

# Analysis of Temporal Change in Voice Quality After Thyroidectomy: Single-institution Prospective Study

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**Summary: Objectives.** This study analyzed the temporal changes of voice quality after thyroidectomy and assessed the predictive perioperative parameters of postthyroidectomy voice disorder (PTVD).

**Study design.** This is a prospective cohort study.

**Methods.** From March 2011 to July 2014, 559 patients who underwent thyroidectomy with or without central neck dissection were prospectively enrolled. All patients underwent prospective voice evaluation using the subjective and objective comprehensive battery of assessments, preoperatively and postoperatively at 1 week, 1 month, 3 months, 6 months, and 12 months.

**Results.** Fundamental frequency (F0) was not significantly decreased during the postoperative follow-up. Maximal vocal pitch (MVP) and maximal intensity were not recovered, even at 1 year postoperatively, whereas the Grade, Roughness, Breathiness, Asthenia, Strain scale reached preoperative value at postoperative 3–6 months and voice handicap index at 1 year. Postoperative 1-month MVP was the best predictor for PTVD, and the cut-off value was 80% of preoperative value. Wide surgical extent and high preoperative F0 were the parameters that significantly correlated with PTVD ( $P = 0.021$  and  $P < 0.001$ , respectively), and large tumor, higher preoperative MVP, and lower postoperative 1-month F0 were significantly associated with permanent PTVD ( $P = 0.028$ ,  $P < 0.001$ , and  $P = 0.003$ , respectively).

**Conclusions.** Different recovery patterns of voice parameters should be considered in preoperative counseling. Intensive voice therapy may be needed for patients with the ability to produce higher pitch than normal preoperatively and wide surgical extent.

**Key Words:** thyroidectomy–voice–maximal vocal pitch–fundamental frequency–papillary thyroid carcinoma.

## INTRODUCTION

The incidence of thyroid cancer worldwide has rapidly increased and thyroid cancer is now the most frequently occurring cancer.<sup>1</sup> Papillary thyroid carcinoma is the leading cause of this abrupt increase, and thyroidectomy is one of the most common surgical procedures.<sup>2</sup> Because of the low mortality rate associated with papillary thyroid carcinoma, postoperative quality of life in thyroidectomies is considered to be as important as disease control.<sup>3</sup> Unfortunately, thyroidectomy is reportedly associated with a 25–84% risk of postoperative voice alterations, termed postthyroidectomy voice disorder (PTVD).<sup>4–8</sup> Presumed causes include injury to the external branch of the superior laryngeal nerve, vascular congestion, and laryngeal edema; surgical trauma to the cricothyroid muscle or cricoarytenoid joint; endotracheal intubation-related trauma; surgical adhesions; strap muscle denervation; and pain or psychological distress.<sup>9–12</sup> A recent survey of over 200 patients with PTVD found that vocal changes are a greater concern than traditional complications such as hypocalcemia or unsightly cervical scar.<sup>13</sup>

Vocal manifestations from these various pathologies can range from a seemingly normal voice to transient voice fatigue, and to profound and permanent dysphonia with a substantially adverse impact on the quality of life.<sup>7,8,14</sup> Voice changes include difficulty

in speaking aloud, voice huskiness, and, most commonly, lowered pitch and inability to produce a high-pitch sound.<sup>8</sup> Several studies have reported the results of acoustic voice analysis in patients with PTVD, but few had sufficient power to quantify long-term outcomes because of insufficient cohort size.<sup>9</sup>

In this single-institution, large prospective cohort study, we evaluated temporal changes of voice parameters including subjective and objective assessments and assessed the predictability of PTVD.

## MATERIALS AND METHODS

### Study population

From March 2011 to July 2014, patients undergoing thyroidectomy were prospectively included in this study. The inclusion criteria for enrolment were: (1) papillary thyroid carcinoma, (2) no clinical evidence of lateral neck node involvement, (3) no evidence of preoperative mucosal lesion or immobility of vocal fold, and (4)  $\geq 20$  years of age. The enrolment exclusion criteria were: (1) diagnosis of anaplastic or medullary carcinoma, (2) completion thyroidectomy or recurrent case, (3) inadequate 1-year follow-up data, (4) preoperative evidence of lateral nodal disease or lymph node dissection of any lateral compartment during the initial operative intervention, and (5) mucosal lesion or immobility of vocal fold preoperatively or postoperatively. The operation was performed by a single senior surgeon (K-Y Jung). The study protocol was approved by the Institutional Review Board of Korea University College of Medicine.

### Analysis of voice quality and assessment of subjective functional status and satisfaction

Using a comprehensive battery of functional assessments, all patients underwent repeated functional evaluations for voice quality

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before surgery and at 1 week, 1 month, 3 months, 6 months, and 12 months postoperatively. In addition, all patients were given voice therapy at the same postoperative periods.

Voice evaluations were performed under consistent conditions by a single voice specialist who was blinded to the study. The voice specialist performed a perceptual rating of subjective voice assessments using the GRBAS scale consisting of five parameters: overall grade of hoarseness (G), roughness (R), breathiness (B), asthenia (A), and strain (S). A 4-point grading scale was used for each parameter, where 0 = normal, 1 = slight, 2 = moderate, and 3 = severe. Acoustic voice evaluations were performed using the multidimensional voice program and the voice range profile program of the *computed speech lab* (Kay Elemetrics, Lincoln Park, NJ, USA). The subjective voice outcome was assessed using the voice handicap index (VHI)<sup>15</sup> including functional, physical, and emotional subscales that measured defects in verbal communication. Each item on the VHI is scored using a 5-point scale (range, 0–4); the highest score is 120 points. For the VHI, a higher score indicates a greater perception of functional disability.

#### Definition of postthyroidectomy voice dysfunction and assessment of affecting parameters

PTVD was defined as decrease of maximal vocal pitch (MVP) > 20% of preoperative values at any postoperative follow-up period. During the 1-year postoperative follow-up, PTVD without improvement of MVP at 80% of the preoperative value was defined as permanent PTVD. Changes of subjective and objective perioperative voice parameters were evaluated and compared with preoperative values. Predictions of PTVD using postoperative 1-week, 1-month, 3-month, 6-month, and 1-year MVP were assessed, and perioperative parameters correlated with PTVD were also evaluated. Additionally, parameters affects permanent PTVD was also assessed.

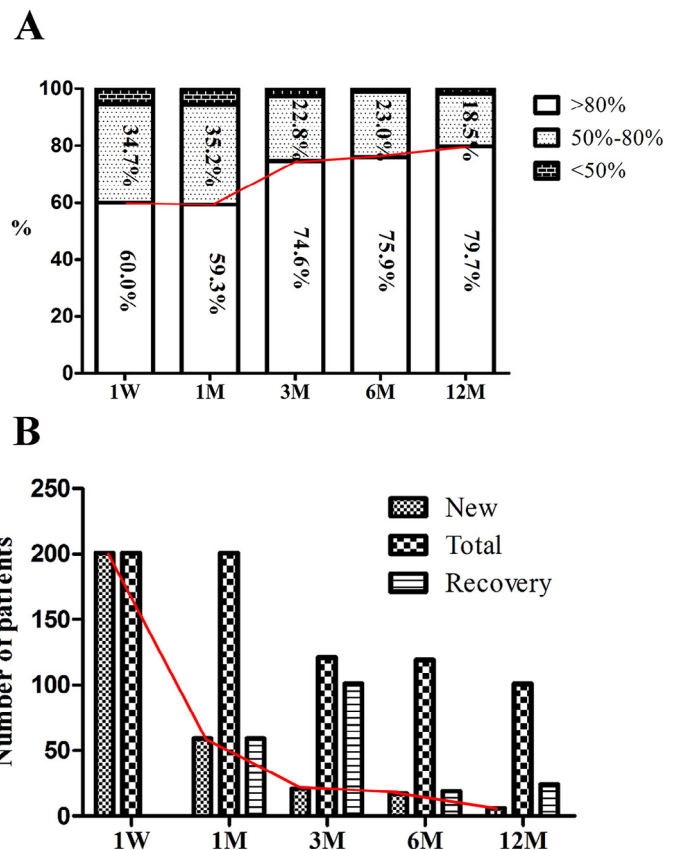
#### Statistical analyses

Results are presented as the mean value  $\pm$  standard deviation for continuous variables and as counts and group percentages for categorical variables. Continuous outcomes were analyzed using paired *t* tests for comparisons between two groups. Dichotomous outcomes were analyzed using the chi-square test for trend. A receiver-operating characteristic curve analysis using the area under the curve (AUC) was performed to evaluate accuracy in predicting PTVD. Bivariate logistic regression analysis was performed to assess the predictor for PTVD and permanent PTVD. All statistical analyses were performed using *IBM SPSS Statistics for Windows, Version 20-0* (IBM Corp., Armonk, NY, USA). *P* values of <0.05 were considered statistically significant.

## RESULTS

#### Demographics and prevalence of PTVD

A total of 559 patients were enrolled in this study. Mean age was  $48.4 \pm 12.7$  years, and the male-to-female ratio was 1:4.18. Among them, 281 (50.2%) patients had PTVD, which was transient in 189 (67.3%) patients. PTVD was most prevalent at postoperative 1 month (40.7%), followed by postoperative 1 week



**FIGURE 1.** Proportion of PTVD (MVP less than 80% of preoperative) during postoperative 1 year (A) and number of patients who showed newly appeared PTVD or recovery from PTVD (B). PTVD, postthyroidectomy voice disorder; MVP, maximal vocal pitch.

(40.0%) (Figure 1A). Although the total number of patients with PTVD was highest at postoperative 1 month, newly detected PTVD was most prevalent at postoperative 1 week, and it abruptly decreased from postoperative 1 month (Figure 1B). At postoperative 1 year, 20.3% of the total cohort had PTVD; these patients were deemed to have permanent PTVD.

#### Temporal changes of postoperative voice parameters

The recovery pattern differed according to postoperative parameters (Table 1). In the early postoperative period, most of the voice parameters were aggravated. In the GRBAS scale, except for asthenia and strain scale, minimal/maximal vocal pitch, and VHI showed significant aggravation compared with preoperative values. However, fundamental frequency (F0), shimmer, and noise-to-harmonic ratio (NHR) did not change postoperatively. Minimal vocal pitch showed fastest recovery among the aggravated parameters (at postoperative 3 months), followed by the GRBAS scale (grade, roughness, and breathiness at postoperative 6 months) and VHI (at postoperative 1 year). Among the voice parameters, MVP and maximal intensity were not recovered in the 1-year follow-up. Although the mean value of MVP reached a level that was similar to the preoperative value (Figure 2), statistical analysis by paired *t* test revealed no significant improvement during the 1-year follow-up.

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