Subjective and Objective Voice Assessments After Recurrent Laryngeal Nerve-Preserved Total Thyroidectomy

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Summary: Objectives. This study aims to investigate early voice changes after total thyroidectomy, to assess the improved parameters in intermediate postoperative intervals, to evaluate the effect of age on voice after thyroidectomy, and to determine the correlation between the objective and the subjective method outcomes.

Study Design. This is a prospective, nonrandomized study.

Materials and Methods. One hundred ninety-one participants, divided into two age groups, underwent three full voice assessments (preoperatively and 1 and 8 weeks after thyroidectomy) by means of videostroboscopy, perceptual evaluation, acoustic analysis, aerodynamic evaluation, and a self-evaluation questionnaire. Two control groups enrolled in the study: (1) patients with an indication of neck surgery not related to laryngeal nerve injury risk or strap muscle dissection and (2) patients with an indication of a non-neck surgery.

Results. No statistically significant difference was found in any voice parameter, between preoperative and 1-week postoperative assessment regarding the control groups. A statistically significant difference was found between preoperative evaluation and 1 week after thyroidectomy for the total study population, as well as for the ≥40 years' age subgroup for all parameters evaluated except for shimmer. The <40 years' age subgroup showed a statistically significant difference in pitch, maximum phonation time, and grade, roughness, breathiness, asthenia, and strain (GRBAS) score between preoperative evaluation and 1 week after thyroidectomy. None of the parameters showed a statistical significant difference in the <40 years' age subgroup at 8 weeks' evaluation. The Voice Handicap Index (VHI) score correlated significantly with the GRBAS score preoperatively and postoperatively at 1 and 8 weeks' evaluations. Furthermore, VHI correlated significantly with pitch a week postoperatively. GRBAS scores showed significant correlation not only with VHI but also with acoustic parameters including pitch, shimmer, and noise-to-harmonic ratio 1 and 8 weeks after thyroidectomy.

Conclusions. Objective voice changes are common in the majority of the thyroidectomized patients in the early postoperative period. Our results revealed that these changes are related to thyroidectomy *per se*. Older patients (≥40 years of age) show acoustic and aerodynamic changes 8 weeks postoperatively, although they report no voice abnormalities and their perceptual evaluation is similar to the preoperative one.

INTRODUCTION

Thyroid pathology shows a constant increase through the years and thyroidectomy has become the most common neck operation. Voice changes are often encountered after thyroidectomy, whereas recurrent laryngeal nerve (RLN) function does not solely predict functional voice outcome. Other mechanisms that have been reported to affect vocal function include injury to the external branch of the superior laryngeal nerve (SLN), postoperative inflammation, laryngeal edema due to vascular congestion, damage to the cricothyroid muscle, endotracheal intubation-related trauma (eg, cricoarytenoid joint injury, granuloma formation), strap muscle trauma, and laryngotracheal fixation with surrounding tissues.[1–3] Patients may present with a seemingly normal voice without any complaint of vocal dysfunction, or with easy fatigue, difficulty in singing or speaking in a loud voice, and hoarseness. Most of these voice changes resolve spontaneously, but there are cases where patients show maladaptive compensation, which may persist after the resolution of the underlying pathology.

Multidimensional voice outcomes (videostroboscopic examination, patient self-evaluation, perceptual rating of voice quality, acoustic analysis, and aerodynamic variables) are essential to assess voice changes comprehensively. The high incidence of patients suffering from post-thyroidectomy voice changes, as well as the fact that almost half of the patients with unilateral RLN or SLN palsy before surgery may be asymptomatic, has led surgeons to incorporate laryngoscopy or videostroboscopy as a part of the preoperative evaluation. In terms of self-evaluation of dysphonia, numerous quality-of-life (QoL) instruments have been developed and used.[4] Voice Handicap Index (VHI), translated and validated in many languages, remains the most popular and widely used tool for the evaluation of voice dysfunction.[5] Perceptual evaluation is performed either by an experienced speech pathologist or a phoniatric specialist. The grade, roughness, breathiness, asthenia, and strain (GRBAS) scale has a proven inter-rater reliability and is recommended for clinical purposes by the European Laryngeal Research Group.[6,7] Acoustic analysis of voice is often used as a supplementary tool in perceptual evaluation. Numerous acoustic parameters are available through a growing number of software programs. Most clinical studies analyze sustained habitual vowel production and use voice pitch, as well as perturbation measures such as jitter, shimmer, and

Accepted for publication December 16, 2016.

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Journal of Voice, Vol. ■■, No. ■■, pp. ■■-■■

0892-1997

http://dx.doi.org/10.1016/j.jvoice.2016.12.011

noise-to-harmonic ratios (NHR). Jitter and shimmer are time-based perturbation parameters and quantify the degree of cycle-to-cycle variability in the fundamental period and amplitude, respectively. NHR is also a time-based measure that integrates elements of both jitter and shimmer. NHR divides the mean amplitude of the noise components by the mean amplitude of the cyclic or periodic component of the voice signal.[8] Maximum phonation time (MPT) does not represent a real aerodynamic variable, such as mean phonatory airflow, subglottal air pressure, laryngeal airway resistance, or phonation threshold pressure, but is thought to be a reasonable predictor of airflow and has been used by several studies as an indicator of vocal aerodynamic function.

Voice changes after RLN-preserved thyroidectomy have been recently investigated. Previous studies have implicated different assessment tools at various time intervals after thyroidectomy. Complaints of voice dysfunction are reported by 37%–87% of patients after thyroidectomy, whereas acoustic analysis of speech shows lowered pitch and altered perturbation parameters in 18% of patients.[9–12]

In the present study, we used a voice assessment protocol including both objective and subjective tools. The aims of the study were (1) to investigate early voice changes after RLN-preserved total thyroidectomy, (2) to assess the improved parameters in intermediate postoperative interval, (3) to investigate the effect of age on voice after thyroidectomy, and (4) to find out the correlation between the objective and the subjective method outcomes.

MATERIALS AND METHODS

Patients

Patients with indications for thyroid surgery for benign, suspicious, or malignant pathology were recruited by endocrinologists (institutional or private). The study population was divided into two age subgroups: (1) patients <40 years of age and (2) patients ≥40 years of age. Two control groups enrolled in the study: (1) patients with an indication for neck surgery not related to laryngeal nerve injury risk or strap muscle dissection (control group A) and (2) patients with an indication for a non-neck surgery (control group B). All patients signed a written consent for their participation in the study and in the surgical procedure. Exclusion criteria were (1) age under 18 years, (2) laryngostroboscopic findings indicating altered voice quality (vocal fold polyps or cysts, Reinke's edema, posterior laryngitis due to laryngopharyngeal reflux, vocal fold immobility, etc), (3) history of a previous phonosurgery procedure and history of a previous thyroid surgery (subtotal thyroidectomy or lobectomy), and (4) history of a progressive neurological disease. Patients were also excluded postoperatively from the study in cases of (1) RLN or SLN injury, (2) pathologic mucosal findings attributed to endotracheal intubation, (3) a well-differentiated T3 or T4 TNM stage thyroid carcinoma, (4) lymph node or distal metastasis, or (5) loss to follow-up. Furthermore, control patients were excluded if intubation lasted less than 90 minutes. The study protocol was approved by the Institutional Review Board of the General Hospital of Chania (# 093/2012).

Surgery

Total thyroidectomy was performed by extracapsular dissection with identification and preservation of the RLN by the same surgeon. In the vast majority of cases, intraoperative monitoring of the RLN was used (Medtronic NIM-Pulse 2.0). Accurate dissection and distal ligation of the thyroid's superior pole vessels contributed critically to the preservation of the external branch of the SLN. Control group A consisted of 14 patients who underwent superficial parotidectomy (n = 4), selective neck dissection levels I–III (n = 1), excision of the submandibular gland (n = 3), branchial cleft cyst (n = 2), large neck lipoma (n = 2), desmoid neck tumor (n = 1), and large dermoid cyst of the mouth floor (n = 1). Control group B consisted of 24 patients who underwent ear surgery (n = 5), abdominal surgery (n = 9), and orthopedic surgery (n = 10).

Study design

Study participants underwent three full voice assessments (preoperatively and 1 and 8 weeks postoperatively). The preoperative measurements allowed baseline assessment of voice parameters for each patient and all subsequent assessments were compared to these measures. A persistent voice complication after the second postoperative assessment was followed up at a 1-month interval. Voice outcome measures included the following:

(1) Videostroboscopy. Clinical examination was performed with videostroboscopy (70° rigid endoscope, type Xion endoSTROB, DIVAS EndoStrob; Xion Medical, Berlin, Germany). The examination was performed in all cases by the same expert. Phonatory characteristics of the larynx at rest and during speech were viewed and mucosal waves of the vocal folds were examined during phonation of the prolonged vowel /i/.

(2) Perceptual examination. GRBAS scale, as has been suggested by Hirano,[13] was used by the same speech pathologist to grade voice quality. Grading was applied blindly to voice samples of the patients containing conversational speech, counting from 1 to 10 and pronouncing the vowels "α/e/i/o/ou." The GRBAS scale allows a rating of voice over four parameters (roughness, breathiness, asthenicity, and strain) and an overall grade for voice quality. Each aspect is rated on a four-point scale ranging from 0 (normal) to 3 (severely abnormal).

(3) Acoustic analysis. The voice signal was recorded digitally, via a head microphone (~30 cm head-to-mouth distance) placed at 45° from the mouth axis, in a quiet room (ambient noise <50 dBA) and saved in a computer, with a sampling frequency of 44,100 Hz and a resolution of 16 bits per sample. It consisted of a sustained /α/, voiced three times, at a comfortable pitch and loudness. Acoustic analysis was performed on voice samples by *Praat* system (University of Amsterdam, The Netherlands; http://www.fon.hum.uva.nl/praat), and the mean score for pitch, jitter, shimmer, and harmonic-to-noise ratio was calculated (mean duration of the analyzed sample: 5 seconds).