External laryngeal nerve to identify or not during thyroidectomy: a single-institute experience

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Background
Iatrogenic injury to the external branch of the superior laryngeal nerve (ESLN) may occur during thyroidectomy because of its close proximity to the upper pole of the thyroid gland. Injury to the ESLN results in postoperative voice changes, which may be severe, especially in professional voice users. Although the main principle in neck surgery is proper dissection and identification rather than avoidance of important structures for their preservation, many surgeons do not routinely identify the ESLN during thyroidectomy because the nerve has variable anatomical courses. This encouraged us to conduct this study to evaluate the incidence of ESLN injury during thyroidectomy when superior thyroid vessels were ligated individually close to thyroid capsule without prior identification of the nerve.
Patients and methods
The present study included 200 patients with goiters who underwent either total or hemithyroidectomy at the Department of Surgery, Medical Research Institute Hospital, Alexandria University. In all patients, superior thyroid vessels were ligated in branches very close to thyroid capsule without prior positive search for the ESLN.
Results
In the present study, 185 (92.5%) patients underwent total thyroidectomy, whereas the remaining 15 (7.5%) patients underwent hemithyroidectomy. Transient ESLN injury occurred in 3% of patients, whereas 2% suffered from permanent nerve injury.
Conclusion
Preservation of the ESLN is necessary during thyroidectomy, especially in professional voice users. Ligation of superior thyroid vessels in branches close to thyroid capsule without prior identification of the ESLN is a safe procedure and does not increase the incidence of nerve injury.

Keywords:
cricothyroid muscle, external laryngeal nerve, thyroidectomy, voice changes

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Introduction

The rate of surgery of the thyroid gland has tripled over the last 30 years [1]. Many investigators have reported acoustic changes after surgery of the thyroid gland [2–8]. These changes can result from either laryngeal nerve injury or other events during thyroidectomy [2–8]. The importance of the external branch of the superior laryngeal nerve (EBSLN) has been overshadowed by the clinical significance of recurrent laryngeal nerve and it received little attention during surgery. The external laryngeal nerve is the sole motor nerve supply of the cricothyroid muscle, which is the tensor of vocal folds and raises the pitch of voice [9]. Post-thyroidectomy ESLN injury symptoms include voice fatigue, breathy voice, and a decrease in voice range [10]. This injury is important, especially in professional voice users such as singers and teachers and may impair the quality of their lives. The reported risk for ESLN injury is variable, ranging from 3 to 13% [11]. The ESLN is at risk for injury during dissection of upper thyroid pole, as it runs close to superior thyroid vessels [12–14]. Various techniques have been reported for preservation of the ESLN, including skeletonization and ligation of superior thyroid vessels in branches close to the thyroid capsule [15], visual identification of the nerve before ligation of the upper thyroid pole [11], and the use of either nerve stimulator [16] or intraoperative nerve monitoring (IONM) [17,18]. The best technique to avoid EBSLN injury is still debatable. Identification of any structure to preserve it is the main issue of any surgical intervention. However, many surgeons do not apply this principle to the ESLN, and hence we conducted this study to assess the incidence of ESLN injury during

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thyroidectomy when superior thyroid vessels are ligated individually in branches very close to thyroid gland capsule without prior identification of the nerve.

Patients and methods

This study was a prospective nonrandomized study. It included 200 patients with goiter who underwent either total or hemithyroidectomy in the Department of Surgery, Medical Research Institute Hospital, Alex University, from January 2014 to January 2016. Preoperative workup included full history taking, general and local clinical examination, routine laboratory investigations in addition to thyroid function tests and serum calcium level (total and ionized), and neck ultrasonography. Fine needle aspiration cytology was performed on selected basis (suspicious lesions). All patients in the study underwent videostroboscopy laryngoscopy examination before surgery to exclude vocal cord disorders (mobility disorders and lesions). Preoperative normalization of thyroid hormones and serum calcium levels were emphasized so as to avoid their effects on voice. Patients with a history of previous cervical or laryngeal operations, cervical radiotherapy, vocal cord disorders, preoperative voice changes, and those with thyroid malignancy with extrathyroid extension were excluded from the study.

Ethics

Before inclusion in the study, each patient signed an informed consent form, which included thorough information about his or her operation and the possible complications. This consent was approved by the Ethics Committee of the Medical Research Institute.

Outcomes

Primary outcome

The primary was to evaluate the incidence of post-thyroidectomy ESLN injury in the studied group.

Secondary outcomes

The secondary outcomes were operative time, post-operative recurrent laryngeal nerve injury, hypo-calcemia, and other postoperative complications.

Surgical technique

All patients in the study underwent either total or hemithyroidectomy using extracapsular dissection technique described by Shah and Patel [19]. Superior thyroid vessels were skeletonized and individually ligated distally very close to the thyroid capsule without prior identification of the external laryngeal nerve. Keeping cricothyroid muscles intact was emphasized during dissection. Integrity of strap muscles was restored if muscle cutting was performed. Closed negative suction drain was utilized routinely for every patient in the study.

Postoperative course

Operative and postoperative data of each patient were recorded, stressing upon operative time and postoperative complications. Videostroboscopy laryngoscopy was performed for each patient on the seventh postoperative day and any voice changes were assessed clinically with stress upon aphonia, hoarseness, voice fatigue, and inability to produce high-pitched voice. Laryngoscopic signs of external laryngeal nerve injury include inferior displacement of the affected cord leading to oblique glottic opening, irregular or wavy cord, flaccid and shorter than normal, bowing of the vocal cord, and or rotation of posterior glottis toward the site of lesion when using the voice at an extremely high pitch [20–25].

Follow-up

Follow-up of patients was carried out at the outpatient clinic at 7 days, 1 month, and 6 months after operation for the assessment of complications. Patients with voice changes, suspected nerve injury, and those with hypocalcemia were followed up every month for the detection of any improvement and better evaluation of their conditions.

Results

In the present study, preoperative data of the studied group are shown in Table 1. One hundred and eighty-five patients underwent total thyroidectomy and 15 patients underwent hemithyroidectomy with 385 ESLN at risk. Operative data of the studied group are shown in Table 2. In the present study, transient ESLN injury occurred in six (3%) patients, whereas permanent injury occurred in four (2%) patients. Other postoperative complications are shown in Table 3. Figures 1 and 2 show postoperative laryngoscopy for two patients with EBSLN injury.

Discussion

Voice changes after thyroidectomy may result from ESLN injury, and hence preservation of this nerve during thyroidectomy is necessary, especially in professional speakers such as teachers and singers. In the present study, transient ESLN injury occurred in 3% of patients and permanent injury occurred in 2% of patients. Aluffi *et al.* [20] in their study followed the

Table 1 Preoperative data of the studied group (*n*=200)

	N (%)
Sex	
Male	46 (23.0)
Female	154 (77.0)
Age (years)	
Min.–max.	14–65
Mean±SD	41.7±10.7
Type of goiter	
SMNG	125 (62.5)
Controlled Toxic	32 (16.0)
Malignant	21 (10.5)
STN	15 (7.5)
Thyroiditis	7 (3.5)
Comorbidities	
Hypertension	13 (6.5)
Cardiac	5 (2.5)
BA	7 (3.5)
DM	9 (4.5)

BA, bronchial asthma; DM, diabetes mellitus; max., maximum; min., minimum; SMNG, simple multinodular goiter; STN, solitary thyroid nodule.

Table 2 Operative data of the studied groups (*n*=200)

	Total thyroidectomy (*n*=185)	Hemithyroidectomy (*n*=15)
Operative time (min)		
Min.–max.	50–130	30–70
Mean±SD	91.4±14.9	48.4±10.8
Operative blood loss (ml)		
Median (min.–max.)	31 (10–250)	14 (10–70)
Mean±SD	50.8±43	18.4±15.3
Number of identified parathyroid glands		
Median (min.–max.)	4 (2–5)	2 (1–2)
Mean±SD	3.6±0.6	1.9±0.3
Weight of thyroid glands (g)		
Median (min.–max.)	39 (20–200)	17 (14.3–80.4)
Mean±SD	46.7±23.4	23.4±18

Max., maximum; min., minimum.

same surgical protocol for management of the ESLN during thyroidectomy as in the present study and reported 14% incidence for ESLN injury despite their small study population (45 patients). Teitelbaum and Wenig [26] also did not routinely identify the ESLN and reported a high permanent nerve injury (5%). The incidence of ESLN injury in the previous two studies was much higher than that in the present study. This may be attributed to the use of both laryngoscopy and electromyography of cricothyroid muscles for the diagnosis of ESLN injury in these two studies, whereas, in the present study, we used only laryngoscopy. Lekacos *et al.* [27] performed individual ligation of superior thyroid vessels without prior ESLN identification and

Table 3 Postoperative data of the studied groups (*n*=200)

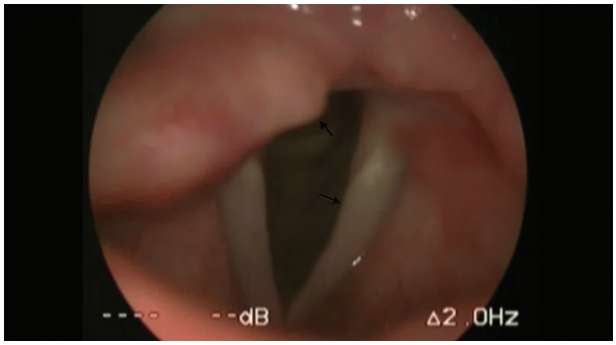
	N (%)
ESLN injury	
Transient	6 (3.0)
Permanent	4 (2.0)
RLN injury	
Transient	6 (3.0)
Permanent	2 (1.0)
Hypocalcemia	
Transient	10 (5.0)
Permanent	5 (2.5)
Postoperative hematoma	8 (4.0)

ESLN, external branch of the superior laryngeal nerve; RLN, recurrent laryngeal nerve.

Figure 1

Post-operative laryngoscopy showing severe deviation of posterior glottis to the left side denoting left ESLN injury.

Figure 2



Post-operative laryngoscopy for another patient showing bowing of left vocal cord with mild deviation of posterior glottis to the left side denoting left ESLN injury.

reported 0% ESLN injury with distal ligation close to thyroid capsule and 5.6% injury with high ligation. Evaluation of ESLN injury in their study was carried out using laryngoscopy. Likewise, Loré *et al.* [15] and Kierner *et al.* [28] reported that gentle mobilization of upper thyroid pole and individual ligation of superior thyroid vessels very close to thyroid capsule without systematic positive search for the ESLN may avoid nerve injury. Page *et al.* [29], studying over 50

thyroidectomies, also found no benefit of systematic search for the ESLN.

Some authors claim that it is important to positively identify the ESLN before ligation of superior thyroid vessels, especially type IIb nerve according to the Cernea classification (the nerve crosses superior thyroid vessels under cover of upper thyroid pole) [30]. Despite the rarity of this nerve type, it is the most dangerous type and is considered to be most at risk during ligation of superior thyroid vessels close to thyroid capsule [31]. Hurtado-Lopez *et al.* [32] found that patients who underwent thyroidectomies without positively searching for the ESLN had more voice changes compared with patients with thyroidectomies with intentional searching for the nerve (14 vs. 8%, respectively) and emphasized upon the importance of intraoperative identification. Bellantone *et al.* [33] conducted a study to compare visual identification of the ESLN before ligation of upper pole vessels (group A) with distal ligation of individual branches of superior thyroid vessels close to thyroid capsule without prior identification of the ESLN as in the present study (group B) as regards the incidence of ESLN injury. They found no significant difference between the two groups as regards ESLN injury and a significantly shorter operative time in group B. Kark *et al.* [23] reported an injury rate of 3% without nerve identification compared with 5% with the nerve search.

Patnaik *et al.* [34] conducted a study to evaluate the visual identification rate of the ESLN during 64 thyroidectomies in a tertiary care hospital. The nerve was identified and preserved in 83% of patients and could not be identified at all in the remaining patients (17%). None of these patients (17%) showed any symptoms and signs of ESLN paresis as their nerves were preserved using individual ligation of superior thyroid vessels close to thyroid capsule. Patnaik *et al.* [34] proposed that the ESLN was buried under inferior constrictor muscle fibers, and hence it was impossible to identify the nerve in the field of thyroidectomy. They concluded that trial of nerve identification if it is buried under inferior constrictor muscle fibers would take a longer period of time with more injury to surrounding structures and without any benefit as the nerve could be preserved with individual ligation of superior thyroid vessels close to thyroid capsule. Barczyński *et al.* [18] conducted a randomized study to compare surgical visualization with neuromonitoring (IONM) of the ESLN during thyroidectomy and concluded that the use of intraoperative neuromonitoring significantly improved intraoperative identification of the ESLN and decreased early postoperative voice changes with no significant difference in delayed postoperative voice changes between IONM and surgical visualization. Improvement in the identification rate of the ESLN by the use of IONM and thus limitation of the risk for nerve injury were confirmed in other several studies [35,36]. We propose that despite the benefit of IONM during thyroidectomy it could not be used routinely in developing countries because of deficiency of resources. According to the results of the present study, individual ligation of superior thyroid vessels close to thyroid capsule can be safe and save the cost and time of the use of IONM.

Injury and identification rates of the ESLN vary greatly from one study to another with identification rates varying from 33 to 93% and injury rates varying from 0 to 58% [10,16,17,23,26–28,37]. Lack of standard surgical technique for preservation of the ESLN may be responsible for this great variation in the results of various studies. Inaccuracy of diagnostic procedures of nerve injury used in some studies may play a role. Jansson *et al.* [10] reported that partial injury of the ESLN could not be diagnosed accurately with indirect laryngoscopy or voice symptoms alone. They propose that electromyography (EMG) of the cricothyroid muscle is very important for the definitive diagnosis of partial nerve injury. Most of the up-to-date studies do not use EMG when reporting injury rates of the nerve [15–17,23,27]. Another important factor is training level of the surgeon. Cernea *et al.* [37] reported 28% injury rate of the ESLN by resident compared with 12% injury rate by the senior author. The lack of consensus as regards the optimal surgical protocol for ESLN preservation is most probably due to variable anatomical courses of the nerve. Various classification systems have described the anatomical course of this nerve, such as Cernea, Kierner, and Friedman classification systems, in an attempt to facilitate ESLN identification and preservation [28,30,31,34,37].

Conclusion and recommendations

Preservation of the ESLN during thyroidectomy is necessary to avoid post-thyroidectomy voice changes, especially in professional voice users. Individual ligation of superior thyroid vessels close to thyroid capsule without prior identification of the ESLN is safe and may prevent ESLN injury. Larger numbers of patients with large goiters have to be evaluated in further studies for safety of this surgical technique as regards ESLN injury and to be compared with intraoperative neuromonitoring of the ESLN as regards the incidence of nerve injury and cost.

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Conflicts of interest
There are no conflicts of interest.

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