Review Article

Injury of Recurrent Laryngeal Nerve in Thyroid Surgery: A Scoping Review

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Abstract

Thyroid surgery is a common surgical procedure in routine surgical practice. Recurrent laryngeal nerve (RLN) injury is an important reason for medical disputes from thyroid surgery. One of the most feared complications of thyroid surgery is vocal cord paralysis brought on by RLN damage. Injury of RLN with vocal cord palsy is a complication of thyroidectomy that profoundly affects patients. Patients are severely disabled as a result, both mentally and physically. Even though RLN injuries are rare, they might compromise one's quality of life. A significant clinical condition known as bilateral RLN damage occurs when both vocal cords assume the median or paramedian position, obstructing the airway and necessitating an immediate tracheostomy. Identification and preservation of nerves depend on intraoperative hemostasis and a thorough knowledge of RLN anatomy. Injury of RLN following thyroid surgery is one of the leading causes of medico-legal litigation against the operating surgeon. Early identification of RLN injuries and appropriate management are crucial to prevent these surgical complications.

Keywords: Airway obstruction, hoarseness, recurrent laryngeal nerve, thyroid surgery, vocal cord paralysis

Introduction

Recurrent laryngeal nerve (RLN) injury is a common complication of thyroidectomy that results in vocal cord paralysis.[1] Paralysis of the vocal cord is a dreaded complication following thyroidectomy. It may cause a disturbing permanent postoperative hoarseness of voice. It is an important cause of malpractice following thyroid surgery.[2] Unilateral RLN injury can cause hoarseness whereas bilateral RLN injury can result in bilateral vocal cord paralysis.[3] Bilateral vocal cord paralysis is the most dreaded complication following thyroidectomy, as it can limit airway function.[3] The best method to avoid RLN injury is to visually identify it on a regular basis during thyroid surgery. Improved knowledge of vocal cord paralysis after thyroid surgery is necessary to advise patients about the danger and its impact on quality of life, as well as to help them deal with any difficulties that may arise.

Methods of Literature Search

The search was done for recent research articles on RLN paralysis in thyroidectomy. First, we conducted a search of the PubMed, Scopus, Medline, and Google Scholar databases online. We developed our search strategy based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The published works' abstracts were identified by our search method, although more research publications had to be manually located from the citations. A variety of study designs were looked at, such as case reports, case series, comparative studies, observational studies, and randomized controlled trials. There were 15 case reports, 14 case series, and 31 research papers in all [Figure 1]. This review article focuses only on the postoperative paralysis of the RLN paralysis in thyroid surgery. A better understanding of the RLN paralysis in thyroid surgery is provided by this review analysis. It will also catalyze further study and better understanding of the RLN paralysis in thyroid surgery which is helpful for early detection and treatment of RLN injury in thyroid surgery.

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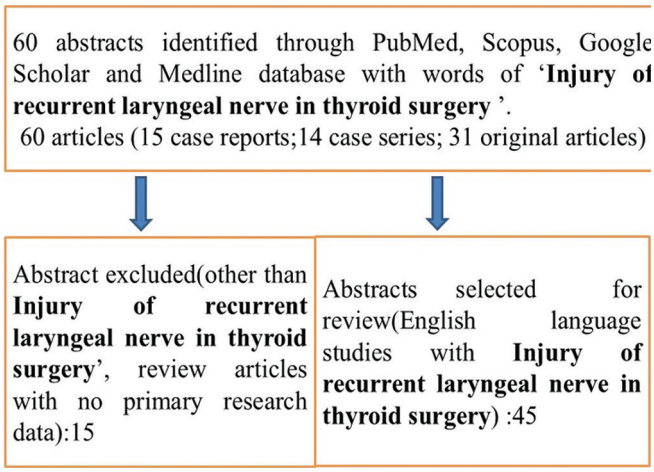

Figure 1: Methods of literature search

Prevalence

Vocal cord paralysis is a relatively rare complication after thyroidectomy and is reported between 1% and 20% transient or temporary injury of RLN and permanent injury of RLN <1%–5%.[4] However, a number of thyroid surgeries performed has risen significantly over the past few decades and the incidence of iatrogenic vocal cord paralysis is unfortunately increasing as well.[5] The paralysis of RLN can be transient or permanent. Transient paralysis of RLN occurs in 5%–11% of all thyroid surgeries, and permanent RLN paralysis occurs in 0.9%–3%, the percentage increases further in case of high-risk cases.[6] The prevalence of permanent injury of RLN after careful dissection is <2% of cases of thyroid surgery.[7] Bilateral RLN damage is less common than unilateral RLN damage because of increased application of nerve monitoring and aborting complete surgery in cases of unilateral RLN injury.[8]

Surgical Anatomy of Recurrent Laryngeal Nerve

The vagus provides the origin of the RLN in the upper part of the thorax. Aiming toward the right tracheoesophageal groove, the right RLN ascends the neck after passing beneath the right subclavian artery.[9] The left RLN hooks around the arch of the aorta and ascends more vertically and deeper in the left tracheoesophageal groove. Both RNL nerves reach the larynx at the cricothyroid articulation through fibers of inferior constrictor muscles of the pharynx.[9] Sensory, motor, and parasympathetic fibers are carried by the RLN. There are two branches of RLN: internal and external. Four intrinsic laryngeal muscles, with the exception of the cricothyroid muscle, which is innervated by the external lateral branch of the superior laryngeal nerve, receive motor function from the external branch of the RLN, while the vocal cords and subglottic region receive sensation from the internal branch.[10] These four muscles consist of the transverse and oblique arytenoid, lateral and posterior cricoarytenoid, and thyroarytenoid. RLN branches to the cricopharyngeus and inferior constrictor muscles before entering the larynx.[10] The most common variant of RLN is extra laryngeal bifurcation which is seen in 18.5%–72% of cases.[10] Bifurcation of RLN is more prone to injury near Berry's ligament.[11] The bifurcated nerve fibers of RLN are reported to be thinner, more fragile, and more sensitive to traction injury or compression injury. If the anterior branch is pushed forward by the Berry's ligament, the posterior branch may be mistaken for the RLN trunk which leads to unintended damage of the anterior branch. The diameter of the posterior branch may be bigger than the anterior branch of RLN.[12] The posterior branch can appear to be RLN trunk which may lead to transection of the thin anterior branch.

Risks Associated with Recurrent Laryngeal Nerve Injury

Thyroid surgery types and extent, the presence or absence of cancer and its invasion, the presence of Grave's disease or chronic thyroiditis, the volume of goiter, retrosternal extension, the surgeon's experience, and the size of the RLN all increase the risk of RLN injury.[13] Important factors that can raise the risk of RLN injury include thin RLN nerve, underlying malignancy or chronic thyroiditis with adhesions, and total thyroidectomy with central neck dissection. Thyroid cancer, Grave's disease, and reexploration procedures are associated with a higher incidence of RLN injury.[14] When a thyroidectomy is performed for a malignant disease or by a less experienced surgeon, the risk of RLN injury is increased.[15] If RLN encounters aggressive thyroid cancers, it may occasionally be purposefully sacrificed.[16] Hyperthyroidism identified previously is considered a risk factor for RLN injury and temporary vocal cord paralysis.[17] RLN injury is more likely to occur in patients having secondary or reoperative thyroid surgery. It has been reported that reoperative surgical procedures carry a 2%–30% risk of permanent RLN paralysis.[18] In reoperative surgical procedures, the anatomical planes are distorted because of scarring from primary surgery, leading to difficulty in identification and increased traction of RLN.[19] The extent of thyroid surgery also carries a higher risk for RLN injury.[20]

Etiopathogenesis of Recurrent Laryngeal Nerve Injury

The exact pathogenesis of transient RLN palsy is not known. It can occur due to direct injury (mechanical or electrical) to RLN without severing. Other potential factors responsible for transient RLN injury include stretching, perineural devascularization, or compression by a hematoma. Surgery for thyroid cancers, hyperthyroid (toxic) goiter, and recurrent goiter cases are more likely to cause RLN damage. Adhesions and anatomical displacement cause RLN damage in recurrent goiter cases, while the gland's increased vascularity causes it in hyperthyroid cases.[21] When the distal portion of the RLN (close contact with Berry's ligament) is dissected during an extracapsular resection (lobectomy or total thyroidectomy), transient RLN injury is still a frequent side effect of thyroid surgery. Because of anatomical variations of the RLN, such

as extra-laryngeal branching of the nerve, abnormal traction forces can result in RLN injury. Complete or partial transection, handling or traction of the nerve, crush, contusion, burn, clamping, misplaced ligature, and compromised blood supply are some of the mechanisms of nerve injury.[22] Intraoperative visualization and capsular dissection of the RLN is the gold standard for intraoperative care during thyroidectomy to minimize the injury of RLN.[23]

Manifestations of Recurrent Laryngeal Nerve Injury

Vocal cord palsy by injury of RLN is a dreaded consequence after thyroid surgery, as it manifests substantial handicaps to patients both physically and psychologically.[24] Unilateral RLN injury can result in varying degrees of hoarseness, micro-aspiration, coughing, and other symptoms that seriously affect the patient's quality of life. Following thyroidectomy, patients with RLN injury experience a range of symptoms, from hoarseness and trouble eating or breathing to severe respiratory distress and airway obstruction.[25] Not all patients with bilateral vocal cord paralysis develop airway obstruction or need a tracheostomy.[26] Patients with bilateral RLN injuries may experience aphonia, dysphonia, or even suffocation, which could endanger their lives. The factors pertaining to vocal cord status include the position of the vocal cord (median/paramedian) and edema, or the presence of airway edema, which play an important role in clinical presentations and outcomes.[27] Edema is the primary cause of dysphonia that manifests between the 2nd and 5th postoperative days. Six months of dysphonia may be caused by traction injury to the RLN and axon destruction. Cutting, ligating, or cauterizing the RLN is the usual cause of dysphonia that lasts longer than 6 months.[28] In addition to the hoarseness that comes with unilateral RLN injury, bilateral RLN injury causes dyspnea and frequently fatal glottic blockage.[29] The voice is typically husky with unilateral RLN injury because the vocal cords do not approximate one another. Edema is typically the source of the dysphonia that begins on the 2nd–5th postoperative days, while traction damage of the RLN can result in dysphonia that lasts up to 6 months. Cutting, ligating, or cauterizing the RLN is typically the cause of dysphonia that lasts longer than 6 months.[28]

Diagnosis of Recurrent Laryngeal Nerve Injury

Preoperative and postoperative laryngoscopy are usually advocated for the assessment of RLN. The diagnostic methods for diagnosis of vocal cord paralysis range from indirect laryngoscopy to fiber-optic laryngoscopy or even supplemented by video-stroboscopy.[30] Although indirect laryngoscopy is simple to perform, it has restricted visual field and diagnostic accuracy. Many patients cannot tolerate this method because of the gag reflex. Indirect laryngoscopy is often not considered an adequate method for assessment of the vocal cord or larynx. Fiber-optic nasopharyngolaryngoscopy offers a more detailed and wider view of the larynx in a physiological position compared to indirect laryngoscopy. In fiber-optic nasopharyngolaryngoscopy, the optical illumination and magnification can allow images to be seen on a screen for higher definition evaluation. Video-stroboscopy is an advanced technology for the assessment of vocal cords. This technique utilizes a high-frequency strobe light to analyze the vibration and mucosal wave of the vocal folds during phonation.[30] Intraoperative visualization and capsular dissection of RLN is the gold standard for the evaluation of RLN injury during thyroid surgery.

How to Prevent Injury of Recurrent Laryngeal Nerve

Intraoperative hemostasis and a thorough understanding of the RLN anatomy are needed for nerve identification [Figure 2] and preservation. Intraoperative neuromonitoring helps in several ways to prevent injury of RLN. The major advantage of intermittent intraoperative neuromonitoring is at the dominant side of a thyroid surgery as it decreases the risk of bilateral RLN paralysis by staging the thyroidectomy.[31] Chronic intraoperative neuromonitoring is helpful in detecting imminent and/or increasing RLN risk intraoperatively. The traction of RLN is still the commonest cause of RLN injury and is difficult to avoid with the use of intermittent intraoperative neuromonitoring during thyroid surgery. Chronic intraoperative neuromonitoring is helpful in avoiding imminent tract of RLN injury by detecting the progressive reduction of EMG amplitude combined with a progressive increase of latency. The best way to ensure the integrity of RLN is to identify the nerve during thyroid surgery.[32] In the last few years, bilateral subtotal thyroidectomy has been replaced by total thyroidectomy as the better option for the management of patients with bilateral benign multinodular goiter, Grave's diseases, and all but very low-risk thyroid cancer patients. An important change in operative technique has been moved from lateral dissection to capsular dissection that prevents injury to RLN.[33] Permanent injuries of RLN are best avoided

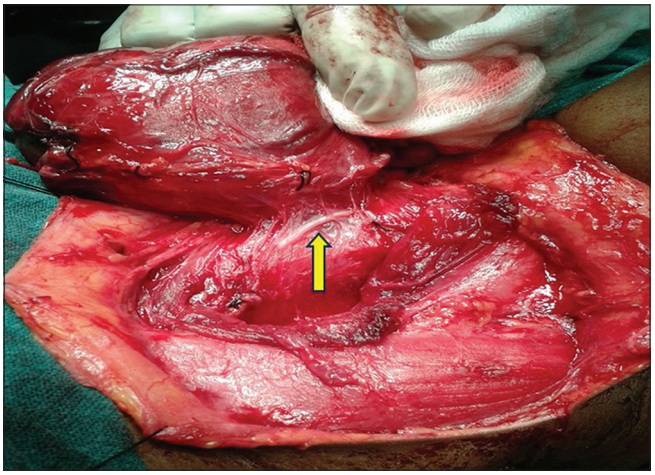

Figure 2: Intraoperative identification of recurrent laryngeal nerve (yellow arrow)

by identifying and carefully tracing the pathway of the RLN.[34] The experiences of the surgeon, histopathological diagnosis, previous thyroid surgery, surgical technique, and anatomical variations are important factors affecting the injury of RLN.[35] Visual identification of RLN during thyroid surgery is considered the gold standard for preserving RLN and is associated with a lesser chance of permanent vocal cord palsy.[36] Intraoperative neural monitoring of RLN should not be used as the sole method for identification and preserving the nerve although it can be utilized to help in the identification and dissection of the RLN and may aid in the protection of the nerve in high-risk cases including cancer surgery and reoperative surgery.

Treatment

Treatment is not necessary for unilateral asymptomatic vocal cord paralysis brought on by RLN damage. Teflon paste injections or medialization thyroplasty may be used to treat hoarseness of voice caused by glottic air leakage (lateral to the vocal cord).[37] Treatment of bilateral abductor vocal cord paralysis needs an immediate adequate airway. Treatment options for bilateral vocal cord paralysis include corticosteroid injections, arytenoidectomy with or without cordectomy, and tracheostomy.[38] Arytenoid surgery usually displaces the posterior part of the vocal cord laterally, so provides an adequate airway. The injured RLN can be repaired immediately after injury. The reinnervation techniques of RLN injury are usually selected as per the course of the disease, the extent of neurological injury, and the types. Ultrasonic dissector may be useful to reduce the damage of RLN.[39] It also reduces the rate of complications such as transient and definitive hypocalcemia and reduces the operative time of thyroid surgery.[39] It is usually suggested that when RLN has been avulsed, severed, or sacrificed during thyroid surgery, it should be repaired immediately during surgery. Intraoperative repair of RLN enables the maintenance of vocal cord tone, better voice recovery, and avoidance of aspiration.[40] It has been found that microsurgical repair of the RLN improves function. After both cranial and experimental nerve injuries, the calcium antagonist nimodipine (patients were taken orally nimodipine tablet at 30 mg × 2 three times daily for 2–4 months) enhances functional recovery. According to one study, nimodipine medication combined with acute reinnervation of the RLN via graft or raphy provides a safe and great outcome after RLN injury.[41] To fix the flaw without creating tension, direct microsuture is frequently utilized.[42] The use of fibrin glue for RLN repair has also been suggested, although it has drawn criticism because to its toxicity, excessively delayed reabsorption, and potential to cause inflammation in peripheral tissues.[42] Nerve grafting may be performed using the transverse cervical nerve, supraclavicular nerve, vagus nerve, or ansa cervicalis if the proximal stump of the RLN cannot be utilized.[42]

Prognosis

To anticipate the functional result for patients with nerve injury, laryngeal electromyography is a dependable method for diagnosing the type of lesion inside the RLN.[43] After thyroid surgery, the prognosis for RLN injuries is favorable, while it is less favorable for thermal burns.[44] According to one study, almost 87% of RLN palsy patients had a full recovery in 6 months.[44] The risk of harm during thyroid surgery is decreased by the intentional detection of RLN. More pronounced pathological alterations result from the extended denervation time. To lessen the atrophy and fibrosis of laryngeal muscles brought on by denervation, intrinsic laryngeal muscles may get subclinical innervation due to the possibility of spontaneous healing of RLN injuries.[45] Long-term denervation results in severe denervation, atrophy, and muscle fibrosis. Since denervation cannot be reversed completely, muscle contractility cannot be fully restored.

Conclusion

During thyroid surgery, RLN injury is a known consequence. Voice changes and respiratory difficulties are just two of the many signs that can indicate RLN injury. There is a higher chance of RLN injury after surgery for thyroid cancer, Grave's disease, and recurrent goiter. The surgery for thyroid cancer has a higher rate of permanent RLN paralysis due to a higher incidence of extra-thyroid invasion. Surgeons should be more meticulous when approaching the RLN during surgery of the thyroid gland, specifically when performing total thyroidectomy with central lymph node clearance.

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Conflicts of interest

There are no conflicts of interest.

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