The Laryngoscope

Type I Thyroplasty: A Safe Outpatient Procedure

Attapon Junlapan, MD; C. Kwang Sung, MD, MS; Edward J. Damrose, MD

Objectives/Hypothesis: Overnight hospitalization is routinely advocated following type I thyroplasty (TP) because of concerns for airway compromise. Hospitalization increases cost and patient inconvenience, and may not necessarily be appropriate. This study evaluated complications following surgery and identified predictors for same to assess which patients benefit most from hospitalization.

Study Design: Retrospective chart review.

Methods: A study was conducted on patients who underwent TP with or without arytenoid repositioning procedures between June 2008 and March 2017. The demographic data of the subjects, characteristics, etiology of glottic insufficiency, interventions performed, and subsequent complications were evaluated.

Results: Of 147 patients reviewed, 100 underwent TP alone, 41 underwent TP with arytenoid adduction, and six patients underwent TP with adduction arytenopexy. Iatrogenic vocal fold paralysis was the most common indication. Major complications, which included transient airway compromise and hematoma requiring reoperation, occurred in 7% of patients. Revision surgery and thyroplasty combined with arytenoid repositioning maneuvers were associated with increased risk of major complications.

Conclusions: In general, TP is a safe procedure, with a major complication rate that is lower than that of outpatient thyroidectomy. Overnight hospitalization should be considered in patients undergoing revision surgery and in those requiring concurrent arytenoid repositioning procedures.

Key Words: Thyroplasty, arytenoid adduction, adduction arytenopexy, glottic insufficiency, complication, outpatient.

Level of Evidence: 4

***Laryngoscope*, 00:1–7, 2018**

INTRODUCTION

Glottic insufficiency—inadequate vocal fold adduction during phonation—may be secondary to vocal fold atrophy, vocal fold paralysis (VFP), or vocal fold fixation. It may also result from injury to the epithelium or lamina propria, as is seen with sulcus vocalis or as the sequelae of vocal fold surgery.[1] Vocal fold immobility is commonly iatrogenic but may be idiopathic or secondary to malignancy, trauma, or intubation.[2,3]

The mainstays of surgical treatment for glottic insufficiency are either injection laryngoplasty or laryngeal framework surgery. Type I thyroplasty (TP) using Silastic (Bentec Medical, Inc., Woodland, CA) or Gore-Tex (W.L. Gore & Associates, Inc., Flagstaff, AZ) implants are the most popular implants for medialization laryngoplasty, a technique originally developed by Isshiki et al.[4,5] Arytenoid adduction (AA) is helpful in patients with a significant posterior glottic gap or with vocal fold height mismatch.[6] Some authors advocate adduction arytenopexy (AP) and cricothyroid subluxation in lieu of AA, particularly when the cricoarytenoid joint is fixed.[7–9]

Numerous studies have discussed complications following laryngeal framework surgery. Major complications include airway compromise, for which intubation or tracheostomy may be required, hematoma requiring wound exploration, pharyngocutaneous fistula, or implant extrusion.[10–16] Overall complications and airway complications in particular appear to be more frequent following AA than TP alone.[12,17–19] Implant displacement or extrusion may occur spontaneously or following endotracheal intubation,[20–24] and laryngotracheal fistulas have been reported in irradiated patients.[25–27] Although significant complications have been reported with laryngeal framework surgery that have led to the assumption that patients undergoing these procedures require postprocedure hospitalization and observation, the vast majority of patients do well, and therefore, determining which patients require hospitalization remains a subject of debate.[11,17]

MATERIALS AND METHODS

This study was approved by the Stanford Institutional Review Board and Research Compliance Office. Patients aged 18 years and older who had undergone TP with or without AA or AP between June 2008 and March 2017 in the Department of Otolaryngology–Head and Neck Surgery, Stanford University Medical Center, were included in the initial database extraction. Variables evaluated included the following: etiology of glottic

From the Department of Otolaryngology–Head and Neck Surgery (E.J.D.), Stanford University School of Medicine, Palo Alto, California, U.S.A.; the Department of Otolaryngology–Head and Neck Surgery (A.J., C.K.S.), Faculty of Medicine, Naresuan University, Phitsanulok, Thailand.

Editor's Note: This Manuscript was accepted for publication on October 22, 2018.

Presented at the 139th Annual Meeting of the American Laryngological Association at the Combined Otolaryngological Spring Meetings, National Harbor, Maryland, U.S.A., April 18–22, 2018.

The authors have no funding, financial relationships, or conflicts of interest to disclose.

Send correspondence to Edward J. Damrose, MD, Department of Otolaryngology–Head and Neck Surgery, Stanford University School of Medicine, 801 Welch Road, Stanford, CA 94305. E-mail: edamrose@stanford.edu

DOI: 10.1002/lary.27686

insufficiency, complications and interventions for revision procedures, demographics (sex, age, body mass index), respiratory comorbidities (including asthma, chronic obstructive pulmonary disease, pulmonary fibrosis, lung cancer, and history of pneumonectomy), previous open neck surgery, smoking (categorized as never, former, and current smoker), and alcohol consumption (categorized as yes or no). The etiology of glottic insufficiency and number and type of prior treatments, such as vocal fold injections, were also recorded.

Procedure characteristics evaluated included the following: side (categorized as left, right, and bilateral), new or revision case, type of implant (categorized as Silastic or Gore-Tex), operative time, estimated blood loss (categorized as less than 20 mL, 20–100 mL, and 100–300 mL), and length of hospital stay. Both intraoperative and postoperative complications within 1 week were recorded. A secondary analysis of further interventions following laryngeal framework surgery was performed. These were categorized as injection laryngoplasty (IL), AA alone, AA with reinnervation, TP alone, or TP with AA.

Statistical Analysis

The quantitative data are presented in mean ± standard deviation. The qualitative data were calculated with the Pearson χ^2 test. For comparison of means among different groups, we used one-way analysis of variance (ANOVA). χ^2 and Fisher exact tests were used to compare dichotomous variables. Logistic regression analyses were performed between groups classified by overall complication as dependent variables and other clinical parameters as independent variables. SAS 9.4 (SAS Institute, Cary, NC) was used for the statistical calculations in this study. Significance level was accepted at $P < .05$ in two-tailed tests.

RESULTS

A total of 147 subjects (82 males and 65 females), with mean age of 62 (± 17) years were reviewed. There were 100 cases of TP alone, 41 cases of TP with AA, and six cases of TP with AP. The demographic data are shown in Table I.

TABLE I.
Demographic Data of the Subjects.

Groups	TP n = 100	TP + AA n = 41	TP + AP n = 6	*P* Value
Sex, no. (%)				
Male	54 (54)	22 (53.7)	6 (100)	.031*
Female	46 (46)	19 (46.3)	0 (0)	
Age, yr				
Mean	64 ± 17	58 ± 15	51 ± 22	.045†
Range	21–95	18–85	18–79	
BMI, kg/m^2				
Mean	26.1 ± 4.7	26.2 ± 4.7	25.4 ± 3.1	.924
Range	17.8–41.5	19.8–38.9	21.5–28.4	
Airway comorbidity, no. (%)‡	33 (33)	13 (31.7)	1 (16.7)	.706
Previous open neck surgery, no. (%)	32 (32)	17 (41.5)	4 (66.7)	.159
Smoking, no. (%)				
Never smoker	52 (52)	27 (65.9)	3 (50)	.309
Former smoker	46 (46)	11 (26.8)	3 (50)	
Current smoker	2 (2)	3 (7.3)	0 (0)	
Alcohol, no. (%)				
Yes	51 (51)	22 (53.7)	5 (83.3)	.304
No	49 (49)	19 (46.3)	1 (16.7)	

The quantitative data are presented as mean ± standard deviation, and the qualitative data are presented as number (%).

*Statistically significant differences were found only between TP + AA and TP + AP.

†Statistically significant differences were found among all groups.

‡Included are asthma, chronic obstructive pulmonary disease, pulmonary fibrosis, lung cancer, postpneumonectomy.

AA = arytenoid adduction; AP = adduction arytenopexy; BMI = body mass index; TP = type I thyroplasty.

The etiology of glottic insufficiency is shown in Table II as two groups: VFP and non-VFP. The non-VFP cases included presbylarynges, sulcus vocalis, spasmodic dysphonia, and Parkinsonian hypophonia. The most common causes of VFP were surgery, idiopathic, malignancy, benign neoplasms, intubation, trauma, and cerebrovascular accidents. Anterior cervical surgery accounted for most cases of paralysis, followed by thoracic surgery and skull base/neurosurgery.

In regard to demographics, characteristics of glottic insufficiency, and procedure characteristics, ANOVA (Table 1–2, and III) showed no significant differences among the groups of patients. Most of these statistically significant differences were found among all groups (TP, TP with AA, TP with AP) except for sex, where statistically significant differences were found only between TP with AA group and TP with AP group.

Surgical complications (Table IV) were classified as either intraoperative or postoperative. Major complications were defined as complications that caused prolonged hospitalization, required higher acuity of care, or necessitated reoperation within the acute phase. Only 10 cases (7%) involved major complications: laryngeal mucosal lacerations (two), hematoma (two), airway compromise (two), pulmonary edema (one), pneumonia (one), delirium (one), and acute urinary retention (one). Intraoperative complications included two cases of mucosal perforation and when two cases of attempted AP were aborted. The attempted adduction arytenopexies were aborted due to the cricoarytenoid joint being found to be severely sclerosed and could not be entered to disarticulate the joint. One case of mucosal perforation was caused by a small mucosal tear in the ventricle during elevation of the inner perichondrium requiring a transposition muscle flap with thyrohyoid muscle to seal the tear and medialize the vocal fold. Another case of mucosal perforation occurred when a 3-mm perforation was made into the left pyriform sinus mucosa. This was closed with a 35-mm endoscopic gastrointestinal anastomosis stapler. Both cases of mucosal perforation were repaired intraoperatively, and they were kept in the hospital for 3 days, in which an oral diet was started on postoperative day (POD) 1.

Only two cases of hematoma were found. One case occurred in a patient requiring bridging anticoagulation therapy with enoxaparin due to an underlying pulmonary embolism. Another patient had a hematoma on the morning of POD 2 following TP with AP in the setting of prior aspirin use. The former case was managed with bedside

TABLE II.
Characteristics of Glottic Insufficiency.

Groups	TP n = 100	TP + AA n = 41	TP + AP n = 6	*P* Value
Causes of glottic insufficiency, no. (%)				
Cervical surgery	22 (22)	11 (26.8)	3 (50)	.237
Thoracic surgery	18 (18)	7 (17.1)	0 (0)	.779
Skull base/neurosurgery	1 (1)	5 (12.2)	0 (0)	.023*
Malignancy	11 (11)	8 (19.5)	1 (16.7)	.339
Benign tumor	4 (4)	3 (7.3)	0 (0)	.566
Intubation	3 (3)	0 (0)	0 (0)	.609
Trauma	1 (1)	1 (2.4)	1 (16.7)	.082
Cerebellar stroke	0 (0)	1 (2.4)	0 (0)	.320
Idiopathic	27 (27)	5 (12.2)	1 (16.7)	.150
Presbylarynges	9 (9)	0 (0)	0 (0)	.113
Sulcus vocalis	2 (2)	0 (0)	0 (0)	1.000
Spasmodic dysphonia	1 (1)	0 (0)	0 (0)	1.000
Parkinson hypophonia	1 (1)	0 (0)	0 (0)	1.000
Previous vocal fold injection(s), no. (%)				.307
Never	41 (41)	20 (48.8)	1 (16.7)	
1–2 injections	52 (52)	19 (46.3)	5 (83.3)	
≥3 injections	7 (7)	2 (4.9)	0 (0)	

The qualitative data are presented as number (%).
*Statistically significant differences were found among all groups.
AA = arytenoid adduction; AP = adduction arytenopexy; BMI = body mass index; TP = type I thyroplasty.

evacuation under local anesthetic, the second required reoperation and placement of a drain.

Airway compromise was observed in three patients following TP and in two cases following TP with AA. None of the patients required intubation or tracheostomy. One patient experienced episodes of stridor and shortness of breath on POD 1 following TP after the Penrose drain was removed, with no documented desaturations, so he was hospitalized 1 additional night. Another patient had oxygen desaturation to the 80s while walking the next day after TP, so she was hospitalized 2 additional nights. Another patient had complained of laryngospasm following TP, which resolved spontaneously.

Postoperative pulmonary edema following TP was noted in one patient who had multiple underlying diseases (e.g., leiomyosarcoma of the left pulmonary artery status post left pneumonectomy, atrial fibrillation, constrictive pericarditis, coronary artery disease, hypertension, hyperlipidemia, and obstructive sleep apnea). He responded to diuretic treatment and was discharged on POD 2.

Postoperative pneumonia following TP with AA was noted in one patient by chest x-ray, but he did not have oxygen desaturations. He was treated with oral levofloxacin and was discharged on POD 2.

Dysphagia was noted in three patients, one of whom required hospitalization for 3 days for intravenous steroid administration and medical treatment of achalasia. Persistent dysphonia requiring revision procedure was noted in 17 patients following TP and in nine patients following TP with AA. These revision procedures were classified into A) injection laryngoplasty in 14 patients, B) revision TP ± AA in nine patients, C) AA in two patients, and D) one patient who had AA combined with reinnervation using the ansa cervicalis (Table V). The 14 patients in category A had ILs performed 3 weeks to 2 years after TP. Of the nine patients in category B, six had revision TP alone and three had revision TP with AA, which were performed at 1 month to 2 years after the original TP.

To predict the odds of major complications, binary logistic regression analysis was performed between the noncomplication group and the complication group, as shown in Table VI. Variables included in the multivariate analysis were selected from those with a P value < .2 from the univariate analysis. The multivariable model used the backward selection approach. Penrose drain insertion and airway comorbidity were included in the initial model, but they did not maintain the significance level of .05 in the process, so they were not included in the final model. After controlling for other factors in the analysis, revision surgery and TP with AA or AP were the only significant predictors for overall complications, with adjusted odds of 5.7 and 2.4, respectively.

DISCUSSION

This study revealed that iatrogenic surgical injury (46%) was the major cause of glottic insufficiency, which is slightly higher than previously reported larger series.[3] The majority of these were in patients undergoing anterior cervical fusion. Idiopathic VFP was the second most common etiology of paralysis.

Previous studies have reported major complications following laryngeal framework surgery, including airway compromise, necessitating intubation or tracheostomy, hematoma requiring wound exploration, pharyngocutaneous fistula, or implant extrusion.[10–14,16] However, this study found a rate of major complications of only 7%, lower than the 15% from the previously reported studies[10] and in contrast to prior studies, which suggested that laryngeal framework surgery incurs significant airway risk necessitating overnight hospital admission.[11,17]

In this study, two cases of airway complications were considered major, but none of the patients required surgical intervention, and the etiology was unrelated to hematoma formation. Furthermore, airway compromise may be early (<24 hours) or delayed (>24 hours), and all early airway compromise occurred only in the group undergoing thyroplasty, which differs from previous reports,[12,17,18] suggesting this occurs more frequently in patients undergoing AA. The etiology of early airway compromise in this study was from laryngeal mucosal edema, which was confirmed by flexible endoscopic examination, and all occurrences improved by systemic corticosteroid administration. On the other hand, all delayed airway compromise situations were reported following TP with AA.

Implant extrusion or migration was not observed in this study. Improper size and position of the Silastic implant was noted in only two cases that needed revision (caudal malposition in one case, overmedialization in another). Although the overall rate for patients requiring

further intervention including injection laryngoplasty was 9.5%, the rate for revision laryngeal framework surgery (TP ± AA, AA, and AA with reinnervation) of 8.2% achieved in this study was similar to that seen in previous studies.[10,12]

Dysphagia following TP was noted in three cases. This could be explained by the procedure that included dissection of the thyrohyoid and inferior constrictor muscle along the inferior oblique line to expose the thyroid ala. One of these patients suffered from Parkinson's disease, a disease frequently associated with dysphagia and in whom surgery may have exacerbated underlying symptoms.[28–30] In patients with Parkinsonism, vocal fold injection may be a better long-term strategy to avoid swallowing complications.[31–34]

TABLE III.
Procedure Characteristics.

Groups	TP n = 100	TP + AA n = 41	TP + AP n = 6	*P* Value
Side(s) of operation, no. (%)				
Left	66 (66)	26 (63.4)	6 (100)	.005*
Right	16 (16)	15 (36.6)	0 (0)	
Bilateral	18 (18)	0 (0)	0 (0)	
Type of surgery, no. (%)				
New patient	94 (94)	38 (92.7)	6 (100)	.809
1-sided revision	6 (6)	3 (7.3)	0 (0)	
Type(s) of implant, no. (%)				
Silastic	76 (76)	36 (87.8)	0 (0)	.609
Gore-Tex	20 (20)	5 (12.2)	6 (100)	
Pedicled muscle flap	1 (1)	0 (0)	0 (0)	
Silastic and Gore-Tex on the same side	2 (2)	0 (0)	0 (0)	
Silastic and Gore-Tex on the opposite side	1 (1)	0 (0)	0 (0)	
Operative time, min, no. (%)				
Mean	89 ± 23	127 ± 36	156 ± 35	<.0001*
Range	50–168	72–259	123–221	
EBL, mL (%)				
<20	99 (99)	32 (78)	5 (83.3)	<.0001*
20–100	1 (1)	8 (19.5)	1 (16.7)	
100–300	0	1 (2.4)	0	
Penrose drain insertion, no. (%)				
Yes	19 (58)	8 (24)	6 (18)	.0002*
No	80 (71)	33 (29)	0 (0)	
Discharge medication, no. (%)				
ASA	24 (24)	4 (9.8)	0 (0)	.080
Warfarin/LMWH	4 (4)	0 (0)	1 (16.7)	.091
LOS, d†				
Mean	1.00 ± 0.59	1.15 ± 0.42	1.17 ± 0.41	.298
Range	0–4	1–3	1–2	

The quantitative data are presented as mean ± standard deviation, and the qualitative data are presented as number (%).

*Statistically significant differences were found among all groups.

†Eleven patients in the TP group (7.5%) were outpatient procedures; others were admitted for postoperative observation.

AA = arytenoid adduction; AP = adduction arytenopexy; ASA = acetylsalicylic acid; EBL = estimated blood loss; LMWH = low-molecular-weight heparin; LOS = length of hospital stay; TP = type I thyroplasty.

TABLE IV.
Complications.*

Groups	TP n = 100	TP + AA n = 41	TP + AP n = 6
Intraoperative, no. (%)			
Mucosal perforation	2 (2)	0 (0)	0 (0)
Attempted AP was aborted	2 (2)	0 (0)	0 (0)
Postoperative, no. (%)			
Hematoma	1 (1)†	0 (0)	1 (16.7)‡
Airway compromise§	3 (3)	2 (4.9)	0 (0)
Pulmonary edema§	1 (1)	0 (0)	0 (0)
Pneumonia§	0 (0)	1 (2.4)	0 (0)
Noncardiac chest pain	1 (1)	0 (0)	0 (0)
Delirium	1 (1)	0 (0)	0 (0)
Acute urinary retention	0 (0)	1 (2.4)	0 (0)
Extensive bruise	0 (0)	1 (2.4)	0 (0)
Bleeding wound	0 (0)	1 (2.4)	0 (0)
Stitch abscess	1 (1)	0 (0)	0 (0)
Seroma	0 (0)	1 (2.4)	0 (0)
Cellulitis	1 (1)	1 (2.4)	0 (0)
Dysphagia	2 (2)	1 (2.4)	0 (0)
Odynophagia	1 (1)	0 (0)	0 (0)
Vocal granuloma	0 (0)	2 (4.9)	0 (0)
Dermatitis	0 (0)	1 (2.4)	0 (0)
Hyperglycemia	1 (1)	0 (0)	0 (0)
Poor voice quality requiring intervention	12 (12)	7(17.1)	0 (0)

The qualitative data are presented as number (%).

*Eleven patients have more than one complication. Major complications included laryngeal mucosal perforation, hematoma, airway compromise, pulmonary edema, pneumonia, chest pain, delirium, and acute urinary retention.

†Onset postoperative day 0: underwent wound exploration with stop bleeding, no airway compromise.

‡Onset postoperative day 2: underwent wound exploration with stop bleeding, No airway compromise.

§Did not require intubation or tracheostomy.

AA = arytenoid adduction; AP = adduction arytenopexy; TP = type I thyroplasty.

Multivariate logistic regression analysis revealed that revision cases and those cases requiring TP and AA or AP were the only two predictors for overall complications. This may be helpful in preoperative counseling and planning, and patients should be informed that risk of complications and need for hospitalization may be required in these situations. Revision surgery, in theory, may necessitate more extensive dissection and laryngeal

TABLE V.
Voice Intervention Following Initial Surgery.

Intervention	Incidence (%)
IL	14 (9.5)
AA	2 (1.4)
AA with reinnervation	1 (0.7)
Revision TP ± AA	9 (6.1)

AA = arytenoid adduction; IL = injection laryngoplasty; TP = type I thyroplasty.

TABLE VI.
Logistic Regression Analysis of Factors Affecting Overall Complication Compared to Noncomplication Group.

Groups	Noncomplication Group, n = 108[†]	Overall Complication Group, n = 39*	Univariate		Multivariate	
			Crude OR (95% CI)	*P* Value[†]	Adjusted OR (95% CI)	*P* Value[‡]
Sex						
Male	59 (72)	23 (28)	1.2 (0.6-1.2)	.649		
Female	49 (75.4)	16 (24.6)				
Age, yr						
<65	56 (76.7)	17 (23.3)	1.4 (0.7-2.9)	.377		
≥65	52 (70.3)	22 (29.7)				
BMI, kg/m^2						
<30	91 (75.2)	30 (24.8)	1.6 (0.7-4.0)	.306		
≥30	17 (65.4)	9 (34.6)				
Airway comorbidity						
Yes	31 (66)	16 (34)	1.7 (0.8-3.7)	.160		
No	77 (77)	23 (23)				
Previous open neck surgery						
Yes	39 (73.6)	14 (26.4)	1.0 (0.5-2.1)	.981		
No	69 (73.4)	25 (26.6)				
Smoking						
Never	60 (73.2)	22 (26.8)	1.0 (0.5-2.0)	.927		
Former or current	48 (73.8)	17 (26.2)				
Alcohol						
Yes	59 (75.6)	19 (24.4)	0.8 (0.4-1.6)	.526		
No	49 (71)	20 (29)				
Cause of glottic insufficiency						
VFP[§]	97 (72.4)	37 (27.6)	2.1 (0.4-9.9)	.35		
Non-VFP[‖]	11 (84.6)	2 (15.4)				
Previous vocal fold injection						
Yes	45 (72.6)	17 (27.4)	1.1 (0.5-2.3)	.835		
No	63 (74.1)	22 (25.9)				
Side of operation						
Unilateral	93 (72.1)	36 (27.9)	0.5 (0.1-1.9)	.319		
Bilateral	15 (83.3)	3 (16.7)				
Type of surgery						
Nonrevision	104 (75.4)	34 (24.6)	3.8 (1.0-15.1)	.055	5.7 (1.2-26.3)	.026
Revision	4 (44.4)	5 (55.6)				
Technique of surgery						
TP alone	77 (77)	23 (23)	1.7 (0.8-3.7)	.16	2.4 (1.1-5.3)	.038
TP with AA or AP	31 (66)	16 (34)				
Type of implant						
Silastic	84 (75)	28 (25)	1.0 (0.4-2.4)	.927		
Gore-Tex	23 (74.2)	8 (25.8)				
Operative time, min						
<120	3 (100)	0 (0)	0 (0-0)	NA		
≥120	105 (72.9)	39 (27.1)				
Estimated blood loss, mL						
<20	98 (72.1)	38 (27.9)	0.3 (0.0-2.1)	.204	0.1 (0.0-1.0)	.052
≥20	10 (90.9)	1 (9.1)				
Penrose drain insertion						
Yes	21 (63.6)	12 (36.4)	0.5 (0.2-1.3)	.158		
No	86 (76.1)	27 (23.9)				

(Continues)

TABLE VI.
(*Continued*)

Groups	Noncomplication Group, n = 108[†]	Overall Complication Group, n = 39*	Univariate		Multivariate	
			Crude OR (95% CI)	*P* Value[†]	Adjusted OR (95% CI)	*P* Value[‡]
ASA prescribed at discharge						
Yes	23 (82.1)	5 (17.9)	0.5 (0.2-1.6)	.253		
No	85 (71.4)	34 (28.6)				
Warfarin/LMWH prescribed at discharge						
Yes	4 (80)	1 (20)	0.7 (0.1-6.3)	.738		
No	104 (73.2)	38 (26.8)				
Length of hospital stay, d						
0	9 (81.8)	2 (18.2)	0.6 (0.1-2.9)	.518		
1–4	99 (72.8)	37 (27.2)				

*Data are presented as number of subjects (%).
[†]*P* values representing the significance of adjusted odds ratio from univariate analysis.
[‡]*P* values representing the significance of adjusted odds ratio from multivariate analysis.
[§]Included surgery, benign or malignant tumor, intubation, trauma, stroke, idiopathic.
[‖]Included presbylarynges, sulcus vocalis, spasmodic dysphonia, Parkinson hypophonia.
AA = arytenoid adduction; AP = adduction arytenopexy; ASA = aspirin; CI = confidence interval; LMWH = low-molecular-weight heparin; NA = not available; OR = odds ratio; TP = type I thyroplasty; VFP = vocal fold paralysis/paresis.

manipulation, which may induce greater trauma. Greater exposure is needed for AA or AP, necessitating cutting of strap muscles and elevation of the pyriform sinus mucosa. This too may be a contributing factor to increased bleeding or overall trauma.

Anticoagulant and antiplatelet drugs prescribed at discharge did not increase the risk of intraoperative and postoperative complications, with a crude odds ratio of 0.7 and 0.5, respectively. This study confirmed that it has been a safe, routine practice to stop anticoagulant and antiplatelet drugs 7 days before surgery, or otherwise provide bridging anticoagulation therapy, particularly in high cardiovascular risk patients. Resumption of anticoagulants in the early postoperative period therefore appears to be safe. Neither intraoperative blood loss nor drain placement were predictors of complications. In this institution, drains are no longer routinely placed. Although postoperative hematoma can be a serious complication, it was rare in this study, and hospitalization or lack thereof did not affect outcomes.

Logistic regression analysis showed that the length of hospital stay did not affect the incidence of overall complications. Routine hospitalization postoperatively, therefore, is unnecessary in most patients, unless there is an increased risk of serious airway complications, as may be predicted in revision surgery. This important finding differs from previous reports.[11,17] As our practice has evolved, we have begun performing thyroplasties on an outpatient basis. In this series, 11 thyroplasties alone were performed as outpatient procedures. Two of the 11 outpatient patients had minor complications that did not require intervention. One case had a small stich abscess which resolved spontaneously. Another patient had poor voice quality requiring IL.

These data compare favorably to the literature on outpatient thyroidectomy, with complication rates of 5% to 12% reported for patients undergoing hemi or total thyroidectomy, and demonstrating that when patients are carefully selected, the majority can be managed on an outpatient basis.[35–38]

The small sample size (n = 10) and consequent inability to perform logistic regression analysis in analyzing the prediction factors for serious complications was a limitation of this study. But this study did demonstrate that major complications are rare, confirming the safety of laryngeal framework surgery.

CONCLUSION

In general, TP is a safe procedure, with a major complication rate that is lower than that of outpatient thyroidectomy. Major complications, which included transient airway compromise and hematoma requiring reoperation, occurred in 7% of patients. Overnight hospitalization should be considered in patients undergoing revision surgery and in those requiring concurrent arytenoid repositioning procedures.

Acknowledgments

The authors express appreciation to Yifei Ma, PhD, consulting statistician, for his kind contributions.

BIBLIOGRAPHY

1. Damrose EJ, Berke GS. Advances in the management of glottic insufficiency. *Curr Opin Otolaryngol Head Neck Surg* 2003;11:480–484.
2. Benninger MS, Gillen JB, Altman JS. Changing etiology of vocal fold immobility. *Laryngoscope* 1998;108:1346–1350.
3. Rosenthal LH, Benninger MS, Deeb RH. Vocal fold immobility: a longitudinal analysis of etiology over 20 years. *Laryngoscope* 2007;117:1864–1870.
4. Isshiki N, Morita H, Okamura H, Hiramoto M. Thyroplasty as a new phonosurgical technique. *Acta Otolaryngol* 1974;78:451–457.
5. Isshiki N, Okamura H, Ishikawa T. Thyroplasty type I (lateral compression) for dysphonia due to vocal cord paralysis or atrophy. *Acta Otolaryngol* 1975;80:465–473.
6. Isshiki N, Tanabe M, Sawada M. Arytenoid adduction for unilateral vocal cord paralysis. *Arch Otolaryngol* 1978;104:555–558.
7. Zeitels SM, Mauri M, Dailey SH. Adduction arytenopexy for vocal fold paralysis: indications and technique. *J Laryngol Otol* 2004;118:508–516.

8. Zeitels SM, Hochman I, Hillman RE. Adduction arytenopexy: a new procedure for paralytic dysphonia with implications for implant medialization. *Ann Otol Rhinol Laryngol Suppl* 1998;173:2–24.
9. Zeitels SM, Hillman RE, Desloge RB, Bunting GA. Cricothyroid subluxation: a new innovation for enhancing the voice with laryngoplastic phonosurgery. *Ann Otol Rhinol Laryngol* 1999;108:1126–1131.
10. Young VN, Zullo TG, Rosen CA. Analysis of laryngeal framework surgery: 10-year follow-up to a national survey. *Laryngoscope* 2010;120:1602–1608.
11. Tucker HM, Wanamaker J, Trott M, Hicks D. Complications of laryngeal framework surgery (phonosurgery). *Laryngoscope* 1993;103:525–528.
12. Rosen CA. Complications of phonosurgery: results of a national survey. *Laryngoscope* 1998;108(11 pt 1):1697–1703.
13. Cotter CS, Avidano MA, Crary MA, Cassisi NJ, Gorham MM. Laryngeal complications after type 1 thyroplasty. *Otolaryngol Head Neck Surg* 1995;113:671–673.
14. Schneider-Stickler B, Gaechter J, Bigenzahn W. Long-term results after external vocal fold medialization thyroplasty with titanium vocal fold medialization implant (TVFMI). *Eur Arch Otorhinolaryngol* 2013;270:1689–1694.
15. Benscoter BJ, Akst LM. Saccular cyst as a complication of medialization laryngoplasty: a case report. *Ear Nose Throat J* 2014;93:E1–E3.
16. McKennis AT, Waddington C. Thyroplasty type I for unilateral vocal cord paralysis. *AORN J* 1994;60:38–42.
17. Weinman EC, Maragos NE. Airway compromise in thyroplasty surgery. *Laryngoscope* 2000;110:1082–1085.
18. Abraham MT, Gonen M, Kraus DH. Complications of type I thyroplasty and arytenoid adduction. *Laryngoscope* 2001;111:1322–1329.
19. Koufman JA, Isaacson G. Laryngoplastic phonosurgery. *Otolaryngol Clin North Am* 1991;24:1151–1177.
20. Halum SL, Postma GN, Koufman JA. Endoscopic management of extruding medialization laryngoplasty implants. *Laryngoscope* 2005;115:1051–1054.
21. Feinberg S, Lopez-Guerra G, Zeitels SM. Hypopharyngeal extrusion of 2.5 feet (76 cm) of polytetrafluoroethylene (Gore-Tex): initial laser-assisted office-based removal and micropharyngeal completion. *Ann Otol Rhinol Laryngol* 2010;119:573–577.
22. Rosen CA, Murry T, DeMarino DP. Late complication of type 1 thyroplasty: a case report. *J Voice* 1999;13:417–423.
23. Cohen JT, Bates DD, Postma GN. Revision Gore-Tex medialization laryngoplasty. *Otolaryngol Head Neck Surg* 2004;131:236–240.
24. Ayala MA, Patterson MB, Bach KK. Late displacement of a Montgomery thyroplasty implant following endotracheal intubation. *Ann Otol Rhinol Laryngol* 2007;116:262–264.
25. Kubik M, Rosen C. Laryngeal framework surgery in the irradiated neck: a retrospective matched cohort study. *Ann Otol Rhinol Laryngol* 2016;125:823–828.
26. Netterville JL, Stone RE, Luken ES, Civantos FJ, Ossoff RH. Silastic medialization and arytenoid adduction: the Vanderbilt experience. A review of 116 phonosurgical procedures. *Ann Otol Rhinol Laryngol* 1993;102:413–424.
27. Rosow DE, Al-Bar MH. Type I thyroplasty in previously irradiated patients: assessing safety and efficacy. *Otolaryngol Head Neck Surg* 2015;153:582–585.
28. Kalf JG, de Swart BJ, Bloem BR, Munneke M. Prevalence of oropharyngeal dysphagia in Parkinson's disease: a meta-analysis. *Parkinsonism Relat Disord* 2012;18:311–315.
29. Miller N, Allcock L, Hildreth AJ, Jones D, Noble E, Burn DJ. Swallowing problems in Parkinson disease: frequency and clinical correlates. *J Neurol Neurosurg Psychiatry* 2009;80:1047–1049.
30. Sapir S, Ramig L, Fox C. Speech and swallowing disorders in Parkinson disease. *Curr Opin Otolaryngol Head Neck Surg* 2008;16:205–210.
31. Remacle M, Lawson G. Results with collagen injection into the vocal folds for medialization. *Curr Opin Otolaryngol Head Neck Surg* 2007;15:148–152.
32. Berke GS, Gerratt B, Kreiman J, Jackson K. Treatment of Parkinson hypophonia with percutaneous collagen augmentation. *Laryngoscope* 1999;109:1295–1299.
33. Hill AN, Jankovic J, Vuong KD, Donovan D. Treatment of hypophonia with collagen vocal cord augmentation in patients with parkinsonism. *Mov Disord* 2003;18:1190–1192.
34. Sewall GK, Jiang J, Ford CN. Clinical evaluation of Parkinson's-related dysphonia. *Laryngoscope* 2006;116:1740–1744.
35. Grubey JS, Raji Y, Duke WS, Terris DJ. Outpatient thyroidectomy is safe in the elderly and super-elderly. *Laryngoscope* 2018;128:290–294.
36. Khadra H, Mohamed S, Hauch A, Carter J, Hu T, Kandil E. Safety of same-day thyroidectomy: meta-analysis and systematic review. *Gland Surg* 2017;6:292–301.
37. McLaughlin EJ, Brant JA, Bur AM, et al. Safety of outpatient thyroidectomy: review of the American College of Surgeons National Surgical Quality Improvement Program. *Laryngoscope* 2018;128:1249–1254.
38. Lee DJ, Chin CJ, Hong CJ, Perera S, Witterick IJ. Outpatient versus inpatient thyroidectomy: a systematic review and meta-analysis. *Head Neck* 2018;40:192–202.