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Epidemiology of Vocal Fold Paralyses After Total Thyroidectomy for Well-Differentiated Thyroid Cancer in Medicare Population

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Abstract

Objectives—Population-level incidence of vocal fold paralysis after thyroidectomy for well-differentiated thyroid carcinoma (WDTC) is not known. This study aimed to measure longitudinal incidence of post-operative vocal fold paralyses and need for directed interventions in the Medicare population undergoing total thyroidectomy for WDTC.

Study Design—Retrospective Cohort Study

Setting—United States Population

Subjects—Medicare Beneficiaries

Methods—SEER-Medicare data (1991 – 2009) were used to identify beneficiaries who underwent total thyroidectomy for WDTC. Incident vocal fold paralyses and directed interventions were identified. Multivariate analyses were used to determine factors associated with odds of developing these surgical complications.

Results—Of 5,670 total thyroidectomies for WDTC, 9.5% were complicated by vocal fold paralysis [8.2% unilateral vocal fold paralysis (UVFP); 1.3% bilateral vocal fold paralysis

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(BVFP)]. Rate of paralyse decreased 5% annually from 1991 to 2009 (OR 0.95, 95% CI 0.93 – 0.97; $p < 0.001$). Overall, 22% of patients with vocal fold paralysis required surgical intervention (UVFP 21%, BVFP 28%). Multivariate logistic regression revealed odds of post-thyroidectomy paralysis increased with each additional year of age, with non-Caucasian race, particular histologic types, advanced stage, and in particular registry regions.

Conclusions—Annual rates of post-thyroidectomy vocal fold paralyse are decreasing among Medicare beneficiaries with WDTC. High incidence in this aged population is likely due to a preponderance of temporary paralyse, which is supported by the need for directed intervention in less than a quarter of affected patients. Further population-based studies are needed to refine the population incidence and risk factors for paralyse in the aging population.

Keywords

vocal fold paralysis; unilateral vocal fold paralysis; bilateral vocal fold paralysis; thyroid cancer; thyroidectomy; epidemiology; incidence; Medicare

INTRODUCTION

Whether due to improved diagnostic testing¹, scrutiny², or a real increased disease burden³, thyroid carcinoma remains the only non-cutaneous head and neck malignancy that continues to increase in incidence⁴, almost tripling in the past 30 years from 3.6/100,000 in 1973 to 11.9/100,000 in 2007^{5,6}. Well-differentiated thyroid carcinoma (WDTC) is the indication for 50% of the 80,000 thyroid surgeries performed annually in the U.S.^{7,8}. Increase in thyroidectomies, not surprisingly, has been associated with more post-operative complications. In fact, surgical manipulation is responsible for 46% and 56% cases of unilateral (UVFP) and bilateral vocal fold paralysis (BVFP)⁹, which often result in severe dysphonia¹⁰, dysphagia¹¹, and dyspnea¹².

Most thyroidectomies occur in patients less than 65 years of age¹³. However, prevalence of thyroid nodules, the typical presenting symptom of carcinoma, does increase with age with an estimated 50% of patients over 65 years of age having nodules on ultrasound examination^{14,15}. Importantly, the malignant potential of nodules appears to increase with advancing age^{15,16}. As a result, thyroidectomies have burgeoned in the Medicare population over the past decades. More surgeries leads to more attributable vocal fold paralyse, which have major detrimental effects on quality of life¹⁷, substantially increase morbidity and medical costs¹⁸, and often require surgical intervention.

Recent epidemiological studies report post-thyroidectomy UVFP and BVFP rates of 0.85% – 3.5% and 0.35% – 2.3%, respectively^{7,19–26}. However, to date, there are no population-based estimates of vocal fold paralysis incidence after total thyroidectomy for WDTC in the Medicare population. The current study aims to fill that void by measuring the longitudinal incidence of post-operative vocal fold paralyse and need for directed interventions in Medicare beneficiaries undergoing total thyroidectomy for WDTC.

METHODS

The study was performed in accordance with the Declaration of Helsinki, Good Clinical Practice, and was approved by the Vanderbilt Institutional Review Board (IRB #111775).

SEER-Medicare Data

Patients were identified from the combined SEER-Medicare database. SEER is a national cancer surveillance tool that merges 17 population-based tumor registries capturing 26% of cancer diagnosed in the United States²⁷. SEER is linked to Medicare, which is a government-funded entity that manages 95% of insurance claims of the U.S. population aged 65 years and older²⁸. SEER-Medicare successfully links 94% of SEER cancer patients over age 65 years with their Medicare claims. Within the combined database, SEER contributes information about cancer diagnosis dates and tumor details, while Medicare contributes longitudinal follow-up data²⁸.

Cohort Selection

To be included, patients had a total thyroidectomy (Table 1) on a known date, for pathologically-confirmed well-differentiated thyroid carcinoma (WTDC) diagnosed between 1991 and 2007 and uninterrupted enrollment in Medicare Part A and B based on age being 65 years or older. WTDC was defined as those with papillary, follicular, or medullary histopathology (Table 1). Patients with other histologic types of thyroid cancer (e.g. anaplastic, lymphoma, metastases, melanoma) were excluded, as were those with pre-operative diagnoses of vocal fold paralyses (Table 1). Non-WTDC histologic types of cancer were excluded due to differences in their aggressiveness, staging, and treatment.

Outcomes and Variables

The primary outcome measures were 1) *post-operative vocal fold paralysis* and 2) *interventions to treat these conditions* (Table 1). All treatments directed at paralyses were extracted. Treatment of BVFP includes tracheotomy and cordotomy/arytenoidectomy procedures (Table 1). UVFP treatments are categorized into temporary or permanent. Temporary intervention primarily includes injection medialization procedures, while permanent treatments are laryngoplasty +/- arytenoid adduction and reinnervation procedures (Table 1).

Additional data accessed from SEER-Medicare were patient characteristics (gender, race, age), socioeconomic status (SES), registry geographic region, practice setting (big metropolitan, metropolitan, urban, less urban, rural)²⁷, cancer characteristics (diagnosis date, histology, SEER historic stage) and date of total thyroidectomy. SES was estimated using the 2000 census tract median household income for the zip code of each patient's residence. Median incomes were divided into quartiles for analysis. The 17 SEER registries were divided into geographic regions: Western (California, Washington), Southwestern (Utah, New Mexico), Midwestern (Iowa, Michigan), Southern (Kentucky, Louisiana, Georgia), Northeastern (Connecticut, New Jersey), and Hawaii. SEER historic staging was used since American Joint Commission on Cancer (AJCC) staging data was inconsistently recorded

during the study period. Use of intra-operative recurrent laryngeal nerve monitoring during thyroidectomy was identified from Medicare claims (Table 1).

Data Analysis

All data management and analysis were done using SAS® Version 9.2 (SAS Institute Inc., Cary, North Carolina) and STATA/MP® Version 12.1 software (STATA Corp, College Station, TX). Vocal fold paralysis was the primary outcome analyzed, while secondary analyses considered UVFP and BVFP separately. Longitudinal post-operative vocal fold paralyses (overall, UVFP, BVFP) and IONM utilization rates were calculated. Interventions to treat these conditions were extracted and reported. The need for intervention was used as a surrogate for those paralyses causing severe or persistent enough symptoms (e.g. permanent paralyses) to warrant surgical treatment. Duration from thyroidectomy to 1) paralysis diagnosis and 2) directed treatment were calculated and reported as medians and interquartile ranges (IQR) due to the non-parametric nature of this data.

Univariate analyses were performed using pairwise t-tests, chi-square tests, and logistic regression as appropriate. Stepwise multivariate analysis logistic regression analyses were employed to identify independent risk factors for post-thyroidectomy vocal fold paralyses. A significance level of $p < 0.20$ was the criterion for inclusion in multivariate models, although a $p < 0.05$ was required for statistical significance.

RESULTS

Of 10,225 Medicare beneficiaries with uninterrupted Part A and B coverage diagnosed with well-differentiated thyroid carcinoma (WDTC) between 1991 and 2009, 5,670 (55%) met inclusion criteria and underwent total thyroidectomy (Figure 1). The cohort was 69% female, 85% Caucasian, and had a mean age of 73.7 years (95% CI 73.6 – 73.9). Of histologic types of WDTC, papillary was most common (81.8%) followed by follicular (14.7%) and medullary (3.5%).

Univariate Analysis

Overall, 9.5% of Medicare beneficiaries undergoing total thyroidectomy for WDTC were diagnosed with post-operative vocal fold paralysis (annual incidence 6.1 – 16.0%; Figure 2). The rate of these complications decreased 5% annually between 1991 and 2009 (OR 0.95, 95% CI 0.93 – 0.97; $p < 0.001$). Diagnosis was made a median 5.6 months post-operatively (IQR 0.9 – 17).

In unadjusted analysis, older age, male gender, non-Caucasian race, geographic region, and stage were all associated with significantly increased odds of vocal fold paralysis (Table 2). Odds increased 3% with each additional year of age among Medicare patients who had thyroidectomy performed. For stage, rate of paralysis was 4.5% if localized to the thyroid and 13.7% and 22.4% with regional extension and regional extension + lymph node involvement, respectively. In all, 22% (N=119) of patients diagnosed with vocal fold paralysis required surgical intervention, which occurred a median 8.5 months after thyroidectomy (IQR 2.4 – 27).

Unilateral vocal fold paralysis (UVFP) was diagnosed after 8.2% of total thyroidectomies for WDTC (annual incidence 5.7% – 13.2%; Figure 2), a median 5.6 months post-operatively (IQR 0.9 – 16). There was 4% annual reduction in UVFP rate between 1991 and 2009 (UVFP OR 0.96, 95% CI 0.94 – 0.99; $p < 0.001$). In this Medicare cohort, unadjusted odds of UVFP increased with each additional year of age, male gender, non-Caucasian race, and with advancing cancer stage, while being significantly increased in specific geographic regions (Table 3). Overall, 1.7% (N=98) of those who underwent total thyroidectomy for WDTC or 21% of patients diagnosed with UVFP were subsequently treated with temporary injection medialization (10.3%, N=48), Type I laryngoplasty +/- arytenoid adduction (7.3%, N=34), or both (3.4%, N=16). Directed treatment was initiated a median 8.5 months post-thyroidectomy (IQR 2.5 – 27).

Bilateral vocal fold paralysis (BVFP) was diagnosed after 1.3% of total thyroidectomies for WDTC (annual incidence 0.34% – 4.8%; Figure 2) within a median 6.7 months post-operatively (IQR 0.76 – 33). There was a 9% annual reduction in rate of BVFP diagnosis between 1991 and 2009 (OR 0.91, 95% CI 0.87 – 0.95; $p < 0.001$). In unadjusted analysis, rates of BVFP were significantly increased with higher stage and increased in specific geographic regions (Table 4). Only 0.37% (N=20) of those who underwent total thyroidectomy for WDTC or 28% of patients diagnosed with BVFP required subsequent tracheotomy (8.2%, N=6), cordotomy/arytenoidectomy procedures (5.5%, N=4), or both (13.7%, N=10). Directed surgery occurred a median 9 months post-thyroidectomy (IQR 1.7 – 55).

In this cohort, Intraoperative nerve monitoring (IONM) was introduced during total thyroidectomy in 1992 and its application increased 5-fold (3% to 15%) between 2001 and 2009. IONM increased 22% annually over during the period of study (OR 1.22, CI 1.18 – 1.26). Overall, 9.9% of total thyroidectomies (n=562) were done with IONM. It was used most commonly in Northeastern registries (15%) followed by Western (10.8%), Southern (9.1%), Southwestern (6.0%), Hawaii (5.3%), and Midwestern regions (3.2%). There was no difference in overall rate of vocal fold paralysis based on IONM use (none 9.6% vs. IONM 8.4%; $p = 0.33$) nor were there differences when stratified by UVFP (none 8.3% vs. IONM 7.3%; $p = 0.40$) and BVFP (none 1.3% vs. IONM 1.1%; $p = 0.63$).

Multivariate Analysis

In multivariable modeling, odds of post-thyroidectomy vocal fold paralysis were found to be independently associated with age, race, stage, and geographic region. Odds of vocal fold paralysis increased 3% for each additional year of age in this Medicare population (Table 5). Non-Caucasian race increased overall odds of paralysis 41%. Higher stage was associated with significantly higher odds of developing a paralysis. Follicular histology was most favorable compared to those with papillary and medullary types who had significantly higher odds of these complications. When compared with localized disease, regional extension or regional extension + lymph node involvement was associated with 3.3- and 5.8-fold increased odds of paralysis, respectively. Patients undergoing total thyroidectomy in the Western and Southwestern regions had significantly higher odds of vocal fold paralysis

when referenced against those in Southern registries. Results were similar when stratified into UVFP and BVFP (Table 6 and 7, respectively).

Discussion

This is the first report on national longitudinal incidence of post-thyroidectomy vocal fold paralyses in the Medicare population with WDTC. The overall 9.5% mean annual incidence (8.2% UVFP, 1.3% BVFP) of post-thyroidectomy vocal fold paralysis translates into nearly 1:10 Medicare patients experiencing these complications. Incidence of vocal fold paralyses decreased 5% annually between 1991 and 2009. The reason for decline is unclear. A plausible explanation is that over time, a higher proportion of thyroidectomies are being performed for smaller, less aggressive cancers thus resulting in less risk of iatrogenic injury. It has also been proposed that intra-operative nerve monitoring (IONM) reduces the risk of recurrent laryngeal nerve injury and that its increased use has effectively decreased post-thyroidectomy vocal fold paralyses^{29,30}. However, our findings do not support this second assertion.

Affect of Intraoperative Nerve Monitoring

Intraoperative nerve monitoring (IONM) during thyroidectomy is a hotly debated topic. Use in this cohort began in 1992, was used sparingly (0–3%) until 2000, and thereafter its use increased 5-fold by 2009. Since the introduction of IONM over 30 years ago³¹, utilization has grown, yet to date there have been no studies on longitudinal trends in the use of IONM. Our results suggest usage has increased over time, but to what degree in the U.S. requires further population-based longitudinal assessment that includes patients less than 65 years of age.

Overall, 9.9% of total thyroidectomies in this cohort were done in conjunction with IONM [range 0% (1991) – 15% (2009)]. Adoption of this technology was the focus of a 2007 survey that found the majority of U.S. otolaryngologists (71.4%) did not regularly use IONM in their practices³². More recent studies of utilization indicate that 53% of general surgeons and up to 65% of head and neck surgeons use IONM in some thyroidectomies^{33,34}. Interestingly, a 2013 national epidemiologic study from Denmark reported that IONM was used in 79% of their thyroidectomy procedures over a similar time period²⁴.

Our study was not able to show a statistically robust association between IONM and reduced risk of vocal fold paralysis, which is consistent with the majority of prior investigations into this relationship^{21,24,35–38}. However, the reason for the wide discrepancy in utilization rates between this and other recent studies is unclear. Several possibilities exist. First, capturing the use of IONM in administrative data requires accurate and complete coding, which usually improves if coding results in improved reimbursement^{39,40}. Thus, it is possible IONM was used and not properly coded for depending on practice and reimbursement patterns. If this is true, the study methodology could have underestimated its use. Second, the present study may be a more accurate representation of IONM use as it derives from population-based data and was not subject to biases inherent in surveys of “expert” experience. The recent *Academy of Otolaryngology – Head & Neck Surgery (AAO-HNS)* clinical practice guideline on improving voice after thyroid surgery systematically reviewed

the research on IONM and found equipoise between benefit and non-utility⁴¹. Research must identify circumstances that IONM can consistently impart statistically significant reduced risk of vocal fold paralysis. Until then, it should be considered an “option”⁴¹ or adjunct to the “gold standard” of direct recurrent laryngeal nerve identification during thyroid surgery.

High Rates of Vocal Fold Paralysis

Post-thyroidectomy UVFP and BVFP incidences are higher in this study than the 0.85% – 3.5% and 0.39% – 2.3% conventionally cited^{7,19–26}. The explanation is multifactorial. First, this study used Medicare claims data, which results in a more representative estimation of population disease burden than many previous epidemiological studies that are primarily limited to single institution, case series of tertiary care experience²². Second, population risk is higher since all total thyroidectomies were performed for carcinoma^{24,25,42}. Third, increased risk in our cohort may relate to the population’s advanced age, which was found to be an independent risk factor for UVFP. Increased age has been cited as a predictive factor for recurrent laryngeal nerve paralyses in several studies^{23,24,43} and refuted in others^{7,44}. Older age has been linked to increased malignant potential of nodules^{15,16} and differentiated thyroid carcinomas in the elderly tend to behave more aggressively with more extrathyroidal spread and distant metastases⁴⁵. Thus, transitively, age may be a surrogate for cancer aggressiveness, which in turn may increase the odds of vocal fold paralyses. In this analysis, however, age remained a risk factor even after adjusting for cancer stage.

However, the most plausible explanation for the high rates is a preponderance of temporary paralyses. This is supported by the finding that only a fraction of patients diagnosed with post-thyroidectomy UVFP and BVFP underwent directed intervention: 21% and 28%, respectively. Supporting this hypothesis is a systematic review that analyzed 27 studies with over 25,000 cumulative thyroidectomy patients and found 9.8% and 2.3% mean incidences of temporary and permanent post-thyroidectomy vocal fold paralyses²², which are nearly identical rates to those in the present study (9.5% overall, 2.1% “permanent”/requiring intervention). More reinforcing evidence is gained from studies that actively examined patients immediately post-operatively from thyroidectomy and reported similar rates to those herein (4.9 – 8.4%)^{46,47}. Interestingly, Bergenfelz *et al.* found that the odds of vocal fold paralysis increased 1.9-fold in Scandinavian Departments that, even in absence of symptoms, routinely perform post-operative laryngoscopy²³. This finding substantiates that early diagnostic testing will identify temporary paralyses that may not necessarily be symptomatic or require intervention and, demonstrates how ascertainment bias can complicate incidence estimates.

Contrastingly, several large epidemiological studies of post-thyroidectomy vocal fold paralysis from Europe found temporary rates between 2.0% and 3.9%^{23–26}. Godballe *et al.* recently evaluated the Danish National experience where it is routine to perform laryngoscopy in the immediate post-operative period and reported temporary and permanent rates of 2.6% and 2.2%²⁴. While these incidences are lower than reported in our study, they must be taken in context. None of these population-level studies were limited to total thyroidectomies performed strictly for malignancy in an aged population. In fact, those

studies that analyzed subpopulations similar to ours, found similarly that there was significantly higher risk of vocal fold paralysis in those that had thyroidectomy for malignancy (i.e. 5.7–9.0% rate of UVFP)^{24,25} or were in higher age strata^{23,24} [i.e. 2% increase with each additional year or age thyroidectomy was performed (i.e. adjusted OR 1.02 vs. 1.03 current cohort)]²³.

Further supporting the assertion that high incidences derive from a preponderance of temporary paralyses is the 5.6- and 8.5-month and 6.7- and 9-month median time to diagnosis and treatment for UVFP and BVFP patients, respectively. These times closely coincide with conventional teaching that recurrent laryngeal nerve recovery takes between 6 – 12 months⁴⁸. Thus, it is the authors' expectation that delays in diagnosis were largely intentional, as many practitioners prefer to wait to determine whether the vocal fold paralysis and associated symptoms will resolve (temporary) or persist and require intervention.

AAO-HNS clinical practice guidelines on improving voice after thyroid surgery strongly recommend referring patients for vocal fold evaluation if symptoms persist longer than 2 weeks to 2 months⁴¹. Directed and effective interventions are readily available to reduce an unnecessarily prolonged period of symptoms and reduced quality of life. In fact, opting for a temporary vocal fold injection versus conservative management in the treatment of UVFP may reduce the need for subsequent permanent intervention⁴⁹. Unfortunately, the majority of the Medicare cohort was not expeditiously referred for vocal fold assessment to head off troublesome voice¹⁰, swallowing¹¹, and breathing sequelae¹².

Limitations

Several study limitations deserve mention. This study was performed in Medicare beneficiaries with WDTC. Most thyroidectomies are done in those under 65 years of age¹³. Thus, results may not be applicable to a younger population or those having total thyroidectomy for benign indications. Additionally, data from large administrative databases are inherently subject to errors in coding and sampling, and reporting biases. During the period of study, SEER expanded from 13 to 20 sites. Systematic differences in treatment strategies based on new registries' experience add heterogeneity that could affect results. However, correlational analyses were unable to detect any clear systematic differences based on added sites. In addition, an *a priori* decision was made to only consider total thyroidectomy procedures. The rationale was that several codes and descriptions are used for partial thyroidectomies thereby producing confusing heterogeneity that cannot be clarified using available claims data.

Conclusions

Annual rates of post-thyroidectomy vocal fold paralyses are longitudinally decreasing among Medicare beneficiaries with WDTC. High incidence in this aged population is likely due to a preponderance of temporary paralyses, which is supported by the need for directed intervention in less than a quarter of affected patients. Further population-based studies are needed to refine the population incidence and risk factors for paralyses in the aging population.

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Figure 1.

Study Flow diagram of Medicare beneficiaries who had uninterrupted enrollment in Part A and B and first diagnosis of WDTC that underwent total thyroidectomy between 1991 – 2009

Figure 2.
Annual Incidence of Unilateral Vocal Fold Paralysis (Solid) and Bilateral Vocal Fold Paralysis (Dashed) among Medicare Beneficiaries Undergoing Total Thyroidectomy for WDTC (1991–2009)

Table 1

Administrative codes used for inclusion/exclusion criteria and identification of vocal fold paralysis diagnoses and directed treatments

Description		Codes
Total Thyroidectomy		<i>ICD-9 CM:</i> 06.40, 06.50, 06.52 <i>CPT:</i> 60240, 60252, 60254, 60270-1
Histology	Papillary	<i>ICD-03:</i> 8050, 8130, 8260, 8340-4, 8350, 8450-9, 8460, 8540
	Follicular	<i>ICD-03:</i> 8290, 8330-5, 8337
	Medullary	<i>ICD-03:</i> 8345-7, 8510-5
Vocal fold Paralysis	Unilateral	<i>ICD-9:</i> 478.31, 478.32
	Bilateral	<i>ICD-9:</i> 478.33, 478.34
	NOS	<i>ICD-9:</i> 478.30*
Intraoperative nerve monitoring		<i>ICD-9 CM:</i> 00.94 <i>CPT:</i> 95868, 95920
UVFP Treatments		<i>ICD-9:</i> 31.0 <i>CPT:</i> 31513, 31570, 31571, 31587, 31588, 31590, 31599
BVFP Treatments		<i>ICD-9:</i> 30.09, 30.22, 31.1, 31.21, 31.29 <i>CPT:</i> 31400, 31541, 41560-1, 31600, 31610, 31603, 31605, 31370

Table 2

Univariate Analysis of Post-Thyroidectomy Vocal Fold Paralyses

Characteristic		Rate	Unadjusted OR	P-value
Age		9.5% *	1.03 (1.02 – 1.05)	<0.001
Gender	Male	11.1%	Reference	
	Female	8.8%	0.78 (0.65 – 0.94)	0.008
Race	Caucasian	8.8%	Reference	
	Non-Caucasian	13.6%	1.62 (1.30 – 2.03)	<0.001
Population Density	Big Metro	9.7%	Reference	
	Metro	9.1%	0.93 (0.76 – 1.15)	0.52
	Urban	9.8%	1.01 (0.68 – 1.51)	0.96
	Less Urban	9.6%	1.00 (0.71 – 1.39)	0.98
	Rural	9.1%	0.93 (0.48 – 1.81)	0.84
ZIP Median Income	Less than \$36,182	9.0%	Reference	
	\$36,183 – \$47,293	10.0%	1.12 (0.87 – 1.45)	0.37
	\$47,294 – \$61,603	9.8%	1.06 (0.84 – 1.42)	0.50
	Greater than \$61,603	9.2%	1.02 (0.78 – 1.32)	0.89
Region	Southern	7.14%	Reference	
	Western	11.3%	1.65 (1.25 – 2.18)	<0.001
	Southwestern	13.1%	1.96 (1.32 – 2.91)	0.001
	Midwestern	8.0%	1.13 (0.80 – 1.60)	0.472
	Northeastern	8.1%	1.14 (0.84 – 1.57)	0.399
	Hawaii	14.9%	2.28 (1.23 – 4.22)	0.009
Histology	Follicular	8.5%	Reference	
	Papillary	9.5%	1.13 (0.87 – 1.47)	0.35
	Medullary	13.1%	1.61 (1.00 – 2.60)	0.05
Historic Stage	Localized	4.5%	Reference	
	Regional Extension	13.7%	3.41 (2.76 – 4.22)	<0.001
	Regional + LN	22.4%	6.19 (4.71 – 8.13)	<0.001
Nerve Monitoring	No	9.6%	Reference	
	Yes	8.4%	0.86 (0.62 – 1.17)	0.33

* Overall vocal fold paralysis rate; LN = lymph node involvement

Table 3

Univariate Analysis of Post-Thyroidectomy Unilateral Vocal Fold Paralysis

Characteristic		Rate	Unadjusted OR	P-value
Age		8.2% *	1.04 (1.02 – 1.05)	<0.001
Gender	Male	9.7%	Reference	
	Female	7.6%	0.81 (0.62 – 0.92)	0.006
Race	Caucasian	7.6%	Reference	
	Non-Caucasian	11.9%	1.64 (1.30 – 2.08)	<0.001
Population Density	Big Metro	8.4%	Reference	
	Metro	8.0%	0.95 (0.76 – 1.18)	0.62
	Urban	8.8%	1.05 (0.69 – 1.60)	0.82
	Less Urban	7.9%	0.93 (0.65 – 1.34)	0.70
	Rural	7.3%	0.86 (0.41 – 1.78)	0.68
ZIP Median Income	Less than \$36,329	7.4%	Reference	
	\$36,329 – \$47,516	8.9%	1.22 (0.92 – 1.60)	0.17
	\$47,517 – \$61,310	8.7%	1.19 (0.90 – 1.57)	0.22
	Greater than \$61,311	7.8%	1.07 (0.80 – 1.41)	0.66
Region	Southern	6.22%	Reference	
	Western	9.7%	1.62 (1.20 – 2.18)	0.002
	Southwestern	10.5%	1.78 (1.16 – 2.72)	0.009
	Midwestern	6.54%	1.05 (0.73 – 1.53)	0.784
	Northeastern	7.4%	1.20 (0.86 – 1.68)	0.271
	Hawaii	14.9%	2.64 (1.41 – 4.92)	<0.001
Histology	Follicular	7.0%	Reference	
	Papillary	8.4%	1.22 (0.92 – 1.63)	0.17
	Medullary	10.1%	1.49 (0.88 – 2.55)	0.14
Historic Stage	Localized	4.0%	Reference	
	Regional Extension	11.9%	3.27 (2.61 – 4.09)	<0.001
	Regional + LN	18.7%	5.58 (4.18 – 7.47)	<0.001
Nerve Monitoring	No	8.3%	Reference	
	Yes	7.3%	0.87 (0.62 – 1.21)	0.40

* Overall UVFP Rate; LN = lymph node involvement

Table 4

Univariate Analysis of Post-Thyroidectomy Bilateral Vocal Fold Paralyses

Characteristic		Rate	Unadjusted OR	P-value
Age		1.3% *	1.01 (0.97 – 1.05)	0.72
Gender	Male	1.3%	Reference	
	Female	1.3%	0.97 (0.59 – 1.59)	0.90
Race	Non-Caucasian	1.2%	Reference	
	Caucasian	1.7%	1.38 (0.77 – 2.48)	0.28
Population Density	Big Metro	1.3%	Reference	
	Metro	1.1%	0.87 (0.50 – 1.52)	0.64
	Urban	1.0%	0.78 (0.24 – 2.52)	0.67
	Less Urban	1.8%	1.39 (0.65 – 2.98)	0.40
ZIP Median Income	Rural	1.8%	1.41 (0.34 – 5.89)	0.64
	Less than \$36,329	1.6%	Reference	
	\$36,329 – \$47,516	1.2%	0.72 (0.38 – 1.38)	0.33
	\$47,517 – \$61,310	1.1%	0.68 (0.35 – 1.32)	0.25
Region	Greater than \$61,311	1.3%	0.82 (0.44 – 1.53)	0.53
	Southern	0.92%	Reference	0.14
	Western	1.6%	1.75 (0.84 – 3.68)	0.028
	Southwestern	2.6%	2.84 (1.12 – 7.21)	0.26
	Midwestern	1.5%	1.63 (0.69 – 3.84)	0.54
	Northeastern	0.7%	0.75 (0.30 – 1.89)	
Histology	Hawaii	-	-	-
	Follicular	1.6%	Reference	
	Papillary	1.2%	0.75 (0.41 – 1.37)	0.35
Historic Stage	Medullary	3.0%	1.96 (0.74 – 5.22)	0.18
	Localized	0.5%	Reference	
	Regional	1.8%	3.80 (2.09 – 6.91)	<0.001
Nerve Monitoring	Regional + LN	3.7%	7.70 (3.86 – 15.4)	<0.001
	No	1.3%	Reference	
	Yes	1.1%	0.81 (0.35 – 1.88)	0.63

* Overall BVFP Rate; LN = lymph node involvement

Table 5

Multivariate analysis: Characteristics independently associated with VFP

Characteristics		OR (95% CI)	P-value
Age, years		1.03 (1.01 – 1.04)	0.001
Race	Caucasian	<i>Reference</i>	
	Non-Caucasian	1.41 (1.12 – 1.78)	0.004
Stage	Localized	<i>Reference</i>	
	Regional	3.31 (2.67 – 4.10)	<0.001
	Regional + LN	5.80 (4.39 – 7.66)	<0.001
Histology	Follicular	<i>Reference</i>	
	Papillary	1.35 (1.03 – 1.77)	0.029
	Medullary	1.88 (1.15 – 3.09)	0.012
Region	Southern	<i>Reference</i>	
	Western	1.29 (1.07 – 1.57)	0.009
	Southwestern	1.68 (1.19 – 2.39)	0.003

Table 6

Multivariate analysis: Characteristics independently associated with UVFP

Characteristics		OR (95% CI)	P-value
Age, years		1.03 (1.02 – 1.05)	<0.001
Race	Caucasian	<i>Reference</i>	
	Non-Caucasian	1.46 (1.14 – 1.87)	0.003
Stage	Localized	<i>Reference</i>	
	Regional	3.14 (2.50 – 3.95)	<0.001
	Regional + LN	5.10 (3.78 – 6.89)	<0.001
Histology	Follicular	<i>Reference</i>	
	Papillary	1.46 (1.09 – 1.96)	0.011

Table 7

Multivariate analysis: Characteristics independently associated with BVFP

Characteristics		OR (95% CI)	P-value
Stage	Localized	<i>Reference</i>	
	Regional	3.80 (2.10 – 6.92)	<0.001
	Regional + LN	7.46 (3.73 – 14.9)	<0.001
Histology	Follicular	<i>Reference</i>	
	Medullary	2.50 (1.06 – 5.89)	0.037