Oropharyngeal dysphagia: pathophysiology and diagnosis for the anniversary issue of Diseases of the Esophagus

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SUMMARY. The oropharyngeal swallow involves a rapid, highly coordinated set of neuromuscular actions beginning with lip closure and terminating with opening of the upper esophageal sphincter. Evaluation of the oropharyngeal swallow usually involves the use of a modified barium swallow radiographic study with the goals of (i) defining the patient’s swallow anatomy and physiology causing the dysphagia; and (ii) evaluating the immediate effectiveness of treatment procedures including selected postures, sensory enhancement, swallow maneuvers, and diet changes. Exercise programs may be helpful, but their immediate effects cannot be examined during the initial modified barium swallow. Exercise programs can be evaluated on a second radiographic study 3–4 weeks later. The resultant report should include all of this information. The speech–language pathologist is usually the professional most involved in the evaluation and treatment. Medications and surgery have a very limited role in the treatment of oropharyngeal dysphagia.

KEY WORDS: anatomy and physiology, dysphagia, evaluation, oropharyngeal swallow, treatment.

THE NORMAL OROPHARYNGEAL SWALLOW

To understand and accurately diagnose oropharyngeal swallowing disorders, one must first understand the physiology of the normal oropharyngeal swallow.1 The oropharyngeal swallow is composed three stages: oral preparatory, oral, and pharyngeal. Both voluntary and involuntary/reflex responses are involved in a normal swallow. The oropharyngeal swallow mechanism can be described as the function of valves and pressures.

The oral preparatory stage involves sensory recognition, manipulation, and formulation of the bolus. Adequate labial seal must be maintained to ensure that the bolus remains in the oral cavity. Lingual movements and saliva production form the bolus and hold it in a cupped position, with the tip and sides of the tongue sealed against the hard palate and the lateral alveolus. During mastication, the tongue and mandible work together in a lateral rotary motion until the food’s viscosity is reduced to an easily swallowed consistence. Saliva begins to break the food down in the oral cavity during this stage. Then the bolus is formed with tongue action. Some premature spillage of the bolus into the pharynx prior to the triggering of the pharyngeal swallow is considered normal during mastication. During this time, the airway is normally open.

Once the food or liquid is formed into a cohesive bolus, the oral preparatory phase is completed.1,2 The oral stage of the swallow is initiated as the oral tongue begins to propel the bolus posteriorly toward the pharynx and is generally completed within 1–1.5 s, with some variability as bolus viscosity increases. Lingual movement during this stage can be described as a progressive squeezing motion of the midline of the tongue as it propels the bolus posteriorly.3 As the viscosity of the material being swallowed increases, increased lingual strength or pressure is required. Both the oral preparatory and oral stages are considered to be under cortical or volitional neural control.

The pharyngeal stage of the swallow is hypothesized to be controlled by a sensory recognition
center located in the medulla. Sensory input from the oropharynx and deep proprioceptive receptors in the tongue are thought to be decoded by the nucleus tractus solitarius and sent to the nucleus ambiguous, which in turn initiates the motor movements of the pharyngeal swallow. The pharyngeal swallow is initiated or triggered when the head of the bolus passes any point between the anterior faucial arches and the lower edge of the ramus of the mandible. Once the pharyngeal swallow triggers, a series of muscular movements occur: (i) closure of the velopharyngeal port; (ii) elevation and anterior movement of the hyolaryngeal complex; (iii) laryngeal closure at the level of the true vocal folds, false vocal folds, and epiglottis as well as the anterior tilting of the arytenoid cartilages; (iv) posterior movement of the tongue base and pharyngeal wall contraction; and (v) upper esophageal sphincter (UES) opening. The duration of the pharyngeal stage of swallowing is usually 1 s or less. Once the bolus passes through the UES, the esophageal stage of the swallow is initiated.

AGING

As we age, there are some small systematic changes in the oropharyngeal swallow largely related to a slight slowing in the movement of the bolus and triggering of the pharyngeal stage of swallow. There is a small but significant increase in oral transit time and in the delay time between the oral and the pharyngeal stage. Flexibility and reserve in swallow have also been seen as reduced in elderly normal individuals. The frequency of penetration of liquids and pudding into the airway also increases significantly with age over 50 years. There is a tendency that the frequency of infrequent aspiration increases in older (over 70 years) normal volunteers. Reduced muscle strength, particularly in the tongue, has been found in individuals over age 60. The oropharyngeal swallow changes with growth and development. Unfortunately, we do not have many studies of the oropharyngeal swallow in infancy because usually radiographic studies are needed and exposure to x-ray is typically avoided in an infant unless absolutely necessary. Sucking from a bottle requires good lip seal around the nipple as well as tongue pumping to bring the bolus from the nipple and back to the posterior oral cavity. In many infants, the bolus will fall into the valleculae until the pharyngeal swallow has triggered and then move on into the esophagus where it will remain until a large-size bolus is formed and the esophageal stage initiates. When bottle feeding is eliminated, the infant moves toward the adult pattern of oral propulsion of the bolus to the back of the oral cavity, followed by triggering of the pharyngeal stage of swallow, and finally, to the esophageal stage. Because of the reserve in swallowing, much of the information we have on the development of normal chewing and dietary change comes from observational studies, which indicate that adult mastication with lateralization of the bolus by the tongue to the teeth can occur between 3 and 5 years of age. While older literature tends to indicate that infants can chew, swallow, and breathe simultaneously because their airway is more protected by its elevated position, it has become clear that this is not true. Infants will maintain airway opening during the oral propulsion phase, but during the pharyngeal stage of swallow, the airway does close in the same manner as it does in an adult.

DISORDERS OF THE OROPHARYNGEAL SWALLOW

Swallowing disorders can occur at any stage of the swallow. It is important to realize that observations such as residue, laryngeal penetration, and aspiration are not disorders themselves but are symptoms of a disorder.

DISORDERS OF THE ORAL STAGE

In the oral stage, reduced lingual range of motion, strength, or control can impact the ability to efficiently propel the bolus posteriorly into the pharynx. Inefficiency in the oral phase may affect the ability to maintain adequate nutrition or may lead to more restrictive diets. In some cases, poor oral control can result in material falling into the pharynx and being aspirated before the pharyngeal phase is initiated.
DISORDERS IN THE PHARYNGEAL STAGE

Disorders in the pharyngeal stage of swallowing can involve both sensory and motor components. A delay in triggering the pharyngeal swallow may result in a portion of the bolus reaching lower levels of the pharynx and airway before the swallow is triggered and airway closure is initiated. Depending on the duration of the delay and the individual’s pharyngeal anatomy, this can result in penetration or aspiration before or as the airway closes. Incomplete velopharyngeal closure can result in nasopharyngeal backflow. Disorders involving laryngeal closure can occur at the vestibule or glottic levels. Incomplete laryngeal vestibule closure can result in penetration of material. If this material is not squeezed out of the laryngeal vestibule, it is often aspirated after the swallow as gravity pulls it lower into the airway. If both laryngeal vestibule and glottic closure are incomplete, material may be aspirated during the swallow. Reduced tongue base posterior movement to touch the pharyngeal wall can result in incomplete or weak contact with the posterior pharyngeal wall, with reduced pressure generation on the bolus. This often results in residue in the valleculae or along the tongue base. Residue along the posterior pharyngeal wall may indicate reduced pharyngeal wall contraction. Unilateral pharyngeal weakness, occasionally seen in strokes affecting the brainstem region, results in residue collecting on one side of the pharynx and in one of the pyriform sinuses. Reduced elevation and anterior movement of the hyoid and larynx can result in reduced laryngeal closure or in residue in the pyriform sinuses bilaterally. Residue in the pyriform sinuses, in absence of disordered laryngeal movement, may be a sign of cricopharyngeal dysfunction or weakness in the base of tongue. Diffuse residue throughout the pharynx is often indicative of generalized weakness and reduced pressure generation in the pharyngeal swallow response.

SCREENING FOR DYSPHAGIA

Before an instrumental diagnostic procedure is used, a screening for dysphagia is conducted by reading the patient’s chart and observing the patient to determine whether the patient is highly likely to have dysphagia. Then a diagnostic study is conducted.

ETIOLOGY OF OROPHARYNGEAL SWALLOW DISORDERS

Oropharyngeal swallow disorders can result from many etiologies. Congenital disorders such as cerebral palsy, cleft palate, muscular dystrophy, dysautonomia, or other congenital neurological or structural malformations can affect swallow function early in life. There are numerous neurological problems that can impact swallowing function, including cerebral vascular accidents, Guillain-Barré syndrome, traumatic brain injuries, seizure disorders, or dementia. Neurosurgical procedures including aneurysm clipping or tumor resections can also impair swallow function, particularly if the brainstem region or cranial nerves are involved. Progressive neurological disorders, including Parkinson’s disease, progressive supranuclear palsy, oculopharyngeal dystrophy, amyotrophic lateral sclerosis, multiple sclerosis, muscular dystrophy, dystonia, or myasthenia gravis, can significantly impair swallow function. Collagen diseases including dermatomyositis or scleroderma may result in impaired pharyngeal contraction.

Oropharyngeal dysphagia can also result from structural causes, including cervical osteophytes, criocopharyngeal bars or oral or pharyngeal scar tissue. Surgical reconstruction for head and neck cancer often impacts normal swallow function to a great but variable degree. Anterior cervical spinal fusion surgery may temporarily impair pharyngeal swallow function. Medical causes of oropharyngeal dysphagia include deconditioning, rheumatoid arthritis, advanced chronic obstructive pulmonary disease, some viral infections, and prolonged endotracheal intubation. Radiotherapy for head and neck tumors can result in fibrosis of muscle fibers crucial for normal swallowing. Temporarily, radiotherapy-induced mucositis often makes swallowing extremely painful. Many medications can either result in xerostomia or in oversedation, which may affect swallow efficiency or safety.

OROPHARYNGEAL DIAGNOSTIC STUDY

To evaluate a dysphagic patient’s oropharyngeal swallow in relationship to normal oropharyngeal physiology, the modified barium swallow, or video-fluoroscopic evaluation, was developed initially in the mid-1970s and was modified over the 1980s and 1990s, based on our increasing knowledge of normal swallow physiology. The modified barium swallow has a number of purposes and is in some ways unusual as a radiographic study. First, the evaluation is designed to examine the patient’s oral and pharyngeal anatomy and swallow physiology in a series of swallows that reflect the systematic changes in normal swallow physiology as volume and viscosity increase. Changes in the modified barium swallow procedure occurred as a result of studies of normal swallow physiology, which revealed the effects of bolus volume and viscosity on oropharyngeal swallow physiology. The study begins with two swallows each of measured volumes: 1 mL, then 3 mL, 5 mL, and 10 mL, followed by two swallows of
self-selected volumes from a cup. This graduation in bolus volume comes from a number of studies that have shown us that volume is the most important variable in determining oropharyngeal swallow physiology, including coordination and duration of airway closure and upper sphincter opening into the esophagus.\textsuperscript{3,18,19} Bolus viscosity also has an effect on physiology, but to a lesser degree than volume.\textsuperscript{22,23}

The modified barium swallow study can be conducted in children as well as adults of all ages. During the study, the patient should be seated upright and provided foods in measured amounts via syringe or placement of a measured volume in an empty cup. The thicker foods should also be measured via calibrated syringe to assure that the degree of effect of volume or viscosity can be observed. If a young infant is the subject of the test, barium is generally mixed with the infant’s formula or sometimes given alone.\textsuperscript{24}

If the patient exhibits severe dysphagia, such as excessive residue in the mouth or pharynx or aspiration, the study may be paused and the second purpose of the study undertaken – that is, an attempt to improve the swallow with treatment interventions that can have an immediate positive effect on the swallow. Introduction of treatment strategies typically begins with postural changes,\textsuperscript{25,26} followed by heightening sensory input.\textsuperscript{27,28} If the patient exhibits a disorder of airway closure, laryngeal elevation, or increases in effort exerted during the swallow, the application of voluntary control for protection of the airway, elevation of larynx, or increases in effort exerted during the swallow, and finally, changing diet are examined.\textsuperscript{29,30} Based upon the patient’s swallows of each bolus volume and viscosity, the clinician will identify the patient’s swallowing disorders. Identification of the patient’s swallow disorders is the first purpose of the oropharyngeal videofluorographic study.\textsuperscript{31}

The second overall goal of the modified barium swallow is to examine the effects of treatment strategies with the goal of returning the patient to as wide a range of oral intake as is safe and efficient. All of this adds some acceptable variability to the procedure.\textsuperscript{31}

At the end of the modified barium swallow, the clinician will write a report that outlines the types of foods and volumes given to the patient to gain full understanding of the patient’s oropharyngeal swallow physiology, followed by a description of the swallow dysfunctions that occurred to create the patient’s dysphagia. Then, the effects of intervention, whether successful or not, should be described. Finally, recommendations regarding the management of the patient’s diet and treatment should be defined.\textsuperscript{31}

The modified barium swallow should be conducted by a speech–language pathologist who is experienced in the area of oropharyngeal dysphagia and a radiologist or other physician. The speech–language pathologist should be the one who develops the report of the study.

Reevaluation by modified barium swallow should be done if the clinician who is treating the patient is unsure of whether or not safe and efficient swallow has been reestablished or if there may be need to reassess to define the degree of improvement in the patient’s oropharyngeal swallow.

The clinician hoping to improve the oropharyngeal dysphagic patient’s swallow is likely to be unsuccessful unless a physiologic study of swallow is conducted, and such a study should be the modified barium swallow. There are alternative techniques that can provide selected information on the oropharyngeal swallow including manometry, which provides pressure data during the swallow and is usually best interpreted when both videofluoroscopy and manometry are done concurrently. This enables the examiner to determine which pharyngeal movements result in the increased pressure. Fiberoptic endoscopic evaluation of swallowing does not image the oral cavity, but it does image the pharynx before and after the swallow, but not during the swallow, so that its application to the study of oropharyngeal dysphagia is limited.\textsuperscript{32,33}

At the minimum, the oropharyngeal swallow study, or modified barium swallow, should include at least 14 swallows, two of 1 mL, two of 3 mL, two of 5 mL, two of 10 mL, two cup-drinking swallows, two of pudding, and two of 1/4 of an easily dissolvable cookie coated with barium pudding when possible. Some patients cannot manage the larger boluses, the pudding, or the cookie. The procedures should move to the treatment process to identify procedures that improve the swallows. The latter boluses provide information on the patient’s ability to chew. Those patients who cannot chew, such as those with surgical treatment for oral cancer of the tongue, should not be given the cookie bolus but should be evaluated clinically for the chewing function instead. Without such a modified barium swallow study, the clinician will not have a full understanding of the patient’s oropharyngeal swallow physiology and therefore cannot plan appropriate treatment.

**TREATMENT TYPES**

Treatment for oropharyngeal dysphagia is typically quite different than that for esophageal dysfunction. While there are many medications and surgical procedures that affect the esophageal aspect of swallow, this is not true in the pharynx. The focus of most management of oral and/or oropharyngeal dysphagia is behavioral, involving postural changes, sensory enhancements, swallow maneuvers or voluntary controls exerted over the swallow, and/or changes...
in diet. Depending upon the patient’s medical diagnosis causing the dysphagia, the use of these various types of treatment will vary quite systematically. Postural changes affect the way in which gravity moves food through the mouth and pharynx or changes the relationship of oropharyngeal structures before, during, and after the swallow. Five different postures can be used to assist dysphagic patients. The posture that is most effective will vary with the specific swallow physiology. The five postures are (i) chin down to the chest; (ii) head lifted; (iii) head rotated to the dynamic side of the pharynx; (iv) head tilted to the better side of the pharynx or oral cavity; and (v) lying down, either on the side or on the back. The effects of these postures can be seen and understood in Logemann. If the patient exhibits a sensory disorder of swallow, such as delay in triggering the pharyngeal swallow, the patient may benefit from heightening sensory input either prior to the swallow with thermal tactile stimulation or by providing the patient with sensory enhanced boluses such as carbonation or sour boluses. Heightening sensory input via changing the nature of the bolus is a relatively new treatment procedure for which greater information and study are needed; however, it is generally well understood that the food eaten is the primary sensory stimulus for the swallow. The patient will often benefit from voluntary control applied to the swallow including techniques such as the supraglottic and/or supraglottic swallow during the swallow including techniques such as the super. Postural changes affect the way in which gravity moves food through the mouth and pharynx or changes the relationship of oropharyngeal structures before, during, and after the swallow. The oropharyngeal swallow is quite different from esophageal function in that it must coordinate with respiration, both of which are coordinated at the brainstem level. This coordination, the ability to shift from respiration to safe swallowing and back, is a critical one in the oropharyngeal swallow. All of the normal physiology described at the beginning of this chapter is important in facilitating the safe and efficient transport of the bolus from the mouth to the esophagus. Typically, the speech–language pathologist who is educated in the anatomy, physiology, evaluation, and treatment of oropharyngeal dysphagia is the professional most involved in assessment and treatment in the oropharyngeal stage, along with the patient’s physician, dietitian, gastroenterologist, and otolaryngologist, as needed. To date, the major treatments for oropharyngeal dysphagia are behavioral. Medication and surgical procedures have not been identified to make major differences in the oropharyngeal dysphagic patient. Surgery has been helpful in patients with Zenker’s diverticulum and in diverticuli in the esophagus. A team approach to the care of the oropharyngeal dysphagic patient is often needed to integrate the treatment issues with their medical diagnosis, dietary needs, and other aspects of successful dysphagia management.

**OROPHARYNGEAL DYSPHAGIA AS AN EARLY SYMPTOM OF DISEASE**

In some cases, oropharyngeal dysphagia can be one of the first presenting symptoms of a progressive disease. Dysphagia may be an early symptom of diseases including myasthenia gravis, bulbar amyotrophic lateral sclerosis, Guillain-Barré syndrome, or polymyositis. Dysphagia or odynophagia can be one of the first noted symptoms with a head or neck tumor.

**SUMMARY AND CONCLUSION**

The oropharyngeal swallow is quite different from esophageal function in that it must coordinate with respiration, both of which are coordinated at the brainstem level. This coordination, the ability to shift from respiration to safe swallowing and back, is a critical one in the oropharyngeal swallow. All of the normal physiology described at the beginning of this chapter is important in facilitating the safe and efficient transport of the bolus from the mouth to the esophagus. Typically, the speech–language pathologist who is educated in the anatomy, physiology, evaluation, and treatment of oropharyngeal dysphagia is the professional most involved in assessment and treatment in the oropharyngeal stage, along with the patient’s physician, dietitian, gastroenterologist, and otolaryngologist, as needed. To date, the major treatments for oropharyngeal dysphagia are behavioral. Medication and surgical procedures have not been identified to make major differences in the oropharyngeal dysphagic patient. Surgery has been helpful in patients with Zenker’s diverticulum and in diverticuli in the esophagus. A team approach to the care of the oropharyngeal dysphagic patient is often needed to integrate the treatment issues with their medical diagnosis, dietary needs, and other aspects of successful dysphagia management.

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