Surgery: Current Research

Qin et al., Surgery Curr Res 2014, 4:6
DOI: 10.4172/2161-1076.1000208

Research Article

Open Access

Surgical Risk after Unilateral Lobectomy versus Total Thyroidectomy: A Review of 47,434 Patients

Charles Du Qin[1], Sujata Saha[1], Ryan Meacham[2], Sandeep Samant[2], Jon P Ver Halen[3,*] and John YS Kim[1]

[1]*Division of Plastic and Reconstructive Surgery, Northwestern University, Feinberg School of Medicine, Chicago, Illinois, USA*
[2]*Department of Otolaryngology- Head and Neck Surgery, University of Tennessee Health Science Center, Memphis, Tennessee, USA*
[3]*Division of Plastic and Reconstructive Surgery, Baptist Cancer Center, Memphis, Tennessee; Department of Surgery, St. Jude Children's Research Hospital, Memphis, Tennessee; Department of Surgical Oncology, Vanderbilt-Ingram Cancer Center, Nashville, Tennessee, USA*

Abstract

Background: We reviewed the 2005-2012 ACS-NSQIP Databases to evaluate factors associated with adverse events (AE) after unilateral thyroid lobectomy (UL) and total thyroidectomy (TT).

Methods: All unilateral lobectomies and total thyroidectomies performed from 2005 to 2012 were identified for analysis. The cohort was characterized with respect to preoperative and demographic characteristics, complications, reoperation, and mortality.

Results: 47,434 patients were identified, of which 17,584 underwent unilateral lobectomy and 29,850 underwent total thyroidectomy. On multivariable regression analysis, UL was associated with a 2.786 greater risk of returning to the OR, and a 1.377 risk of surgical complications. The increased risk of return to the OR was eliminated when controlling for patients returning to the OR for completion thyroidectomy after UL.

Conclusion: NSQIP is the only dataset that is able to discern between unilateral lobectomy and total thyroidectomy to make viable comparisons in outcomes.The NSQIP dataset may be imperfect, as pertinent details of chemotherapy and radiation, and procedure-specific complications, including hematoma and airway compromise, are not tracked. In spite of this, our findings suggest avenues for improvement in the care of thyroidectomy patients, and suggest directions for a thyroidectomy-specific outcomes database.

Keywords: Thyroidectomy; NSQIP; Lobectomy; Outcomes; Mortality; Complications

Introduction

The incidence and severity of thyroid cancer continues to rise. The rate for new diagnoses of thyroid cancer has increased an average of 6.4% per year over the last 10 years and mortality of thyroid cancer has increased 0.9% per year over the same period [1]. With this increasing disease burden, the need for both diagnostic and therapeutic thyroidectomy remains high.

Although thyroid surgery is a relatively safe procedure, there are a number of severe, preventable complications [2,3]. Because medical sustainability proposals link reimbursements with quality control measures, it is imperative to establish normative data by which surgeons and hospitals can be compared to their cohorts with regard to thyroidectomy outcomes. Although more than 20,000 thyroidectomies are performed every year in the United States, only a few papers have attempted to describe high-volume, multi-center outcome data for thyroid surgery [4,5].

Many factors may be weighed when considering a unilateral thyroid lobectomy (UL) versus total thyroidectomy (TT). Even in the setting of known thyroid cancer, there is not always agreement about the requirement for lobectomy or total thyroidectomy [6,7]. Furthermore, there remains discussion about the need for central and lateral neck dissection in the setting of thyroid cancer [8,9]. It would stand to reason that with an increasing extent of thyroid surgery there would be a commensurate increase in nontechnical complications (i.e., not including recurrent laryngeal nerve injury and hyperparathyroidism), but the details of this relationship have not been described. Conversely, the technically more complicated procedure of thyroid-conserving surgery could, in turn, increase technical complications

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) is a multi-institutional collaborative effort that collects data from more than 500 hospitals. Over 230 variables are captured including preoperative status, intraoperative variables, and postoperative outcomes, including 30-day postoperative adverse events (AE). The NSQIP database is an excellent resource for population-based analyses of critical health care issues, including registry-based trials, risk adjustment, surgical outcomes and cost [10].

The purpose of this study was to use the ACS-NSQIP database to evaluate a large volume of patients to assess the relationship between the type of thyroid surgery and surgical outcomes. Although most reports on thyroidectomy outcomes focus on technical complications such as recurrent laryngeal nerve injury and hyperparathyroidism, we examined all outcomes comparing UL to TT.

Methods

Data acquisition and patient population

Data collection methods for the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) registry have been previously described [11,12]. All study aspects were approved by the respective Institutional Review Boards.

The 2005 to 2012 NSQIP registries were queried for all patients who

***Corresponding author:** Jon P Ver Halen, MD, FACS, Division of Plastic and Reconstructive Surgery, Baptist Cancer Center, Department of Surgery, St. Jude Children's Research Hospital; Department of Surgical Oncology, Vanderbilt-Ingram Cancer Center 3268 Duke Circle, Germantown, Tennessee; Tel. 206- 963-8714; Fax: 901- 227-9825, E-mail: jpverhalen@gmail.com

Received August 18, 2014; **Accepted** October 27, 2014; **Published** November 05, 2014

Citation: Qin CD, Saha S, Meacham R, Samant S, Ver Halen JP, et al. (2014) Surgical Risk after Unilateral Lobectomy versus Total Thyroidectomy: A Review of 47,434 Patients. Surgery Curr Res 4: 208. doi:10.4172/2161-1076.1000208

Copyright: © 2014 Qin CD, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

were recorded to have undergone a total thyroidectomy or a unilateral lobectomy. Total thyroidectomy cases were identified by the presence of the Current Procedural Terminology (CPT) codes 60240 and 60225, and unilateral lobectomies were identified by the CPT code 60220. Patients were stratified by surgical modality.

Risk adjustment variables and outcomes

NSQIP-defined preoperative variables were compared between total thyroidectomy and unilateral lobectomy. They included demographic variables (eg, age, BMI class); lifestyle variables (eg, smoking), medical comorbidities (eg, diabetes, dyspnea, hypertension, COPD, congestive heart failure, bleeding disorders, prior angioplasty or cardiac surgery, previous stroke or transient ischemic attack, radiotherapy within 90 days of operation, chemotherapy within 30 days of operation, previous operations within 30 days of operation) and intraoperative characteristics (e.g., total operation time). Tracked 30-day adverse events (AE) were categorized as surgical complications, medical complications, and overall complications. Surgical complications included superficial, deep, organ-space surgical site infection (SSI), or wound disruption. Medical complications included deep venous thrombosis (DVT), pulmonary embolism (PE), unplanned re-intubation, ventilator dependence >48 hours, progressive renal insufficiency, acute renal failure, coma, stroke, cardiac arrest, myocardial infarction (MI), peripheral nerve injury, pneumonia, urinary tract infection (UTI), blood transfusions, and sepsis/septic shock. All AE were used as defined in the NSQIP user guide. Overall complications included all surgical and medical complications. Data for unplanned readmission, which was available in 2011 and 2012, was tracked. Readmission was defined as an unplanned readmission to the same or other hospital within 30 days of the primary or concurrent procedure. Return to the operating room within 30 days identified all major surgical procedures that required the patient to be taken to the surgical operating room for intervention of any kind.

Statistical analysis

Chi-square tests, for categorical variables, and Student *t* test, for continuous variables, were used to identify differences in perioperative variables between the two groups. Significance was defined as $P < 0.05$. This method was then used to identify differences in overall, medical, and surgical complications. Perioperative variables with $n \geq 10$ and $P < 0.2$ were identified as possible predictors for AE and included in a binary logistic regression which assessed the independent association of surgical modality with overall, medical, and surgical complications, return to the operating room, and unplanned readmission, with proper risk adjustment for other factors. Again, $P < 0.05$ was considered significant. Hosmer-Lemeshow (H-L) and c-statistics were calculated to assess model calibration and discriminatory capability, respectively. All analysis was performed using SPSS version 22 (IBM Corp, Armonk, NY). V

Results

Cohort characteristics

Between 2005 and 2012, 47,434 patients were identified for our analysis. 17,584 patients (37%) underwent UL and 29,850 patients (63%) underwent TT (Table 1). The UL group was more likely to be male and have a history of alcohol use. Comorbidities and clinical

		Unilateral Thyroidectomy (n=17584)		Total Thyroidectomy (n=29850)		
		N	%	N	%	P
Male		3523	20.04%	5161	17.29%	<.001
Race	Asian	799	4.54%	923	3.09%	<.001
	Black	1793	10.20%	4075	13.65%	
	Other	2165	12.31%	2996	10.04%	
	White	12827	72.95%	21856	73.22%	
Outpatient		10557	60.04%	13841	46.37%	<.001
Diabetes		1653	9.40%	3765	12.61%	<.001
Active Smoker		2374	13.50%	5012	16.79%	<.001
Alchohol Use		169	0.96%	218	0.73%	0.007
Dyspnea		1197	6.81%	2654	8.89%	<.001
Ventilator dependent		8	0.05%	30	0.10%	0.041
History of severe COPD		294	1.67%	613	2.05%	0.003
Current pneumonia		4	0.02%	18	0.06%	0.067
Ascites		2	0.01%	10	0.03%	0.143
Esophageal varices		2	0.01%	2	0.01%	0.592
CHF		16	0.09%	81	0.27%	<.001
MI		15	0.09%	32	0.11%	0.464
Previous Cardiac Surgery		436	2.48%	815	2.73%	0.1
Angina		30	0.17%	81	0.27%	0.028
Hypertension		5943	33.80%	12082	40.48%	<.001
Peripheral Vascular Disease		27	0.15%	91	0.30%	0.001

Rest Pain		3	0.02%	9	0.03%	0.387
Acute renal failure		5	0.03%	15	0.05%	0.264
Dialysis		59	0.34%	103	0.35%	0.864
Impaired sensorium		4	0.02%	7	0.02%	0.961
Coma >24 hours		1	0.01%	1	0.00%	0.705
Spinal Cord Injury		59	0.34%	129	0.43%	0.106
Previous Stroke		376	2.14%	711	2.38%	0.087
Tumor involving CNS		8	0.05%	22	0.07%	0.238
Disseminated cancer		54	0.31%	197	0.66%	<.001
Wound Infection		46	0.26%	90	0.30%	0.432
Steroid Use		253	1.44%	585	1.96%	<.001
Weight Loss		87	0.49%	282	0.94%	<.001
Bleeding disorders		189	1.07%	404	1.35%	0.008
Pre-operative transfusion		1	0.01%	9	0.03%	0.076
Chemotherapy		29	0.16%	62	0.21%	0.304
Radiotherapy		21	0.12%	33	0.11%	0.782
Sepsis		58	0.33%	101	0.34%	0.877
Pregnancy		30	0.17%	51	0.17%	0.995
Prior Operation		93	0.53%	92	0.31%	<.001
Emergency case		52	0.30%	109	0.37%	0.209
Wound classification	1	17254	98.12%	29225	97.91%	0.068
	2	283	1.61%	501	1.68%	
	3	45	0.26%	118	0.40%	
	4	2	0.01%	6	0.02%	
ASA Class 3,4, or 5		3788	21.54%	8158	27.33%	<.001
Age		51.3 (14.8)		51.6 (14.4)		<.001
BMI		29.1 (7.3)		30.1 (7.6)		<.001
Total Operation time		91.9 (43.9)		123.8 (58.9)		<.001

* Denotes Significance P<.05
Continuous variables expressed as mean (SD)

Table 1: Patient Demographics and Clinical Characteristics.

characteristics including diabetes, smoking, dyspnea, COPD, CHF, hypertension, and steroid use were more prevalent in the TT group. Patients who underwent TT were more likely to be ASA class 3, 4, or 5, older, and have a higher BMI.

Post-operative outcomes

Univariate analysis of 30-day AE for both UL and TT were captured in (Table 2). Incidence of overall and medical complications were significantly higher (p<.001) in TT. There was no significant difference between the two surgical modalities in surgical complications. Patients who underwent TT were more likely to experience pneumonia, reintubation, cardiac arrest, sepsis and septic shock. Rates of return to the OR were higher in the UL group. Rates of unplanned readmission were higher in the TT group. No significant difference in mortality rates between the two groups was detected.

Effect of modality on 30-day outcomes

Table 3 details the multivariate analysis performed to evaluate the independent effect of surgical modality on 30-day AE, adjusting for other risk factors. Neither surgical modality was associated with increased overall or medical complications, or unplanned readmission rates. Of note, unilateral thyroidectomy conferred increased surgical complication risk (OR, 1.377) as well as a 2.786 greater risk of returning to the OR.

Discussion

The NSQIP database is a unique and robust database with large volumes that can support critical analyses of risk factors with small confidence intervals. NSQIP collects data from both major academic tertiary-care medical centers as well as community hospitals, thereby capturing a broad snapshot of procedures and patients with their preoperative risks and postoperative outcomes. Because the data is prospectively collected and validated by a highly-trained and dedicated surgical clinical nurse reviewer (SCNR), the NSQIP has a large advantage over other registry and Medicare-based analyses that are primarily administrative discharge datasets without emphasis on accuracy.

We identified 47,434 thyroidectomy patients. Rates of total, surgical, and medical complications, repoperation, readmission and mortality were: 1.5%; 0.4%; 1.1%; 2.2%; 2.5%; and 0.05%, respectively. Previous research has demonstrated a low rate of morbidity for all thyroid operations (3.8%) [13]. Commonly reported overall complication rates for thyroid operations are in the following ranges: bleeding 0.1–3%,

	Unilateral Thyroidectomy (n=17584)		Total Thyroidectomy (n=29850)		
	N	%	N	%	P
Overall Complications	201	1.14%	490	1.64%	<.001
Surgical Complications	69	0.39%	111	0.37%	0.725
Superficial Surgical Site Infection	42	0.24%	82	0.27%	0.46
Deep Surgical Site Infection	9	0.05%	13	0.04%	0.709
Organ space infection	2	0.01%	7	0.02%	0.356
Wound Dehiscence	16	0.09%	13	0.04%	0.043
Medical Complications	137	0.78%	396	1.33%	<.001
MI	5	0.03%	17	0.06%	0.164
Pneumonia	15	0.09%	65	0.22%	<.001
Reintubation	26	0.15%	133	0.45%	<.001
Pulmonary Embolism	7	0.04%	19	0.06%	0.284
Failure to Wean off Ventilator	16	0.09%	87	0.29%	<.001
Renal Insufficiency	1	0.01%	1	0.00%	0.705
Renal Failure	1	0.01%	5	0.02%	0.301
Urinary Tract Infection	48	0.27%	105	0.35%	0.144
Cerebrovascular Accident	4	0.02%	14	0.05%	0.192
Coma	1	0.01%	3	0.01%	0.617
Peripheral Nerve Deficit	8	0.05%	12	0.04%	0.786
Cardiac Arrest	1	0.01%	17	0.06%	0.006
Transfusion	8	0.05%	32	0.11%	0.025
DVT	9	0.05%	14	0.05%	0.838
Sepsis	9	0.05%	35	0.12%	0.022
Septic Shock	2	0.01%	16	0.05%	0.023
Death	5	0.03%	18	0.06%	0.128
Unplanned readmission[a]	138	2.10%	311	2.70%	0.009
Return to OR	587	3.34%	442	1.48%	<.001

* Denotes Significance P<.05

[a] Data for unplanned readmission available from 2011-2012 NSQIP dataset

Table 2: Unadjusted Outcomes.

Effect of thyroidectomy modality on outcomes*	P	OR	95% C.I. for OR	
			Lower	Upper
Overall Complications	0.725	1.209	0.42	3.476
Medical Complications	0.784	0.843	0.249	2.852
Surgical Complications	0.044	0.726	0.532	0.991
Return to the OR	0	0.359	0.311	0.415
Readmission	0.385	1.329	0.7	2.522

* reference group is unilateral lobectomy

Table 3: Risk-adjusted analysis: Odds ratios reflect risk of total thyroidectomy (with respect to reference group of unilateral thyroidectomy) for the given adverse event.

pneumonia 1%, wound infection 0.25–2%, urinary tract infections 0.2%, and cardiac morbidity 0.2–0.9% [14-16]. When the NSQIP reporting hospitals are used as a benchmark, it appears that thyroid surgery continues to have an excellent safety profile.

Aside from decreased morbidity and cost savings, the use of TT versus UL is relevant for a number of thyroid cancer subtypes, including papillary thyroid cancer (PTC), Hurthle cell microcarcinomas, and well-differentiated thyroid microcarcinomas (WDTC). Thyroid lobectomy has been shown in previous literature to have less associated vocal and throat function mobidty, and is associated with lower cost and hospital length of stay than total thyroidectomy [17,18]. Current guidelines recommend TT for PTC tumors greater and 1.0 cm, but it has traditionally been thought that TT is associated with greater morbidity, compared to UL. Adam, et al evaluated 61,775 patients with PTC from the National Cancer Database, and found no difference in survival in TT versus UL, regardless of tumor size [19]. Lee et al. made a similar conclusion in their study of 2,014 patients [20]. However, Ebina et al. found decreased survival after UL in patients > 50 years old, those with massive extrathyroidal extension, or large (>3 cm) lymph node metastasis) in a study of 1,187 patients from a single center [21]. Of note, none of these studies evaluated surgical outcomes after TT versus UL, as the respective datasets were not capable of analyzing these outcomes. Ogilvie et al., reviewed 346 patients with WDTC and found that UL was not sufficient for local tumor control in WDTC patients with tumor size between 6-10 mm, in spite of American Thyroid Association guidelines recommending UL alone [22]. Kuo et al., found poor survival for patients with Hurthle cell microcarcinoma in a study of 22,738 patients, regardless of the extent of resection [23]. Thyroid tumors can recur as a result of positive margins, microsatellite disease, or unrecognized nerve invasion. A statistical evaluation of the presence of histologic tumor subtypes, positive surgical margins, extent of locoregional disease, need for postoperative radiation, and tumor recurrence is beyond the level of detail available in ACS-NSQIP. However, preoperative diagnosis codes identify thyroid malignancy as the reason for surgery in 88% of cases, and goiter in 8% of cases, with non-specified reasons making up the remaining 4% of cases. Further development of the NSQIP dataset may facilitate more granular detail with regards to indications for surgery.

One analysis evaluated the NSQIP database for trends in thyroidectomy and parathyroid outcomes between different specialties [24]. They concluded that there was no difference in outcomes or case complexity between general surgery and otolaryngology, that operative time was less for general surgery (115 vs 123 minutes), and that duration of hospital stay beyond 1 postoperative day was more frequent for otolaryngology (8% vs 5%). One weakness of their study was that their data set included 51,470 cases from general surgery and only 3,932 cases from otolaryngology, a reflection of the fact that NSQIP captures far more general surgery cases than surgical subspecialty cases. Furthermore, the percentage of thyroidectomy cases vs parathyroidectomy cases was higher for otolaryngology (86%) than general surgery (68%), which may have influenced overall average operative times and hospital stays. Our analysis did not detect any differences in total, surgical, or medical complications, reoperation, readmission, or mortality between surgical specialties performing thyroidectomy (i.e., general surgery, otolaryngology, thoracic surgery, and plastic surgery). A more valuable distinction may be surgical oncology specialization with respect to the performing surgeon; however, NSQIP does not identify this variable.

A 2012 NSQIP report showed that patients undergoing either thyroidectomy and parathyroidectomy, or both had a 30-day mortality of 0.08%, 0.16%, and 0.2%, respectively. They identified mean length of stay (LOS) values at 1.1 days, 1.1 days, and 1.4 days, respectively. Congestive heart failure (CHF), dependent functional status, dialysis dependence, and chronic corticosteroid use were significantly associated with increased LOS and postoperative adverse events [25]. Preoperative pneumonia and new exacerbation of CHF are well documented comorbidities that affect postoperative pulmonary complications [26,27]. Incentive spirometry, head of bed elevation, ambulation, and oral hygiene have been shown to decrease these complications [28,29].

A 2014 NSQIP study assessed how various preoperative comorbidities and intraoperative variables were tied to thyroidectomy outcomes [30]. In an analysis of 38,577 patients they found that risk factors independently associated with morbidity after thyroidectomy included hypertension, diabetes, advanced age greater than 70 years, COPD, and dialysis. Interestingly they found that the surgical approach was related to the rate of return to the operating room. As compared with a partial thyroidectomy, patients undergoing a total thyroidectomy were 73% less likely to return to the operating room and those undergoing substernal thyroidectomy were 37% less likely to return to the operating room.

In our study the 30 day mortality was 0.03% for UL and 0.06% for TT. This mortality rate compares well with mortality rates of other procedures such as pancreatectomy (8.3%), coronary artery bypass graft (3.5%), craniotomy (10.7%), and repair of aortic aneurysm (3.9%) [31]. the morbidity rates found in our study were also low: 1.14% for UL and 1.64% for TT. This underscores the relative safety profile of thyroidectomy procedures. Thyroidectomy surgeons and hospitals should use these data as a benchmark to compare their own rate of complications and for quality improvement initiatives.

Interestingly, UL was significantly more likely than TT to be associated with surgical complications and return to OR (Table 3). With regard to surgical complications, there was a greater incidence of wound dehiscence and deep SSI in the UL group, indicating that some unidentified factor contributes to increased surgical complications in this cohort. It is possible that the challenge of partial thyroidectomy through a limited skin incision results in greater soft tissue trauma and consequent AE, although the techniques for UL versus TT are nearly identical. While the surgical extent of TT is greater, it may be that the technical sophistication of UL is more, in that it entails organ-sparing of half of the thyroid gland. Of note, when we separated surgical complications by type (i.e., superficial/deep/ organ space wound infection, wound dehiscence, etc) and performed additional multivariable analysis for TT versus UL, no one specific complication type was significantly elevated in the UL group. NSQIP is limited in that it does not track surgeon experience (which has been shown to decrease the risk of AE after UL or TT). However, it is possible to track the reason for reoperation and/or readmission. After analyzing causes for reoperation and readmission, we found that over 70% of reoperations and readmissions were for cancer, neoplasm, and/or goiter (Table 4). These cases are thus attributable to completion thyroidectomy, and

Post-operative Diagnosis for Patients who Returned to the OR			
Diagnosis	Unilateral (n=587)	Diagnosis	Total (n=442)
Malignant neoplasm of thyroid gland	51.30%	Malignant neoplasm of thyroid gland	29.40%
Nontoxic uninodular goiter	15.50%	Nontoxic multinodular goiter	29%
Benign neoplasm of thyroid glands	9.20%	Benign neoplasm of thyroid glands	5.40%
Nontoxic multinodular goiter	6.60%	Goiter unspecified	5.40%
Neoplasm of uncertain behavior of other and unspecified endocrine glands	2.90%	Toxic diffuse goiter without thyrotoxic crisis or storm	4.80%
Goiter unspecified	2.20%	Nontoxic uninodular goiter	4.50%
Unspecified disorder of thyroid	1.90%	Chronic lymphocytic thyroiditis	3.40%
Unspecified nontoxic nodular goiter	1.40%	Toxic multinodular goiter without thyrotoxic crisis or storm	2.90%
Post-operative Diagnosis for Patients Who Were Readmitted			
Diagnosis	Unilateral (n=138)	Diagnosis	Total (n=311)
Malignant neoplasm of thyroid gland	34.10%	Malignant neoplasm of thyroid gland	33.40%
Nontoxic uninodular goiter	15.90%	Nontoxic multinodular goiter	26.70%
Benign neoplasm of thyroid glands	15.20%	Goiter unspecified	5.80%
Nonotoxic multinodular goiter	11.60%	Nontoxic uninodular goiter	5.80%
Goiter unspecified	3.60%	Toxic diffuse goiter without thyrotoxic crisis or storm	5.10%
Unspecified disorder of thyroid	2.90%	Benign neoplasm of thyroid glands	4.50%
Neoplasm of uncertain behavior of other and unspecified endocrine glands	2.20%	Chronic lymphocytic thyroiditis	3.50%
Nontoxic uninodular goiter	2.20%	Unspecified nontoxic nodular goiter	2.30%
	Unilateral (n=2275)	Total (n=4066)	P
Return to the OR	1.90%	1.90%	0.91
	Unilateral (n=448)	Total (n=977)	
Readmission	2.50%	3.10%	0.52

Unilateral refers to unilateral lobectomy; total refers to total thyroidectomy.

Table 4: Diagnosis codes associated with return to operating room and readmission.

not reoperation or readmission for postoperative complications. After excluding these cases from statistical analysis, there were no longer any significant differences in UL versus TT groups for reoperation and/or readmission (1.9% vs 1.9%, p=.91 for reoperation; 2.5% vs 3.1%, p=.52 for readmission). Based on this preliminary analysis, it appears as though the vast majority of reoperations and readmissions are thus attributable to the need for completion thyroidectomy after UL, and not any specific AE requiring surgical intervention. This finding would suggest that UL does not confer any specific risk for reoperation greater than TT, outside of the possible need for completion thyroidectomy. Thus, future research may be useful identifying which patients will go on to ultimately require completion thyroidectomy, versus any specific modification of the techniques for UL. Similarly, we found a higher rate of readmission on univariate analysis for TT, as opposed to UL. However, regression analysis demonstrated that modality choice does not confer increased risk of readmission, which would suggest that there is some other reason that readmission rates are higher for TT. Given that this outcome is partially, but not totally ameliorated when accounting for completion thyroidectomies, it suggests that there are other, unidentified factors contributing to these results.

A major weakness of the NSQIP database is that it was designed to capture data for all surgeries and therefore some procedure-specific information is not collected. NSQIP does not specifically track the most critical complications for which monitoring are recommended following thyroidectomy. For instance, it may not be representative to use "need for transfusion" as a metric to assess postoperative hemorrhage, or hematoma requiring evacuation. Some authors have used the information on reoperation as a surrogate for the development of neck hematoma [32]. While the reported morbidity rate (0.1%) is accurate based on the data recorded, this number could be an underrepresentation of the true morbidity rate associated with postoperative bleeding. For example, while 0.4% of patients were listed as having a 30-day surgical complication, 2.2% of patients had a reoperation within 30 days of the index procedure, thus suggesting a discrepancy (as most reoperations are due to surgical complications).

Neither the incidence of nerve injury specific to thyroid surgery (recurrent laryngeal nerve and superior laryngeal nerve), nor the use of intraoperative neuromonitoring is specifically tracked in the NSQIP. While a systematic review with meta-analysis showed no statistically significant difference in the incidence of recurrent laryngeal nerve palsy when using intraoperative nerve monitoring versus visualization alone during thyroidectomy, the technique of intraoperative neuromonitoring in thyroid surgery has high accuracy, specificity, sensitivity and negative predictive value in excluding postoperative recurrent laryngeal nerve palsy, and is very commonly used in thyroid surgery [33,34].

Hypocalcemia is another feared complication of thyroid surgery. The incidence of postoperative hypocalcemia (transient or permanent) following thyroidectomy ranges from 0% to 83%, with the highest incidence in patients with total thyroidectomy for cancer (28%), and those with subtotal thyroidectomy for thyrotoxicosis (23%). Conversely, its incidence is lowest in patients having subtotal thyroidectomy for other diseases (1.5%) and lobectomy (0%) [35]. Baldassarre, et al studied the incidence of hypocalcemia after thyroidectomy in 119,567 patients [36]. The overall incidence of hypocalcemia was 5.5%, with significant increases in patients undergoing total thyroidectomy (9.0%) and total thyroidectomy with bilateral neck dissection (23.4%), as opposed to thyroid lobectomy alone (1.9%). In their study, hypocalcemia resulted in an additional 1.47 inpatient hospital days, on average. There is additional debate over which postoperative labs to obtain (PTH versus ionized calcium levels), the timing of postoperative laboratory testing, and doses of supplemental calcium to administer in the setting of postoperative hypocalcemia. NSQIP dataset does not directly record this data, which is relevant to thyroid surgery. For patients readmitted within 30 days, the reason for readmission was hypocalcemia in 33%. Finally, NSQIP does not allow comparisons between high volume and low volume surgeons as well as high volume and low volume institutions; therefore conclusions cannot be made regarding surgical outcomes among these groups. Each of these factors has been found to be associated with mortality, complication rates and length of stay for different surgical procedures [37]. Regardless of these limitations, these data are important for patient informed consent, and quality improvement processes.

Conclusion

The morbidity and mortality of thyroid surgery is relatively low, and compares favorably with other surgical procedures. Surgical complications (specifically deep wound infection and wound dehiscence) are increased with respect to UL as opposed to TT. The increased risk of reoperation seen in UL as compared to TT is likely attributable to the need for completion thyroidectomy in these patients. Preoperative comorbidities should be considered when weighing the risks of thyroid surgery and its accompanying complications.

References

1. Howlader N, Noone AM, Krapcho M (2014) SEER Cancer Statistics Review, 1975-2010, National Cancer Institute.
2. Pieracci FM1, Fahey TJ 3rd (2008) Effect of hospital volume of thyroidectomies on outcomes following substernal thyroidectomy. See comment in PubMed Commons below World J Surg 32: 740-746.
3. Sosa JA1, Bowman HM, Tielsch JM, Powe NR, Gordon TA, et al. (1998) The importance of surgeon experience for clinical and economic outcomes from thyroidectomy. See comment in PubMed Commons below Ann Surg 228: 320-330.
4. Sosa JA1, Mehta PJ, Wang TS, Boudourakis L, Roman SA (2008) A population-based study of outcomes from thyroidectomy in aging Americans: at what cost? See comment in PubMed Commons below J Am Coll Surg 206: 1097-1105.
5. Gupta PK1, Smith RB, Gupta H, Forse RA, Fang X, et al. (2012) Outcomes after thyroidectomy and parathyroidectomy. See comment in PubMed Commons below Head Neck 34: 477-484.
6. Udelsman R1, Shaha AR (2005) Is total thyroidectomy the best possible surgical management for well-differentiated thyroid cancer? See comment in PubMed Commons below Lancet Oncol 6: 529-531.
7. Clark OH (1982) Total thyroidectomy: the treatment of choice for patients with differentiated thyroid cancer. See comment in PubMed Commons below Ann Surg 196: 361-370.
8. White ML1, Gauger PG, Doherty GM (2007) Central lymph node dissection in differentiated thyroid cancer. See comment in PubMed Commons below World J Surg 31: 895-904.
9. Roh JL1, Park JY, Park CI (2007) Total thyroidectomy plus neck dissection in differentiated papillary thyroid carcinoma patients: pattern of nodal metastasis, morbidity, recurrence, and postoperative levels of serum parathyroid hormone. See comment in PubMed Commons below Ann Surg 245: 604-610.
10. Lauer MS1, D'Agostino RB Sr (2013) The randomized registry trial--the next disruptive technology in clinical research? See comment in PubMed Commons below N Engl J Med 369: 1579-1581.
11. site.acsnsqip.org/participant-use-data-file/
12. Shiloach M1, Frencher SK Jr, Steeger JE, Rowell KS, Bartzokis K, et al. (2010) Toward robust information: data quality and inter-rater reliability in the American College of Surgeons National Surgical Quality Improvement Program. See comment in PubMed Commons below J Am Coll Surg 210: 6-16.
13. Goldfarb M1, Perry Z, A Hodin R, Parangi S (2011) Medical and surgical risks in thyroid surgery: lessons from the NSQIP. See comment in PubMed Commons below Ann Surg Oncol 18: 3551-3558.

14. Burkey SH1, van Heerden JA, Thompson GB, Grant CS, Schleck CD, et al. (2001) Reexploration for symptomatic hematomas after cervical exploration. See comment in PubMed Commons below Surgery 130: 914-920.

15. Reeve T1, Thompson NW (2000) Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. See comment in PubMed Commons below World J Surg 24: 971-975.

16. Hall BL1, Hirbe M, Yan Y, Khuri SF, Henderson WG, et al. (2007) Thyroid and parathyroid operations in veterans affairs and selected university medical centers: results of the patient safety in surgery study. See comment in PubMed Commons below J Am Coll Surg 204: 1222-1234.

17. Ryu J1, Ryu YM, Jung YS, Kim SJ, Lee YJ, et al. (2013) Extent of thyroidectomy affects vocal and throat functions: a prospective observational study of lobectomy versus total thyroidectomy. See comment in PubMed Commons below Surgery 154: 611-620.

18. Leiker AJ, Yen TW, Cheung K, Evans DB, Wang TS.(2013) Cost analysis of thyroid lobectomy and intraoperative frozen section versus total thyroidectomy in patients with a cytologic diagnosis of “suspicious for papillary thyroid cancer”. Surgery 154: 1307-1313.

19. Adam MA1, Pura J, Gu L, Dinan MA, Tyler DS, et al. (2014) Extent of surgery for papillary thyroid cancer is not associated with survival: an analysis of 61,775 patients. See comment in PubMed Commons below Ann Surg 260: 601-605.

20. Lee J, Park JH, Lee CR, Chung WY, Park CS (2013) Long-term outcomes of total thyroidectomy versus thyroid lobectomy for papillary thyroid microcarcinoma: comparative analysis after propensity score matching. Thyroid 23: 1408-1415.

21. Ebina A, Sugitani I, Fujimoto Y, Yamada K (2014) Risk-adapted management of papillary thyroid carcinoma according to our own risk group classification system: Is thyroid lobectomy the treatment of choice for low-risk patients? See comment in PubMed Commons below Surgery .

22. Ogilvie JB1, Patel KN, Heller KS (2010) Impact of the 2009 American Thyroid Association guidelines on the choice of operation for well-differentiated thyroid microcarcinomas. See comment in PubMed Commons below Surgery 148: 1222-1226.

23. Kuo EJ1, Roman SA, Sosa JA (2013) Patients with follicular and Hurthle cell microcarcinomas have compromised survival: a population level study of 22,738 patients. See comment in PubMed Commons below Surgery 154: 1246-1253.

24. Monteiro R1, Mino JS, Siperstein AE (2013) Trends and disparities in education between specialties in thyroid and parathyroid surgery: An analysis of 55,402 NSQIP patients. See comment in PubMed Commons below Surgery 154: 720-728.

25. Gupta PK1, Smith RB, Gupta H, Forse RA, Fang X, et al. (2012) Outcomes after thyroidectomy and parathyroidectomy. See comment in PubMed Commons below Head Neck 34: 477-484.

26. Arozullah AM1, Khuri SF, Henderson WG, Daley J; Participants in the National Veterans Affairs Surgical Quality Improvement Program (2001) Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. See comment in PubMed Commons below Ann Intern Med 135: 847-857.

27. Johnson RG, Arozullah AM, Neumayer L, Henderson WG, Hosokawa P, et al. (2007) Multivariable predictors of postoperative respiratory failure after general and vascular surgery: results from the patient safety in surgery study. J Am Coll Surg 204: 1188-1198.

28. Wren SM1, Martin M, Yoon JK, Bech F (2010) Postoperative pneumonia-prevention program for the inpatient surgical ward. See comment in PubMed Commons below J Am Coll Surg 210: 491-495.

29. Al-Tawfiq JA1, Abed MS (2010) Decreasing ventilator-associated pneumonia in adult intensive care units using the Institute for Healthcare Improvement bundle. See comment in PubMed Commons below Am J Infect Control 38: 552-556.

30. Abraham CR1, Ata A2, Carsello CB2, Chan TL2, Stain SC2, et al. (2014) A NSQIP risk assessment for thyroid surgery based on comorbidities. See comment in PubMed Commons below J Am Coll Surg 218: 1231-1237.

31. Dimick JB1, Welch HG, Birkmeyer JD (2004) Surgical mortality as an indicator of hospital quality: the problem with small sample size. See comment in PubMed Commons below JAMA 292: 847-851.

32. Gupta PK1, Smith RB, Gupta H, Forse RA, Fang X, et al. (2012) Outcomes after thyroidectomy and parathyroidectomy. See comment in PubMed Commons below Head Neck 34: 477-484.

33. Pisanu A, Porceddu G, Podda M, Cois A, Uccheddu A (2014) Systematic review with meta-analysis of studies comparing intraoperative neuromonitoring of recurrent laryngeal nerves versus visualization alone during thyroidectomy. J Surg Res 188: 152-161.

34. Calò PG1, Pisano G, Medas F, Tatti A, Pittau MR, et al. (2013) Intraoperative recurrent laryngeal nerve monitoring in thyroid surgery: is it really useful? See comment in PubMed Commons below Clin Ter 164: e193-198.

35. Burnett HF, Mabry CD, Westbrook KC (1977) Hypocalcemia after thyroidectomy: mechanisms and management. See comment in PubMed Commons below South Med J 70: 1045-1048.

36. Baldassarre RL1, Chang DC, Brumund KT, Bouvet M (2012) Predictors of hypocalcemia after thyroidectomy: results from the nationwide inpatient sample. See comment in PubMed Commons below ISRN Surg 2012: 838614.

37. Stavrakis AI1, Ituarte PH, Ko CY, Yeh MW (2007) Surgeon volume as a predictor of outcomes in inpatient and outpatient endocrine surgery. See comment in PubMed Commons below Surgery 142: 887-899.