Published in final edited form as:

Laryngoscope. 2019 February ; 129(2): 519–524. doi:10.1002/lary.27297.

Association between Age and Patient-Reported Changes in Voice and Swallowing after Thyroidectomy

Zeyad Sahli, MD^a, Joseph K Canner, MHS^a, Omar Najjar, BS^c, Eric B. Schneider, PhD^a, Jason D. Prescott, MD PhD^a, Jonathon O Russell, MD^b, Ralph P. Tufano, MD^b, Martha A. Zeiger, MD^a, and Aarti Mathur, MD^{a,*}

^aEndocrine Surgery, Department of Surgery, Baltimore, Maryland 21287

^bHead and Neck Surgery, Department of Otolaryngology, Baltimore, Maryland 21287

^cThe Johns Hopkins University School of Medicine, Baltimore, Maryland 21287

Abstract

Background—Despite intact recurrent laryngeal nerves, patient-reported voice and swallowing changes are common after thyroidectomy. The association between patient age or frailty status and these changes is unknown. The aim of this study was to evaluate the impact of age and frailty on the incidence of voice and swallowing alterations after thyroidectomy.

Materials & Methods—We performed an IRB-approved retrospective review of consecutive patients who underwent total thyroidectomy with intraoperative recurrent laryngeal nerve (RLN) monitoring at a single institution between January 2014 and September 2016. Patients with RLN injury were excluded. After data extraction, a modified frailty index (mFI) was calculated for each patient. The association among risk factors, including age, mFI, prior history of neck surgery, frequent voice use, presence of malignancy or gastroesophageal reflux disease, and smoking status and reported voice and/or swallowing changes was examined.

Results—Of 924 patients undergoing thyroidectomy, 148 (16.0%) reported only changes in voice, 52 (5.6%) only difficulty in swallowing, and 26 (2.8%) patients reported changes with both voice and swallowing. On multivariate analysis, we found a significant increase in voice or swallowing alterations up to the age of 50 (5% increased odds per year) after which these changes plateaued. We found that mFI was not associated with voice or swallowing changes.

Conclusions—Age 50 is independently associated with development of voice or swallowing changes after thyroidectomy despite intact RLN. Additional prospective studies are needed to validate these findings, further define this association, and identify risk factors for developing these changes.

Evidence Level—Individual retrospective cohort study (2b)

*Corresponding Author: Aarti Mathur MD, FACS, Endocrine Surgery, Department of Surgery, The Johns Hopkins University School of Medicine, 600 North Wolfe Street, Blalock 606, Baltimore, MD 21287, Phone: +1(202) 270-7290, Fax: +1(410) 630-7822, amathu10@jhmi.edu.

Conflict of Interests: None

Abstract presented at the American Thyroid Association, Victoria, British Columbia, Canada, October 18-22, 2017

Keywords

Thyroid Surgery; Voice/dysphonia; Swallowing/dysphagia; Postoperative issues/complications

Introduction

Despite the reported low incidence of temporary or permanent recurrent laryngeal nerve (RLN) injury (0.0 – 15.4%) and superior laryngeal nerve injury (0.0 – 4.6%), voice and swallowing alterations after total thyroidectomy are increasingly prevalent with studies reporting rates up to 87%¹⁻¹⁰. Dysphagia and dysphonia after thyroidectomy can significantly impact one's quality of life, affecting social interactions, compliance with medications, and nutritional intake¹¹.

Risk factors that have been identified in prior studies for developing postoperative changes in voice or swallowing include presence of gastroesophageal reflux disease (GERD), frequent voice use, smoking history, prior neck surgery, and arytenoid trauma due to endotracheal intubation^{6,7,12,13}. However, the roles of age and frailty as potential risk factors for postoperative voice and swallowing changes after total thyroidectomy have not been well studied. Papadakis and colleagues demonstrated that patients above 40 years of age suffer from voice changes for a longer duration postoperatively compared to younger patients¹⁴. We are not aware of any additional studies evaluating the association of age with post-operative changes.

With increasing age, deterioration of the cartilaginous and myoelastic structures of the larynx can occur and can contribute both to presbyphonia and dysphagia. Atrophy of the upper esophageal sphincter can affect swallowing as well. Thus, aging alone can cause changes in the structure, motility, and coordination of swallowing. Therefore, we hypothesize that after surgical manipulation older patients would be at higher risk of having voice and swallowing changes

Frailty is defined as a state of increased vulnerability and reduced physiologic reserve that places patients at increased risk of adverse health outcomes and is also a surrogate for sarcopenia¹⁵. Frailty status has been shown to independently predict postoperative complications in older adults¹⁶. The modified frailty index (mFI) is a validated deficit accumulation measure of frailty developed by Velanovich *et al* that evaluates 11 measures of comorbidity and categorizes people as robust, pre-frail or frail¹⁷. Frailty status may help to identify patients at increased risk for developing changes.

Therefore, the aim of the present study is to assess the association of patient-reported voice and swallowing changes following total thyroidectomy with both age and mFI in the absence of RLN injury.

Material and Methods

Under IRB approval, we performed a retrospective review of the medical records of consecutive patients who underwent total thyroidectomy at a single institution between

January 2014 and September 2016. Patients with RLN injury, defined as loss of intraoperative signal with nerve monitor or nerve transection, incomplete medical records, or lost on follow-up were excluded. Clinical variables reviewed included patient demographics, co-morbidities, frequent voice use, smoking status, pathology reports, operative and clinical notes, frequency of post-operative voice or swallowing complaint, and referral to speech language pathology (SLP). Determination of voice or swallowing difficulty was done consistently among all patients at the post-operative outpatient visit 1 – 4 weeks after surgery. Voice and swallowing complaints were patient reported. Frequent voice use was defined as patients who identified themselves as singers.

An mFI was calculated for each patient using the following variables recorded from the medical record: presence of diabetes mellitus, congestive heart failure, history of chronic obstructive pulmonary disease exacerbation or pneumonia, myocardial ischemia, percutaneous coronary intervention, hypertension, peripheral vascular disease, transient ischemic attack, and cerebrovascular accident¹⁷. To calculate the mFI, one point was assigned for each comorbidity, and the sum of points was divided by 11. Patients with a scores of 0 – 0.08, 0.09 – 0.18, and 0.27 were considered robust, pre-frail, and frail, respectively. The mFI is a validated tool by Velanovich *et al* that is calculated using the variables previously mentioned¹⁷.

Statistical Analysis

Data collected was entered into Stata version 14.2 (StataCorp, College Station, TX) for statistical analysis. To explore age associations, we used locally weighted regression and smoothing scatterplots (LOWESS) that showed the pattern of voice, swallowing, and either change by age. Based on the LOWESS patterns we used linear splines to model the relationship between age and each complaint.

Results

Demographics

We identified 924 consecutive patients who underwent thyroidectomy by 22 surgeons without nerve injury. Of this cohort, the majority of patients were female (761, 82.4%) and white (563; 60.9%) (Table 1). Mean patient age was 51.1 years (range 6.6 – 90.2 years). Mean patient body mass index (BMI) was 30.7 kg/m² (range 14.8 – 65.5 kg/m²). Among our cohort, 30 (3.2%) patients were frequent voice users, 153 (16.6%) patients had a diagnosis of GERD, and 35 (3.9%) patients had a history of previous neck surgery. The majority of patients were non-smokers (602; 65.2%), followed by former smokers (207; 22.4%), and current smokers (97; 10.5%). On final pathology, 526 patients (56.9%) had benign disease. The first postoperative visit occurred between 1 and 4 weeks in most patients (97.7%). Among our cohort, 92 patients (10.01%) were evaluated during the first week, 454 (49.6%) during the second week, 227 (24.8%) during the third week, 121 (13.2%) patients during the fourth week, and 21 (2.3%) patients after the fourth week.

Patient-Reported Voice and Swallowing Changes

Of 924 patients undergoing thyroidectomy, 174 (18.8%) reported voice or swallowing change postoperatively. Of the entire cohort, 148 (16.0%) patients reported an alteration with their voice and 51 (5.5%) patients reported a change with their swallowing.

Age Stratification

Upon initial exploratory data analysis using locally weighted regression and smoothing scatterplots (LOWESS), voice and swallowing changes examined independently demonstrated a different trend with age. Voice changes increased until about age 50, plateaued until about 65, and then slightly declined, however were still higher than those below the age of 50 (Figure 1). Swallowing changes had a direct correlation with age (Figure 2). Voice or swallowing changes increased steadily until around age 50 and then plateaued thereafter, remaining higher than those below the age of 50 (Figure 3). Of our cohort, 428 patients were < 50 years old and 496 patients were ≥ 50 years old.

Table 1 describes the demographics of the younger and older patient groups. Among patients <50 years, 56 (13.1%) reported voice changes, 17 (4.0%) swallowing changes, and 67 (15.7%) had swallowing or voice changes. Among patients ≥ 50 years, 92 (18.6%) patients reported voice changes, 34 (6.9%) had swallowing changes, and 107 (21.6%) reported swallowing or voice changes. Among those <50 years and ≥ 50 years, 8 (11.9%) and 13 (12.1%) of these patients, respectively, were seen by our Speech Language Pathology (SLP) department. Among our cohort, the most common diagnosis (40.9%) was muscle tension dysphonia (MTD) in patients sent to SLP. Of those referred to SLP, only one patient (4.8%) was noted to have laryngopharyngeal reflux.

Risk Factors

In univariate analysis of other known risk factors, post-operative voice changes were significantly associated with frequent voice use in both age groups ($p < 0.05$). Of the 31 frequent voice users, 18 (58.1%) reported a change in voice. Post-operative swallowing changes were significantly associated with presence of GERD ($p < 0.05$) in patients <50 years and a malignant final pathology among patients ≥ 50 years ($p < 0.05$).

Reported changes in each patient age group, were not significantly associated with BMI, race, gender, history of previous neck surgery, surgery type, mFI, or smoking history.

Age Modeling

Our unadjusted age spline model for voice changes demonstrated a knot or threshold at age 50 with a significant slope for patients <50 years of 1.05 (95% Confidence Interval: 1.02 – 1.09, $p = 0.001$). This age threshold association remained significant on multivariate analysis after adjusting for race, gender, mFI, prior history of neck surgery, frequent voice use, presence of malignancy, GERD, and smoking status. The adjusted slope for patients <50 years was 1.06 (95% CI, 1.02 – 1.09, $p = 0.001$). On multivariate analysis, significant covariates included frequent voice use (OR = 7.5, 95% CI 3.5 – 16.2, $p < 0.001$) and malignant pathology (OR = 1.5, 95% CI 1.0 – 2.2, $p = 0.039$).

Modified Frailty Index

Among the total cohort, the mFI identified 531 patients (57.5%) as robust, 366 (39.6%) patients as pre-frail, and 27 patients (2.9%) as frail. On both univariate and multivariate analysis, mFI was not found to have a significant association with either voice or swallowing changes.

Discussion

To the best of the authors' knowledge, this is the first study addressing the relationship between age, mFI, and the onset of voice and swallowing impairments following total thyroidectomy in the absence of intra-operatively recorded RLN injury. Our results demonstrate that the highest incidence of postoperative voice and swallowing changes occurs in patients greater than 50 years of age. Furthermore, reported difficult swallowing directly increases in frequency with increasing age.

The data in the literature assessing the association of voice and swallowing changes after thyroidectomy without RLN injury in relation to age is limited. However, several studies have described the objective voice and swallowing changes associated with thyroid surgery across all age groups. In a survey completed by 4,426 members of the Thyroid Cancer Survivors' Association, 51% of participants who had undergone thyroidectomies reported postoperative voice disorders, most commonly complaining of hoarseness or a decreased ability to speak loudly, shout, or sing¹⁸. In another study by Hong *et al*, acoustic analysis of 54 patients following thyroidectomy without nerve injury showed that speaking fundamental frequencies had been altered and that vocal range had been reduced in 86% of patients³. A 6-month prospective evaluation of 53 patients undergoing total thyroidectomy without RLN injury showed that there was no significant association between laryngeal mobility and hoarseness. Furthermore, 47% of patients reported postoperative swallowing difficulties, most commonly foreign body sensation in the throat. The swallowing difficulties and laryngeal mobility impairments resolved in the majority of patients with only 7.6% reporting postoperative swallowing difficulties after 6 months¹⁹.

As the US population ages, more thyroidectomies will be performed on older adults. The population aged greater than 65 years, reported as 43.1 million or 13.7% of the total population of the United States in 2012, is estimated to double by 2050 to 83.7 million and comprise 20.9% of the total population²⁰. Additionally, the number of total thyroid nodule related operations has increased from 99,613 in 2006 to 130,216 in 2011, representing a 31% increase in a 5 year period²¹. Thus, the number of older patients undergoing total thyroidectomies is expected to grow with time. There is a paucity of data regarding the association between increased age and post-thyroidectomy voice and swallowing alterations and the impact this would have on this population.

The impact of these changes on quality of life is significant¹¹. Voice and swallowing alterations have a daily impact on interaction with family and friends, quality of life, participation in society, and difficulty taking medications, which may affect compliance. Furthermore, swallowing difficulties can lead to weight loss, nutritional deficits, and an

elevated risk of pneumonia^{22,23}. These difficulties may be exaggerated in older adults and can, in turn, increase the risk becoming more frail.

We also hypothesized that frailty, which is also in part a sarcopenia phenotype, may help to identify a group of patients who are at higher risk of developing these changes. Our results did not show a significant association, however, this may also be a result of the scoring system used to assess frailty. Numerous indices have been developed to measure frailty among patients and no gold standard test has been designated. While the mFI includes only 11 comorbidities and is easy to apply, other indices can include a more exhaustive list of comorbidities, body mass index, activity level, walking speed, and weight loss²⁴.

Advanced age, particularly above 70 years, has been associated with more aggressive thyroid neoplasms than in younger patients²⁵⁻²⁷. Our results show that malignant pathology is associated with swallowing difficulties in patients ≥ 50 years old ($p = 0.035$) but not in patients <50 years old (Table 3). This age-related discrepancy may be tied to more aggressive neoplasms in older patients, however, all patients underwent total thyroidectomy.

Our study has several limitations, including its retrospective nature. Voice and swallowing changes were elicited from postoperative surgical and referring physicians' notes, which sometimes did not include this information. It is unclear how all providers directly inquired about these changes, how the question was phrased, and the thoroughness of recording. Thus the observed incidence of voice and swallowing changes is likely an underestimate. Reported impairments were assessed on their presence or absence, however the degree, severity, and duration can vary in quality. Our follow-up was limited^{4,5}. There was no standardized objective assessment of voice and swallowing function in all patients. Despite the time of evaluation taking place within the same time period, between 1 – 4 weeks, among all our patients, postoperative symptoms may still change over time. Superior laryngeal nerve monitoring was not done intraoperatively and, for this reason, it is unclear what proportion of voice and swallowing changes could be attributed to superior laryngeal nerve injury. We used mFI to assess frailty status, however, it may be more beneficial to prospectively measure frailty as defined by Fried et al²⁸, to better assess whether sarcopenia can predispose to voice or swallowing alterations.

Conclusions

The results presented in this paper provide a representation of the prevalence of voice and swallowing impairments among patients without evidence of RLN nerve injury and the association of age. This information can aid in the identification of patients at high risk of developing voice or swallowing difficulties, particularly patients for whom these impairments, even when transient, could cause undue distress and risks of aspiration. Age above 50 years, malignant pathology, and frequent voice use are all factors that should be taken into consideration when assessing patient risk for developing these common postoperative impairments. Preoperative discussions of the likelihood of these changes could reduce patient distress, and rapid recognition of symptoms by patients and healthcare providers could hasten referral to speech therapy or other appropriate therapies. This knowledge promotes an improved explanation of surgical risks to patients and enhances the

process of preoperative consent. Additional prospective studies are needed to validate these findings and more firmly identify risk factors associated with post-thyroidectomy voice and swallowing impairments.

Acknowledgments

Funding Sources: NIH K23AG053429 (AM), Johns Hopkins Clinician Scientist Award (AM)

References

1. Vidal Fortuny J, Guigard S, Karenovics W, Triponez F. Surgery of the thyroid: recent developments and perspective. *Swiss medical weekly*. 2015; 145:w14144. [PubMed: 26218498]
2. Lee JC, Breen D, Scott A, et al. Quantitative study of voice dysfunction after thyroidectomy. *Surgery*. 2016; 160(6):1576–1581. [PubMed: 27596752]
3. Hong KH, Kim YK. Phonatory characteristics of patients undergoing thyroidectomy without laryngeal nerve injury. *Otolaryngology-Head and Neck Surgery*. 1997; 117(4):399–404. [PubMed: 9339803]
4. Lombardi CP, Raffaelli M, De Crea C, et al. Long-term outcome of functional post-thyroidectomy voice and swallowing symptoms. *Surgery*. 2009; 146(6):1174–1181. [PubMed: 19958946]
5. Lombardi CP, Raffaelli M, D'Alatri L, et al. Voice and swallowing changes after thyroidectomy in patients without inferior laryngeal nerve injuries. *Surgery*. 2006; 140(6):1026–1034. [PubMed: 17188153]
6. Sinagra DL, Montesinos MR, Tacchi VA, et al. Voice changes after thyroidectomy without recurrent laryngeal nerve injury. *Journal of the American College of Surgeons*. 2004; 199(4):556–560. [PubMed: 15454138]
7. Stojadinovic A, Shaha AR, Orlikoff RF, et al. Prospective functional voice assessment in patients undergoing thyroid surgery. *Annals of surgery*. 2002; 236(6):823–832. [PubMed: 12454521]
8. Soylu L, Ozbas S, Uslu HY, Kocak S. The evaluation of the causes of subjective voice disturbances after thyroid surgery. *The American Journal of Surgery*. 2007; 194(3):317–322. [PubMed: 17693275]
9. Rulli F, Ambrogi V, Dionigi G, et al. Meta-analysis of recurrent laryngeal nerve injury in thyroid surgery with or without intraoperative nerve monitoring. *Acta Otorhinolaryngologica Italica*. 2014; 34(4):223. [PubMed: 25210215]
10. Barczy ski M, Randolph GW, Cernea CR, et al. External branch of the superior laryngeal nerve monitoring during thyroid and parathyroid surgery: International Neural Monitoring Study Group standards guideline statement. *The Laryngoscope*. 2013; 123(S4)
11. Grogan RH, Aschebrook-Kilfoy B, Angelos P. Interventions to improve thyroid cancer survivors' quality of life. *Future Medicine*. 2016
12. Mcivor NP, Flint DJ, Gillibrand J, Morton RP. Thyroid Surgery and Voice-Related Outcomes. *Australian and New Zealand Journal of Surgery*. 2000; 70(3):179–183. [PubMed: 10765899]
13. Echternach M, Maurer C, Mencke T, Schilling M, Verse T, Richter B. Laryngeal complications after thyroidectomy: is it always the surgeon? *Archives of surgery*. 2009; 144(2):149–153. [PubMed: 19221326]
14. Papadakis CE, Asimakopoulou P, Proimos E, Perogamvrakis G, Papoutsaki E, Chimona T. Subjective and Objective Voice Assessments After Recurrent Laryngeal Nerve-Preserved Total Thyroidectomy. *Journal of Voice*. 2017
15. Lally F, Crome P. Understanding frailty. *Postgraduate medical journal*. 2007; 83(975):16–20. [PubMed: 17267673]
16. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. *Journal of the American College of Surgeons*. 2010; 210(6):901–908. [PubMed: 20510798]

17. Velanovich V, Antoine H, Swartz A, Peters D, Rubinfeld I. Accumulating deficits model of frailty and postoperative mortality and morbidity: its application to a national database. *Journal of surgical research*. 2013; 183(1):104–110. [PubMed: 23415494]
18. Kuhn MA, Bloom G, Myssiorek D. Patient perspectives on dysphonia after thyroidectomy for thyroid cancer. *Journal of Voice*. 2013; 27(1):111–114. [PubMed: 22925427]
19. Gohrbandt AE, Aschoff A, Gohrbandt B, Keilmann A, Lang H, Musholt TJ. Changes of Laryngeal Mobility and Symptoms Following Thyroid Surgery: 6-Month Follow-Up. *World journal of surgery*. 2016; 40(3):636–643. [PubMed: 26560148]
20. Ortman, JM, Velkoff, VA, Hogan, H. An aging nation: the older population in the United States. Washington, DC: US Census Bureau; 2014. 25–1140.
21. Sosa JA, Hanna JW, Robinson KA, Lanman RB. Increases in thyroid nodule fine-needle aspirations, operations, and diagnoses of thyroid cancer in the United States. *Surgery*. 2013; 154(6):1420–1427. [PubMed: 24094448]
22. Sura L, Madhavan A, Carnaby G, Crary MA. Dysphagia in the elderly: management and nutritional considerations. *Clinical interventions in aging*. 2012; 7:287. [PubMed: 22956864]
23. Takeuchi K, Aida J, Ito K, Furuta M, Yamashita Y, Osaka K. Nutritional status and dysphagia risk among community-dwelling frail older adults. *The journal of nutrition, health & aging*. 2014; 18(4):352–357.
24. Pijpers E, Ferreira I, Stehouwer CD, Kruseman ACN. The frailty dilemma. Review of the predictive accuracy of major frailty scores. *European journal of internal medicine*. 2012; 23(2): 118–123. [PubMed: 22284239]
25. Vini L, Hyer SL, Marshall J, A'Hern R, Harmer C. Long-term results in elderly patients with differentiated thyroid carcinoma. *Cancer*. 2003; 97(11):2736–2742. [PubMed: 12767085]
26. Toniato A, Bernardi C, Piotto A, Rubello D, Pelizzo MR. Features of papillary thyroid carcinoma in patients older than 75 years. *Updates in surgery*. 2011; 63(2):115–118. [PubMed: 21416286]
27. Falvo L, Catania A, Sorrenti S, et al. Prognostic significance of the age factor in the thyroid cancer: statistical analysis. *Journal of surgical oncology*. 2004; 88(4):217–222. [PubMed: 15565630]
28. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 2001; 56(3):M146–M157.

Figure 1. Relationship between Reported Postoperative Voice Changes Versus Age
Patient responses are coded as 0 (no) or 1 (yes) for complaints on y-axis; Age measured in years.

Figure 2. Relationship between Reported Postoperative Swallowing Difficulty Versus Age
Patient responses are coded as 0 (no) or 1 (yes) for complaints on y-axis; Age measured in years.

Figure 3. Relationship between Reported Postoperative Voice or Swallowing Changes Versus Age
VorS: Voice and Swallowing. Patient responses are coded as 0 (no) or 1 (yes) for complaints on y-axis; Age measured in years.

Table 1
Patient Cohort Demographics

Patient Characteristics	All Patients (N = 924)	Patients <50 Years (N=428)	Patients 50 years (N=496)
Sex			
Female	761 (82.4%)	360 (84.1%)	401 (80.9%)
Male	163 (17.6%)	68 (15.9%)	95 (19.2%)
Race			
White	563 (60.9%)	251 (58.6%)	312 (62.9%)
Black	238 (25.8%)	111 (25.9%)	127 (25.6%)
Hispanic	35 (3.8%)	19 (4.4%)	16 (3.2%)
Asian	13 (1.4%)	6 (1.4%)	7 (1.4%)
Unknown	75 (8.1%)	41 (9.6%)	34 (6.9%)
Mean Age ± SD [Range]	51.1 ± 14.9 [6.6 – 90.2]	37.9 ± 8.9 [6.6 – 49.9]	62.5 ± 8.0 [50.0 – 90.2]
BMI (kg/m²)	30.7 ± 7.4 [14.8 – 65.5]	30.4 ± 7.8 [14.8 – 58.7]	31.0 ± 7.0 [15.88 – 65.5]
Frequent Voice Use	30 (3.2%)	14 (3.3%)	17 (3.4%)
GERD	153 (16.6%)	36 (8.4%)	117 (23.6%)
History of Neck Surgery	35 (3.9%)	5 (1.2%)	30 (6.1%)
Smoking Status			
Current smokers	97 (10.5%)	51 (11.9%)	46 (9.3%)
Non-smokers	602 (65.2%)	304 (71.0%)	298 (60.1%)
Former smokers	207 (22.4%)	70 (16.4%)	137 (27.6%)
Unknown	18 (1.9%)	3 (0.7%)	15 (3.0%)
Pathology			
Benign	526 (56.9%)	236 (55.1%)	290 (58.5)
Malignant	398 (43.1)	192 (44.9%)	206 (41.5)
Mean mFI ± SD [Range]		0.3 ± 0.5 [0 – 3]	0.9 ± 0.9 [0 – 4]
Robust	531 (57.5%)	331 (77.3%)	200 (40.3%)
Prefrail	366 (39.6%)	94 (22.0)	272 (54.8%)
Frail	27 (2.9%)	3 (0.7%)	24 (4.8%)
Reported Changes			
Voice	148 (16.0%)	56 (13.1%)	92 (18.6%)
Swallowing	51 (5.5%)	17 (4.0%)	34 (6.9%)
Voice or Swallowing	174 (18.8%)	67 (15.7%)	107 (21.6%)
SLP Referral	21 (12.1%)	7 (10.4%)	13 (12.2%)

Table 2

Associations Between Variables and Reported Voice Changes

	Patients<50 Years			Patients 50 years		
Voice Changes						
Variable	N	n (%)	P Value	N	n (%)	P Value
Race						
White	251	29 (11.6)	0.792	312	54 (17.3)	0.308
Black	111	18 (16.2)		127	28 (22.1)	
Hispanic	19	3 (15.8)		16	2 (12.5)	
Asian	6	1 (16.7)		7	3 (42.9)	
Unknown	41	5 (12.2)		34	5 (14.7)	
Frequent Voice Use						
No	414	50 (12.1)	0.001	479	80 (16.7)	0.000
Yes	14	6 (42.9)		17	12 (70.6)	
Sex						
Female (Code = 1)	360	47 (13.1)	0.968	401	75 (18.7)	0.855
Male (Code = 2)	68	9 (13.2)		95	17 (17.9)	
History of Neck Surgery						
No	423	55 (13.0)	0.645	466	87 (18.7)	0.784
Yes	5	1 (20.0)		30	5 (16.7)	
GERD						
No GERD	392	49 (12.5)	0.222	379	75 (19.8)	0.201
Yes GERD	36	7 (19.4)		117	17 (14.5)	
Smoking History						
Never	303	40 (13.2)	0.647	298	53 (17.8)	0.779
Quit	70	10 (14.3)		137	26 (19.0)	
Unknown	3	1 (33.3)		15	4 (26.7)	
Yes	51	5 (9.8)		46	9 (19.6)	
Pathology						
Benign	236	27 (11.4)	0.264	290	49 (16.9)	0.261

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

	Patients<50 Years			Patients 50 years		
Voice Changes						
Variable	N	n (%)	P Value	N	n (%)	P Value
Malignant	192	29 (15.1)		206	43 (20.9)	
Modified Frailty Index						
Robust	331	40 (12.1)	0.364	200	40 (20.0)	0.786
Prefrail	94	16 (17.0)		272	48 (17.7)	
Frail	3	0 (0.0)		24	4 (16.7)	

Table 3

Associations Between Variables and Swallowing Changes

	Patients<50 Years			Patients 50 years		
Swallowing Changes						
Variable	N	n (%)	P Value	N	n (%)	P Value
Race						
White	251	11 (4.4)	0.412	312	27 (8.7)	0.329
Black	111	2 (1.8)		127	5 (3.9)	
Hispanic	19	2 (10.5)		16	1 (6.3)	
Asian	6	0 (0.0)		7	0 (0.0)	
Unknown	41	2 (4.9)		34	1 (2.9)	
Frequent Voice Use						
No	414	17 (4.1)	0.439	479	33 (6.9)	0.872
Yes	14	0 (0.0)		17	1 (5.9)	
Sex						
Female (Code = 1)	360	14 (3.9)	0.840	401	30 (7.5)	0.257
Male (Code = 2)	68	3 (4.4)		95	4 (4.2)	
History of Neck Surgery						
No	423	16 (3.8)	0.065	466	32 (6.9)	0.966
Yes	5	1 (20.0)		30	2 (6.7)	
GERD						
No GERD	392	13 (3.3)	0.022	379	22 (5.8)	0.096
Yes GERD	36	4 (11.1)		117	12 (10.3)	
Smoking History						
Never	304	11 (3.6)	0.483	298	23 (7.7)	0.411
Quit	70	2 (2.9)		137	6 (4.4)	
Unknown	3	0 (0.0)		15	2 (13.3)	
Yes	51	4 (7.8)		46	3 (6.5)	
Pathology						
Benign	236	9 (3.8)	0.852	290	14 (4.8)	0.035

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

	Patients<50 Years				Patients 50 years			
Swallowing Changes								
Variable	N	n (%)	P Value	N	n (%)	P Value		
Malignant	192	8 (4.2)		206	20 (9.7)			
Modified Frailty Index								
Robust	331	14 (4.2)	0.847	200	13 (6.5)	0.532		
Prefrail	94	3 (3.2)		272	18 (6.6)			
Frail	3	0 (0.0)		24	3 (12.5)			

Table 4
Univariate and Multivariate Spline Regression for Voice Changes

Univariate Analysis				
Covariate	Odds Ratio	95% Confidence Interval		P – value
Age <50	1.054694	1.023102	1.087262	0.001
Age 50	.9868584	.9636446	1.010631	0.276
Constant	.0186159	.0048355	.0716672	0.000
Multivariate Analysis				
Covariate	Odds Ratio	95% Confidence Interval		P – value
Age <50	1.0533548	1.020178	1.088010	0.001
Age 50	.9922563	.965965	1.019263	0.570
Race				
White	Reference			
Black	1.459903	.9307345	2.28993	0.099
Hispanic	.955163	.351447	2.595943	0.928
Asian	1.858571	.4960799	6.963169	0.358
Unknown	.9896141	.4793647	2.042988	0.977
Sex				
Female	Reference			
Male	.9094752	.5566628	1.485900	0.705
GERD	.8738229	.5246611	1.455352	0.604
Smoking Status				
Non-smoker	Reference			
Quit	1.038597	.6634721	1.625817	0.868
Unknown	2.352277	.7928289	6.985597	0.123
Current Smoker	.8339087	.4372871	1.590268	0.581
Frequent Voice Use	7.543925	3.518725	16.17370	0.000
Prior History of Neck Surgery	1.174807	.4671222	2.954624	0.732
Pathology				
Benign	Reference z			
Malignant	1.509675	1.021417	2.23133	0.039
Modified Frailty Index				
Robust	Reference			
Prefrail	.9664629	1.6350157	1.470909	0.874
Frail	.8084883	.2537636	2.575836	0.719