Vocal Changes Following Thyroid Surgery: Prospective Study of Objective and Subjective Parameters

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Summary: Objective. Vocal changes are frequent following a surgical procedure to the thyroid gland. Even though they are a recognized morbidity, their bases are yet to be defined as well as their effect on vocal parameters. This study investigates the objective and subjective changes that occur after the surgery.

Study design. This study is a prospective analysis of consecutive cases.

Setting. This study was conducted in a single-center tertiary care facility.

Subjects and methods. Patients programmed for any thyroid procedure in Hospital Universitario Ramón y Cajal were enrolled consecutively to perform the vocal analysis before and after the surgery from April 2014 to April 2016. Patients were divided according to the vocal fold motility, and their vocal and aerodynamic parameters were obtained by means of electroglottography and phonatory aerodynamic system. Patients filled in the 10-item Voice Handicap Index (VHI-10) questionnaire. Statistical analysis was performed comparing vocal and aerodynamic parameters and quality of life before and after the surgery.

Results. 218 patients met inclusion criteria and completed the protocol. A total of 86.6% of the sample showed no vocal motility impairment, whereas the rest of the patients showed a paresis or a paralysis. Maximum phonatory time and VHI-10 questionnaire showed a statistically significant difference ($P < 0.05$) between groups. No differences were assessed regarding other vocal parameters.

Conclusions. Efforts are still needed to understand the groundings and magnitude of the vocal changes after a thyroid surgery.

Key Words: Voice–Thyroidectomy–Acoustic analysis–Aerodynamic analysis–Quality of life.

INTRODUCTION

Vocal changes and swallowing impairment are well-known sequelae following thyroid surgery due to laryngeal nerve lesion.

Lesions to the recurrent laryngeal nerve (RLN) derive in marked dysphonia as a result of vocal fold movement impairment. However, when the superior laryngeal nerve (SLN) is the one damaged, symptoms are more subtle, and patients do not feel as much handicapped as in the case of the RLN lesion, unless patients require a high-efficient voice for professional purposes.[1]

Permanent lesions to these nerves happen in 0.7–13.3% of the cases for the RLN and 5–30% of the cases for the external branch of the superior laryngeal nerve (EBSLN) following a thyroid surgery. This rate varies notably depending on the experience of surgeon.[2,3]

Vocal changes following a thyroid surgery tend to resolve spontaneously over a short time, but it can endure over months in almost 30% of the cases. This may be caused by a vocal or cricopharyngeal dysfunction related to alterations in motor and sensitive branches of the laryngeal nerves to laryngeal muscles and mucosa.

Because of these facts, it is obvious that neural lesion avoidance is fundamental during any thyroid procedure. On hands of an experienced surgeon, complication rate, including RLN lesion, is less than 2%.[4]

Nevertheless, the vast majority of vocal and swallowing alterations after a thyroidectomy are self-limiting and not related to a neural injury.[5]

Subjective vocal changes present a high variation between series of cases, from 37% to 87%. Patients describe vocal strain, singing impairment, inability to produce high-pitched or strong voice, and roughness.

Multiple factors may lead to these symptoms, such as arytenoid trauma following orotracheal intubation, surgical trauma, alterations on laryngeal blood supply and venous drainage, local neck pain, cricothyroid dysfunction, prelaryngeal muscle dysfunction or lesion to the nervous plexus, surgical lesion of the anastomotic branches that connect inferior laryngeal nerve to the EBSLN, laryngotracheal fixation with vertical immobility, and as psychological reaction toward the procedure.

Over the last years, a number of studies have attempted to analyze the vocal changes caused by thyroid surgery and their impact on quality of life. However, these have not yet been fully understood.

In that sense, our study attempts to add evidence to this subject to better diagnose and treat our patients.

METHODS

This study was conducted according to the principles stated in the 1983 Declaration of Helsinki. Approval was obtained from the Ethics Committee of the Hospital Universitario Ramón y Cajal.A total of 301 consecutive patients were included in the study before the surgery on the thyroid gland in Hospital Universitario Ramón y Cajal (Madrid, Spain) from April 2014

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to April 2016. Surgeries were performed by either General Surgery or Otolaryngology Departments. Patients were eligible for the study when they were older than 18 years of age. Benign and malignant thyroid disease was included in the study. Complete assessment included video laryngoscopy, acoustic analysis, aerodynamic analysis, and quality of life assessment before and 1 month after the procedure. In case that a motility impairment was assessed on video laryngoscopy, patients were followed up 3, 6, and 12 months after surgery or until motility recovery. SLN impairment was not assessed during the video laryngoscopy as only subjective findings such as diminution of laryngeal sensitivity would be noted. We consider that this feature would not be reliable enough to determine the SLN integrity, and a laryngeal electromyography would be needed to define accurately SLN function. Every examination was always performed by one of the two first authors of the paper.

Video laryngoscopy was performed with the Olympus HD flexible videoscope. Acoustic parameters were obtained by electroglottography (KayPENTAX Model 6103, Pentax Medical, Tokyo, Japan). The parameters taken into account were the contact quotient (CQ), standard deviation of the CQ (CQ SD), fundamental frequency (F0), and jitter.

Aerodynamic parameters were achieved with KayPENTAX Phonatory Aerodynamic System Model 6600 that allows obtaining the voicing efficiency quotient (VEQ) that represents glottis efficiency in sound production. Maximum phonatory time (MPT) was measured for both /e/ and /s/.

Every patient filled in the 10-item Voice Handicap Index (VHI-10) questionnaire before and after surgery.

Statistical analysis was performed using *XLSTAT* 2014 Software (Addinsoft, New York, NY, USA). Continuous data were summarized as mean ± interval of confidence 95%. Kolmogorov-Smirnov test demonstrated a parametric distribution of the sample according to age, whereas the sample presented a significant statistical difference ($P < 0.001$) according to the gender of the patients. Vocal parameters depending on vocal motility were studied with the Student *t* test for paired sample test on parametric sample (normal motility) and Wilcoxon test on nonparametric sample (paresis and paralysis). *P* values below 0.05 were considered significant.

RESULTS

A total of 301 consecutive patients were enrolled in the current study, but only 218 completed the protocol up to the first postoperative month.

At the end of the study, 218 patients were included for statistical analysis. Median age at the surgery date was 53 years. Furthermore, 76.5% (167) patients were female and 23.5% (51) were male; this difference is statistically significant. The most performed procedure was total thyroidectomy, in 122 patients, which represents 56% of the sample. The remaining patients underwent hemithyroidectomy.

The majority of patients (79.8%) that underwent thyroid surgery had either a benign thyroid node or a multinodular goiter. The second most frequent etiology leading to thyroidectomy was differentiated thyroid carcinoma (20.1%) and the remaining of the sample had Graves disease.

TABLE 1.
Baseline Characteristics of the Patients that Underwent Thyroid Surgery (n = 218)

Parameter	No. of Patients (%)
Gender	
Male	51 (23.5)
Female	167 (76.5)
Age (mean ± SD, y)	53.03 ± 13.77
Pathology	
Benign	174 (79.8)
Malignant	44 (20.1)
Extent of surgery	
Total thyroidectomy	122 (56)
Hemithyroidectomy	96 (44)

Abbreviation: SD, standard deviation.

Patient baseline characteristics are summarized in Table 1.

One month after the surgical procedure, 189 patients (86.6%) presented no vocal motility impairment and were discharged in that moment. Paresis was assessed on 19 cases (8.7%); 8 cases presented a right vocal fold paresis and 11 cases a left one. Only 10 cases (4.5%) presented a truly paralysis; five cases a right vocal fold paralysis and five cases a left one. Those patients that showed any vocal fold motility impairment were followed up until recovery or until one year after the surgery. One-year postoperative examination was performed in just one case due to spontaneous motility recovery or loss of follow-up of the patient.

Figure 1 shows vocal fold motility outcome at 1-month follow-up appointment.

Regarding cases presenting a vocal fold paresis, 13 of 19 cases were observed after a total thyroidectomy; nine cases showed a left vocal fold paresis and four cases a right one. In those cases on which a hemithyroidectomy was performed (six cases), paresis matched in every case to the side on which surgery was carried out.

A total thyroidectomy was performed on the 10 patients that presented a vocal fold paralysis after the surgery; five cases a left vocal fold paralysis and five cases a right one.

Of the 19 cases that presented a vocal paresis, 10 patients recovered normal function on the 3-month appointment, 4 did not attend the appointment, and 5 patients still showed vocal paresis. On the 6-month appointment, two patients recovered motility, two patients did not attend the appointment, and one patient still showed paresis that diminished a year after the surgery.

Regarding patients that presented a vocal paralysis after the procedure, four patients recovered normal motility on the 3-month appointment, three did not attend the visit, and three patients still showed some degree of motility impairment; two of them still presented vocal paralysis and abandoned the follow-up, and the remaining case presented paresis that recovered normal movement on the 6-month appointment.

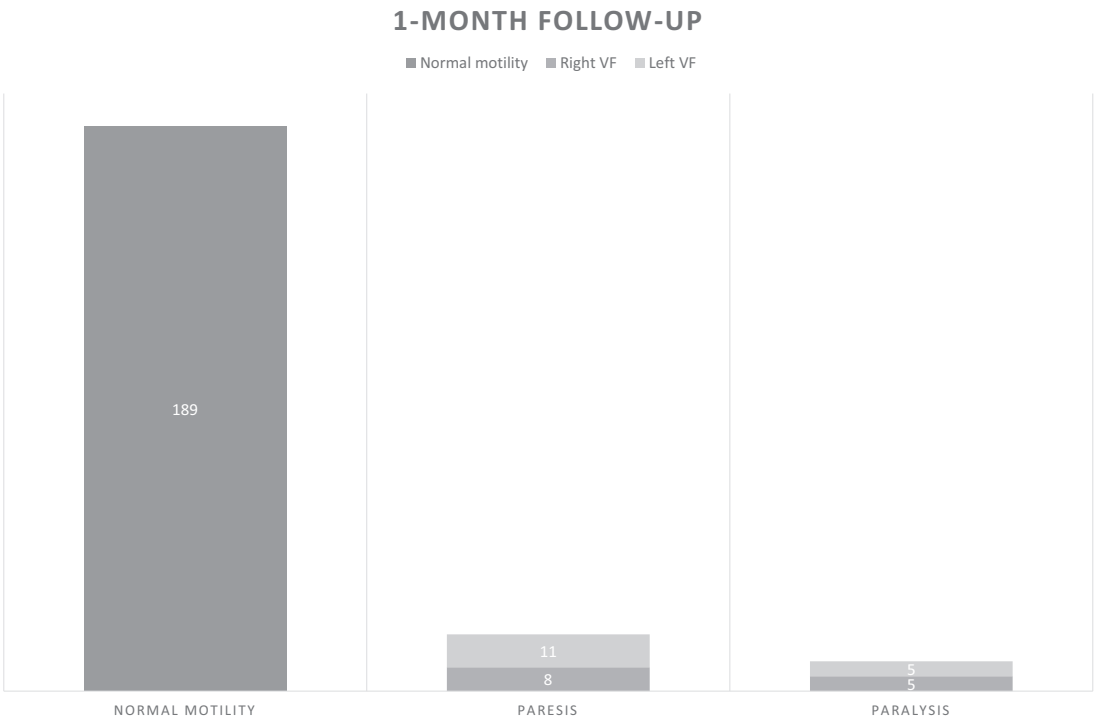

FIGURE 1. VF motility outcome at 1-month follow-up appointment. VF, vocal fold.

Table 2 describes the acoustic, aerodynamic, and subjective parameters before and 1 month after the surgery.

Patient's distribution regarding vocal motility impairment upon follow-up appointment is shown in Figure 2.

Patients were divided into three different groups depending on the vocal motility showed 1 month after surgery appointment: normal motility, paresis, and paralysis.

Table 3 shows *P* values of the different parameters analyzed between groups, remarking those that present statistical significance.

Acoustic parameters that were analyzed were CQ, CQ SD, F0, and jitter. No statistically significant difference ($P < 0.005$) was found when comparing pre- and postoperative acoustic parameters of the voice, regardless of the vocal fold motility.

The main aerodynamic parameter considered was the VEQ and it did not show a significant difference ($P < 0.005$) after the surgery in none of the groups. Regarding the MPT, the difference between the prethyroidectomy and post-thyroidectomy times was statistically significant in patients that presented a vocal paralysis following the surgery ($P < 0.05$). Such difference was not observed in patients with no motility impairment or patients presenting a vocal paresis after the surgery.

The other parameter reviewed that revealed a significant change after the surgery was the self-assessed voice quality, measured with the VHI-10 questionnaire. This parameter worsened in the three groups ($P < 0.005$) but it differs notably between groups. On the group that showed a normal motility, 68.25% presented the same result or even their voices got better after the surgery. Only 31.7% of the patients of this group addressed a worsening in their vocal quality, whereas in the group that showed some vocal motility impairment, a worsening was remarked in 75.8% of the patients.

TABLE 2.
Preoperative and Postoperative (1 Month) Acoustic, Aerodynamic, and Subjective Analysis of Patients Undergoing Thyroid Surgery (n = 218)

Analysis	Parameter	Preoperative	Postoperative
Acoustic	CQ (%)	47.72 ± 7.12	47.51 ± 5.57
	CQ SD (%)	7.74 ± 10.07	6.60 ± 5.79
	F0 (Hz)	204.12 ± 79.99	203.92 ± 87.24
	Jitter (%)	5.99 ± 8.22	4.98 ± 7.15
Aerodynamic	EC	503.26 ± 1964.14	287.16 ± 453.74
	MPT /e/ (s)	18.49 ± 6.12	17.40 ± 6.38
Subjective	VHI-10	1.38 ± 2.95	3.88 ± 7.07

Abbreviations: CQ, contact quotient; CQ SD, contact quotient standard deviation; F0, fundamental frequency; Hz, hertz; EC, efficiency coefficient; MPT, maximum phonatory time; s, seconds; VHI-10, Voice Handicap Index—10.

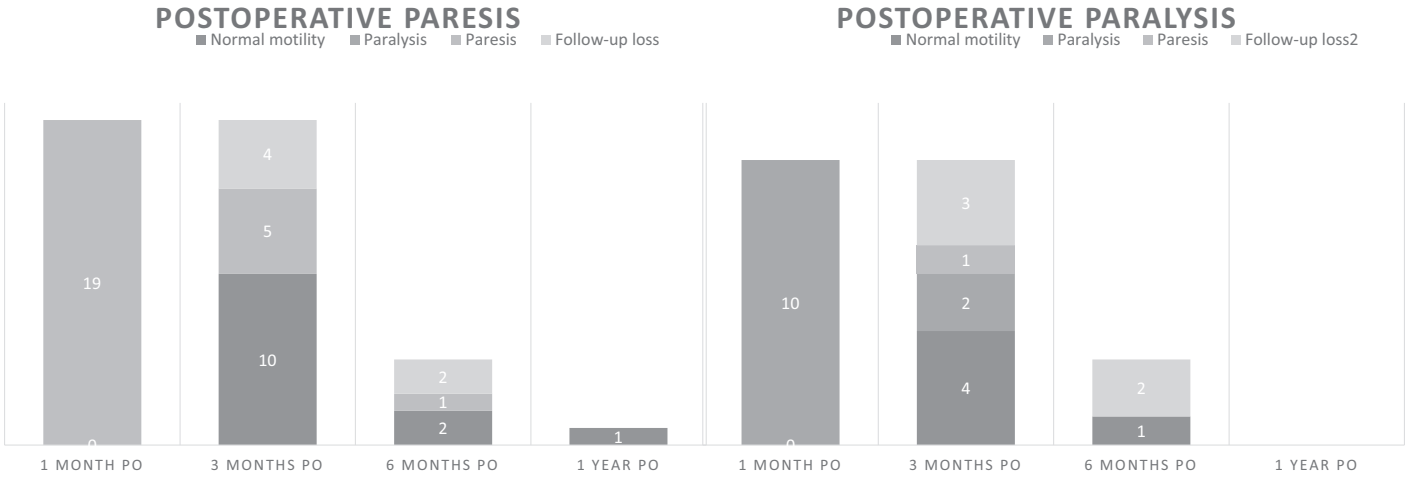

FIGURE 2. Patient's distribution regarding vocal motility impairment upon follow-up appointment.

DISCUSSION

Preservation of voice quality following thyroid surgery is a concern for both the patient and the surgeon. Conservation of the RLN and the EBSLN is a major concern during this surgery. The outcomes of injury to these nerves during surgery are widely described nowadays,[4] but vocal changes following thyroid surgery are more frequent than expected if they were only produced by neural damage.[1]

Post-thyroidectomy voice disturbance in patients with preserved nerve function is frequent and heterogeneous between different series of cases presented in current literature.[6] The fact that each study presents a different design in which different measurement tools, outcome variables, and postoperative measurement times are used is the basis of the lack of agreement about the impact and effect of these changes.

In a recent review of the current literature conducted by Lang et al,[6] the incidence of vocal changes ranged between 29.7% and 87%, depending on the definition and timing of the assessment. Stojadinovic et al[7] reported that 30% of the patients presented vocal changes 1–2 weeks after the surgery, but this rate decreased to 14% 3 months after the surgery.

TABLE 3.
***P* values for the Different Parameters Between Groups**

	Normal motility	Paresis	Paralysis
CQ	$P = 0.8594$	$P = 0.1531$	$P = 0.9057$
CQ SD	$P = 0.1356$	$P = 0.1474$	$P = 0.5536$
F0	$P = 0.1498$	$P = 0.1346$	$P = 0.1551$
Jitter	$P = 0.1984$	$P = 0.1031$	$P = 0.6103$
EC	$P = 0.2357$	$P = 0.0883$	$P = 0.0756$
MPT	$P = 0.8937$	$P = 0.4200$	$P = 0.0090$*
VHI-10	$P = 0.0010$*	$P = 0.0021$*	$P = 0.0092$*

* $P < 0.05$.

Abbreviations: CQ, contact quotient; CQ SD, contact quotient standard deviation; F0, fundamental frequency; EC, efficiency coefficient; MPT, maximum phonatory time; VHI-10, Voice Handicap Index—10.

In our study no significant difference, but for the MPT, was assessed in objective parameters between patients that presented normal motility after the surgery and those that presented any degree of vocal immobility. These findings are not concordant to the ones presented in the systematic review performed by Lang et al[6] in 2016, in which they find a significant change in F0, shimmer, and mean phonation time in the early postoperative period that tends to resolve over the late postoperative period independently of the vocal movement presented by the patient. No other parameters were affected after the surgery in this review.

We may take into account that most of the articles included in this review performed the early assessment 1–2 weeks after the surgery, and the late assessment 3 months after the surgery. Orotracheal intubation is thought to play a part in vocal changes after a general anesthesia, and the time when these changes resolve is yet to be clarified.[8,9] The vocal inflammation following short-term general anesthesia is not supposed to endure over more than 1 or 2 weeks;[10] consequently, no vocal changes secondary to the orotracheal intubation are assumed after this time. In our case, the postoperative assessment was performed 1 month after the surgery to avoid the bias caused by vocal changes derived from orotracheal intubation, and therefore identify exclusively changes resulting directly from the thyroid surgery.

One of the most frequently altered parameters after the surgery is a lower pitched voice that may be secondary to a modified vascular supply and venous drainage. These vascular changes, in addition to the slight congestion produced by the orotracheal intubation,[11] may act as the ground for this decrease in the vocal pitch. Many studies have demonstrated this decrease months after the surgery,[7,11–16] but many others describe no objective vocal changes after the surgery supporting our findings.[17–22]

Aerodynamic analysis consisted of MPT measurement and estimation of the VEQ. Regarding the MPT, a significant difference was presented on those patients that presented a vocal fold paralysis following the surgery, whereas those patients that presented either a vocal fold paresis or no motility impairment showed no

statistical difference in MPT before and after the surgery. No significant statistical difference was shown regarding the VEQ in the different groups, which means that no loss of efficiency occurs to the glottal unity following the thyroid surgery. To our knowledge, there are only four articles in existing literature that performed aerodynamic recording.[7,20,23,24] Therefore, our results are consistent with the rest of the studies that performed this analysis, and confirm that no difference may be encountered in VEQ values after a thyroidectomy.

Even though no objective changes in voice parameters were found, patients reported voice symptoms independently of the motility status showed at the follow-up. Subjective parameters were assessed by means of the VHI-10 questionnaire, and differences shown after the surgery were significant whether a motility impairment was present or not. Patients that presented paralysis or paresis after the surgery reported higher values on the postoperative questionnaire, and the difference between the preoperative and postoperative test was higher than those patients that presented a normal vocal fold movement. This fact supports the idea that VHI-10 may serve as a screening tool for post-thyroidectomy vocal changes when an increase of at least two points in the postoperative questionnaire is presented. Most patients that underwent thyroid surgery report some degree of voice and/or swallowing discomfort shortly after the procedure[4,7,16] that does not correlate directly with the severity of the vocal or swallowing alterations demonstrated in the physical examination. Quality of life questionnaires help us to identify patients that present symptoms without a matching physical examination that may have passed unnoticed without this tool.

One limitation of our study is that we are unable to estimate the rate of lesion to the EBSLN as its symptoms and laryngoscopic findings are very subtle, and we would have needed for instance the use of videostroboscopy to guess them, or the use of cricothyroid electromyography to demonstrate this recognized morbidity of thyroid surgery. Lesions to the EBSLN are supposed to be responsible for the loss of upper pitch range after the surgery,[3] but this is a parameter that we did not measure because it is not feasible, nor ethical, to perform an electromyography to each patient undergoing a thyroidectomy to assess the integrity or a lesion to the EBSLN. Other effects of the lesion of the EBSLN are a loss of vocal projection and hoarseness that may be registered in the acoustic analysis, that in our study were not presented.

Throughout the study, we lost follow-up of 83 of 301 patients that were enrolled at the beginning. We suspect that the lack of subjective pathology perceived by the patient may be the reason why patients do not attend their follow-up appointments. In case we would have been able to follow these patients, we believe that significant statistical differences may have been found in other parameters of the sample.

In 2013, the AAO-HNSF published a Clinical Practice Guideline to improve voice outcomes following a thyroid surgery.[25] These actions included the preoperative evaluation of each patient with a laryngoscopic examination and a vocal analysis, EBSLN preservation, registering any vocal change between 2 weeks and 2 months postoperatively, early referral to a voice specialist whenever a motility impairment was assessed following the thyroid surgery and an adequate counseling to patients presenting vocal changes or abnormal motility about voice rehabilitation options.

Even though we did not find a significant statistical change in objective parameters but for the MPT, we believe that voice assessment following any surgery regarding the thyroid gland should be included in the follow-up of these patients. Depending on the findings of vocal quality, the study within an ENT Department and early referral to rehabilitation should be initiated with the aim to minimize the impact on the quality of life of patient.

CONCLUSIONS

Surgery of the thyroid gland may produce vocal changes of different magnitude, even when the laryngeal nerves remain intact. These changes are not clearly defined, but they appear to be temporary. Even when these changes are not assessed on objective tests, patients still address them on quality of life questionnaires and remark the impairment derived of them.

Vocal changes should be taken into account in every patient undergoing a surgery on the thyroid gland, whether it is performed by an otolaryngology or a general surgeon; therefore, at least questions regarding these symptoms should be included in the follow-up of the patient. Whenever a change in vocal quality is presented following the surgery, the patient should be referred immediately to an otolaryngologist to establish the level of impairment and possible therapies.

We still need to make efforts to better establish the groundings of vocal changes after a thyroid procedure and their impact on patient's life. The more we understand about them, the better we will be able to decrease the impairment perceived by the patient, and diminish the morbidity of one of the most common surgeries worldwide.

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