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ORIGINAL RESEARCH

DIFFERENT SURGICAL TECHNIQUES FOR PRESERVATION OF RECURRENT LARYNGEAL NERVE DURING THYROIDECTOMY

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ABSTRACT

Background: The most significant risk that associated with thyroid surgery, is the occurrence of recurrent laryngeal nerve palsy. If this condition affects both sides of the larynx, it leads to laryngeal diplegia, resulting in severe respiratory complications. Aim: To evaluate the surgical techniques used to preserve recurrent laryngeal nerves during thyroidectomy safely.

Methods: This cross-sectional study was conducted in the general surgery department of Beni-Suef University Hospital and Fayoum General Hospital. We included 60 patients who were indicated for thyroidectomy. According to the approach of RLN identification, the included patients were divided into four groups: lateral (n = 15), inferior (n = 15), superior (n = 15), and medial (n = 15).

Result: The operative time of the inferior approach was the lowest operative Time 41.4 ± 10.7, compared with the lateral approach 46.3 ± 9.9, the superior approach 55.6 ± 11.1, and the medial approach 67.7 ± 4.8. Inferior, superior, and medial approaches were not associated with cases of paralyzed VC. The lateral approach group showed two cases with paralyzed VC (11.8%). The lateral approach group showed a statistically significant number of cases with hoarseness of voice (17.6%), while the other approaches showed no cases with hoarseness of voice (0%) (p = 0.042).

Conclusion: Our study highlights that identifying the RLN superiorly near its constant point of entry into the larynx is an effective and safe technique to reduce the risk of RLN injury, nerve exposure, and low risk of hypocalcemia. The lateral approach requires expertise and wide exposure to minimize RLN injury risk. The inferior approach poses a lower RLN injury risk but raises concerns about parathyroid gland devascularization. The medial approach is helpful in local infiltrative malignancy and offers safer dissection for the parathyroid gland and ITA.

***Keywords**:* Thyroidectomy, recurrent laryngeal nerve, RLN, thyroid

INTRODUCTION

During every thyroidectomy, it is crucial to intentionally identify and protect the recurrent laryngeal nerve (RLN), the external branch of the superior laryngeal nerve (EBSLN), and parathyroids. The recurrent laryngeal nerve (RLN) arises from the vagus nerve in the neck region, travels downwards into the thorax, and encircles the arch of the aorta on the left side and the subclavian artery on the right side. It then ascends back up into the neck. It travels through the

tracheoesophageal groove and enters the larynx. The surgeon must thoroughly understand the varying course of the RLN to prevent potential damage. The susceptibility of the (RLN) to injury is contingent upon its anatomical location and the level of expertise possessed by the surgeon. [1]

In the conventional thyroidectomy, the surgeon moves the thyroid lobe forward and inward by 120° to locate the (RLN). The RLN is typically found in the cleft between the trachea and oesophagus, behind the tubercle of Zuckerkandl or among the branches of the inferior thyroid artery. While this method is commonly used, the use of force to rotate the thyroid lobe can lead to traction and localized compression injury to the recurrent laryngeal nerve at areas of attachment.[2]

Other techniques, including the superior, medial, lateral , and inferior approaches, are available.The superior method of accessing the (RLN)is a dependable option. This method is not affected by the variations caused by thyroid dysfunction. Initially, it enables the reliable visualization of the (RLN)at its place of entry. Implementing this technology to recognize recurring non-specific nerve issues when the diagnosis is already known in advance could be a preventive measure against recurring morbidity. [3]

The dominant method in primary surgery for the thyroid is the lateral approach. The (RLN)is typically located during dissection around the inferior thyroid artery, namely around the level of the middle lobe of the thyroid gland. When the inferior route is used, RLN is typically located near where it enters the neck region, and no scar formation is observed, particularly in cases involving secondary surgery. Patients with goitres that are enlarged substernally or retropharyngeally are preferably treated using the medial technique. This method involves initially dissecting and separating the isthmus, then dissecting the isthmus and the central portion of the lobe away from the trachea. This allows for the exposure of the front and side portions of the trachea. The fibres connecting the side of the second or third rings of the trachea to the thyroid and the fibers of the Berry ligament are carefully separated in an upward direction. This is done to provide a clear view of (RLN) on the side of the trachea. [4]

To guarantee the secure preservation of (RLN) undergoing thyroidectomy, this study aimed to analyze several surgical approaches: superior, medial, lateral, and inferior.

METHODS

This study was a descriptive cross-sectional study performed on 60 Patients subjected to thyroidectomy as a primary surgery for treating various thyroid diseases. The search was carried out in the surgical departments of Fayoum General Hospital and Beni-Suef University Hospital.

The patients included in the study were categorized into four categories based on the RLN identification approach.: patients managed with the lateral technique. (n = 15), the inferior technique. (n = 15), the superior approach (n = 15), and the medial technique. (n = 15). The study did not include all patients with previous thyroid surgery, congenital immobile vocal cords, tumours infiltrating the recurrent laryngeal nerve, history of preoperative injury to laryngeal nerves, and patients with neuropathies.

All patients had comprehensive history taking, which included gathering demographic information such as age, gender, and place of residence, as well as history of previous medications and thyroid surgery. Preoperatively, the patients were evaluated by general and local examination, neck US, indirect laryngoscopy to check vocal cord and standard laboratory testing, such as complete blood count (CBC), hematocrit (PT), international normalized ratio (INR), thyroid, liver, kidney, viral, and glucose values.

Surgical technique:

The surgery was performed under general anaesthesia while the patient was lying on their back with their legs spread apart. The head was elevated by positioning a support beneath the shoulder blades. Precautions were taken to avoid excessive neck stretching since this can cause considerable discomfort after surgery, especially in those with cervical disc degeneration.

A collar incision was delineated one centimetre superior to the clavicle line, and the skin was infused with 0.5% Marcaine. A cut was made in the skin, and layers were lifted below the level of the platysma muscle. The exposure was achieved by laterally retracting both sternomastoid muscles and dissecting up to the tendon of the omohyoid, which

rests above the internal jugular vein. Both thyroid lobes were meticulously examined by touch and sight to identify any abnormalities that were not readily apparent during the preoperative assessment.

The lateral approach

The RLN is found at the thyroid lobe's midpoint using this approach. The upper and lower thyroid poles are released, The gland above the trachea retracted, and The recurrent laryngeal nerve (RLN) is located at a rather elevated position in the neck, namely at the mid-polar level. Before contact with the nerve, the inferior parathyroid gland is frequently located close to the inferior pole. The advantage of this approach is that the inferior parathyroid blood flow is preserved, and the exposure to RLN is restricted.

The inferior approach

This approach mobilizes the gland, and the lobe is delivered out. The dissection starts at the apex of the riddle's triangle. The medial, lateral, and superior boundaries are formed, respectively, by the trachea, carotid, and inferior thyroid arteries. The loose areolar tissue is dissected upward by scissors to reach the inferior thyroid artery, and then the RLN is revealed. However, this approach is inappropriate for large goitres, especially the substernal ones.

The superior approach

This approach begins with the transection of the superior pedicle and movement of the upper thyroid pole. The clinical landmark is the inferior constrictor muscle. The RLN nerve traverses beneath this muscle. And can be exposed at its inferior border. The Berry ligament can be securely divided once the proximal RLN is identified.

The medial approach

This approach begins with isthmus

splitting. Then, the medial part of the thyroid lobe is moved laterally between the anterolateral aspect of the trachea and the gland itself, providing an avascular plane. Following the avascular line between the medial upper thyroid lobe and the cricothyroid muscle fascia, the lower border of the cricothyroid muscle is visualized.

This provides a safe dissection plane as The recurrent laryngeal nerve (RLN) is situated directly beneath the inferior constrictor muscle

Postoperative assessment:

The operative time and any complications were recorded. The vocal cords were evaluated by an anaesthesia consultant immediately after tube removal. Postoperative cord paralysis was documented for any decrease in cord mobility. Transient or permanent palsy and recovery time were also reported.

Statistical Analysis

The peri-operative data were gathered and categorized based on the method employed to identify the (RLN). The (SPSS-version 21) was used to examine the data. The data were displayed as a percentage for dichotomous variables, and for continuous variables, the mean with standard deviation. The continuous variables were compared using the T-test. Simultaneously, The category variables were analyzed using chi-square tests. The correlation between different variables was assessed using Pearson correlation and multivariate linear regression tests. The statistical tests were two-tailed, with a $p < 0.05$ as the predefined statistical significance threshold.

RESULTS

Baseline attributes of the individuals under study (Tables 1, 2).

Based on our inclusion criteria, we included 60 patients, ten males and 50 females, who underwent thyroidectomy in our study. The mean age of the included cases was 42.53 ± 10.8 years; most cases were females (83.3%), and neck US revealed that (46.6%) had a multinodular goitre. All patients had a mobile vocal cord, and the investigations were normal in (91.6%) of cases. In 71.67% of cases, a complete thyroidectomy was the most prevalent procedure. There were no statistically significant differences seen across the groups in terms of age (P-value 0.307), sex (P-value 0.320), neck ultrasound findings (P-value 0.520), and preoperative investigations (P-value 0.428).

Table 1. Baseline Descriptive characteristics of the studied cases

Variable	Category	n = 60
Age (years)	• Mean ± SD • Median	42.53 ± 10.8 41.5 (24 – 66)
Sex	• Male • Female	10 (16.6%) 50 (83.3%)
Neck U/S	• Neoplastic thyroid nodule • Thyroiditis • Right Thyroid Nodule • Left Thyroid Nodule • Diffuse Goiter • Multinodular Goiter	1 (1.6%) 1 (1.6%) 5 (8.4%) 14 (23.3%) 11 (18.3%) 28 (46.6%)
Routine Investigations	• Normal • Abnormal (Cardiac patient)	55 (91.6%) 5 (8.4%)
Preoperative Laryngoscopy Finding	• Mobile VC	60 (100%)
Thyroid Function	• Normal • Controlled Toxic Goiter	55 (91.6%) 5 (8.4%)
Type of Operation	• Total Thyroidectomy • Left Hemi-thyroidectomy • Right Hemi-thyroidectomy	43 (71.67%) 13 (21.67%) 4 (6.67%)

Table 2. Relationship between Operative Approach and Operative determinants.

	Lateral (I) (n = 15)	Inferior (II) (n = 15)	Superior (III) (n = 15)	Medial (IV) (n = 15)	P-value
Age/year	44.40 ± 7.1	38.01 ± 12.5	44.44 ± 13.3	43.13 ± 8.5	0.307*
P-value**	I vs. II =0.107 I vs. III =0.992	II vs. III =0.100 II vs. IV =0.195	III vs. IV=0.736	I vs. IV=0.747	
Sex					
Male Female	1 (6.7%) 14 (93.3%)	4 (26.7%) 11 (73.3%)	2 (12.5%) 13 (86.67%)	3 (20%) 12 (80%)	0.320***
Neck U/S (Thyroid Nodule)					
Solitary Multiple	5 (33.3%) 10 (66.7%)	8 (53.3%) 7 (46.7%)	5 (31.3%) 11 (68.7%)	6 (40%) 9 (60%)	0.520$
Abnormal Invest.	2 (13.3%)	0 (0%)	2 (12.5%)	2 (13.3%)	0.428***

*The ANOVA test assessed the disparity in means among different groups.
**A post-hoc test was employed for pairwise comparisons, and the Bonferroni correction was applied.
***Monte Carlo The exact test was employed to compare the disparity in proportions between the groups.
The chi-square test assessed the disparity in proportions between the groups.

Analysis of the operative outcomes (tables 3 & 4)

The mean operative time was 52.80 ± 13.9 min. Vocal cords were assessed by an anesthesiologist, who revealed that all patients had a mobile vocal cord. Hoarseness of voice was shown in 5 (8.4%) patients, and transient RLN palsy was seen in 4 (6.7%) patients. Dyspnea, chocking and dyspnea were seen in 1 patient only. Otherwise, all patients had no postoperative complications.

The operative time of the inferior approach was significantly lower than all other approaches ($p<0.01$) except the superior ($p=0.18$). Inferior, superior, and medial approaches were not associated with cases of paralyzed VC (0%). The lateral approach group showed a statistically significant number of cases with hoarseness of

voice (17.6%), while the other approaches showed no cases with hoarseness of voice (0%) (p = 0.042).

The lateral approach group showed two cases with RLN palsy (11.8%), while the other approaches showed no cases with RLN palsy (0%) (p = 0.135)

Table 3. Operative outcomes of the studied cases.

Variable	Category	n = 60
Operative time in minutes	• Mean ± SD • Median (Range)	52.80 ± 13.9 55 (30 – 75)
VC Assessment by Anesthetist	• Mobile VC	60 (100%)
Vocalization	• Good • Hoarseness	55 (91.6%) 5 (8.4%)
Complication (RLN Palsy)	• No • Transient	56 (93.3%) 4 (6.7%)
Other Complications	• No • Bleeding • Dyspnea on Exertion • Chocking	57 (95%) 1 (1.67%) 1 (1.67%) 1 (1.67%)

Table 4 . Relationship between Operative Approach and Operative determinants (B).

	Lateral (I) (n = 15)	Inferior (II) (n = 15)	Superior (III) (n = 15)	Medial (IV) (n = 15)	P-value
Operative Time/min.	46.33 ± 9.7	41.40 ± 10.8	55.63 ± 11.5	67.67 ± 6.5	< 0.001*
P-value**	I vs. II=0.181 I vs. III=0.012	II vs. III<0.001 II vs. IV<0.001	III vs. IV=0.001	I vs. IV<0.001	
Paralyzed VC	1 (6.7%)	0 (0%)	0 (0%)	0 (0%)	0.732***
Hoarseness of Voice	3 (20%)	0 (0%)	0 (0%)	2 (13.3%)	0.326***
RLN Palsy	2 (13.3%)	0 (0%)	0 (0%)	0 (0%)	0.201***
Other Complication	2 (13.3%)	0 (0%)	0 (0%)	1 (6.7%)	0.312***
Operative Type					
• T. Thyroidectomy • Lt. Hemi-thyroid. • Rt. Hemi-thyroid.	11 (73.3%) 1 (6.7%) 3 (20%)	7 (46.7%) 7 (46.7%) 1 (6.7%)	13 (81.3%) 3 (18.7%) 0 (0%)	13 (86.7%) 2 (13.3%) 0 (0%)	0.019***

*The ANOVA test assessed the disparity in means among different groups.
**A post-hoc test was employed for pairwise comparisons, and the Bonferroni correction was applied.
***Monte Carlo The exact test was employed to compare the disparity in proportions between the groups.

DISCUSSION

A stretch injury to the distal section of the RLN, adherent to Berry's ligament, may result from the medial rotation of the thyroid gland during thyroid surgery. These overstretching injuries can be classified into two subtypes: type 1, which is brought on by pulling down the distal segment of RLN, and type 2, which is brought on by directly distressing the nerve by stretching the ligament. The most susceptible location to damage from overstretching is the fixed terminal tract of the nerve, which is located above the penetration in the larynx. [5]

One of the most dangerous side effects of thyroid surgery is RLN damage. While unilateral RLN injuries might result in complications like hoarseness and aspiration that can significantly lower quality of life, bilateral RLN injuries can result

in life-threatening breathing difficulties. [6]

The two main risks associated with totalthyroidectomy are the preservation of the RLN and its function, as well as the preservation of the parathyroid glands. To reduce the danger of laryngeal paralysis following surgery, it is essential to identify and completely expose RLN throughout its course in the thyroid region. [7]

In our cross-sectional study, we included patients indicated for thyroidectomy as a primary surgery for managing different thyroid conditions. According to the approach of RLN identification, the included patients were divided into four groups: lateral, inferior, superior, and medial. Each group included patients whose ages were matched, with no discernible difference (P = 0.31). Besides, the gender was matched with no significant difference (P = 0.32). Also, the type of the operation (T. Thyroidectomy, Lt. Hemi-thyroid, or Rt. Hemi-thyroid) was matched between the four groups (P = 0.258). That's why our results were not affected by the age and gender of the included patients and the operative type. The main advantage of the inferior and lateral approaches is the significantly less operative time compared with other techniques. The main disadvantage of the lateral approach is a higher association with vocal cord palsy and hoarseness of voice. However, all differences between the four approaches regarding postoperative complications were non-significant.

The RLN is recognized using the superior approach as it passes through the inferior constrictor muscle close to the cricothyroid junction. [8] This approach is beneficial because the RLN position about the cricothyroid junction is constant despite thyroid disease and congenital abnormalities. [9]

The location of the nerve at a fixed anatomical landmark reduces issues brought on by anatomical differences in the cervical course of the RLN, such as a non-recurrent nerve or a huge goiter-superior nerve identification results in a shorter length of RLN exposure than inferior identification. There is no increased risk of hypocalcemia, primary haemorrhage, or wound complications when the nerve is identified superiorly during surgery. [10]

Our study found that the superior approach was not associated with RLN palsy, hoarseness of voice, paralyzed VC, or any other complication.

Page et al. used the superior approach to identify RLN. They found that it was a safe approach and was not associated with RLN palsy, hoarseness of voice, paralyzed VC, or any other complication. [11]

Veyseller et al. reported no cases of RLN paralysis with the superior approach. However, they reported four cases (8.3%) of postoperative hypothyroidism and one case (1.4%) of postoperative bleeding. [12]

Consistent with our findings, Skyes et al. discovered that locating the RLN close to its reliable point of entry into the larynx is a safe and efficient method of lowering the risk of RLN paresis and palsy during thyroid surgery. [10]

The inferior approach generally means the identification of the RLN during secondary surgical procedures from its entry into the neck region free of scar tissue. Patients with huge substernal goitres and those who have non-RLN should not use the inferior approach. [13]

Our study found that the inferior approach was not associated with RLN palsy, hoarseness of voice, paralyzed VC, or any other complication.

Veyseller et al. found that there were two cases (1.5%) of RLN paralysis, 18 cases (20%)of hypothyroidism, and one case of postoperative bleeding with the inferior approach. They concluded that the superior approach was associated with a lower incidence of complications than the inferior approach. At the same time, in our study, we found that both approaches are equally suited to the complications. [12]

Sreejayan et al. reported 14 (3.56%) patients with temporary hoarseness of voice that recovered during the recovery period and no cases with VC paralysis. They concluded that an inferior approach decreases the possibility of harming the extra laryngeal branches of the RLN and is particularly helpful in people with short necks and large goitres, which is consistent with our findings. [1]

The medial approach is one of several techniques used to access the RLN during surgery. This approach involves dissecting along the medial aspect of the thyroid gland to expose the nerve as it courses around the inferior border of this structure. A study by Butskiy et al. reports that the medial approach provides excellent visualization of the RLN and allows for safe dissection close to other important structures, such as the parathyroid glands. [14]

The medial approach is commonly used during thyroidectomy procedures, which involve the removal of all or part of the thyroid gland. This technique allows for identifying and preserving both RLNs, which is critical for maintaining vocal function postoperatively. In addition, it can be used during other procedures requiring access to the RLN, such as cervical lymph node dissection or resection of tumours close to this nerve .Our study found that the medial approach was not associated with RLN palsy, hoarseness of voice, paralyzed VC, or any other complication. [10]

A retrospective analysis by Butskiy et al. analyzed the retrograde medial approach for dissecting the (RLN) at the cricothyroid junction. The transient and persistent vocal cord palsy rates were reported as 9% and 0.3%, respectively. The mean operative time for this procedure was approximately 41 minutes, which closely resembled the operative time observed in our study. [14]

The incidence of permanent VC palsy and hypocalcemia in the retrograde medial approach was similar to other methods, such as the superior approach. However, transient VC palsy was higher in the retrograde medial approach when compared with different techniques. Sykes et al. reported that the incidence of hypocalcemia was 2.2%, and the permeant VC palsy was 0.4%.

Comparing the results of the medial approaches to the lateral and inferior approaches is very difficult because using a single approach exclusively is very rare. For this reason, national studies give the best estimate of thyroidectomy complications in the Scandinavian Quality Register for Endocrine Surgery study 2008. The authors of the Scandinavian research report reduced rates of transient vocal cord palsy (3.9%) but similar rates of persistent palsy (0.9%) based on 3660 thyroidectomies. [15]

In primary thyroid surgery, the lateral approach is the most widely utilized. The RLN is normally discovered by dissecting around the inferior thyroid artery at the thyroid's middle lobe level. This technique has gained popularity recently due to its potential to reduce the risk of RLN injury while providing adequate exposure for surgical procedures involving the thyroid gland or other adjacent structures. However, this approach also has some potential drawbacks, including an increased risk of bleeding. [16]

Therefore, it is essential for surgeons performing this procedure to have extensive experience with this technique and carefully evaluate each patient's case to determine if it is appropriate. The thyroid and strep muscles are dissected before the lateral thyroid veins are cauterized and ligated. If there is no reason to suspect the presence of non-RLN on the right side, releasing the higher pole first may give an advantage. This method may be difficult in situations with large goitres or a significant Zuckerkandl's Tubercle.[14]

Looking for the nerve inside this region after subsequent surgery may pose hazards due to extensive scar tissue development. In the presence of non-RLN, the lateral approach may be dangerous because the nerve in secondary cases runs perpendicular to its usual pathway. Dissanayake et al. studied the lateral thyroid approach. They found that both first and follow-up thyroid explorations and thyroidectomies are equally safe. This is a workable method for follicular lesions, such as diagnostic hemithyroidectomy. This study demonstrated that this approach is also safe for open surgery. It is widely used in endoscopic thyroidectomies. [17]

CONCLUSIONS

Our study highlights RLN-preserving surgical approaches, prioritizing patient safety during thyroidectomy. Identifying the RLN superiorly near its constant point of entry into the larynx is an effective and safe technique to reduce the risk of RLN injury, reducing nerve exposure and low risk of hypocalcemia. The lateral approach requires expertise and wide exposure to minimize RLN injury risk. Its variable course and the possibility of extra laryngeal branches increase the risk of RLN injury. The inferior approach poses a lower RLN injury risk but raises concerns about parathyroid gland

devascularization. The medial approach is helpful in local infiltrative malignancy and offers safer dissection for the parathyroid gland and ITA.

DECLARATIONS

Author contributions

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