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Research Article

The Outcome of Voice in Endoscope Assisted Intra-Operative Identification of External Branch of Superior Laryngeal Nerve during Thyroid Surgery

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ABSTRACT
Introduction: The external branch of the superior laryngeal nerve (EBSLN) innervates the cricothyroid muscle (CTM),to promote lengthening and thinning of the vocal fold. The EBSLN is at an increased risk during superior thyroid pole ligation during thyroidectomy which can result in significant post operative complications in voice production. This injury can be avoided by intraoperative identification of the nerve which can be aided by endoscope assisted magnification during thyroid surgery.
Aims: (I) To identify the External Branch of Superior Laryngeal Nerve (EBSLN), along with Recurrent Laryngeal Nerve (RLN), during thyroid surgery by adopting endoscopic magnification along with routine dissection methods.
(II) To determine the significance of intra-operative identification of EBSLN for preservation of quality of voice following Thyroid surgery.
Methodology: A prospective institutional comparative study was carried out for 2 years from November, 2022 to November, 2024 with a sample size of 80 patients. The sample size was divided into two equal groups of 40 patients each. In Group A, Thyroid surgery was conducted by employing conventional dissection techniques. In Group B, special care was taken to preserve the EBSLN with the aid of endoscopic magnification. The patients were clinically evaluated for any changes in voice, particularly related to injury to the EBSLN; by assessing for hoarseness of voice, easy fatigability, inability/difficulty to produce high pitched voice; at day 3 and one month following surgery. Furthermore, patients underwent indirect and flexible videolaryngoscopy and voice recording and the results were statistically evaluated.
Results: Use of endoscopic magnification along with routine dissection techniques, helped in the preservation of EBSLN in Group B patients. Cernea Type 1 variation of EBSLN was the most common (74%). The voice outcome assessment in Group B patients was found to be superior to that in Group A.
Conclusion: The preservation of EBSLN along with RLN during thyroid surgery plays a major role, for conserving a superior quality of voice and it has been found that endoscopic magnification aids in identification of EBSLN and its variants.

INTRODUCTION

Thyroidectomy is a commonly employed surgical procedure for the treatment of benign and malignant thyroid diseases. The intricate anatomical structures for phonation, which lie in proximity to the thyroid gland, are vulnerable to injury during thyroid surgery. The identification and preservation of the laryngeal nerves during the procedure aids in the conservation of voice.

Similar to the parathyroid gland and the recurrent laryngeal nerve (RLN), the external branch of the superior laryngeal nerve (EBSLN) is a crucial nerve in thyroid surgery. Unlike recurrent laryngeal nerve (RLN), it is not a routine practice to identify the external branch of superior laryngeal nerve (EBSLN) but considering its high injury rate (up to 58%) and varying exposure rate, routine identification of the EBSLN prior to surgical manipulation is necessary for a complication-free thyroidectomy.

The EBSLN carries only the motor fibers to the cricothyroid muscle, which functions to tilt the thyroid cartilage relative to the cricoid cartilage, thereby increasing the distance between the anterior commissure and the posterior commissure of the larynx. This in turn, increases the length and tension of the vocal folds. The course of the nerve is variable and not always visible prior to innervating the cricothyroid muscle (CTM). Injury to the EBSLN results in changes in voice quality, voice projection, and the production of high pitched sounds. [3,4]

Clinically, a patient with EBSLN palsy may present with a hoarse or weak voice. Voice related symptoms may be more noticeable with professional speakers, especially in singers. The famous opera singer Amelita Galli- Curci had suffered damage to the EBSLN after her thyroid surgery and this nerve has since came to be known as the "nerve of Galli-Curci."

Various classification systems have been adopted to describe the course of the EBSLN. In the present study, the Cernea classification has been used. The various types are- Type 1 where EBSLN crosses Superior Thyroid Artery (STA) > 1 cm above upper pole of thyroid; Type 2a crosses STA < 1 cm above upper pole of thyroid; Type 2b crosses STA under cover of upper pole of thyroid. [7] The use of magnifying glasses, as well as video-endoscopic thyroid surgery has been explored for preservation of EBSLN. [7,8,17,19] Recently, intraoperative neuromonitoring (IONM) techniques have been shown to increase the rates of EBSLN identification and have allowed the surgeon to verify the integrity of the nerve. But in the present study, we have advocated a simple modification of the conventional thyroid surgery for easy identification of the EBSLN, using endoscopic magnification.

Aims

(I) To identify the External Branch of Superior Laryngeal Nerve (EBSLN), along with Recurrent Laryngeal Nerve (RLN), during thyroid surgery by adopting endoscopic magnification along with routine dissection methods.

(II) To determine the significance of intra-operative identification of EBSLN for preservation of quality of voice following Thyroid surgery.

Inclusion Criteria

Patients between 15 – 55 years of age, presenting with non- malignant and malignant thyroid diseases with preoperative voice assessment within normal limits.

Exclusion Criteria

Toxic goiter, patients not giving consent, unfit (physically, mentally), mute patients, previous neck surgeries.

MATERIALS AND METHODS

An institutional prospective comparative study was carried out in the Department of Otorhinolaryngology at Silchar Medical College and Hospital for a period of 2 years. Out of 85 patients, admitted for thyroid surgery, 80 patients, who satisfied the inclusion and exclusion criteria, were randomly divided into 2 equal groups, A and B.

In Group A, Thyroid surgery was conducted by routine dissection techniques, where no extra effort was made to identify EBSLN.

In Group B, along with the conventional dissection techniques, EBSLN was identified and preserved with the help of endoscopic magnification during dissection of the superior pole which was termed as the "hybrid technique".[1]

Clinical, voice test application and laryngoscopic voice assessment was carried out 1 day preoperatively and at 3rd day and 1st month postoperatively. The results were statistically evaluated [chi sq test, $p<0.05$]

Surgical Technique

Group A: Inferior to superior pole, thyroid dissection was done with preservation of RLN but no extra attempts were made to identify EBSLN.

Group B: Space of Reeves is an avascular space bounded by the medial aspect of the superior pole of the thyroid laterally and the cricothyroid muscle medially which is useful in dissection during thyroid surgery and helps in avoiding injury to the surrounding structures. During dissection of the superior pole, the space of Reeves is opened and endoscope was introduced and magnification by video-endoscopy (4mm 0 degree rigid endoscope) was additionally used to identify and preserve both the laryngeal nerves, recurrent laryngeal nerve inferiorly and external branch of superior laryngeal nerve superiorly. Cernea classification was used for identifying the type of EBSLN.

Voice Assessment

Voice assessment was done using a voice test application, which comprised of variables like F0, jitter, shimmer which measures voice in frequency and amplitude and results are indicated in the form of green and red light where green light signifies result within average or normal limits and red light signifies abnormality in the quality of voice. The maximum amount of time a person can hold a vowel sound on a single breath is known as Maximum Phonation Time(MPT). It is used to evaluate vocal proficiency and breath control and is a measure of vocal fold efficiency. Adult males can typically sustain a vowel for 25–35 seconds, while adult females for 15–25 seconds. Patient was asked to say a sustained vowel for example -'aa' continuously for as long as possible; longest of 3 performance was

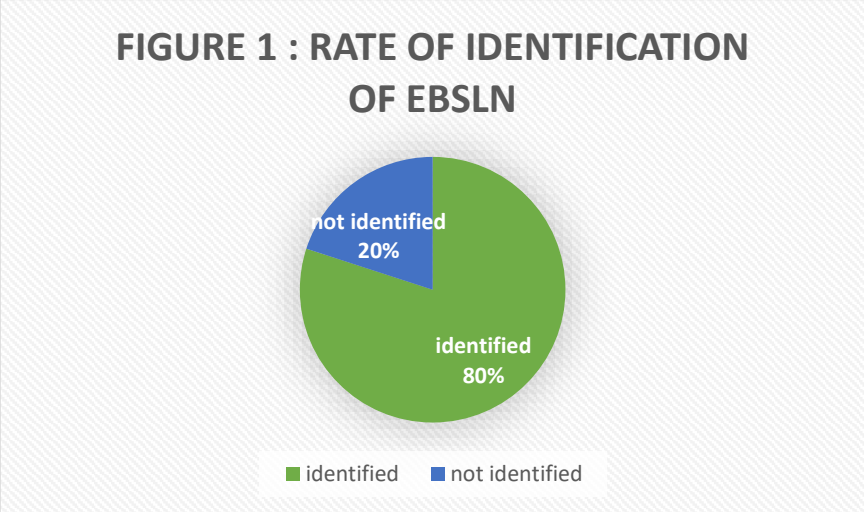
recorded and <10 sec was considered abnormal. **[8]**

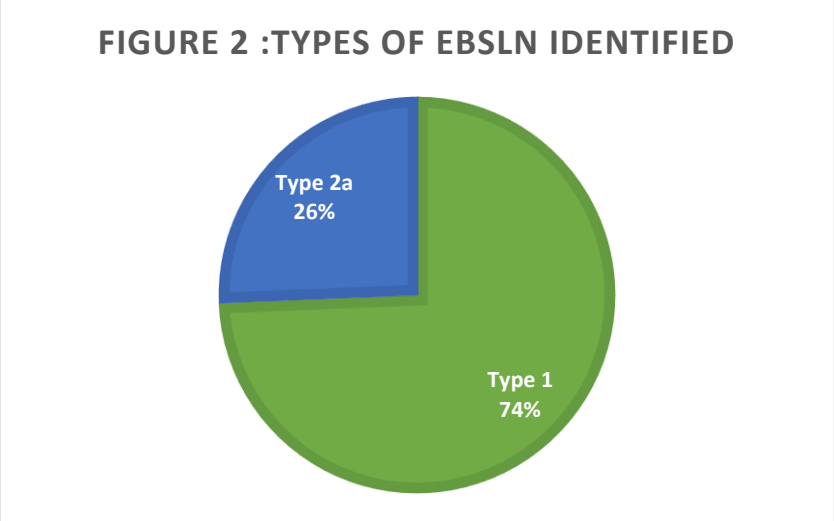
Laryngoscopy

Flexible fibreoptic videolaryngoscopy was used for laryngoscopy and patient was asked to utter sustained vowels. Positive laryngoscopy findings due to probable nerve injury were noted by the following: Glottic asymmetry, Vocal Cord bowing, Inadequate Vocal Cord approximation, Vocal Cord displacement inferiorly.

RESULTS

Rate of identification of RLN was 100% in both the study groups, EBSLN was identified in 80% of patients in Group B. Type 1 EBSLN was predominant (74%), followed by Type 2a (26%). Mean duration of surgery was 50.57 ± 5.19 minutes in Group A; 52 ± 6.55 minutes in Group B (p=0.06). At 3rd postoperative day, voice change was noted in 21/40 patients in Group A; 16/40 patients in Group B (p=0.694). At 1 month postoperative period, 14/40 patients had voice change in Group A; 5/40 patients in Group B (p=0.15).





Voice assessment of the patients was done on the 3rd day and 1 month post operatively using voice test application where 22/40 and 18/40 patients showed red colour and 19/40 and 27/40 patients showed green colour by Group A and Group B patients respectively on 3rd post operative day and 19/40 and 10/40 showed red colour and 28/40 and 30/40 showed green colour by group A and group B respectively and a better result was seen in Group B patients at 1 month post operative period with hybrid technique (green colour indicated satisfactory results and red colour indicated some abnormality)

Table 1: voice assessment on the 3rd postoperative day

3rd day	**A**		**B**	
	Red	Green	Red	Green
F0	21	19	18	22
Jitter	23	17	13	27
Shimmer	22	18	17	23
P value = 0.19				

Table 2: Voice Assessment after 1 Month

1 month	A		B	
	Red	Green	Red	Green
F0	15	25	10	30
Jitter	12	28	9	31
Shimmer	19	21	10	30
P value =0.1003				

Fig1

Fig2

Fig 1 and 2 Voice assessment recordings at pre-operative and post-operative periods

When comparing the Maximum Phonation Time (MPT), at 3rd day postoperative period, >10% decrease from preoperative MPT values was found in 24/40 patients in Group A, 15/40 patients in Group B (p=0.01); at 1 month postoperative period, it was found in 20/40 patients in Group A, 5/40 patients in Group B (p=0.0033).

Table 3: MPT> and < 10% from preoperative MPT at 3rd day postoperatively

3rd day	MPT> 10%	MPT <10%
Group A	24	16
Group B	15	25
P = 0.04		

Table 4 MPT> and < 10% from Preoperative MPT at 1 Month Postoperatively

1 month	MPT> 10%	MPT <10%
Group A	20	20
Group B	5	35
P = 0.0049		

Table 5 & 6: Positive postoperative laryngoscopy findings, At 3rd day postoperative period, it was found in 22/40 patients in Group A, 17/40 patients in Group B (p=0.751); at 1 month postoperative period, it was found in 8/40 patients in Group A, 6/40 patients in Group B (p=0.235).

3rd day	Positive postoperative flexible laryngoscopy findings	Negative postoperative flexible laryngoscopy findings
Group A	22	18
Group B	17	23
P = 0.26		

Table 6

1 month	Positive postoperative Flexible laryngoscopy findings	Negative postoperative flexible laryngoscopy findings
Group A	8	32
Group B	6	34
P = 0.55		

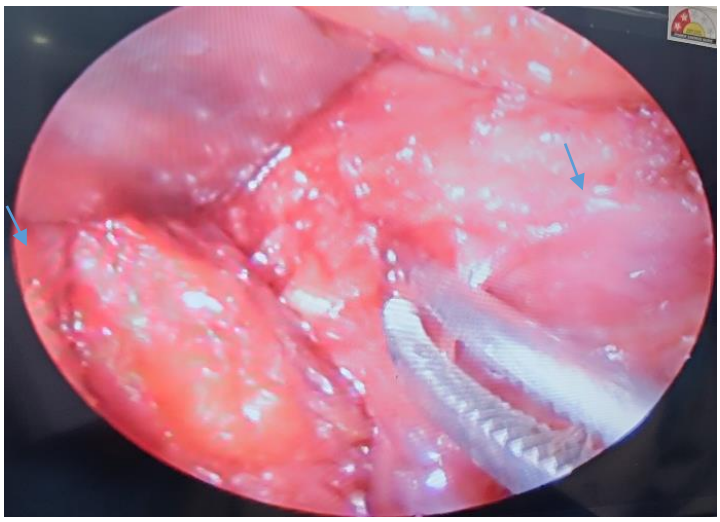


Fig3: Intraoperative picture showing endoscopic magnification of EBSLN type I
Type I

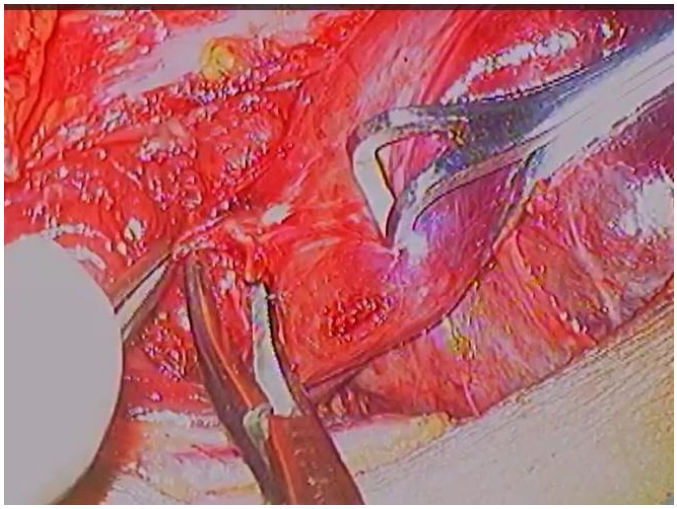


Fig4: Intraoperative picture showing endoscopic magnification of EBSLN type II A
Type II A

DISCUSSION

The injuries to the EBSLN are frequently less addressed because the complications simply include some easily overlooked, tolerable and even subtle symptoms and changes, such as vocal fatigue and diminished vocal frequency range. However, preserving the physical and functional integrity of the EBSLN is crucial to people who are engaged in a voice-related professional activity. Damage to the EBSLN, associated with impairment of cricothyroid muscle motility, leads to alteration in the ability to produce high tones, the voice and frequency. This nerve is surgically relevant because of its proximity to the superior thyroid pole and vessels and must be carefully approached in order to avoid iatrogenic injury. [9] In only about 15% of the cases, the EBSLN is protected from surgical manipulation via a location far from the superior pole vessels. Iatrogenic injuries can be avoided via an accurate anatomic localization during surgical dissection. [6, 12] Unfortunately, the identification of this nerve is not practiced routinely. [8] However, there is an increasing trend to explore new technologies for EBSLN localization. Endoscopic magnification of the nerve can help to identify and preserve the laryngeal nerves, hence reducing the morbidity. [11]

Notably, Berti et al. reported a 65% EBSLN detection rate in video-assisted thyroidectomy with the aid of an optical magnification endoscope based visualization guidance. In this way, IONM has been proposed as an adjunct to the standard technique of intraoperative detection of the laryngeal nerves. [12,13] In our study, along with the routine dissection techniques, the identification and preservation of EBSLN was facilitated with the help of endoscopic magnification during dissection of the superior thyroid pole, a "Hybrid technique".[1] The result showed a superior voice outcome in comparison to the control group where EBSLN was not identified. A comparison of our results was done with other studies where EBSLN was preserved during thyroid surgery.

With the "Hybrid technique" in the current study, 80% of EBSLN was identified, in comparison to Barczynski et al (84%) and Bin et al's (75.6%) IONM studies; and Dedivitis et al's Endoscopic Thyroid Surgery (83.3%). Berti et al. reported a 65% EBSLN detection rate in video-assisted thyroidectomy with the aid of an optical magnification endoscope based visualization guidance. [9,12] Bhagavan et al. also demonstrated retrograde thyroidectomy, which mobilizes the superior pole caudally before ligation, minimizes the risk of EBSLN injury even without direct nerve visualization.

Cernea Type 1 EBSLN was the most commonly encountered (74%) in our study, which was supported by studies by Barczynski et al (47.6%) and Bellantone et al (58.6%). [14,9] Duration of surgery was comparable in both the groups. Current study showed statistically significant MPT, indicating post-operative conservation of the pitch, strength and projection of voice in the Group B in comparison to the control Group A. Such favourable voice outcome due to EBSLN preservation was supported also by IONM study by Barczynski et al and Endoscopic Thyroid surgery by Lombardi et al. However, a study by Bellantone et al., revealed a contrasting opinion where they came to the conclusion that while nerve stimulators helped to identify nerves, careful positioning of the superior pole ligature near the gland

produced a reliable vocal outcome . [7,14,16] There were certain limitations in our study, namely; a small sample size, limited inclusion criteria, unavailability of superior methods of vocal cord assessment like videostroboscopy and high speed cinematography.

CONCLUSION

The identification and preservation of EBSLN, along with RLN during thyroid surgery, undoubtedly yields a better voice outcome. Hence, possible attempts should be made to facilitate the preservation of voice quality by emphasising, preservation of EBSLN. Intraoperative nerve monitoring, video assisted Endoscopic Thyroidectomy and magnifying glasses are the recent tools which have helped in identification of EBSLN along with RLN. In our study, the combination of routine thyroid dissection method along with endoscopic magnification during dissection of the superior pole to help in the identification of EBSLN was adopted, termed as the "Hybrid Technique". This technique, requires no extra skill or armamentarium and has yielded favourable results. It does not claim to be superior to the other available tools for identification of EBSLN, but can be easily used as an adjunctive step during conventional thyroid surgery.

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