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Dysfunctional Swallowing in the Pediatric Patient: Clinical Considerations

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Abstract. When caring for the pediatric patient with impaired or dysfunctional swallowing, the clinician must consider clinical issues unique to this age group. These include growth and development of the swallowing apparatus, maturation of feeding behavior, oral feeding and the development of parent-child bonding, and adequate nutrition for growth. This article will review these issues and examine their impact on the evaluation and treatment of the infant and child with dysfunctional swallowing.

Key words: Dysfunctional swallowing, infants and children – Pediatrics, developmental.

Table 1. Concerns unique to the pediatric patient with impaired swallowing

Anatomical and functional growth of the swallowing apparatus
Maturation of feeding behavior
"Critical period" of learning
Nutritive and nonnutritive sucking
Oral feeding and the development of parent-child bonding
Nutritional adequacy for growth
Poor cognitive ability: (in certain high-risk groups)
Unable to follow therapeutic recommendations
Unable to report symptoms
Unable to adapt to and/or compensate for oropharyngeal dysfunction

A wide range of clinical issues must be considered in the evaluation and treatment of the infant and child with impaired or dysfunctional swallowing. For example, growth and development of the swallowing apparatus, maturation of feeding behavior, the importance of oral feeding in the development of parent-child bonding, and adequate nutrition for growth represent clinical concerns unique to this age group. In addition, many pediatric patients with dysfunctional swallowing lack the cognitive skills necessary to follow specific therapeutic recommendations (e.g., premature infants, children with central nervous system disease), and therefore patient management may be difficult. Clinical issues in the pediatric patient with dysfunctional swallowing are summarized in Table 1. This article reviews these "unique" clinical concerns and discusses their impact on the evaluation and management of the pediatric patient with dysfunctional swallowing.

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Physiology of Swallowing: Developmental Aspects

In Utero

There is evidence that the human fetus swallows in utero; the exact age when this occurs and the stimulus for its development have not been determined [1]. Using radioisotopic methods, in utero swallowing has been documented to occur as early as 16–17 weeks of gestation [2]. Evidence of a pharyngeal swallow has been described in a delivered fetus at a gestational age of 12.5 weeks [3]. It has been estimated that the normal fetus at term swallows approximately 450 ml amniotic fluid daily out of a total amniotic fluid volume of 850 ml [2]. Fetal swallowing plays a significant role in the regulation of amniotic fluid volume in a normal pregnancy [1].

Postnatal Development

Structure. After birth, components of the oral and pharyngeal cavities undergo dramatic changes in size and relative location. Interpretation of pediatric imaging studies of the oropharynx must take into account the normal anatomic relationships that evolve during development of the infant and child. Structurally, the central mobile elements of the oropharynx are large in comparison to their containing chambers [4]. For example, the tongue is large compared to the oral cavity. Similarly, the arytenoid mass is nearly mature in size during infancy, as opposed to the small sized vestibule and ventricle of the larynx [4].

In the infant, the tongue lies entirely within the oral cavity. The larynx is positioned high in the neck, resulting in a small oropharynx [5]. Between 3 and 4 years of age, the tongue begins its descent and by approximately 9 years of age its posterior third is present in the neck [5]. Noback [6] traced the descent of the larynx in the fetus, infant, and child with autopsy studies. Comparing the location of the cricoid cartilage to the level of vertebral bodies, he found that in the prenatal period the larynx descends from the third to the fourth cervical body, an arrangement that persists during infancy. During childhood the larynx descends until it is opposite the sixth vertebra. The larynx eventually reaches the seventh cervical vertebra in adulthood. As maturation progresses, the face elongates vertically and the chambers of the oral cavity and oropharynx enlarge [7].

Nutritive versus Nonnutritive Sucking. Sucking movements made by infants may be classified as either nutritive or nonnutritive. Nonnutritive sucking is defined as rhythmic mouthing movements made on a nonfeeding (blind) nipple. Wolfe [8] analyzed patterns of sucking in normal term infants by using a modified nipple attached to a pressure transducer and polygraph recorder. He found that nonnutritive sucking was characterized by a pattern of swallowing bursts alternating with periods of rest, whereas the pattern of nutritive sucking occurred continuously and at a slower rate.

In the absence of oral feeding, continuation of nonnutritive sucking may favorably influence the development of normal sucking behavior and growth. Bernbaum et al. [9] studied the effects of nonnutritive sucking in a group of low-birthweight infants receiving feeding by gavage. They found that, compared to a control group, infants receiving nonnutritive sucking on a blind pacifier had accelerated maturation of oral motor function and earlier transition to oral feedings. In addition, the infants who received nonnutritive sucking gained weight more rapidly than the control group despite equivalent energy intakes. Although the mechanism for this difference in weight gain is not clear, it may be secondary to stimulation of additional digestive enzymes such as lingual lipase in the nonnutritive sucking group, thereby enhancing absorption of fat.

Suckle Feeding. The oral phase of swallowing in the normal infant is characterized by a pattern known as suckle feeding [10, 11]. Suckle feeding, or suckling, refers to motion of the lower jaw and tongue compressing the upper jaw and palate. During suckling, the tongue, lip, and mandible move synchronously. The movements of this unit are in two general directions: inferior-anterior and superior-posterior. This motion results in the creation of negative intraoral pressure alternating with compression, an action that promotes fluid delivery from a nipple. Suckle feeding is followed by the development of transitional feeding, which occurs at the age of 6–36 months [10]. As discussed by Bosma [10], graduation from suckle to transitional feeding occurs mainly as a result of central nervous system maturation and is not secondary to changes in the physical characteristics of end-organs (e.g., development of teeth in the oral cavity). Feeding behavior matures as motor activity is directed by higher centers such as the thalamus and the cerebral cortex. The transitional phase of feeding develops into mature feeding, characterized by biting and chewing.

Swallowing Function in Preterm Infants

Premature infants are able to suckle feed at a gestational age of approximately 34 weeks. However, successful oral feeding in the preterm infant requires coordination of swallowing and breathing. Respiratory difficulties such as aspiration may result if these actions are not well integrated. There is controversy regarding the ability of infants to swallow and breathe simultaneously. Negus [12], a proponent of this view, suggested that separate air and food pathways are possible as a result of movement of the epiglottis into the nasal airway, allowing liquid to flow along the lateral pharyngeal channels while the airway remains open. However, other investigators do not support this concept [13, 14]. Shivpuri et al. [15] evaluated breathing patterns and pulmonary function in preterm infants during nipple feeding. Airflow was measured by nasal mask pneumotachometer and blood gases

were monitored by transcutaneous electrodes. They found that during continuous nutritive sucking there was a significant decrease in minute ventilation as a result of decreases in respiratory frequency and tidal volume. These changes were associated with a fall in transcutaneous pO2, with differences ranging from 10 ± 2 to 13 ± 4 mmHg depending on gestational age. Wilson et al. [16] evaluated the coordination of breathing and swallowing in preterm infants. These investigators measured airflow with a nasal flowmeter, respiratory effort with an esophageal balloon, pharyngeal pressures with a saline-filled catheter, and electromyographic activity of submental and neck muscles using surface electrodes. Onset of a swallow was identified by a peak in pharyngeal pressure or an electromyographic burst associated with interruption of nasal airflow. They found that swallows were initiated during all phases of the respiratory cycle. During the oral and pharyngeal phases of swallowing, respiratory movements were suspended and the respiratory cycle in which a swallow occurred was prolonged. In addition, they noted the existence of a "swallow-breath," defined as a brief inspiratory effort that occurred at approximately 0.12 s following the onset of the swallow. As described by the authors, the swallow-breath was identified as a fall in pharyngeal pressure associated with brief outward movement of the abdomen probably secondary to contraction of the diaphragm.

Swallowing: Critical Period of Learning

There are a number of clinical settings in which an infant may be unable to receive oral nutrition for a prolonged period of time. For example, infants with severe gastrointestinal disease, central nervous system dysfunction, or prematurity may be given nutritional support using total parenteral nutrition administered by central vein or enteral feeding by tube. Infants deprived of oral stimulation during a critical stage of maturation may have difficulty reinitiating oral feeding. Illingworth and Lister [17] have reviewed the concept of a "critical" or sensitive period in the development of a particular action or behavior. A critical period refers to a segment of time during maturation during which a specific stimulus must be applied to produce a particular action. It has been suggested that inadequate oral stimulation during a critical period may result in problems related to oral feeding. Geertsma et al. [18] have reported the case of an infant who received long-term total parenteral nutrition and subsequently developed resistance to oral feeding. The reintroduction of oral feeding was accomplished using behaviorally based intervention. Blackman and Nelson [19] described difficulties in reinstituting oral feeding in a group of children who had previously been fed using a gastrostomy tube. They evaluated 17 children under 4 years of age for possible oral feeding. Ten candidates for an oral feeding program were selected using the criteria of (1) a stable medical condition, (2) a developmental level greater than 6 months, and (3) no clinical evidence of impaired swallowing. Using behavioral techniques, 9 of 10 patients considered candidates for oral feeding were successfully weaned off gastrostomy feedings. In general, outpatient management required months to years for a successful outcome, whereas inpatient therapy required 2 or 3 weeks. These authors stress that a team composed of a physician, social worker, physical therapist, speech-language pathologist, psychologist, occupational therapist, and dietitian is required to manage these patients.

Psychosocial Concerns and Pediatric Swallowing Disorders

Infants and children with dysfunctional swallowing receiving nutrition by the oral route usually tolerate only small boluses of food per swallow and, as a result, require long periods of time for feeding. This problem may interfere with normal daily activities and have a detrimental effect on family schedules. In addition, feeding difficulties may compromise the eligibility of a handicapped child for institutional care when staffing is limited.

Because of the hazards and difficulties associated with oral feeding, alternative routes of providing nutrition, such as feeding by gastrostomy tube, are frequently used. Yet continuation of at least some oral feeding in the pediatric patient is important for several reasons. First, feeding by gastrostomy is not easily accepted by families because of unfamiliarity and fear associated with tube feeding. Second, feeding an infant by the oral route has strong psychosocial significance in terms of developing and maintaining parent-child bonding and a strong sense of nurturing [38]. Third, continuation of oral feeding allows the therapist to use and train oropharyngeal muscles for rehabilitation, although oral muscles can be trained without the use of food.

"At Risk" Pediatric Populations and Clinical Consequences of Dysfunctional Swallowing

Articles reviewing the spectrum of pediatric swallowing disorders have been published elsewhere

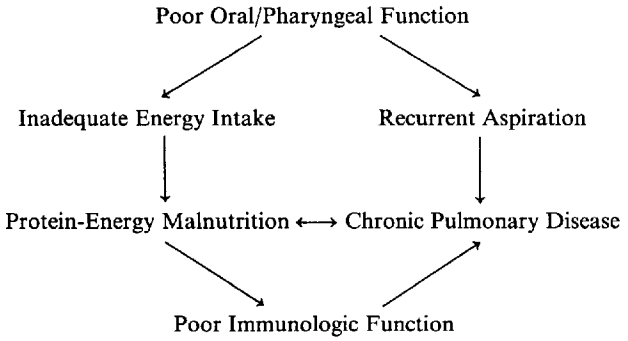

Fig. 1. Clinical sequelae of dysfunctional swallowing.

[10, 20, 21]. In clinical practice, most infants and children with impaired swallowing have disorders of the central nervous system such as cerebral palys, mental retardation, and brain injury secondary to infection or trauma. Premature infants with poor coordination of breathing and swallowing, infants with long-term deprivation of oral feeding, and infants with chronic pulmonary disease represent additional "at risk" groups.

The clinical sequelae of dysfunctional swallowing include repeated episodes of aspiration, recurrent pulmonary infections, and possible development of chronic lung disease. As a consequence of this and poor oral intake, protein-energy malnutrition may result. Protein-energy malnutrition may impair the immunologic response to infection and adversely affect growth of the central nervous system in the developing infant [22, 23] (see Fig. 1).

Dysfunctional Swallowing and Associated Motor Disorders of the Gastrointestinal Tract in the Pediatric Patient

In addition to dysfunctional swallowing, neurologically impaired children frequently have an associated dysfunction involving the gastroesophageal junction, a condition known as gastroesophageal reflux (GER); the incidence of GER has been reported to be as high as 75% in children with central nervous system disease [24, 25]. Although the mechanism for the association of GER and central nervous system dysfunction is unknown, several factors may be involved including diaphragmatic distortion secondary to kyphosis and scoliosis, habitual aerophagia, and frequent recumbent positioning. Diaphragmatic contraction has been demonstrated in animal studies to be an important component in maintaining gastroesophageal competence [26].

The child with impaired swallowing frequently has poor protection of the airway so that reflux of acid may result in pulmonary symptoms. The pulmonary response to acid reflux may depend on the region of the tracheobronchial tree or gastrointestinal tract that receives stimulation by the refluxed material [27]. For example, direct tracheal aspiration of acid may result in reactive airway disease (i.e., wheezing) or aspiration pneumonia. Acid stimulation of the larynx may give rise to apnea, especially in infants. Finally, exposure of the esophagus to acid may stimulate acid receptors in the esophageal mucosa and result in bronchospasm [28].

Previously unsuspected GER may occur following placement of a gastrostomy tube in the neurologically impaired child. Mollitt et al. [29] report that 25% of their patients, diagnosed as reflux-free prior to surgical gastrostomy, developed vomiting following the procedure and eventually required an antireflux operation. As a result, some authors recommend that children with central nervous disease and dysfunctional swallowing be evaluated for GER prior to gastrostomy tube insertion, even if obvious clinical symptoms of reflux are lacking [30]. In the event that GER is diagnosed, surgical placement of the gastrostomy tube is combined with an antireflux operation. If there is no suspicion or documentation of GER, a gastrostomy, placed endoscopically, may be sufficient [31]. The validity of this approach requires further investigation and confirmation.

Treatment of the Pediatric Patient with Dysfunctional Swallowing

Extensive reviews regarding the management of the patient with impaired swallowing have been published [32–37]. A discussion of the various ther-

Table 2. Dysfunctional swallowing: therapy

Dietary manipulation of feeding[a]
Volume and consistency
Positioning of head and neck during deglutition[a]
Intraoral bolus placement[a]
Thermal sensitization/stimulation
Exercises
Tongue resistance/range of motion
Laryngeal adduction
Supraglottic swallow procedure
Cricopharyngeal myotomy
Suckle feeding[a]
Valved feeding bottle

[a] This form of therapy has been used frequently in pediatric patients.

apeutic modalities available to the clinician is beyond the scope of this article. However, Table 2 lists available therapies, including special reference to those used in pediatric patients. Unfortunately, there are few well-controlled clinical trials establishing the efficacy for any specific form of treatment in children.

Treatment of the infant and child with impaired swallowing presents a special set of problems for the swallowing therapist. First, children with mental retardation have limited cognitive skills and therefore may be unable to follow therapeutic instructions. Second, the child with cerebral palsy or other neuromuscular disorders with poor motor control of the head and neck may lack the ability to position the oropharynx properly during a swallow.

Conclusion

The clinician caring for the pediatric patient with dysfunctional swallowing must deal with a set of clinical problems unique to this age group. Recognition of age-specific issues related to oromotor structure and function, growth and development, nutritional status, and family concerns regarding infant feeding is necessary to allow the clinician to provide optimal management for these complicated patients. A pediatric dysphagia team, similar in concept to the interdisciplinary group of clinicians recommended for adult patients, can provide the necessary expertise needed to care for the child with impaired swallowing [37]. The pediatric team may consist of specialists in any or all the following disciplines: medicine (including general pediatricians and pediatricians with specialties in developmental disorders, rehabilitation, gastroenterology, neurology, otolaryngology, and radiology), nursing, speech-language pathology, occupational therapy, nutrition, behavioral pediatrics, and social work. Given the complexity of clinical problems in the field of pediatric swallowing disorders, collaborative efforts are needed to develop and expand the diagnostic and therapeutic alternatives available to the swallowing-impaired infant and child.

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