Introduction

Pathology involving the anterior subaxial cervical spine is most commonly accessed through an anterior retropharyngeal approach (Fig. 3.1). While this approach uses tissue planes to access the anterior cervical spine, visceral structures such as the trachea and esophagus and nerves such as the recurrent laryngeal nerve (RLN), superior laryngeal nerve (SLN), and pharyngeal plexus are vulnerable to direct or traction injury (Table 3.1). Complaints such as dysphagia and dysphonia are not rare following anterior cervical spine surgery. The treating surgeon must be aware of these possible complications, must actively look for them in the postoperative period, and deal with them expeditiously to avoid secondary complications.

This chapter analyzes the problems of dysphagia, dysphonia, and esophageal tears during the anterior approach to the cervical spine and suggests ways of prevention and management.

Dysphagia

Dysphagia or difficulty in swallowing is a symptom indicative of impairment in the ability to swallow because of neurologic or structural problems that alter the normal swallowing process. Postoperative dysphagia is labeled as acute if the patient presents with difficulty in swallowing within 1 week following surgery, intermediate if the presentation is within 1 to 6 weeks, and chronic if the presentation is longer than 6 weeks after surgery.

Table 3.1 Vulnerable nerves during ACDF

<table>
<thead>
<tr>
<th>Nerves</th>
<th>Level/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glossopharyngeal, hypoglossal</td>
<td>C3 or above—oral and pharyngeal phases of swallowing.</td>
</tr>
<tr>
<td>Superior laryngeal nerve</td>
<td>C3–4 level—laryngeal sensory impairment—aspiration, dysphagia.</td>
</tr>
<tr>
<td>Recurrent laryngeal nerve</td>
<td>C6 level or below—milder dysphagia, mainly during swallowing of liquids.</td>
</tr>
<tr>
<td>Nerves of the pharyngeal plexus</td>
<td>Vagus nerve (normally protected by the carotid sheath)—retractional injury at any subaxial cervical levels—C2 to C5—pharyngeal dysphagia.</td>
</tr>
</tbody>
</table>

Abbreviation: ACDF, anterior cervical decompression and fusion.
Anatomy and Physiology of Deglutition

Normal swallowing involves more than 30 muscles and is performed up to 600 times a day. It involves the following three phases (Fig. 3.2):

1. **Oral phase** begins with the entry of food into the oral cavity. It involves preparing the food for digestion by sucking, chewing, and rolling, followed by transport of food into the throat. Oral phase is voluntary and is mediated by the facial, hypoglossal, and glossopharyngeal nerves.

2. **Pharyngeal phase** starts when the leading edge of the bolus of food goes past the faucial arch. The larynx is elevated, and there is inversion of the epiglottis with closure of the true and false vocal cords, preventing aspiration of food or liquid. The respiration temporarily ceases, while powerful contractions from the constrictor muscles clear the bolus of food from the pharynx. The pharyngeal phase is involuntary and is mediated by the SLN, RLN, and pharyngeal plexus.

3. **Esophageal phase** begins with entry of food through the upper esophageal sphincter and its exit through the lower esophageal sphincter into the stomach. It involves relaxation and tightening of the esophageal sphincters and coordinated peristalsis of the esophageal musculature. The esophageal phase is mediated by the myenteric plexus of Auerbach, triggered by the vagus nerve.

Swallowing dysfunction can be divided into four categories: an inability or excessive delay in initiating pharyngeal swallowing, aspiration of ingested food, nasopharyngeal regurgitation, and residue of ingested food within the pharyngeal cavity even after swallowing.¹

Incidence

The incidence of postoperative dysphagia after anterior cervical decompression and fusion (ACDF) varies widely in literature, ranging from 5 to 69%.²⁻⁸ Recent prospective studies have reported a higher incidence when compared with previous retrospective studies.⁹,¹⁰ Bazaz et al prospectively studied 249 patients who underwent anterior cervical spine surgery. They reported difficulty in swallowing in 50.3%, 17.7%, and 12.5% of their patients at 1, 6, and 12 months postsurgery, respectively.⁸ The wide variation in published incidence rates can be attributed to differences in surgical technique, extent of surgery, and the size of the implant used. Variations in the definition of dysphagia and its measurement, as well as the time period when the patient is evaluated, also contributes to the large variation in reported incidence. Although the incidence of postoperative dysphagia is high, most patients recover within 1 to 3 months postsurgery. Yue et al reported that although 35% of 74 patients had varying degree of persistent dysphagia when evaluated at 7.2 years following anterior cervical surgery, only 1 patient reported severe difficulty in swallowing.⁶
Causes

Causes of dysphagia following anterior cervical spine surgery can be divided into the following:

- **Intrinsic**: Edema of the esophageal or pharyngeal wall due to excessive or prolonged retraction at surgery or trauma during intubation. Esophageal tears may also present with dysphagia.

- **Extrinsic**: Compression of the esophagus or pharynx by a large retropharyngeal hematoma (Fig. 3.3) and displaced bone graft, cage, or plate (Fig. 3.4).12,13

- **Neurologic**: Injury to the RLN, SLN, or nerves of pharyngeal plexus due to prolonged or forceful retraction, nerve division, misplaced ligatures, or thermal injury due to aggressive use of monopolar cautery.

Extrinsic compression usually causes dysphagia to solids. Nerve injury usually results in dysphagia to both liquids and solids. Injury to the RLN typically occurs at C6 or below. It can result in diminished closure of the glottis predisposing the patient to aspiration, coughing, and a gasping voice. Denervation of the inferior constrictor and cricopharyngeal muscles may result in milder forms of dysphagia, especially during swallowing of liquids.14,15 The SLN is vulnerable during anterior approach at C3–4. Sensory innervation is usually bilateral, such that ipsilateral injury may be asymptomatic. Nerves of the pharyngeal plexus originate from the vagus nerve. A retraction injury at C2 to C5 levels causes pharyngeal dysphagia with difficulty in initiating swallowing, pooling of secretions in the throat, aspiration, choking sensation, and often severe dysphagia to both solids and liquids. The glossopharyngeal and hypoglossal nerves are vulnerable during surgeries from C1 to C3.

Patients undergoing revision surgery, multi-level procedures, prolonged surgery, female sex, and those in the older age group (> 60 years) are at higher risk of dysphagia.66 Sixty-six percent of patients with cervical myelopathy have been found to have subtle swallowing difficulties on preoperative barium swallow. Spinal cord compression can cause swallowing dysfunction by interfering with the preganglionic, sympathetic outflow or spinal afferents that interrupt local reflex mechanisms.6 These patients are more prone to developing worsening of dysphagia postoperatively.

Investigations

Radiography of the cervical spine gives the initial clues in terms of increase in gas shadow, prevertebral edema/hematoma, graft, and implant position.6,18 Subjective assessment of dysphagia can be done with a questionnaire and represented semiquantitatively using the

![Fig. 3.3 (a) Postoperative radiograph showing increased prevertebral space after surgery due to a large retropharyngeal hematoma. (b) Hematoma with plate impression removed during reexploration.](image1)

![Fig. 3.4 Delayed esophageal perforation due to backing out of plate and screws.](image2)
Complications in Spine Surgery

Bazaz-Yoo grading score (Table 3.2). Objective assessment can be done with indirect and direct laryngoscopy, video fluoroscopic swallow evaluation (VSE), or fiberoptic endoscopic evaluation of swallowing (FEES). Other tests that may be useful include electromyography (EMG) to record the electrical activity of the swallowing muscles, an ultrasound to observe movement of the swallowing muscles, and esophageal manometry. Indirect laryngoscopy helps evaluate the position of the vocal cords in patients with suspected RLN injury. The VSE is used to determine the presence, severity, and timing of aspiration, and to detect and analyze functional impairment of the swallowing mechanism.

Preventive Measures

- Tracheoesophageal traction exercises (TTEs)—since prolonged/excessive traction of the trachea and esophagus is postulated to be the main cause of postoperative dysphagia, the trachea and esophagus are manually mobilized by the patient preoperatively. Using the thumb belly, the patient is asked to push the thyroid cartilage across the midline from right to left multiple times a day. This exercise started 3 to 4 days before surgery has been shown to reduce the incidence of swallowing difficulties after surgery.19

- Atraumatic endotracheal intubation.

- Gentle dissection with adequate release of the platysma and cervical fascia. At C5 to C7 levels, the omohyoid muscle may have to be transected, to allow less forceful retraction (Fig. 3.5).

- Retraction of the trachea and esophagus has to be gentle, applied for a short period (< 175 minutes) and relieved intermittently. The authors prefer using handheld retractors in which the pressure can be controlled and released intermittently, as compared with static self-retaining retractors.20 The retractor blades must be placed below the longus colli (Fig. 3.6), and the pressure must be downward rather than transversely.

- Reduction in endotracheal cuff pressures (ETCPs) to 20 mm Hg after the placement of neck retractors.14,15,21 In the anterior cervical approach, the esophagus gets compressed in between the unyielding cervical retractors and endotracheal tube.

Table 3.2 Bazaz-Yoo dysphagia grading score

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No difficulty No difficulty with liquids or solids.</td>
</tr>
<tr>
<td>1</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Fig. 3.5 Omohyoid needs to be cut during approaches to C6/7.

Fig. 3.6 Retractors placed safely below the longus colli.
By reducing the cuff pressure, there is less compression on the esophagus with retraction.

- Choosing a low-profile, small, and smooth cervical plate.\textsuperscript{20,22,23} Plate should sit flush with the bone.
- Avoid routine use of rhBMP2. It results in prolific and heterotopic bone formation that may result in compression of esophagus.
- Meticulous hemostasis. Use of a postoperative drain to prevent hematomas.
- Application of local steroids (triamcinolone) into the retropharyngeal space to limit edema. Intravenous (IV) administration of methylprednisolone or hydrocortisone reduces edema following prolonged surgeries.
- Application of icepacks over the wound postoperatively reduces bleeding as well as edema of the soft tissue structures.

**Treatment**

Dysphagia is the most common postoperative patient complaint following ACDF. In the vast majority of patients, it is temporary and resolves within 3 months.\textsuperscript{8} During the postoperative rounds following an anterior cervical spine surgery, it is vital to make the patient sit up in bed and evaluate his/her ability to swallow. Mild difficulty in swallowing is not unexpected and is usually due to edema of the esophageal wall due to prolonged retraction at surgery. In these patients, icepacks are placed over the neck to limit bleeding and edema, and the patient is kept on a liquid diet.

If difficulty in swallowing is more severe so that the patient is unable to even swallow his/her own sputum and there is pooling of secretions in the throat, nerve injury or significant trauma to the pharynx/esophagus is suspected. The patient is kept nil by mouth, the pooled secretions are suctioned, and a Ryle’s tube may be inserted.\textsuperscript{24} Icepacks are placed over the neck, and IV steroids may be administered to reduce the edema. IV fluids are continued. The patient must be nursed in the sitting position to reduce the risk of aspiration. If necessary, an ENT surgeon may be consulted to perform an indirect laryngoscopy to rule out RLN injury. In patients with persisting severe dysphagia, after the first week, consideration must be given to introducing a PEG to rest the oropharynx.\textsuperscript{25}

Rapid progression of symptoms, especially with accompanying inspiratory stridor, may be observed in patients with an expanding hematoma. A radiograph may reveal widening of the retropharyngeal space. This necessitates urgent exploration of the wound to drain the epidural hematoma.

Late presentations secondary to bone graft/cage or plate failure need to be assessed for fusion status.\textsuperscript{26} Decision of hardware removal is based on symptomatic status of the patient and response to conservative means as shown in algorithm. Patients with persistent dysphagia or with repeated aspiration suspected due to coughing, choking, or atelectatic changes on chest radiographs should undergo speech pathology evaluation and active swallow therapy. An algorithm for the management of postoperative dysphagia is proposed in Fig. 3.7.

**Rehabilitation for Patients with Persistent Dysphagia**

The goals of treatment in patients with persistent difficulty in swallowing are to maximize food transfer and minimize or prevent aspiration. Compensatory strategies that can be used for facilitating the safe and effective passage of bolus material include (1) modifying diet: controlling bolus size or texture and avoiding certain foods; (2) heightening sensory input prior to or during swallowing; (3) applying voluntary control to the swallow (breath holding, effortful swallow); (4) protecting the airway with postural adjustments to reduce risk of aspiration (e.g., chin tuck, head tilt, head rotation, head lift, lying down); and (5) doing exercises to strengthen weak facial muscles, to improve range of oral or pharyngeal structural movement, and/or to improve coordination.\textsuperscript{27} If the patient is still unable to swallow safely despite rehabilitation, surgical procedures such as Teflon augmentation, vocal cord medialization, and palatal lifts can be used to minimize risk of aspiration.
Key Points

- Dysphagia is a self-resolving condition that is successfully managed nonoperatively in most patients.
- Preoperative assessment for dysphagia especially in myelopathy cases and prior to repeat anterior cervical procedures.
- Predisposing factors for postoperative dysphagia include older age, female sex, revision surgery, multilevel procedures, prolonged operation, and cervical myelopathy.
- Gentle handling of tissues and meticulous hemostasis.
- Reduced endotracheal tube cuff pressure and avoidance of prolonged, continuous retraction.
- Must specifically examine for dysphagia and dysphonia on postoperative rounds.

Esophageal Injury

Esophageal injury during anterior cervical surgery is fortunately rare, but the risk of deep cervical or mediastinal infection and secondary airway compromise makes this injury serious and potentially life threatening. Mortality rates reaching 20% have been reported even when the injury is detected and treated within the first 24 hours. Mortality rate increases to as high as 50% when treatment is further delayed.\(^{28-30}\)

Anatomy

The esophagus lies directly anterior to the spine and requires to be retracted medially when performing an anterior retropharyngeal approach to the cervical spine. The esophagus is separated from the spine by several layers of prevertebral fascia. This adventitious tissue protects the esophagus during the anterior approach. However, there are two areas where the esophagus is vulnerable to injury. The most vulnerable area called “Killian’s triangle” is anterior to the C5/6 disk and is formed by the cricopharyngeus muscle along with the inferior constrictor muscle of the pharynx from either side. Here the posterior esophageal mucosa is covered only by a thin layer of buccopharyngeal fascia without any muscular layer in between. The second region is at the level of the thyrohyoid membrane laterally. The esophagus is made up of a mucosa, a submucosa, and a muscle layer made up of circular and longitudinal muscles.

Incidence

The reported incidence of esophageal injuries ranges from 0.2 to 4% in several large reported studies.\(^{13,28,31-33}\) Hershman et al reported two
esophageal perforations among 9,591 (0.02%) patients who underwent anterior cervical spine surgery.34 Both the cases were detected and treated in the acute postoperative period. One patient was successfully treated with debridement and primary closure, whereas the other one died despite multiple debridements. Gaudinez et al reported 44 esophageal perforations among 2,496 patients treated for spinal cord injury over a period of 25 years. Approximately 95% of the patients with esophageal injuries underwent direct repair.13

Causes

Most cases of esophageal perforations are direct iatrogenic injuries due to improper handling of sharp instruments during various stages of surgery.12,28,35 During anterior cervical spine surgery, aggressive use of monopolar cautery, improper placement of retractors, slippage of sharp instruments, or entanglement of soft tissue in a high-speed drill can result in esophageal injury. Such injuries are usually identified during surgery. Esophageal perforations can also occur later, as a result of bone graft/cage or plate/screw displacement. Pressure necrosis can also occur due to repeated microtrauma by proud metallic hardware (Fig. 3.8).13,15,36–39

Clinical Presentation

The clinical presentation of patients with esophageal perforation is highly variable. Reports by Yee and Terry40 and Pompili et al29 suggest that occasionally patients may be completely asymptomatic. In such cases, the perforation comes to light during routine radiographs, esophagoscopy, and rarely when a patient coughs up or passes a screw in stools. More commonly patients complain of dysphagia, neck pain or fullness, odynophagia, fever or subcutaneous emphysema, chest pain, and vomiting. There may be deep wound infection with drainage from the wound along with redness and swelling. If injury remains undetected, the patient goes on to develop florid sepsis with abscess, osteomyelitis, mediastinitis, pleuritis, and pericarditis. Incidence of mediastinitis is less common with injuries to the cervical esophagus as compared with injuries to the thoracic esophagus.

Investigations

Plain radiographs are assessed for presence of air in the anterior cervical area (Fig. 3.9), subcutaneous emphysema, paravertebral air, widening of retro-pharyngeal space, or migration of bone graft or hardware.17,18,41 Cervical CT and MRI would be helpful for detailed assessment. Esophagoscopy and contrast esophageal study (Fig. 3.10) should be performed to identify the size and location of injury whenever necessary.13,28,30,37 Use of water-soluble contrast should be encouraged instead of barium contrast to prevent barium-related inflammation of mediastinum.42

Preventive Measures

- Careful dissection with adequate soft tissue mobilization. Special care with cautery.

![Fig. 3.8](image)

Three years following anterior cervical decompression and fusion (ACDF). Patient was asymptomatic. **(a, b)** Screw was observed to be missing during routine follow-up radiographs. **(c, d)** Esophagoscopy demonstrated a delayed pharyngoesophageal perforation. Plate and screw seen on esophagoscopy.
• Placement of the retractor blades beneath the longus-colli muscles. Intermittent release of retraction.

• Care in handling sharp instruments and drills. The esophagus must be protected during placement of screws and plates.

• Use of smooth, low profile, well-contoured locking plates.

**Treatment**

If the esophageal tear is detected intraoperatively, the tear must be isolated from surrounding structures, edges freshened, and sutured using interrupted or imbricating absorbable sutures, without any tension on the suture line (Fig. 3.11). The wound needs to be thoroughly irrigated and debrided, following which the instruments used must be preferably discarded, and surgery is completed with fresh uncontaminated instruments. If possible, insertion of metallic hardware is avoided. The wound is closed over a suction drain. A nasogastric tube must be inserted, the patient must be kept nil by mouth for 2 to 3 weeks, and wide-spectrum antibiotics that also provide anaerobic cover must be started. No specific recommendation for the length of time of wound drainage or antibiotic therapy has been mentioned in literature. At 2 to 3 weeks, repeat imaging is performed to see whether there is any residual leak from the esophagus. If there is no leakage, patient can be started on oral feeds. However, if there is some residual leakage, it is recommended that a percutaneous endoscopic gastrostomy tube be placed for feeding and a repeat wound exploration be performed. Use of a sternocleidomastoid or omental flap must also be considered to reconstruct the esophageal

![Fig. 3.9 X-ray demonstrating air in the retropharyngeal space, indicating esophageal perforation.](image)

![Fig. 3.10 Contrast CT showing gas, fluid, and debris within the retropharyngeal space due to undetected intraoperative esophageal tear.](image)

![Intercostal muscle pedicle](image)

![Fig. 3.11 Suturing an esophageal tear in layers without tension.](image)
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wall. Local sternomastoid flap is often used in view of its proximity and ease of mobility.\textsuperscript{43} Flap cover helps in improving antibiotic delivery, wound healing, controlling leaks, and in stopping further erosion.\textsuperscript{44} The wound can also be left open and a negative suction drain applied till the leak seals, wound is healthy, and can be closed secondarily. An algorithm for management of esophageal perforations is depicted in Fig. 3.12.

Postoperatively, an esophageal injury is suspected if there is subcutaneous emphysema, drainage from the wound, and chest pain with vomiting. The injury is confirmed with plain X-rays, or a CT scan that may show presence of prevertebral air or subcutaneous emphysema and soft tissue swelling. Contrast swallow studies may be used to confirm the diagnosis. Although nonoperative treatment has been described, in patients with suspected or confirmed tears, surgical debridement and an attempt at closing the esophageal rent directly are recommended. The esophageal wall may be friable and difficult to suture. In such cases, a flap may be used to reconstruct it. The role of hardware in maintaining the spinal stability needs to be assessed and managed accordingly as discussed in Fig. 3.12. Missed cases, poor blood supply, relatively thin wall, and leakage of digestive juices pose challenges in the treatment of esophageal injury.\textsuperscript{28,30,37,43}

Key Points

- Adequate exposure and proper use of retractors, especially in long-duration surgery. Retractors must protect the esophagus all the time.
- In redo surgery, Ryle’s tube may be inserted preoperatively. Approach should be from the opposite side, if possible. Extra care during retraction.

![Fig. 3.12 Algorithm for management of esophageal perforations.](image-url)
• When esophageal tear is suspected, do not procrastinate.
• High index of suspicion. An oropharyngeal bypass is primary treatment.

Dysphonia

Dysphonia is defined as a dysfunction in the ability to produce voice. For voice to be classified as “dysphonic,” abnormalities must be present in one or more vocal parameters: pitch, loudness, quality, or variability. Perceptually, dysphonia can be characterized by hoarse, breathy, harsh, or rough vocal qualities, but some kind of phonation remains.

Anatomy

The larynx, commonly called the “voice box,” is the organ in the neck that is involved in breathing, sound production, and protecting the trachea against food aspiration. The larynx is innervated by branches of the vagus nerve on each side (Fig. 3.13).

The SLN arises from the vagus nerve, within the carotid sheath midway between the jugular foramen and the carotid bifurcation at C2. It then runs medially and caudally for 1.5 cm, before dividing into the internal and external branches. The internal branch of the SLN courses along with the superior laryngeal artery medially and in a transverse trajectory inferior to the hyoid bone. It pierces the thyrohyoid membrane and culminates into three branches. The internal branch provides sensory and parasympathetic innervation to the laryngeal vestibule and glottis, up to the level of the vocal cords. It also sends a motor branch to the interarytenoid muscle. Because of bilateral nerve supply, a unilateral injury that may occur during anterior cervical spine surgery is usually asymptomatic. A bilateral injury would result in complete loss of sensations within the larynx and decreased laryngeal cough reflex resulting in aspiration and choking. The smaller external branch of the SLN travels caudally, medial to the carotid arteries, along with the superior thyroid artery. Besides supplying innervation to the inferior pharyngeal constrictor muscles, it innervates the cricothyroid muscle that plays an important role in phonation by regulating tension of the vocal folds. Injury to the external branch results in impairment of both high and low frequencies of sound and easy fatigability of voice, besides dysphagia.

The RLNs branch off from the vagus nerve, the left at the aortic arch, and the right at the right subclavian artery. After branching, the nerves typically ascend toward the larynx in a groove between the trachea and esophagus. They then pass behind the outer lobes of the thyroid gland and enter the larynx underneath the inferior constrictor muscle, passing into the larynx just posterior to the cricothyroid joint.

Fig. 3.13 Nerve supply of the larynx.
The left RLN loops around the arch of aorta before entering the tracheoesophageal groove, and hence it is longer than the right, making it less susceptible to stretch injuries than the right. The RLN supplies sensations to the larynx below the vocal cords. It innervates all the intrinsic muscles of the larynx except the cricothyroid. The posterior cricoarytenoid muscles, which are the only muscles that can open the vocal cords, are innervated by the RLN. Unilateral RLN paresis causes unilateral paralysis of the vocal cord so that it lies in the paramedian position, unable to adduct or abduct. Insufficient laryngeal closure during phonation causes a breathy and rough voice quality (hoarseness), with increased vocal effort and fatigue and dyspnea on exertion. Because of loss of sensations in the glottis and the lack of complete closure of the vocal cord, there is a higher risk of aspiration.

**Chapter 3**

Approach-Related Complications Following Anterior Cervical Spine Surgery

**Incidence**

Laryngeal complications are not uncommon after anterior cervical spine surgery.\(^{45-49}\) The reported incidence of dysphonia in the early postoperative period varies between 2 and 30%.\(^{46,50,51}\) Some authors have reported the rates of clinical dysphonia due to any cause, whereas others have specifically studied vocal cord paralysis secondary to RLN palsy. Ziedman et al studied the Cervical Spine Research Society database and reported a 0.2% incidence of RLN palsy among 4,589 patients.\(^7\) A more recent systematic review of literature by Tan et al revealed that the incidence of RLN palsy with vocal cord paralysis following anterior cervical spine surgery is between 0.2 and 24.2%.\(^{52}\) More recently Gokaslan et al, from the AO Spine North America Clinical Research Network, conducted a multicenter study and reported that the incidence of RLN palsy ranged from 0.6 to 2.9% between centers. Seventy-four percent of the patients in their study showed complete resolution of symptoms and 16% had partial resolution with residual effects.\(^{53}\) The reported rate of persistent (> 12 months) symptomatic vocal fold paresis varies from 0.33 to 2.5%.\(^{14,45}\) Because SLN palsy is often subclinical, the data on the incidence of SLN palsy are limited. A recent multicenter study identified one patient with SLN palsy from among 8,887 anterior cervical spine surgeries.\(^{54}\)

**Causes**

Dysphonia results either from impairment in vocal cord vibration or from injury to the nerve supply of the larynx.\(^{48,49,55,56}\) Impairment in vocal cord vibration can occur due to direct vocal cord trauma occurring during intubation, postoperative acid reflux, and laryngeal and vocal fold edema.\(^{14,50,55,57}\) Excessive and forceful retraction of the trachea and esophagus can also cause swelling of the pharyngeal and laryngeal musculature and, rarely, even fracture or dislocation of the arytenoid cartilage. During surgery at the C2 to C5 levels, traction and compression injuries to the SLN have also been reported. However, the most common cause of dysphonia following anterior cervical surgery is injury to the RLN.\(^{14}\)

Injury to the RLN can occur due to compression, contusion, traction, thermal damage, nerve division or misplaced ligature, and postoperative edema.\(^{31,45-47}\) One of the main causes is compression of the RLN during retraction of the trachea and esophagus, between the retractor blade and the inflated cuff of the endotracheal tube. Apfelbaum et al found that laryngeal tissues adjacent to the endotracheal tube were subject to significant compression and displacement. There is approximately threefold increase in endotracheal tube cuff pressure during deep retractor placement.\(^{14}\) Reducing the cuff pressure below 20 mm Hg allows the endotracheal tube to shift away from the endolaryngeal wall. This limits compression of the RLN and reduces the rate of symptomatic palsy from 2.2 to 0.7%.\(^{57}\) This movement of the tube has been noted fluoroscopically when retraction was briefly eased and the cuff deflated. Deflating the cuff of the endotracheal tube after positioning of the retractors also allows the RLN to slip down within the tracheoesophageal groove so that it is unaffected by subsequent retraction. Thereafter, the cuff pressure is again elevated up to 20 mm Hg.

Controversy remains as to whether the approach to the anterior cervical spine should be from the right or the left to minimize the risk of RLN injury. A retrospective study in the otolaryngology literature indicated that 15 of 16 patients who presented to one clinic with aspiration and dysphagia following anterior cervical spine surgery had injury to the RLN on the contralateral side.\(^{58}\) A recent study at our institution that evaluated 77 patients with RLN palsy after anterior cervical spine surgery revealed that 34 of these patients showed complete resolution of symptoms and 43 showed incomplete resolution with residual effects.\(^{59}\) This highlights the importance of identifying and preserving the RLN during anterior cervical spine surgery.
Complications in Spine Surgery

CHAPTER 3  Approach-Related Complications Following Anterior Cervical Spine Surgery

Cervical spine surgery had right-sided, unilateral vocal fold paralysis. However, Kilburg et al found no statistical difference in the rate of RLN injury based on side of approach in their retrospective comparison of 418 patients treated for one- or two-level instrumented anterior cervical discectomy and fusion. Other studies too have reported low rates of RLN injury following procedures using a right-sided approach. It is difficult to advocate one approach over the other on the basis of the current clinical literature. The authors prefer the left-sided approach, irrespective of the side of pathology.

Several factors have been identified as being associated with a higher risk of RLN palsy, including right-sided surgery, revision surgery, multilevel procedures, duration of surgery, and type surgery. Only repeat spine surgery has been shown to have a strong association with RLN palsy.

Investigations

Indirect laryngoscopy, direct laryngoscopy, or videostroboscopy with high-speed camera can be used for visualization of vocal fold mobility (Fig. 3.14) and differentiation of vocal fold paralysis from paresis, hypo- and hyperfunctional vocal fold behavior. Laryngeal EMG is the gold standard in diagnosis and may be used to look for evidence of chronic denervation or reinnervation of the intrinsic laryngeal muscles. The interpretation of findings, however, is subjective, and accuracy is dependent on experience.

Preventive Measures

- Left-sided approach to the cervical spine.
- Careful dissection and adequate soft tissue mobilization. Use of bipolar cautery.
- Placement of the retractor blades beneath the longus-colli muscles, away from the tracheoesophageal groove.
- Avoid opening the retractor excessively wide.
- Intermittent release of retraction.
- Deflating the cuff of the endotracheal tube after placement of retractors, followed by reinflation to less than 20 mm Hg.
- In patients with previous anterior cervical spine surgery, thyroidectomy, radical neck dissection, and previous radiation therapy, an indirect laryngoscopy should be done preoperatively to assess the status of the vocal cords. If the vocal cord on the side of the previous surgery is nonfunctional, it is preferable to approach the cervical spine from the same side during repeat surgery.
- Use of intraoperative laryngeal EMG. Dimopoulos et al used this modality to predict development of RLN palsy in 298 patients who underwent ACDF.

![Fig. 3.14 Indirect laryngoscopic picture of vocal cords in health and diseases.](image-url)
They found significant laryngeal activity in 14.4% patients of whom 2.3% developed RLN palsy.\textsuperscript{60}

**Treatment**

Although dysphonia is not uncommon following anterior cervical spine surgery, it is usually temporary in most patients.\textsuperscript{48} Even neuropraxia of the RLN or SLN is a reversible condition, and recovery of complete vocal cord movement is seen in a large number of patients within 12 months of surgery. Hence most patients can be observed for recovery, without performing an extensive diagnostic workup.\textsuperscript{56}

Icepacks can be applied to the operative site postoperatively to limit bleeding and edema. Steam inhalation and a short course of steroids hasten the recovery. The patient must be reassured about the benign nature of the problem. Swallowing may also be affected. One must be careful not to feed these patients in the supine position. Liquids may have to be thickened. Swallowing therapy may be initiated in patients with mild to moderate discomfort. Ryle’s tube may be inserted to limit the chances of aspiration. Assessment by a speech pathologist is useful to initiate compensatory mechanisms and voice therapy.

Surgical intervention is very rarely required. It is usually performed in patients who develop aspiration pneumonia or in whom the potential for aspiration precludes oral feeding. Voice professionals tolerate dysphonia poorly. Injection laryngoplasty (placement of a filler substance in the lateral aspect of the thyroarytenoid/lateral cricoarytenoid muscle complex) and medialization thyroplasty (one or both of the vocal folds is/are augmented by placing an implant into the vocal fold) are used as treatment for permanent vocal cord palsy.\textsuperscript{61}

**Key Points**

- Preoperative assessment of the vocal cord.
- Prefer left-sided approach.
- Release retraction intermittently. Avoid excessive endotracheal tube cuff pressure.
- Most dysphonia is temporary. Even neuropraxia of the RLN or SLN recovers over 12 months in most patients.
- Icepacks, steam inhalation, short course of steroids, speech therapy, and swallowing therapy are nonoperative interventions.
- Surgery is rarely required.

**References**

CHAPTER 3  Approach-Related Complications Following Anterior Cervical Spine Surgery


44. Reid RR, Dutra J, Conley DB, Ondra SL, Dumanian GA. Improved repair of cervical oesophageal fistula complicating anterior spinal fusion: free omental flap compared with pectoralis major flap. J Neurosurg 2004;100:66–70


46. Heeneman H. Vocal cord paralysis following approaches to the anterior cervical spine. Laryngoscope 1973;83(1):17–21

47. Sperry RJ, Johnson JO, Apfelbaum RI. Endotracheal tube cuff pressure increases significantly during anterior cervical fusion with the Caspar instrumentation system. Anesth Analg 1993; 76(6):1318–1321


