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State of the art: Rehabilitation of speech and swallowing after total laryngectomy

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ABSTRACT

Despite the development and expansion of non-surgical organ preservation therapy, total laryngectomy continues to be the optimal therapy for far-advanced local disease and the only curative option for radiotherapy failures not amenable to partial laryngeal procedures. Laryngectomy, however, remains a life-altering operation with profound effects on swallowing and speech. In the nearly 150 years since the first total laryngectomy was performed, few ablative aspects have changed, but reconstructive techniques have undergone radical evolution. This review will trace the origins of laryngeal rehabilitation for voice and swallowing, the current state of the art with attention to pre-treatment considerations and post-operative management, current surgical management techniques, and the future of functional laryngeal reconstruction.

Introduction

In 2018, a projected 13,150 new cases of laryngeal cancer will be diagnosed in the United States and a further 3710 will die of this disease [1]. Although definitive non-surgical therapy has become the preferred treatment for many of these patients, total laryngectomy continues to have an important role in both the primary and salvage treatment of advanced laryngeal and hypopharyngeal cancer [2,3]. In the primary setting, patients with T4a disease undergoing laryngectomy with adjuvant therapy demonstrate significantly improved local control and survival as compared with definitive non-surgical therapies and these findings are reflected in national guidelines [4]. In the salvage setting, over 60% of patients undergoing salvage laryngectomy after prior radiotherapy achieve long-term disease control and most can develop intelligible tracheoesophageal speech and maintain an oral diet [5]. Furthermore, in patients rendered disease-free but functionally debilitated by the late effects of definitive chemoradiotherapy, laryngectomy offers an option to restore both speech and swallowing.

With the continued role of total laryngectomy in the current management of laryngeal cancer, optimizing post-laryngectomy function becomes paramount. Since the earliest laryngectomies performed in the 1870s, although *peri*-operative outcomes have improved with advances in antibiotics and antisepsis, the ablative aspects of the procedure have not substantially changed [6]. The reconstruction and rehabilitation of laryngectomy defects, however, have evolved considerably. With the advent of free tissue transfer, extensive pharyngeal defects including long circumferential segments can be reliably repaired in a single stage operation. Alaryngeal voice options have expanded, as well, including esophageal speech, use of the electrolarynx, and the tracheoesophageal prosthesis. Nonetheless, laryngectomy patients remain obligate neck breathers and although many achieve excellent alaryngeal voice, tracheoesophageal prostheses require continued maintenance and are subject to valve failure and leakage. These challenges are magnified by the tumor burden or prior treatment effects of current laryngectomy patients. Presently in the United States, most patients undergoing laryngectomy have either extensive primary disease or have undergone chemoradiotherapy with disease recurrence or have such severe treatment effects that they are functionally debilitated. This review will discuss the current state of the art in post-laryngectomy swallowing and voice restoration in this challenging population and examine the future directions and developments in laryngeal rehabilitation.

Swallowing

In normal physiology, swallowing is accomplished by alterations in pressure dynamics. Briefly, tongue base and pharyngeal contraction exert positive pressure on the bolus while simultaneous hyolaryngeal excursion anteriorly and superiorly open the pharyngoesophageal

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segment allowing the bolus to enter the cervical esophagus. In laryngectomy patients, tongue base interaction with pharyngeal wall contraction must overcome the resting pressure of the closed pharyngoesophageal segment for boluses to enter the esophagus. This change in physiology is a set up for dysphagia causing slow bolus transit or accumulation of neopharyngeal residue and is more prevalent in patients who have already received chemoradiation therapy.

Peri-operative considerations to limit post-laryngectomy dysphagia

While the majority of patients who undergo total laryngectomy can maintain an oral diet, the incidence and adverse effects of long-term post-laryngectomy dysphagia can be substantial. Over 40% of post-laryngectomy patients may experience subjective dysphagia in long-term follow up [7]. Further, these patients suffer significant perceived disability and distress as compared with laryngectomy patients who are able maintain an unrestricted diet. Several factors account for these differences and in particular, radio- or chemoradiotherapy has a significant detrimental effect on post-laryngectomy swallowing [8]. Dysphagia, however, is multifactorial and swallowing outcomes depend on both treatment- and patient-related factors, including surgical technique, pre-operative and adjuvant therapies, and comorbid conditions.

For this reason, to limit the incidence or severity of symptoms, it is essential to understand the modifiable factors related to post-laryngectomy dysphagia. In particular, considerable effort has been made to correlate reconstructive methods in laryngectomy closure with swallowing outcomes. Reconstructive techniques, however, including the type and levels of pharyngeal closure, vary widely across institutions [9]. Nonetheless, certain technical aspects of pharyngeal reconstruction have been associated with long-term swallowing function.

Consistently, patients requiring circumferential pharyngeal resection have an increased incidence of post-laryngectomy neopharyngeal stenosis and slow pharyngeal bolus transit, particularly in the distal anastomotic region, and resulting dysphagia as compared with those undergoing only partial pharyngectomy [7,10–12]. These patients often complain of obstruction of solid foods and medications and slow transit of liquids causing reduced oral intake and increased duration of mealtimes (Fig. 1). Free jejunal reconstruction in such cases, compared with tubed fasciocutaneous flaps, may decrease the incidence of post-operative stricture [13]. This is partially related to the decreased incidence of fistula in jejunal patients as stricture is a frequent subsequent complication of fistula. Enteric flaps, however, come with added donor site morbidity. Although intra-abdominal complications are uncommon, they can be significant, including wound dehiscence, intraperitoneal bleeding, bowel obstruction, and hernia [14]. Deglutition in enteric flaps, such as the jejunal free flap, can also be adversely affected by ill-timed peristalsis which can be problematic even when the flap is inset along the direction of natural peristalsis. Similarly, the secretory nature of the mucosa, initially thought to be beneficial, can be limiting by resulting in problematic pooled secretions. Patients with gastric pull-up reconstructions can be prone to frequent and voluminous regurgitation secondary to pooling of material in the patulous transferred stomach.

For patients who do not require circumferential pharyngeal resection, however, the amount of residual pharyngeal mucosa sufficient for primary closure has been a subject of controversy. Early authors advocated empiric cutoffs based on personal experience, such as closure over a 40Fr bougie or 3 cm of stretched native mucosa [15,16]. Few studies have addressed this question systematically, however. Hui, et al. [17] reported on 52 patients undergoing laryngectomy with primary closure, measuring the width of the remnant pharyngeal mucosa in both the relaxed and stretched positions. These authors found no correlation between post-laryngectomy dysphagia and pharyngeal mucosal width. In two patients, as little as 1.5 cm of mucosa in the relaxed position, or 2.5 cm stretched, was sufficient in for primary closure. Despite a luminal diameter of 0.8 cm, and a cross-sectional area of only 0.5 cm^2,

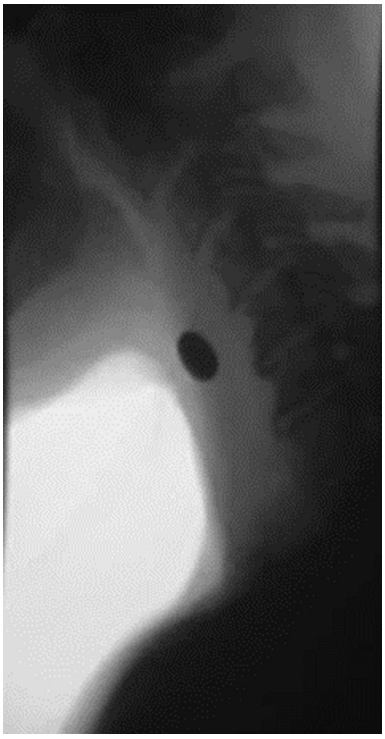

Fig. 1. Post-laryngectomy videofluoroscopy demonstrating a pill stuck in the neopharynx after prior pharyngeal reconstruction.

these patients had excellent post-operative weight gain and no post-laryngectomy dysphagia. In a follow up study, Hui et al. [18] performed objective swallowing measures on patients 8–10 years after laryngectomy to correlate neopharyngeal size with long-term dysphagia. For patients with a remnant pharyngeal mucosal width of 1.8–5.0 cm in the relaxed position, or 3.0–8.0 cm in the stretched position, prior to primary closure during laryngectomy, no significant relationship could be identified between the neopharyngeal size and long-term swallowing function.

While there is certainly a theoretical limit of pharyngeal width below which significant stenosis and dysphagia will occur, larger neopharyngeal size does not necessarily correlate with improved swallowing outcomes. This is likely a result of reduced bolus propulsion in the post-laryngectomy neopharyngeal conduit. An efficient swallow is not solely a function of pharyngeal diameter, but a concerted process of tongue base and progressive pharyngeal wall contraction, raising pharyngeal pressure and creating a propulsive force on the food bolus. Furthermore, a post-surgical pseudoepiglottis which traps residue can decrease swallow efficiency, particularly of solid consistencies [12]. Maclean, et al. [19] performed combined videoradiography and manometry on 24 laryngectomy patients, and found improved intrapharyngeal pressures and reduced post-swallow residue in those who had undergone closure of both the mucosa and the pharyngeal constrictors as compared with mucosal closure alone. While reapproximation of the pharyngeal constrictors can also lead to pharyngoesophageal spasm (PES) and limit tracheoesophageal speech, this study highlights the importance of physiological reconstruction when possible. When sufficient residual pharyngeal mucosa is available for primary closure, such physiological reconstruction should incorporate functional constrictor musculature to improve pharyngeal tonicity. To balance improving pharyngeal function with limiting PES, reconstructive options include the half-muscle closure or a full constrictor reapproximation with a unilateral pharyngeal plexus neurectomy [20,21]. Stronger lingual propulsion of boluses can sometimes overcome increased resistance within the neopharynx provided the tongue base is not involved in the resection or hypoglossal function has not