Recurrent laryngeal nerve and voice preservation: routine identification and appropriate assessment – two important steps in thyroid surgery

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ABSTRACT

INTRODUCTION The aims of this study were to assess and compare vocal cord functions before and after thyroid surgery after intra-operative identification of recurrent laryngeal nerve.

PATIENTS AND METHODS Recurrent laryngeal nerve (RLN) is seen intra-operatively in all cases undergoing thyroid surgeries. Vocal cord functions including any voice change were evaluated by indirect laryngoscopy (I/L) and direct laryngoscopy (D/L) before and after surgery.

RESULTS Prospective study on 100 patients over 18 months with a total of 146 nerves at risk (NAR). Majority were women ($n = 86$) with mean age of 37.48 years (range, 13–60 years). RLN was seen in all patients and 19 patients complained of some change in quality of their voice after surgery. Evaluation by I/L and D/L at 6 weeks showed recurrent laryngeal nerve palsy (RLNP) in nine (47.36%) and five (26%) of these 19 patients respectively. Analysed according to total NAR, the incidence of voice change and temporary RLN palsy (I/L and D/L) at 6 weeks was still less at 13.01%, 6.16% and 3.42%, respectively. Voice change improved in all cases at 3 months with no RLNP palsy by I/L or D/L. All these 19 patients had undergone difficult or extensive surgery for malignancy, large gland, extrathyroidal spread or fibrosis.

CONCLUSIONS Despite identification and preservation of RLN, patients can develop postoperative voice change and RLNP although all voice change cannot be attributed to damaged RLN. Proper assessment of vocal cord functions by I/L and D/L laryngoscopy is required to rule out injuries to these nerves. Risk of damage is higher in patients undergoing more difficult surgery.

KEYWORDS

Recurrent laryngeal nerve – voice Assessment

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Thyroidectomy is one of the most frequent head and neck surgical procedures world-wide. Total thyroidectomy or thyroid lobectomy has been accepted as current surgical therapy for benign and malignant thyroid disorders, but extensive resection might increase the risk of postoperative complications.^{1–5}

The identification and preservation of the recurrent laryngeal nerve (RLN) are essential to avoid its injury.^{6,7} This needs more dissection and may cause undesirable harm to RLN and parathyroid glands with consequent vocal fold immobility leading to voice changes.⁵ The overall incidence of permanent injury to RLN is 1–3%, while the temporary RLN injury is seen in 5–8%.^{8,9} However, the incidence of recurrent laryn-

geal nerve palsy (RLNP) vary widely depending on definition, patient selection, surgeons' experience, type of thyroidectomy, underlying disease and the assessment tool.^{5,10,11} Complications after thyroid surgery are often underestimated because of reporting preferences.¹²

Preservation of RLNs is not the only factor in maintaining a normal voice after operation.¹⁵ Voice changes after thyroidectomy may be caused by damage to any of the intrinsic structures, recurrent and superior laryngeal nerves and the strap muscles. These may be damaged by the excessive retraction, use of diathermy, cutting of muscles during thyroid surgery or by wound contracture after surgery.¹⁴ As a result, based on clinical symptoms without

routine vocal cord examination may not be reliable for documenting the incidence of RLN as the incidence may be underestimated.^{12,15,16} The British Thyroid Association guidelines on the management of thyroid cancer recommend direct and/or indirect laryngoscopy (IL) for voice dysfunction persisting beyond 2 weeks after thyroidectomy.^{17,18} The purpose of this prospective study was to examine the incidence of RLN by assessing vocal cords using different diagnostic tools after routinely identifying the RLN in cases undergoing various types of thyroid surgery.

Patients and Methods

The study was conducted in the surgical ward of a tertiary care, free, government hospital in the capital city of a developing country over a period of 18 months. The study was conducted according to the guidelines laid down in the Declaration of Helsinki and was approved by the hospital ethical committee. Witnessed verbal informed consent was obtained from all patients and formally recorded in the case sheet. A total of 108 patients were assessed with 100 of these being included in the study. Patients with documented pre-operative recurrent nerve palsy (RLP), inadequate follow-up and unwilling for surgery were excluded from the study. A total of 100 patients with 146 nerves at risk (NAR) were finally studied.

On admission, a detailed clinical examination was carried out related to the main disease along with appropriate investigations. This included besides thyroid function (TSH, FT3, FT4) a complete blood count, blood sugar, kidney and liver function test and fine needle aspiration cytology (FNAC). An ultrasonography (USG) of neck and computed tomography (CT) scan was done whenever indicated. Voice assessment was based on the quality of voice before and after surgery. Vocal cord functions were then assessed by indirect and direct (70° telescope) laryngoscopy. After due consent and explanation about the possible impact on voice change, patients were taken up for surgery. The various types of thyroid surgeries were performed by a standardised surgical technique by a single surgical unit routinely performing the surgery for over 10 years. Intra-operatively, recurrent laryngeal nerve (RLN) was routinely identified and preserved in all cases. An attempt was also made to identify the external branch of superior laryngeal nerve (SLN).

Postoperatively, the patient was followed up for a minimum of 3 months and any untoward incident and complications were recorded and documented. Voice assessment and vocal cord functions were assessed after 6 weeks and 3 months of surgery by indirect (I/L) and direct (D/L) laryngoscopy using 70° fibre-optic telescopic laryngoscope. The superior laryngeal nerve (SLN) is an important nerve for the tensile strength of vocal cords; if the vocal cords are at

different levels, the one at a lower level will have paralysis of ESLN. Direct laryngoscopy helped to assess both the movement and level of the vocal cords thereby assessing the functions of the RLN and SLN. Serum calcium levels were also monitored regularly especially in cases undergoing total/near total or completion thyroidectomies. Follow-up thyroid scan, thyroid function tests and ablation when required was done in all cases of differentiated thyroid carcinomas. Data were entered into Microsoft Excel and used for analysis. Descriptive analysis was done by using mean and standard deviation. Data are expressed as frequency and percentage.

Results

Out of the 100 patients finally included in the study, 86 were women and 14 men (F:M, 6:1) with a mean age of 37.48 years (range 15–60 years; SD, ± 10.72 years). Size of the thyroid lesion varied from as small as 1.5×1.5 cm to 15×15 cm (mean, 6.13 cm). Eleven patients had hypothyroidism, five had hyperthyroidism while the remaining 84 were clinically and biochemically euthyroid. Six patients had retrosternal extensions of the thyroid gland with CT scan showing extension of the thyroid in the superior mediastinum with tracheal compression and deviation in all the cases. The diagnostic accuracy of FNAC in the present study was 89% with sensitivity of 95.6% when compared to the ultimate histopathology. The ultimate histopathological diagnosis and various types of surgery performed is shown in Tables 1 and 2, respectively.

Pre-operative assessment of voice and vocal cord function by indirect and direct laryngoscopy was normal in all patients included in the study. Peri-operatively, the recurrent laryngeal nerve (RLN) was identified in all the 100 cases undergoing surgery. Keeping in mind that 46 patients had bilateral identification of the nerve, a total of 146 nerves at risk (NAR) were identified and preserved. In the majority of patients (95%) the nerve was identified either in the upper or middle third of the course near its insertion. On right side, the nerve was exposed in 73 patients and in relation to inferior thyroid artery (ITA) in the majority, *i.e.* 45 (61%), it was posterior to it, being anterior 20 (27%) or in between eight (10%) the branches in the rest. Similarly, on the left side, among the 73 nerves exposed, 58 (79.45%) were posterior, eight (10.95%) anterior, and seven (9.5%) in between the branches of the left ITA. As opposed to the RLN, the superior laryngeal nerve (SLN) could be seen in 70 (48%) NAR, *i.e.* 34 on right and 36 on the left side. In relation to the upper pole, 57 SLN were Type I (> 2 cm), six were Type IIa and seven Type IIb with almost identical pattern on both sides. An enlarged tubercle of Zuckerkandl was noted in 18 NAR of which in 14 the RLN was seen to lie in a fissure between the tubercle and the body of the thyroid.

Table 1 Distribution of patients according to histopathology (*n* = 100)

Histopathology report	Patients (<i>n</i>)
Colloid goitre	35
Follicular adenoma	19
Follicular carcinoma	3
Papillary thyroid carcinoma	37
Chronic lymphocytic thyroiditis	3
Medullary carcinoma thyroid	2
Hurthel cell carcinoma	1

Nineteen patients complained of some change in the quality of their voice postoperatively. The changes varied from mild hoarseness, huskiness, and change in pitch starting from immediate postoperative period to a maximum of 80 days. Out of these 19 patients, 17 had undergone a total, near total or completion thyroidectomy with 10 (50%) also undergoing some type of neck dissection. Evaluation of these 19 patients with voice change by I/L at 6 weeks revealed RLNP in nine patients. Further evaluation by direct laryngoscopy at the same time using a fibre-optic 70° scope revealed RLNP in five patients only (see Table 3). None of the patients showed features of SLN injury by either indirect or direct laryngoscopy. No patient with normal voice postoperatively showed any abnormality by indirect laryngoscopy or direct laryngoscopy. The voice change resolved by 3 months in all the patients (mean, 34.9 days). When analyzed according to total nerves at risk (NAR), the incidence of voice change, temporary RLNP by I/L and D/L was 13.01, 6.16 and 3.42%, respectively. There was complete

Table 2 Types of surgical procedures (*n* = 100)

Type of thyroidectomy	Patients (<i>n</i>)	NAR
Completion thyroidectomy ^a	6	6 ^b
Hemithyroidectomy	48	48
Near total thyroidectomy	3	6
Subtotal thyroidectomy	5	10
Total thyroidectomy	38	76

^aDone in 6 cases, 4 were for papillary carcinoma and 2 for follicular carcinoma.

^bAll patients of completion thyroidectomy previously operated in this hospital by the same team prior to the start of the study; therefore, only one nerve was at risk in this group.

resolution of voice changes and RLNP (on I/L and D/L) at 3 months (Table 3).

Discussion

There is a wide variation in reported incidence of RLNP rates following thyroid surgery. In a recent review, temporary RLNP rates ranged from 1.4–38%, higher than previously reported.¹⁹ Many authors agree that the true overall injury rate of RLN is not yet delineate for several reasons:

1. No routine audit by centres performing thyroid surgery – not all patients in fact undergo a systematic laryngeal examination in the postoperative period.^{20–22}
2. Units with unfavourable data are less likely to report their data.^{20,21}
3. Absence of data in the literature on bilateral RLN paralysis incidence.^{20,22}

Table 3 Distribution of patients with postoperative voice changes based on their histopathology and type of surgery (*n* = 19)

Histology (<i>n</i>)	Type of surgery (<i>n</i>)	Neck dissection (<i>n</i>)	RLNP on I/L (<i>n</i>)	RLNP on D/L (<i>n</i>)
Benign (7)				
Colloid goitre (5)	TT (5)	Nil	4	3
CLT (2)	HT (2)			
Malignant (12)				
PCT (10)	TT/NTT (9), CT (1)	CND (4), CND + ULND (5), B/L ND (1)	5	2
FCT (1)	TT (1)			
MCT (1)	TT(1)			

CLT, chronic lymphocytic thyroiditis; PCT, papillary thyroid carcinoma; FCT, follicular thyroid carcinoma; MCT, medullary thyroid carcinoma; TT, total thyroidectomy; NTT, near total thyroidectomy; CT, completion thyroidectomy; CND, central neck dissection; ULND, unilateral neck dissection; B/L ND, bilateral neck dissection.

4. Lack of reliability of clinical symptoms in vocal cord paralysis. Symptomatic assessment of vocal cord paralysis is notoriously inaccurate, and unilateral laryngeal paralysis can sometimes be completely asymptomatic. So, too many patients with postoperative hoarseness may not have vocal cord paralysis.^{20,23,24}
5. There is considerable variation in the reported frequency of RLN palsy rates after thyroid surgery due to the different methods of diagnosing RLN palsy (indirect laryngoscopy versus fibre-optic nasolaryngoscopy (FNL) versus videostroboscopy), each of which have significant different sensitivities and specificities.^{19,20}

In the present study, 19% of patients developed some voice change after surgery. The changes varied from mild hoarseness, huskiness, and change in pitch starting immediately postoperatively to a maximum of 80 days. When assessed by indirect and direct laryngoscopy at 6 weeks and 3 months, respectively, each of the assessment methods had different sensitivity, therefore, impacting RLNP rate. Indirect laryngoscopy (the easiest and most commonly performed diagnostic tool to assess voice change after thyroid surgery) was inaccurate in the present study. At 6 weeks, nine out of these 19 patients showed impairment of RLN using this method, which on further evaluation by direct laryngoscopy (D/L) confirmed RLNP in five patients only. Although I/L is simply performed, it has a restricted visual field, low diagnostic accuracy and is observer dependent.²⁵ A significant percentage of patients cannot tolerate this method of examination because of the gag reflex. Telescopic laryngoscopy or D/L has the advantage of direct visualisation of the vocal cords and is available in many centres. It offers a more detailed and wider field of vision to the larynx in a physiological position compared with mirror IL. The optical illumination and magnification can also allow the images to be portrayed on a screen for higher definition assessment and the findings can be recorded for better analysis.²⁵

The ideal method to detect the RLNP is videostroboscopy.²⁶ Videostroboscopy is a specialised method of illuminating the vocal folds that is quasi-synchronised with vocal fold vibration to provide what appears to be a slow-motion view of vocal fold movement and vibration. The investigation is, however, not widely available and is expensive; it was not used in this study.

Overall, the incidence of temporary RLNP varied based on the assessment tool with symptomatic evaluation being least reliable. Although not all patients with voice change had RLNP, no patient with normal voice had temporary or permanent RLNP. This was perhaps surprising as it is well known that a nerve injury can occasionally be accompanied by a normal voice. A small sample size and increasing experience over the years may have been the possible reason for this outcome. The overall incidence of 5% based on the

number of patients and 3.42% according to NAR on D/L in our study is in accordance with the reported incidence of temporary RLNP of between 2.5–5% in various studies.²⁵ There are very few studies in the literature comparing each of the above diagnostic tools in assessing voice disorders. Therefore, sensitivities, specificities and predictive values for each tool in diagnosing RLNP need to be calculated after weighing up relevant confounding factors.¹⁹ As it is readily available, easy to use and relatively inexpensive, we recommend fibre-optic laryngoscopy as the standard method to examine the larynx after thyroidectomy.

The identification, careful exposure and preservation of the RLN throughout its course routinely in our study helped us to avoid any permanent damage to RLN. The majority of the nerves were posterior to the ITA, especially on the left side. The relation of RLN to ITA in our study was similar to that reported by Ozer *et al.*²⁷ in their study. Repeat evaluations at a minimum follow-up of 3 months confirmed this as voice changes resolved completely in all patients and none of the patients showed RLNP on I/L or D/L. Although Bergamaschi *et al.*²⁸ reported that RLN identification failed to reduce injury rate, there are many studies demonstrating a significant decrease in the rate of RLN injury maintained by the identification of the nerve.^{4–6,9}

Besides nerve damage there are other causes of voice change and preservation of RLN is not the only factor in the preservation of normal voice after operation.¹⁵ These may be important in affecting reported RLNP rates and include: the type of surgery (primary vs re-do), thyroid disease (benign vs malignant), extent of surgery (lobectomy vs subtotal resection), formal identification of the RLN, ESLN injury and surgical volume (high vs low).^{10,11} Seventeen out of the total 19 patients in the present study having postoperative voice changes had many adverse features or difficult surgery. Twelve (63%) were operated for malignancy including one patient undergoing completion thyroidectomy. Five had large difficult goitres and two had chronic lymphocytic thyroiditis with fibrosis. Six patients with retrosternal extensions had tracheal compression with deviation in all the cases but none developed RLNP or voice change although Arici *et al.*²⁹ have reported transient and permanent RLNP of 4% in patients with retrosternal goitre. Despite an attempt to identify the ESLN, the nerve could not be identified in all the cases although none of our patients with voice change had features of ESLN injury. A small sample size again may have contributed to this. Contrary to this, one patient undergoing simple hemithyroidectomy for chronic lymphocytic thyroiditis developed voice change due to temporary RLNP in our study.

Conclusions

Despite routine identification and preservation of RLN,

patients can develop postoperative voice change. This cannot always be attributed to damaged nerves and proper postoperative assessment of vocal cord function by indirect or preferably telescopic laryngoscopy is required. Damage to RLN can be avoided by knowledge of their course, anatomical relation to surrounding structures, meticulous surgical technique and their routine identification. Routine identification of the RLN avoids injury to these structures especially when surgery is more difficult due to malignancy, presence of extrathyroidal spread, fibrosis due to chronic lymphocytic thyroiditis, large thyroid or those undergoing simultaneous neck dissections.

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