Review Article

Techniques of detecting recurrent laryngeal nerve palsy in patients undergoing thyroid surgery: Pearls and pitfalls

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Abstract

Though permanent vocal cord palsy consequent to recurrent laryngeal nerve (RLN) injury is rare following thyroidectomies, its consequences are grave enough for it to be the most feared complication postoperatively. Anesthesiologists and surgeons take various precautions to prevent its occurrence and employ various methods for its early detection. They include direct visualization of the nerve intraoperatively, use of intraoperative nerve monitoring, and post-extubation visualization of vocal cord mobility by use of direct or indirect methods. In the present narrative review, we aim to discuss the clinical evidence pertaining to the various methods adopted for the prevention and early detection of RLN palsy during thyroidectomy.

Keywords: Recurrent laryngeal nerve palsy, thyroidectomy, vocal cord movement

Introduction

Vocal cord palsy consequent to intraoperative recurrent laryngeal nerve (RLN) injury is one of the most serious and dreaded complications of thyroid and parathyroid surgery. The incidence of transient vocal cord injuries is between 2% and 30%; however, permanent RLN injury varies from 0.5% to 5%.[1,2] The patency of RLN is assessed by checking the vocal cord movements intraoperatively via intraoperative nerve monitoring (IONM)[3] or before awakening the patient at the end of thyroidectomy.[4] The RLN integrity is checked either intraoperatively or immediately after completion of surgery before extubation of trachea. The latter includes various techniques such as direct laryngoscopic visualization,[5,6] visualization using fiberoptic bronchoscope via laryngeal mask airway (LMA),[7] LMA CTrach assisted visualization,[8] and recently, use of videolaryngoscopes (VLs)[9] and ultrasonography (USG).[10] These various methods utilized both intraoperatively and after surgery assist in the early detection of vocal cord palsy. This can help in formulating an airway management plan in consultation with the surgeons; in addition, the documentation of vocal cord movement at the end of surgery may have medicolegal relevance, especially in high-risk patients. The present narrative review discusses the efficacy and clinical evidence for and against each technique and the future perspectives as regards to the assessment of vocal cord function to rule out RLN palsy during thyroidectomy.

Material and Methods

The literature search was done using PubMed, Medline, and Science Direct databases. The abstracts of articles published between January 2006 and April 2022 were retrieved. The search strategy used in PubMed was "(thyroidectomy OR parathyroid surgery) AND (recurrent laryngeal injury

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OR recurrent laryngeal nerve palsy) AND (intraoperative nerve monitoring) " OR "direct laryngoscopy" OR "fiberoptic-assisted visualization via LMA" OR "videolaryngoscopes "OR "ultrasonography" OR "LMA CTrach"). Similarly, the search strategy was adapted for the other databases. Following review of the abstracts, the full text of the relevant articles was retrieved and reviewed. Two authors (GCT and AG) had read all the articles and also took a decision regarding their incorporation in the present review. We did not apply any language restriction, so as to include the maximum number of articles, thus minimizing language bias.

IONM system

Conventionally visual inspection of the RLN during the surgery has been used to reduce vocal cord paralysis.[3] It has been touted as a tool for guided and graded resection of the thyroid. However, a visual inspection cannot be failproof and a more reliable indicator is desirable to prevent this dreaded complication. IONM is increasingly being applied in these procedures as an advanced modality that has been thought to identify RLN, predict postoperative function, and reduce the incidence of RLN injury and enhance the overall safety of thyroid surgery.[3,11] However, the present evidence is conflicting. Essentially, IONM monitors vocal cord muscle response to RLN stimulation. The response of the vocal cord is measured using surface electrodes, which are part of specialized endotracheal tubes or attached externally. The endotracheal tubes with embedded electrodes increase their outer diameter, and one needs to be careful in selecting the appropriate size of the tube [Figure 1]. The RLN can be either monitored using a handheld probe or electrodes attached to the vagus nerve. Stimulation of RLN leads to laryngeal adductor reflex.[12] The response is displayed on the monitor as either audio or visual electromyographic (EMG) signal. The changes in the signal received alert the operating team regarding the integrity of the nerve. This can be done intermittently or continuously. Logically, a continuous stimulation may facilitate earlier identification of the possible RLN injury. However, continuous stimulation may lead to hemodynamic instability due to increased vagal tone. Intermittent monitoring is most commonly used.

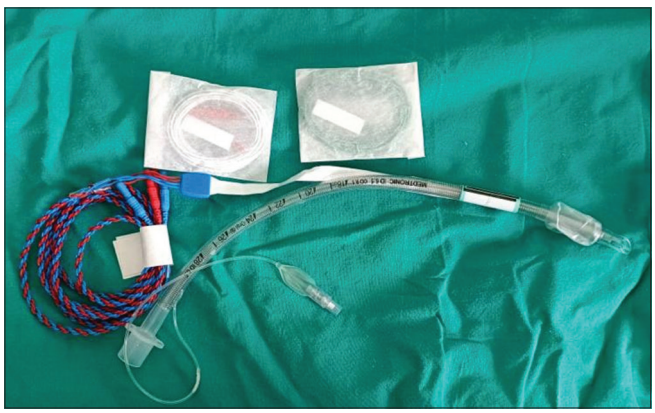

Figure 1: Electromyography tube for IONM monitoring. IONM = intraoperative nerve monitoring

Cautious dose of a short-acting neuromuscular blocker may be administered before laryngoscopy and its effect should be allowed to wear off before the IONM commences. One may consider intubation without the use of muscle relaxant, wherein adequate depth of anesthesia is achieved by the use of propofol and remifentanil infusions.

The EMG activity to IONM is best measured with short-acting muscle relaxants like succinylcholine. No long-acting muscle relaxants should be used after anesthesia induction as they may interfere with the signals. A loss of the EMG signal is defined as a decrease in the EMG amplitude to 100 cV from a baseline of >500 μV with suprathreshold vagal stimulation.[13] The use of IONM needs experience and planning, and one needs to modify the anesthesia technique appropriately.

Evidence regarding the efficacy of IONM

IONM has been compared to the current standard for RLN monitoring, that is, direct visualization of vocal cord movement, in many trials, but most of them are observational studies and small randomized trials. The role of IONM in the prevention of RLN injury is controversial. Some studies have shown that IONM was effective in reducing RLN injury, while others have revealed a nonsignificant role in preventing RLN injury.[14-16] It has been suggested that IONM may be more helpful in low-volume centers. A recent meta-analysis and systematic review has reported no specific advantage of IONM with respect to RLN palsy (permanent: relative risk [RR] 0.77, 95% confidence interval [CI] 0.33–1.77 or transient: RR 1.25, 95% CI 0.45–3.47) compared to visualized RLN identification, especially in experienced hands.[17]

However, it may be useful for procedures done in low-volume centers. A meta-analysis showed that IONM reduced the incidence of RLN injury in low-volume centers with less than 300 nerves at risk.[18] Also, it may be a useful adjunct to the visualization of RLN in patients with redo surgery, bilateral surgery, large retrosternal thyroid, and malignancy.[19] However, it should not be considered as a replacement for a good surgical technique.

Techniques to rule out RLN injury in thyroidectomy

In routine clinical practice, vocal cord movements are assessed to rule out RLN injury before awakening the patient at the end of thyroidectomy. It is recommended that routine postoperative

laryngoscopy should be done in patients who have undergone thyroidectomy, more so, in suspected cases.[4,20,21] Detection of vocal cord palsy before extubation of trachea can help in formulating an airway management plan.[22] Various techniques described for this purpose are direct laryngoscopy following reversal of neuromuscular blockade, fiberoptic-assisted visualization of vocal cords via LMA, LMA CTrach, transcutaneous ultrasonography (TCUSG), and use of VLs.[5-10] The most commonly utilized techniques are direct laryngoscopic assessment using conventional laryngoscopes and fiberoptic-assisted visualization via LMA.[22]

Direct laryngoscopy using conventional Macintosh blade under sedation for visualization of glottis at the end of thyroidectomy

The frequently used technique for this purpose is direct laryngoscopy following reversal of neuromuscular blockade under sedation.[23] However, the reported concerns are obscured laryngeal view, difficulty in laryngoscopy in difficult airway cases, precipitation of laryngospasm, considerable hemodynamic changes, and patients' discomfort. The root cause of the aforementioned problems is the light plane of anesthesia.[5,22,24] The main advantages of this technique are familiarity with the technique and no need for any preparation or advanced equipment.

Fiberoptic-assisted visualization of laryngeal structures via LMA

The most recommended technique for vocal cord assessment following thyroidectomy is replacement of endotracheal tube (ETT) with LMA (Bailey's maneuver) followed by fiberoptic assessment of glottic structures.[22,25-28] Ellard *et al.*[25] first reported this extubation strategy, wherein LMA-Classic was utilized as an intermediate device to facilitate the passage of flexible bronchoscope for visualization of vocal cords following thyroidectomy. The technique was reported to be safe and allowed visualization of vocal cord movement and supraglottic structures in addition to tracheal repair.[25] Similar to this, Lee *et al.*,[29] in a case report, described bronchoscopic assessment through an LMA-Classic in a patient with documented supraglottic, subglottic, and intrathoracic airway obstruction following thyroidectomy. This technique confirmed tracheomalacia, which enabled early management with noninvasive continuous positive airway pressure to maintain airway patency.

This technique is associated with minimal airway trauma and sympathetic stimulation.[5,30] The practical concerns with this technique are the availability of fiberoptic bronchoscope, the setup and skill of the operator, replacement of ETT with LMA, and the need for continuous oxygenation during the procedure.[25,31]

LMA CTrach for visualization of laryngeal structures

LMA CTrach is a device identical to intubating laryngeal mask airway (ILMA) as far as the functionality is concerned. In addition, it has an integrated fiberoptic bundle along with liquid crystal display (LCD) leading to the direct visualization of laryngeal structures. LMA CTrach not only enables ventilation, but also allows real-time visualization of intubation. A case series has evaluated the role of LMA CTrach for assessment of glottic structures following thyroidectomy and the result of this preliminary study was promising in terms of its safety and tolerability by the patients.[32] A panoramic view of vocal cords accessible for view to the surgeons is the major advantage of this device. In addition, it provides continued ventilation during the procedure.[32] A randomized preliminary study has compared the efficacy of LMA CTrach with the standard fiberoptic-assisted visualization via LMA for visualization of laryngeal structures in thyroidectomy.[8] This study concluded that both techniques were equivalent in terms of the optimal laryngeal view obtained and the ease of visualization; however, lesser time was taken with LMA CTrach to achieve optimal laryngeal view. The LMA CTrach was designed primarily for facilitating endotracheal intubation, thus lacking the gastric drain. Therefore, there may be a very rare risk of regurgitation and aspiration; however, no such report is available till date pertaining to its use for this indication.[8,32]

VLs for visualization of laryngeal structures

Various authors have reported or evaluated the performance of various VLs, that is, GlideScope®,[33,34] C-MAC,[30,35] King Vision,[31] Truview,[31] McGrath,[36] and Airtraq®[9,37,38] VLs for visualization of vocal cords to rule out RLN injury at the end of thyroidectomy [Table 1].

VL is an alternative to the conventional laryngoscope and has the advantage of providing a better glottic view, lesser lifting force, fewer hemodynamic fluctuations, and better patient comfort. In addition, its use does not mandate the alignment of three axes into one plane, and thus offers better visibility of the vocal cords when compared to the conventional laryngoscopy.[41-43] The latter feature is of specific advantage in this situation as the neck dressing post-thyroidectomy can limit the neck movement required for visualization of laryngeal structures.

The channeled VLs have been observed to have superior laryngoscopic view when compared to the unchanneled VLs. Two case reports have evaluated Airtraq VL, a channeled VL for this indication, and observed a better laryngeal view.[9,36] Other studies utilizing VLs for this indication have observed that channeled VLs like Airtraq and Pentax AWS provide

Table 1: Literature on use of various VLs for vocal cord assessment to rule out intraoperative RLN injury during thyroidectomy

Authors	Type of research	VL used	Vocal cord view	Hemodynamics during the procedure	Patient cooperation and procedure tolerance
Shamim *et al.*[30]	Case report	C-MAC VL (C-MAC) (Karl Storz, Tuttlingen, Germany)	Optimal view	NR	Under deep anesthesia
Gupta *et al.*[35]	Case series/5	C-MAC VL (Karl Storz, Tuttlingen, Germany)	Optimal view; vocal cords easily visualized	Minimal hemodynamic changes	NR
Bensghir *et al.*[38]	Case report	Airtraq VL versus Macintosh laryngoscope	Better view than Macintosh helped in ruling out VC palsy	Better hemodynamics with Airtraq VL	Better
Sastre *et al.*[9]	Case series	Airtraq® optical VL (Prodol Meditec, Bilbao, Spain)	Better view and permits to check proper insertion and positioning of the electromyographic endotracheal tubes used for neuromonitoring	NR	NR
Tawfic *et al.*[33]	Case series	GlideScope VL versus conventional laryngoscope	Better and optimal view with GlideScope VL	NR	NR
Priyanka *et al.*[31]	RCT (60)	King Vision versus Truview VL	VC view comparable, but time to intubation was higher with King Vision	Comparable	Comparable
Shin *et al.*[36]	Case report	McGrath VL	Optimal view	NR	Better
Elbeialy *et al.*[34]	RCT (120)	GlideScope® VL versus Macintosh laryngoscope	GlideScope was more sensitive (86.7%) and specific (95.2%) with higher diagnostic accuracy (94.2%) for detecting vocal cord dysfunction than Macintosh direct laryngoscopy. The CL score was significantly better with the GlideScope	NR	NR
Jillella *et al.*[37]	RCT (66)	Macintosh laryngoscope versus McGrath VL versus Airtraq VL	The CL grade was comparable among the three groups. The CL grade improved with Airtraq than the other two groups when compared to baseline (P=0.023)	NR	Patients' comfort better with Airtraq than the other two groups
Dubey *et al.*[40]	RCT (100)	TLUSG versus C-MAC VL	Good correlation for vocal fold mobility between TLUSG and C-MAC in all, except one patient	NR	NR
Shah *et al.*[39]	RCT (45)	TLUSG versus VL	The sensitivity, specificity, positive predictive value, and negative predictive value of TLUSG when compared to VL were 75%, 95.1%, 60%, and 97.5%, respectively	Better hemodynamics with TLUSG	NR

CL=Cormack–Lehane, NR=Not reported, RCT=randomized controlled trial, TLUSG=transcutaneous laryngeal ultrasound, VL=videolaryngoscope

better Cormack–Lehane (CL) view when compared to unchanneled VLs, although the ease of blade insertion might be better in C-MAC compared to channeled VLs.[44,45]

Recently, Tawfic *et al.*,[33] in a case series, evaluated GlideScope VL to visualize vocal folds post-thyroidectomy following extubation and found that its hyperangulated blade curvature and camera with enhanced optical resolution placed at the inflection point of the blade give a superior magnified view with a larger viewing angle of the glottis, even without the proper alignment of the oral and tracheal axis. In a randomized controlled trial (RCT) by Priyanka *et al.*,[31] both Truview and King Vision VLs were found to be equally effective in the visualization of vocal cords during extubation. Patients' comfort and hemodynamic changes were both comparable between the two groups during laryngoscopy. Recently, Elbeialy *et al.*[34] concluded GlideScope to have higher diagnostic accuracy (94.2%) for detecting vocal cord disfunction than Macintosh laryngoscope with 86.7% sensitivity and 95.2% specificity. The CL score was found to be significantly better with GlideScope than by direct laryngoscopy. Similarly, Shin *et al.*[36] evaluated McGrath VL for visualization of glottic view post-thyroidectomy and found it to be more efficacious than conventional laryngoscopy.

The Airtraq VL (Prodol Meditec S.A., Vizcaya, Spain) is a channeled VL which was developed in order to facilitate tracheal intubation in both normal and difficult airways. It has recently been used in a few case reports to assess the vocal cord mobility following thyroidectomy.[9,37] We have recently completed a trial, which was also prospectively registered at the Clinical Trial Registry-India (http://ctri.nic.in) (CTRI/2018/12/022863), with the aim to evaluate and compare the performance of Airtraq VL with Macintosh laryngoscope for this indication. The results of this trial is yet to be published.

Hemodynamic pertu rbations associated with the use of VLs for vocal cord visualization following thyroidectomy

are a concern when they are used following reversal of neuromuscular blockade under intra venous (IV) sedation. In the literature search, in general, no difference in hemodynamics has been found to be reported with the use of VL when compared to conventional laryngoscopy.[46] On the contrary, in another study, lesser hemodynamic response is observed with VL (GlideScope) compared to Macintosh laryngoscope when used in controlled hypertensive patients.[47] As far as the use of VLs for this indication is concerned, the only study[31] comparing the hemodynamic changes between King Vision and Truview VL observed comparable hemodynamic changes between the two groups. Till now, no study has compared the hemodynamic changes between the use of VL and conventional laryngoscopy for this indication.

USG to rule out VC palsy

TCUSG has been reported to be a cheap and noninvasive alternative when compared to the aforementioned invasive direct visualization methods.[48,49] With B-mode USG, the vocal cord movement is confirmed by the presence of the real-time, high-resolution, gray scales.[6]

Fiberoptic and videoscopic visualization of VCs have been the recommended methods to assess vocal cord movement. On literature search, however, very few studies highlighting and evaluating the role of USG to visualize the VC in thyroidectomy have been found. Therefore, it seems to be underutilized for this purpose.[10,48,50-54] Recently, two studies have compared VL with TCUSG for this indication; the vocal cord mobility was reported to be comparable.[39,40] However, better hemodynamics was reported with TCUSG.[40]

Dedecjus *et al*.[50] evaluated 50 thyroidectomy patients perioperatively and concluded USG to be an efficacious alternative to direct laryngoscopy or detecting postoperative vocal cords dysfunction. Kumar *et al*.[10] reported USG to have a sensitivity of 100% with CI = (0.34, 1.00) and a specificity of 93.44% with CI = (0.84, 0.97), when compared to video rhinolaryngoscopy (VRL) for this indication. However, a major setback of this study was that since the sample size was small, VC palsy developed in only a few patients; but the study concluded TCUSG to be a noninvasive and cheap alternative to VRL for detecting VC palsy following thyroidectomy.

Flexible nasoendosopy (FNE) has been considered to be the gold standard for assessment of vocal cords in a spontaneously breathing patient scheduled for thyroidectomy. Recently, transcutaneous laryngeal ultrasound (TLUSG) has been found to be as efficacious as FNE, with a reported sensitivity and specificity of 100% and 89%, respectively.[55] Recently, the use of USG has been attempted intraoperatively as well to check vocal cord movement.[56] Its use intraoperatively has the advantage of being cost-effective than IONM, and studies have found it to be as efficacious as EMG during IONM for detecting VC palsy.[56]

Undoubtedly, TCUSG is an easy, safe, better tolerated, and efficacious noninvasive alternative to the other established invasive methods to visualize VCs and rule out RLN palsy in thyroid surgeries. Studies with a larger sample size are warranted to affirm its role for this indication.

Conclusion

RLN injury and consequent vocal cord palsy is a catastrophic complication of thyroidectomies, which should be diligently prevented. Intraoperatively, IONM is an upcoming modality to detect and rectify any breach in the RLN integrity, while postoperatively, various methods have been used directly or indirectly to visualize the vocal cord. Both fiberoptic-assisted and videoscopic visualization have literature backing and provide most consistent views compared to the conventional direct laryngoscopes. The LMA CTrach or similar airway device allowing direct visualization of vocal cords and continued ventilation with an additional gastric drain can be a useful potential tool for the postoperative detection of RLN palsy. USG visualization of the vocal cords is a noninvasive, quick, easy, and reproducible promising method which is likely to gain a wider role in future.

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Conflicts of interest

There are no conflicts of interest.

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