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# Recurrent laryngeal nerve injury after thyroid and parathyroid surgery

## Incidence and postoperative evolution assessment

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**Abstract**

Recurrent laryngeal nerve (RLN) injury is a feared complication after thyroid and parathyroid surgery. It induces important postoperative morbidity. The present study aimed to assess the incidence of transient/permanent postoperative RLN injuries after thyroid and parathyroid surgery in the present cohort, to observe the timing of recovery, and to identify risk factors for permanent RLN injury after thyroidectomy.

All consecutive patients operated on at our institution for thyroid and parathyroid pathologies from 2005 to 2013 were reviewed for vocal cord paresis. Vocal cord paresis was defined based on postoperative fiberoptic laryngoscopy. Demographics, intraoperative details, and postoperative outcomes were collected. Treatment types were assessed, and recovery times collected. Patients with vocal cord paresis on preoperative fiberoptic laryngoscopy were excluded from the analysis.

The cohort included 451 thyroidectomies (756 nerves at risk) and 197 parathyroidectomies (276 nerves at risk). There were 63 postoperative vocal cord pareses after thyroidectomy and 13 after parathyroidectomy. Sixty-nine were transient (10.6%) and 7 permanent (1.1%). The main performed treatment was speech therapy in 51% (39/76) of the patients. Median recovery time after transient injuries was 8 weeks. In the group with vocal cord paresis, risk factors for permanent injuries after thyroidectomy were previous thyroidectomy and intraoperative RLN injury on univariate analysis. On multivariate analysis, only intraoperative RLN injury remained significant.

Most of the patients with transient postoperative RLN injury recovered normal vocal cord mobility within 6 months. The most common performed treatment was in this cohort speech therapy. Permanent RLN injuries remained rare (1.1%).

**Abbreviations:** ENT = ear, nose, and throat, HR = hazard ratio, RLN = recurrent laryngeal nerve.

**Keywords:** dysphonia, endocrine surgery, parathyroid surgery, recurrent laryngeal nerve, thyroid surgery, vocal cord paresis

## 1. Introduction

Recurrent laryngeal nerve (RLN) injuries represent one of the most feared complications after thyroid and parathyroid surgery.[1] These injuries induce a significant postoperative morbidity.[2] As the RLN innervates all intrinsic muscles of the larynx except the cricothyroid muscle, injury of this nerve induces a paresis or palsy of the vocal cord.[3] The patient often presents with postoperative dysphonia that may or may not be associated with deglutition problems or dyspnea.[3] These symptoms can resolve rapidly or can persist over time depending on the injury type (e.g., heat, compression, stripping, and section).[3]

Identifying the RLN during thyroid dissection is the gold standard to avoid neural injury.[4] However, finding the RLN intraoperatively is not always that easy and can even be challenging in some cases (e.g., voluminous multinodular goiter and redo surgery).[4] The difficulty of dissecting and finding the RLN during cervical surgery also lies in the great anatomic variability of its position and sometimes is due to an early division in branches.[5] In the case of exposition difficulty during bilateral neck exploration, surgeons can always change their dissection site because the RLN can be exposed on different anatomical levels. Multiple methods have been described to help detecting the RLN such as the use of intraoperative neurostimulator.[6,7] The RLN is very sensitive and can easily be harmed by different intraoperative actions (i.e., cutting, clamping, stretching, compressing, and heating).[8]

Postoperative RLN injuries can be transient or permanent. Moreover, vocal cord paresis can appear without clear intraoperative injury of the nerve (i.e., direct section), for example, just by intense stretching during retraction of the gland. Permanent RLN injuries are documented in 0.5% to 5% of the patients, whereas transient injuries are observed between 1% and 30% according to various studies and depending on the stringency of the postoperative otolaryngologic controls.[8–10]

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Transient injuries have different recovery times (usually between 4 and 6 weeks to complete recovery), up to 12 months. Nonfunctions or dysfunctions lasting more than 1 year are considered permanent.[2] Only a few studies in the literature found risk factors for intraoperative RLN injury such as reoperation for bleeding or Graves disease.[11–13]

The present study aimed to assess the incidence of transient and permanent RLN injuries after thyroid and parathyroid resections in a cohort of a medium-size academic center with strict systematic policy of pre- and postoperative vocal cord control. In addition, postoperative evolution of RLN injuries was assessed, and risk factors for permanent RLN injuries after thyroidectomy were searched.

## 2. Methods

### 2.1. Patients and data

All consecutive thyroid and parathyroid operations performed in the Visceral Surgery Department of the Lausanne University Hospital (CHUV, tertiary referral center, Switzerland) between January 2005 and December 2013 were retrospectively collected. Patients with preoperative RLN injury were excluded. All patient charts were reviewed for RLN injury observed during fiberoptic laryngoscopy postoperatively. Preoperative data (demographics and patient characteristics), intraoperative data (operation type, visualization of the RLN, and noticed RLN injury), and postoperative outcomes (pathology, transient vs permanent RLN injuries, recovery time, and undertaken treatments) were registered in an Excel database. All operations were performed or supervised by 1 single surgeon board-certified in endocrine surgery (MM).

### 2.2. Perioperative care

Neuromonitoring was not routinely used. It was only used in the case of second thyroid operation or in the case of large symptomatic goiters. All patients scheduled for elective thyroidectomy or parathyroidectomy had preoperative ear, nose, and throat (ENT) examination before the operation, and a postoperative control on postoperative day 1 or 2. ENT controls by otolaryngologists included visual inspection, physical examination, and laryngoscopy. These ENT controls were mandatory for all patients. Moreover, all patients had a clinical control at the surgical outpatient clinic 1 week after surgery. In the case of total thyroidectomy, patients were additionally followed by an endocrinologist for 6 to 8 weeks in order to assess thyroid function. After total thyroidectomy, patients were usually given levothyroxine sodium starting on postoperative day 1. In the case of postoperative hypocalcemia, patients were given oral calcium ± vitamin D. Intravenous calcium was only given in the case of persisting symptoms or very low blood calcium levels ($<1.8\,\mu$mol/L).

If RLN injury was detected postoperatively, the patient was followed by the otolaryngologist. The timing of follow-up was guided by the intensity of symptoms and findings of the physical examination. If the voice was easily fatigued and the patient was symptomatic, he was sent to see a speech therapist. Moreover, some patients were also sent to ENT physician specialized in voice disorders (speech pathologist, phoniatrician, specialist in phoniatrics). If the paresis/palsy lasted more than 1 year, and if the patient was still symptomatic, surgical treatment was offered (cord medialization or resection of an arytenoid cartilage).

### 2.3. Recurrent laryngeal nerve injury

Vocal cord paresis was defined as a dysfunction of the vocal cord mobility compared to the contralateral one, based on postoperative fiberoptic laryngoscopy. Vocal cord palsy was defined as a total absence of movement of the vocal cord. Diagnosis of vocal cord paresis or palsy was made by the ENT specialist during the fiberoptic laryngoscopy. Vocal cord was described as positioned median, paramedian, or lateral at fiberoptic laryngoscopy. Treatments performed during the first 3, 6, and 12 months after operation were recorded. RLN injury lasting more than 1 year was classified as permanent injury. Time to vocal cord recovery at fiberoptic laryngoscopy and time for symptom disappearance were recorded. Injuries of the external branch of the superior laryngeal nerve leading to a paresis of the cricothyroid muscle were not included in this study. Only RLN injuries were included.

### 2.4. Statistical analyses

Statistics for continuous variables were performed using *t* test or Mann–Whitney *U* test depending on the variable distributions and heterogeneity of the variances. For discrete variables a Fisher exact test was used. A $P$ value $<0.05$ was considered statistically significant. Uni- and multivariate binary logistic regressions were used to find risk factors for permanent RLN injuries. Only items with $P$ values $<0.1$ on univariate analysis were included in the multivariate analysis. Statistical analyses were performed using GraphPad 5.0 (Prism, GraphPad Software Inc., La Jolla, CA) for Mac OS X and SPSS 23 (SPSS Inc., Chicago, IL).

The study was performed in accordance with the Helsinki Declaration as revised in 2013 and in accordance with the local Ethics Committee of the University of Lausanne. This study was reported according to the STROBE statements for observational studies.

## 3. Results

### 3.1. Patient characteristics

During the study period, 653 consecutive patients underwent thyroid or parathyroid resections. There were 456 thyroidectomies (305 total thyroidectomies, 149 lobectomies, and 2 isthmectomies) and 197 parathyroidectomies (118 minimally invasive techniques: 31 by cervicoscopy, 87 by minicervicotomy; and 79 bilateral neck explorations). Of note, 5 RLN injuries (4 permanent injuries and 1 transient injury after thyroid surgery) were found preoperatively and were therefore excluded of the study. Of these 5 patients, 3 were asymptomatic. The lesions were due to previous thyroid surgery (3) and stretching by a goiter (2). The total numbers of nerves at risk were 756 (bilateral: 610, unilateral: 146) for thyroid resections and 276 (bilateral: 158, unilateral: 118) for parathyroid resections.

Among the 648 included patients (451 thyroidectomies and 197 parathyroidectomies), 13 RLN injuries were observed after parathyroid surgery (7%, 1 permanent and 12 transient injuries) and 63 after thyroid surgery (14%, 6 permanent and 57 transient) during routine postoperative ENT examination. Table 1 shows the characteristics of the patients with RLN injury and the pathological diagnoses.

### 3.2. Recurrent laryngeal nerve injuries

Details on RLN injuries are shown in Table 2. Among the 63 thyroidectomy RLN injuries and 13 parathyroidectomy RLN

**Table 1**

**Characteristics of patients with RLN injury and pathological diagnoses.**

| | Thyroidectomies (n = 63) | Parathyroidectomies (n = 13) |
|---|---|---|
| Median age*, y | 50 (43–63) | 63 (48–73) |
| Median BMI†, kg/m$^2$ | 26 (22–29) | 25 (21–30) |
| ASA‡ score I/II/III | 9/49/5 | 1/9/3 |
| Women/men | 51/12 | 11/2 |
| Comorbidities | | |
| None | 27 | 1 |
| Hypertension | 11 | 8 |
| Diabetes | 6 | 2 |
| Hypercholesterolemia | 7 | 3 |
| Osteoporosis | 5 | 2 |
| Hypo/hyperthyroidism | 3/2 | 0 |
| Other comorbidities§ | 25 | 6 |
| Surgical history | 40 | 11 |
| Thyroid surgery | 7 | 1 |
| Cervical surgery | 1 | 1 |
| Other surgeries | 32 | 9 |
| Preoperative symptoms (yes/no) | 48/15 | 0/13 |
| If yes: dysphonia‖ | 5 | |
| Cervical disturbance | 33 | |
| Dyspnea | 6 | |
| Dysphagia | 14 | |
| Other symptoms | 5 | |
| Pathological diagnosis | | |
| Multinodular goiter | 40 | 0 |
| Papillary cancer | 12 | 0 |
| Follicular cancer | 2 | 0 |
| Parathyroid adenoma | 0 | 13 |
| Other diagnoses | 9 | 0 |

* Medians are expressed with interquartile range.
† Body mass index.
‡ American Society of Anesthesiologists.
§ Other comorbidities included peripheral vertigo, migraine, asthma, cardiac pathologies, chronic pain, psychiatric diseases, gastroesophageal reflux, obesity, nephrolithiasis, renal failure, epilepsy, and other cancers. More than 1 comorbidity could be present per patient.
‖ More than 1 symptom could be present per patient.

**Table 2**

**Details of the postoperative RLN injuries.**

| | Thyroidectomies (n = 63) | Parathyroidectomies (n = 13) |
|---|---|---|
| Operation type | | |
| Right/left/total thyroidectomy | 10/6/44 | 0 |
| Parathyroidectomy* | 0 | 13 |
| Others† | 3 | 0 |
| Nerves at risk: 1/2 | 17/46 | 11/2 |
| Intraoperative neuromonitoring | 8 | 1 |
| RLN visualized intraoperatively | 60 | 12 |
| Intraoperative RLN injury‡ | 6 | 1 |
| Left/right/bilateral vocal cord paresis/palsy | 33/26/4 | 7/5/1 |
| Postoperative symptoms | 53 | 9 |
| Paresis/palsy at postoperative fiberoptic laryngoscopy§ | 47/16 | 10/3 |
| Position of the vocal cord at postoperative laryngoscopy | | |
| Median | 12 | 1 |
| Paramedian | 46 | 7 |
| Lateral | 5 | 5 |

RLN = recurrent laryngeal nerve.
* Among the parathyroid resections, 4 associated a thyroid resection (2 total thyroidectomies, 1 right lobectomy, and 1 left lobectomy).
† Other surgeries included totalization of thyroid resection (3).
‡ RLN injury performed and observed during surgery.
§ Paresis = decrease of the cord mobility, palsy = absence of mobility of the cord.

injuries, neuromonitoring was used in 9 patients (8 thyroid and 1 parathyroid patient) only. Among the 7 patients who had a clearly identified intraoperative RLN injury, 5 were stretching injuries (thyroid and parathyroid patients) and 2 were section/tear of the nerve (thyroid patients). No direct repair was attempted in the 2 cases of intraoperative nerve tear. Most of the time, the diseased vocal cord was found paramedian at the fiberoptic laryngoscopy (46/63 in the thyroid group and 7/13 in the parathyroid group). Regarding the treatment, 51% (39/76) of all patients with RLN injury and 63% (39/62) of the symptomatic patients benefited from speech therapy during the first semester. In 46 patients, the symptoms were resolved within 6 months after the operation and in 7 patients the symptoms were resolved between 6 and 12 months. The exact recovery time for 17 patients with transient paresis was not found. When the paresis lasted for more than 1 year (4 thyroid patients out of 756 nerves at risk = 0.5% and 3 parathyroid patients out of 276 nerves at risk = 1.1%), interventional treatment was performed in 4 patients (3 cord medializations and 1 arytenoidectomy). Three of these patients recovered a normal voice 1, 3, and 4 months after the operation, respectively, and 1 patient mentioned an improvement of the symptoms. Among the 4 thyroid and 1 parathyroid patients with bilateral RLN injuries, 3 received synthetic glucocorticoids postoperatively and none of them necessitated to be intubated. In 1 of these 5 patients with bilateral RLN injuries, intraoperative neuromonitoring was used. The performed treatments are summarized in Table 3. The minimal length of follow-up for all patients was 6 months.

In the group of RLN injury after thyroidectomy, a previous history of thyroid surgery and an intraoperative RLN lesion were associated with permanent injury on univariate analysis (hazard ratio [HR]: 8.5, $P = 0.020$ and HR: 18, $P = 0.004$, respectively). On multivariate analysis, only an intraoperative RLN injury (stretching or section) was a risk factor for permanent RLN injury (HR: 15, $P = 0.020$). Preoperative symptoms, Graves disease, goiter, presence of malignancy, unilateral lobectomy, total thryroidectomy, or absence of neuromonitoring use were not risk factors for permanent RLN injury in the patients with RLN injury after thyroid surgery. These results are summarized in Table 4.

Transient medialization of the vocal cord was undertaken in 1 patient for disturbing dysphonia before 12 months after the operation. In 6 patients, the injury side was opposite to the operation side. The operative reports were reviewed and did not mention a particular lesion (section or tear) of the contralateral nerve. One can hypothesize that an involuntary and unnoticed injury occurred during intraoperative manipulations such as compression or stretching. Otherwise, the injury could be explained by the thyroid pathology.

Among 76 patients with RLN injuries, preoperative ENT examination found a concomitant ENT pathology in 11 patients. Eight patients had pharyngolaryngeal reflux, 1 rhinosinusitis, 1 laryngitis, and 1 laryngeal edema.

## 4. Discussion

The present study assessing the incidence and evolution of postoperative RLN injuries after thyroid and parathyroid surgery showed that 1.1% of the patient cohort presented a permanent postoperative vocal cord paresis. These results show that

**Table 3**

**RLN injury treatment details and postoperative complications.**

| | Thyroidectomies (n = 63) | Parathyroidectomies (n = 13) |
|---|---|---|
| Transient/permanent injuries | 59/4 | 10/3 |
| Treatment performed during the first semester | | |
| None | 30 | 2 |
| Speech therapy | 28 | 11 |
| Other | 5 | 0 |
| Treatment performed during the second semester | | |
| None | 54 | 6 |
| Speech therapy | 9 | 7 |
| If transient injury, median recovery time of total and symmetric cord mobility, wk* | 8 (4–12) | 12 (5–30) |
| Concomitant ENT problem† | 10 | 1 |
| Postoperative hypocalcemia/cervical hematoma | 7/1 | 5/0 |

* Median is expressed with interquartile range.

† Ear, nose, and throat.

permanent RLN injuries happen infrequently after thyroid and parathyroid resections.

In this cohort, RLN injuries appeared in 14% after thyroid surgery and in 7% after parathyroid surgery, well in line with previous published results.[8,14–17] Thyroid surgery is therefore more at risk than parathyroidectomy due to the fact that bilateral neck exploration is more often performed in the case of thyroid surgery, resulting in 2 RLN to be at risk. In addition, parathyroid surgery has different preparation and dissection techniques than thyroid surgery, which can also explain why injuries after parathyroidectomy are less frequent.

Various treatments have been described according to the severity of the injury.[1] Speech therapy or vocal exercises are usually the first measures. In the case of definitive injury, vocal cord surgery can be offered (e.g., transient or permanent vocal cord medialization, arytenoid cartilage resection). When a 1-sided RLN injury appeared and was symptomatic, speech therapy was prescribed for 3, 6, or 12 months. In 1 patient with important disturbing dysphonia appearing rapidly after the operation, a transient medialization of the diseased vocal cord was undertaken using Gelfoam (Pfizer, New York City, NY). The patient showed rapid improvement in terms of voice tone and stability.

When RLN injury was considered definitive, that is, lasting more than 12 months, a definitive vocal cord medialization with Vox-Implants or with autologous fat was suggested. These treatments allowed one to restore normal voice in 2 out of 3 patients and induced rapid improvement of the dysphonia in the other patient 1 month after the procedure. Another patient with arytenoid cartilage dysmotility benefited from partial arytenoidectomy and recovered normal voice 4 months after the operation. These surgical treatments therefore are effective and safe in the case of definitive RLN injury.

The following risk factors were associated on univariate analysis with permanent RLN injury: previous history of thyroid surgery (not significant on multivariate analysis) and intraoperative RLN injury (significant on multivariate analysis). These potential associations suggest that patients with postoperative vocal cord palsy with these abovementioned factors should be presented early to an ENT specialist, and that they could benefit from a surgical treatment more quickly than other patients. In

**Table 4**

**Risk factors for permanent RLN injury in the group of RLN injury after thyroid resections.**

| | Transient RLN injuries (n = 57) | Permanent RLN injuries (n = 6) | Univariate analysis, HR, *P* | Multivariate analysis, HR, *P* |
|---|---|---|---|---|
| Preoperative symptoms | 41 | 6 | 0.8 (0.5–1.4) 0.324 | |
| Previous history of thyroid surgery | 6 | 3 | 8.5 (1.4–52.0) **0.020** | 2.5 (0.2–26.8) 0.446 |
| Intraoperative injury | 3 | 3 | 18.0 (2.5–130.0) **0.004** | 15.0 (1.5–147.5) **0.020** |
| Graves disease | 1 | 1 | 11.2 (0.6–207.4) 0.105 | |
| Goiter | 43 | 4 | 0.7 (0.1–3.9) 0.641 | |
| Cancer | 13 | 1 | 0.9 (0.1–8.9) 0.957 | |
| Unilateral lobectomy | 17 | 2 | 1.5 (0.3–9.3) 0.641 | |
| Total thyroidectomy | 41 | 4 | 0.7 (0.1–4.1) 0.678 | |
| Absence of neuromonitoring | 52 | 3 | 0.2 (0.3–1.3) 0.094 | 0.2 (0.1–3.4) 0.293 |

Only items with *P* values <0.1 on univariate analysis were included in the multivariate analysis. Significant *P* values are indicated in bold. HR = hazard ratios with 95% confidence intervals.

this context, Wang et al recently showed that laryngeal electromyography had a predictive positive value for permanent RLN injury of 93%.[11] Patients with the above-associated factors could be good candidates to laryngeal electromyography in order to perform a surgical treatment more rapidly if the test were positive.

In thyroid and parathyroid surgery, guidelines[18] underline the importance of pre- and postoperative ENT examinations for several reasons. First, it allows a precise preoperative assessment of the vocal cord movement (landmark) and can serve as medicolegal proof.[19] In this study, 0.8% (5/653) of patients were discovered with a preexisting vocal cord paresis (excluded patients). They were due to previous thyroid surgeries or large goiters. Second, it permits to have a more adequate postoperative comparison with the preoperative examination, and thus to tailor the surgical approach. Finally, in the case of new ENT findings different from RLN injury (e.g., acid reflux), this can be treated as well. In this study, at the preoperative fiberoptic laryngoscopy 11 patients among 76 patients with RLN injuries were found with other ENT problems (8 laryngopharyngeal refluxes, 1 laryngitis, 1 sinusitis, and 1 laryngeal edema). These 15% (11/76) are similar with what is usually found in the literature.[20,21] These results confirm the importance of a routine pre- and postoperative ENT examination.

Intraoperative neuromonitoring was used in this study only for specific cases (9 patients). Guidelines presently do not recommend routine use of neuromonitoring for thyroid surgery.[22] Several articles have shown that the use of neuromonitoring did not decrease the risk of RLN injuries, but literature shows contradictory data.[23]

The main limitation of this study is its retrospective design. It was not possible to retrieve some data from the computer or handwritten patients' charts. Moreover, the follow-up of the patients with RLN injuries was not standardized and was depending on the otolaryngologist who saw the patient postoperatively. Of note, 11 patients were lost in follow-up because they were followed in another hospital or because they benefited from speech therapy in another Swiss region.

In conclusion, this study showed that incidence of new operation-related permanent vocal cord palsies was rare in our cohort (1.1% of all patients and 0.7% of the nerves at risk). The median recovery time for transient RLN injuries was 8 weeks after operation, confirming the good recovery potential of these lesions. Intraoperative RLN injury during thyroidectomy was associated with permanent RLN injury.

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