

Updates on pediatric feeding and swallowing problems

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Purpose of review

There is increased recognition in the range of feeding and swallowing problems that occur in conjunction with congenital and acquired pediatric conditions. Differential diagnosis and management of these problems is often not straightforward and requires consideration and collaboration between multiple disciplines that are involved in the care of this special population. This article reviews recent investigations across disciplines regarding the cause and evaluation of pediatric feeding and swallowing issues, intervention efficacy, and available evidence to guide clinical practice.

Recent findings

Knowledge of the basis for feeding issues associated with a variety of causes has advanced. Recent investigations of specific feeding and swallowing issues accompanying prematurity, selected diagnoses, and congenital syndromes are described. Significant advancements in the objective analysis of nonnutritive sucking have been made and provide increased understanding of the precursors for transition to oral feeding. Preliminary evidence regarding the effectiveness of selected clinical interventions to treat feeding and swallowing issues is highlighted.

Summary

Research is increasingly available to guide practitioners in evidence-based evaluation and management of pediatric feeding and swallowing issues. These continued advancements increase our understanding of the causes of pediatric dysphagia, the efficacy of treatment, and underscore the opportunities for continued research for best practice in clinical evaluation and management.

Keywords

dysphagia, feeding, pediatric, swallowing

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Introduction

The evaluation and management of pediatric feeding and swallowing problems (pediatric dysphagia) is seldom straightforward. The possible causes are abundant. Available data regarding long-term outcomes is limited, and historically the clinical pathways for work-up, management and treatment have varied among practitioners. However, there has been an encouraging, steady progression in research advances, and subsequently increased knowledge specific to the nature of dysphagia in infants and children. This article provides a summary of recent investigations that contribute to our understanding of the various causes of pediatric dysphagia. Clinical pathways for management and intervention efficacy for some selected problems in this complex patient population are reviewed.

The causes of feeding and swallowing problems are arguably varied and include combinations of structural deficits, neurologic conditions, respiratory compromise, feeder–child interaction dysfunction, and numerous medical conditions including genetic, metabolic, and

degenerative diseases [1]. Clinical and instrumental examinations such as videofluoroscopy and endoscopy are mainstays of the evaluation process; but careful consideration must also be given to other factors including feeder–child interaction, concurrent medical diagnoses, environmental factors, and the findings of other disciplines involved in the care of the patient [2].

Prevalence of feeding problems at some point in typically developing children has been estimated to be in the range of 25–45%; incidence and persistence is known to be significantly higher in children with developmental delays [3]. However, the true epidemiology of pediatric dysphagia remains largely unavailable, as there is no established registry, standardized reporting system, or other means of objectively tracking dysphagia in all of the possible contexts that may occur in infants and children. At this time, there is lack of standardization in documenting evaluation findings (clinical and instrumental), variation in regard to identification of deviant patterns, and little outcome data to guide the type and duration of interventions. Recently, the use of the International Classification of Functioning, Disability, and

Health (ICF) has been proposed as a potential method to establish a standardized reporting system of pediatric feeding and swallowing problems, document the impact on overall functioning of the individual and family, and track response to treatment interventions [3,4]. Use of such a system in the future will facilitate accumulation and organization of data on patterns of dysphagia in association with certain diagnoses and determine the efficacy of interventions.

Causes and assessment

Problems with feeding and swallowing occur in association with a range of diagnoses and conditions in the pediatric population. Specific signs, symptoms, and patterns of dysphagia have been described in recent investigations of selected diagnoses, including prematurity, certain syndromes, congenital heart defects, eosinophilic esophagitis, laryngomalacia, and autism. Updates in regard to objective assessment of infant swallowing dynamics are discussed.

Prematurity

A range of feeding and swallowing issues are known to be associated with premature birth depending on the presence of co-morbidities, neurologic status, degree of prematurity/physiologic readiness for oral feeding, and presence of respiratory compromise (i.e., bronchopulmonary dysplasia, respiratory distress syndrome, need for intubation). Mizuno *et al.* [5] analyzed suck/swallow characteristics in infants with bronchopulmonary dysplasia (BPD), documenting the poor suck–swallow–breathe coordination and weak sucking pressures in association with severe BPD. The infants were noted to have weak sucking pressures and less frequent swallowing in association with relatively long deglutition apnea. The decreased frequency of swallowing was considered to be compensatory considering the prolonged deglutition apnea. Poore *et al.* [6] examined the degree to which extensive oxygen therapy may have an effect on the development of coordinated nonnutritive sucking in preterm infants with respiratory distress syndrome (RDS), finding that extended lengths of oxygen therapy were associated increased likelihood of impairment in non-nutritive sucking and feeding behavior. The authors discussed the lack of normal sensorimotor input during oxygen therapy, the potential for aversive peri-oral input (taping, intubation), and the possible implications for normal development of oromotor patterns.

Spinal muscular atrophy, type II

Feeding problems in association with spinal muscular atrophy type II (SMA type II) were investigated by Messina *et al.* [7] and were differentiated predominantly

as issues with limited range of motion in the oral phase, chewing difficulty, and swallowing dysfunction; all of which were noted to increase with age. The investigation focuses on SMA type II, distinguishing it from previous studies that include patients with different types of SMA.

CHARGE syndrome

Dobbelsteyn *et al.* [8] reported a high prevalence of feeding problems in an investigation of the correlates of feeding difficulties in a cohort of children diagnosed with CHARGE syndrome (coloboma, heart malformation, atresia of choanae, retarded growth and development, genital hypoplasia, and ear abnormalities or deafness). Cranial nerve dysfunction was found to be the primary clinical feature impacting on functional sucking, chewing, and swallowing. In an earlier investigation, Dobbelsteyn *et al.* [9] recorded early oral sensory and feeding experiences in a small group of children with CHARGE, reporting persistent oral sensory dysfunction and defensiveness, oral motor skill deficits, and the acquisition of maladaptive behavioral patterns in some cases. Results of the investigation stressed the importance of early management with primary focus on minimizing oral defensiveness.

Congenital heart defects and dysphagia

Infants with congenital heart defects represent another population at risk for potential dysphagia secondary to postoperative vocal cord dysfunction, as highlighted in an investigation of over 2000 children by Sachdeva *et al.* [10]. The association of unilateral vocal fold paralysis following patent ductus arteriosus (PDA) ligation in extremely low birth weight infants was recently investigated by Clement *et al.* [11]. Results of this investigation indicated a high incidence of unilateral vocal fold paralysis postoperatively, increased duration of tube feeding requirement, and a high incidence of aspiration and swallowing difficulty. Likewise, Davis *et al.* [12] discussed a range of issues related to feeding difficulties in children born with congenital heart defects, with special focus on two groups of infants; one group with hypoplastic left heart syndrome and a separate group of infants with transposition of the great arteries.

Eosinophilic esophagitis

Eosinophilic esophagitis has become increasingly recognized in both children and adults over the past decade [13,14,15]. Eosinophilic esophagitis is defined as mucosal inflammation of the esophagus with eosinophils with possible risk of esophageal tissue remodeling, esophageal stenosis, and the formation of esophageal strictures if left untreated [15]. Pediatric patients present with signs and symptoms similar to gastroesophageal reflux disease but

are refractory to acid reflux therapy [13**]. Eosinophilic esophagitis frequently occurs in association with asthma, eczema, and with food/environmental allergies in children [13**,16]. Pentiuk *et al.* [17] described clinical signs and symptoms in infants, children, and toddlers, including food refusal, oral aversion, vomiting, failure to gain weight, and eczema. The investigators suggest that eosinophilic esophagitis should be considered in the differential diagnosis of children less than 4 years of age who present with feeding problems. Likewise, Putnam [13**] describes clinical manifestations of eosinophilic esophagitis (as distinguished from gastroesophageal reflux) in the pediatric population, citing early onset of vomiting associated with eczema, vomiting with irritability that does not respond to acid suppression, and vomiting from 6 months and more following introduction of solid foods.

Laryngomalacia

Thompson [18] described feeding difficulties associated with congenital laryngomalacia and abnormal sensorimotor integrative function of the larynx. Severe laryngomalacia was associated with increased respiratory effort of feeding and overall increased feeding difficulty. The diagnosis of failure to thrive as a result of poor feeding was a major consideration factor in regard to whether or not surgical intervention of the laryngomalacia was indicated.

Autism

Lukens and Linscheid [19*] reported on the development of a new standardized measure to describe and evaluate the feeding behaviors in autistic children: the Brief Autism Mealtime Behavior Inventory (BAMBI). This instrument contains 18 items that range from behavioral observations (i.e., crying, expelling food, aggressiveness) to specific oral motor characteristics (i.e., prefers 'crunchy foods', dislikes certain foods). The authors describe the applicability of the tool for use in both research and clinic settings and the potential for use as an outcome measure to determine effectiveness of interventions to manage the behaviors and improve oral intake. The investigators cite an important additional use of the BAMBI as a means to unify reporting in future investigations and publications.

Instrumental assessment

In a recent article, Arvedson [2] reviews current clinical and instrumental assessments used in the evaluation of pediatric dysphagia. Of the available instrumental assessments, the videofluoroscopic swallowing study or modified barium swallow (MBS) continues to be the most widely utilized to assess dynamic swallowing. Although the pediatric videofluoroscopic study has many advan-

tages in regard to delineating phases of swallowing function, the exposure of the child to radiation, particularly with repeated interval examinations must be considered. Data on exposure and effective dose were investigated by Weir *et al.* [20*], who reported that the radiation dose associated with pediatric videofluoroscopic swallowing assessment presents an acceptable risk. However, higher doses were found to present more of a risk for younger infants as opposed to older children. Such data raise clinician awareness and emphasize the importance of planning and executing studies to minimize radiation dose as possible. Videomanometry and its potential clinical utility in the assessment of swallowing dynamics, specifically in the pediatric population, are described by Rommel *et al.* [21]. The combination of manometry and videofluoroscopy, as described, provides a means for objective measurement of oropharyngeal transit time, duration of pharyngeal contraction, and function of the upper esophageal sphincter.

Analysis of nonnutritive and nutritive sucking characteristics in preterm infants is described by Miller and Kang [22] through the use of ultrasound. The advantages of ultrasound as an objective, noninvasive means to study and identify neuromaturation of nonnutritive sucking components and to help identify key times for treatment/introduction of oral feeds are discussed. Additional study of nonnutritive sucking characteristics performed outside the maternal abdomen through fetal biomagnetometry is reported by Popescu *et al.* [23]; implications for further research in regard to nonnutritive sucking dynamics, correlation with other measures of sucking components, and the potential of biomagnetic measurements in future investigations is summarized.

Treatment and outcomes

Empirical data regarding the efficacy of treatment intervention are essential for provision of evidence-based practice. Such supporting data have traditionally been scant in the field of pediatric dysphagia; currently, an increased number of reports are available that describe the effects of interventional strategies to facilitate nonnutritive sucking for transition to oral feeding and for treatment of feeding and swallowing issues associated with cerebral palsy, Pierre Robin Sequence (PRS), and laryngopharyngeal response.

Facilitation of nonnutritive sucking

Oral feeding candidacy in infants is determined in part by the ability to initiate and maintain a coordinated nonnutritive sucking pattern. Sucking patterns vary during feeding and nonfeeding events; the ability to demonstrate a coordinated nonnutritive sucking pattern is generally considered indicative of the potential to

develop more complex nutritive swallowing patterns required during breast-feeding or bottle-feeding [24–26]. Recently, Barlow *et al.* [27^{*}] described the use of patterned orocutaneous stimulation through a computer-controlled entrainment pacifier, the NTrainer (KC Bio-MediX Inc. of Shawnee, KS, USA). The premise for provision of the stimulation (which mimics the temporal components of sucking) is to facilitate development of the central pathways key to regulation of sucking [27^{*}]. Results of the investigation by Barlow *et al.* indicated a significant positive relationship between the use of the NTrainer and faster transition to oral feeding in a group of preterm infants who had no functional suck and were completely tube fed, as compared with a control group. Poore *et al.* [28] also reported on the use of the NTrainer and provided specific data in regard to nonnutritive sucking pressure pretreatment and posttreatment with the NTrainer. Their results indicate increased suck pattern stability in a treatment group as compared with a control group. Continued investigations are underway that will provide additional evidence in regard to the efficacy of the NTrainer for the development of non-nutritive sucking and later transition to nutritive sucking for safe and efficient oral feeding.

Transitioning to oral feedings

Interventions for breast-feeding and bottle-feeding for infants in the Neonatal Intensive Care Unit (NICU) are reviewed by Sheppard and Fletcher [29^{**}], who summarize available evidence supporting oral stimulation and nonnutritive stimulation strategies. The evidence as reported shows independent studies with encouraging results regarding the benefits of nonnutritive stimulation and oral feeding outcomes. An additional, supporting overview of feeding practices in the NICU and factors that influence success with transition to oral feedings, such as accompanying medical comorbidities, specifically respiratory and digestive issues is described by Ross [30].

Results of a study using a cue-based clinical pathway to guide oral feeding initiation in a group of premature infants greater than 32 weeks are reported by Kirk *et al.* [31]. Criteria for inclusion in the study included satisfactory toleration of full volume enteral feeds, no severe congenital anomalies or neurologic disorders, and no requirement for ventilation. A clinical pathway was designed based on behavioral readiness signs for feeding, using evidence from prior studies of preterm infants, and regulatory feeding progression [24]. The investigators found that use of behavioral readiness cues for provision of feeding resulted in earlier attainment of full oral feeds and better weight gain in comparison to infants in the control group, providing support for the use of behavioral cues to determine schedules for oral feeding.

Children who require prolonged supplemental tube feedings often face challenges as they transition back to oral feedings. Frequently, the normal hunger–satiety cycle has been disrupted, experience with oral feeding has been limited, and problems with oral aversion and/or oral motor dysfunction may have developed. Behaviorally based feeding treatments have been described as successful in some cases [32]; however, there is no treatment approach at this time that is recognized as universally effective for rapid transition from tube feeding to oral feeding. Kindermann *et al.* [33] reported results of a recent study of children less than 2 years of age, using short-term hunger as the main intervention strategy. The investigators stress the benefits of a multidisciplinary team in a short-term intensive treatment paradigm.

Interventions used in transitioning to oral feeding from tube feeding for children of school age in the educational setting are described by McKirdy *et al.* [34]. This is a relevant report, as the number of children in the school setting who require dysphagia evaluation and management is rising as medical advancements continue [3]. Children with significant and complex medical conditions now survive, develop, and need to be fully integrated into the school setting [35]. Clinicians and other professionals in the school system must be prepared to recognize signs and symptoms of dysphagia, which accompany complex medical conditions, and be prepared to provide appropriate interventions for dysphagia, including assistance with the transition to oral feedings as appropriate.

Cerebral palsy

The effectiveness and limitations of oral motor interventions for children with cerebral palsy (CP) are comprehensively reviewed by Gisel [36]. Her investigation provides a thorough analysis of the basis for therapeutic interventions for oral motor dysfunction/dysphagia in CP and effectively illustrates the need for homogeneous samples, standardized documentation of interventions, and multicenter studies in order to assess long-term outcomes.

Pierre Robin Sequence and feeding issues

Lidsky *et al.* [37] reported on the benefit of early airway intervention for infants with PRS in a study consisting of 67 infants, divided into groups according to isolated PRS (iPRS), and PRS with additional disorders and syndromes (sPRS). The investigators found that the infants with iPRS who received early airway intervention to relieve upper airway obstruction as opposed to later airway intervention were more successful with oral feeds. A greater number of infants with iPRS who received later airway intervention required gastrostomy tubes, and the

infants with sPRS tended to require gastrostomy feedings regardless of the timing of airway intervention. Positioning can be key to successful feeding in PRS as can specific nipple choice and feeding strategy. Oral motor facilitation strategies for PRS are summarized by Cooper-Brown *et al.* [38**] in a review article of feeding and swallowing dysfunction associated PRS as well as with other genetic syndromes.

Laryngopharyngeal sensation and protective responses

Gastroesophageal reflux that involves refluxate to the level of the pharynx has been associated with decreased laryngopharyngeal sensation and silent aspiration in pediatric patients [39,40]. The refluxate is theorized to cause edema of the posterior glottic region, resulting in decreased sensory threshold and blunting of laryngeal protective reflexes. Suskind *et al.* [41] reported on a population of infants diagnosed with LPR and swallowing dysfunction who showed definite improvement in airway protection during swallowing following treatment for gastroesophageal reflux. Arvedson [42] provides a thought-provoking review of the known and unknown aspects of the pharyngeal and laryngeal protective responses, maturation of cough response specific to term and preterm infants, and the role of the laryngeal chemoreflex (LCR).

Conclusion

Pediatric feeding and swallowing problems represent a compelling and complex array of issues for the practitioner to consider. Continued advancements are needed for establishing a standardized method of reporting of evaluation findings, documenting and tracking the effects of interventions, and following patient outcomes. Additional research efforts will provide the needed data to guide future management and intervention protocols.

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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 241).

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