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RESEARCH ARTICLE

Surgical Interventions as a Treatment Option for Severe Dysphagia with Intractable Aspiration: Concept, Indications, and Efficacy

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ABSTRACT

The incidence of dysphagia is increasing, particularly among the elderly according to varied of causes. Patients with severe dysphagia are unable to take food orally and are at risk for life-threatening aspiration pneumonia. Treatments for swallowing disorders focus on restoring oral food intake and preventing recurrent aspiration pneumonia. Therefore, swallowing rehabilitation and food texture modifications are essential. However, in cases with severe or progressive dysphagia, these conservative treatments may not restore oral feeding and prevent intractable aspiration pneumonia. In these cases, surgical interventions has recently been attracted as an alternative treatment option. In this article, we present its concept, indications, and efficacy.

Surgeries to restore swallowing function address impaired pharyngolaryngeal motor function during the pharyngeal swallowing stage while preserving laryngeal functions. These procedures include laryngeal elevation, cricopharyngeal myotomy, and vocal cord medialization. Meanwhile, aspiration prevention surgeries reduce the risk of aspiration pneumonia by separating the lower respiratory tract from the pharynx and larynx. These procedures include total laryngectomy, laryngotracheal separation, and glottal closure; although they do not spare laryngeal functions, they prevent aspiration pneumonia completely, improve quality of life, and reduce the burden on caregivers. Clinicians should be aware of surgical interventions as a possible treatment option for intractable dysphagia. Establishment and popularization of the surgical indications are the future issues.

1. Introduction

With the aging of society, swallowing disorders caused by stroke, neuromuscular disorders, head and neck cancer treatment, and sarcopenia have become critical medical and social issues worldwide.[1–3] Patients with severe dysphagia, particularly the elderly, are unable to take food orally and are at risk of life-threatening aspiration pneumonia. In Japan, pneumonia is the third most common cause of death.[4] The majority of elderly pneumonia patients also have swallowing disorders. Treatment goals in cases of swallowing disorder include recovery of oral intake and prevention of aspiration pneumonia. The treatments for dysphagia include food texture modification, oral hygiene measures, pharmacological therapy, and swallowing rehabilitation.[3,5] However, patients with severe or progressive dysphagia may not improve sufficiently by these conservative treatments. In such cases, surgical intervention can be an option for restoration of oral feeding and prevention of recurrent aspiration pneumonia. [6,7] Recent articles has reported its successful outcome and increasing number of medical institutions has introduced it. However, its concept, surgical indication, and efficacy are not familiar for the majority of clinicians who treat dysphagic patients. The aim of this article is to outline the surgical treatments for swallowing disorders including their roles and to lead that as many patients with dysphagia as possible will be able to restore oral food intake and be free from the risk of recurrent aspiration pneumonia.

2. Physiology of swallowing

Swallowing involves oral-preparatory, oral, pharyngeal, and esophageal stages.[8] During the oral-preparatory and oral stages, voluntary muscles allow food to be taken into the mouth, and then masticate it, mix it with saliva, reduce its volume for deglutition, and transport it to the pharynx. The pharyngeal stage involves complex reflex movements of the swallowing organs, including nasopharyngeal closure, tongue elevation, glottal closure, laryngeal elevation, pharyngeal contraction, and opening of the upper esophageal sphincter (UES) (Fig.1).[9] During the esophageal stage, peristaltic movements drive the food into the stomach. The pharyngeal stage is the most complex and delicate of these stages. Impairment of the pharyngeal stage may cause recurrent aspiration followed by intractable pneumonia.

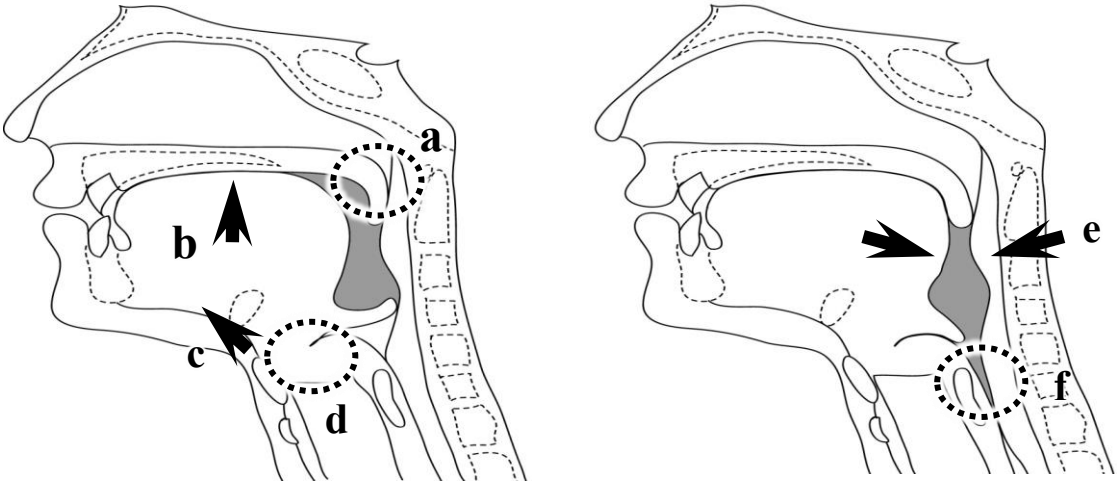

Fig.1: Physiology of pharyngeal swallowing stage
a: nasopharyngeal closure, b: tongue elevation, c: laryngeal elevation, d: glottal closure, e: pharyngeal contraction, f: opening of the upper esophageal sphincter

3. Procedures of surgical treatment for dysphagia

Surgical treatments of dysphagia can be classified into procedures that restore swallowing and those that prevent aspiration while swallowing. The former procedures restore oral feeding while preserving laryngeal functions, including phonation and respiration.[6] Meanwhile, aspiration-preventing surgeries aim to prevent the occurrence of aspiration pneumonia, even at the expense of vocal function.[10–12] These are indicated for patients with severe or progressive dysphagia with intractable recurrent lower airway infections. In both cases, several surgical procedures are reported.

3.1 Surgery to improve swallowing

3.1.1 Indications

Surgical intervention to improve swallowing is indicated in patients with impaired pharyngeal

swallowing. Patients with disturbances in oral or esophageal stages are not candidates for surgery. Additional criteria include preserved swallowing reflex initiation, insufficient response to structured swallowing rehabilitation, stable underlying disease, motivated patient, and sufficient consciousness, cognitive function, and ability to perform activities of daily living (important for postoperative rehabilitation). Patient age is another important factor; in a previous retrospective study, we found that patients aged ≥ 75 years had poorer outcomes compared to those aged < 75 years.[13]

3.1.2 Surgical procedures

Surgical interventions to restore oral swallowing aim to compensate for impaired pharyngolaryngeal functions and enhance the unimpaired pharyngeal swallowing functions.[6,13] These procedures include pharyngeal valvuloplasty, laryngeal elevation surgery, infrahyoid myotomy, vocal cord medialization (medialization thyroplasty, arytenoid adduction, or injection augmentation, and cricopharyngeal (CP) myotomy. Procedure selection is based on the types of disturbances of pharyngolaryngeal functions. Table 1 shows the indications for each procedure. Laryngeal elevation surgery, CP myotomy, and vocal cord medialization are the most common procedures, and significantly improve oral food intake. Patients may require multiple procedures.

Table 1: Surgical procedures to improve swallowing function

Surgical procedure	Indication
Pharyngeal valvuloplasty	Insufficient nasopharyngeal closure
Laryngeal elevation Infrahyoid myotomy	Insufficient or delayed laryngeal elevation
Medialization thyroplasty Arytenoid adduction Injection augmentation of vocal cords	Unilateral vocal cord paralysis Vocal cord atrophy
Pharyngeal constriction	Pharyngeal paralysis
Cricopharyngeal myotomy	Insufficient upper esophageal sphincter opening

3.1.3 Laryngeal elevation surgery

Antero-superior movement of the larynx is essential during pharyngeal swallowing for laryngeal closure and passive opening of the esophagus. Laryngeal elevation surgery is indicated in cases with insufficient or delayed laryngeal elevation. The usefulness of laryngeal elevation has been reported previously, particularly for patients who have undergone extensive head and neck cancer resections.[14–16] Preoperative videofluorographic examination is required for assessment. Although there are several surgical techniques, we usually suspend and fix the thyroid cartilage to the anterior mandible to ensure sufficient laryngeal elevation (thyro-mandibular proximation) (Fig 2). Teflon tape is used to fix the thyroid cartilage, because it is durable enough to maintain long-term laryngeal suspension. Tracheostomy is needed for postoperative airway management because of the temporary laryngopharyngeal mucosal edema, which usually diminishes within a few weeks such that the tracheostoma can be closed). Figure 3 shows pre- and post-operative cervical radiographic images. Postoperatively, the larynx shifts anterosuperiorly and the upper esophageal entrance is widened during the non-swallowing phase. As a result, the risk of aspiration decreases and the food bolus easily passes through the esophageal entrance.

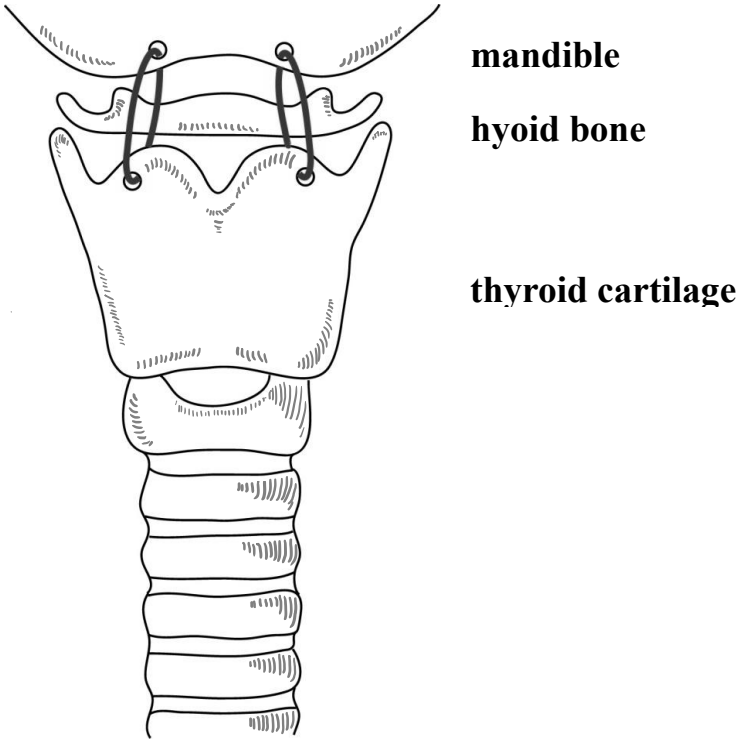

Fig. 2: Schema for laryngeal elevation.
The thyroid cartilage is suspended toward the mandible and fixed.

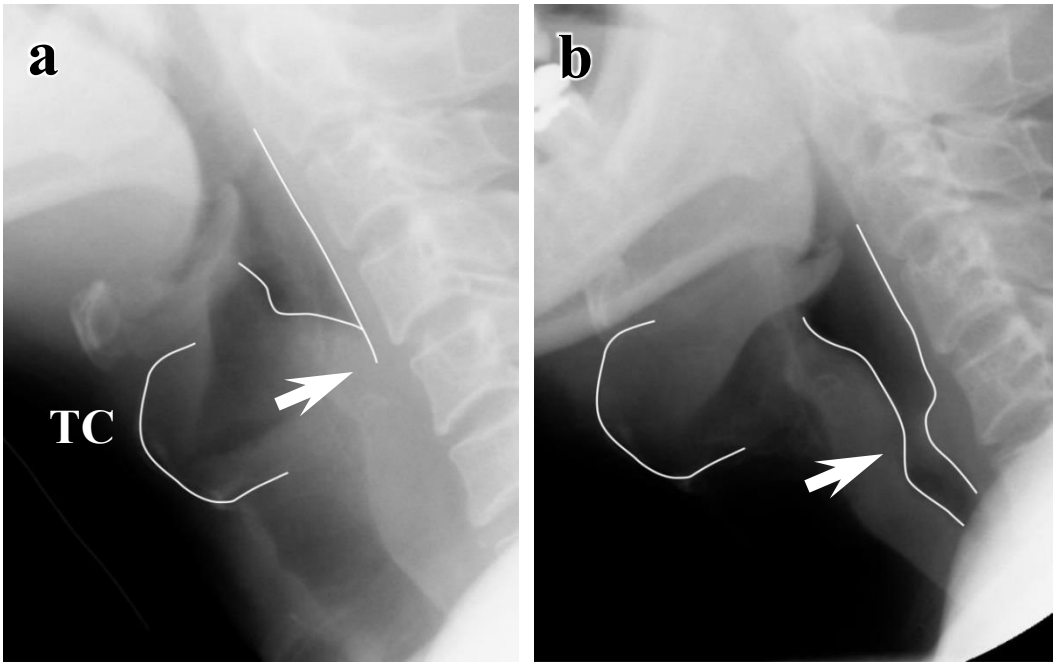

Fig. 3: Lateral radiographic images at non-swallowing phase in a patient who underwent laryngeal elevation
Esophageal entrance is closed preoperatively (a) (arrow). Postoperatively, the thyroid cartilage (TC) is shifted antero-superiorly, and upper esophageal entrance is wide open (arrow) (b).

3.1.4 CP myotomy

The CP muscle functions as the UES via continuous contraction, and relaxes during the pharyngeal stage of swallowing to allow food to pass through.[17,18] Its activity is precisely controlled by the central pattern generator for swallowing in the medulla oblongata, and motor innervation occurs through the vagus nerve; its function can be affected by cerebrovascular and neuromuscular diseases. CP myotomy eliminates abnormal

contractures in the UES and facilitates food passage, and is the most common procedure to restore swallowing function. CP myotomy was first reported in 1951 by Kaplan for medullary gray leukomyelitis patients,[19] but is no longer used to treat dysphagia caused by various diseases.[20,21] The indications for CP myotomy are impaired UES opening and residual contrast medium in the piriform sinus after swallowing on videofluorographic examination.

To avoid reattachment, 3 × 1 cm of CP muscle is resected bilaterally (Fig. 4). The lower part of thyropharyngeal muscle and upper part of esophageal muscle are included in the resection because their boundaries with the CP muscle are not macroscopically or histologically distinct.[22] After complete muscle fiber resection, the mucosa of the esophageal entrance bulges in synchronously with ventilation (Fig. 5). The recurrent laryngeal nerve runs antero-caudally and should be preserved. As the patients lose UES function postoperatively, it is necessary to pay attention to gastroesophageal reflux. Patients are instructed not to lie down for at least 1 hour after meals. CP myotomy is often combined with laryngeal elevation and results in better improvement of swallowing function (Fig.6).

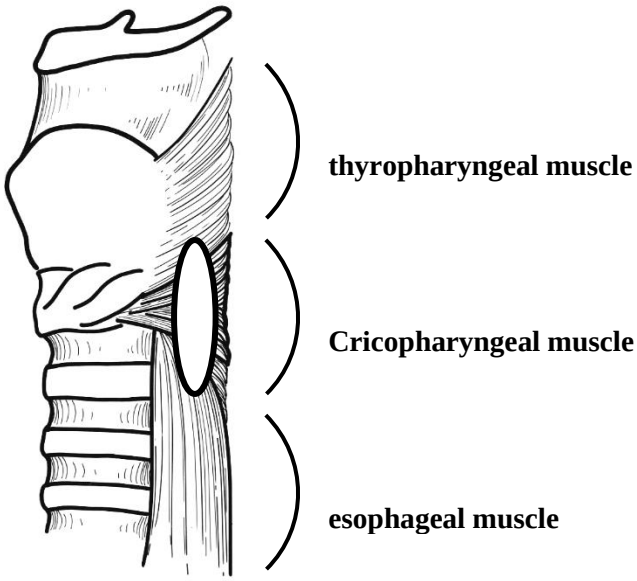

Fig. 4: Schema for cricopharyngeal myotomy.
The cricopharyngeal muscle is resected as an oval shape.

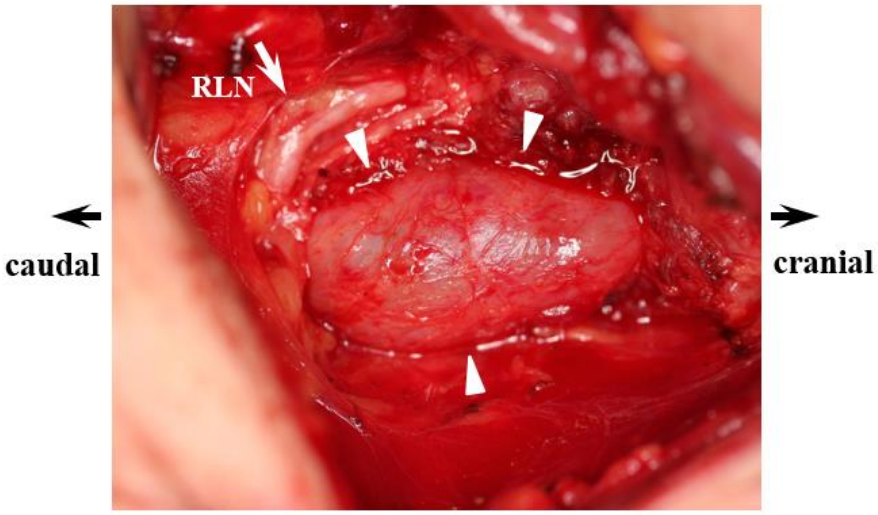

Fig. 5: Intraoperative findings of cricopharyngeal myotomy.
The pharyngoesophageal mucous membrane bulges following myotomy, RLN: recurrent laryngeal nerve.

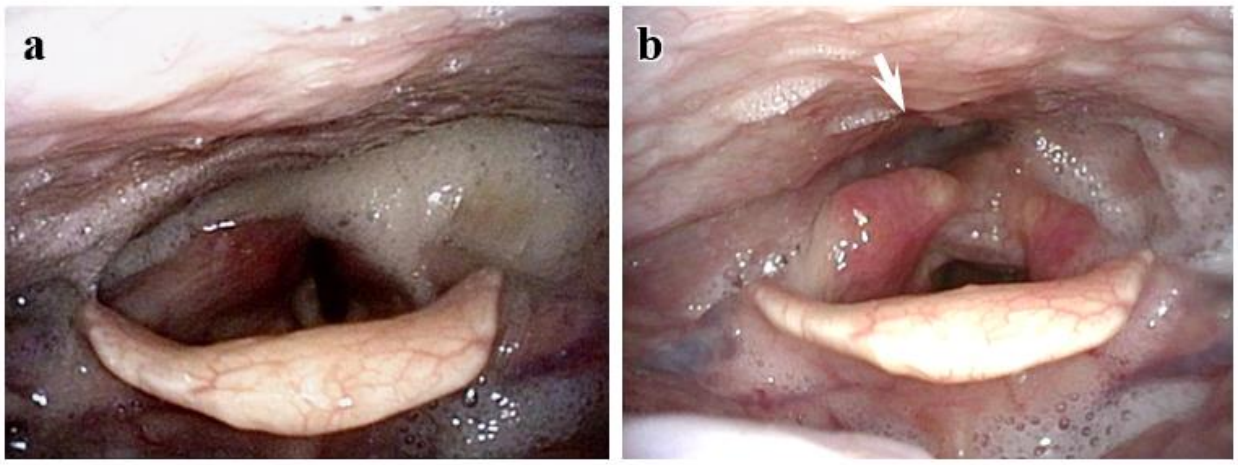

Fig. 6: Endoscopic findings after laryngeal elevation and cricopharyngeal myotomy in a patient with brainstem infarction.
Preoperatively, much saliva pooling in the piriform sinuses is obvious (a). Postoperatively, the entrance of the esophagus is widely open (arrow) and saliva pooling is only a little (b).

Endoscopic CP myotomies are becoming increasingly common.[23,24] Huntley *et al.* [25] reported that the endoscopic approach was a safe and effective alternative to the open approach. Endoscopic CP myotomies are associated with shorter operating times and fewer inpatient days.

3.1.5 Vocal cord medialization

Dysphagia due to unilateral brainstem lesions, for example in Wallenberg syndrome, may be accompanied by vocal cord paralysis. Surgeries for thyroid gland, skull base, esophagus, and dissecting aortic aneurysms may also cause recurrent laryngeal nerve paralysis. In patients with unilateral vocal cord paralysis, glottal closure during swallowing becomes insufficient and aspiration is likely. Vocal cord paralysis is accompanied by breathy hoarseness and difficulty in expectorating the aspirated material. In these cases, surgical medialization of the paralyzed vocal cord improves glottal closure. This can be attained by medialization thyroplasty,[26,27] arytenoid adduction,[28] or vocal cord augmentation using autologous fat or collagen injections (Fig. 7).[29] These procedures reduce the risk of aspiration and improve vocal hoarseness. Figure 7 shows the pre- and post-operative endoscopic laryngeal images obtained during sustained phonation (Fig. 8).

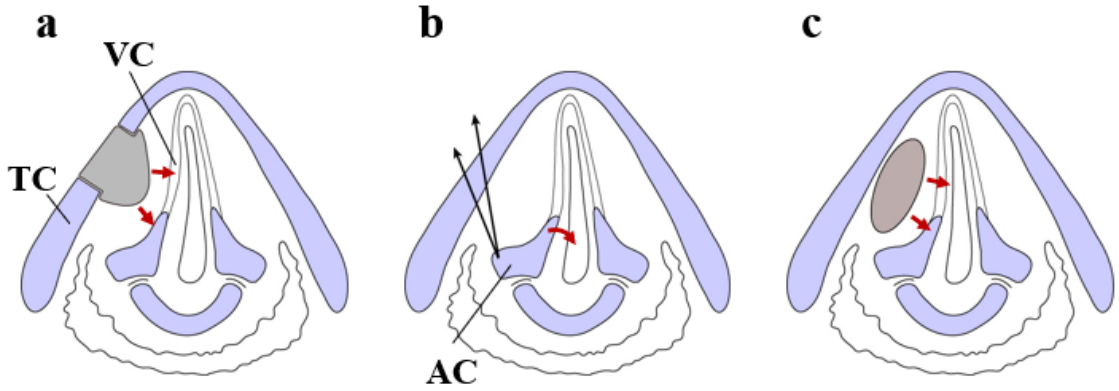

Fig. 7: Schema for vocal fold medialization surgeries.
a: Medialization thyroplasty (lateral compression of the vocal cord), b: arytenoid adduction, c: injection augmentation of the vocal cord. VC: vocal cord, TC: thyroid cartilage, AC: arytenoid cartilage

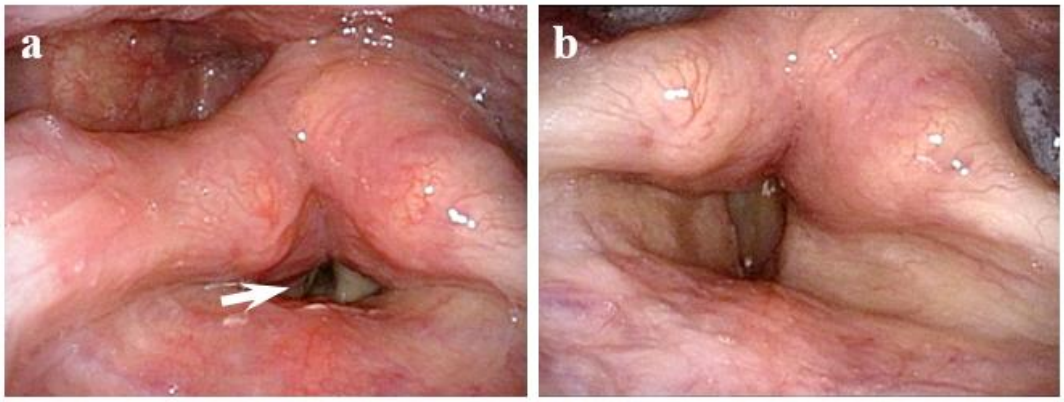

Fig. 8: Endoscopic findings in a patient with left vocal cord paralysis.
Preoperatively, glottal insufficiency during phonation is obvious (arrow) (a). Sufficient glottal closure is achieved by arytenoid adduction (b).

3.2 Surgery to prevent intractable aspiration

In patients with very severe dysphagia, cognitive impairments, intellectual disabilities, and compromised ability to perform activities of daily life, surgery and rehabilitation may lead to insufficient improvement. These patients suffer from sustained and chronic aspiration of food and saliva, which leads to recurrent aspiration pneumonia and an increased risk of mortality. Aspiration prevention surgery reduces the likelihood of aspiration pneumonia by separating the lower respiratory tract from the pharyngolarynx.[30–32] Although this surgery sacrifices the phonatory function and requires the creation of a permanent tracheostoma, it reduces the risk of lower respiratory tract infections due to aspiration.

3.2.1 Indications

The indications for aspiration prevention surgery are severe dysphagia and insufficient restoration of swallowing by rehabilitation; recurrent episodes or a high risk of aspiration pneumonia; a likely improvement in quality of life through surgery; and acceptance of the loss of phonation. Although patients lose the ability to communicate verbally, many of them would have undergone tracheostomies for airway management, resulting in impaired vocal function in any case. Various causes of dysphagia can be included for surgical indication, such as cerebrovascular or neuromuscular diseases, post-treatment sequelae for head and neck cancer, head trauma, or cerebral palsy.

3.2.2 Surgical procedures

Several surgical options are available, including laryngectomy,[33] laryngotracheal separation/diversion,[31,32,34,35] and laryngeal closure.[8–10] Laryngectomy is a popular technique, but is relatively invasive. Moreover, removal of the larynx imposes a psychological burden on the patient and their family.[33,36] Laryngotracheal separation or diversion is less invasive, easy to perform, and reliable, particularly in children. Lindeman *et al*.[30] reported anastomosis of the cranial stump of the separated trachea to the esophagus (tracheoesophageal anastomosis), and a modification to close the cranial trachea (laryngotracheal diversion) (Fig. 9). These procedures do not remove the larynx, which shortens the operating time and reduces the psychological burden.[30,31] Figure 10 shows endoscopic and videofluorographic images obtained following tracheoesophageal anastomosis. Laryngeal closure is another simple minimally invasive procedure that can be performed in various age groups.[36, 37]

3.2.3 Efficacy and role of aspiration prevention surgery

The risk of intractable lower airway infections is eliminated, and the frequency of hospitalizations due to aspiration pneumonia is significantly reduced, after these surgeries.[35–37] Moreover, they may lead to recovery of oral intake. In addition, since there is minimal need for intratracheal suctioning, the burden on patients, families, and caregivers is significantly reduced. As a result, patients can safely return to their homes. These surgeries lead to significant improvements in quality of life and provide great benefit to patients.[10,38]

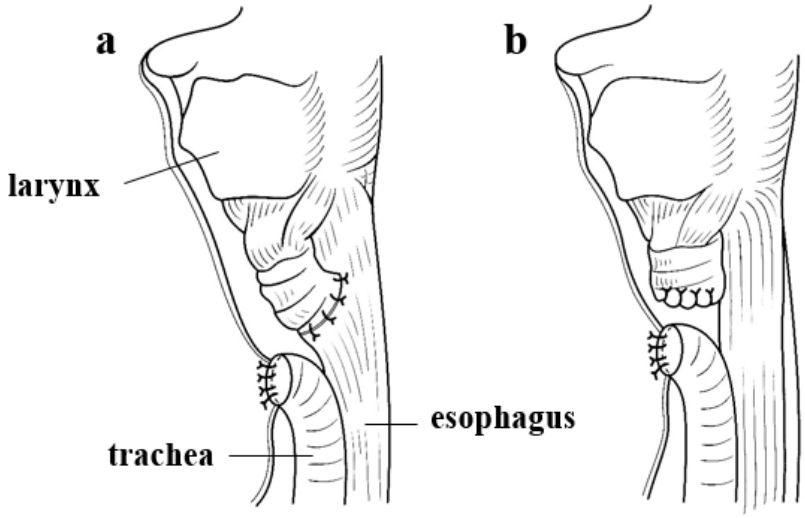

Fig. 9: Schema for Lindeman's aspiration preventing surgeries.
Cranial stump of the trachea is anastomosed to the esophagus (tracheoesophageal anastomosis) (a), and it is closed to create a dead end (laryngotracheal diversion) (b).

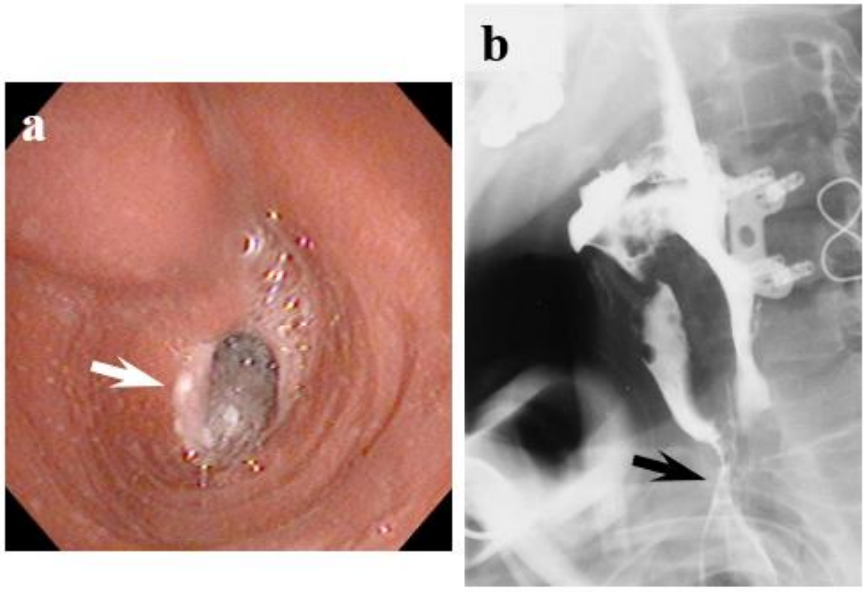

Fig. 10: Endoscopic and videofluorographic images following tracheoesophageal anastomosis.
The trachea connects to the cervical esophagus (a), and aspirated contrast medium flows into the esophagus (arrow) (b).

4. Conclusion

The goal of dysphagia treatment is to restore oral food intake and prevent recurrent aspiration pneumonia. Conservative treatment is the treatment of choice; however, surgical intervention plays an important role in severe dysphagia. Surgery to improve swallowing is indicated to compensate for impaired pharyngolaryngeal motor function or enhance unimpaired functions. Aspiration prevention surgery prevents recurrent bronchopulmonary infections in patients with a high risk of aspiration pneumonia. These surgeries may restore oral feeding and improve quality of life, therefore, they should be considered as a treatment option for severely dysphagic patients.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

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