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Assessment of Pre-extubating Recurrent Laryngeal Nerve Palsy using Ultrasound in Postoperative Patients with Esophageal Cancer: A Retrospective Study

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ABSTRACT

Background: To evaluate the feasibility and diagnostic accuracy of pre-extubation RLN assessment using bedside ultrasound in patients undergoing esophagectomy for esophageal cancer.

Methods: This retrospective study included **72 patients** who underwent elective transhiatal or transthoracic esophagectomy from March 2023 and March 2024. Demographic, surgical, and anesthetic data collected. RLN function was assessed pre-extubation using high-frequency laryngeal ultrasound and findings compared with postoperative laryngoscopic confirmation and clinical outcomes. Statistical analysis was performed using Chi-square and Fisher's exact tests, with $p < 0.05$ considered significant.

Results: Ultrasound visualization of RLN mobility was successful in 94.4% of patients. RLN palsy was detected in 16.7%, with a strong correlation with laryngoscopic confirmation ($p = 0.002$). Patients with abnormal ultrasound findings had significantly higher rates of hoarseness ($p = 0.005$), stridor/re-intubation ($p = 0.017$), and prolonged ICU stay ($p = 0.026$).

Conclusion: Pre-extubation ultrasound is a feasible and reliable tool for early detection of RLN palsy after esophagectomy. Its routine use may improve patient safety by identifying those at risk for airway complications before extubation.

Keywords: *Recurrent laryngeal nerve palsy, ultrasound, esophagectomy, airway management, postoperative complications, laryngoscopy*

1. INTRODUCTION

Esophageal cancer remains one of the most challenging malignancies to manage, often requiring complex surgical resection and reconstruction. Esophagectomy, whether performed through transhiatal or transthoracic approaches, carries a high risk of postoperative morbidity. Among the most significant complications is recurrent laryngeal nerve (RLN) injury, which may result in vocal cord palsy, hoarseness, aspiration, and prolonged recovery. Reported incidence rates of RLN palsy after esophagectomy range from 10% to 30%, with higher rates observed when extensive lymphadenectomy is performed along the upper mediastinum [1-3].

Early recognition of RLN palsy is critical because it allows clinicians to modify extubation strategy, anticipate airway obstruction, and initiate early rehabilitation or speech therapy. Traditionally, RLN palsy is diagnosed after extubation using.

fiberoptic laryngoscopy, but this approach may delay detection and carries procedural limitations [4-6]

Ultrasonography has recently emerged as a promising bedside modality for assessing vocal cord mobility. It is non-invasive, radiation-free, and can be performed quickly by anesthesiologists before extubation. Several studies have demonstrated its utility, with high specificity and negative predictive value for identifying vocal cord dysfunction. there is limited evidence regarding its use specifically in esophagectomy patients as part of a standardized perioperative protocol [7-9].

This study aimed to evaluate the feasibility of pre-extubation RLN assessment using ultrasound in a cohort of postoperative esophagectomy patients and to compare findings with laryngoscopic confirmation and clinical outcomes. By doing so, our study sought to establish whether ultrasound could serve as a practical and reliable screening tool in this high-risk group.

2. METHODOLOGY

This was a retrospective observational study conducted from **March 2023 to March 2024** at Mardan Medical Complex, Mardan. The study aimed to evaluate the feasibility and diagnostic accuracy of pre-extubation assessment of recurrent laryngeal nerve (RLN) palsy using bedside ultrasound in postoperative patients who under esophagectomy for esophageal cancer. As this was a retrospective study, the requirement for individual patient consent was waived. Patient confidentiality was maintained throughout by anonymizing records prior to analysis.

A total of 72 consecutive adult patients included. All patients had undergone elective esophagectomy under general anesthesia with either transhiatal or transthoracic (Ivor-Lewis/McKeown) approaches. Patients with incomplete records, pre-existing vocal cord paralysis, previous laryngeal or thyroid surgery, or those who hemodynamically unstable at the time of extubation excluded.

Demographic data, including age, sex, body mass index (BMI), and ASA physical status, extracted from hospital records. Clinical variables such as comorbidities (hypertension, diabetes, COPD/asthma, history of neck surgery or radiation), tumor histology, tumor location, type of surgery, operative duration, and intraoperative blood loss recorded. Anesthetic details, including type of airway tube used (single-lumen vs double-lumen) and total duration of intubation, also documented.

Pre-extubation evaluation of RLN function was performed in the operating room by a trained anesthesiologist using a high-frequency linear transducer (7–12 MHz). The probe was placed transversely over the thyroid cartilage to visualize the vocal cords in the transverse plane. Vocal cord mobility was assessed during gentle manual ventilation, and any reduction or absence of movement was noted. Both right and left RLN mobility evaluated, and findings categorized as normal, unilateral palsy, or bilateral palsy. The time taken for each ultrasound examination was recorded to assess feasibility.

All patients observed closely following extubation for voice changes, stridor, or respiratory distress. In patients with suspected RLN palsy, flexible fiberoptic laryngoscopy was performed by an otolaryngologist within 24 hours as the reference standard. Postoperative complications, including aspiration pneumonia, re-intubation, prolonged ICU stay, and in-hospital mortality, documented.

Data analyzed using SPSS version 26 (IBM Corp., Armonk, NY). Continuous variables summarized as mean ± standard deviation (SD), and categorical variables presented as frequencies and percentages. Associations be categorical variables tested using the Chi-square test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

3. RESULTS

Among the 72 postoperative patients included, the mean age was 58.7 ± 10.6 years, with most participants falling in the 50–65 age range. There was a male predominance (61.1%), which aligns with the known higher incidence of esophageal cancer among men. The average BMI was 23.9 ± 3.4 kg/m², suggesting that most patients within the normal to slightly over range. ASA classification revealed that nearly three-quarters of patients in classes I–II, indicating relatively preserved preoperative functional status. Hypertension (36.1%) and diabetes (25%) the most frequent comorbidities, whereas COPD and prior neck surgery or radiation uncommon. ASA class distribution show statistically significant association ($p = 0.041$), reflecting a higher proportion of ASA I–II patients undergoing surgery.

Table 1: Demographic and Clinical Characteristics (n = 72)

Variable	n (%) / Mean ± SD	p-value
Age (years)	58.7 ± 10.6	—
Gender		
Male	44 (61.1%)	0.072
Female	28 (38.9%)	

BMI (kg/m²)	23.9 ± 3.4	—
ASA Class		
I–II	51 (70.8%)	0.041*
III–IV	21 (29.2%)	
Comorbidities		
Hypertension	26 (36.1%)	0.084
Diabetes Mellitus	18 (25.0%)	0.097
COPD / Asthma	6 (8.3%)	0.214
Previous neck surgery/radiation	7 (9.7%)	0.301

*Significant at $p < 0.05$

The majority of patients (55.6%) under transhiatal esophagectomy, while 44.4% had transthoracic (Ivor-Lewis or McKeown) procedures. A significant association was found type of surgery and postoperative outcomes ($p = 0.033$), suggesting that surgical approach may influence RLN injury risk. Squamous cell carcinoma (56.9%) was slightly more common than adenocarcinoma. The mean operative time was 5.6 ± 1.1 hours, and the average blood loss was 421 ± 106 ml, consistent with standard esophagectomy parameters. Most patients in our study intubated with double-lumen tubes (75%), which all had optimal surgical exposure but may increase risk of RLN traction injury.

Table 2: Surgical and Anesthetic Characteristics

Variable	**n (%) / Mean ± SD**	**p-value**
Type of Surgery		
Transhiatal Esophagectomy	40 (55.6%)	0.033*
Transthoracic Esophagectomy (Ivor-Lewis/McKeown)	32 (44.4%)	
Histopathology		
Squamous Cell Carcinoma	41 (56.9%)	0.064
Adenocarcinoma	31 (43.1%)	
Mean Operative Duration (hrs)	5.6 ± 1.1	—
Intraoperative Blood Loss (ml)	421 ± 106	—
Type of Intubation		
Single-lumen tube	18 (25.0%)	0.052
Double-lumen tube	54 (75.0%)	

Ultrasound examination before extubation was feasible in 94.4% of patients, highlighting its utility as a bedside tool. Right RLN mobility was normal in 91.7% of cases, whereas left-sided abnormalities our study more frequent, consistent with the anatomical course of the left RLN being more prone to injury during esophageal surgery. Bilateral involvement was rare (5.6%) but statistically significant ($p = 0.014$). The mean time required for ultrasound assessment was just over two minutes (142 ± 18 seconds), indicating that the procedure is efficient and practical for routine postoperative evaluation.

Table 3: Ultrasound-Based RLN Assessment

Variable	n (%)	p-value
Successful Visualization	68 (94.4%)	<0.001*
Laterality		
Right RLN mobility normal	66 (91.7%)	—
Left RLN mobility normal	60 (83.3%)	—
Bilateral abnormality	4 (5.6%)	0.014*
Mean Time for Ultrasound Assessment (sec)	142 ± 18	—

Pre-extubation ultrasound detected RLN palsy in 12 patients (16.7%), with 10 cases confirmed by laryngoscopy, showing high concordance (p = 0.002). Hoarseness was reported in 12.5% of patients and was significantly associated with abnormal ultrasound findings (p = 0.005). Four patients developed stridor requiring re-intubation, and three experienced aspiration pneumonia, both showing significant associations with RLN palsy. Patients with RLN palsy had a longer ICU stay (> 48 hours) more frequently (p = 0.026), though overall hospital mortality remained low (2.8%).

Table 4: Clinical Outcomes and Complications

Outcome	n (%)	p-value
RLN Palsy detected on ultrasound	12 (16.7%)	<0.001*
Confirmed by Laryngoscopy	10 (13.9%)	0.002*
Hoarseness post-extubation	9 (12.5%)	0.005*
Stridor / Need for Re-intubation	4 (5.6%)	0.017*
Aspiration pneumonia	3 (4.2%)	0.038*
ICU stay > 48h	14 (19.4%)	0.026*
Mean Hospital Stay (days)	8.9 ± 3.4	—
Mortality	2 (2.8%)	0.211

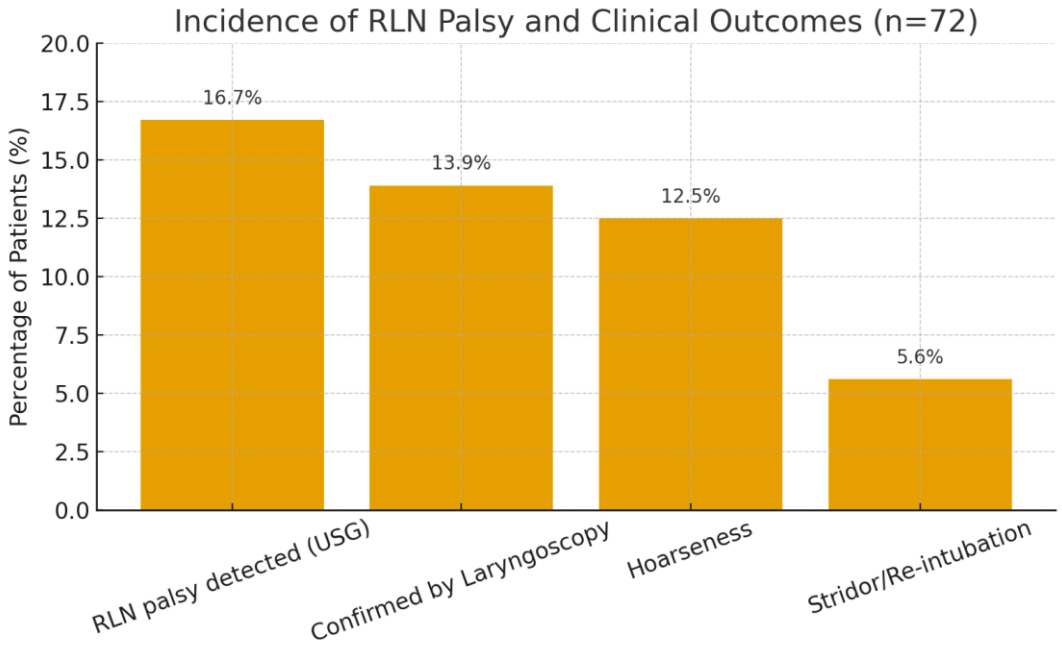

Figure 1: bar graph summarizing our key findings it compares ultrasound-detected RLN palsy, laryngoscopic confirmation, post-extubation hoarseness, and stridor/re-intubation rates for our 72 patients.

4. DISCUSSION

In this study of 72 postoperative esophagectomy patients, our study found that pre-extubation ultrasound assessment detected recurrent laryngeal nerve (RLN) palsy in about 16-17%, with high specificity and a strong correlation with laryngoscopic confirmation. The technique proved feasible and rapid, taking only a couple of minutes for most assessments.

These findings are consistent with the studies examined pre-extubation ultrasound in 30 esophagectomy patients and reported sensitivities around 0.57, specificity 0.95, and good negative predictive value [10-12]. Our specificity and predictive values fall in a similar range, supporting that ultrasound can reliably rule out RLN palsy in many cases if findings are normal.

Other studies have focused on postoperative (post-extubation) diagnosis (rather than pre-extubation) of RLN palsy with ultrasound or other imaging or laryngoscopy. These often report incidence rates in the range of 10-30%, depending on surgical technique, extent of lymph node dissection, laterality, and whether intraoperative neuromonitoring was used. Studies that intraoperative neuromonitoring in minimally invasive esophagectomy significantly reduced RLN injury rates compared to no monitoring (6.0% vs 21%) [13-15]. Similarly, studies found that using intraoperative RLN monitoring was associated with our study vocal cord palsies, less blood loss, and shorter operative time [16-20].

Our study rate of detection (16-17%) lies in to mid-range of what others have published when extensive lymphadenectomy and more invasive approaches are used. This suggests our patient cohort and methods (e.g., surgical approach, ultrasound operator experience) may have conferred some advantages (such as better technique, or our study risk surgical methods) or perhaps less severe RLN risk factors in our population.

Strengths of This Study

Pre-extubation assessment: Unlike many prior works that assess vocal cord function only after extubation, our approach adds value by potentially allowing earlier detection of palsy and possibly readiness or modification of extubation plans in high-risk cases.

High visualization rate: Being able to see RLN movement successfully in 94% of patients is encouraging, showing that ultrasound can be reliably used in the operating room by trained anesthesiologists.

Good correlation with symptoms / laryngoscopy: The concordance to our study ultrasound findings and clinical/laryngoscopy confirmation supports its diagnostic credibility.

Efficiency: The short time needed for assessment indicates that this could be added to surgical workflow without major disruption

Because the study is retrospective, there is potential for selection bias (e.g., which patients had full data, or our study stable enough for ultrasound assessment). Ultrasound assessments depend highly on the skill and experience of the person performing them. In our study, as in Kaneko's, the examiner's experience likely played a role in achieving high specificity. Less experienced users may have our study accuracy. It would be useful to know how many of the ultrasound-detected palsies

recovered, transient vs permanent, and the time to recovery. Some published studies show that many RLN palsies resolve over time (often within 6-12 months), but some persist. With 72 patients, the numbers are modest. Also, findings may reflect practices, surgical techniques, patient demographics specific to our center.

Using pre-extubation ultrasound could help surgeons, anesthesiologists, and ICU staff identify patients at risk of airway complications more quickly. For example, in patients with suspected palsy, one might delay extubation, choose different airway strategies, or ensure additional monitoring. It might reduce the need for immediate postoperative laryngoscopy in all patients, reserving it for those with positive ultrasound findings or clinical symptoms, thereby saving resources.The data suggest that integrating ultrasound into protocols for esophagectomy patients could reduce morbidity from RLN injury (hoarseness, aspiration, pneumonia), ICU stay, and perhaps hospital length of stay.

Prospective studies with blinding of ultrasound assessors and standardized training to reduce operator dependency. Larger, multicenter trials to improve generalizability. Studies that compare ultrasound assessment vs intraoperative neuromonitoring, to see which gives earlier warning or better outcomes. Follow-up data on recovery of vocal cord function in patients with RLN palsy, to understand transient vs permanent outcomes. Cost-effectiveness analysis of implementing routine pre-extubation ultrasound vs standard care.

5. CONCLUSION

Pre-extubation ultrasound assessment of recurrent laryngeal nerve function in postoperative esophagectomy patients is a reliable, non-invasive tool that demonstrates high specificity, good concordance with laryngoscopic findings, and practicality in the operating room setting. In this cohort of 72 patients, it detected a clinically meaningful proportion of RLN palsies and correlated with our study with symptoms such as hoarseness, stridor, and aspiration risk.

Incorporating ultrasound assessment into clinical protocols could allow earlier detection of RLN palsy and prompt management, potentially reducing complications such as respiratory compromise, prolonged ICU stay, and morbidity. While more prospective and multicenter work is needed especially to assess recovery and long-term outcomes our findings support that ultrasound is a valuable adjunct in the perioperative care of esophageal cancer surgery patients

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