

## Comparing Functional Results of Superior Laryngeal Nerve in Thyroid Surgery with and without Identifying the Nerve

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### ABSTRACT

**Background:** Thyroid operations is surgically challenging due to its important anatomical features. Harm to the external branch of the superior laryngeal nerve (EBSLN) can lead to harmful voice alterations, the intensity of which varies based on the voice requests of the patient. So, the objective of research was the evaluation of functional results of superior laryngeal nerve in thyroid procedure with and without identifying the nerve.

**Materials and Methods:** In this prospective non-randomized study, patients of both genders, who underwent total thyroidectomy during July 2018 to March 2019 in the Amir Alam hospital, were entered into the research. An appropriate method of surgery for upper thyroid pole dissection followed by lateralization and exposure of cricothyroid space was utilized on the right side, to preserve SLN (EBSLN) after its recognition. On the left side, superior thyroid vessels were ligated near the superior thyroid pole without any effort of nerve recognition.

**Results:** Totally, 50 cases (29 females and 21 males) who underwent total thyroidectomy in a period of 6 months. Assessment of all cases demonstrated that only 1 subject presented symptoms of temporary nerve paralysis in the left side.

**Conclusions:** Intraoperative identification can elude injury to the SLN (EBSLN). Routinely intraoperative assessment of the nerve is not necessary because the rate of damage of SLN in thyroidectomy is low.

### KEYWORDS

Thyroidectomy, Superior Laryngeal Nerve, Cricothyroid Space.

### Introduction

The vagus nerve consists of various branches including the superior laryngeal nerve (SLN), and the SLN consists of internal and external branches. This nerve generally emanates at the nodose ganglion near the jugular foramen at the level of C2 and it descends posterior to the carotid arteries toward the larynx (1). Anatomical and electrophysiological recognition of the external branch of the superior laryngeal nerve (EBSLN) is one of the main stages of thyroidectomy (2). Along the way, the SLN subsides in a medial orientation through the thyrohyoid membrane and at a changeable interval from its source (0–20 millimeters, mean 15 millimeters); generally, almost at the upper cornu of the hyoid bones (3), the SLN splits into two parts including the internal branch of the superior laryngeal nerve (IBSLN) and the external branch of the superior laryngeal nerve (EBSLN) (4).

The IBSLN enervates the larynx's mucus membranes, and the EBSLN controls the cricothyroid and lower constrictor muscles (5). From its source at two to three centimeters over the upper pole, the nerve subsides medial to the carotid sheath adjacent to the pharynx. It enters the larynx by the deep surface of the cricothyroid muscle (6). Overall, the EBSLN has its route back to the carotid sheath and next passes in a medial orientation through the larynx. The outside branch is dorsal to the upper thyroid artery and in an exterior position to the lower pharyngeal constrictor muscle as it moves caudally and progresses in a medial route to pass through, on the bottom section of the cricoid cartilage, the cricothyroid muscle (1, 7). It has been shown that the cricoid lamina is tilted backward by the constriction of the cricothyroid (CT) muscle at the cricothyroid joint, which causes prolongation, tension, and adduction of vocal cords, leading to an increment in the pitch of the voice. Harm to the EBSLN would cause voice changes, in a range from modest huskiness, low voluminosity, and exhausted voice to inability to reach a high tone, and this can considerably influence the people who professionally use their voice, including singers and public speakers (8, 9). The SLN is a short nerve with various courses that can enhance the risk of inadvertent iatrogenic injuries, especially during surgery of the upper thyroid vessels. (10) The EBSLN is important in terms of surgery since anatomically it is in adjacent proximity to the upper thyroid vessels. Mainly, the external nerve develops in a

medial route to the larynx, therefore cranial to the upper thyroid pole, and so it must be at least a risk-factor for iatrogenic injury during the closing of the upper pole (11, 12). Observed risk of EBSLN injury can be from 0.3 to 13%.6. Methods that have been individually described to safeguard the nerve include accurate dissection in cricothyroid space, (13) skeletonization and ligating of upper thyroid vessels, recognition of nerve before ligating of upper pole (6). The objective of the present prospective nonrandomized study was to compare the functional findings of SLN in thyroid surgery with identification of the nerve in right side and without in left side.

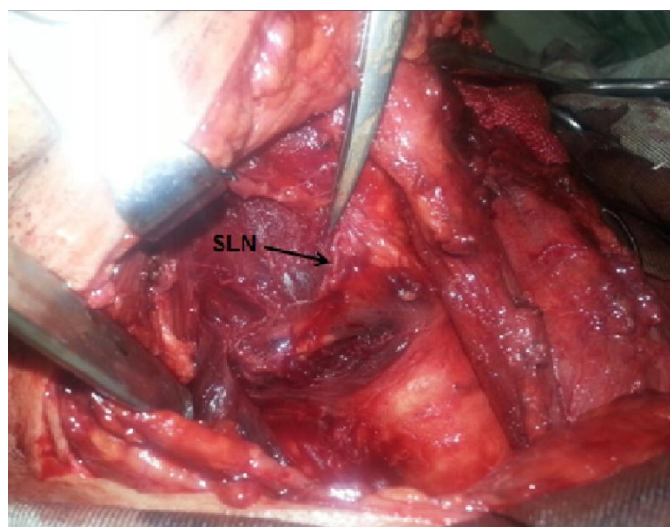
## Materials and Methods

### Patients

In the present prospective nonrandomized study, cases with total thyroidectomy during July 2018 to March 2019 in the Amir Alam hospital were evaluated for SLN injury. Identification of SLN before ligating the upper thyroid vessels in right side was compared with left side without identification of nerve during. Exclusion criteria included former neck irradiation, former laryngeal or thyroid surgery or any other cervical exploration. Accordingly, fifty consecutive patients with total thyroidectomy were enrolled and evaluated for SLN injury over a 6-month period. In addition, the research was done according to the Helsinki principles. Written consent was obtained from all cases. The ethics committee approved the protocols of this research. Patients were also assured that their information would be kept confidential and that no changes would be made to their diagnostic and treatment procedures.

### Method of Study

All patients underwent a detailed voice evaluation, including weakness or fatigue after use, inability to reach high pitch or change in fundamental speaking frequency, preoperatively and on the second postoperative month by indirect laryngoscopy and videostroboscopy. The signs of EBSLN injury on indirect laryngoscopy were taken as rotation of posterior glottis towards side of the lesion and bowing and displacement of affected vocal cord. Surgical procedure was standardized to avoid operational bias. Keeping close to capsule of gland and dissecting both laterally and at the junction of upper thyroid pole with upper border of isthmus, the entire pole was encircled and taped. With gentle traction on this tape, further facilitated by application of a hemostat at lateral border of the pole, 'lateralization' of the pole was achieved. Careful dissection in avascular cricothyroid space was then begun and an attempt was made to identify nerve in this space in right side. However, we did not persist with extensive dissection for identification of the nerve. Capsular dissection, skeletonization and individual ligating of the upper polar vessels were then carried out (Figure 1).



**Figure 1.** Identification of right superior laryngeal nerve (SLN) crossing the superior thyroid vessels.

No nerve stimulators or other laryngeal nerve monitoring were used in this study. In all cases, the laterality of the

procedures was recorded, and associated nerve and their Cernea classifications were identified, table 1. (14)

**Table 1.** CERNEA criteria for external branch of superior laryngeal nerve's (EBSLN) Classification Systems

Type 1	Crosses STA > 1cm upper pole
Type 2a	Crosses STA <1cm upper pole
Type 2b	Crosses STA under cover of upper pole

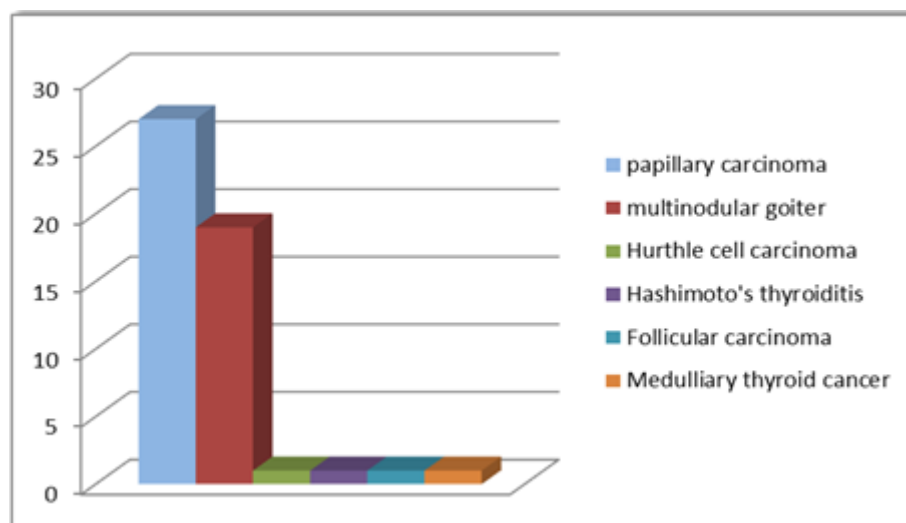
Finally, based on the patient's history and assessments, demographic information such as age, gender, Thyroid lobe length (preoperative sonographic report), CERNEA criteria, pre and post-operative videostroboscopy data, and thyroid pathology were collected for each patient.

### Statistical Analysis

Analysis was performed using the IBM SPSS (version 24.0 Armonk, NY: IBM Corp).

### Results

50 cases who met the inclusion criteria were entered into this research. The gender ratio was 29 females to 21 males. The age range was from 20 to 53 years old and the average was 39.3 years. Thyroid surgery was used for papillary carcinoma in 27 cases, multinodular goiter in 19, hurthle cell carcinoma in 1, hashimoto's thyroiditis in 1, follicular carcinoma in 1 and medullary thyroid cancer one patient (Figure 2).



**Figure 2.** The frequency and types of thyroidectomies done during our study

Considerably more type 1(68%) nerves were observed with nerve stimulator, and then type 2a (24%) and type 2b (8%) were mostly seen (table 2). Findings were assessed considering postoperative indirect laryngoscopy and videostroboscopy. One of fifty patients (2%) diagnosed with a postoperative temporary nerve paralysis in left side without identifying the nerve, which persisted for few weeks.

**Table 2.** Demographic parameters of the study population

<b>Gender</b>	Male %(n)	42 % (21)
	Female %(n)	58 % (29)
<b>Age (year)</b>		39.3 (20 to 53)
<b>Thyroid lobe length (mm)</b>	Right	48
	left	51
<b>CERNEA criteria</b>	Type 1	68 % (34)
<b>for right side EBSLN</b>	Type 2a	24 % (12)

	Type 2b	8 % (4)
Data were presented as mean (range) or percent (number). EBSLN: external branch of superior laryngeal nerve		

## Discussion

Thyroidectomy allows radical resection of the gland without removing tissues, therefore the possibility of recurrence of the disorder is overall removed (15). Regrettably, subtotal thyroidectomy causes a remarkable possibility of recurrent disease for some cases after a long break (16, 17). The basics of every procedure are based on recognition and protection to evade injuries of major organs. Recognition and protection of the nerves during procedures should be also considered in thyroid surgery. Harm to the outside branch of the upper laryngeal nerve in thyroid surgery is associated with problems in diagnosis and can often be overlooked due to inappropriate clinical symptoms (18-20). The occurrence observed in the studies on the intraoperative SLN injuries in thyroid surgery is not greatly assessed compared to the recurrent disorders of the nerves of larynx, which was observed to be between 0.30 to 57 percent (21, 22). In this research, the occurrence of SLNs injury and related complications were studied in 50 cases that had thyroid surgery and have been reported to be 2%. The procedure to protect the upper nerve is based on expanding a plane through the surgical capsule, that would usually insulate the vessels from the nerves. In 5.20 percent of patients, these nerves are attached to, or convolved around, the branches of the upper thyroid artery. Hence, the enormous ligature of the supra-polar vessels can surely ensnare these nerves in 1 in 5 of in all patients (23). Other studies reported that the vicinity of these nerves to the arteries in an even superior ratio of patients (24).

Besides the assessment of clinical voice changes after thyroid procedure, indirect laryngoscopy and videostroboscopy were used in each case by two researchers who looked for any structural and kinetic laryngeal abnormality. Comprehension of the 3 anatomic grades of the bottom part of SLN and its association with the superior thyroid pole leads to a high frequency of SLN recognition. Our findings in this research demonstrated that the correct surgery of the superior thyroid pole by its lateralization and could assess the SLN. In terms of anatomical assessment, the cricothyroid muscle is induced by outside branch of upper nerves of the larynx that produce tension in the vocal cords. Tension of the vocal cord induces the voice production ability, even above 150 Hz that are referred as the high pitch of voice range (25). Then, the clinical assessment of each subject for the ability of high tones production and videostroboscopy after thyroid procedure was used in right and left sides. Some research reported this nonpermanent finding due to association of vocal function and extrinsic muscles of the larynx that demonstrates enhanced activity at low tones and reduced activity at high tones (26-29).

Overall, recognition of the SLN during surgery my help surgeons to prevent intraoperative injuries of the superior thyroid pole. Although conventional method of the upper vessels ligation near the glands may lead to lower nerve injuries.

## Conclusion

The amount of SLN injuries in this study was 2% (that occur in the left side without identifying the nerve). Despite this low amount, it still can significantly affect the quality of voice of patients. Damage to the SLN (EBSLN) may be considerable in patients whose occupations depend heavily on full range of their voices. Conservation of the SLN is crucial for optimal activity of the larynx. The basics of head and neck surgery express that the most appropriate method to avoid injury to SLN is by identification and preservation. It was concluded that the SLN must not be identified usually through the thyroidectomy.

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