INTRODUCTION

Aspiration is a frequently misunderstood diagnosis. Many healthcare workers either under-diagnose aspiration or assign the diagnosis improperly. More importantly, many physicians fail to recognize aspiration and dysphagia as a symptom of other disease processes. Needless to say, the confusion surrounding the diagnosis often leads to delayed intervention and treatment. Otolaryngologists are an integral part of the team caring for the aspirating patient. In the case of patients aspirating after surgery for the extirpation of head and neck malignancy, the otolaryngologist plays the lead role in the diagnosis and treatment of the problem. When neuromuscular disease is the causative factor however, the otolaryngologist acts as a consultant to the primary care physician or medical specialist. Speech pathologists play a key role in the rehabilitation and care of the aspirating patient and are well equipped to aid in their evaluation and treatment. This discussion will review the physiology of a normal swallow, the more common etiologies of aspiration, the evaluation of the patient and methods of intervention.

PHYSIOLOGY OF SWALLOWING

Oral Preparatory Phase

The first stage of the normal swallow is the oral preparatory phase. Food is taken into the oral cavity, chewed and mixed with saliva. This involves the coordination of lip closure, rotary and lateral motion of the jaw, buccal or facial tone, rotary and lateral motion of the tongue and anterior bulging of the soft palate to widen the nasal airway while narrowing the oropharyngeal inlet. These actions break down the food into a size and consistency appropriate for the swallow while preventing premature escape of food into the pharynx. The oral preparatory phase is under complete voluntary control and it is from this phase that the pleasure of eating is derived. Cranial nerves involved include cranial nerves V, VII, X and XII. Injury to any of these nerves may lead to decreased efficiency of the oral preparatory phase.
**Oral Phase**

Once the food is prepared for the swallow, the tongue centers and positions the bolus against the hard palate. Afferent receptors in the anterior tonsillar pillars, soft palate and oropharynx are stimulated by this action and initiate the reflexive pharyngeal phase. The action of the tongue serves not only to clear the bolus from the oral cavity, but also likely plays some role in initiating the pharyngeal swallow. At the completion of the oral phase, there is little or no food or liquid remaining in the oral cavity. The motor function of the tongue is derived from cranial nerve XII and injury to this nerve may adversely effect the tongue’s role in the oral phase.

**Pharyngeal Phase**

The exact stimuli necessary to elicit the pharyngeal phase of swallowing are still poorly understood, but the neuromuscular components of the pharyngeal swallow have been clearly identified. They involve: (1) velopharyngeal closure to prevent food from refluxing into the nose; (2) laryngeal closure to prevent material from penetrating the glottis and entering the airway; (3) peristalsis of the pharyngeal walls to clean the pharynx with a wave of contraction that follows the bolus; (4) laryngeal elevation and anterior movement to carry the larynx up under the tongue and out of the path of the bolus as well as to apply extrinsic stretch to the cricopharyngeus; (5) opening of the cricopharyngeal region. Cranial nerves IX, X and XII involved in the pharyngeal phase either through sensation or motor function.

The cricopharyngeus muscle, the lower fibers of the inferior constrictor muscle, the upper fibers of the esophageal constrictor and the cricoid cartilage to which these muscles attach make up the upper esophageal sphincter (UES) or pharyngoesophageal (PE) segment. The opening of this region and laryngeal elevation during the pharyngeal swallow are closely related. At rest, the cricoid cartilage contacts the posterior pharyngeal wall in the region of the cricopharyngeus muscle maintaining closure of UES. As the larynx elevates and moves anteriorly during the swallow, the cricoid cartilage is pulled anteriorly away from the posterior pharyngeal wall while stretch is being applied to the muscle fibers of the cricopharyngeus. Relaxation of the cricopharyngeus muscle just prior to opening of the cricopharyngeal region allows for greater stretch of these fibers and a larger increase in the cross-sectional area of the UES.

Laryngeal closure during the pharyngeal phase involves a complex sequence of events beginning at the level of the true vocal folds and proceeding superiorly to the false vocal folds, aryepiglottic folds and epiglottis. The most important and critical component of laryngeal closure is at the glottic level. As the vocal folds close, the arytenoid cartilages tilt up and forward while the base of tongue moves posteriorly effecting closure of the laryngeal vestibule. As this is occurring, the epiglottis moves posteriorly over the airway but fails to completely seal the airway. Epiglottic movement is due to combination of three forces: (1) pressure from the bolus above, (2) the downward pull of muscular forces and (3) the combined pressure of the tongue base moving posteriorly and the larynx elevating. Epiglottic closure prevents entry of food into the laryngeal vestibule and vocal fold closure prevents entry of food into the trachea. The term aspiration refers to the entrance of food into the trachea below the level of the true vocal folds.

Pharyngeal peristalsis begins in the nasopharynx and proceeds inferiorly to the hypopharynx. Due to the incomplete tubular shape of the pharynx, movements of the tongue and larynx contribute to the generation of pressures within the pharynx during the swallow. Retraction of the tongue and lowering
of the larynx at the end of the swallow lead to increased pressure in the hypopharynx. This in concert with the peristaltic muscular wave propels the bolus through the UES.

**Esophageal Phase**

The esophageal phase of the swallow is under involuntary neural control via cranial nerve X. The food bolus is propelled along the esophagus by active peristalsis in two waves, primary and secondary peristalsis. The bolus then traverses the lower esophageal sphincter (LES) which is usually closed to prevent reflux.

**ETIOLOGY OF ASPIRATION**

Aspiration is the entry of liquid or particulate matter into the tracheobronchial tree. This may occur in normal individuals and is usually followed by a violent cough. When it occurs continuously or in large quantities it may produce chemical pneumonitis, bacterial pneumonia or mechanical obstruction of the airway. Aspiration is a relatively common occurrence. Recurrent or chronic aspiration has been noted in 10% to 20% of patients with gastroesophageal reflux or achalasia. It has been shown that 69% of tracheotomized patients aspirated dye placed on their tongues. Contrast material has been demonstrated in the tracheobronchial tree on chest x-ray of normal patients who had contrast material placed in their mouths the night before while sleeping. Silent aspiration has also been demonstrated in 7% of a large series of patients undergoing routine general anesthesia. These observations demonstrate that aspiration is a relatively common phenomenon but severe secondary complications of aspiration seldom occur in otherwise healthy people.

Many conditions may predispose to aspiration and its complications. These include reduced levels of consciousness with compromise of glottic closure and cough reflexes, dysphagia from various neurologic, esophageal and neuromuscular disorders, and anatomic derangements of normal respiratory and swallowing reflexes as may be seen following trauma or surgery involving the skull base, central nervous system (CNS) or head and neck.

Aspiration may be due to a structural abnormality of the upper aerodigestive tract. Tumors arising in the tongue, hypopharynx, supraglottis or glottis may cause significant aspiration. This can occur by direct infiltration, mass effect or pain. The dysphagia and weight loss common in head and neck cancer patients may be a result of aspiration.

The most common patient with aspiration seen by the otolaryngologist is the post-surgical patient. Partial pharyngectomy, glossectomy and supraglottic laryngectomy are all associated with aspiration during the rehabilitative period. Surgical procedures involving the tonsillar pillars or palate may disrupt the transition from the oral to pharyngeal phases of swallowing potentiating aspiration. Surgery involving the mobile tongue may lead to inadequate preparation of the food bolus and limitation in moving it toward the pharynx. In general, procedures more anterior on the tongue are less difficult to overcome than those on the posterior aspect of the tongue. Similarly, surgery for larger lesions is more likely to cause aspiration than procedures for smaller lesions, and procedures affecting multiple regions of the upper aerodigestive tract may lead to complex dysfunction with significant and serious aspiration. For these reasons, head and neck surgeons must be accustomed to dealing with these difficulties. Patients and family members must be counseled appropriately pre-operatively, and consultation with speech pathology obtained early to assist in teaching and rehabilitation.
The presence of a nasogastric tube (NGT) is associated with an increased risk of laryngeal dysfunction and glottic incompetence. Edema of the post-cricoid region and larynx are often present with an NGT resulting in a suppression of the cough reflex, pooling of secretions in the hypopharynx and dysfunction of the upper and lower esophageal sphincters. Approximately 40% of patients who are endotracheally intubated will aspirate oropharyngeal secretions as determined by the aspiration of dye placed in the oral cavity prior to suctioning. This incidence is lower with low-pressure, high-volume cuffs now in use. This demonstrates that an inflated cuff does not prevent aspiration.

It has long been known that tracheostomy predisposes to aspiration. As stated previously, over 65% of tracheotomized patients can be found to aspirate with blue dye test. The presence of a tracheostomy likely influences many aspects of the normal swallow. There is a loss of normal phasic glottic function with respiration and glottic closure during swallowing is impaired. Laryngeal elevation is decreased, the cough is often ineffective and glottic reflexes are reduced. These effects can be reversed with closure of the tracheostomy, but full recovery may take some time in the chronically tracheotomized patient. Plugging of the tube or use of a speaking valve has been shown to greatly reduce the aspiration in these patients by increasing subglottic pressure and should be considered in tracheotomized, aspirating patients in whom there is some residual glottic function.

Perhaps the greatest proportion of aspirating patients do so as a result of neurologic injury, often from multiple cerebrovascular accidents. A wide variety of neurologic defects predispose to or cause aspiration, however. Lesions limited to one cranial nerve are the most easily treated, while multiple cranial nerve deficits, brainstem insults or neuropathy resulting from chronic cachexia, inanition and concurrent disease may be life-threatening and very challenging to treat.

Injury to the recurrent laryngeal nerve is a relatively common deficit occurring as complication of surgery or intubation or due to tumor infiltration of the nerve by a malignant lesion. Voice complaints are the primary symptom, but the paramedian position of the paralyzed true vocal cord as a result of injury to the recurrent laryngeal nerve may lead to incomplete glottic closure and occasional aspiration of liquids or small particulate matter. Most patients are able to accommodate a unilateral deficit with the contralateral, mobile cord, but patients with debilitating co-morbidity or loss of sensation may have significant aspiration as a result of unilateral injury.

Injury to the superior laryngeal nerve results in paralysis of the cricopharyngeus muscle and anesthesia of the ipsilateral supraglottic larynx. Voice changes in superior laryngeal nerve injury are subtle, but aspiration as a result of the loss of sensation may be a significant problem. Liquid and solid material may be allowed to pass through the glottis undetected due to the anesthesia. Vagal injuries above the nodose ganglion result in dysfunction of both the superior and recurrent laryngeal nerves. The combination of supraglottic anesthesia and median position of the paralyzed true vocal cord is highly vulnerable to aspiration. In addition, injury of the vagal contributions to the pharyngeal plexus may cause incoordination of the pharyngeal musculature and possibly incomplete relaxation of the cricopharyngeus muscle during the swallow.

Multiple cranial nerve injuries, particularly to cranial nerves IX, X and XII, result in major dysfunction of the upper aerodigestive tract with resultant aspiration. Such injuries may occur due to trauma, surgery, tumor, or as a result of a number of neurologic syndromes resulting in bulbar paralysis.
DIAGNOSIS AND EVALUATION

Clinically significant aspiration is not always easily recognizable. The signs and symptoms of aspiration may be attributed to the primary disease process and go unnoticed even when the patient develops life-threatening complications. Many debilitated patients have “silent” aspiration. Common complaints in the aspirating patient include recurrent pneumonia, bronchorrhea post tracheotomy, coughing and choking with eating, dysphagia and weight loss.

The classic clinical picture of gastric acid aspiration was best described by Mendelson and has been termed Mendelson’s syndrome. The initial presentation of gastric acid pneumonitis is that of tachypnea, cough, rales, cyanosis, wheezing and fever. Chest radiographs demonstrate opacities in the dependent portions of the lungs. The aspiration of non-acidic particulate matter frequently presents with derangements suggestive of acute mechanical obstruction. Aspiration of oropharyngeal secretions usually leads to pneumonia due to the high concentrations of bacteria in saliva.

Evaluation of the patient suspected of aspirating begins with a thorough history and physical. Special attention should be directed to the oropharynx, hypopharynx and larynx. This may be limited due to pooled secretions, but this finding alone provides strong evidence of aspiration. A complete cranial nerve examination may reveal deficits in nerves V, VII, IX, X and XII.

Patients with tracheotomies in place may be found to aspirate when the bedside administration of a colored liquid such as grape juice elicits coughing and the production of the same colored liquid via the tracheostomy tube. This “grape juice test” is a less sophisticated version of the Evans blue dye test in which 4 drops of methylene blue are placed on the patient’s tongue and the tracheal secretions examined for blue color.

Radiography may play a significant role in the diagnosis of aspiration. It is prudent to perform a chest radiograph in any patient suspected of aspiration to assure that pneumonia is not present. Computed tomography and magnetic resonance imaging may be useful if aspiration is due to a tumor of the upper aerodigestive tract. Videofluoroscopy is the most common and most useful radiographic study in the evaluation of aspiration. It allows real time evaluation of the entire oropharynx and esophagus. It not only allows the confirmation of aspiration, but also may delineate the mechanism of aspiration. The extent of aspiration can be quantified, as well as the patient’s ability to clear the tracheobronchial tree of the aspirated material.

The modified barium swallow (MBS) is the gold standard test for diagnosing and treating aspiration. A speech pathologist and radiologist perform the examination jointly. A small bolus size is used, and the patient is examined with varying consistencies of contrast material (thin, thick, solid) to determine what food types are most troublesome for the patient. All phases of swallowing can be closely scrutinized to identify specific areas of dysfunction. At the same setting, the patient is given therapeutic maneuvers and their efficacy is demonstrated by this same test.

Some centers have utilized radionucleotide scanning in the evaluation of aspiration. A radioactive substance such as Technetium 99 is placed on the patient’s tongue and a lung scan is performed. Aspiration can be confirmed by this method and can be quantified by measuring radioactivity.
In recent years, multiple authors have popularized a fiberoptic examination with assessment of swallowing. It has been termed fiberoptic endoscopic evaluation of swallowing (FEES) or videoendoscopic evaluation of dysphagia (VEED). Other authors have added sensory testing of the larynx and termed this fiberoptic endoscopic evaluation of swallowing with sensory testing (FEESST). All examinations are performed similarly in an awake, cooperative patient at the bedside or in the clinic setting. Standard fiberoptic examination of the upper aerodigestive tract is performed. The patient then ingests dyed substances of varying consistencies. The presence of aspiration is noted, as is residual material in the valleculae and hypopharynx. This may be recorded for slow motion play back and review. FEESST adds sensory testing with pulsed air stimuli via the fiberoptic scope. These tests have proved to be useful not only as adjuncts to the MBS, but also in situations in which MBS is not available or impractical.

The modified barium swallow has the benefit of evaluating all phases of the swallow, and is excellent at assessing the overall swallow. It does have several deficiencies however. The MBS does not always provide detailed diagnostic information about subtle abnormalities of the palate, vocal folds, pharyngeal musculature and sensation. It also requires a radiology suite with radiologist, technician and speech pathologist in attendance of the procedure. These resources are sometimes unavailable. In addition, critically ill patients often are unable to be transported to the radiography suite for the procedure. These strengths and weaknesses are complementary to the endoscopic evaluation of swallowing. The FEES and FEESST is a complete examination of the upper aerodigestive tract that is quite sensitive in detecting structural abnormalities of the palate, pharyngeal walls and vocal folds. This test, however, only analyzes the pharyngeal phase of swallowing. The required equipment includes a fiberoptic scope and light source. A video camera, monitor and video tape recorder improve the examination by allowing multiple observers and slow motion replay for review, but are not absolutely necessary. For seriously ill patients who are unable to leave the intensive care unit (ICU), the procedure may be performed at the bedside if the equipment is mounted on a mobile cart. While both tests have their place in the evaluation of aspiration, they are perhaps best used in conjunction with one another.

MANAGEMENT

**Non-surgical**

The initial management of the aspirating patient is non-surgical. Patients should immediately made NPO (nothing by mouth). Enteral nutrition via a nasogastric feeding tube or gastrostomy should be established. Patients with respiratory failure may require intubation and ventilatory support. In debilitated patients requiring prolonged intubation, tracheostomy should be considered early to avoid the sequelae of prolonged laryngeal intubation. As previously noted, the inflated tracheostomy tube cuff does not prevent aspiration but it does allow for easier pulmonary toilet. As the tracheotomized, aspirating patient’s condition improves, the residual glottic function can be assessed. When glottic function is intact, the patient may benefit from the use of a speech valve. The Passy-Muir speech valve is the most commonly used. The exact mechanisms of improvement are unclear, but subglottic pressure is restored, and the return of airflow through the glottis allows the return of glottic reflex mechanisms.

If the speaking valve is tolerated, plugging of the tube and the consideration of decannulation should be considered. Restoration of normal airway function and removal of the tethering effect of the tracheostomy tube may allow the return of normal swallow function. When decannulation is not possible, the speaking valve should be used to aid in maintaining more normal glottic function.
Some patients may be managed with dietary and behavioral modification techniques. Thickener added to liquids may slow the bolus adequately to prevent aspiration when swallow initiation is delayed. Techniques involving postural changes based upon findings on MBS have been shown to decrease aspiration in 81% of head and neck surgical patients. If residue in the supraglottis and hypopharynx leads to aspiration, the supraglottic swallow technique may be effective in clearing this residue. This is performed by having the patient take a deep breath prior to swallowing. The patient then coughs and swallows a second time prior to the next inspiration. Instructing the patient to turn their head toward the side of a unilateral pharyngeal weakness can compress the pyriform sinus and prevent the accumulation of residue, as can flexing the neck (the “chin tuck”) which compresses the valleculae. Some patients with a weak swallow reflex may benefit from a liquid rinse or multiple swallows.

These swallow techniques are most effective when learned with the guidance of an experienced speech pathologist after careful evaluation with MBS. Even with expert teaching, the proficient use of many of these techniques requires a very motivated patient and failure rates are considerable. When non-surgical methods of managing aspiration are unsuccessful, the surgeon has a number of options for improving swallow function. Often times conservative management, such as swallow techniques combined with an adjunctive surgical procedure will provide adequate prevention of aspiration.

**Surgical**

The surgical management of aspiration should be effective, yet as non-invasive as possible. These patients often have multiple medical problems and are poor surgical candidates who would not tolerate extensive procedures. No single procedure is absolutely indicated in all patients, therefore many varied approaches have been developed. All surgeries have a certain degree of risk and potential complications. Procedures can be broadly divided into two groups, adjunctive and definitive procedures.

**Adjunctive**

Tracheostomy may be quite valuable in the early care of the aspirating patient. Tracheostomy will not prevent aspiration and may in fact exacerbate the condition, but it does facilitate the nursing care of patients who are actively aspirating, particularly those requiring aggressive pulmonary toilet. In patients with acute conditions in whom recovery is expected, tracheostomy with a cuffed tube may serve as an easy route for mechanical ventilation and allow for frequent suctioning. Upon recovery however, plugging and decannulation would be indicated to reduce aspiration risk.

Some patients with severe complications of aspiration and poor neurologic function and prognosis may never regain the ability for oral intake. In such patients, a permanent feeding should be established with a cervical esophagostomy, gastrostomy or jejunostomy tube. The ligation of the parotid and submandibular ducts can effectively reduce salivary flow and decrease the aspiration of oral secretions in the vegetative patient.

Cricopharyngeal myotomy (CPM) may be performed either as a primary procedure or in conjunction with other procedures. The premise on which the procedure is based is that the aspiration may be worsened by delay or failure of relaxation of the cricopharyngeus muscle during the pharyngeal phase of the swallow. The procedure is performed via a lateral cervical or low collar incision. With both RLN
intact, it is best performed on the left, as the longer course of the left RLN places it at greater risk to injury from an unrelated process. If one nerve is non-functional, the myotomy should be performed on the side of the lesion. A bougie placed into the esophagus aids in palpation of the muscle. The muscle fibers of the inferior constrictor, cricopharyngeus and upper fibers of the esophageal sphincter are divided down to the mucosa near the posterior midline for a vertical distance of 4 to 6 cm. Care must be taken to avoid breaching the mucosa and inadvertent injury must be recognized and repaired.

Laryngeal suspension is usually performed at the time of the primary surgical procedure for extirpative head and neck surgery involving the supraglottic larynx and tongue (total glossectomy). The disruption of the normal anatomic relationships between the tongue, pharynx and larynx in such procedures may greatly reduce laryngeal elevation during swallowing. This may leave the glottis exposed and vulnerable to aspiration during the pharyngeal phase. When associated with limited epiglottic rotation and laryngeal closure, as is the case in patients after supraglottic laryngectomy, the patient is almost assured to aspirate. Laryngeal suspension returns the larynx to a more superior and protected position. It is usually performed by passing a non-absorbable suture from the hyoid bone or thyroid lamina to the mandible.

Krespi and Sisson described a technique of partial resection the cricoid to reduce aspiration in patients undergoing extensive resections of the tongue base and pharynx. The technique consists of a submucosal dissection of the posterior lamina of the cricoid cartilage with its removal. The cricoarytenoid joints and posterior cricoarytenoid muscle and its innervation are preserved. It is performed with a CPM. The result is a decreased anteroposterior laryngeal dimension and enlarged hypopharyngeal inlet. Phonation is preserved, but a permanent tracheostomy is required.

Patients with unilateral vocal fold paralysis, especially those with loss of supraglottic sensation as occurs in high vagal lesions, are at risk for aspiration. In such circumstances, a number of procedures to medialize the paralyzed vocal fold are available. The most common of these is the injection of the vocal fold with material in order to displace it toward the midline. Many substances have been used for this purpose including Gelfoam, Teflon and autogenous fat. The procedure can be performed under local or general anesthesia, either with direct laryngoscopy or trans-cutaneously. Local anesthesia has the benefit of allowing voice assessment during the procedure and does not require that the injection be performed with the distorting effects of an endotracheal tube. The material is injected lateral to the thyroarytenoid muscle between the vocal process and thyroid cartilage in the middle and posterior two thirds of the vocal fold. Over-injection or subglottic injection should be avoided for the risk of airway compromise. Gelfoam is resorbed over 6 to 10 weeks and is a good option if the status of the nerve is unknown or recovery is expected. Teflon is permanent, but has been found to form exuberant granulation tissue in some patients with airway impingement. Its use should therefore be reserved for use in the palliation of patients with terminal disease. Medialization can also be accomplished either by rotation of the arytenoid (arytenoid adduction), placement of a prosthesis within the laryngeal framework (thyroplasty), or a combination of the two procedures.

Thyroplasty is most commonly performed under local anesthesia although some surgeons now use general anesthesia with laryngeal mask airway. Fiberoptic examination of the airway during the procedure is used to assess the degree of medialization. A lateral neck incision overlying the inferior portion of the thyroid cartilage is used to gain access to the thyroid lamina on the affected side. The perichondrium of the thyroid cartilage is incised and a window created in the cartilage at the level of the
true vocal fold. A customized Silastic, Gore-Tex or hydroxyapatite implant is then placed in the paraglottic space to medialize the true vocal fold.

Occasionally, the posterior glottic chink is too large (> 4mm) to allow medialization with thyroplasty or TVC injection alone. In such cases, the patient may benefit from the addition of an arytenoid adduction (AA) procedure. Typically the procedure is performed with the patient under local anesthesia with sedation. The extent of the dissection is greater than with thyroplasty alone, therefore it should be considered permanent and not performed when the status of the nerve is uncertain. An incision similar but slightly more posterior than that used in thyroplasty is employed. Dissection is carried medially until the inferior portion of the inferior constrictor muscle at its attachment to the thyroid ala is identified. These fibers are divided, the cricothyroid joint is separated and the thyroid ala is retracted anteriorly allowing elevation of the mucosa of the pyriform sinus. This exposes the cricoid which is traced superiorly until the muscular process of the arytenoid is palpated. A hollow needle is placed through the thyroid cartilage anteriorly, inferior and lateral to the anterior commissure. A non-absorbable suture is then passed through the muscular process of the arytenoid and the adjacent muscular attachments. The suture is then passed through the hollow needle. Traction on this suture results in rotation of the vocal process in a medial and superior direction. One of the main benefits of the AA procedure is that it often brings the level of the TVC back to a more normal relationship with this superior rotation. Endoscopic visualization as the suture is tightened allows accurate approximation of the paralyzed vocal process in the midline.

Definitive

The patient who has intractable, life-threatening aspiration that does not respond to conservative treatment may be a candidate for one of several procedures designed to completely halt the soilage of the tracheobronchial tree. This situation most often occurs in patients with severe neurologic impairment from multiple cerebrovascular accidents or brainstem infarctions. Occasionally patients with multiple deficits affecting multiple aspects of the swallow will qualify for such a procedure. All of these definitive procedures require a tracheostoma.

Multiple authors have designed stents to occlude the larynx. The idea is analogous to a cork in a bottle. The approach has several advantages. The procedure is completely reversible, insertion and removal is relatively simple and it does not preclude later performing a more permanent procedure. Perhaps the most widely used stent is that designed by Eliachar. It is a silicone tube designed to adhere to the configuration of the larynx and upper trachea. Multiple sizes are available. A domelike projection from the superior portion of the tube can be incised to form a one-way valve, allowing air to escape from the airway while still preventing aspiration. Airflow through the valve allows for some functional phonation in alert patients. Leakage around the stent can occur, but may be rectified with the placement of a larger size. The stent may remain in place for as long as 9 to 12 months. Stent placement is a reasonable first choice to halt aspiration in a seriously ill patient, especially if their condition is potentially reversible.

Laryngeal closure procedures may be divided into subglottic, glottic and supraglottic. All require a permanent tracheostomy and have the potential for recurrence of aspiration. Glottic closure is performed via a midline thyrotomy. The mucosa of the free edge of the true and false vocal cords is stripped and they are sutured to one another. A variation of this procedure utilizes a superiorly based sternohyoid flap anchored to the midline posterior commissure to bolster the posterior aspect of the
closure. Normal speech is sacrificed with glottic closure. The closure is potentially reversible, although successes have not been reported. Closure at the glottic level has been unreliable in patients with mobile true vocal cords, likely due to persistent laryngopharyngeal movement placing excessive tension on the closure.

Laryngeal closure at the level of the supraglottis has been reported as well. The mucosal edges of the epiglottis, arytenoids and aryepiglottic folds are stripped, and then sutured together through an infrahyoid pharyngotomy. In the first description of this procedure, a small posterior dehiscence occurred which acted as a one-way valve, allowing air escape and phonation yet still controlling aspiration. This original patient underwent successful reversal of the procedure as well. Other forms of “epiglottopexy” have been described as an adjunctive procedure to minimize aspiration risk in patients undergoing total glossectomy. Biller described the elevation of epiglottic and supraglottic submucosal flaps that are then closed in two layers leaving a superior opening for phonation. The procedure has been successful in 60% to 70% of patients with several reported cases of reversal. It should be noted that glottic and supraglottic closures have a relatively high failure rate and recurrence of aspiration is not uncommon.

Closures of the airway in the subglottic region include cricoidectomy, laryngeal diversion and laryngotracheal separation. Eisele in 1990 described a subperichondrial cricoidectomy with closure of the subglottic mucosa. This provides separation of the upper respiratory and digestive tracts. A midline split of the cricoid cartilage is performed and the perichondrium elevated. The subglottic mucosa is transected and closed. The closure may be reinforced with the rotation of a muscle flap. This procedure requires a permanent tracheostomy, phonation is lost and it is not reversible.

The techniques of laryngeal diversion and laryngotracheal separation involve the division of the trachea just below the larynx with either closure of the proximal stump or diversion to the skin or esophagus. The classic Lindeman procedure, named for the author of its initial description, divides the trachea in its upper rings with the proximal stump diverted to the anterior esophagus. This procedure has largely been abandoned as the anastamosis to the anterior esophagus is technically challenging. Tucker later described the “double-barrel” tracheostomy technique in which the proximal trachea is sutured to the skin of the neck as a controlled fistula.

A variation of the Lindeman procedure that is widely used today is the laryngotracheal separation (LTS). The proximal tracheal stump is closed on itself and may be reinforced with flaps created from the strap muscles. Secretions pool in the blind pouch and empty when the patient assumes a supine position. The closure prevents a high-tension anastamosis to the esophagus that may result if the patient has a short proximal stump after prior high tracheostomy. The fistula rate for LTS is reported as greater than 33% and is even higher in patients with prior tracheostomy. The prevention of aspiration is near 100% with any of the procedures and successful reversals have been reported for each of the techniques.

Total laryngectomy (TL) clearly separates the respiratory and digestive tracts, and has for many years been regarded as the procedure of choice for the definitive treatment of the patient with life-threatening aspiration. Some authors feel that it remains the procedure of choice in patients with extremely poor prognoses, other associated medical conditions or evidence of poor wound healing, as less radical procedures have more frequent complications. A narrow field laryngectomy may be performed in which the larynx from the hyoid to the lower border of the cricoid is resected, sparing the hyoid bone, mucosa of the arytenoids and postcricoid region, and strap muscles. The mucosal closure is reinforced using the
strap muscles. While TL remains the most reliable and definitive way to achieve complete cessation of aspiration, it has no potential for reversal and has significant negative stigmata for the patient and family.

CONCLUSION

Chronic aspiration can occur in patients with a wide variety of pathologic processes. The determination of etiology is paramount, as it will guide treatment and determines overall prognosis. Options for intervention include conservative, minimally invasive techniques, to complete separation of the respiratory and digestive tracts. The otolaryngologist is often called upon to evaluate these patients and should be thoroughly aware of methods of evaluation and treatment. Early intervention and treatment may prevent life-threatening complications and speed recovery from the primary disease process.

REFERENCES


