

# Recurrent laryngeal nerve integrity repair: ten years' experience

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**Background.** Vocal cord palsy due to recurrent laryngeal nerve (RLN) injury during thyroid surgery is a rare postoperative complication. There are controversial opinions concerning the surgical management of this complication.

**Materials and methods.** From 1994 to 2004, 18 patients with RLN injury during thyroid operation underwent surgery. The causes, location, type, operative procedures and long-term results of the surgical treatment of RLN injuries were retrospectively analyzed.

**Results.** There were 15 unilateral and 3 bilateral lesions of RLN. Overall, there were 21 RLN injuries in 18 patients. In 7 patients RLN was sutured straight after the lesion, in 7 patients during the first postoperative day, and in 4 patients, two months and later. RLN was injured in the region of the Berry's ligament in 15 cases. In 6 months following the RLN repair, 15 patients (one with bilateral palsy) and 16 vocal cord functions were evaluated: in 37.5% movements of vocal cords renewed totally, in 12.5% partially, and in 50% palsy of the vocal cords remained and phonation was bad. The movements of vocal cords restored completely or partially only in patients operated for RLN lesion during the first postoperative day.

**Conclusions.** Identification of the RLN during thyroid surgery is the main principal to avoid its lesion. The most common site of the RLN injury is the region of the Berry's ligament. Having diagnosed vocal cord palsy after thyroid surgery without the identification of RLN, reoperation and repair of the RLN should be performed during the first postoperative day.

**Key words:** vocal cord paralysis, recurrent laryngeal nerve, nerve reconstruction

## INTRODUCTION

Disorders of thyroid gland affect from 3% to 5% of the population. They are the second most common endocrine disease beside diabetes mellitus (1). With the advent of modern surgical techniques thyroid surgery has become more safe treatment modality with an acceptable low risk profile, offering many patients the prospect of cure. Nowadays, death from thyroid surgery is rare. The morbidity of thyroid surgery has decreased markedly over the past century, but technical complications such as recurrent laryngeal nerve (RLN) injury continue to occur. The reported complication rates in the literature vary significantly, ranging from 0% for primary surgery to 20% for repeated surgery for permanent RLN injury (2). Recently the percentage of RLN injuries has increased slightly. Higher injuries rates would be expected in secondary operations for recurrent goiter, in operations for thyroid cancer, retrosternal goiter and after postoperative bleeding (3). Reduction of the risk of RLN injury during thyroid surgery remains a very important problem.

In surgical centres with good experience postoperative vocal cord palsy is treated as a temporary problem, since RLN is being exposed and identified during thyroid operation. At the end of the operation the surgeon verifies whether the nerve is not injured. Inexperienced surgeons can damage RLN while dissecting or identifying it. Highly skilled surgeons might also experience some difficulties identifying RLN and preserving it while performing the operation for the recurrent goiter or thyroid cancer. Permanent vocal cord palsy remains in up to 1% of patients after purposive (removing thyroid cancer) or incidental incision, ligation or thermal damage of the RLN. Reinnervation of vocal cord can be restored suturing the ends of the nerve, stitching the distal end of RLN to any branch of *ansa cervicalis* or inserting nerve segment between cut off ends. There is no much experience in performing such operations, and controversy exists concerning the influence of time and RLN integrity repair type on the long-term results. The purpose of this work was to analyze our own results of the surgically treated patients with RLN injuries.

## MATERIALS AND METHODS

From 1994 to 2004, 18 patients (16 women, 2 men, mean age 47.6 years, range 22–72 years) were operated for RLN lesions associated with thyroid surgery in Vilnius University Hospital

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Santariškių Klinikos. The causes, location, type of injuries, operative procedures and follow-up results were retrospectively analyzed.

Most common indications for initial thyroid operations were multinodular and uninodular goiter (Table 1). RLN injury was noticed during initial thyroid surgery and on the first postoperative day when unilateral or bilateral vocal cord palsy was detected by direct laryngoscopy. In the late postoperative period after thyroid surgery patients suffering for vocal and respiratory disorders were diagnosed having permanent vocal cord palsy by indirect laryngoscopy.

Having noticed the injury of RLN during the operation, the ends of severed nerve were sutured directly if possible. The nerve sutures were made with two or three stitches of 8-0 Prolene on epineurium (direct epineurial suture) without any tension using microsurgical instruments and four times magnifying glasses.

During the reinnervation surgery, in patients operated for RLN injury in the late postoperative period, the trunk of RLN was searched through lateral approach: retracting *m.sternocleidomastoideus* laterally and anterior muscles of the neck medially. The principal mark searching the trunk of RLN is the stump of *a.thyroidea* inferior where it is crossing with RLN. Having identified the trunk of RLN, dissection along its course towards the larynx should be done until the damage site is found. The ends of the nerve or its branches were renewed with scalpel and sutured with stitches. Ligatures compressing RLN were removed.

The RLN recovery function was evaluated by the same laryngologist during patients' follow-up 6 months after the surgical treatment of RLN injuries. The movements of vocal cords were defined into three categories: vocal cord is not moving, movements of vocal cord are restricted or normal. Two aspects were assessed while evaluating the long-term results of surgical treatment: the type and time of the injured RLN repair. All the types of nerve repair were divided into two groups: group A – the trunk or branch of the injured RLN was sutured, group B – compressing ligature was removed. Movements of vocal cords were evaluated according to the time of the RLN integrity repair.

## RESULTS

During the study period in 11 patients (61.1%) the injury of RLN occurred during thyroid surgery in the first four years period (1994–1998) when the technique of thyroid surgery with the RLN identification was brought into practice in our Centre. The remaining 7 patients (38.9%) were referred after injury from other hospitals where initial subtotal thyroid resections using technique without the RLN identification had been performed.

RLN injury was detected during thyroid surgery in 7 patients (38.9%). It was made by visualizing the severed trunk or the branch of RLN. All the injured nerves were sutured during the same operation (Table 2).

7 patients (38.9%) had unrecognized RLN injury during the initial operation. Unilateral or bilateral (in 1 patient) vocal cord palsy was detected immediately after the operation by direct laryngoscopy. During the repeated operation performed on the same day the severed trunk or branch of RLN was found in 3 cases and ligatures compressing the nerve in 5 cases (Table 2).

In the late postoperative period 4 patients (22.2%) were diagnosed having vocal cord palsy by indirect laryngoscopy: 2 patients with bilateral vocal cord palsy two months after the initial thyroid operation, 1 patient one year after the initial thyroid operation and 1 patient 35 years following thyroidectomy performed during his deportation to Siberia. Patients arrived for repeated operation and RLN revision due to difficult breathing and speech disturbances following 2 months and one year, respectively; they had weak, hoarse voice and respiratory stridor. The patient having undergone the operation 35 years ago arrived for repeated operation due to recurrent goiter in contralateral side. Unilateral vocal cord palsy resulted in hoarse and weak voice. During reoperations the injured trunks of RLN were found in 3 cases and ligatures compressing the nerve in 3 cases (Table 2).

In patient with permanent vocal cord palsy after the initial thyroid surgery 35 years ago during the reoperation for recurrent goiter, granuloma around the ligature with RLN neuroinoma was removed, the nerve ends were exposed, dissected a little and a direct suture without any tension were carried out.

Table 1. Indications for thyroid surgery in patients with RLN injuries

Indication for thyroid surgery	No. of patients	Female : Male
Multinodular goiter	5*	4 : 1
Uninodular goiter	5	5 : 0
Recurrent goiter	4	4 : 0
Thyroid cancer	2	1 : 1
Graves' disease	2	2 : 0
Total	18	16 : 2

\* 3 patients with bilateral vocal cord palsy.

Table 2. Time of reoperation and RLN integrity repair modalities (n = 21)

Time of RLN repair	Neurorrhaphy	Removal of ligature
During initial thyroid surgery	7	–
First postoperative day	3	5
Late postoperative period	3	3
Total	13	8

Out of 18 patients 4 (22.2%) required tracheostomies: 2 patients due to unilateral vocal cord palsy and laryngeal oedema, 2 patients due to bilateral vocal cord palsy and breathing disturbance (Table 4). Both patients with unilateral vocal cord palsy and breathing insufficiency due to posttraumatic laryngeal oedema underwent tracheostomies on the third day after thyroidectomy and RLN suture. In one patient tracheostomy was removed 10 days later, after the laryngeal oedema had subsided. Another patient operated on for anaplastic thyroid cancer remained with tracheostomy till the end of his life (for 2 months).

Two patients with bilateral vocal cord palsy required tracheostomies due to insufficient airway between vocal cords. Having diagnosed bilateral vocal cord palsy by direct laryngoscopy, one patient was operated repeatedly on the first day after thyroidectomy – ligatures compressing both RLN were removed and tracheostomy was performed. The second patient was diagnosed having bilateral vocal cord palsy 2 months after the initial operation performed in another hospital. She could not work or climb more than 2 steps due to dyspnoea. The patient was operated on to repair the RLN integrity. In one side the cut ends of RLN were sutured, in the other one ligature was removed. At the end of the operation tracheostomy was performed. Tracheostomy remained for 3 months until lateral fixation of vocal cord was performed according to the patient's wish, without attaining the final results of RLN injury repair.

Also one patient underwent laterofixation after thyroidectomy performed in another hospital due to bilateral vocal cord palsy and reoperation 2 months later when ligatures compressing both RLN were removed. There were no indications for tracheostomy. One month later the patient felt ill with acute laryngitis causing suffocation, therefore laterofixation was performed without attaining final results after the removal of compressing ligatures.

Overall, there were 21 RLN injuries in 18 patients (Tables 3, 4). In all the cases there were two locations of RLN injury: where it is crossing the inferior thyroid artery or the distal end of the nerve in the region of the Berry's ligament. The distal end of RLN was injured two times more often: RLN was injured in the region of the Berry's ligament in 15 cases (71.4%) and beside its crossing the inferior thyroid artery in 6 cases (28.6%) (Figure).

Out of 16 nerves injured, 11 nerve trunks or their branches were sutured and 5 ligatures compressing the nerve were removed.

Out of 11 nerve trunks or branches having been sutured, in 3 cases (27.3%) movements of vocal cords recovered completely, in 2 cases (18.2%) partially, and in 6 cases (54.5%) vocal cord palsy remained (group A).

After ligatures compressing RLN had been removed in 5 cases, in 3 cases (60%) movements of vocal cords recovered completely (there was bilateral vocal cord palsy in one case), in 2 cases (40%) vocal cord palsy remained (group B).

After 6 months the outcomes of RLN integrity repair were evaluated in 15 patients (one with bilateral vocal cord palsy) because 1 patient died after the surgery for anaplastic thyroid cancer, 2 patients underwent lateral fixation of the vocal cord 3 months later due to dyspnoea caused by bilateral vocal cord palsy.

Overall, after 16 RLN repairs in 6 cases (37.5%) movements of vocal cords renewed totally, in 2 cases (12.5%) movements recovered partially and in 8 cases (50%) palsy of vocal cords remained (Table 5). Movements of vocal cords restored completely or partially only in the patients operated for RLN lesion during the first postoperative day (Tables 3, 4).

Table 3. Unilateral RLN injury

Patient No, age (years), gender	Time of RLN repair	Location of RLN injury	Type of RLN repair	Tracheostomy required	Vocal cord function 6 months later
1. 42, F	Intraoperative	Crossing ATI	Neurorrhaphy	10 days	Restricted
2. 36, F	Intraoperative	Crossing ATI	Neurorrhaphy	–	Normal
3. 61, M	Intraoperative	Crossing ATI	Neurorrhaphy	2 months	?*
4. 22, F	Intraoperative	Distal end	Neurorrhaphy	–	Not moving
5. 28, F	Intraoperative	Crossing ATI	Neurorrhaphy	–	Normal
6. 43, M	Intraoperative	Distal end	Neurorrhaphy	–	Not moving
7. 47, F	Intraoperative	Distal end	Neurorrhaphy	–	Restricted
8. 72, F	1 postoperative day	Crossing ATI	Removal of ligature	–	Not moving
9. 68, F	1 postoperative day	Distal end	Removal of ligature	–	Normal
10. 43, F	1 postoperative day	Distal end	Neurorrhaphy	–	Not moving
11. 41, F	1 postoperative day	Distal end	Removal of ligature	–	Not moving
12. 35, F	1 postoperative day	Distal end	Neurorrhaphy	–	Normal
13. 28, F	1 postoperative day	Distal end	Neurorrhaphy	–	Not moving
14. 62, F	1 year after thyroid surgery	Distal end	Neurorrhaphy	–	Not moving
15. 70, F	35 years after thyroid surgery	Distal end	Neurorrhaphy	–	Not moving

\* Patient died.

ATI – *a. thyroidea inferior*.

Table 4. Bilateral RLN injury

No.	Patient's age (y)	Patient's gender	Time of RLN repair 1 postoperative day	Location of RLN injury	Type of RLN repair	Tracheostomy	Vocal cord function 6 months later
1.	64	F		R- distal end L- distal end	R- removal of ligature L- rem. of ligature	+	R- normal
2.	52	F	2 months after thyroid surgery	R- distal end L- crossing ATI	R- neurorrhaphy L- removal of ligature	+	L- normal Unvalued*
3.	37	F	2 months after thyroid surgery	R- distal end L- distal end	R- removal of ligature L- removal of ligature	-	Unvalued*

\* Unvalued because lateral fixation of vocal cord was performed.

ATI – *a. thyroidea inferior*.

Table 5. Method of RLN lesion repair and function of the vocal cord (evaluation 6 months after the RLN injury repair, n = 16)

Method of RLN repair	Vocal cord function Normal movements	Restricted movements	Not moving
Neurorrhaphy (group A; n-11)	3	2	6
RLN decompression (group B; n-5)	3	-	2
Total	6(37.5%)	2(12.5%)	8(50%)

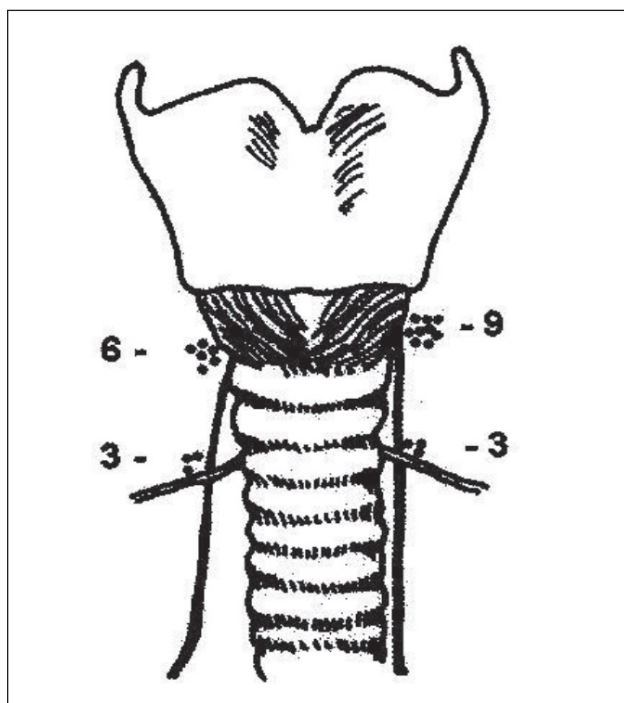


Figure. Location of RLN injuries

## DISCUSSION

The vocal cord palsy rate depends on the disease of thyroid gland. Friedrich T et al. analyzed the frequency of bilateral recurrent nerve injury in 985 operations and determined that palsy rate depended on the disease of thyroid gland. After the resection of simple goiter they found a 0.2% transient injury rate (0.1% permanent), after the operation of thyroid cancer 2.0% transient (1.0% permanent) and in cases of recurrent goiter 5.9% transient (1.9% permanent) palsies (4).

Among etiologic factors of vocal cord palsy, thyroid surgery is one of the most common (5–8). Therefore, the methods that reduce the number of temporary and, especially, permanent vocal cord palsies are of great interest. Some surgeons still perform “blind” operations as they are confident that the exposure of RLN by dissection is likely to produce more palsies from its handling than if it is left unidentified (9, 10). Other surgeons believe that in bilateral operation at least one recurrent laryngeal nerve should be identified and its integrity confirmed (11).

The only promising way to ensure the integrity of the RLN is to identify the nerve during thyroid surgery. On the basis of a group of 466 patients who underwent thyroid operation due to cancer, Misiolek et al. confirmed the advantage of recurrent laryngeal nerve identification during thyroid cancer surgery. In 4.7% of patients with vocal cord palsy after the thyroid operation more than half of them did not have the nerve identified during the secondary operation due to significant anatomic changes in the remaining part of the thyroid gland (12).

Analysing the risk factors of complications after surgery due to benign thyroid diseases, Thomusch and colleagues in the prospective multicentre study confirmed the importance of routine identification of the RLN, independent of the extent of thyroid resection. Identification of RLN considerably ( $p = 0.01$ ) reduced permanent vocal cord palsy rates (13).

Having brought the method of thyroid surgery with RLN identification into practice, “blind” ligature of RLN occurs seldom. Until 1994, operations without the RLN identification were performed in Lithuania. Surgeons could only imagine the course of RLN and avoid any surgical actions in a dangerous location. Having begun performing thyroid operations identifying RLN with accurate nerve dissection we performed several repeated operations revising laryngeal nerves due to vocal cord palsies after “blind” thyroidectomies. The most common lesion of RLN was the ligature compressing the nerve. On the basis of our experience it is possible to formulate a certain advantage of RLN

identification during thyroid surgery. This relation is also shown in the results of other investigators (14).

Most of the RLN injuries caused by thyroid surgery are in the region of the Berry's ligament, at the distal end of the nerve. Mostly they are mechanical injuries and require operation to resolve the cause. Once the RLN injury is made, an operation should be performed as early as possible (15). Although simple neuroorrhaphy of the injured recurrent laryngeal nerve usually results in impaired movements of the vocal cord because of misdirected regeneration, phonation recovers because the vocal cord maintains tension during phonation. Sceptical attitude towards neuroorrhaphy can be explained by a complex structure of the RLN consisting of three different types of fibres: two motor fibres and a sensory one. While suturing RLN, it is possible to connect the proper nerve fibres together only incidentally. Though movements of vocal cord remain restricted, reinnervation of vocal cord leads to better trophics, tonus and phonation. These are arguments why the injured RLN should be sutured whenever vocal cord palsy is diagnosed after thyroid surgery.

Miyauchi and associates reported that all 8 patients who had undergone vagus nerve – recurrent nerve suture, *ansa cervicalis* – RLN suture or simple neuroorrhaphy, recovered from hoarseness (16). Maximum phonation time of these patients was significantly longer than that of the patients without the nerve repair. Crumley reported that quality of phonation after *ansa cervicalis* – RLN anastomosis was superior to that after polytetrafluoroethylene (Teflon) injection or Isshiki thyroplasty (17).

Neuroorrhaphy of recurrent laryngeal nerve is a simple and effective procedure to improve voice quality, aspiration, GRBAS [perceptual voice quality rating according to grade, roughness, breathiness, asthenia, and strain (GRBAS)] scales, glottal gap, and maximum phonation time by preventing atrophy of the vocal cord (18). After the suture the nerve's function regenerates up to 6 months, but there are no data showing how long it takes to renew the function of the vocal cord.

Our results and those of reports in the literature indicate very clearly the benefit of the RLN identification during thyroid surgery. RLN injury after thyroid surgery should be diagnosed immediately not only to exclude severance but also to relieve, if possible, physical involvement of the RLN by suture or removal of ligature. The benefit of neurolysis when the onset of paralysis is delayed due to fibrosis surrounding the nerve is also discussed. Earlier intervention is associated with better results.

## CONCLUSIONS

1. Visual identification of RLN along its entire course is the principal condition to preserve voice after thyroid surgery.

2. Most common site of the RLN injury is the distal end of the nerve in the region of the Berry's ligament.

3. Having diagnosed vocal cord palsy after thyroid surgery without the identification of RLN, reoperation and repair of the RLN should be performed during the first postoperative day.

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#### GRĮŽTAMOJO GERKLŲ NERVO VIENTISUMO ATSTATYMAS: 10 METŲ PATIRTIS

##### *S a n t r a u k a*

**Tikslas.** Balso klostės paralyžius dėl *nervus laryngeus recurrens* (NLR) pažeidimo skydliaukės operacijos metu yra reta pooperacinė komplikacija. Chirurginis šios komplikacijos šalinimo būdas vertinamas kontroversiškai.

**Pacientai ir metodai.** 1994–2004 m. 18 pacientų buvo atstatytas skydliaukės operacijos metu pažeistas NLR vientisumas. Retrospektyviai buvo vertintos NLR pažeidimų priežastys, vieta, pobūdis, chirurginės intervencijos būdai ir atokūs gydymo rezultatai.

**Rezultatai.** NLR vientisumas atstatytas 18 pacientų: 15 ligonių NLR buvo pažeistas vienoje pusėje, 3 – abiejose pusėse. Iš karto po pažeidimo NLR susiūtas 7 pacientams, pirmą parą po operacijos – 7, po dviejų mėnesių ir vėliau – 4 pacientams. Penkiolikai ligonių NLR buvo pažeistas *lig. Berry* srityje. Po 6 mėnesių 15 pacientų (1 – po abipusio NLR vientisumo atstatymo) vertinta balso klosčių funkcija: 37,5% paralyžuotų balso klosčių judesiai atsistatė visiškai, 12,5% – iš dalies, 50% balso klosčių paralyžius išliko. Balso klosčių judesiai visiškai arba iš dalies atsistatė tik tiems pacientams, kuriems NLR pažeidimas atstatytas iš karto arba per pirmą parą po pažeidimo.

**Išvados.** Skydliaukės operacijos metu NLR būtina identifikuoti per visą jo ilgį. Dažniausiai NLR pažeidžiamas *lig. Berry* srityje. Nukirpus NLR jį reikia susiūti. Diagnozavus balso klostės paralyžius po skydliaukės operacijos, pakartotinė operacija ir NLR vientisumas turi būti atstatytas per pirmą parą po operacijos.

**Raktažodžiai:** balso klostės paralyžius, *n. laryngeus recurrens*, nervo rekonstrukcija