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Postoperative Voice Changes and Occult Recurrent Laryngeal Nerve Dysfunction Following Thyroidectomy

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ABSTRACT
Background: Voice disturbance following thyroidectomy may occur with or without recurrent laryngeal nerve injury, while mild nerve dysfunction may remain clinically silent.
Objective: To determine the frequency, pattern, recovery, and predictors of postoperative voice changes and occult recurrent laryngeal nerve dysfunction following thyroidectomy.
Methods: This prospective observational study included 120 adults undergoing thyroidectomy at Continental Medical College, Lahore, Pakistan, between March 2024 and December 2025. Assessments were performed preoperatively and at 48–72 hours, 2 weeks, 6 weeks, and 3 months using the Voice Handicap Index-10, perceptual voice grading, acoustic analysis, maximum phonation time, and flexible videolaryngoscopy. Patients with persistent dysfunction were followed for 6 months. Multivariable logistic regression identified factors associated with recurrent laryngeal nerve dysfunction.
Results: Clinically significant voice changes occurred in 39 patients (32.5%) at 48–72 hours and declined to 5 patients (4.2%) at 3 months. Recurrent laryngeal nerve dysfunction was detected in 11 patients (9.2%), corresponding to 5.5% of 200 nerves at risk. Four cases (36.4%) were occult. Among 109 patients with normal vocal-fold mobility, 32 (29.4%) developed clinically significant voice changes. Normal vocal-fold mobility was restored in 10 of 11 affected patients within 6 months. Central neck dissection, longer operative duration, and intraoperative loss of signal independently predicted postoperative recurrent laryngeal nerve dysfunction.
Conclusion: Post-thyroidectomy voice changes were more frequent than detected recurrent laryngeal nerve dysfunction. Routine or risk-based postoperative laryngoscopy may detect clinically silent paresis, while multidimensional voice assessment can identify non-paralytic dysfunction and support rehabilitation and specialist follow-up.
Keywords: Thyroidectomy; voice disorders; recurrent laryngeal nerve; vocal-fold paresis; dysphonia; videolaryngoscopy.

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INTRODUCTION
Thyroidectomy is one of the most commonly performed endocrine surgical procedures and generally yields favorable outcomes when undertaken by experienced surgeons [1]. Nevertheless, despite advances in operative technique, routine identification of the recurrent laryngeal nerve (RLN), and increasing use of intraoperative neuromonitoring, postoperative voice alteration remains an important clinical concern. Even minor changes in voice quality may adversely affect communication, occupational performance, social interaction, and quality of life, particularly among professional voice users [2].

The RLN innervates nearly all intrinsic muscles of the larynx and plays a central role in vocal-fold movement, glottic closure, airway protection, and phonation [3]. Following thyroid surgery, vocal-fold weakness, paresis, or paralysis may present as hoarseness, breathiness, vocal fatigue, reduced voice projection, weak cough, choking, or aspiration. Although bilateral dysfunction is uncommon, it may cause severe airway compromise. The risk of RLN dysfunction may be greater in patients undergoing total thyroidectomy, central neck dissection, or reoperative surgery, and in those with malignant, retrosternal, or anatomically complex thyroid disease [4].

However, postoperative dysphonia cannot always be attributed to visible RLN injury [5]. Voice changes may occur despite normal vocal-fold mobility because of intubation-related trauma, laryngotracheal edema, postoperative pain, strap-muscle dysfunction, local inflammation, scar formation, impaired laryngotracheal mobility, or injury to the external branch of the superior laryngeal nerve. These factors may alter pitch, loudness, endurance, stability, and phonatory effort. Post-thyroidectomy voice disturbance should therefore be regarded as a multifactorial condition rather than as an exclusive indicator of RLN palsy [6].

On the other hand, the RLN dysfunction may occur without any voice symptoms being detected [7]. If the paresis is unilateral and mild, the contralateral vocal fold may compensate, and patients with less extensive vocal needs may not be aware of subtle changes in their projection, pitch or phonation time. So, subjective hoarseness should not be the sole index of nerve dysfunction after surgery, which might lead to underestimation. Structured laryngeal examination is more reliable in the detection of clinically occult abnormalities [8].

Flexible videolaryngoscopy is still the main technique used to assess vocal-fold mobility pre- and postoperatively of thyroid surgery [9]. But laryngoscopy does not necessarily fully depict the functional impact of voice disturbance after surgery. In addition, patient-reported assessments like the Voice Handicap Index-10, perceptual voice assessment, acoustic analysis and maximum phonation time may be included in a comprehensive evaluation. Combining subjective and objective measures may help distinguish neural dysfunction from non-neural causes of postoperative voice change [10].

Early identification of RLN dysfunction, including mild or clinically silent cases, is important because it facilitates patient counselling, aspiration-risk assessment, structured follow-up, voice therapy, and referral for laryngeal intervention when recovery is incomplete. It also improves operative documentation and surgical audit [11]. However, routine postoperative laryngoscopy is not universally performed, and symptom-based assessment may fail to detect clinically silent abnormalities in vocal-fold mobility [12].

Further prospective studies using standardized preoperative and scheduled postoperative assessments are needed to define the incidence, pattern, and recovery of voice changes after thyroidectomy [13]. Therefore, this study aimed to determine the frequency and severity of postoperative voice changes, identify occult RLN dysfunction through systematic laryngeal examination, evaluate the relationship between subjective voice symptoms and objective vocal-fold findings, assess recovery over time, and identify perioperative predictors of postoperative RLN dysfunction.

MATERIALS AND METHODS

This prospective observational study was conducted at Continental Medical College, Lahore, Pakistan, from March 2024 to December 2025. Ethical approval was obtained from the Institutional Review Board of Continental Medical College before participant recruitment (Reference No. 55/IRB/CMC). Written informed consent was obtained from all participants after explaining the study objectives, procedures, potential risks, and benefits. Participant confidentiality and anonymity were maintained, and the collected data were used exclusively for research purposes. The study was conducted in accordance with the principles of the Declaration of Helsinki.

A total of 120 adults aged 18–70 years who were scheduled to undergo elective primary hemithyroidectomy, near-total thyroidectomy, total thyroidectomy, or total thyroidectomy with central-compartment lymph-node dissection were enrolled through consecutive non-probability sampling. The sample size was calculated using an anticipated postoperative voice-change frequency of 25%, an absolute precision of ±8%, and a 95% confidence level. Patients were eligible if they had normal phonatory function and normal bilateral vocal-fold mobility before surgery.

Patients with a history of thyroid or major neck surgery, previous neck irradiation, pre-existing vocal-fold dysfunction, structural laryngeal disease, severe dysphonia, neuromuscular disorders affecting phonation, previous tracheostomy, planned recurrent laryngeal nerve resection, emergency surgery, or prolonged postoperative mechanical ventilation were excluded. Patients who did not undergo the required postoperative laryngoscopic assessment or complete the scheduled follow-up were also excluded from the final analysis.

Baseline data included age, sex, body mass index, smoking status, professional voice use, thyroid-disease characteristics, thyroid-function status, ultrasonographic findings, thyroid size, retrosternal extension, cytological findings, and indication for surgery. Professional voice users were defined as individuals whose occupations required frequent, sustained, or precise use of the voice.

All participants underwent flexible transnasal videolaryngoscopy and multidimensional voice assessment within 7 days before surgery. Videolaryngoscopic assessment included vocal-fold mobility, symmetry, glottic closure, mucosal appearance, and the presence of structural abnormalities. Voice-related disability was assessed using the Voice Handicap Index-10 (VHI-10). A VHI-10 score of ≥11 or an increase of ≥6 points from baseline was considered clinically significant. Participants were also assessed for hoarseness, breathiness, vocal fatigue, reduced voice intensity, altered pitch, weak cough, choking, aspiration, and increased phonatory effort.

The perceptual voice quality was assessed by the Grade, Roughness, Breathiness, Asthenia, Strain scale. Sustained /a/ vowel recordings were obtained and standardized for acoustic analysis using Praat software, version 6.4. The acoustic parameters that were assessed were F0, jitter, shimmer and HNR. The Fundamental frequency was analysed separately for males and females. Maximum phonation time was obtained after a maximum inspiration. Three attempts were made and the longest duration analysed.

A standardized extracapsular technique was used for all procedures, which were either performed by consultant surgeons or suitably supervised senior trainees. The recurrent laryngeal nerve was identified and protected whenever possible and the superior thyroid vessels were ligated near the thyroid capsule. Excessive traction, compression, ligation, and thermal-energy application near the nerve were avoided.

Recorded operative variables included the type of surgical procedure, presence of malignancy, thyroid size, retrosternal extension, central neck dissection, operative duration, difficulty of dissection, visual identification of the recurrent laryngeal nerve, number of nerves at risk, and suspected intraoperative nerve injury. One recurrent laryngeal nerve was considered at risk during hemithyroidectomy, whereas two nerves were considered at risk during near-total or total thyroidectomy.

Intermittent intraoperative neuromonitoring was used when available. Vagal and recurrent laryngeal nerve responses were assessed before and after thyroid resection. Loss of signal was defined as a reduction of more than 50% in response amplitude or the complete disappearance of a previously satisfactory response after excluding technical causes.

Postoperative assessments were performed at 48–72 hours, 2 weeks, 6 weeks, and 3 months. Patients with unresolved vocal-fold dysfunction were reassessed at 6 months. At each follow-up visit, participants underwent symptom evaluation, VHI-10 scoring, perceptual voice assessment, acoustic analysis, and measurement of maximum phonation time. Routine flexible videolaryngoscopy was performed in all patients at 48–72 hours after surgery, regardless of the presence of voice symptoms. Repeat videolaryngoscopy was performed in patients with abnormal vocal-fold mobility or persistent voice-related complaints.

Postoperative recurrent laryngeal nerve dysfunction was defined as newly developed vocal-fold hypomobility, paresis, or paralysis following surgery. Occult recurrent laryngeal nerve dysfunction was defined as abnormal postoperative vocal-fold mobility without subjective hoarseness or clinically significant deterioration in the VHI-10 score. Clinically significant postoperative voice change was defined as the presence of at least one of the following: a VHI-10 score of ≥11, an increase of ≥6 points from baseline, new-onset dysphonia, deterioration of at least one grade on perceptual voice assessment, a reduction of at least 20% in maximum phonation time from baseline, or clinically meaningful deterioration in acoustic parameters.

Clinically significant voice changes occurring despite normal bilateral vocal-fold mobility were classified as non-paralytic voice changes. Recurrent laryngeal nerve dysfunction that resolved within 6 months was classified as transient, whereas dysfunction persisting at 6 months was classified as persistent. The primary outcome was clinically significant voice alteration at 2 weeks after thyroidectomy. Secondary outcomes included postoperative recurrent laryngeal nerve dysfunction, occult dysfunction, longitudinal changes in subjective and objective voice parameters, recovery of vocal-fold mobility, non-paralytic voice changes, and perioperative predictors of recurrent laryngeal nerve dysfunction.

Data were analyzed using IBM SPSS Statistics, version 26.0. Continuous variables were presented as mean ± standard deviation or median with interquartile range, while categorical variables were reported as frequencies and percentages. Appropriate parametric and non-parametric tests were used for within-group and between-group comparisons. Multivariable logistic regression was performed to identify independent predictors of postoperative recurrent laryngeal nerve dysfunction. Results were reported as adjusted odds ratios with 95% confidence intervals, and a two-sided P value <0.05 was considered statistically significant.

RESULTS

A total of 120 patients undergoing elective thyroidectomy were included and completed follow-up to 3 months; all patients with postoperative recurrent laryngeal nerve (RLN) dysfunction were reassessed at 6 months. The cohort comprised 72 women (60.0%) and 48 men (40.0%), with a mean age of 44.6 ± 12.2 years and a mean body mass index of 26.2 ± 4.1 kg/m². Twelve patients (10.0%) were current smokers, and 18 (15.0%) were professional voice users. Benign thyroid disease was present in 90 patients (75.0%), whereas 30 (25.0%) had malignant disease. Hemithyroidectomy was performed in 40 patients (33.3%), and 80 (66.7%) underwent near-total or total thyroidectomy. Central neck dissection was performed in 18 patients (15.0%), and retrosternal extension was present in 12 (10.0%). The mean operative duration was 110 ± 32 minutes. Intraoperative neuromonitoring was used in 76 patients (63.3%), with loss of signal recorded in eight (6.7%). Postoperative RLN dysfunction occurred in 11 patients (9.2%). Affected patients were older and more frequently had malignant disease, central neck dissection, longer operative duration, and intraoperative loss of signal, as shown in Table 1.

Clinically significant voice changes were observed in 39 patients (32.5%) at 48–72 hours, including 25 women (34.7%) and 14 men (29.2%), with no significant difference between the sexes. The frequency declined to 31 patients (25.8%) at 2 weeks, 14 (11.7%) at 6 weeks, and five (4.2%) at 3 months. Hoarseness was reported by 25 patients (20.8%), vocal fatigue by 20 (16.7%), reduced voice intensity by 17 (14.2%), altered pitch by 13 (10.8%), increased phonatory effort by 12 (10.0%), and difficulty sustaining speech by nine (7.5%). The median Voice Handicap Index-10 score increased from 1 preoperatively to 7 at 48–72 hours and returned to 1 by 3 months. Maximum phonation time, jitter, shimmer, harmonics-to-noise ratio, and sex-specific fundamental frequency deteriorated during the early postoperative period but progressively approached baseline values by 3 months (Table 2).

Among 200 RLNs at risk, 11 developed postoperative dysfunction, corresponding to a nerve-based rate of 5.5%. These included 40 nerves in patients undergoing hemithyroidectomy and 160 nerves in patients undergoing near-total or total thyroidectomy. All cases were unilateral: five patients had mild hypomobility, four had partial paresis, and two had complete unilateral paralysis. RLN dysfunction occurred in eight women (11.1%) and three men (6.3%), without a significant sex difference. Seven patients had clinically apparent symptoms, whereas four had abnormal vocal-fold mobility without hoarseness or clinically significant deterioration in their Voice Handicap Index-10 scores. These four occult cases represented 36.4% of patients with RLN dysfunction and 3.3% of the overall cohort. No bilateral vocal-fold palsy, postoperative airway obstruction, or emergency tracheostomy occurred.

Among the 109 patients with normal postoperative vocal-fold mobility, 32 (29.4%), including 21 women and 11 men, experienced clinically significant early voice changes. Most non-paralytic voice changes resolved within 2–6 weeks. Three patients remained symptomatic at 3 months; two were diagnosed with muscle-tension dysphonia and one with mild glottic insufficiency without vocal-fold paralysis. Overall, 10 of the 11 patients with RLN dysfunction regained normal vocal-fold mobility within 6 months, including all four patients with occult dysfunction. One 58-year-old man had persistent unilateral vocal-fold paralysis following total thyroidectomy with central neck dissection for papillary thyroid carcinoma.

In univariable analysis, older age, malignant thyroid disease, central neck dissection, longer operative duration, and intraoperative loss of signal were associated with postoperative RLN dysfunction. In the multivariable model, central neck dissection remained associated with increased odds of dysfunction (adjusted odds ratio [aOR], 4.21; 95% confidence interval [CI], 1.14–15.56; P=0.031).

Table 1: Demographic and operative characteristics according to postoperative recurrent laryngeal nerve function

Characteristic	Total, n=120	Normal vocal-fold mobility, n=109	RLN dysfunction, n=11	P value
Age, years, mean ± SD	44.6 ± 12.2	43.8 ± 12.0	52.1 ± 11.4	0.032
Female sex, n (%)	72 (60.0)	64 (58.7)	8 (72.7)	0.521
Male sex, n (%)	48 (40.0)	45 (41.3)	3 (27.3)	0.521
Body mass index, kg/m², mean ± SD	26.2 ± 4.1	26.1 ± 4.0	27.1 ± 4.6	0.449
Professional voice user, n (%)	18 (15.0)	17 (15.6)	1 (9.1)	1.000
Current smoker, n (%)	12 (10.0)	10 (9.2)	2 (18.2)	0.300
Benign thyroid disease, n (%)	90 (75.0)	85 (78.0)	5 (45.5)	0.024
Malignant thyroid disease, n (%)	30 (25.0)	24 (22.0)	6 (54.5)	0.024
Hemithyroidectomy, n (%)	40 (33.3)	39 (35.8)	1 (9.1)	0.098
Near-total or total thyroidectomy, n (%)	80 (66.7)	70 (64.2)	10 (90.9)	0.098
Central neck dissection, n (%)	18 (15.0)	13 (11.9)	5 (45.5)	0.006
Retrosternal extension, n (%)	12 (10.0)	9 (8.3)	3 (27.3)	0.069
Operative duration, minutes, mean ± SD	110 ± 32	106 ± 29	148 ± 37	<0.001
Intraoperative neuromonitoring used, n (%)	76 (63.3)	69 (63.3)	7 (63.6)	0.984
Intraoperative loss of signal, n (%)	8 (6.7)	2 (1.8)	6 (54.5)	<0.001

Table 2: Subjective and objective voice outcomes during postoperative follow-up

Voice outcome	Preoperative	48–72 hours	2 weeks	6 weeks	3 months	P value
Voice Handicap Index-10 score, median (IQR)	1 (0–3)	7 (2–14)	5 (1–10)	2 (0–5)	1 (0–3)	<0.001
Maximum phonation time, seconds, mean ± SD	18.1 ± 4.7	14.6 ± 4.3	15.7 ± 4.4	17.1 ± 4.6	17.8 ± 4.5	<0.001
Jitter, %, mean ± SD	0.60 ± 0.24	0.95 ± 0.43	0.84 ± 0.39	0.69 ± 0.30	0.62 ± 0.26	<0.001
Shimmer, %, mean ± SD	3.1 ± 1.1	4.6 ± 1.9	4.1 ± 1.7	3.5 ± 1.3	3.2 ± 1.2	<0.001
Harmonics-to-noise ratio, dB, mean ± SD	21.7 ± 3.6	18.4 ± 4.1	19.2 ± 4.0	20.7 ± 3.7	21.4 ± 3.6	<0.001
Female fundamental frequency, Hz, mean ± SD	210.6 ± 20.1	201.2 ± 22.4	203.8 ± 21.7	208.2 ± 20.8	210.0 ± 20.3	<0.001
Male fundamental frequency, Hz, mean ± SD	123.8 ± 16.9	119.7 ± 17.8	120.9 ± 17.4	122.6 ± 17.1	123.4 ± 16.8	0.018
Clinically significant voice change, n (%)	0	39 (32.5)	31 (25.8)	14 (11.7)	5 (4.2)	<0.001
RLN dysfunction, n (%)	0	11 (9.2)	8 (6.7)	4 (3.3)	2 (1.7)	<0.001

Table 3: Logistic regression analysis of factors associated with postoperative recurrent laryngeal nerve dysfunction

Predictor	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age, per 10-year increase	1.57 (1.03–2.39)	0.036	1.31 (0.81–2.13)	0.269
Female sex	1.87 (0.47–7.43)	0.372	1.42 (0.31–6.47)	0.652
Malignant thyroid disease	4.25 (1.20–15.05)	0.025	2.08 (0.49–8.85)	0.319
Central neck dissection	6.15 (1.66–22.81)	0.007	4.21 (1.14–15.56)	0.031
Operative duration, per 30-minute increase	2.12 (1.39–3.24)	<0.001	1.78 (1.12–2.84)	0.015
Intraoperative loss of signal	64.20 (9.57–430.64)	<0.001	21.63 (4.15–112.72)	<0.001

Each additional 30 minutes of operative duration was associated with higher odds of dysfunction (aOR, 1.78; 95% CI, 1.12–2.84; P=0.015), while intraoperative loss of signal showed the strongest association (aOR, 21.63; 95% CI, 4.15–112.72; P<0.001). Age, female sex, and malignant disease were not independently associated with RLN dysfunction after adjustment. These estimates should be interpreted cautiously because of the limited number of events and wide confidence intervals (Table 3).

DISCUSSION

The present study demonstrated that postoperative voice disturbance was substantially more frequent than objectively confirmed recurrent laryngeal nerve (RLN) dysfunction. Clinically significant voice changes occurred in 32.5% of patients at 48–72 hours, whereas RLN dysfunction was detected in 9.2% of patients and 5.5% of the 200 nerves at risk. Yang et al. identified surgical extent and operative complexity as important determinants of RLN injury [1]. Nevertheless, voice impairment after thyroidectomy may arise from neural injury, intubation-related effects, laryngeal edema, strap-muscle dysfunction, altered laryngotracheal mobility, and postoperative pain [2]. The higher frequency of dysphonia than vocal-fold dysfunction in the present cohort therefore supports a multifactorial interpretation of postoperative voice morbidity. Similar voice changes despite preserved vocal-fold mobility have been documented in prospective investigations [3,4].

The frequency of clinically significant voice change declined from 32.5% at 48–72 hours to 25.8% at 2 weeks, 11.7% at 6 weeks, and 4.2% at 3 months. This recovery pattern suggests that most early disturbances were transient rather than consequences of permanent neural injury. Choi et al. showed that objective acoustic abnormalities can be detected early after thyroidectomy and may improve progressively during follow-up [5]. Comparable temporary deterioration in voice quality has also been observed among patients with intact recurrent and superior laryngeal nerve function [6]. Patient-reported voice and swallowing complaints may persist despite apparently uncomplicated surgery, further indicating that vocal morbidity cannot be evaluated solely through vocal-fold mobility [7,8].

The Voice Handicap Index-10 score, maximum phonation time, jitter, shimmer, harmonics-to-noise ratio, and fundamental frequency deteriorated during the early postoperative period and subsequently approached their preoperative values. Temporary reductions in fundamental frequency were observed in both women and men, although the frequency of clinically significant voice change did not differ significantly between the sexes. These findings support the use of multidimensional assessment combining patient-reported disability, perceptual grading, acoustic analysis, aerodynamic measurement, and videolaryngoscopy. A single symptom such as hoarseness may not identify subtle impairments in projection, endurance, pitch control, or phonatory effort [5,8].

Postoperative RLN dysfunction was identified in 11 patients, and all cases were unilateral. Mild hypomobility and partial paresis were more frequent than complete paralysis, while no patient developed bilateral palsy, postoperative airway obstruction, or required emergency tracheostomy. Tabriz et al. similarly reported that postoperative RLN palsy is closely related to surgical complexity and intraoperative factors [9]. Temporary vocal-fold paralysis has also been described following thyroid cancer surgery, particularly after extensive procedures [10]. The predominance of mild and unilateral dysfunction in the present study suggests that traction, compression, ischemia, or thermal spread may have produced transient neuropraxia in most affected patients.

Four of the 11 patients with RLN dysfunction had no clinically significant voice complaint, representing 36.4% of all confirmed cases. Mild unilateral paresis may be compensated for by the contralateral vocal fold and may therefore remain undetected during ordinary speech. Obata et al. showed that the clinical presentation and recovery of postoperative RLN dysfunction vary according to the degree of impaired vocal-fold movement [11]. Symptom-based surveillance alone may consequently underestimate the true incidence of neural dysfunction. Objective postoperative examination is particularly relevant after central neck dissection, prolonged surgery, technically difficult dissection, or intraoperative loss of signal [12].

Voice disturbance also occurred frequently in the absence of abnormal vocal-fold mobility. Among 109 patients with normal postoperative mobility, 32 developed clinically significant early voice changes. These non-paralytic disturbances may reflect laryngeal irritation, edema, altered laryngeal fixation, strap-muscle dysfunction, compensatory muscle tension, or superior laryngeal nerve impairment [13,14]. Most cases resolved within 2–6 weeks; however, three patients remained symptomatic at 3 months. Conventional laryngoscopy should therefore not be the means of reassuring in the presence of persistent symptoms, even after normal mobility has been established, and sound videostroboscopy or detailed acoustic testing or speech-language evaluation should be performed [15,16].

Recovery of neural function was favourable, with 10 of the 11 affected patients regaining normal vocal-fold mobility within 6 months. Transient neuropraxia is likely the mechanism as all four patients with occult dysfunction recovered within 6 weeks. Phonation disorders following the surgery can often be reversible, especially if there is no complete paralysis [17]. Mohammad et al. reported that the likelihood and timing of recovery depend on the severity and mechanism of nerve dysfunction [18]. The one patient who had persistent paralysis had had total thyroidectomy with central neck dissection for papillary thyroid carcinoma, implying that more extensive surgery might be correlated with incomplete recovery [4].

Central neck dissection, longer operative duration, and intraoperative loss of signal remained independently associated with postoperative RLN dysfunction. Central neck dissection was associated with more than fourfold higher adjusted odds, potentially because of increased nerve exposure, traction, skeletonization, thermal injury, and disruption of the perineural blood supply. Large surgical series have also identified extensive dissection and operative complexity as important determinants of RLN injury [19]. Each additional 30 minutes of operative duration increased the adjusted odds by 78%, possibly reflecting larger glands, retrosternal extension, distorted anatomy, bleeding, malignancy, or difficult nerve identification [1,11].

Intraoperative loss of signal showed the strongest association with postoperative RLN dysfunction, with an adjusted odds ratio of 21.63. This finding supports neuromonitoring as a functional adjunct to visual nerve identification because anatomical continuity does not necessarily confirm preserved neural function [12,15]. However, the use of neuromonitoring itself was not associated with a lower dysfunction rate, most likely because it was applied selectively in more complex operations. The wide confidence interval around the adjusted estimate and the small number of signal-loss events require cautious interpretation, and the finding should be considered associative rather than causal [13,19].

The principal strengths of this study were its prospective design, confirmation of normal preoperative vocal-fold mobility, routine postoperative videolaryngoscopy irrespective of symptoms, inclusion of both women and men, multidimensional voice assessment, and repeated follow-up [14]. These features allowed the identification of symptomatic, non-paralytic, and clinically occult dysfunction. Heikkinen et al. demonstrated that routine preoperative and postoperative laryngoscopy provides a more reliable estimate of vocal-fold paresis than symptom-based assessment alone [20]. The present study also adds prospective evidence from a Pakistani surgical population, where structured data on occult RLN dysfunction remain limited [5].

Several limitations should be considered. The single-center design and consecutive non-probability sampling may restrict external validity. Only 11 RLN dysfunction events occurred, resulting in wide confidence intervals and limited stability of the multivariable model [1,19]. Selective use of neuromonitoring may have introduced confounding by indication, while the 6-month follow-up period may not have captured delayed recovery. Videostroboscopy, laryngeal electromyography, and formal superior laryngeal nerve testing were not routinely performed, so subtle neural or vibratory abnormalities may have remained undetected [11,18].

Future multicenter prospective studies should include larger and more diverse cohorts, standardized definitions of clinically significant voice change and occult RLN dysfunction, and uniform neuromonitoring protocols. Advanced acoustic and cepstral analysis, videostroboscopy, laryngeal electromyography, swallowing assessment, and standardized voice-therapy outcomes should be incorporated into longer follow-up pathways [5,14]. Larger patient-level datasets would also permit more reliable multivariable modelling, internal validation, and development of clinically applicable risk-prediction tools [9,20].

Overall, postoperative voice changes were common but predominantly transient and frequently occurred despite normal vocal-fold mobility. RLN dysfunction was less frequent, generally unilateral, and reversible in most patients; however, more than one-third of objectively confirmed cases were clinically occult. These findings support systematic preoperative documentation, multidimensional postoperative voice assessment, and routine or risk-based laryngoscopy to improve detection, counselling, rehabilitation, and specialist follow-up after thyroidectomy [2,16,20].

CONCLUSION

Post thyroidectomy voice changes were frequent, although they were mostly temporary and did not necessarily indicate impaired vocal-fold mobility. Recurrent laryngeal nerve dysfunction was detected in 9.2% of the patients, and over one-third of these cases were clinically silent. Independent predictors of nerve dysfunction included central neck dissection, longer surgical time and intraoperative signal loss. Most patients with affectation recovered within 6 months. Documentation of voice before surgery and appropriate voice assessment after surgery with timely laryngoscopy are therefore critical to the detection and management of neural and non-neural voice complications.

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