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Contemporary Trends in the Diagnosis and Management of Pediatric Dysphagia

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Abstract

Purpose of Review The purpose of this review is to present the most recent data on the causes, diagnosis and treatment of pediatric dysphagia. The diagnosis and management of swallowing disorders presents a formidable dilemma to diagnose and manage in the pediatric population. Swallowing disorders can occur subtly or with overt signs and symptoms, and can occur in the context of other comorbidities such as premature birth, respiratory insufficiency, craniofacial anomalies, and motor delays. Pediatric dysphagia poses a significant risk because it can lead to chronic malnutrition and irreversible lung disease.

Recent Findings Recent findings advocate for the use of multidisciplinary teams, such as the Aerodigestive and Swallowing Clinic (ADSC) to treat children with dysphagia. Expeditious return to oral intake of food is necessary to prevent long term issues such as food aversion.

Summary The summary of findings from the current literature suggests that the understanding of pediatric dysphagia and treatment is still in its infancy, and an algorithmic approach to diagnosis and treatment is necessary to allow the accumulation of objective outcomes data.

Keywords Dysphagia · Pediatric · Swallowing · Aspiration · FEES · VFSS · Assessment · Management

Introduction

Pediatric swallowing disorders, or dysphagia, encompass a range of conditions that affect a child's ability to eat and drink safely and effectively. Swallowing disorders can manifest clinically as difficulty latching and/or nursing, being an extremely picky eater, choking and coughing on liquids, recurrent respiratory tract infections, and failure to thrive. Sometimes, pediatric dysphagia is not readily diagnosed, especially in the context of other comorbidities such as extreme prematurity, congenital syndromes that alter the anatomy of the upper aerodigestive tract and/or cognition, gastro-esophageal reflux disease (GERD), respiratory insufficiency. When babies are deprived of the oral intake of food, they quickly develop aversions to food, which often create another obstacle to achieving full swallow function. Understanding the intricacies of pediatric swallowing disorders is crucial for healthcare providers, parents, and caregivers to ensure timely and effective intervention.

Given the complexity of swallowing disorders, the multiple etiologies, multiple body systems, and the possibility of overlapping causes, pediatric dysphagia is frequently managed by a multidisciplinary group involving speech pathology, pulmonary, gastroenterology, and otolaryngology and surgery. These groups are commonly referred to as aerodigestive centers (ADSC), and offer a more in-depth and comprehensive evaluation and management of afflicted children, than can be done by a single specialty group[1, 2]. Patients will be evaluated by all specialists, and the workup and management will be determined at team meeting of all the stakeholders of the center. Besides the virtue of comprehensive care, these centers facilitate data collection for research, the development of protocols, and the dissemination of knowledge.

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Anatomical structures critical to the 4 phases of swallowing.

Swallowing is a complex process involving the coordinated action of muscles and nerves in the mouth (oral cavity), throat (pharynx), and esophagus, and can be divided into 4 phases (oral, oropharyngeal, pharyngeal, and esophageal). Prior to the commencement of the swallowing process, there are several psycho-social "hurdles" that must be surmounted. The child should be interested in swallowing, and not have an aversion to having food placed into the mouth. Infants who have a history of premature birth and prolonged periods of time with no oral feeding and/or repetitive instrumentation of the aerodigestive tract with feeding tubes and endotracheal tubes, develop a strong dislike/avoidance of food being placed into their mouth[1]. In contrast to skill-based dysphagia that will be discussed in the chapter, food aversions are thought to be rooted more in behavioral issues and will not be discussed[3]. In neonates and young infants, all four components of swallowing are reflexive and involuntary. Later in infancy, the oral preparatory phase comes under voluntary control, which is essential to allow children to begin to masticate solid food. Mastication relies on appropriate sensory registration of the food source and a coordinated motor response influenced by cognitive thought processes. In later life, the triggering of the swallow reflex during the oropharyngeal phase is an involuntary activity, though, it can be controlled voluntarily. The pharyngeal and esophageal phases of swallowing always remain an involuntary activity[3]. Therefore the causes of swallowing disorders in children center around neuromuscular growth and development and anatomical disorders. The specific neuromuscular disruption in swallowing disorders is often difficult to pin point except when a Chari Malformation is present. Anatomical disorders include ankyloglossia, thickened upper lip frenulum, cleft lip/palate, vocal cord paralysis, laryngeal cleft, tracheoesophageal fistula, esophagitis (gastroesophageal reflux disease and eosinophilic esophagitis), cricopharyngeal achalasia/esophageal dysmotility and chronic disorders of breathing. The swallowing process begins with food being placed in the mouth, and can be divided into 4 over-lapping phases:

1. **Oral preparatory phase:** Food is chewed and mixed with saliva to form a bolus. In an infant who is nursing or bottle-fed, this phase is fairly rapid and requires the ability to create a seal using the tongue and lips against the nipple and a suction to allow the let-down of milk. The physiological steps relevant to this phase involves the excursion of tongue past the gum line, and the cupping/curling of the anterior portion of the tongue. The upper and bottom lips need to curl out to create a sealed interface with the nipple, and a vacuum has to be created to allow the flow of milk into the mouth. Given the rapid swallowing seen in infants, there has to be a precise coordination between the facilitating the milk let-down from the nipple and the respiratory cycle. This phase of the oral phase in infants is often referred to as the "suck-swallow-breath" cycle. [2, 4]

As the child grows and is introduced to pudding consistency foods, tongue mobility continues to be important. The food has to be moved from one side of the mouth to the other, to form a bolus for the next step of swallowing. As more solid foods are introduced, teeth become necessary to bite of a piece of food and to grind it down to a pureed consistency. The maxillary and mandibular incisors are necessary to bite off a piece of food, and molars are required to grind the hard foods down to small pieces. Proper mixture of foods with saliva is a prerequisite to the next phase of swallowing. If the food in not properly ground down, or if the bolus is not of a proper consistency, the subsequent steps in the swallowing process will be hindered [2, 4].

2. **Oropharyngeal Phase** Once a bolus is formed of the proper consistency, the tongue pushes the bolus to the back of the oral pharynx and the swallow reflex is triggered . The critical physiological steps for this step to occur is the elevation of the tongue to the roof the mouth, in an anterior to posterior motion. In addition, timing of pushing the bolus into the oral pharynx has to occur in coordination with the respiratory cycle. If the infant or child has respiratory issues, and is breathing rapidly or with difficulty, this step will be dysfunctional and the food can be aspirated. [2, 4]
3. **Pharyngeal Phase:** In the next phase of swallowing, the bolus transitions from the oropharynx to the hypopharynx, to the introitus of the esophagus and triggers the swallowing reflex. The swallowing reflux consists of elevation of the base of tongue with an associated tilting of the larynx to shield the laryngeal introitus, adduction of the vocal folds, and relaxation of the upper esophageal sphincter to allow food to enter the esophagus. The physiological steps critical for this phase of swallowing is elevation of the base of tongue, sensation of the bolus entering the hypopharynx, closure of the vocal folds, and relaxation of the esophageal sphincter. Given the rapid transition through this stage, neuromuscular coordination is essential for successful completions of this step, and coordination with the respiratory cycle. [2, 4, 5]
4. **Esophageal Phase** Similar to the pharyngeal phase of swallowing, the esophageal phase also requires neuromuscular control. As the bolus enters the esophagus, a series of peristalic contractions occur starting at the top

of the esphagus. These tightly coordinated contractions of the esophageal musculature push the food down the esophagus, past the lower esophageal sphincter which relaxes, and into the stomach. [2–4]

Contemporary diagnostic modalities for swallowing disorders

The prevalence of dysphagia in the pediatric population is thought to be about 1%, with slightly higher numbers in cohorts of children with neuro-cognitive or upper aerodigestive tract anomalies [4, 6]. Dysphagia often presents in the oral phase with primitive or absent oral reflexes, weak or uncoordinated suck, disordered biting and/or chewing, and poor bolus formation and/or movement. In the oral and pharyngeal phase there can be absent or delay in triggering the swallow reflex and/or a lack of synchronization with the breathing cycle. During the pharyngeal phase there is penetration (bolus enters the laryngeal vestibule to the level of the vocal folds), aspiration (bolus moves past the vocal folds), choking (bolus blocks airway) and nasopharyngeal reflux. Over time the child demonstrates poor weight gain, failure-to-thrive, and chronic respiratory disease. There are several diagnostic options available for identifying and characterizing pediatric dysphagia: Clinical assessment by a speech-language pathologist (SLP), fluoroscopic evaluation of swallowing, functional endoscopic evaluation of swallowing, and operative endoscopic evaluation of the upper aerodigestive tract. Modalities such as Chest x-ray and CT scans are options for monitoring chronic damage to the lung, but do not directly identify and characterize dysphagia. In addition, MRI of the brain can be used to evaluate for anatomical anomalies the could correlate to dysphagia, but will not directly identify dysphagia. [2, 4]

1. **Clinical Assessment:** The Schedule for Oral-Motor Assessment (SOMA) and the Dysphagia Disorder Survey (DDS) are two of the more commonly used standardized clinical assessment tools for evaluating and describing swallowing abilities in pediatric populations [2, 4]. In a study by Ko et al (2011) SOMA was compared to videofluroscopic evaluation of swallowing (FEES) in children with dysphagia. The results showed a significant consistency between the findings of SOMA and the oral phase evaluation by VFSS (Kappa=0.419, p=0.023). SOMA reached 87.5% sensitivity, 66.6% specificity, and 95.4% positive predictive value when compared with the oral phase of the VFSS. The findings of SOMA failed to show any consistency with the pharyngeal phase evaluation by VFSS (Kappa=-0.105, p=0.509). The authors concluded that SOMA is recommended for children that were unable to complete the oral phase evaluation by VFSS due to poor cooperation. [7]

Sheppard et al (2014) examined the internal consistency, and consistency comparison of the DDS metrics to the judgement of expert evaluators. The statistical analysis was performed on a sample of 654 individuals (age range 8-82) with intellectual and developmental disability living in two residential settings in the United States that served somewhat different populations. The results of the study suggested that the DDS is a reliable and valid test for identifying and describing swallowing and feeding disorder in children and adults with developmental disability. [8]

These clinical tools can be used in adjunct to checklists of normal swallowing and feeding milestones. Furthermore, signs of a wet voice, wet breathing and/or cough associated with swallowing thin liquids' has a high sensitivity of dysphagia and aspiration [9, 10]. Given the high rates of silent aspiration in the pediatric population, there are several studies in the literature which question a clinician's accuracy for predicting airway compromise based on clinical observation alone. DeMatteo et al (2005) found for fluids, clinical evaluation showed a sensitivity of 92% for aspiration. For solids, sensitivity for detecting aspiration was 33%. Analysis of the therapists' mean confidence ratings compared with the accuracy of their judgement demonstrated that when therapists were very sure that the child was aspirating or penetrating or not, they were correct. When the therapists were unsure, then the accuracy of prediction was not as good. Cough was the most significant predictor ($p < 0.05$) of fluid aspiration and penetration. These authors concluded that clinical evaluation with experienced clinicians can detect aspiration and penetration of fluids in children of varied ages and diagnoses, but that it is not accurate with solids. [11] When Beer et al (2014) compared clinical assessment to FEES, the clinical judgment to be correct in only 70% (for aspiration of saliva), 55% (of puree), and 67% (of thin liquids). The authors conclude that, because of this unacceptably high error rate of clinical assessment, a fiberoptic evaluation of swallowing is a necessary diagnostic step both for the planning of therapy and for the development of feeding strategies in children and adolescents with neurogenic. [12]

2. **Instrumental evaluation of swallowing:** VFSS and FEES are the most commonly used instrumental assessments in pediatric dysphagia. VFSS allows for the assessment of the swallow in all of the 4 stages of swallowing. The patient is presented with barium-impregnated liquid and food of different standardized consistencies ranging from thin liquids to purred to solids, and videofluoroscopic monitoring is used to document oropharyngeal swallow function and swallowing disturbances. [13] Requirements for a proper study and

interpretation include standardization of food consistencies, utilizing a pulse rate of at least 15 radiographic pulses per second. [14, 15]

FEES, in contrast, does not require intake of barium or radiation exposure, but it does require that a patient tolerate the ingestion of food and the passing of a nasal endoscope, simultaneously. FEES provides images of the larynx and hypopharynx before and after the pharyngeal swallow, which allows the detection of structural and physiological swallowing impairments. Functional integrity of the vocal folds can be evaluated. The pharyngeal phase itself is not examined as the constriction of pharyngeal muscles causes a "white-out" effect and blocks visualization. FEES is a safe and effective tool for evaluating dysphagia in pediatric populations and also allows for evaluation of laryngopharyngeal sensation in children with dysphagia[16, 17].

In contrast to VFSS which requires a child to ingest food, a FEES can be useful even in children who do not take significant volumes of food by mouth. Evaluation of management of oral secretions in itself can be useful in characterizing dysphagia. In one study, FEES when compared to VFSS had a sensitivity of 80.8% and specificity 85.3%. [18] Other studies have shown a poor diagnostic agreement between FEES and VFSS, but had a strong agreement on penetration and aspiration. [19] In general, VFSS and FEES exams can be complimentary, and both provide accurate diagnosis of dysphagia in pediatric populations when applied and interpreted by experienced clinicians [20].

Other less evaluated tools have received recent attention for their diagnostic usefulness as adjunct assessments for the diagnosis of dysphagia in pediatric populations. Digital cervical auscultation provides objective acoustic information about the swallowing process that may be able to augment clinical judgment and assist caregiver education in children with dysphagia [21]. Accelerometry, measurement of cervical vibrations, has been identified as a possible noninvasive way to distinguish between safe and unsafe swallows [22]. Ultrasound is being used in preliminary investigations of infants while they are being breastfed to provide visualization of bolus movement through the pharyngeal [23]. There have been several recent investigations into the usefulness of manometry and impedance as detectors of swallowing dysfunction [24, 25]. These tools provide information about pharyngeal and esophageal motility, as well as presence of gastroesophageal reflux. Possible advantages that have been identified for these procedures in swallow assessment include the fact that they do not involve radiation and are portable.

3. Operative evaluation of the upper aerodigestive tract: In specific cohorts of children, it is reasonable to consider airway endoscopy to evaluate for anatomical anomalies of the larynx and trachea that can give rise to aspiration and/or penetration. Such anatomical anomalies include laryngeal cleft and trachea-esophageal fistula, and can be present in both syndromic and non-syndromic children. Repair of these anomalies can lead to a reduction in penetration and aspiration. [26, 27] Flexible bronchoscopy with broncho-alveolar lavage can also be an adjunct in evaluating children with dysphagia, since not all children with aspiration on instrumental exam will have aspirate move into their lower airways. [28] Some children are able to clear their airways with a productive cough when they aspirate. Finally esophogastroduodenoscopy (EGD) can also help in the evaluation of dysphagia, in identifying gastroesophageal reflux disease (GERD) and other causes of esophagitis that can lead to esophageal dysmotility and decreased laryngeal sensation. [29]

Contemporary treatment modalities for swallowing disorders

The ultimate goal of treatment of children with dysphagia is a gradual return to normal age appropriate foods. Much of the treatment is centered around the speech language pathologist (SLP), who will not only aide in the evaluation of the child but also in determining strategies to allow a safe swallow. As mentioned previously, when children are restricted from food ingestion they can develop aversions to food, which can add to the existing problem.

A SLP will during the evaluation phase of the child determine if the feeding techniques/positioning and utensils used are appropriate, and modifications will be made to these variables to suite the child. If there is evidence of ankyloglossia or a thickened upper lip frenulum, correcting this issue can help improve feeding. Some children will feed faster than normal, and by simply pacing the child during feeding, dysphagia symptoms can be mitigated. Exercises can be designed to strengthen muscles of mastication and swallowing. The temperature, texture and consistency of ingested food can be adjusted to allow a slower transition of food and more reliable triggering of the swallow reflux during the oropharyngeal phase. The prognosis of returning to a full oral diet by early childhood is excellent for most children without a neurogenic or anatomical cause for dysphagia [30, 31].

Summary and proposal of an algorithm for diagnosing and managing pediatric swallowing disorders

The evaluation and treatment of pediatric dysphagia is complex, and involves multiple body systems including the upper aerodigestive tract, multiple sets of muscles, and

proper neuro-cognitive control. Therefore, as previously mentioned dysphagia in children is best managed by a multidisciplinary team including speech-language pathology, otolaryngology, gastroenterology, pulmonary, and neurology. First of all a high index of suspicion should be maintained in children with prematurity, global developmental delay, poor weight gain, multiple congenital anomalies of the head and neck, and those with chronic upper respiratory insufficiency or infections. The first step in evaluation is for the speech-language pathologist to assess the overall feeding techniques and equipment for feeding, and at the same time looking for signs suggestive of dysphagia. If dysphagia is suspected, then instrumental evaluation of the swallowing mechanism by VFSS and/or FEES can help identify the cause of the swallowing dysfunction, at which time therapies targeted to mitigate the cause can be devised as previously discussed. If there is a concern for GERD or anatomical airway anomalies it may be reasonable to consider a rigid endosopy of the airway and an EGD. If there are chronic respiratory symptoms, then a flexible bronchoscopy with broncho-alveolar lavage can also be helpful. Ancillary test such as lung or brain imaging can be used to target specific questions in the evaluation of the child, but are not generally not useful to characterize dysphagia.

Author contribution The author listed by themselves contributed to the writing of the paper. Ravindhra Elluru: wrote the main manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing Interests The authors declare no competing interests.

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