Intraoperative Identification versus non-Identification of External Branch of Superior Laryngeal Nerve on Post-Thyroidectomy Voice Changes in Qena University Hospital

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Abstract:

Background: Total thyroidectomy is a common surgical procedure for thyroid disordersbut carries risks, including hypocalcemia and nerve injury, particularly to the external branch of the superior laryngeal nerve (EBSLN). While nerve identification may reduce injury, its role remains debated.

Objectives: To compare the effect of intraoperative EBSLN identification versus non-identification on postoperative voice changes in patients undergoing total thyroidectomy.

Patients and methods: This was aprospective, comparative study which included 80 patients undergoing total thyroidectomy at Qena University Hospital over an 8-month period. Patients were divided into: Group 1 (n=60): EBSLN was not identified intraoperatively, and Group 2 (n=20): EBSLN was identified intraoperatively. All patients underwent a comprehensive evaluation, including medical history, physical examination, and ENT examination with laryngoscopy.

Results: No significant differences were observed between the two groups regarding age (P=0.4011), gender distribution (P=0.3053), or operative time (P=0.7428). Postoperative voice outcomes were similar between both groups: normal voice in 90% and 88.33% (P=0.8381), dysphonia in 10% and 6.67% (P=0.624), and high-pitched voice loss in 0% and 5% in the identified versus the non-identified groups (P=0.2453). Laryngoscopic findings revealed normal vocal cord function in 90% vs 88.33% (P=0.8381), bowing in 5% vs6.67% (P=0.0711) in the identified versus the non-identified groups, and weak mobility in 5% of both groups (P=0.99). The rate of EBSLN injury was comparable between both groups (10% vs. 11.67%, P=0.838).

Conclusion: Intraoperative EBSLN identification does not significantly reduce postoperative voice changes; thus, advanced techniques are required for better nerve preservation.

Keywords: Voice changes; Laryngoscopy; External Branch of the Superior Laryngeal Nerve (EBSLN); Thyroidectomy.

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Introduction

Total thyroidectomy is one of the most frequently performed surgical procedures, indicated for conditions such as nodular goiter, toxic goiter, and malignant thyroid nodules. Despite its efficacy, the procedure is associated with various complications, including hypocalcemia and nerve injuries, particularly involving the recurrent laryngeal nerve and EBSLN**(Zhang et al., 2021).**

The superior laryngeal nerve arises from the inferior (nodose) ganglion of the vagus nerve and bifurcates into internal and external branches approximately 1.5 cm below its origin. The EBSLN provides motor innervation to the cricothyroid muscle, which plays a crucial role in vocal fold tension and high-pitched voice modulation. Injury to this nerve may result in voice fatigue and a reduced vocal range**(Shoffel and Johns, 2024).**

Post-thyroidectomy voice changes due to EBSLN involvement have been reported in 0–6% of cases, with some studies documenting incidences as high as 58%, depending on the method of assessment (subjective evaluation versus electromyography). Intraoperative identification of the EBSLN remains a challenge, as many surgeons opt for superior thyroid vessel ligation in close proximity to the upper pole without direct nerve visualization**(Karpathiotakis, 2021).**

Theoretically, direct exposure of the EBSLN during surgery is considered a protective measure, like the standardized approach for recurrent laryngeal nerve identification. Several prospective studies have demonstrated a reduced incidence of EBSLN injury following nerve dissection and exposure compared to cases where the nerve is not actively identified**(Jin and Sugitani, 2021).**However, some surgeons argue against intentional nerve dissection, citing concerns about increased injury risk. In a previous study nerve dissection was associated with a significant reduction in the amplitude of electrical response when assessed via nerve stimulation**(Bourabaa and Settaf, 2024).**

Various techniques have been proposed for EBSLN preservation, including meticulous identification and ligation of superior thyroid vessel branches close to the thyroid capsule, visual nerve identification prior to vessel ligation, and the use of intraoperative nerve stimulation or monitoring **(Urahman and Reksoprawiro, 2021)**

The aim of this study was to compare the effect of intraoperative EBSLN identification versus non-identification on postoperative voice changes in patients undergoing total thyroidectomy.

Patients and methods

This was a prospective comparative study performed at Qena University Hospital on 80 cases scheduled for total thyroidectomy selected over the study period of 8 months. Patients were divided into 2 groups based on nerve identification: Group 1: Patients with intraoperative EBSLN identification and Group 2: Patients without intraoperative EBSLN identification in all patients.

All patients who were candidate for total thyroidectomy from Qena University Hospital aged $\geq$ 16 years old were included in the study. Exclusion criteria were history of neck surgery or irradiation, preoperative voice change, laryngeal cancer or patients' refusal to participate.

All patients underwent complete history, physical, and ENT examinations, including anterior and posterior rhinoscopy to exclude nasal pathology affecting voice (e.g., polyps, deviated septum). Preoperative laryngoscopy confirmed normal vocal cord function in all patients.

Operation steps

All operations were performed under general anesthesia, the patient was positioned supine with full neck extension, and a low collar transverse skin incision was made. A subplatysmal flap was raised just above the upper thyroid cartilage, and the investing deep fascia was incised along

the midline using electrocautery. A standardized approach for the upper pole was then adopted by retracting the sternothyroid and sternohyoid muscles laterally while retracting the thyroid lobe inferolaterally.

For intraoperative EBSLN identification, inferior and middle thyroid veins were ligated and both parathyroid glands were identified and preserved in situ; the thyroid lobe was dissected from the cricothyroid muscle (CTM) to create an optimal operative field within the sternothyroid–laryngeal (Joll's) triangle when the lobe was retracted laterally and inferiorly, for better intraoperative visualization of the nerve we used a magnifying loup to clearly identify the EBSLN. The region within 1–2 mm of the superior edge of the sternothyroid muscle was carefully dissected and stimulated, serving as an excellent landmark for the linear oblique path of the EBSLN. If the EBSLN was not identified after thorough exploration, it was presumed to penetrate the inferior pharyngeal constrictor at a high level above the STP and be protected by this muscle throughout its course to the CTM. If the nerve wasn't identifiable, the patients was categorized into group 2.

Once confirmed, the superior thyroid vessels and the distal course of the EBSLN were meticulously dissected. In Group 1, individual ligation of the superior thyroid vessels was performed close to the thyroid capsule, whereas in Group 2, complete exploration of these vessels with individual ligation was carried out after full exposure of the EBSLN; in both cases, the EBSLN was stimulated proximal to the ligation point to verify its postoperative functional integrity, and the same procedure was repeated on the contralateral side. Finally, in both groups, ligation of the inferior thyroid veins was conducted at the lower pole, followed by exposure of the recurrent laryngeal nerve in the tracheoesophageal groove, and the terminal branches of the inferior thyroid artery were ligated. (**Fig.1**).
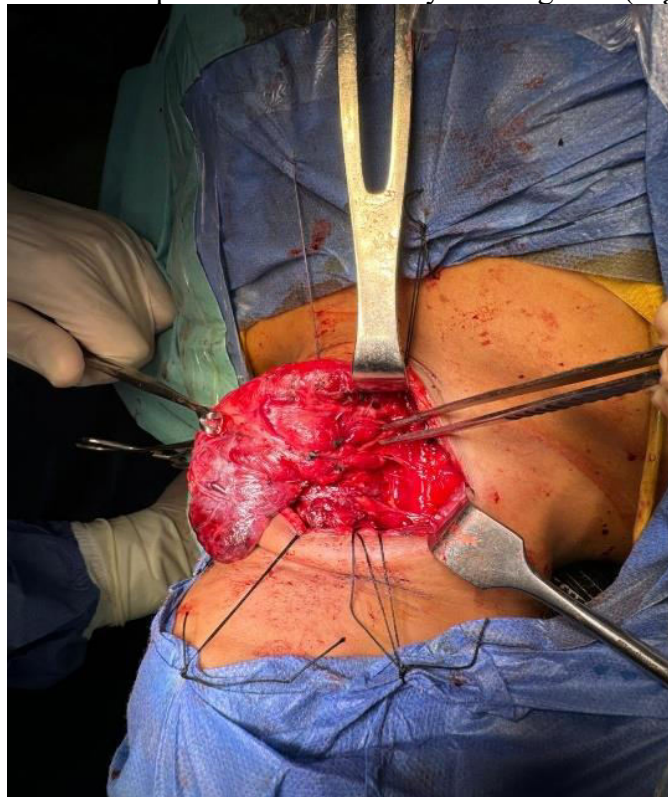

Fig.1. Thyroidectomy with intraoperative identification of the EBSLN.

Patients were followed up at 2 weeks, 3 months and 6 months postoperatively. Post operative voice status and laryngoscopic findingsat6 months after the operation were noted and documented. Laryngoscopic signs suggestive of EBSLN injury included bowing of the vocal fold, inferior displacement of the affected fold, and rotation of the posterior glottis toward the site of lesion when using the voice in high pitch

Ethical approval code: SVU-MED-SUR011-1-24-1-796.

Statistical analysis:

Data was processed using SPSS version 23. Qualitative variables were presented as numbers and percentages, while quantitative data were expressed as mean ± standard deviation (SD). Mann-Whittney test was used for data comparison for continuous data. Chi-square and fisher exact tests were used for comparison between non-continuous data.

Results

This was a prospective comparative study that was conducted on 80 patients. 25 patients underwent nerve identification from which 5 cases had unidentifiable nerve and were stratified into group 2.

The comparison between the studied nerve groups based on nerve identification showed no significant differences in pre-operative and operative data. The mean age was 30.25 ± 8.95 years in the identified nerve group (N = 20) versus 32.13 ± 8.71 years in the non-identified nerve group (N = 60) (P = 0.4011). Males comprised 15% (N = 3) of the identified nerve group versus 21.67% (N = 13) of the non-identified nerve group (P = 0.5186). The mean operative time was 107.3 ± 9.06 minutes in the identified nerve group versus 106.42 ± 9.5 minutes in the non-identified nerve group (P = 0.7428). (**Table.1).**

Table 1. Comparison between the studied groups regrading pre-operative and operative data

Variables	Patients with intraoperative EBSLN identification (N = 20)	Patients without intraoperative EBSLN identification (N = 60)	P. Value
Age	30.25 ± 8.95	32.13 ± 8.71	0.4011 [MWU]
Gender			
• Male	3 (15%)	13 (21.67%)	0.5186 [X]
• Female	17 (85%)	47 (78.33%)	
Operative time (min)	107.3 ± 9.06	106.42 ± 9.5	0.7428 [MWU]

MWU: Mann-Whittney U test, X: chi-square test.

Postoperative voice status was comparable between the identified nerve group (N = 20) versus the non-identified nerve group (N = 60). Normal voice was observed in 90% versus 88.33% of cases, respectively (P = 0.8381). Dysphonia (hoarseness) was slightly higher in the identified nerve group (10%) compared to 6.67% in the non-identified group, though the difference was not significant (P = 0.624). Loss of high-pitched voice was only reported in the non-identified nerve group (5%, P = 0.2453), while no cases of aphonia were recorded in either group.

Laryngoscopic findings showed normal vocal cord function in 90% of the identified nerve group versus 88.33% of the non-identified group (P = 0.8381). Bowing of the vocal cords was detected in 5% versus 6.67% of cases, respectively (P = 0.0711). Weak mobility of the vocal cords was observed in 5% in both groups (P = 0.99), and no cases of vocal cord paralysis were reported.

Affection of EBSLN was noted in 10% in the identified nerve group versus 11.67% in the non-identified group, with no statistically significant difference (P = 0.838). In group 1, no injuries were detected during exploration thus all injuries in this study were during the thyroidectomy operation. (**Table.2**).

Table 2. Comparison between the studied groups regarding postoperative data

Variables	Patients with intraoperative EBSLN identification (N = 20)	Patients without intraoperative EBSLN identification (N = 60)	P. Value
Postoperative voice status			
• Normal	18 (90%)	53 (88.33%)	0.8381 [X]
• Dysphonia (Hoarseness of voice)	2 (10%)	4 (6.67%)	0.624 [X]
• Loss of high bitched voice	0 (0%)	3 (5%)	0.2453 [f]
• Aphonia	0 (0%)	0 (0%)	-
Laryngoscope finding			
• Normal	18 (90%)	53 (88.33%)	0.8381 [X]
• Bowing of vocal cords	1 (5%)	4 (6.67%)	0.0711 [X]
• Weak mobility of vocal cords	1 (5%)	3 (5%)	0.99 [X]
• Paralysis of vocal cords	0 (0%)	0 (0%)	-
EBSLN injury	2 (10%)	7 (11.67%)	0.838 [X]

Discussion

Total thyroidectomy is a common procedure for both benign and malignant thyroid conditions but carries risks, particularly injury to EBSLN, which modulates pitch. Damage to the EBSLN can cause vocal fatigue, loss of high-pitched voice, and reduced vocal projection. Due to its proximity to the superior thyroid artery, the EBSLN is vulnerable during vessel ligation, increasing the risk of injury **(Dekhou et al., 2021; Zhao et al., 2021).**

The necessity of routine intraoperative EBSLN identification remains debated. While some advocate for direct identification to minimize injury, others argue that dissection itself may cause trauma. Various protective techniques, including meticulous dissection, close vessel ligation, and intraoperative nerve monitoring, have been employed to mitigate risks **(Del Rio et al., 2021; Erfan et al., 2024).**

Although EBSLN injury is less severe than recurrent laryngeal nerve damage, it can significantly impact voice quality and patient well-being. Optimizing intraoperative nerve management is essential for improving surgical outcomes while balancing effective thyroid resection with nerve preservation **(Rodriguez et al., 2023; Sahoo et al., 2024).**

Our study aimed to evaluate the intraoperative identification of EBSLN and its correlation with postoperative voice outcomes.

This prospective comparative study was conducted at Qena University Hospital and included all patients who were candidates for total thyroidectomy. The sample size was calculated to include 80 cases.

The higher prevalence of total thyroidectomy among females in our study likely reflects the greater incidence of thyroid disorders in women. Conditions such as nodular goiter, thyroid dysfunction (hyperthyroidism and hypothyroidism),

and autoimmune diseases like Hashimoto's thyroiditis and Graves' disease are more common in females, influenced by hormonal factors, particularly estrogen, which affects immune regulation and thyroid function. Additionally, iodine metabolism and genetic predisposition may contribute to this increased susceptibility, leading to a higher need for thyroid surgery in women **(Mardani et al., 2024; Şahin et al., 2024)**.

In line with our results, **Singh et al. (2025)** highlighted that voice-related complications are a major cause of morbidity in patients undergoing thyroidectomy. They reported a mean patient age of 35.73 ± 9.13 years, with the most common age group being 36–45 years. The male-to-female ratio was 1:9.

Gavid et al. (2017) studied 144 patients who underwent total thyroidectomy, reporting a wider age range of 18 to 106 years, with a mean age of 59.4 ± 15.8 years. Their study also demonstrated a strong female predominance (83%), which is consistent with our findings. The slightly higher mean age in Gavid et al.'s study may be attributed to differences in patient selection criteria or geographic variations in thyroid disease presentation.

Similarly, **Ng et al. (2020)** recruited 90 patients, with a mean age of 53.3 years (SD ±15.3, range 18–91), including 60 females and 30 males. Their study involved both hemithyroidectomy and total thyroidectomy, leading to a total of 130 lobectomies. The broader age range and mixed surgical procedures provide additional insights into patient demographics and surgical outcomes.

In line with our results, **Asgari et al. (2016)** identified the nerve in 33% of cases and reported that the risk of injury nearly doubled in cases where the nerve was not explored (16% vs. 7.4%). These findings emphasize the potential benefits of active nerve identification in reducing postoperative complications.

Friedman et al. (2002) further reinforced this by demonstrating that in more than 85% of cases, the EBSLN could be identified at the junction of the inferior constrictor muscle and the cricothyroid muscle.

Page et al. (2004) studied 50 thyroidectomies, successfully identifying the EBSLN in only 20% of cases using neuromonitoring—comparable to our identification rate of 25%.

However, **Ng et al. (2020)** reported a significantly higher identification rate (87.4%) using a nerve stimulator in lobectomies. This discrepancy highlights the potential benefit of intraoperative nerve monitoring in improving EBSLN identification. The lower identification rate in our study may be attributed to the reliance on visual identification alone, the anatomical variability of the nerve, or surgical experience.

In our study, intraoperative nerve identification was achieved in 20 cases (25%). EBSLN was injured in 2 cases of the identified group (10%) versus 7 cases of the non-identified group (11.67%) , there was no significant difference in the mean operative time between the identified nerve group (107.3 ± 9.06 min) and non-identified nerve group (106.42 ± 9.5 min) (P = 0.7428). This suggests that nerve identification did not significantly prolong the surgical procedure.

Compared to our results, **Abdelrahim et al. (2022)** reported a lower EBSLN was injured in 8 patients (5.3%), versus 133 patients (94.7%) showing no nerve involvement, indicating variability in nerve injury rates across different studies. Similarly, **Shaaban et al. (2017)** examined 200 cases of hemi or total thyroidectomy without EBSLN identification and found a 5% rate of EBSLN injury detected through laryngoscopy.

Aluffi et al. (2001) reported a 14% incidence of EBSLN injury in 45 patients undergoing different thyroid surgeries. Also, **Page et al. (2004)** reported only one

case (2%) of postoperative nerve affection. This suggests that factors beyond intraoperative identification, such as surgical technique or neuromonitoring sensitivity, may play a role in nerve preservation.

In this study, injury of EBSLN was observed in 10% of the identified nerve group and 11.67% of the non-identified nerve group, with no significant difference (P = 0.838). These findings suggest that while intraoperative identification of the EBSLN may offer some benefits, it does not completely eliminate the risk of nerve dysfunction.

In line with our results, **Bellantone et al. (2001)**reported no significant difference in EBSLN injury rates between patients undergoing upper pole dissection with or without nerve exploration, raising questions about whether routine nerve identification should be a standard practice. Additionally, the role of intraoperative EBSLN identification even with applying neuromonitoring (IONM) remains controversial. While **Barczyński et al. (2013)**concluded that IONM significantly enhances nerve identification, **Aina and Hisham (2001)**found no added benefit of using a nerve stimulator in detecting EBSLN.

Ding et al. (2023)highlighted the advantages of video-assisted surgery (VAS) in improving EBSLN identification. Their study demonstrated significantly higher visual identification rates (91.04% vs. 77.61%) and total identification rates (100% vs. 89.6%) in the VAS group compared to the conventional open surgery (COS) group. Notably, both groups had a 0% EBSLN injury rate, reinforcing the potential benefits of enhanced visualization techniques in thyroid surgery.

Contrasting our results, **Hurtado-Lopez et al. (2005)**conducted a prospective randomized study comparing EBSLN identification versus non-identification. They found significantly lower injury rates in the identified

nervegroup (8%) compared to the non-identified nervegroup (20%). Their use of electromyography (EMG) for assessment may have provided a more sensitive detection of nerve dysfunction compared to our laryngoscopic evaluation.

There was non-significant differences between the studied groups regarding postoperative voice status and laryngoscopic findings.

Comparing our findings with previous studies, **Abdelrahim et al. (2022)**reported dysphonia in 6 cases (4%) and loss of high-pitched voice in 10 cases (6.7%) among 150 patients undergoing total thyroidectomy. Laryngoscopic examination in their study showed that 120 patients (85.7%) had normal vocal cord function, while 9 patients (6%) exhibited vocal cord bowing, 4 patients (2.7%) had inferior displacement of the vocal cord, and 8 patients (5.3%) had weak vocal cord mobility.

Similarly, **Asgari et al. (2016)**investigated 90 patients divided into two groups: 40 patients in the explored nerve group, where the EBSLN was identified and upper pole vessels were individually ligated, and 50 patients in the non-explored nerve group. Across both groups, 22 patients (24.4%) experienced temporary hoarseness. This rate is noted to be higher than in our study, potentially due to differences in surgical technique, patient demographics, or the extent of intraoperative nerve exploration.

Bellantone et al. (2001)reported no significant voice or endoscopic changes Postoperatively, unlike our study, this discrepancy could be due to differences in assessment methods, as Bellantone et al. utilized video laryngoscopy and spectrographic analysis.

Asgari et al. (2016)explored the effects of direct nerve visualization by comparing an "explored" group (where the EBSLN was actively identified) with a "non-explored" group (where the nerve was not specifically sought). They found temporary hoarseness in 22.5% of the

explored group and 26% of the non-explored group (P = 0.70), confirming that intraoperative nerve identification does not completely eliminate the risk of postoperative voice disturbances.

Our results align with those reported by **Abdelrahim et al. (2022)**who also investigated the impact of EBSLN identification on postoperative voice changes . Their study, which included 75 patients in the non-identified group versus 66 patients in the identified group, showed that dysphonia was present in 5.3% of the non-identified group versus 3% of the identified group (P = 0.499, NS). Similarly, loss of high-pitched voice was observed in 9.3% of the non-identified group versus 4.5% of the identified group (P = 0.269, NS). These findings reinforce the possibility that nerve identification may reduce specific voice impairments, although the differences remain statistically insignificant.

Laryngoscopic evaluation in our study further demonstrated that nerve identification did not result in significant differences in postoperative structural or functional vocal cord abnormalities. Bowing of the vocal cords was observed in 5% of the identified nerve group versus 6.67% of the non-identified nerve group (P = 0.07). Weak vocal cord mobility was equally distributed (5% in both groups, P = 0.99). Overall, EBSLN affection was noted in 10% of the identified nerve group versus 11.67% of the non-identified nerve group, again showing no significant difference (P = 0.838).

Similarly, **Abdelrahim et al. (2022)**reported that laryngoscopic findings did not differ significantly between nerve groups. Normal vocal cord function was found in 82.7% of the non-identified nerve group versus 87.9% of the identified nerve group (P = 0.821, NS). Bowing of the vocal cords was reported in 6.7% of the non-identified nerve group versus 6.1% of the identified nerve group, while weak vocal cord mobility was noted in 6.7% of the non-identified nerve group versus 4.5%

of the identified nerve group. Inferior displacement of the vocal cords was observed in 4% of the non-identified nerve group versus 1.5% of the identified nerve group. These findings collectively indicate that while EBSLN identification might aid in voice preservation, it does not entirely prevent postoperative voice changes.

In contrast to our study, **Naytah et al. (2019)**proposed that intraoperative neuromonitoring (IONM) enhances EBSLN identification and visualization, potentially reducing post-thyroidectomy voice disorders. **Ng et al. (2020)**described a surgical maneuver involving exploration of the upper pole of the thyroid lobe, with routine division of the anterior fibers of the sternothyroid muscle near its insertion onto the oblique line. This approach was found to improve exposure and facilitate EBSLN dissection without leading to adverse functional voice outcomes, thereby reducing the risk of postoperative voice complications.

Chen et al. (2024)emphasized that expanding the sternothyroid-laryngeal triangle and thoroughly exploring the upper pole of the thyroid gland are crucial for minimizing EBSLN injury. They highlighted the clinical significance of meticulous dissection in reducing postoperative voice dysfunction and laryngeal impairment.

Study limitations: This study had several limitations, including a small sample size, which may affect generalizability. Postoperative voice changes were assessed clinically and via laryngoscopy, without advanced tools like electromyography for objective nerve function evaluation. The lack of long-term follow-up limited insight into voice recovery, and uncontrolled confounding factors such as surgical expertise variations, may have influenced outcomes.

Conclusion

Our study indicates that intraoperative identification of EBSLN during thyroidectomy does not fully prevent postoperative voice changes, as

voice outcomes were similar between identified and non-identified groups. While identification may slightly reduce high-pitched voice loss, it does not eliminate the risk of EBSLN injury. Future research should explore advanced visualization techniques, intraoperative neuromonitoring, and refined surgical methods to improve EBSLN preservation and optimize voice outcomes.

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