Dysphagia following Head and Neck Cancer Surgery

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Abstract. Surgical resection of head and neck cancer results in predictable patterns of dysphagia and aspiration due to disruption of the anatomic structures of swallowing. Common procedures undertaken in the treatment of head and neck cancer include tracheostomy, glossectomy, mandibulectomy, surgery on the palate, total and partial laryngectomy, reconstruction of the pharynx and cervical esophagus, and surgery of the skull base. An overview is presented of normal swallowing physiology, as well as swallowing perturbations that are frequently encountered in postoperative head and neck cancer patients.

Key words: Postsurgical cancer — Glossectomy — Mandibulectomy — Laryngectomy — Laryngopharyngectomy — Palate — Skull base surgery — Deglutition — Deglutition disorders.

Normal Swallowing Physiology

Deglutition is a complex event that is conveniently divided into an oral, pharyngeal, and esophageal phase. The oral phase is further subdivided into an oral preparatory phase in which the bolus is readied for swallowing, and an oral phase proper which initiates the events of swallowing. Normal deglutition requires fine neuromuscular coordination of the organs of the upper aerodigestive tract, all occurring during a brief pause in respiration. Studies have shown that an average adult swallows 35 times per h while awake and 6 times per h while asleep, for a total of approximately 600 swallows per day [1].

In the oral preparatory phase, fine motor control of the tongue is the most vital component. The tongue continually mixes the food particles and redistributes them from the recesses and dependent portions of the mouth to the occlusal surfaces of the teeth. Intact sensation of the oral and buccal mucosa, provided by cranial nerves V, IX, and X, is important for efficient manipulation of the bolus. Facial tone in the lips and cheeks prevents billowing of these structures with food particles. The soft palate bulges somewhat anteriorly during the chewing process to prevent leakage of food into the pharynx prematurely [2]. The mandible is responsible for all of the motion involved in the chewing process, as the maxilla housing the upper teeth does not move. Rotary and lateral motion of the mandible in addition to vertical motion is an important part of effective grinding and crushing of food. The oral preparatory phase provides what we know as the pleasure of eating [2]. Strictly speaking, this phase is not completely necessary for adequate swallowing, and the phase may be bypassed by feeding a liquid diet. The oral preparatory phase concludes when the food is adequately mixed with saliva and is of an appropriate consistency for swallowing. The oral phase of swallowing then commences with the bolus being gathered on the dorsal surface of the tongue. The bolus is essentially totally encased in a dynamic compartment, with the tip of the tongue contacting the anterior portion of the hard palate, the lateral edges of the tongue curved upward, and the posterior tongue forming a seal with the soft palate and faucial pillars. The bolus is then pushed posteriorly by a rolling motion of the tongue on the palate from front to back. The oral phase of swallowing lasts approximately one sec in a normal individual and, although automatic, is largely under voluntary control via cranial nerves V (the muscles of mastication), VII (the muscles of facial expression), and XII (the tongue).

The pharyngeal phase begins the involuntary part of the swallowing mechanism. The stimulus or stimuli...
that initiate the pharyngeal phase are not clearly defined, but appear to be derived from the end of the oral phase and are carried by the ninth and tenth cranial nerves to the swallowing center in the reticular substance of the upper medulla [2,3]. The four key components of the pharyngeal phase are (1) closure of the nasopharynx to prevent nasal reflux by approximation of the soft palate to the posterior nasopharyngeal wall, (2) elevation and closure of the larynx, (3) contraction of the pharyngeal constrictors, and (4) opening of the cricopharyngeus muscle (upper esophageal sphincter). Laryngeal closure occurs not only at the level of the epiglottis, but actually begins at the level of the true vocal cords and continues upward to include the false cords, the epiglottis, and the aryepiglottic folds. This produces a multilayered barrier against aspiration in normal individuals. Elevation of the larynx occurs early in the pharyngeal phase through contraction of the suprahyoid musculature. The larynx moves anteriorly and superiorly, nestling under the tongue base and moving out of the direct path of the incoming bolus. The tongue base moves posteriorly during the pharyngeal phase, creating a positive pressure push which is the main driving force behind the bolus. A pharyngeal peristaltic wave then begins in the nasopharynx with contraction of the superior constrictor in the hypopharynx. This wave primarily acts to strip the pharyngeal walls of residue [3,4].

Laryngeal elevation is largely responsible for opening of the cricopharyngeus muscle. A slight tonic contraction is present in the cricopharyngeus at rest, which protects against reflux of gastric contents. As the larynx elevates during the swallow this tonicity is inhibited, and the muscular and fibrous attachments of the cricopharyngeus onto the posterior lamina of the cricoid cartilage are drawn upward with the larynx. This widens the cavity at the esophageal inlet and creates a negative pressure that combines with the positive tongue pressure from above to move the bolus into the esophagus. The blanket of the epiglottis over the laryngeal inlet is the end result of several forces acting in unison: contraction of the aryepiglottic muscles, elevation of the larynx, posterior movement of the base of the tongue, and pressure exerted downward from the incoming bolus. The total duration of pharyngeal activity is approximately 1 sec, with times slowing somewhat (an additional 1/10–3/10 sec) to accommodate larger bolus sizes [3,4].

The esophageal stage of swallowing is characterized by a primary peristaltic wave that travels the length of the esophagus at approximately 3–4 cm/sec, lasting 8–20 sec in normal individuals [4,5]. At any given time, only one peristaltic wave can exist in the esophagus. This is in contrast to pharyngeal peristalsis, which is much faster and is complete with each swallow. The contents of several rapid swallows may be carried essentially together in the esophagus. Secondary peristaltic waves occur spontaneously several times per h and help to clear residue of swallowed material as well as any refluxed gastric material [5]. Pressure waves generated in the esophagus are different than those in the pharynx. McConnel et al. [4], using a sensitive intraluminal solid-state strain gauge, has shown pharyngeal pressures of 200–400 mmHg at rates of up to 4,000 mmHg/sec, whereas esophageal pressures reach only 80–140 mmHg with much slower crescendos. Esophageal transit time significantly increases with age, whereas oral and pharyngeal transit times remain fairly constant [2].

Swallowing in the Postoperative Head and Neck Cancer Patient

Surgical resections for cancer of the head and neck result in predictable patterns of dysphagia and aspiration. The functional deficits encountered are related to the specific anatomic or neurologic insult produced by the resection. The following is a general overview of common deglutition disorders associated with surgical procedures undertaken in the treatment of cancer of the head and neck.

Tracheostomy

Although tracheostomy is thought of by many as a treatment for chronic aspiration, dysphagia and aspiration are well documented sequelae of tracheostomy [6,7,8]. Nash [9] summarized the causes of aspiration after tracheostomy and categorized them into mechanical and neurophysiologic factors. Mechanical factors include decreased laryngeal elevation due to suturing of the trachea to the skin, and stasis of secretions in the upper airway and cervical esophagus due to local compressive forces exerted by the inflated cuff. Two neurophysiologic changes induced by chronic cannulation are desensitization of the protective cough reflex and a loss of coordination of laryngeal closure. The notion that an inflated cuff is protective against aspiration in tracheotomized patients appears to be incorrect. Aspiration is well documented in patients with the older low volume, high pressure cuffs, occurring in 69% of patients in one study [7], and in 87% in another [8]. The newer high volume, low pressure tracheostomy tube cuffs appear to significantly decrease the risk of aspiration. Bone et al. [8] reported aspiration in only 17% of tracheotomized patients with the newer cuffs.

Glossectomy

The swallowing deficits that result from oral and oropharyngeal resections vary with the site of resection and type