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FEEDING DISORDERS IN INFANTS AND CHILDREN

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Feeding disorders are common in early childhood, with the reported incidence of minor feeding problems ranging between 25% and 35% in normal children and with more severe feeding problems observed in 40% to 70% of infants born prematurely[21] or children with chronic medical conditions.[35, 39, 54, 55, 57, 58] Early recognition of feeding problems, diagnosis of underlying disorders, and appropriate intervention improve outcomes for the child and family.

Feeding and swallowing is a complex process that can be divided functionally into phases (Table 1). The pre-oral phase is initiated when the infant or child senses and communicates hunger to the parent. The oral phase is a food processing step in which the ingested material is formed into a bolus that can pass safely through the pharynx without entering the airway. The pharyngeal phase is rapid. It is initiated by bolus contact with the tonsillar pillars and pharyngeal wall with subsequent elevation of the larynx, vocal cord closure, and relaxation of the upper esophageal sphincter. A peristaltic wave of contraction of the pharynx propels the bolus into the esophagus. During passage of the bolus through the pharynx, excellent coordination between breathing and swallowing is essential to prevent aspiration. In the esophageal phase, the bolus is transported into the stomach. Finally, the bolus is broken down and absorbed during the gastrointestinal (GI) phase. Disorders associated with feeding difficulties are classified in Table 2.

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Table 1. PHASES OF NORMAL FEEDING

Pre-oral phase
Appropriate food provided
Food introduced into oral cavity
Oral phase
Suck or mastication prepares bolus
Bolus passage to pharynx
Pharyngeal phase
Respiration ceases
Elevation of larynx, glottic closure
Opening of upper esophageal sphincter
Pharyngeal peristalsis with clearance of pharynx
Respiration resumes
Esophageal phase
Esophageal peristalsis
Opening of lower esophageal sphincter
Gastrointestinal phase
Receptive relaxation allows storage of food in stomach
Titurbation and controlled emptying of nutrients into small intestine
Intestinal digestion and absorption of nutrients

Courtesy of Colin D. Rudolph, MD, PhD, Milwaukee, WI.

Table 2. CAUSES OF FEEDING DISORDERS IN CHILDREN

Disorders that affect appetite, food-seeking behavior, and ingestion
Depression
Deprivation
CNS disease (diencephalic syndrome)
Poverty (inadequate food available)
Metabolic diseases
Hereditary fructose intolerance
Urea cycle disorders
Organic acidemias
Sensory defects
Anosmia
Blindness
Neuromuscular disease (see below)
Oral hypersensitivity or aversion resulting from a lack of feeding experience during crucial sensitive periods (long-term parenteral or enteral tube feeding)
Conditioned dysphagia
Aspiration
Oral inflammation (see below)
Gastroesophageal reflux
Dumping syndrome or gastric bloating after gastric surgery
Fatigue (heart disease, lung disease)
Anatomic abnormalities of the oropharynx
Cleft lip and/or palate
Macroglossia
Ankyloglossia
Pierre Robin sequence
Retropharyngeal mass or abscess
Velopharyngeal insufficiency
Tonsillar hypertrophy
Dental caries

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Table 2. CAUSES OF FEEDING DISORDERS IN CHILDREN *(Continued)*

Anatomic/congenital abnormalities of the larynx and trachea
Laryngeal cleft
Laryngomalacia
Laryngeal cyst
Subglottic stenosis
Tracheomalacia
Tracheoesophageal cleft
Tracheoesophageal compression from vascular ring/sling
Anatomic abnormalities of the esophagus
Tracheoesophageal fistula
Congenital esophageal atresia
Congenital esophageal stenosis because of tracheobronchial remnants
Esophageal stricture, web, or ring
Esophageal mass or tumor
Foreign body
Vascular rings and dysphagia lusorum
Disorders affecting suck-swallow-breathing coordination
Choanal atresia
Bronchopulmonary dysplasia
Cardiac disease
Tachypnea (respiratory rates > 60 breaths/min)
Disorders affecting neuromuscular coordination of swallowing
Cerebral palsy
Bulbar atresia or palsy
Brain stem glioma
Arnold-Chiari malformation
Myelomeningocele
Familial dysautonomia
Tardive dyskinesia
Nitrazepam-induced dysphagia
Postdiphtheritic and polio paralysis
Möbius syndrome (cranial nerve abnormalities)
Myasthenia gravis
Infant botulism
Congenital myotonic dystrophy
Oculopharyngeal dystrophy
Muscular dystrophies and myopathies
Cricopharyngeal achalasia
Polymyositis/dermatomyositis
Rheumatoid arthritis
Disorders affecting esophageal peristalsis
Achalasia
Chagas disease
Diffuse esophageal spasm
Pseudo-obstruction
Scleroderma
Mixed connective tissue disease
Systemic lupus erythematosus
Polymyositis/dermatomyositis
Rheumatoid arthritis

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Table 2. CAUSES OF FEEDING DISORDERS IN CHILDREN *(Continued)*

Mucosal infections and inflammatory disorders causing dysphagia
Adenotonsillitis
Deep neck space infections
Epiglottis
Laryngopharyngeal reflux from gastroesophageal reflux
Gastroesophageal reflux
Caustic ingestion
Candida pharyngitis or esophagitis
Herpes simplex esophagitis
HIV
Cytomegalovirus esophagitis
Medication-induced esophagitis
Crohn's disease
Behçet disease
Chronic graft-versus-host disease
Other miscellaneous disorders associated with feeding and swallowing difficulties
Xerostomia
Hypothyroidism
Neonatal hyperparathyroidism
Idiopathic neonatal hypercalcemia
Trisomy 18 and 21
Velocardiofacial syndrome
Rett syndrome
Prader-Willi syndrome
Allergies
Lipid and lipoprotein metabolism disorders
Neurofibromatosis
Williams syndrome
Coffin-Siris syndrome
Optiz-G syndrome
Cornelia de Lange syndrome
Interstitial deletion (q21.3q31)
Globus sensation
Epidermolysis bullosa dystrophica

Courtesy of Colin D. Rudolph, MD, PhD, Milwaukee, WI.

THE PRE-ORAL PHASE OF FEEDING

Successful feeding is initiated when an infant or child senses hunger and communicates the desire to eat. Centers for hunger and satiety in the hypothalamus receive afferent signals from a variety of sources. Visceral sensors feed back by neural and endocrine pathways to lead to a sense of "fullness" following feeding. Newly recognized leptin, produced in adipose tissue, and other homeostatic mechanisms of feedback control food intake.[4] Appetite also can be affected by a variety of medications, such as megestrol[24]; glucocorticoids and cyproheptadine, which increase appetite; and amphetamines, which reduce appetite. Increases in cachectins or other inflammatory mediators associated with systemic illness also may reduce appetite.[32] Although it seems that these control mechanisms are present in infants, no good studies define hunger and satiety mechanisms in infants. Some infants seem to have deficient hunger drive and fail to ingest enough calories to achieve normal growth in the absence of any GI, endocrine, or other chronic diseases. Presumably, these infants have a defect in appetite or hunger control mechanisms.[17, 30, 60]

Appetite also is affected by emotional state; infants who are not nurtured reduce their food intake.[14] Specific food aversions may be observed in otherwise healthy children. If ingestion of a specific food is temporally associated with a painful or uncomfortable experience, a child may refuse to ingest that food again.[3] This type of specific aversion is observed in patients with metabolic diseases, gastroesophageal reflux, or allergies, and these patients experience nausea or discomfort after ingesting offending nutrients.[2, 22] More generalized feeding aversions can occur if an infant has negative experiences, such as aspiration or choking, during feeding. Infants who have required prolonged airway intubation or tube feeding often learn that efforts by a caretaker to approach their mouths or faces likely result in discomfort, and the "oral defensiveness" can persist long after the patient is extubated or after tube feedings are no longer required.[9, 11]

When the infant or child expresses hunger, the parent responds by providing food in a manner appropriate to the child's abilities. For an infant, this requires bringing the breast or bottle to the infant's mouth. In an older child, the caretaker needs only to provide access to food because feeding can be essentially independent. Preverbal infants and developmentally delayed children communicate hunger by providing behavioral cues to their provider; in turn, the caretaker must interpret these cues correctly. If the caretaker misses the cue and offers food when the child is not interested in eating, the resultant struggle easily can escalate to a continuing negative response to feeding attempts. In toddlers, food seeking consists of communicating hunger. Efforts to use a spoon and cup independently and, ultimately, to obtain food from the refrigerator themselves progress through development. As adults, food seeking is a complicated process that includes most aspects of daily life. The mechanical process of ingestion requires the appropriate muscular coordination and sensation to bring food to the mouth. This learned process evolves through normal development. Neuromuscular disorders, blindness, and fatigue resulting from illness all can interfere with food ingestion.

Infants with subtle feeding disorders are less resilient in responding to difficult environments and emotional deprivation than are normal infants. Many children who have been diagnosed with nonorganic failure to thrive have subtle neuromuscular or oral–motor disorders.[14, 38, 47] Successful management in this setting requires teaching caretakers how to adjust feeding techniques appropriately. Continued unsuccessful efforts to feed the child can disrupt the caretaker–child relationship even in well-adjusted families.

THE ORAL PHASE OF FEEDING

The oral phase of feeding traditionally has been separated into two portions.[12] In the preparatory phase solid food is disrupted mechanically and lubricated, forming a safe bolus for swallowing. The oral transfer phase describes the transit of the bolus between the tongue and palate, into the pharynx. In the infant, milk is ingested from the breast or bottle by sucking.[61] The liquid bolus often moves into the valleculae before swallow initiation, making it more useful to consider the swallowing process as a linked, sequential process.[44]

The anatomy of the oral cavity changes during development (Fig. 1).[10, 28] The small size of the mandible and oral cavity relative to the tongue and the presence of buccal fat pads facilitate suckling. To suck, the lips close around the breast or nipple, and the tongue seals against the pharynx posteriorly, forming a closed intraoral chamber.[37] Depression of the tongue and mandible generates suction up to 150 mm Hg in the oral cavity of the term infant. Nipple shape, composition, and hole size determine the rate of milk flow from different nipples. The usual volume of milk taken in during each suck by a term infant is approximately 0.2

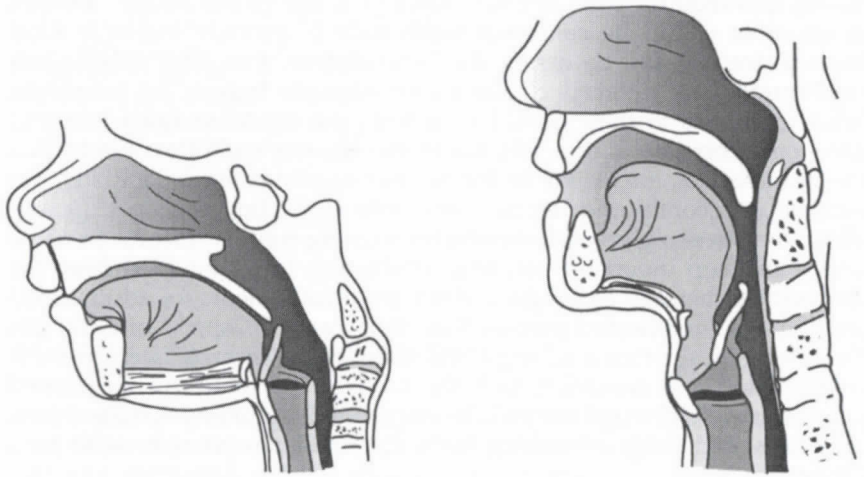

Figure 1. In the infant *(A)*, the small size of the mandible and oral cavity relative to the tongue and the presence of buccal fat pads facilitate suckling. By 6 to 8 months of age, the oral cavity begins *to remodel* and enlarge as the buccal fat pads resorb, creating a cavity for mastication. In the infant, the larynx sits high in the neck at the level of vertebrae C1–C3, allowing for the velum, tongue, and epiglottis to approximate, thereby functionally separating the respiratory and digestive tracts. This separation allows the infant to breathe and feed safely. By age 2 or 3 years *(B)*, the larynx descends with a common channel in the oral portion of the pharynx for respiration and swallowing.

mL, requiring 300 sucking and swallowing events to consume 60 mL, which the normal infant can consume over approximately 5 minutes. The preterm infant generates lower suction pressures, with resultant smaller amounts of milk expression per suck. More rapid milk delivery through a nipple with increased hole size increases the frequency of swallowing in normal term infants. Decreasing hole size increases the work of sucking and thereby increases the time required for feeding. With changes in nipple type, the normal term infant will adjust the amplitude of suction to alter the flow rate.[36] Preterm infants and those with neurologic disorders may have difficulty adjusting to different nipple types. In some, the slow flow rate nipples that require increased energy for suck may be detrimental. In others, the rapid delivery of milk from the nipple may necessitate frequent swallowing, which can interfere with ventilation.

Mouthing and sucking movements have been observed in utero at 13 weeks' gestation by ultrasonography study. In the preterm infant, mouthing patterns persist until approximately 32 weeks' gestational age, when a disordered pattern of sucking bursts and pauses are observed, being replaced with a stable pattern of rhythmic sucking and swallowing by 34 to 36 weeks' gestation.[5] The strength of suck also increases with anatomic and neurologic maturation. For the first months of life, the non-nutritive pattern of tongue movement is to extend and retract the tongue, allowing the nipple to be drawn into the mouth to initiate feeding.[42] At approximately 3 to 4 months of age, the infant develops lateral tongue movements that allow some bolus manipulation, and by 6 months of age, infants can remove soft-textured food from a spoon. The oral cavity begins to remodel and enlarge as the buccal fat pads resorb, a masticatory surface is created as alveolar ridges, and later the teeth form. Mature patterns of mastication develop between 6 and 8 months of age. At 12 months, sucking patterns are minimized, and children generally transition to cup drinking and no longer use the suck pattern. By 18 to 24 months, rotary chewing skills and increased lateral activity of the tongue contribute to more effective handling, crushing, and grinding of food.[15, 16, 52, 53]

At each stage of development, the infant nervous system is primed to acquire new motor skills.[23] A lack of feeding experience during these "critical periods" of development results in great difficulty mastering the skills later in life; thus, infants not able to eat orally for the first months of life may learn how to spoon- and cup-feed without ever learning an effective nutritive suck and swallow. Development of the oral phase requires normal anatomy, intact sensory feedback, and normal muscle strength and coordination. Children with neuromuscular disorders often present initially with poor feeding skills in infancy.[54] Anatomic defects include cleft lip with or without cleft palate, micrognathia, and macroglossia.

THE PHARYNGEAL PHASE OF SWALLOWING

The pharyngeal phase of swallowing is involuntary and triggered by bolus contact with the tonsillar pillars and pharyngeal wall. During pharyngeal swallowing, the upper pharynx and soft palate close to seal the nasal cavity as the bolus enters the pharynx. The bolus is propelled to the esophagus by contraction of the pharyngeal muscles. During pharyngeal contraction, the larynx elevates, the glottis closes, and respiration ceases to protect the lower airway from aspiration. Because the pharynx is the common chamber for the respiration and digestive pathways, important developmental changes affect the ability to swallow safely (Fig. 1). In the infant, the larynx sits high in the neck at the level of vertebrae C1 to C3, allowing for the velum, tongue, and epiglottis to approximate, thereby functionally separating the respiratory and digestive tracts. This separation allows the infant to breathe and feed safely. By age 2 to 3 years, the larynx descends, decreasing the separation of the swallowing and digestive tracts. Problems of aspiration often become evident at this age in children with borderline oral skills or poor laryngeal function.

Coordination of the oral and pharyngeal phases of swallowing is also essential for prevention of aspiration. During swallowing, respiration ceases and the pharynx is cleared before respiration resumes. If either of these protective mechanisms fails, aspiration of milk can occur despite the anatomic protection described earlier. Thus, if there is a lack of relaxation of the upper esophageal sphincter (cricopharyngeal achalasia), the pharynx will not be cleared and aspiration may result. Similarly, if inspiration occurs during the swallow, aspiration may result. Coordination of swallowing and breathing is particularly challenging in the infant in whom the respiratory rate is relatively high. During vigorous sucking and swallowing, as occurs early in a feeding session, there is often a significant reduction in minute ventilation with mild hypoxia, even in normal infants; patients with compromised cardiac or respiratory function often have serious difficulties with hypoxia during feeding.[7, 59] In the preterm infant, the coordination of sucking, swallowing, and breathing is not fully mature. Preterm infants tend to hold their breath for several seconds, during which time a number of sucks and swallows occur. This pattern of multiple swallows without respiration decreases with increasing postconceptual age.[19]

Laryngopharyngeal sensory deficits from neurologic disorders or decreased laryngeal sensitivity from chronic gastrolaryngeal reflux may predispose to problems with coordinating swallowing and increase aspiration risk.[31] Congenital abnormalities, including laryngeal clefts or laryngomalacia, can result in dysphagia and aspiration. Myopathies, CNS abnormalities, tumor masses, foreign bodies, esophageal peristaltic disorders, or inflammation (Table 2) can disrupt the pharyngeal phase of swallowing. As mentioned earlier, infants or children with tachypnea (respiratory rate $>$ 60 breaths/min) or cardiac compromise often have difficulty coordinating swallowing and breathing, thereby making feeding more difficult.

ESOPHAGEAL AND GASTROINTESTINAL PHASE OF FEEDING

The esophagus is a conduit between the pharynx and the stomach with muscular sphincters at either end, the upper and lower esophageal sphincters. The upper esophageal sphincter relaxes during swallowing to allow the food bolus to enter the esophagus, and peristaltic contractions propel the bolus down into the stomach. The lower esophageal sphincter relaxes to allow bolus passage into the stomach. Anatomic and functional disorders of the esophagus can cause dysphagia or recurrent aspiration (Table 2). Gastroesophageal reflux can cause esophagitis, with resultant pain or discomfort during swallowing,[8] but this is a relatively uncommon cause of feeding problems, so other causes also should be considered.[50] Food enters the stomach from the esophagus. The stomach expands to accommodate the additional food bolus and subsequently delivers the food to the intestine. The emptying of the stomach is controlled exquisitely by a variety of feedback mechanisms such that the small intestine receives a slow infusion of nutrients for absorption. Disorders of gastric emptying, such as gastroparesis (delayed emptying) or dumping syndrome (rapid emptying), which frequently occur following antireflux surgery,[46] can result in feeding-associated discomfort and subsequent feeding refusal. Dumping syndrome is a common complication of antireflux surgery.[40]

EVALUATION OF THE CHILD WITH A FEEDING DISORDER

Symptoms of feeding and swallowing disorders in children have many manifestations and clinical presentations including food refusal, failure to thrive, and oral aversion, recurrent pneumonia, chronic lung disease, or recurrent emesis. Swallowing and feeding disorders in infants and children are complex and can have multiple causes, as listed in Table 2. As discussed earlier, anatomic or functional disorders that make feeding difficult or uncomfortable for the child may result in a learned aversion to eating, even after the underlying disorder is corrected. Furthermore, delays in the initiation of feeding caused by underlying disorders may affect the normal acquisition of feeding skills. The complexity of the feeding process and multiple interacting factors that affect the acquisition of feeding skills make the diagnosis and treatment of feeding disorders particularly challenging and complicated.

A multidisciplinary team provides the most complete method to establish a diagnosis, assess a child's needs, and render a treatment or rehabilitative plan.[6, 29, 41] A study of children with special health care needs in Washington State found that nutrition or feeding-team intervention for disabled children who had slow growth or failure to thrive improved dietary intake and adequacy in all of the children who had inappropriate or inadequate intake, decreased illness and hospitaliza-

tion, improved feeding skills, improved feeding behavior, decreased constipation, and developmental feeding progress. Estimated medical cost savings achieved by providing nutritional or feeding team services ranged from $180 to $5000 per year, per child.[33] The team optimally includes the disciplines of speech pathology, occupational therapy, psychology, nutrition, gastroenterology, and otolaryngology for the core evaluation. Support from other specialists in radiology, social services, child life, neurology, and pulmonary medicine often is used. An interdisciplinary evaluation facilitates integration of expertise from different disciplines to provide insight into the various factors that interact in contributing to the child's swallowing disorder and overall health.

The evaluation begins with a focused feeding history, including current diet, textures, and route and time of administration, modifications, and feeding position. In healthy children, meal duration beyond 30 minutes suggests a behavioral feeding problem,[48] whereas in children with other disorders, long meal times may be reflective of ineffective feeding mechanics. Medical comorbidities that may affect swallowing need to be investigated. A history of recurrent pneumonia may indicate chronic aspiration; a history of stridor in relation to feeding may indicate a glottic or subglottic abnormality contributing to feeding disorder. Problems with snoring may suggest problems with tonsillar and adenoid hypertrophy, affecting feeding and growth.[13] Nutritional and psychologic assessments should be undertaken early in the evaluative process. It is important to assess whether caloric intake meets the metabolic needs of the child because many patients with swallowing disorders have concurrent illness that may increase metabolic needs.[27] Specific food aversions may provide clues regarding underlying metabolic or allergic disorders. Psychologic assessments help to identify behavioral and parental factors that may be contributing to a feeding disorder.[1]

Observation of a feeding session by experienced occupational therapists, speech pathologists, psychologists, and nurses often provides tremendous insight into the underlying feeding problem. Positive interactions between the child and parent, such as shared eye contact, reciprocal vocalizations, praise, and touch, or negative interactions, such as forced feeding, lack of conversation, eye contact, or touch, threatening, bribing, and inconsistency are noted. Observations of the child's responses to offered foods, including disruptive behaviors, such as turning the head away from food or throwing of food, provide valuable information. These observations highlight primary or secondary behavior problems that allow for future structuring of appropriate behavior treatment interventions.

The physical examination begins with the observation of feeding, during which neuromuscular tone, posture, and position during feeding; patient motivation; oral structure and function; and efficiency of oral intake are noted. Observations of the ability to handle oral secretions; pace of feeding; escape of food from the mouth; tongue and jaw movements; number of swallows to clear a bolus; noisy airway sounds after swallowing; coordination of suck and swallow; laryngeal elevation; and

gagging, coughing, or emesis associated with feedings can indicate an underlying neurologic or structural problem. Attention to articulation and voice quality also may provide useful information because the same structures as those used for the oropharyngeal phases of feeding are used for speech production. The absence of obvious signs of swallow dysfunction does not rule out a swallowing disorder, particularly in a child with a history of recurrent pulmonary disease in which "silent" aspiration may occur. Oral cavity anatomic abnormalities, such as ankyloglossia, cleft lip or palate, or macroglossia, need to be excluded.

Usually, a careful developmental, medical, and feeding history and physical examination provide clues to the diagnosis that guide the selection of further diagnostic tests. Only after all reasonable physical causes have been ruled out should a feeding or swallowing disorder be attributed to a purely behavioral cause.

Radiographic studies have two separate goals during the evaluation of children with feeding disorders. First, anatomic or structural abnormalities, such as strictures, fistulas, masses, or intestinal rotational anomalies, need to be ruled out. Second, images of the coordination of movement of a bolus through the oropharynx and esophagus can be studied. Standard upper GI contrast studies using barium suspensions are required for careful studies of anatomy. Frequently, children with feeding disorders will not ingest an adequate amount of barium for successful completion of these studies so that passage of a nasogastric feeding tube is required for a complete study. Because this unpleasant experience usually prevents further cooperation, children frequently require a separate session for the evaluation of the functional aspects of swallowing during a videofluoroscopic swallowing study (VSS). This test usually is best performed by a speech pathologist or occupational therapist in cooperation with a radiologist.[49] VSS allows the relatively noninvasive assessment of the oral and pharyngeal stage of swallowing and allows for the determination of consistencies and conditions for safe swallowing.[62]

An alternative or additional examination involves passage of a flexible into the oropharynx after anesthetizing the nares and nasopharynx. In experienced hands, this test can be performed in infants and children with minimal discomfort.[20] Initially, pharyngeal anatomy and movement of pharyngeal and laryngeal structures can be evaluated during speech. The management of secretions is examined by placing a small amount of green food coloring on the tongue. Accumulation of secretions in the valleculae or piriform sinus or aspiration of secretions may be observed directly. Finally, swallows of varying volumes and textures are administered by mouth and the coordination of swallowing and efficiency of pharyngeal clearance are assessed. Fiberendoscopic evaluation of swallowing (FEES) does not provide information regarding the oral phase of swallowing but compares favorably with VSS for the evaluation of the pharyngeal phase of swallowing. FEES can be augmented with a new approach to the evaluation of sensation in the pharynx using a special scope that administers a calibrated puff of air

onto the arytenoids or epiglottis.[31] The ability to initiate airway closure with stimulation demonstrates airway protection. FEES and sensory testing may be particularly valuable for the evaluation of swallowing safety in children who refuse to ingest adequate amounts of barium to perform VSS. In such cases, studying the anatomy and evaluating the patient's ability to handle the oral secretions provide useful information. Flexible endoscopy is not a substitute for rigid endoscopy for the evaluation of laryngeal anatomy. Laryngeal clefts can be overlooked during flexible endoscopy.

In selected patients, other diagnostic tests may be indicated. Any patient with aspiration in addition to a significant feeding disorder with clinical findings suggestive of cranial nerve IX or X involvement should undergo MR imaging to diagnose brain stem, skull base, or spinal problems that can interfere with swallowing, such as a Chiari malformation. MR imaging evaluation of the chest is useful in patients suspected of having a vascular ring/sling cause for stridor or dysphagia. Chest CT scanning may be particularly useful to assess the severity or progression of chronic pulmonary disease, which affects decisions regarding feeding safety.[34] GI endoscopy may be useful in selected cases to rule out strictures, webs, or inflammatory lesions definitively in the esophagus and stomach, but it is generally not a substitute for radiologic evaluation.

TREATMENT OF FEEDING DISORDERS

The careful evaluation of children with feeding disorders should allow for the recognition of treatable anatomic or inflammatory lesions. A child may refuse to eat even after an underlying anatomic abnormality has been corrected because of a learned aversion to feeding. Behavior therapy often can overcome this type of "conditioned" food refusal.[1, 25] Various therapeutic approaches may improve the efficiency and safety of feeding. These include changing the textures of foods[26]; pacing of feeding; changing the bottle or utensils[36]; and changing the alignment of the head, neck, and body with feeding. One small study[46] showed that the systematic presentation of food in a consistent manner improved feeding skills in some children with neurologic impairments. Other more sophisticated maneuvers used to improve feeding in adults are often difficult to teach to children[51]; however, therapies directed toward strengthening of swallowing musculature may be useful in children, although the exercises need to be incorporated into play activities to maintain the child's interest. Frequently, children with severe anatomic disorders but normal neurologic function develop their own adaptive strategies to allow for safe oral feeding. Unfortunately, many children with feeding disorders have noncorrectable neurologic or anatomic abnormalities that make oral feeding difficult or unsafe.

Decisions regarding whether to allow oral feeding depend on balancing the potential risks for aspiration and chronic lung disease with the emotional rewards and convenience of oral feeding. The amount of aspiration that is "safe" depends on the patient's ability to clear the airway with cough and ciliary flow. Society and health care professionals often impose a value system on families and patients that stresses the importance of providing nutrition by oral feedings. Some patients cannot obtain adequate nutrition by mouth because of a risk for aspiration. In others, the time required to provide a child with adequate nutrition by mouth consumes the parents' and child's lives, leaving little time for other nurturing activities. Thus, supplying a portion of the patient's nutrition by nasogastric or gastrostomy feedings may be beneficial.

Families may need counseling to help them realize that, for their child, alternate approaches to providing nutritional support (i.e., gastrostomy feedings) may be better for the child's overall health than persisting in efforts to provide nutrition only by mouth.[43, 56] The timing for aggressive behavioral intervention or for the initiation of attempts at oral feeding needs to be decided in the context of the child's overall development and well-being. Because anatomic relationships of the larynx change during development and disease progression may alter swallowing, episodic reevaluation of the safety or approach to feeding is essential. Periodic reassessment of potential underlying causes of feeding problems is often valuable. In addition, decisions balancing the benefits and risks of oral feeding need to be reassessed. Periodic evaluation of pulmonary status with measurement of oxygen saturation, chest radiography, or chest CT scanning, and formal pulmonary function tests may alert the managing physician to reevaluate feeding safety.

Even if full oral feeding cannot be achieved, providing some oral stimulation will facilitate the possible later introduction of oral feeds and is usually rewarding for the parents. Current data suggest that, even in adults, sensory stimulation may facilitate brain remodeling to facilitate swallowing after brain injury.[18] Also, continuing oral stimulation will prevent the development of aversion to oral touch, allowing good dental care. The nutritional requirements of every patient must be met by an oral or alternate route. Similarly, the development of social skills and interactions achieved during mealtimes must be incorporated into the patient's life despite his or her lack of oral intake.

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