ORIGINAL ARTICLE

Transection of Sternothyroid muscle increases the rate of exposure of the external branch of the superior laryngeal nerve during thyroidectomy

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Abstract

Objective: To assess the benefits of transection of the sternothyroid muscle compared to conventional approach for detecting the external branch of the superior laryngeal nerve while dealing with the upper pole of the thyroid gland.

Method: The randomised controlled clinical trial was conducted at Kafrelsheikh University Hospital, Egypt, from January 2021 to January 2022, and comprised patients who were eligible for total thyroidectomy and met the American Thyroid Association guidelines. They were randomised and divided into conventional approach group A and sternothyroid muscle transection approach group B. The rate of exposure of the external branch of the superior laryngeal nerve, injury, classification, operative time and voice outcomes at 2 weeks and 3 months post-intervention were noted in both the groups. Data was analysed using SPSS 22.

Results: Of the 102 patients, 50(49%) were in group A; 5(10%) males and 45(90%) females with mean age 40.48±12.58 years and mean body mass index 30.676±2.305. There were 52(51%) patients in group B; 5(9.6%) males and 45(90.4%) females with mean age 39.67±11.60 years and mean body mass index 30.096±2.776. The rate of external branch of the superior laryngeal nerve identification was higher and the operative time was shorter in group B compared to group A (p=0.05). No significant difference was noted in terms of voice outcomes either at baseline or at any of the two follow-up points between the groups (p>0.05).

Conclusion: The transection of sternothyroid muscle improved the rate of external branch of the superior laryngeal nerve exposure and preservation compared to the conventional technique during thyroidectomy.

Keywords: Thyroidectomy, Thyroid gland, Laryngeal nerves, Acoustics, Vocal cords, Sternothyroid muscle.

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Introduction

The cricothyroid (CT) muscle is supplied by the external branch of the superior laryngeal nerve (EBSLN), which is a branch of the vagus nerve. CT muscle contraction increases the vocal cord (VC) tension during phonation.[1]

The EBSLN course in the neck exposes it to the risk of injury in thyroidectomy, parathyroid surgery, or carotid endarterectomy. Several factors may increase the risk of EBSLN trauma as it may be ligated or transacted because of inflammation and scarring, such as in Hashimoto's thyroiditis, malignancy, and recent radiotherapy.[2]

The EBSLN was found in the sternothyroid laryngeal triangle, also called Joll's space.[3] This triangle is bounded anterolaterally by the sternothyroid (ST) muscle, laterally by the retracted superior pole of the thyroid gland, and medially by the inferior constrictor muscle of the pharynx and the CT muscle.[2] The ST muscle has an oblique insertion into the thyroid cartilage and is tightly attached to the thyroid gland.[3] Injury to the EBSLN is poorly understood than recurrent laryngeal nerve (RLN) injury. The frequency of EBSLN damage in the literature varies between 0% and 58 %.[1]

Most surgeons performing thyroidectomy identify and visualise the RLN, contrary to EBSLN. In thyroid surgery, EBSLN is referred to as the "neglected" nerve.[4] Except in case of professional singers or public speakers, voice changes occurring after EBSLN injury are often subtle and may go unnoticed. Sometimes, video laryngeal stroboscopy (VLS) can detect subtle vocal cord changes associated with the injury.[5]

The study was conducted to evaluate the transection of the ST muscle as a key step during thyroidectomy to improve the rate of exposure and visual identification of EBSLN compared to the traditional technique.

Patients and Methods

The randomised controlled trial (RCT) was conducted at Kafrelsheikh University Hospital, Egypt, from January 2021 to January 2022. After approval from the institutional ethics review committee, the sample size was determined by

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comparing the identification rate of EBSLN after thyroidectomy employing transection of the sternothyroid muscle group (87.4 %)[6] versus the conventional muscle retraction technique (34.4 %)[7]. Alpha (α) error level was set at 0.05, power at 80% and the target was to detect a true difference of 20% in the nerve identification rate. The calculation was done using PS power and sample size calculations software 3.1.2.[8]

The sample was raised using consecutive sampling technique from among those patients who were eligible for total thyroidectomy and met the American Thyroid Association (ATA) guidelines.[9] The clinical diagnosis was verified by preoperative biochemical thyroid function testing and a neck ultrasound with fine needle aspiration cytology (FNAC) of suspicious lesions. Patients who previously had surgery on the neck or with a history of irradiation, or who had been with a diagnosis of dynamic VC disorders, a VC benign lesion, or speech issues before surgery were excluded.

Written informed consent was obtained from all the patients, and each of them was assigned a code number to ensure anonymity. Patients' information was acquired through history, examinations and investigations.

The patients were randomised using computer-generated block randomisation method into conventional approach group A and sternothyroid muscle transection approach group B.

All the surgeries were conducted by one surgeon. All the patients had total extracapsular thyroidectomy using a standard Kocher's skin incision with a midline fascia opening. After complete identification and preservation of both RLNs, the gland was dissected along the RLN. In group A, thyroidectomy was performed using the conventional standardised approach. The surgeon detached the strap muscles from the gland, ligated the middle thyroid veins, and retracted the strap muscles laterally, including the ST muscle. The lateral portion of the thyroid was revealed. The exposure of the superior pole of the thyroid gland by pushing it into the medial and inferior directions and withdrawing the ST muscle laterally is an essential step in the traditional technique. The sternothyroid laryngeal triangle was shown after upper pole area's dissection by lower-lateral displacement of the thyroid lobe. Careful individual ligatures of superior thyroid artery (STA) branches close to the superior thyroid pole were performed after meticulous dissection to protect the EBSLN with proper exposure in the CT space. STAs near the gland were ligated and divided to guarantee the preservation of the EBSLN.

In group B, at the level of the upper thyroid pole, the sternohyoid muscle was detached from the ST muscle, then about 2cm of the medial part of the ST muscle was cut at its insertion into the thyroid cartilage using a harmonic device (Harmonic Focus; Johnson & Johnson Medical, Cincnnati, United States). After ST muscle transection, the STA and its branches were clearly identified. Also, EBSLN was easily identified in most of the cases because of better exposure to the CT space (Figure 1). There was no reapproximation of the split muscle. The strap muscles were reattached at the midline after thyroid gland removal, and the skin was meticulously closed.

All patients in both the groups were discharged 24 hours after the surgery, and the drain was removed on discharge. Postoperative routine medical treatment after thyroidectomy was administrated to all patients, including calcium supplements. Hormonal replacement treatment was started after histopathology results, and the patients were referred to an endocrinologist for follow-up of the hormonal profile.

Indirect laryngoscopy using a 70-degree endoscope (Karl Storz HopkinsR II Optik endoscope and Storz IMAGE 1 Spies high-definition (HD) camera) was performed preoperatively and postoperatively to view bilateral vocal fold motility, and to confirm intact RLN on both sides.

Postoperatively, the patients were followed up at 2 weeks and 3 months. The follow-up protocol included a subjective tool and an objective tool. The Voice Handicap Index (VHI) is a self-assessment questionnaire for voice symptoms that have been verified and translated into several languages, including Arabic. Rosen et al. created a new short version of 30-item VHI which has 10 items (VHI-10).[10] It has been demonstrated to be a reliable, consistent, and less time-demanding measure[11], and was used in the current study to identify poor voice outcomes following thyroidectomy. A validated Arabic version of the VHI-10 was provided to the participants[12]. The responses were stored in Microsoft Office Excel 2019.

The study also analysed the mean speaking fundamental frequency (F0), which is strongly linked to voice pitch, to examine how it evolved during follow-up.[12] Patients were invited to sit and asked to utter a sustained vowel "a" for three seconds at a tolerable degree of effort. A smartphone microphone was used to record the voice placed 10cm away from the lips, then uploaded to a laptop equipped with PRAAT software.[13]

At the final 3-month follow-up, VLS was performed to check regular periodicity, complete glottic closure, and mucosal pattern.

Data was analysed using SPSS 22. It was presented as mean ± standard deviation (±SD), median and range, or as frequencies and percentages, as appropriate. Numerical variables were compared using student t-test. Chi-square test was employed to measure categorical data. exact Fisher test was used when the frequency was expected to be less than 5. Two-sided p<0.05 was determined considered statistically significant.

Results

Of the 145 patients assessed, 122(84.13%) were enrolled, but the study was completed by 102(83.6%) of them (Figure 2). Of the total, 50(49%) were in group A; 5(10%) males and 45(90%) females with mean age 40.48±12.58 years (range: 18-70 years) and mean body mass index (BMI) 30.676±2.305. There were 52(51%) patients in group B; 5(9.6%) males and 45(90.4%) females with mean age 39.67±11.60 years (range: 19-68) years) and mean BMI 30.096±2.776. The EBSLN injury rate was 0% in both the groups. The rate of EBSLN identification was higher and the operative time was shorter in group B compared to group A (Table 1).

Table-1: Comparison of study groups (n = 102).

Variable	Conventional technique (n = 50)	Transection technique (n = 52)	*p-value*
Mean Age (years)	40.48±12.58	39.67±11.60	0.732
Gender, n (%)			
Male	5 (10%)	5 (9.6%)	1.000
Female	45 (90%)	47 (90.4%)	
BMIa (mean ± SD, kg/m2)	30.676±2.305	30.096±2.776	0.255
Clinical presentation, n (%)			
Neck swelling	34 (68%)	38 (73.1%)	0.817
Family history	6 (12%)	6 (11.5%)	
Toxic Manifestations	10 (20%)	8 (15.4%)	
Postoperative histopathology, n (%)			
Benign	34 (68%)	37 (71.2%)	0.830
Malignant	16 (32%)	15 (28.8%)	
EBSLN identified during operation, n (%)	79 (79%)	98 (94.23%)	0.003
EBSLN injury during operation, n (%)	0(0%)	0(0%)	
EBSLN Cernea classification, n (%)			
Type 1	20 (20%)	41 (39.42%)	0.001
Type 2A	48 (48%)	47 (45.19%)	
Type 2B	11 (11%)	10 (9.61%)	
Operative time (mean ± SD, minutes)	23.04±1.937	16.79±2.052	< 0.001

SD: Standard deviation, BMI: Body mass index, ESBLN: external branch of the superior laryngeal nerve, a: BMI calculated as weight in kilograms divided by height in meters squared.

Table-2: Comparison of the voice handicap index-10 (VHI-10) and Fundamental Frequency (F0) between the groups.

Parameter	Conventional technique (n = 50)	Transection technique (n = 52)	Mean Difference	*p-value*
VHI-10 baseline				
Mean ± SD.	3.70±2.225	3.42±1.923	-0.276	0.502
Median	3.00	3.00		
Range	1 – 9	0 - 9		
VHI-10 2w postoperative				
Mean ± SD.	7.48±4.501	8.62±3.716	1.135	0.167
Median	5.00	7.00		
Range	3 – 16	5 – 18		
VHI-10 3m post-operative				
Mean ± SD.	5.02±2.993	5.35±3.59	0.326	0.620
Median	4.00	4.00		
Range	1 – 13	1 – 15		
F0- baselinea				
Total	202.78±40.24	202.76±40.54	0.024	0.998
F0- 2w post-operativea				
Total	199.69±39.76	197.47±39.53	2.222	0.778
F0- 3m post-operativea				
Total	200.80±39.88	200.36±40.20	0.436	0.956

SD: Standard deviation, a: Frequency of the voice fundamental (Hz).

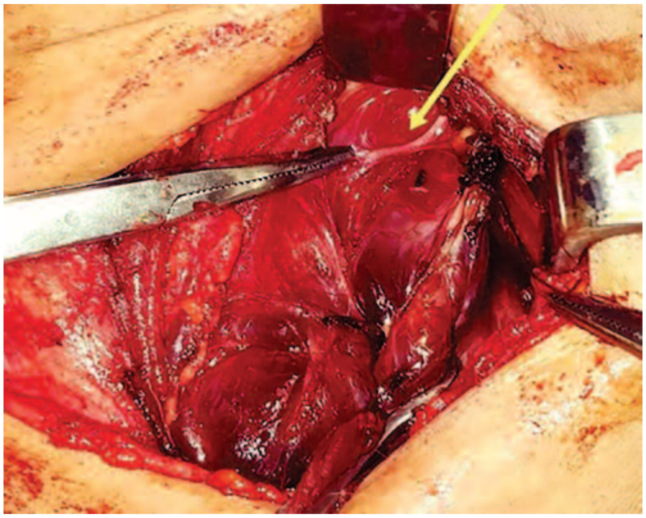

Figure-1: Identification of the external branch of superior laryngeal nerve (EBSLN) during thyroidectomy (transection approach).

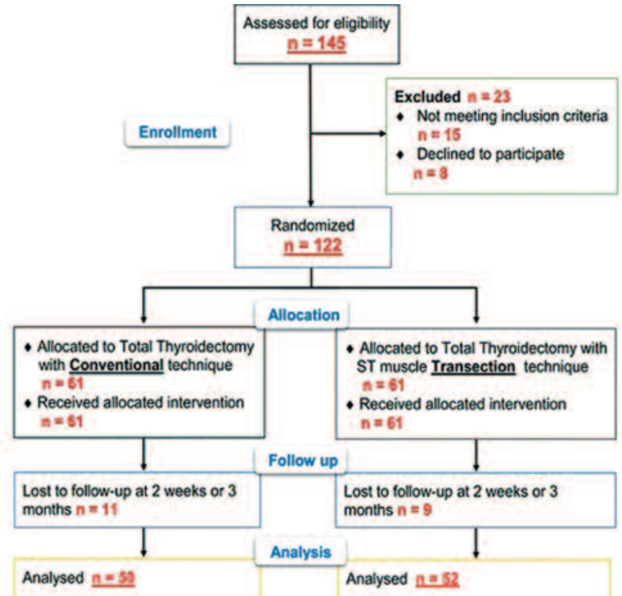

Figure-2: Study flow-chart.

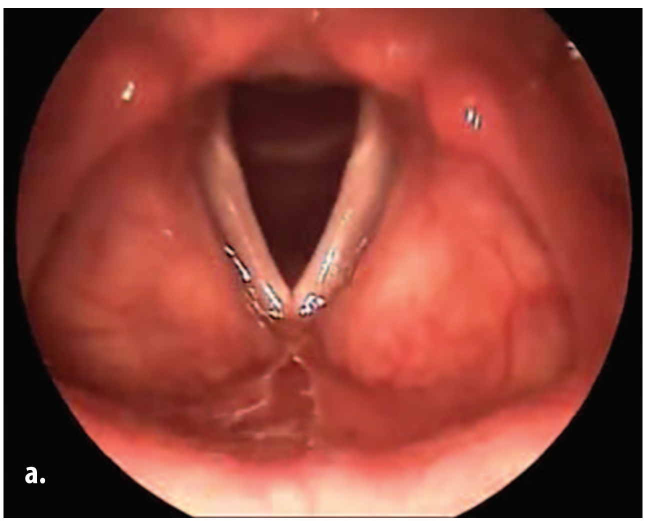

Figure-3: Postoperative video laryngeal stroboscopy (VLS) showing bilateral vocal cords examination during phonation; (a): abduction, (b): adduction, and (c): mucosal waves.

Postoperative VLS showed that the glottis was in the middle of the range, while, during pronunciation, both vocal folds were symmetrical and at the same level, and no oblique glottis was detected (Figure 3).

No significant difference was noted in terms of voice outcomes either at baseline or at any of the two follow-up points between the groups (Table 2).

Discussion

During high-pitched phonation, the CT muscle tilts the thyroid cartilage relative to the cricoid cartilage, increasing the tension of the VC due to increased length. The EBSLN supplies only motor fibres to the CT muscle.[12] Changes in voice quality and the production of high-pitched sounds occur when the EBSLN is injured.[14] A person with EBSLN palsy may feel easy vocal fatigue and inability to obtain high-pitched phonation, which may be more obvious in professional speakers, particularly singers.[15]

The ST muscle arises from the sternum and attaches to the lateral aspect of the thyroid cartilage anterior to and adjacent to the superior pole of the thyroid gland, potentially reducing exposure during the crucial phase of thyroidectomy.[16] In such a circumstance, a transection of the medial portion of ST muscle insertion may be required to improve the EBSLN. The current study revealed that the EBSLN exposure and identification rate was 94.23% with the transection technique. This rate was higher than the conventional technique (79%).

Several studies have proposed anatomical classifications of the EBSLN. In 1992, Cernea et al.[5] created the most frequently accepted classification of the EBSLN, which describes the level above the superior thyroid pole at which the EBSLN crosses the STA. In type 1, the EBSLN crosses the STA at least 1cm above the upper edge of the superior thyroid pole; in type 2a, the EBSLN crosses the STA less <1cm above the upper edge of the superior thyroid pole; and in type 2b, the EBSLN crosses the superior pedicle below the upper border of the superior thyroid pole. As a result, types 2a and 2b are assumed to be more exposed to the risk of injury during the operation.[17]

The operative time was diffrent between the groups in the current study. A variety of factors, including the patient's BMI, the surgeon's experience, and the texture of the thyroid gland, can affect the time of surgery. In addition, RLN and parathyroid glands' exposure and preservation, alongside a variety of other aspects, are known to affect the total time of the surgery.[6]

Thyroidectomy frequently causes voice-related issues, which are usually transitory. Many factors, including the integrity of the superior laryngeal nerve, can affect postoperative laryngeal function. While preserving the EBSLN is the major goal, preserving the CT muscle is also crucial. Injury to the larynx's soft tissues and damage to the pharynx's constrictor muscles may also play a role. Although most voice experts believe that the strap musculature contributes to voice production, the exact function and relevance of the strap muscles, especially the ST muscle, in voice production are uncertain, and the effect of the ST muscle on the VC is still debatable.[18]

According to Sonninen et al.[19], the ST muscle contributed to the VC lengthening and bilateral division of strap muscles, including the ST muscle, during thyroidectomy, resulting in decreased pitch that was not recoverable. On the other hand, Schilling et al.[20] believed that the ST muscle, the primary shortener of the VC, antagonises the CT muscle function. The strength of the strap muscles influences the rise and fall of voice frequency, according to Roubeau et al.[21] According to Jaffe and Young, strap muscle division has no subjective or objective functional consequences on voice.[22] The latter issue was raised by Henry et al.[23] in 2008, who found there were no significant differences in both voice complaints and aerodynamic metrics after thyroidectomy. Lee et al.[24] concluded in 2013 that partial ST muscle cutting during thyroidectomy has no significant deleterious impact on postoperative vocal analysis findings.

Nonetheless, the vocal outcomes following ST muscle transection are consistent with the current data.

The current study has some limitations. Electromyography (EMG) evaluation was not done, and only the speaking voice was studied while ignoring the alterations in acoustic features in postoperative follow-ups.

Conclusion

In thyroidectomy, transection of ST muscle was found to be a key step that may be used to improve the EBSLN visual identification and preservation compared to the conventional technique.

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Conflict of Interest: None.

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