International Journal of Community Medicine and Public Health
Abduljabbar AA et al. Int J Community Med Public Health. 2025 Nov;12(11):5301-5306
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20253718

Review Article

Contemporary approaches to vocal cord immobility after thyroid surgery

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Received: 25 September 2025
Accepted: 17 October 2025

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ABSTRACT

Regardless of the advancements in surgical and management techniques, vocal cord immobility remains the most common complication of thyroid surgery. This can be attributed to the critical and complex location of the recurrent laryngeal nerve (RLN), whose damage contributes to either permanent or temporary vocal cord immobility. However, it can be assessed preoperatively via vocal assessment or laryngeal visualization, monitored perioperatively by intraoperative neuromonitoring, and prevented through identification of both the RLN or the external branch of the superior laryngeal nerve. Post-operative management varies from voice therapy to nerve reinnervation, depending on the degree of severity. The recent employment of artificial intelligence (AI), along with raising patients' awareness and training surgeons, can improve assessment and management approaches. This review aims to explore contemporary approaches for managing vocal cord immobility following thyroid surgery. It also seeks to explain the underlying mechanisms behind vocal cord immobility in order to prompt future research.

Keywords: Vocal cord immobility, Thyroidectomy, Recurrent laryngeal nerve injury, Reinnervation

INTRODUCTION

The surgical removal of all or part of the thyroid gland, known as thyroidectomy, has an increasing rate, which has doubled over the past 3 decades. Thyroidectomy is performed for various clinical indications, including tumor removal, dysphagia from cervical esophageal compression, or dyspnea from airway compression. It is also indicated for other types of thyroiditis and thyromegaly, including multinodular goiter and Hashimoto's. Earlier, thyroid surgery had a mortality risk of 40%. Thus, it was banned by several institutions, such as the French Academy of Medicine. Nowadays, thanks to modern approaches to anesthesia, surgery has become safe with mortality rates dropping to 0.5%. Regardless of the ongoing advancement in anesthesia and surgical techniques, thyroid surgery is associated with several serious complications.

Typical complications for thyroid surgery include hypoparathyroidism, postoperative bleeding, thoracic duct injury, laryngeal edema, recurrent laryngeal nerve (RLN) injury, injury to the external branch of the superior laryngeal nerve (EBSLN), tracheospasm, tracheal injury, and esophageal injury. Moreover, other severe complications, such as dyspnea, asphyxia, or thyroid crisis, are fatal.[1] Although RLN injury and injury to the EBSLN are not fatal complications, they result in vocal cord immobility (VCI) that may cause complete loss of speech. Given that one's voice is the tool for communicating ideas and sharing thoughts, they may have a substantial impact on the patient's quality of life.[2]

Vocal cord immobility can be defined as the array of impairments of motion in the vocal cord. It is mostly characterized by hoarseness, dysphonia, odynophobia, and dysphagia. It may also present with chronic cough and laryngospasm.[3] Vocal cord immobility has an incidence of 3-8% for temporary cases and 1-3% for permanent cases.[4] It occurs as a result of injury to the RLN or to the EBSLN. Moreover, Aref et al, in a prospective cohort study, reported that VCI can occur post thyroid surgery without injury of the RLN or that of the EBSLN.[5] This urges the need for the development of management and prevention strategies for this complication.

Earlier, management approaches were conservative. Patients with suspected RLN or EBSLN injury are routinely followed up for six to twelve months until they recover spontaneously. Final procedures like medialization thyroplasty were postponed until stability was established. Long-term tracheostomy was the standard treatment for bilateral paralysis, which frequently had disastrous social and professional effects. There were little rehabilitation and infrequent comprehensive evaluation of voice outcomes. Thus, more effective interventional approaches are needed.

Effective management encompasses the entire period, prior to, during, and after surgery. In detail, patients undergo counseling and voice examination before surgery. Intraoperative neuromonitoring lowers the risk of damaging the RLN or the EBSLN. Various pharmacological treatments are available as well.[6] This review aims to explore contemporary approaches for managing vocals. Cord immobility following thyroid surgery. It also seeks to explain the underlying mechanisms behind vocal cord immobility to prompt future research.

METHODS

This review is based on a comprehensive literature search conducted on September 26, 2025, in the PubMed and Clinical Key databases, as well as Google Scholar. Utilizing medical subject headings (MeSH) and relevant keywords, such as "Vocal cord immobility", "thyroidectomy"," recurrent laryngeal nerve injury", "reinnervation". The search aimed to explore contemporary approaches for managing vocal cord immobility following thyroid surgery. It also seeks to explain the underlying mechanisms behind vocal cord immobility to prompt future research. The search was not restricted by language, date, or type of publication to ensure a broad exploration of the available literature.

DISCUSSION

Pathophysiology and mechanisms

Recurrent laryngeal nerve injury (RLNI) is the most common complication of thyroid surgery. Unilateral RLNI leads to hoarseness, which may develop into vocal cord immobility, while bilateral RLNI causes life-threatening respiratory outcomes. Vocal cord immobility due to RLNI has an incidence of 3-8% for temporary cases and 1-3% for permanent cases. The severity of the injury varies, with neuropraxia being the mildest injury, where the axon remains intact, and nerve function returns in 6-8 weeks. Axonotmesis involves damage to the axon and has varying degrees of severity, and finally, neurotmesis, which results in permanent disruption of the nerve. Prognosis and recovery vary depending on the mechanism of injury.[7]

Injury to the EBSLN is another important cause of postoperative voice problems. EBSLN injury does not cause immobility but leads to dysfunction of the cricothyroid muscle. This results in reduced pitch control, vocal fatigue, and poor vocal projection, which is particularly disabling in individuals who rely on their voice professionally.[8] Vocal cord immobility can also occur without direct injury to the RLN or EBSLN. Aref et al demonstrated that some patients developed postoperative vocal dysfunction even when intraoperative monitoring confirmed nerve integrity. This may occur due to intubation trauma, postoperative edema, ischemia, or inflammatory neuropathy.[9]

Therefore, the pathophysiology of vocal cord immobility is multifactorial. It includes direct neural injury, neuropraxia from traction or thermal effects, intubation-related trauma, postoperative inflammation, and structural fixation. Understanding these mechanisms is essential for planning enhanced approaches for early diagnosis management strategies.

Diagnosis of vocal cord immobility

Vocal cord immobility is suspected when patients present with hoarseness, a weak or breathy voice, vocal fatigue, dysphagia, or aspiration. Bilateral cases may present with stridor and dyspnea, which require urgent evaluation.[1] The diagnosis is confirmed by laryngoscopic examination. Flexible fiberoptic laryngoscopy provides direct visualization of vocal cord motion and remains the gold standard. It also identifies other conditions that may mimic paralysis, such as laryngeal edema, arytenoid dislocation, or cricoarytenoid joint fixation. Afsah reported that systematic laryngoscopic assessment is essential in all

suspected cases and should be performed both preoperatively and postoperatively to establish a baseline and to detect new deficits.[10]

Laryngeal electromyography is indicated when differentiation between neurogenic paralysis and mechanical fixation is required. It documents denervation and reinnervation and provides prognostic information. Kupfer and Meyer highlighted the role of Laryngeal electromyography (LEMG) in unilateral vocal fold immobility, showing that it allows early prediction of recovery and supports timely intervention. Patients with poor electromyographic prognosis can be referred earlier for medialization procedures, whereas those with signs of reinnervation can be observed.[11] Recent evidence confirms the value of LEMG in guiding therapy. Krasnodebska et al studied patients with vocal fold immobility and found that incorporating LEMG into the treatment process directly influenced management decisions. Patients with preserved reinnervation were managed conservatively, while those with absent activity were referred for surgery. Thus, it directs treatment planning.[12] In general, diagnosis of vocal cord immobility relies on recognition of clinical features, confirmation by laryngoscopy, differentiation by electromyography, and functional voice assessment. Early and systematic use of laryngoscopy and electromyography to improve diagnostic accuracy. However, current research efforts are aimed at developing enhanced strategies for early assessment and prevention with the goal of improving the patient's quality of life and reducing suffering.

EARLY ASSESSMENT AND MANAGEMENT

Preoperative management

Voice changes noticed after thyroid surgery can occur due to an existing voice disorder, not only because of RLN injury. Almost 33% of patients undergo thyroidectomy. Present with preoperative voice symptoms. For instance, patients with thyroid function impairment may develop voice changes owing to swelling of the vocal folds. Therefore, it is crucial to assess any voice abnormalities and counsel patients preoperatively to provide proper voice therapy postoperatively. Among the ways to assess voice changes are patients' self-assessments through questionnaires like voice handicap index (VHI; VAS), which is composed of 30 questions that describe the patient's quality of voice and the severity to which voice symptoms affect daily life. Other ways include psychosomatic assessment by an experienced speech-language pathologist, and acoustic analysis of a voice recording using computer software. Nevertheless, some patients may suffer from an impaired vocal fold without apparent symptoms.[13] For instance, Farrag et al reported that 32% of patients suffering from pre-existing vocal cord immobility were asymptomatic before thyroid surgery.[14] It was also reported that 67% of invasive cases presenting with preoperative vocal cord paralysis did not have a voice change at presentation. Moreover, the incidence of coincident abnormal laryngeal lesions for patients who had dysphonia before thyroidectomy was estimated to be 35%, where patients had laryngeal mucosal lesions, including vocal nodules, vocal polyps, Reinke's edema, and vocal cysts, as well as vocal cord immobility.[15]

Accordingly, pre-operative laryngeal visualization is highly recommended for all patients undergoing thyroid surgery, given that it can identify asymptomatic patients with pre-existing vocal cord immobility, assess the baseline status of preoperative laryngeal function for management of postoperative voice care plans, and predict the extrathyroidal metastasis of thyroid cancers. Nevertheless, thyroid surgery patients remain at risk of developing vocal cord immobility owing to various surgery-related outcomes. Thus, proper surgical techniques and perioperative nerve monitoring are crucial to prevent recurrent laryngeal nerve injury.

Perioperative management

In thyroid surgery, RLN damage can be influenced by the skill and experience of the surgeon, reoperation, thyroid cancer, the presence of a posterior extra-thyroid capsular extension, and the degree of central lymph node involvement. Various factors can influence the risk of RLN injury during surgery and the subsequent vocal cord immobility, including identification of the RLN or ESPLN, intraoperative neuromonitoring, and administration of corticosteroids.[2]

The EBSLN, a branch of the vagus nerve, is responsible for controlling the cricothyroid muscle, which is at surgical risk during superior thyroid pole ligation during thyroidectomy, a vital tensor of vocal folds. It can cause vocal weariness and difficulty reaching high pitches. Surgeons must be familiar with the anatomic variations between the EBSLN and the superior thyroid artery, as these variations influence the risk of injury during thyroidectomy. Visual identification of the EBSLN is more challenging than visualization of the RLN. Dissection should begin through the avascular plane between the inner superior pole of the thyroid glands and cricothyroid muscle and continue until individual ligation and dissection of the vessel pedicles near the thyroid capsule.[16]

Continuous intraoperative neuromonitoring (cIONM) can be used during thyroid surgery, as it enables real-time monitoring of nerve status in order to recognize and prevent potential nerve injury and predict postoperative nerve function. During cIONM, the nerve is stimulated, and the excitation amplitude is analyzed continuously during the whole procedure. This is facilitated using either an electrode that is placed on the nerve or near the nerve, by transcranial nerve stimulation, or using acoustic stimuli at a given frequency (Hz).[17,18] In a meta-analysis, Bai and Chen reported that the use of IONM reduced the rate of recurrent laryngeal nerve injury by almost 20% when compared to cases performed by inexperienced surgeons.[19] A recent study suggests that the administration of systemic

steroids within 10 minutes of detecting signal loss during IONM may help in preventing permanent vocal paralysis.[20] However, routine systemic steroids are not recommended for vocal immobility prevention due to a lack of evidence and the risk of adverse effects. Furthermore, a meta-analysis has reported that Nimodipine (a calcium channel blocker) can improve functional recovery in patients with vocal immobility due to RLN injury.[21] Although the exact mechanism is unknown, it may promote axon growth after neural injury. However, another recent study indicated that nimodipine did not have a significant effect on the recovery rate of vocal immobility after thyroidectomy, although it was associated with a trend toward influencing the time to recovery.[22] Therefore, further research is required to assess the usefulness of nimodipine in patients with vocal immobility after thyroid surgery. Caution is advised during pregnancy, breastfeeding, and in patients with cardiovascular conditions, as dizziness and headache can result in discontinuation of medication in 29% of patients.

POSTOPERATIVE MANAGEMENT

Injection laryngoplasty

Injection laryngoplasty is a relatively simple procedure that can be performed under local anesthesia in outpatient clinics using a percutaneous, transoral, or microlaryngoscopic approach. It involves the injection of hyaluronic acid and collagen, calcium hydroxyapatite, autologous fat, and polymethylmethacrylate microspheres in bovine collagen, which can provide longer-lasting results. It can lead to immediate voice improvement. It is often performed when temporary vocal fold dysfunction is anticipated. Monitoring for 6-12 months may be considered if voice demands are low or the risk of aspiration is minimal.[23] Early injection laryngoplasty after thyroid surgery has been reported to reduce the number of patients requiring laryngeal framework surgery if vocal fold dysfunction persists.[24]

Laryngeal framework surgery

Laryngeal framework surgery is a procedure performed after several months of observation when vocal fold paralysis is not expected to recover. In such cases, muscle atrophy of the vocal fold is identified. If vocal cord immobility is considered permanent, medialization thyroplasty is recommended to push the vocal fold inward, often done in conjunction with arytenoid adduction to align the paralyzed vocal fold.[25] This surgery can be performed 6-12 months after the onset of paralysis and is recommended for permanent management 9 months after VFP, according to the guideline published by the Korean Society of Laryngology, Phoniatrics, and Logopedics.[23]

Reinnervation

Reinnervation techniques can be used to reconstruct nerves that have been accidentally cut or resected with tumor involvement. Techniques include end-to-end anastomosis, free nerve grafting, ansa cervicalis to RLN anastomosis, vagus to RLN anastomosis, and hypoglossal to RLN anastomosis. Voice improvement can be observed within 3-6 months post-surgery. In cases of RLN invasion by thyroid cancer that necessitates nerve resection, reinnervation should be performed immediately after surgery, regardless of pre-operative vocal cord immobility.[26,27]

Voice therapy

Voice therapy includes indirect therapy with counseling and education on vocal hygiene and direct therapy to reduce the vocal gap. It can significantly improve voice quality resulting from VFP and it is advisable to continue therapy even after treatments such as vocal fold medialization. Vocal hygiene education should be included as part of the therapy.[28] Postoperative neck exercise or massage may also help improve voice changes after thyroidectomy.[29]

FUTURE PROSPECTS

Given the recent advancement in technology, the employment of AI in neurological diagnostics can be of great significance. For instance, Gorenshtein et al developed the INSPIRE model, which can contribute to reducing the risk of vocal cord immobility by comprehensive analysis through integrating diverse clinical variables, enhancing diagnostic accuracy and enhancing the efficiency of nerve conduction studies.[30]

CONCLUSION

Despite advances in surgical techniques and management approaches, vocal cord immobility remains a prevalent persistent complication for thyroid surgery. This can be attributed to the complex and sensitive anatomical location of the RLN and the ESPLN. However, it can be prevented and managed prior to, during, and after surgery through vocal assessments, laryngeal visualization, skilled surgical techniques, and reinnervation techniques. Patient education and training surgeons, in addition to the employment of AI.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Abduljabbar AA, Almutiri MK, Alenezi AAQ, Almesbah MJ, Alshammari DF, Alanazi AF, et al. Contemporary approaches to vocal cord immobility after thyroid surgery. Int J Community Med Public Health 2025;12:5301-6.