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No Additional Morbidity Associated with Adding Neck Dissection to A Thyroidectomy: A NSQIP Analysis Of 44,887 Patients

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Abstract

Background: The potential oncologic benefit of adding neck dissection to thyroidectomy procedures is balanced with a presumed increased morbidity from more extensive surgery. Although there has been some literature documenting the risks of adverse events (AE) from neck dissection in single institutions, there has not been a large volume analysis to investigate this issue.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) 2005–2012 registry was queried to identify all patients undergoing thyroidectomy, with or without associated neck dissection. Patients were propensity-score matched 1:1 for preoperative factors. Outcomes of interest included surgical wound and medical complications, reoperation, and mortality. Univariate and multivariate analyses were utilized to identify predictors of these events. Odds ratios were calculated for adverse events between cohorts.

Results: A total of 44,887 patients were identified for analysis. Of these, 38,449 (85.4%) underwent an isolated thyroidectomy (IT) procedure without neck dissection, and 6,438 (14.6%) underwent a thyroidectomy with neck dissection (TND). After matching, there were 4,814 patients found to have similar pre-operative co morbidities, demographics and operative factors. There was a higher rate of overall complications in the IT group (4.25%) than the TND group (3.00%, p<0.001). There was no statistically significant difference in surgical complications. There was, however, a statistically significant increase in medical complications in the IT group (3.83%) over the TND group (2.68%, p=0.005). There was no difference in post-operative mortality between both groups. There was a higher rate of return to the operating room for the IT group (2.54%) compared to the TND group (1.54%, p=0.004).

Conclusions: The morbidity and mortality of thyroid surgery is relatively low overall. In this analysis there was no measurable increase in the complications conferred by the addition of a neck dissection. These data are important for patient informed consent, risk stratification, and surgical planning.

Keywords: Thyroidectomy; NSQIP; Neck dissection; Outcomes; Mortality; Complications

Introduction

The rate of thyroid cancer is increasing, but it is unknown whether this represents a true increase in incidence, or an increased detection rate of cancer in smaller nodules. 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].

It has long been suggested that the presence of cervical metastasis of differentiated thyroid cancer does not affect survival. This was reflected in the various prognostic scoring systems of AMES, AGES, and MACIS [2,4]. One study challenged this dogma, noting there was increased survival with prophylactic removal of lymph nodes [5]. However there is ongoing debate regarding the need for prophylactic neck dissection.

The potential oncologic benefit of adding neck dissection to thyroidectomy procedures is balanced, however, with a presumed increased morbidity from more extensive surgery. Although there has been some literature documenting the risks of hypoparathyroidism [6] and recurrent laryngeal nerve injury from neck dissection in single institutions, there has not been a large volume analysis to investigate potential increased risks of overall medical and surgical complications with the addition of neck dissection to a thyroidectomy procedure [7].

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. The data include 135 variables including preoperative status, intra operative variables, and postoperative outcomes, including 30-day postoperative morbidity and mortality. 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 [8].

The purpose of this study was to use the ACS-NSQIP database to evaluate a high volume of patients to assess whether adding a neck dissection to a thyroidectomy conferred more risk of complications. Although most reports on thyroidectomy outcomes focus on technical complications such as recurrent laryngeal nerve injury and hypo parathyroidism, we sought to understand nontechnical complications that occurred with the addition of neck dissection to thyroid surgery.

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 [9,10]. All study aspects were approved by the respective Institutional Review Boards.

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) 2005 – 2012 registry was queried. The ACS-NSQIP is a prospectively validated multi-institutional database which began in 2004 and provides comprehensive preoperative, per operative, and 30-day postoperative data for 2.3 million de-identified patients from over 460 participating institutions across the United States. Patients with only primary current procedural terminology (CPT) codes 60220, 60225, and 60240 were stratified to the isolated thyroidectomy (IT) group. The thyroidectomy with neck dissection (TND) group consisted of patients with only primary CPT code 60252 or 60254. The CPT codes used are shown in (Table 1).

Peri-operative variables

Preoperative variables defined in NSQIP included demographic variables age, sex, race, and BMI, medical co morbidities including diabetes, dyspnea, COPD, previous cardiac surgery, pervious stroke, hypertension, disseminated cancer, wound infection, steroid use, bleeding disorders, chemotherapy, radiotherapy, sepsis, wound class, and ASA class, and intraoperative characteristics including inpatient status and total RVU.

The primary outcomes of interest were 30-day complication rates, categorized as surgical wound complications, medical complications, and overall complications. Surgical wound complications included superficial, deep, or organ-space surgical site infection (SSI), wound dehiscence. Medical complications examined included pneumonia, unplanned reintubation, pulmonary embolism, ventilator dependence >48 hours, urinary tract infection, stroke, peripheral nerve injury, cardiac arrest, myocardial infarction, blood transfusions, deep vein thrombosis (DVT), sepsis, and septic shock. Return to the operating room and death were also included in this analysis as separate entities.

Statistical analysis

Patients were propensity score matched to balance out differences between the patient populations. For each patient, the variables in (Table 2) were used to model their probability for undergoing an outpatient procedure. Using these values, IT patients were paired with the nearest TND procedure without replacement in a 1:1 ratio. When a close match was not available, the case was eliminated. Specific variables included for matching included: age, BMI, current smoking status, current alcohol abuse, diabetes mellitus, dyspnea, COPD, previous cardiac surgery, previous TIA or stroke, hypertension, disseminated cancer, current steroid or immunosuppressant use, history of bleeding disorder, history of chemotherapy, history of radiotherapy, current sepsis, wound class, and hospital setting. Propensity score matching was carried out in SPSS (IBM Corp, Armonk, NY), and has been previously described in detail [11-13].

Comparison of the descriptive statistics and outcomes for the matched cohorts was performed using chi-square tests for categorical variables and Student's *t* test for continuous variables, with significance defined as $p < 0.05$. Statistical evaluation of outcomes was not evaluated for unmatched cohorts. Multiple logistic regression models with adjusted odds ratios for complications, return to OR, and death were constructed. Perioperative variables with $n \geq 10$ and $p < 0.2$ as identified in a bivariate screen were included in the regression models. Again, $p < 0.05$ was considered significant. C-statistics were calculated to assess model discriminatory capability. All analyses were performed using SPSS version 22 (IBM Corp., Armonk, NY).

		Pre-Match		Post-Match	
CPT	Description	IT	TND	IT	TND
60220	Thyroid lobectomy	15,020	0	1,812	0
60225	Thyroid lobectomy, with contralateral subtotal lobectomy	1,322	0	187	0
60240	Thyroidectomy, total	22,107	0	2,947	0
60252	Thyroidectomy, with limited neck dissection	0	5,586	0	4,149
60254	Thyroidectomy, with radical neck dissection	0	852	0	665
	Totals	38,449	6,438	4,814	4,814

Table 1: Pre- and post-match patient cohort totals, versus American Medical Association's Current Procedural Terminology codes.

CPT= Current Procedural Terminology Code; IT=Isolated Thyroidectomy; TND=Thyroidectomy with Neck Dissection

Results

A total of 44,887 patients were identified for analysis, of which 38,449 (85.4%) underwent an isolated thyroidectomy (IT) procedure without neck dissection, and 6,438 (14.6%) underwent a thyroidectomy with neck dissection (TND).

The mean age was 51.48 years in the IT group compared to 48.72 in the TND group (p<0.001). Males made up 18.2% of the IT group compared to 26.3% in the TND group (p<0.001). BMI was slightly higher in the IT group 29.77 (SEM 7.5) compared to the TND group (SEM 7.02, p<0.001). American Society of Anesthesiologists (ASA) classification 1 or 2 was assigned to 74.7% of those undergoing isolated thyroidectomy compared to 70.9% in those undergoing thyroidectomy with neck dissection (p<0.001).

Preoperative characteristics are described in (Table 2). Within the isolated thyroidectomy group there was a significantly higher incidence of patient smoking (15.8% vs 12%, p<0.001), diabetes mellitus, dyspnea (11.4% vs 9%, p<0.001), chronic obstructive pulmonary disease (1.9% vs 1.4%, p=0.004), stroke (2.9% vs 2.2%, p=0.004), and hypertension (38% vs 31.1%, p<0.001). The thyroidectomy with neck dissection group had significantly higher rates of disseminated cancer (2.3% vs 0.5%, p<0.001), as well as history of radiotherapy (0.3% vs 0.1%, p=0.004). Wound classification was more likely to be clean in the isolated thyroidectomy group (98% vs 96.9%, p<0.001). Operative times were longer (180.5 vs 111.3 minutes, p<0.001) and total relative value units (RVUs) were higher (28.96 vs 15.72, p<0.001) in the thyroidectomy with neck dissection group.

Matching of preoperative characteristics outlined in the methods section was performed to have homogenous groups for analysis. After matching, there were 4,814 patients found to have similar pre-operative co morbidities and demographics, as seen in (Table 3).

Complications for the IT and TND groups, in the matched cohort, are reported in (Table 4). There was a higher rate of overall complications in the IT group (4.25%) than the TND group (3.00%, p<0.001). There was no statistically significant difference in surgical wound complications among the IT cohort (0.65%) and the TND cohort (0.47%, p=0.284). However, a statistically significant increase in medical complications in the IT group (3.83%) over the TND group (2.68%, p=.005) was noted. With regard to

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	Isolated Thyroidectomy (N=38,449)	Thyroidectomy with Neck Dissection (N=6,574)	P
Current Smoker	15.80%	12.00%	<0.001
Alcohol Abuse	1.00%	1.10%	0.748
Diabetes Mellitus	11.40%	9.00%	<0.001
Dyspnea	8.10%	5.10%	<0.001
COPD	1.90%	1.40%	0.004
Previous Cardiac Surgery	3.30%	3.00%	0.210
Previous Stroke	2.90%	2.20%	0.004
Hypertension	38.00%	31.10%	<0.001
Disseminated cancer	0.50%	2.30%	<0.001
Current Steroid Use	1.80%	1.90%	0.955
Bleeding disorders	1.20%	1.40%	0.455
History of Chemotherapy	0.20%	0.40%	0.043
History of Radiotherapy	0.10%	0.30%	0.004
Current Sepsis	0.30%	0.20%	0.211
Wound Class not “Clean”	0.30%	0.20%	0.211

Table 2: Preoperative and Operative Characteristics of Pre-Match Cohorts

	Isolated Thyroidectomy (N=4,946)	Thyroidectomy with Neck Dissection (N=4,946)	P
Current Smoker	11.90%	12.20%	0.649
Alcohol Abuse	1.00%	1.20%	0.380
Diabetes Mellitus	8.20%	8.80%	0.413
Dyspnea	5.20%	5.30%	0.919
COPD	1.30%	1.40%	0.764
Previous Cardiac Surgery	2.60%	2.90%	0.330
Previous Stroke	2.10%	2.30%	0.537
Hypertension	30.1%	31.8%	0.120
Disseminated cancer	2.00%	2.20%	0.579
Current Steroid Use	1.60%	1.70%	0.857
Bleeding disorders	1.50%	1.40%	0.924
History of Chemotherapy	0.50%	0.40%	0.601
History of Radiotherapy	0.30%	0.30%	1.000
Current Sepsis	0.30%	0.20%	0.818

Table 3: Preoperative Characteristics of Post-match Cohorts

the IT cohort, there were trends for higher rates of unplanned reintubation, pulmonary embolism, prolonged post-operative ventilation, urinary tract infection, myocardial infarction, blood transfusion, deep venous thrombosis, and sepsis, but none of these were statistically significant. The only individual complication that reached statistical significance was post-operative stroke (0.16% for IT vs 0.00% for TND, p=0.014). There was no difference in post-operative mortality between each cohort. There was a higher rate of return to the operating room for the IT group compared to the TND group (2.54% vs1.54%, p=0.004).

	Isolated Thyroidectomy (N=4,946)	Thyroidectomy with Neck Dissection (N=4,946)	P
Overall Complications	4.25%	3.00%	0.003*
Surgical Wound Complications	0.65%	0.47%	0.284
Superficial surgical site infection (SSI)	0.47%	0.26%	0.130
Deep Incisional SSI	0.10%	0.13%	0.739
Organ Space SSI	0.05%	0.08%	0.655
Wound Disruption	0.05%	0.05%	1.000
Medical Complications	3.83%	2.68%	0.005*
Pneumonia	0.31%	0.44%	0.352
Unplanned Intubation	0.63%	0.47%	0.353
Pulmonary Embolism	0.08%	0.03%	0.317
Ventilator>48 hours	0.36%	0.23%	0.296
Urinary Tract Infection	0.36%	0.29%	0.548
Stroke	0.16%	0.00%	0.014*
Peripheral Nerve Injury	0.08%	0.13%	0.479
Cardiac Arrest	0.10%	0.03%	0.180
Myocardial Infarction	0.08%	0.05%	0.655
Blood Transfusions	0.13%	0.08%	0.479
Deep Venous Thrombosis	0.16%	0.05%	0.157
Sepsis	0.29%	0.16%	0.225
Septic Shock	0.08%	0.05%	0.655
Death	0.18%	0.08%	0.206
Return to OR	2.45%	1.54%	0.004*
Operative Time (minutes)	115.4	174.8	0.818
Total RVU (avg)	17.16 ± 6.35	24.23 ± 6.79	<0.001*
Academic Hospital	6.91%	5.90%	<0.001*
* Denotes significance P<0.05			

Table 4: Unadjusted Outcomes of Matched Cohorts

Odds ratio analysis was performed between the IT and TND groups for the matched cohort, as seen in (Table 5). With reference to the isolated thyroidectomy group, the thyroidectomy with neck dissection group had a significant adjusted odds ratio <1 for overall complications, medical complications, and return to the operating room.

Discussion

Differentiated thyroid cancer (comprised of papillary thyroid cancer and follicular thyroid cancer) makes up approximately 90% of all thyroid cancers overall [14]. Nodal metastases are known to significantly correlate with persistence and recurrence of disease, and micrometastases are found in up to 90% of prophylactically dissected neck compartments [15,16]. Neck dissection was first described in 1986 for medullary thyroid carcinoma as a method to decrease tumor burden and favorably impact overall survival [17]. Thereafter neck dissection was introduced for papillary thyroid carcinoma [18]. Although it was traditionally held that the presence of cervical metastases did not affect survival in thyroid cancer, this dogma has recently been challenged by a large population-based study demonstrating decreased survival in patients with cervical metastases [5,19,20]. The risks and benefits must also be

	Adjusted Odds Ratio	95% CI for Odds Ratio		p	C-statistic
		Lower	Upper		
Surgical Wound Complications	0.710	0.460	1.096	0.122	0.630
Medical Complications	0.746	0.605	0.919	0.006*	0.599
Overall Complications	0.719	0.584	0.886	0.002*	0.594
Return to OR	0.689	0.527	0.900	0.006*	0.584
Death	0.815	0.400	3.205	0.815	0.838
* Denotes significance P<0.05					

Table 5: 30-day Complications Odds Ratio of TND vs IT

weighed regarding the potential need for a reoperation neck dissection following a thyroidectomy and the obstacles this may practically impose. Notwithstanding the controversy surrounding elective neck dissection in a clinically negative neck, there is general consensus about the utility of therapeutic neck dissection for the treatment of macroscopic lymph node metastases [21,22]. However, little is known about the attendant surgical morbidity associated with neck dissection after thyroidectomy.

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.

A major weakness of the NSQIP database is that it was designed to capture data for all surgeries with general complications as the assessment goal; therefore, some procedure-specific information is not collected. For example, data on thyroidectomy does not include information on injury to the recurrent laryngeal nerve nor on the rate of hypocalcemia. Information on post-operative hematoma is not tracked, but some authors have used the information on “bleeding requiring transfusion” or “reoperation” as a surrogate for the development of neck hematoma [23]. Hypocalcaemia is not specifically tracked in 30-day outcomes, but can be identified from diagnosis codes from patients who are readmitted [24]. Neither recurrent laryngeal nerve, nor spinal accessory nerve injury are specifically tracked, although NSQIP does have an entry for “peripheral nerve injury”. In our analysis, peripheral nerve injury was elevated (although non-significantly) in the TND cohort. Unfortunately, NSQIP is unable to determine if this is due to direct injury to cranial nerves 10, 11, or 12 exposed in a neck dissection, or simply a reflection of transient neuropathies from poor positioning on the operating room table, which may occur more frequently with longer operating times. Another weakness is that NSQIP does not allow comparisons between high volume and low volume surgeons, nor between high volume and low volume institutions; therefore, conclusions cannot be made regarding surgical outcomes among these groups. Furthermore, specific diagnosis codes are not well accounted for in the setting of thyroidectomy within the dataset, hindering the specific comparison of those patients undergoing thyroidectomy for benign versus malignant disease processes. In addition, NSQIP does not differentiate between central and lateral neck dissections in the CPT codes 60252 and 60254 utilized in this study, also hindering the specific comparison of patients undergoing these two procedures. However, we did not aim to compare these disease processes and specific procedures, but rather to compare complications by merely adding a neck dissection to a thyroidectomy.

A 2014 NSQIP study assessed how various preoperative co morbidities and intraoperative variables were tied to thyroidectomy outcomes [25]. In an analysis of 38,577 cases 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 sub sternal thyroidectomy were 37% less likely to return to the operating room.

In our study the 30 day mortality was 0.18% for isolated thyroidectomy and 0.08% for thyroidectomy with neck dissection. These mortality rates compare favorably 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%) [26]. The overall complication rates found in our study were also low; 4.25% for isolated thyroidectomy and 3.0% for thyroidectomy with neck dissection. 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 improve their own quality control.

Rates of reoperation were significantly decreased in the TND group, compared to IT (OR 0.689, p=0.006). It seems reasonable that the increase in reoperation among the IT cohort may be accounted for by the need for completion thyroidectomy after a diagnostic lobectomy within the IT cohort. In fact, Qin et al. found that thyroid lobectomy had a higher rate of return to the operating room than total thyroidectomy [27]. Naturally, it would be expected that there would be an increased rate of hematoma with increased extent of surgery in the TND group compared to the IT group; but it appears that using rate of reoperation as a surrogate for development of hematoma is a dangerous assumption, and we would recommend against it for future NSQIP analyses.

It could easily be reasoned that the increased surgery of TND would confer more risk of complication than IT. Interestingly however, surgical wound complications were no different between cohorts on multivariable analysis, and surprisingly, postoperative medical complications were higher in the isolated thyroidectomy group. What is the driver behind the significantly increased medical (and thus, total) complications in the IT cohort?

On close examination, a number of hypotheses to explain these differences between IT and TND cohorts emerge. Case volume has been shown to correlate with outcomes after thyroidectomy, but is not tracked in NSQIP. Perhaps hospital setting could be used as a surrogate for case volume, as academic centers arguably are referred more advanced cases of thyroid carcinoma requiring neck dissection. Pre-match, the TND group had a higher percentage of academic medical centers (28.5% vs 25.3%, p< 0.05). Post-match, this difference was reversed, thus eliminating hospital setting as a possible reason for the differences seen in outcomes (5.9% vs 6.9%, p< 0.05). It is possible that case volume does indeed correlate with outcomes in these cohorts, but that “academic versus community” setting is not an accurate surrogate for this variable. It could also be reasoned that academic teaching hospitals may have different post-operative admitting protocols after thyroidectomy than their community hospital cohorts; and if the rates of post-operative admission differed in each group, then certainly this could affect the number of complications recorded by the NSQIP’s surgical clinical nurse reviewer.

In the analysis of matched cohorts (Table 4), overall complications were increased in the IT cohort compared to the TND cohort. This difference was not due to the surgical complications (no significant difference), but rather due to the increased post-operative medical complications in the IT cohort. Examination of the medical complications shows that, other than stroke, there was no single adverse event that was significantly higher in the IT group, but rather only in aggregate were the medical complications statistically higher in the IT group. This difference was identified despite the increased operative time and work RVU in the TND cohort (both p<0.001). Given that there is no conceivable direct mechanism by which IT could increase the risk of stroke or other medical complication, we are limited to conjecture to explain this constellation of findings. It is conceivable that patients undergoing TND receive a more extensive preoperative workup, and more invasive postoperative monitoring, and that these factors help to minimize rates of postoperative medical adverse events.

In summary, this NSQIP analysis illustrates little to no objective morbidity conferred to patients by the addition of neck dissection to their thyroidectomy procedure in the matched cohort. No difference occurred regarding surgical wound complications or mortality. Medical complications, overall complications, and return to OR were significantly elevated in the IT group. However, the difference in medical complications was minimal (3.83% vs 2.68%), and should not be considered clinically significant.

Conclusions

The general morbidity and mortality of thyroid surgery is relatively low. In this analysis there was no measurable increase in general complications conferred by the addition of a neck dissection. This conclusion is guarded given the limitations of this study. Preoperative co morbidities should be considered when weighing the risks of thyroid surgery and its accompanying complications.

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Conflicts of Interest

The authors report no relevant financial disclosures related to this current work.

Ethical Approval

De-identified patient information is freely available to all institutional members who comply with the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996.

Disclaimer

The NSQIP and the hospitals participating in the NSQIP are the source of the data used herein; they have not been verified and are not responsible for the statistical validity of the data analysis, or the conclusions derived by the authors of this study.

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