

Original Research Article

Superior laryngeal nerve dysfunction following thyroid surgery: assessment of incidence and long-term effect

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ABSTRACT

Background: Importance of Sentinel lymph node (SLN) in thyroid surgery has received little attention compared to Recurrent laryngeal nerve (RLN). Injury to the external branch of the superior laryngeal nerve (EBSLN) is a voice-altering complication of thyroid surgery that has significant implications for professional voice users. The symptoms can be nonspecific and the subtle laryngoscopic manifestations are often overlooked.

Methods: This study involved 50 patients of thyroid disease with no prior voice pathology who subsequently underwent thyroid surgery. All patients underwent voice analysis pre-operatively, including video laryngoscopy, voice analysis and Grade of hoarseness, roughness, breathiness, asthenia, and strain (GRBAS) scale. Voice analysis was repeated at 2 weeks, 4 weeks, 3 months and 6 months post operatively. Patients with no change in voice after 04 weeks were not followed up subsequently.

Results: Of 50 patients, 20 (40%) patients underwent hemithyroidectomy, 18 (36%) total thyroidectomy, 11 (22%) subtotal thyroidectomy and 1 (2%) Near total thyroidectomy. Based on voice analysis, patients were categorized into four different groups namely - normal with no laryngeal nerve injury (N=45, 90%), RLN palsy (N=2, 4%), SLN palsy (N=3, 6%). Patients with SLN palsy showed bowing of vocal cords persisting till 06 months post operatively. There were changes in fundamental frequency also, which appeared at 02 weeks and gradually improved on subsequent follow up.

Conclusions: The prevalence of SLN injury and dysfunction is unknown as many cases go undiagnosed. Further research is needed to improve the index of suspicion in patients with poor voice quality and reduced vocal range post operatively. On improved diagnostic accuracy, early treatment of this complex disorder may lead to significant recovery.

Keywords: Thyroidectomy, SLN palsy, Voice quality

INTRODUCTION

A number of critical anatomic structures lie in close proximity to the thyroid gland. These include the recurrent laryngeal nerves (RLN), the superior laryngeal nerves (SLN), and the parathyroid glands. Successful thyroid surgery is incumbent upon the technical skill of the surgeon to identify and preserve these vital structures. Sensory-motor impairment of the laryngeal function is a

well-known possible complication of thyroid surgery and is generally reported in terms of RLN or SLN injuries.¹

The clinical importance of the SLN in thyroid surgery has received much less attention than the RLN. Injury to the external branch of the superior laryngeal nerve (EBSLN) is voice-altering complication of thyroid surgery that has significant implications for professional voice users. The symptoms of EBSLN injury can be nonspecific and the

subtle laryngoscopic manifestations are often overlooked. Advanced diagnostic techniques for evaluating EBSLN, which are now more commonly accessible, have documented a significant incidence of this morbidity (5-28%).²⁻⁵

Voice disturbances have also been demonstrated in cases where the laryngeal nerves have been preserved, occurring due to surgical trauma and laryngotracheal fixation of the pre-laryngeal strap musculature. Hence there is a need to be diagnose the exact cause of vocal dysfunction following thyroid surgery.⁶

Both objective and subjective tests can be used for an early diagnosis and prompt management. Objective analysis includes video-stroboscopy and Electromyography (EMG), which are specific to differentiate between neurogenic and traumatic injuries and to detect complete or incomplete denervation.

Video-laryngoscopic examination in a SLN lesion reveals absence of contraction of the cricothyroid muscle with normal adduction and abduction of the Vocal folds (VF). In a unilateral lesion, there is lack of longitudinal tension in the VF, leading to irregular or lax VF. EBSLN denervation causes the weakened ipsilateral vocal fold to be shortened and to be at a lower level, while the anterior larynx shifts to the side of the intact cricothyroid muscle, creating an oblique glottis with the posterior larynx rotated toward the weakened side. The aryepiglottic fold on the side of paralysis is shortened, and the aryepiglottic fold on the opposite side is lengthened.⁷⁻¹⁰

Electroglottography measures the efficiency of glottal closure by graphically recording the contact time of the vocal cords. It is performed by passage of low voltage, high frequency current between two electrodes placed on either side of patient's neck. Voice is analyzed and multiple (more than three) objective voice changes correlate with early and late postoperative symptoms. Alterations in maximum phonational frequency range and vocal jitter predict late perceived vocal changes.

Grade of hoarseness, roughness, breathiness, asthenia, and strain (GRBAS) scale is a well-known scale for perceptual assessment of voice. In this subjective test, G represents overall quality of voice. R stands for roughness, B for breathiness, A for asthenia and S for strain. According to Hirano roughness is defined as psychoacoustic impression of irregular vocal cord vibration. He defined breathiness as psychoacoustic impression of air leakage through the glottis. Asthenia is the weakness or lack of power in voice and strain is psychoacoustic impression of a hyper-functional state of phonation. Each parameter is rated on a 4-point scale with 0 as no deficit in this parameter, 1 as mild deficit, 2 being moderate deficit, and 3 severe deficits.¹¹⁻¹³

This prospective observational study was conducted to assess the incidence and long-term effect of superior

laryngeal nerve dysfunction following thyroid surgery by using both objective and subjective means of evaluation.

METHODS

This study was carried out at the Department of Otorhinolaryngology and Head and Neck Surgery, Army Hospital (R&R), Delhi Cantt, a tertiary care referral hospital of the Armed Forces from October 2017 to March 2019. The approval of the Institutional Ethical Committee was obtained prior to commencing the study. 50 patients of thyroid disease were randomly selected for the study from the Out-patient department (OPD) attendees. A written, informed consent was obtained from each of the selected patients. All 50 patients had no prior voice pathology and subsequently underwent thyroid surgery. Patients with history of previous thyroid surgery, radiation exposure and other lesions of larynx were excluded from the study. The initial evaluation of the subjects involved a detailed history taking and thorough clinical examination. All patients underwent subjective and objective voice analysis pre-operatively, which included video-laryngoscopy, voice analysis and GRBAS scale.

Patient was asked to phonate vowels using high pitches. video-laryngoscopic examination was done using 90 degree, Hopkins laryngeal endoscope. Mobility of the cords, presence or absence of glottic gap at the time of adduction was assessed. Bowing and inferior displacement of the vocal cord and rotation of the posterior glottis towards the paralytic side were considered abnormal findings that suggest injury to EBSLN.

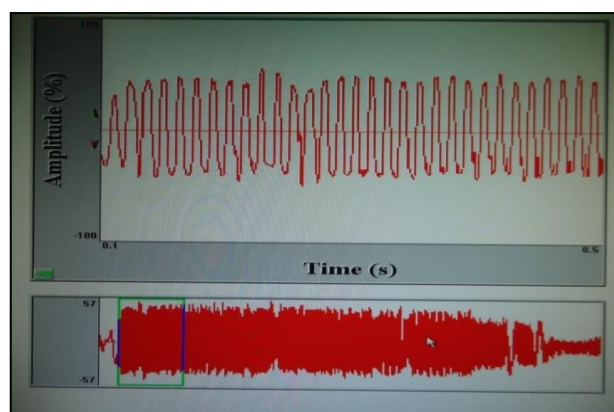


Figure 1: Voice analysis tracing.

Voice analysis was done using Dr Speech software (Figure 1). Microphone used was an electric omni directional pressure sensitive microphone. Boom mounted microphones were used, and recording was done 30 cm from mouth. Parameters considered for comparison in voice analysis were Maximum phonation time (MPT), Fundamental frequency (F0), Shimmer, Jitter, Harmonic to Noise ratio (HNR), and Normalized noise energy (NNE). For MPT, patients were asked to

phonate a vowel (ee) for as long as they could and this time period was recorded.^{12,13}

The voice of the patient was also graded subjectively by GRBAS scale. Patient's voice was recorded and analyzed as per previously mentioned parameters on the 4-point Likert scale.

Following detailed preoperative analysis, all patients underwent hemi, subtotal, near total or total thyroidectomy, as indicated by the primary pathology, under general anesthesia by the same surgical team using standard thyroid surgery procedure (Figure 2). Patients again underwent video-laryngoscopy, voice analysis, and GRBAS scale assessment at 2 weeks, 4 weeks, 3 months and at 6 months post operatively. The patients in whom there was no change in voice after 04 weeks were not followed up subsequently.

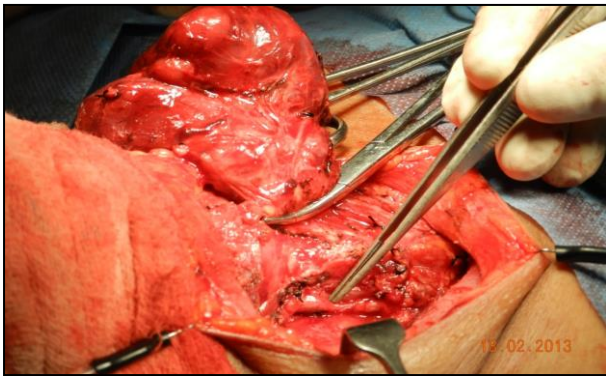


Figure 2: Hemithyroidectomy in progress.

RESULTS

The study included 50 patients, out of which 16 (32%) were males with mean age 49.13 years and 34 (68%) were females with mean age 43.97 years. The total no of patients with benign thyroid disease were 32 (64%) and with malignant disease were 18 (36%). Out of the 50 patients, 20 (40%) patients underwent hemithyroidectomy, 18 (36%) total thyroidectomy, 11 (22%) subtotal thyroidectomy and 1 (2%) near total thyroidectomy. On the basis of change in parameters of voice analysis, subjective voice assessment (GRBAS) and video-laryngoscopy, patients were categorized into four different groups namely - normal without laryngeal nerve injury (N=45, 90%), RLN palsy (N=2, 4%), SLN palsy (N=3, 6%) (Tables 1,2 and 3). All three cases of SLN palsy were found following hemithyroidectomy surgery- two for colloid goiter and other for papillary carcinoma. Post operatively, there were 45 patients in whom no change in voice was observed till 4 weeks were not followed up thereafter.

GRBAS Analysis

pre-operatively overall grading was 0 for all 50 patients. Post operatively for RLN palsy pts, at 2 weeks grading

was 2, which improved with time and at 6 months it was 1. For SLN palsy patient, post operatively at 2 weeks over all grading was 1 and at 6 months it was 0.

Video-laryngoscopy

Preoperatively there was no abnormal finding in all the 50 patients. Post operatively at 2 weeks, 2 patients were found to have glottic gap and (R) vocal cord palsy, which was suggestive of (R) recurrent laryngeal nerve paralysis. On follow up at 3 months and at 6 months glottic gap was reduced. 2 patients were found to have bowing of (R) vocal-cord, and 1 patient had bowing of the (L) vocal cord, post operatively at 2 weeks which was suggestive of superior laryngeal nerve paralysis. Bowing persisted till 6 months follow up.

DISCUSSION

Anatomically, the SLN branches from the vagus nerve near the inferior half of the nodose ganglion, about 36 mm below the jugular foramen and 40 mm above the carotid bifurcation. It then travels 1.5 cm caudally in which it divides into the internal and external branches.¹ The internal branch, which pierces the thyrohyoid membrane, provides sensory innervation to the supraglottic larynx, whereas the external branch, carrying motor innervation, travels to and innervates the cricothyroid muscle.^{14,15}

The major muscle supplied by the SLN, the cricothyroid muscle, consists of two parts: the pars recta and the pars oblique. Both parts originate at the inferior margin of the thyroid cartilage with the pars recta originating from the midline to the thyroid tubercle and the pars oblique from the thyroid tubercle to the inferior cornu. These then insert on the anterior and lateral portions of the cricoid cartilage. Cricothyroid contraction primarily moves the cricoid cartilage. Paired cricothyroid joints and ligaments allow two main types of motion: first, rotation around the common frontal axis of both; and second, sliding horizontal motion in the sagittal direction.¹⁶

The clinical importance and possible damage to the SLN in thyroid surgery has received much less attention than the RLN. Hence the present study was carried out to determine incidence of SLN palsy and the changes if any, in voice of such individuals after standard thyroid surgery. Patients served as their own controls, having undergone preoperative voice testing. The study involved 50 patients who underwent thyroidectomy. There were 31 (62%) benign cases and 19 (38%) malignant cases. Hemithyroidectomy (40%) was the most common type of operation performed due to more number of benign cases and total thyroidectomy (22%) was the second most common type of operation performed. In a comparable study by Stojadinovic et al there were 19 (38%) benign and 31 (62%) malignant cases of which 42% underwent hemithyroidectomy and 58% total thyroidectomy due to a greater number of malignant cases.¹⁷

Table 1: Acoustic analysis: without laryngeal nerve injury (normal) (n=45).

S.no.	Parameter	Mean		Mean		Mean
		Preop	P-value (preop vs 2w)	2 weeks	P value (preop versus 4w)	4 weeks
1	F0	220.57	0.802	220.34	0.097	215.54
2	Shimmer	1.66	0.061	1.88	0.077	1.72
3	Jitter	0.37	0.063	0.42	0.924	0.37
4	MPT	23.00	0.387	22.65	0.274	23.45
5	HNR	24.13	0.087	25.92	0.101	24.75
6	NNE	-17.13	0.107	-17.47	0.063	-18.90

(No significant change in various voice parameters post operatively at 2 weeks and 4 weeks)

Table 2: Acoustic analysis RLN palsy (n=2).

S. no.	Parameter	Mean		Mean		Mean		Mean		Mean
		Preop	P value	2 weeks	P value	4 weeks	P value	3 months	P value	6 months
1.	F0	205.95	0.05	175.80	0.046	180.10	0.049	183.70	0.041	186.80
2.	Shimmer	1.75	0.032	4.03	0.031	3.69	0.012	3.06	0.061	2.84
3.	Jitter	0.20	0.045	1.93	0.050	1.27	0.014	0.86	0.007	0.66
4.	MPT	23.00	0.001	9.00	0.025	10.50	0.063	13.00	0.177	16.00
5.	HNR	26.41	0.013	19.11	0.041	19.65	0.047	22.00	0.037	23.60
6.	NNE	-17.46	0.052	-24.35	0.066	-22.20	0.061	-18.54	0.286	-15.40

(Significant change in voice parameters)

Table 3: Acoustic analysis SLN palsy (n=3).

S.no.	Parameter	Preop	2 Weeks	4 Weeks	3 Months	6 Months
1.	F0	161.10	129.00	151.20	153.11	155.00
2.	Shimmer	1.13	2.76	2.35	1.97	1.51
3.	Jitter	0.13	1.11	0.82	0.57	0.41
4.	MPT	24.00	14.00	19.00	20.00	22.00
5.	HNR	28.01	19.80	25.10	26.11	27.60
6.	NNE	-19.80	-21.10	-20.32	-19.68	-19.68

In our study, 90% patients had no subjective voice changes at 2 week and 4-week post thyroidectomy. Subjective voice changes in symptomatic patients were voice fatigue, decreased pitch range and difficulty in raising the volume (loudness) of voice, which was similar to other studies.¹⁸

We found 40% of patients with significant alteration of at least one objective voice parameter, 2 weeks post operatively, but only 8% patients had voice symptoms. In other studies, 84% of patients had significant alteration of at least one objective voice parameter but only 30% of patients reported voice symptoms early after thyroidectomy and 14% were symptomatic at 3-month follow-up. Two other published prospective studies of voice function after thyroidectomy found that early postoperative voice changes occur commonly (41-47%).^{19,20}

In our study, 4 (8%) patients had significant change in three (Shimmer, jitter and HNR) voice parameters. Alexander et al in their study had found 6 (12%) patients with significant change in more than three voice parameters. In our study, in patients of SLN dysfunction, fundamental frequency was found decreased at 2 weeks post operatively which gradually improved and was near preoperative value at 6 months. Similar changes in fundamental frequency found in study of Koraitim et al. Decrease in fundamental frequency has been attributed to decrease in cordal tension by alteration in the functional character of the cricothyroid muscle or ESBLN. MPT also showed significant reduction at 2 week follow up and gradually improved. Early changes in voice parameters (shimmer, jitter, HNR) from baseline were significantly associated with both early and late perceived alterations in voice. The present data suggests that clinically significant postoperative changes in more than three objective acoustic voice measures from baseline are

associated with early postoperative voice symptoms. The number of abnormal voice parameters at 1 week correlated significantly with persistent voice symptoms at 6 months post-thyroidectomy.^{20,21}

In our study, patients with the EBSLN injury had persistent symptoms and unchanged video stroboscopic abnormalities at 6-month follow-up.

Thus, this study has added to the findings of previous work on the subject by demonstrating that in patients undergoing thyroid surgery, both RLN and SLN may be inadvertently damaged leading to voice changes which though more subtle in SLN palsy are persistent.

CONCLUSION

The prevalence of SLN injury and dysfunction is unknown as many cases go undiagnosed. In fact, isolated injury to the external branch can be difficult to detect because of subtle symptoms and variability in the clinical signs and symptoms.

The major factor impeding progress in determining adequate treatment for SLN paralysis has been the general lack of diagnostic criteria, leading to many undiagnosed or misdiagnosed cases. The complex result of SLN palsy is also noticed by a small subset of patients like professional voice users where subtle changes are more noticeable. New research into voice changes associated with this condition will likely improve diagnostic accuracy. Further research is needed for early diagnosis on examination and to improve the index of suspicion in patients with poor voice quality and reduced vocal range post operatively. Once there is improved diagnostic accuracy, early treatment of this complex disorder may lead to significant recovery

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Ethical approval: The study was approved by the Institutional Ethics Committee

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