Instrumental Assessment of Pediatric Dysphagia

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ABSTRACT

Speech-language pathologists (SLPs) have fulfilled primary roles in the evaluation and management of children with feeding/swallowing disorders for more than five decades. The increased incidence and prevalence of newborns, infants, and children with feeding and swallowing disorders has resulted in increased use of instrumental swallowing evaluations. The videofluoroscopic swallow study and fiberoptic endoscopic evaluation of swallowing are the two most commonly used swallowing assessments by SLPs, with ultrasound used less frequently. This article focuses on updates over the past decade in the procedures and utility of instrumental assessments of swallowing function, and identifies future directions that may enable us to meet the needs of the children who are in our care to attain functional outcomes.

KEYWORDS: Deglutition, swallowing, evaluation, videofluoroscopic swallow study (VFSS), fiberoptic endoscopic evaluation of swallowing (FEES)

Learning Outcomes: As a result of this activity, the reader will be able to (1) explain the rationale for completing an instrumental evaluation; (2) list indications for completing a videofluoroscopic swallow study; (3) list indications for completing a fiberoptic endoscopic evaluation of swallowing; and (4) list advantages and disadvantages of each procedure.

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Speech-language pathologists (SLPs) have played primary roles in the evaluation and management of feeding/swallowing disorders in pediatric populations for more than five decades. The frequency of feeding/swallowing disorders in children is increasing as a result of medical and surgical advances.[1,2] Newborns, infants, and young children presenting with these problems or diagnostic conditions associated with swallowing disorders (dysphagia) may require information provided by specialized studies that assess specific aspects of anatomy, physiology, and underlying pathophysiology of swallowing function, which are not visible during a clinic or bedside evaluation.[3,4] These specialized studies use investigative modalities that are beyond the data obtained from a thorough clinical evaluation. This review will focus on the videofluoroscopic swallow study (VFSS) and fiberoptic endoscopic evaluation of swallowing (FEES) because they are the two most commonly used instrumental swallowing assessments by SLPs. Other evaluation modalities will be mentioned briefly.

Decisions regarding the need for an instrumental assessment of swallowing depend on multiple factors including, but not limited to, the underlying condition associated with dysphagia, the anticipated utility of the information a specific examination is likely to yield, the age and ability of the patient to participate in the examination procedure, and the projected impact of the information on a child's diagnosis or management decisions. The etiologies contributing to swallowing impairments may be congenital or acquired and impact deglutition by affecting the phases of swallowing, the interface between swallowing and breathing, or both.[2,5] Examples of common locations of structural or anatomic defects that may influence deglutition and subsequent decisions about the utility of a VFSS or FEES appear in Table 1. It is important to remember that the impact of the dysphagia will be modified by whether the underlying condition occurs in isolation or within the setting of other conditions or comorbidities (e.g., chronic lung disease or nutrition compromise). In addition, the impact of the dysphagia may be exacerbated or diminished by a child's growth and development status, specific feeding patterns, and overall medical health.

VIDEOFLUOROSCOPIC SWALLOW STUDY

The purposes of the VFSS, also known as the modified barium swallow study, remain the same as when it was introduced by Logemann in 1983.[6] The VFSS is "designed to study the anatomy and physiology of the oral preparatory, oral, pharyngeal and cervical esophageal phases of swallowing" and if aspiration occurs, focus on the "reason for aspiration, so appropriate treatment can be initiated."

Although the purposes of the VFSS remain the same, advances in technology have resulted in the transition from videotape recordings to digital radiography. Digitalization enables the postprocessing of images and makes images immediately available to care providers.[7] Providers are now able to share images rapidly within institutions and across institutions for consultations and educational purposes with appropriate adherence to the Health Insurance Portability and Accountability Act.

Advances Related to Population

The use of VFSS examinations in children is rising as a result of the increased number of children with swallowing problems.[1,2] As a consequence, recent attention has focused on increasing the utility of the examination and minimizing the limitations associated with the VFSS procedure (Table 2). This review will focus on some of the these efforts by highlighting those related to radiation exposure, changes in technology, questions about the generalizability of judgments rendered by observations of images from a small number of swallows over a short period of time, and the concordance between barium contrast and "real" liquids and foods consumed by children.

Radiation Exposure

Over the past few decades, greater attention has been given to concerns about exposing newborns, infants, and children to ionizing X-ray. The importance of weighing the benefits of performing any examination against the potential risk of not performing it cannot be overstated, particularly when X-ray exposure is involved.[8,9] In comparison to adults, children

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Table 1 Potential Indications for Instrumental Swallowing Study: Anatomic Locations and Conditions, Phases of Swallowing Dysfunction, and Utility of VFSS or FEES

Location	Anatomic or Structural Condition	Potential Phase of Swallowing Impairment			Utility of VFSS	Utility of FEES
		Oral	Pharyngeal	Esophageal		
Nose and nasopharynx	Midface hypoplasia	+	+		Sometimes	Sometimes
	Pyriform aperture stenosis	+	+		Sometimes	Sometimes
	Deviated septum	+	+		No	No
	Encephalocele	+	+		No	No
	Tumor	+	+		No	No
	Choanal atresia	+	+		No	No
	Adenoid hypertrophy	+	+		No	No
Oral cavity and oropharynx	Cleft lip/palate	+			No	No
	Micro- or retrognathia	+	+		Sometimes	Sometimes
	Macroglossia	+	+		Sometimes	Sometimes
	Tumor	+	+		Sometimes	Sometimes
Hypopharynx and larynx	Vallecular cyst		+		No	No
	Laryngomalacia		+		Sometimes	Sometimes
	Vocal fold paralysis/paresis		+		Yes	Yes
	Laryngeal web		+		Sometimes	Sometimes
	Posterior laryngeal cleft		+	+	Yes	Yes
	Subglottic stenosis		+	+/−	Sometimes	Sometimes
	Subglottic hemangioma		+	+/−	Sometimes	Sometimes
Trachea and esophagus	Gastroesophageal reflux disease		+/−	+	Sometimes	No
	Eosinophilic esophagitis			+	Sometimes	No
	Vascular ring			+	Sometimes	No
	Tracheal stenosis			+	Sometimes	No
	Tracheomalacia			+	Sometimes	No
	Tracheoesophageal fistula			+	Sometimes	No

Abbreviations: FEES, fiberoptic endoscopic evaluation of swallowing; VFSS, videofluoroscopic swallow study.
Adapted from Arvedson and Lefton-Greif 1998, p. 49. Reprinted with permission.[5]

present with specific concerns about their increased sensitivity for cell damage with radiation exposure, their longer life expectancy coupled with the potential of undergoing more X-rays throughout life, and higher organ dose responses in comparable settings predisposing them to radiation damage.[8,10]

Although it is not known whether low levels of medical radiation increase cancer risk, the conservative approach is to use a dose that is as low as reasonably achievable (ALARA) to be safe.[11] Fluoroscopy of both adults and children is the third largest contributor to the collective radiation dose and accounts for 14% of medical radiation dose.[12] In 2007, the Society of Pediatric Radiology Alliance for Radiation Safety expanded ALARA efforts to develop social marketing campaigns (e.g., Image Gently) aimed at focusing on medical imaging safety in children.[13] Although Image Gently has focused on radiation exposure with computed tomography scans, the need to limit exposure to ionizing radiation overall to children was generally agreed upon. As reviewed by Huda, all examinations involving radiation pose some degree of radiation risk and "there is no threshold below which there are no radiation risks."[14(p.341)]

Huda reviewed two patient protection issues worthy of consideration when completing any diagnostic imaging procedure that involves exposure to ionizing radiation.[14] First, *justification* refers to weighing the risks versus benefits before completing any radiologic evaluation. He encourages clinicians to adhere to the adage, "Don't order tests that don't affect management." The second consideration, *optimization,* concerns adherence to the principles of

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Table 2 Videofluoroscopic Swallow Study and Fiberoptic Endoscopic Evaluation of Swallowing: Components of Swallowing Examined and Advantages and Limitations Associated with Each Procedure

Instrumental Procedure	Components of Swallowing Examined	Advantages	Limitations
Videofluoroscopic swallow study	• Defines anatomy and physiology of the swallowing mechanism during swallowing • Identifies bolus and positioning variables in feeding strategies or maneuvers that enhance the "safety" of swallowing • Defines "reason" for dysphagia • Detects aspiration	• Provides dynamic view of oral preparatory, oral, pharyngeal, and cervical esophageal structures during swallowing • Can detect aspiration secondary to swallowing dysfunction, reflux of contrast that reaches the hypopharynx, or both • Attempts to simulate "typical" feeding situation • May detect the effect of therapeutic maneuvers • Is common procedure, available in most centers	• Exposes patient to radiation • Samples swallowing performance for brief time period • May miss aspiration events prior to and following sampling swallows • Requires contrast medium (barium sulfate) • Requires patient cooperation
Fiberoptic endoscopic evaluation of swallowing	• Views anatomy of pharynx and larynx prior to and immediately following swallowing • Detects pooling and aspiration of salivary secretions • Assesses pharyngeal and laryngeal response to direct stimulation • Detects velopharyngeal insufficiency • Detects vocal fold abnormalities and movement disorders	• Provides dynamic view of nasal, pharyngeal, and laryngeal structures before and after swallowing • May detect aspiration from saliva • May detect structural defects that contribute to swallowing and/or breathing problems. • Has no radiation exposure; therefore, swallows can be sampled repeatedly and for prolonged time periods • May detect the effect of therapeutic maneuvers • Portable equipment is probable • Is increasingly common in most centers • Requires no contrast, uses "real" food or liquid	• Does not view oral, pharyngeal, and cervical esophageal structures during actual swallows • Is minimally invasive and may be uncomfortable • Has potential risks such as vasovagal reaction, laryngospasm, and nasal hemorrhage • Requires patient cooperation

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ALARA. A key element of optimization is to use the least amount of radiation necessary to obtain the needed diagnostic information. These considerations should be considered when making decisions about fluoroscopic evaluations regardless of age.

Relative to justification, SLPs should have sufficient training and knowledge about the VFSS procedures and information that they provide to ensure that the benefits outweigh the risks for every child undergoing the procedure. Four principle factors to consider before recommending a VFSS procedure, regardless of a child's age, are (1) the suspicion of oropharyngeal dysphagia on the basis of underlying diagnostic conditions, presentations, or both; (2) the expectation that VFSS findings may clarify diagnostic inquiries or help direct management; (3) the readiness of the child to participate in the examination procedure; and (4) the probability that findings will make a difference in the care of the child.[5] Decision making is particularly critical for neonates who may require multiple evaluations throughout their lives. Additionally, SLPs need to be aware of specific groups of children (e.g., those with ataxia telangiectasia) who are at increased risk for dysphagia, are particularly sensitive to radiation exposure, and need to have examinations using ionizing radiation adjusted accordingly.[15,16]

Optimization is dependent upon multiple equipment, procedural, personnel, and child-specific factors that influence the balance between the total radiation exposure during VFSS examinations and the images obtained.[17–19] Efforts to limit X-ray exposure during VFSS examinations have included limiting the duration of examinations,[17] decreasing the fluoroscopic pulse rate,[20] minimizing magnification, and careful focusing of the examination on the swallowing dynamics that need definition.[5] In addition to limiting the duration of an individual examination, it is important to remember that X-ray exposure is cumulative. Therefore any repeat VFSS examination should be considered only when "new" information is needed instead of some arbitrary time interval that is independent of the individual child's status.[5] It may be useful to consider or anticipate the number of swallow study evaluations multiplied by the radiation exposure per examination (determined by duration of examination, fluoroscopy pulse rate, and so on).

The duration of VFSS studies performed in children, representing a wide age range and differing underlying conditions, have ranged from 1.0 to 8.12 minutes.[15,21] More recent investigations are reporting shorter durations that appear to average between 1.58 to 2.5 minutes.[17,22] Durations are influenced by multiple factors including the specific swallowing impairments (e.g., delays in pharyngeal swallow initiation may increase duration), the experience of the personnel performing the examination, and the cooperation of the child. A limited number of studies have shown that the standardization of protocols does not appear to increase duration in children or adults.[22,23]

Currently, the generally agreed upon standard for the optimal fluoroscopic pulse rate is 30 frames per second, also called continuous fluoroscopy.[5,24] However, lower frame rates (ranging from 12.5 to 25 frames per second) have been reported with no evidence that these lower rates are equivalent to continuous fluoroscopy.[17,22] Fluoroscopic pulse rate must balance capturing images that provide the necessary diagnostic information without compromising the diagnostic image quality. Clinicians are cautioned that decreasing fluoroscopic frame rates may result in a failure to detect images, particularly of supraglottic penetration during liquid swallows.[25] Further investigations are needed to determine the optimal image quality needed for maximum clinical information and best outcomes in children.[22]

The principles of ALARA and optimization extend to the health care providers involved in all radiologic procedures. Hayes et al studied radiation exposure to SLPs during VFSS procedures and reviewed recommendations to minimize their exposure to ionizing radiation.[26] The investigation emphasized the use of shielding and maximizing distance from the radiation source as two primary considerations in achieving this goal. SLPs who participate in VFSS or other procedures using ionizing radiation may find it helpful to review the literature on occupation exposure. Some sources are listed in the references at the conclusion of this article.[7,26–31]

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Outcomes and Future Directions

The relationship between findings of VFSS examinations and outcomes on the health and quality of life in children undergoing the procedure warrants further investigation. Specific areas that need to be addressed are the clinical validity of the VFSS findings relative to health and developmental outcomes; the impact of standardization on use of terminology, diagnostic accuracy, targeting of therapies, reproducibility of findings; and advances in technology. Recent advances in standardization of the acquisition and reading of VFSS images in adults and children hold promise for advancing our knowledge about the clinical validity of these procedures, unifying terminology, and facilitating the reproducibility of VFSS results in the pediatric population without increasing radiation exposure.[22,23,32] In addition, standardization may enable VFSS findings to serve as biomarkers for clinical trials and biologically mediated assays, and be compatible with the emergence of precision medicine as outlined by the National Institutes of Health.[33] An area for future research is the correspondence between different barium contrasts and dysphagia diet recommendations. Although a comprehensive discussion of how well or whether barium contrasts represent the liquids and foods consumed by children is beyond the scope of this article, recent evidence shows that barium products do not mimic food and liquids in diets of newborns, infants, and children, suggesting that VFSS findings must be interpreted with caution.[34,35] Finally, teleconferencing modalities may enable freer access to centers with expertise in dysphagia assessment and rehabilitation.[36–38]

FIBEROPTIC ENDOSCOPIC EXAMINATION OF SWALLOWING

The FEES is one instrumental tool that can evaluate some specific aspects of swallowing in patients with dysphagia (Table 2). The FEES procedure used with newborns, infants, and children was adapted from protocols established for adults by Langmore and colleagues.[39] They described adults who swallowed foods of different textures and consistencies during flexible fiberoptic laryngoscopy. First reports related to pediatrics were made by Willging,[40,41] Willging and colleagues,[42] and Leder and Karas.[43] In the past 15 to 20 years, this examination has become a staple instrumental procedure in many pediatric medical environments when there is a need to focus on pharyngeal and laryngeal structures and function. Flexible fiberoptic laryngoscopy is a minimally invasive procedure used by pediatric otolaryngologists to examine the upper airway in children of all ages, including very small newborns in the neonatal intensive care unit (NICU). Thus, it is a logical extension to examine swallowing function in both bottle- and breast-fed neonates. FEES can be performed at the bedside and does not require transport to a radiology suite or some other area of a hospital. Although not necessarily used routinely, laryngopharyngeal sensory testing can also be a part of this procedure.

Sensory Testing with Fiberoptic Endoscopic Evaluation of Swallowing

Aviv and colleagues were the first to describe the addition of a test for laryngopharyngeal sensory function (FEESST) by delivery of air pulses to the aryepiglottic folds through a separate scope channel to elicit the laryngeal adductor reflex.[44] Willging and Thompson reported that the study can be performed safely in adults and in children as young as premature neonates.[45] Adequate levels of cooperation can be obtained in nearly all children requiring FEESST. They found no cases of laryngospasm or respiratory compromise. FEESST was applied to patients with dysphagia initially, then later used in the study of the effects of gastroesophageal reflux on the larynx and swallowing function.

Willging and Thompson noted that the presence and amount of pooled secretions in the hypopharynx can be used as a surrogate measure of laryngopharyngeal sensory testing.[45] Increased secretions may also be related to crying as the scope is being passed. It is important to have a baseline for accurate interpretation when making inferences about the status of reduced sensation, because the sensory testing is done with a puff of air delivered to the posterior pharynx, and not while swallowing. Pediatric patients with an increased laryngopharyngeal

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sensory threshold (LPST) have a significantly higher likelihood of laryngeal reflux penetration and aspiration, as do adults with oral feeding. Thompson reported that the study using sensory testing found a possible correlation between a history of GERD and an increased LPST.[46] Thus, she recommended further examination using LPST testing in pediatric patients.

Ulualp and colleagues reported that the majority of children with dysphagia have impaired LPST. The prevalence of abnormal swallowing function parameters in children with normal LPST is lower than that in children with moderately or severely impaired LPST.[47] It is not surprising that the prevalence of aspiration tends to increase when abnormal swallowing function is associated with severely impaired LPST. Reports based on VFSS findings show a high percentage of silent aspiration.[48–50] Given the fact that cranial nerves involved in swallowing have both sensory and motor components (except cranial nerve XII, motor to the intrinsic muscles of the tongue), it is hypothesized that both sensory and motor deficits would be present, rather than motor deficits in isolation.

Relationships between Fiberoptic Endoscopic Evaluation of Swallowing and Videofluoroscopic Swallow Study

Correlations between findings on FEES and VFSS have been reported in a limited number of studies. Leder and Karas reported on pediatric inpatients.[43] Of 30 patients, they assessed 7 subjects with VFSS and FEES (VFSS always completed before FEES) and 23 subjects with FEES only. They found 100% agreement for penetration and aspiration in the 7 subjects with both studies. Recommendations for feeding were in 100% agreement with both VFSS and FEES. Willging and Thompson found that when pediatric patients assessed and managed by findings on FEESST were compared with patients assessed and managed with VFSS, no statistical differences in the rates of pneumonia or pneumonia-free intervals were found.[45] Da Silva and colleagues reported contrasting findings of low overall diagnostic agreement from two observers between FEES and VFSS on early spill over, pharyngeal residue, laryngeal penetration, or aspiration.[51] They found the best interobserver agreement for aspiration and penetration on FEES, which in turn showed the highest specificity and positive predictive value when compared with VFSS.

Procedure

The anatomic and physiologic information that can be obtained by direct visualization of the nasopharynx, hypopharynx, and larynx is very helpful for accurate diagnosis in many instances of pediatric dysphagia. The examination is performed by passing a fiberoptic laryngoscope transnasally to visualize the hypopharynx, larynx, and proximal trachea for the purpose of assessing and treating swallowing disorders. Information is provided about the events occurring immediately before and immediately after the pharyngeal swallow.

The FEES with or without sensory testing for neonates, infants, and children is best performed by a team consisting of a nurse, a pediatric otolaryngologist, and an SLP with specialized knowledge and experience in swallowing and communication.[52] Per American Speech-Language-Hearing Association guidelines, care should be taken to use this examination only in settings where medical personnel are available to ensure patient safety. The findings are interpreted in conjunction with what is known through clinical feeding/swallowing evaluation as well as what is known about the upper airway status and the child's global developmental, medical, and surgical status.

Advantages and disadvantages of FEES include, but are not limited to, those reported in Table 2. Varied findings have been reported regarding utility of food coloring added for contrast. Reports with adults yield varied findings. Leder and colleagues found high intra- and interrater reliability in detecting the critical features of pharyngeal dysphagia and aspiration using either blue-dyed or non–blue-dyed foods.[53] However, Marvin and colleagues found differences in identifying airway invasion (penetration and aspiration) within the same person when assessed with green-dyed liquid and nondyed white liquid.[54] Deeper airway invasion was measured for green-dyed boluses

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compared with white boluses. These findings led those authors to conclude that the use of dye may result in more accurate recommendations and better health outcomes for patients. To date, there are no corresponding data in pediatrics. The literature in pediatrics is still somewhat limited for comparisons to VFSS.

FEES is not intended to be a substitute for VFSS. These two examinations are complementary. Some neonates, infants, or children may undergo only one of the examinations, and some may undergo both examinations. The order of examinations may differ on the basis of questions that need to be answered and depending on the status of the child. For example, if a neonate or infant presents with inspiratory stridor and feeding problems, a FEES may be performed as the initial examination to evaluate for the presence of upper airway obstruction. Depending on findings, a VFSS may or may not be deemed necessary. On the other hand, if a neonate or infant with neurologic impairment and suspicions are primary for oropharyngeal dysphagia, a VFSS may be ordered as an initial examination. Decision making about the utility of follow-up with either VFSS or FEES is determined by the needs of the individual child and the specific questions that need to be addressed.

Recent Expansion of Fiberoptic Endoscopic Evaluation of Swallowing in Pediatrics

In recent years, the FEES has become a useful means for examining breast-fed neonates and infants,[55] both breast- and bottle-fed neonates in the NICU and children with psychogenic dysphagia.[56,57] Willette and colleagues reported on 23 patients, average age 14 weeks, and found FEES to be safe and effective.[55] Common indications for FEES were feeding difficulties (52%), noisy breathing with/without feeding (28%), and cyanosis (16%). Of the patients who participated in active breast-feeding during the exam, a functional swallow was identified in 12.5%. The remaining patients demonstrated dysphagia characterized by laryngeal penetration (83%) and/or direct aspiration (50%). The most common findings were laryngeal edema (29%), anterior displacement of glottis structures (14%), and cobblestoning (11%). No cyanosis or respiratory distress occurred during or immediately after the procedure.

Utility of FEES in the NICU was examined by Reynolds and colleagues with a multidisciplinary team approach for both breast- and bottle-feeders.[56] They found FEES to be a safe alternative to VFSS. Bedside examination may allow clinicians the ability to replicate a more representative feeding to aid in determining a safe feeding plan as compared with what can be achieved in a radiology suite with VFSS. They stressed the importance of competency and training of personnel to establish a multidisciplinary FEES program in the NICU. They stressed the need for further research to compare the efficacy and validity of FEES versus VFSS for neonates in the NICU. Furthermore, evaluating the efficacy of FEES during breastfeeding is warranted.

A recent study by Thottam and colleagues reported on the utility of FEES as a management tool with children who have psychogenic dysphagia.[57] They found FEES to be useful because it provides direct visualization of the oropharyngeal swallowing mechanism and can be used to provide visual reassurance and biofeedback to patients and parents. They added that additional workup should be decided on an individual basis. No abnormalities of the oropharyngeal swallow were appreciated in the five children studied. Additional management included different combinations of VFSS, esophagogastroduodenoscopy, upper gastrointestinal series, antibiotics, and psychotherapy. Mean follow-up with clinic visit was 4.2 months. Three of the five children reported complete resolution of symptoms after FEES at follow-up visit.

Outcomes

Questions have been raised regarding feeding outcomes of patients undergoing FEES and whether associations exist between clinical diagnoses and feeding outcomes. Sitton and colleagues compared clinical diagnoses and initial FEES findings to follow-up feeding status for association in a retrospective review of 79 pediatric patients with diverse underlying

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etiologies.[58] They found that long-term feeding status was not significantly associated with initial FEES findings, although most children showed improvement. Not all children with a combination of tube and oral feeding attained total oral feeding status. Multiple variables contributed to the change from initial to final status. Of interest, and not surprisingly, they found that children with neurologic disorders were less likely to achieve total oral feeding status, whereas many children whose dysphagia was not related to a neurologic condition overcome their dysphagia with time.

ULTRASOUND IMAGING OF SWALLOWING

In addition to VFSS and FEES, both bottle- and breast-feeding neonates and infants can be evaluated using ultrasound imaging, which is a noninvasive procedure.[59,60] Reports have demonstrated detailed descriptions of tongue movements during sucking, identification of oral structures, and measurements of nipple position, as well as measures of nipple diameter and placement with varied scanning planes.[59,60] Findings primarily focus on the oral phase as noted previously, with greater difficulty in delineating pharyngeal function. Although ultrasound is a common radiologic procedure for examining several organs in the body, it is not used routinely by SLPs because of the aforementioned limitation and the need for extensive training to become proficient in carrying out the examination and in interpreting findings.

CERVICAL AUSCULTATION

Cervical auscultation is the use of a listening device, usually a stethoscope, in clinical practice to assess swallow sounds and possibly airway sounds. This procedure cannot be considered an instrumental evaluation. Listeners make judgments on those sounds regarding normality or degree of impairment. There is no evidence on what causes the sounds, which means that it is not possible to make definitive statements about swallow timing or strength in neonates, infants, and children. Stethoscopes differ in their characteristics, which in turn minimizes any chances for standardization of sounds as well as interpretation for management decisions. In light of anecdotal reports of the utility of cervical auscultation to predict aspiration with oral feeding, it is important to reinforce that although cervical auscultation has been shown to improve the sensitivity of predicting aspiration in children, it is not sensitive enough as a diagnostic tool in isolation per report of a randomized controlled trial.[61] At present there is no robust evidence that cervical auscultation of swallow sounds should be adopted in routine clinical practice

REPORTING FINDINGS AND INTERPRETATIONS OF INSTRUMENTAL SWALLOWING EVALUATIONS

Although it is beyond the scope of this article to describe specific reporting of findings and interpretation, it is vital that information is transmitted clearly, concisely, and with as much detail as necessary to allow others to follow through in carrying out recommendations. These examinations are not pass or fail or to determine presence or absence of aspiration; they are intended to define oropharyngeal physiology in terms of timing, strength, and sensory awareness to name a few dimensions. The findings must be interpreted and reported with sufficient detail that other health care professionals and parents understand functional implications clearly.

FUTURE DIRECTIONS

There are numerous areas of need for research to gain increased understanding of the underlying neurophysiology of the neonatal or infant suck-swallow-breathe sequencing, changes in development especially in the first 2 to 3 years of life, differences between typically developing children and those with a range of genetic based diagnoses. Technologic advances are needed so that examinations of oropharyngeal and upper esophageal swallowing mechanisms can be obtained in ways that limit exposure to radiation, the passing of endoscopic tubes, or any other even minimally invasive technique.

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The instrumental swallow examinations should mirror typical eating and drinking as closely as possible.

CONCLUSION

Instrumental evaluations remain the preferred methods for evaluating swallowing dysfunction given the serious implications of missing the diagnosis of aspiration and inability to define pharyngeal physiology via noninstrumental processes. No single instrumental evaluation provides all the information necessary to make optimal management decisions. Every instrumental examination, most commonly VFSS and/or FEES, is used as one piece of the puzzle that usually has many interacting factors. Findings must be interpreted thoroughly and accurately to be useful in decision making for a total child approach. SLPs involved with these high-risk neonates, infants, and children must have extensive knowledge and skills in multiple dimensions.

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