occurring in
   developmental skill levels.

V. Prognosis: Positive for oral feeding practice with small volumes, but not to increase
   volume of oral feeding. It is difficult to predict the long term outcome at this time.

VI. Recommendations – Short Term
   A. Continue to maximize nutrition with GT feeds per gastroenterologist and dietitian.
B. Oral stimulation with tastes 2-3 times per day for 5-10 minutes. Family, therapists, and nurse will present strong flavored liquid in 2-3 drops for the oral taste practice, with a goal to improve timing and coordination of swallowing while keeping aspiration risk minimal.

C. Follow with other physicians as recommended. I will discuss findings with them so that coordinated recommendations can be made.

D. Continue Birth to Three therapeutic interventions with SLP focusing on communication skills and oral skills. SLP is asked to call me at parent request for further information and mutual problem solving.

E. I will continue to follow child with clinical oral sensorimotor evaluation to make more specific recommendations, monitor progress, and determine when we may need to repeat a VFSS or to consider Flexible Endoscopic Examination of Swallowing (FEES) with upper airway examination to visualize larynx.

11/12/06