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Does Surgical Volume Influence the Need for Second Surgery? A Pilot Study

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Abstract

Objective. To examine outcomes of pediatric thyroidectomy in the context of training background, institution, and experience of the surgeon.

Study Design. Case series with chart review.

Setting. A tertiary academic medical center and a pediatric hospital.

Subjects and Methods. Eighty-one thyroidectomy patients younger than 18 years. Outcomes were major complications (recurrent laryngeal nerve injury, permanent hypocalcemia, and wound infection), length of stay (LOS), and need for repeat surgery.

Results. Eighty-one patients, 39 from the University of Nebraska Medical Center and 42 from the Children's Hospital and Medical Center–Omaha, were identified over a 12-year time period. No difference was found in surgeon training (otolaryngology/head and neck surgery vs general/pediatric surgery) for complications (1 vs 1, odds ratio [OR] = 0.76, 95% confidence interval [CI] = [0.05, 13.1]), LOS $>$1 day (5 vs 13, OR = 0.39, 95% CI = [0.13, 1.24]), or need for second surgery (4 vs 7, OR = 1.47, 95% CI = [0.39, 5.49]). Higher surgeon volume ($\geq$12 surgeries) was found to be significant for decreased need for second surgery (3 vs 8, OR = 6.67, 95% CI = [1.57, 27.17]). Patients of higher-volume surgeons were 4.2 times more likely to stay in the hospital 1 day or less compared with those patients operated on by surgeons with less experience (7 vs 11, 95% CI = [1.59, 15.0]).

Conclusions. Need for second surgery in pediatric thyroidectomy may be predicted by surgical volume.

Keywords

pediatric, thyroidectomy, papillary, carcinoma, volume

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Pediatric thyroidectomy is an uncommon procedure, but rates of patients requiring thyroidectomy are increasing.[1] Surgical indications include compressive symptoms, hyperthyroidism, nodule of unknown significance, and thyroid carcinoma. The incidence of thyroid nodules and malignancy in the pediatric population continues to rise every year.[2] While most of these lesions are benign, thyroid nodules in children carry a higher risk of carcinoma compared with in adults.[3] This prompted early investigators to advocate deferment of extended workup while promoting diagnostic surgery.[4] Well-differentiated thyroid cancer is the most common endocrine cancer in children, ranging from 1% of malignancies in prepubertal children to 7% in adolescents.[5] Advancements in radiographic, pathologic, and operative technologies have changed the paradigm for management of these patients, culminating in the recent development of guidelines for workup and management of pediatric patients with thyroid nodules and thyroid carcinoma.

Recent literature has described the influence of surgical volume in patient outcomes following appendectomy, pyloromyotomy, inguinal herniorrhaphy, and endocrine surgery in the pediatric population.[6] Although rates of complications in pediatric thyroid surgery are low, authors have

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demonstrated that pediatric thyroidectomy complications may be reduced by higher operative volume and surgical training. Recent guidelines have emphasized the importance of the multidisciplinary approach involving the surgeon, nuclear medicine physicians, and endocrinologists in dedicated pediatric thyroid clinics with standardization of workup and patient management. Although such programs have clear benefits, adoption continues to be limited.[7-9]

The purpose of this study was to assess practice patterns and outcomes of surgeons within a single catchment area prior to institution of a focused multidisciplinary clinic. We sought to determine whether surgical training, hospital site, or proportionate volume would have any influence on the complication rates, length of hospital stay, and need for reoperation.

Methods

This study was approved by the University of Nebraska Medical Center (UNMC) Institutional Review Board, which has oversight at UNMC and Children's Hospital and Medical Center–Omaha (CHMC). Health databases were queried at both institutions using ICD-9 codes 193, 226, 241.0-241.9, 242.1-242.4, 243, 244.0, 224.3, 244.8, 246.2, 246.8, and 246.9 from January 2002 to March 2014. Our study was limited to subjects $\leq$0 to 17 years old. The initial query found 855 patients. Charts were reviewed for patients coded for thyroid lobectomy, hemithyroidectomy, or total thyroidectomy. Patients were excluded if they had no thyroid surgery, were older than 18 years at the time of surgery, or had incomplete surgical data.

The review included 102 patients, of whom 81 had adequate records for analysis of outcomes. Record access included paper charts and 2 separate electronic charting systems. Demographic information included age, sex, and race. Clinical information included date of procedure, procedure type, nerve monitor use, neck dissection status, operative indication, final diagnosis, operating surgeon's background (general surgery, general pediatric surgery, pediatric otolaryngology, general otolaryngology, and head & neck oncology), presence of fine-needle aspiration (FNA) testing, cancer status, cancer staging, length of stay (LOS) postoperatively, and postoperative complications within 1 year.

Patient outcomes were assessed in 3 paradigms: hospital site, surgeon training background, and surgeon volume. Hospital site was identified as UNMC and CHMC. Surgeons were categorized as otolaryngology/head and neck surgery (OHNS) or general/pediatric surgery based on their academic department. There were no overlaps in categorization.

Stratification of volume was derived from available data. Surgeons were classified as "higher volume" if they met 2 criteria: (1) if they performed 12 or more pediatric thyroidectomies during the study period and (2) if they had multiple pediatric thyroidectomies for multiple years. Remaining surgeons were designated "lower volume." Some surgeons also performed adult thyroidectomies, and some did not. Our outcomes were major complications (recurrent laryngeal nerve [RLN] injury, wound infection, permanent hypocalcemia), LOS, and need for second surgery.

Statistics

PC SAS version 9.4 (Chicago, Illinois, USA) and Microsoft Excel 365 ProPlus (Redmond, Washington, USA) are used for all summaries and analyses. Categorical data were analyzed using χ^2 tests or Fisher exact test. Absolute differences with odds ratios (ORs) and 95% confidence intervals (CIs) are presented. Continuous variables were tested for normality using the Shapiro-Wilk test. None of the variables passed the test of normality, so a nonparametric Wilcoxon test (when comparing 2 groups) or a nonparametric Kruskal-Wallis test (when comparing 3 or more groups) was used for comparisons. A logistic regression model was used to predict the variable "completion." Two logistic regression models were fit to predict LOS = 1 day. The first model contained the predictors number of surgeries performed ($<$12, $\geq$12) and surgeon training (general/pediatric surgery and OHNS).

Results

General Results

Eighty-one patients were identified. Demographic information is listed in **Table 1**. There was a preponderance of female patients (79%), and the age range was 4 to 17 (mean = 13.2) years. Twenty-six (31%) patients had carcinoma of the thyroid, predominantly papillary thyroid carcinoma (n = 22). The remaining patients were classified as adenoma, multinodular goiter, lymphocytic thyroiditis, or Graves' disease on pathology report. Two patients were found to have "no significant histopathology." These patients were brothers undergoing prophylactic thyroidectomy for multiple endocrine neoplasia. Thirty-three patients underwent FNA. Ten FNAs showed papillary thyroid cancer (PTC) or were suspicious for PTC, 7 showed follicular neoplasm, and 13 showed benign pathology. Eighteen patients were found to have parathyroid tissue within the surgical pathology specimen. Thirty-three cases used a intraoperative RLN monitor or performed intraoperative electromyography.

Hospital Site

Thirty-nine patients were treated at UNMC and 42 at CHMC. UNMC had 1 bilateral vocal fold paresis, and CHMC had 1 wound infection. Institution was not a statistically significant variable for complications (OR = 1.08, 95% CI = [0.06, 17.86]) or LOS $>$1 day (10 vs 8, OR = 1.21, 95% CI = [0.42, 3.47]), or second surgery (6 vs 5, OR = 1.34, 95% CI = [0.38, 4.82]; **Table 2**).

Surgeon Training

Surgeon training was not significant for complications (1 vs 1, OR = 0.76, 95% CI = [0.05, 13.1]), LOS of $>$1 day (5 vs 13, OR = 0.39, 95% CI = [0.13, 1.24]), or need for second surgery (4 vs 7, OR = 1.47, 95% CI = [0.39, 5.49]; **Table 2**). General/pediatric surgeons performed 45 of the primary surgeries, while OHNS surgeons performed 36 of the surgeries. General/pediatric surgeons performed FNA before 11 of 45 of primary surgeries. OHNS performed FNA before 20 of 36 primary surgeries. RLN monitoring

Table 1. Demographics.

	UNMC (n = 39)	CHMC (n = 42)	Total (N = 81)
Gender			
Male	5	12	17
Female	34	30	64
Primary surgeon training			
General/pediatric surgery	5	41	
OHNS	34	1	
Mean age, y	13.7	12.6	13.2
Pathology			
PTC	14	8	22
Follicular Ca	1	1	2
Medullary Ca	1	1	2
Adenoma	14	17	31
Multinodular goiter	2	11	13
Graves' disease	1	0	1
Lymphocytic thyroiditis	4	4	8
No significant histopathology	2	0	2
FNA			
Suspicious for PTC	3	0	3
PTC	5	2	7
Follicular neoplasm	5	2	7
Follicular lesion of unknown significance	1	0	1
Benign	7	6	13
Indeterminate	1	1	2
Nerve monitor			
Yes	32	1	33
No	7	41	48
Second surgery	8	3	11

Abbreviations: Ca, carcinoma; CHMC, Children's Hospital and Medical Center–Omaha; FNA, fine-needle aspiration; OHNS, otolaryngology/head and neck surgery; PTC, papillary thyroid cancer; UNMC, University of Nebraska Medical Center.

occurred in 28 of 36 cases in OHNS and 1 of 45 general/pediatric cases.

Surgeon Volume

There were 3 surgeons who were clearly higher-volume surgeons. They performed 53 of the primary surgeries, while lower-volume surgeons performed 28 primary surgeries. Higher-volume surgeons ranged from 12 to 24 surgeries through the study period and included 2 pediatric surgeons and 1 head and neck surgeon. Lower-volume surgeons ranged from 1 to 7 surgeries. Median time to reoperation was 34 days, with a range of 4 to 1134 days (**Table 3**). It should be noted that although there was a higher-volume surgeon who performed 12 thyroidectomies during the study period, most of these procedures occurred within a 3-year time frame toward the end of the study.

Two complications occurred within the lower-volume group (2 vs 0, OR = 2.58, 95% CI = [0.11, 59.2]). Higher-volume surgeons ordered FNA less frequently than lower-volume surgeons did (37.8% vs 53.5%, OR = 1.90, 95% CI = [0.75, 4.81]). Lower-volume surgeons ordered ultrasound less frequently (39.3% vs 58.5%, OR = 0.42, 95% CI = [0.17, 1.08]). The number of second surgeries was statistically significant (3 vs 8, OR = 6.67, 95% CI = [1.57, 27.17]), including in substratification of completion thyroidectomies alone (1 vs 5, OR = 11.3, 95% CI = [1.24, 102.27]) or with neck dissection included (3 vs 6, OR = 4.54, 95% CI = [1.04, 19.84]). There were a high number of LOS > 1 day associated with lower surgical volume. Patients of higher-volume surgeons were 4.2 times more likely to stay in the hospital 1 day or less compared with those patients operated upon by lower-volume surgeons (7 vs 11, 95% CI = [1.59, 15.0]; **Table 2**).

Complications

Patient 1 was a 14-year-old girl who underwent total thyroidectomy for toxic multinodular goiter. Postoperatively, the patient presented to the clinic with neck tenderness, swelling, and fluctuance. The neck wound was explored, frank pus was noted, the wound was thoroughly irrigated, and a drain was placed. The patient followed up in clinic 2 days later, and the drain was removed. She suffered no further sequelae.

Patient 2 was a 16-year-old girl who underwent a total thyroidectomy with central neck and mediastinal dissection with frank metastatic disease from PTC. Intraoperatively, the left nerve was found to be unresponsive to a Silverstein neuromodulator. Because the nerve was anatomically intact and given the extent of gross disease, the contralateral side was addressed in the same setting. Both true vocal fords were mobile after extubation, although the left was weaker than the right. She was monitored inpatient for dysphagia and dysphonia. Because of her intraoperative cord function, serial flexible laryngoscopy was deferred postoperatively. During her hospitalization, her symptoms improved, and she was discharged after 5 days without permanent deficit. Her final staging was T2N1a, and she was treated with radioactive iodine.

Discussion

Primary Findings

We found no significant impact based on location of surgery or surgeon training. We additionally found no difference in significant complications between surgical volume groups. We did find that surgical volume affected LOS >1 day and the need for second surgery (**Table 2**).

Surgical volume is a factor in other surgical fields for cost savings, decreasing LOS, and decreasing complications.[10-13] Authors have emphasized the importance of managing surgical pediatric thyroid disease with dedicated surgeons to promote improved outcomes such as lower costs, decreased complication rates, and shorter LOS.[6,14]

Second surgeries included either completion thyroidectomy, neck dissection, or both. While our numbers were small, we have explored a previously undescribed outcome in pediatric thyroidectomy. Diagnostic lobectomies have

Table 2. Primary and Secondary Outcomes by Site, Training, and Surgeon Volume.[a]

	Major Complication	OR (95% CI)	LOS = 1 d	LOS > 1 d	OR (95% CI)	Repeat Surgery	OR (95% CI)
Site							
UNMC	1		32	10		5	
CHMC	1	1.08 (0.06 to 17.86)	31	8	1.21 (0.42 to 3.47)	6	1.34 (0.38 to 4.82)
Training							
General/pediatric	1		32	13		7	
OHNS	1	0.76 (0.04 to 3.17)	31	5	0.39 (0.12 to 1.24)	4	1.47 (0.39, 5.49)
Volume							
High	0		46	7		3	
Low	2	2.58 (0.11 to 59.20)	17	11	**4.25 (1.41 to 12.76)**	8	**6.67 (1.60 to 27.71)**

Abbreviations: CHMC, Children's Hospital and Medical Center–Omaha; CI, confidence interval; LOS, length of stay; OR, odds ratio; UNMC, University of Nebraska Medical Center.
[a]Bold represents statistically significant differences in the odds ratio.

Table 3. Patients Requiring Second Surgery.

Patient	Surgery	Second Surgery	Interval, d	FNA (Results)	Preoperative Ultrasound	Primary Surgeon Volume
1	Right lobectomy	Completion thyroidectomy	862	No	Unknown	Low
2	Total thyroidectomy	Mediastinal lymph node dissection	329	No	Yes	Low
3	Right hemithyroidectomy	Completion thyroidectomy with CND	6	No	Unknown	Low
4	Left hemithyroidectomy	Completion thyroidectomy	20	Yes (lymphocytic thyroiditis)	Yes	Low
5	Left lobectomy	Completion thyroidectomy	365	No	Yes	Low
6	Right lobectomy	Completion thyroidectomy	48	Yes (follicular neoplasm)	Yes	Low
7	Right lobectomy	Completion thyroidectomy	50	No	Yes	High
8	Right lobectomy	Completion thyroidectomy with CND	4	No	Yes	High
9	Right lobectomy	Completion thyroidectomy with CND	10	No	No	High
10	Left hemithyroidectomy	Completion thyroidectomy	9	Yes (follicular neoplasm)	Unknown	Low
11	Total thyroidectomy	Left lymph node dissection	1134	Yes (PTC)	Unknown	Low

Abbreviations: CND, central neck dissection; FNA, fine-needle aspiration; PTC, papillary thyroid cancer.

played a significant role in the past in the management of pediatric thyroid nodules. However, advancing technologies and clinical investigations now allow for more comprehensive preoperative workup, potentiating a consolidated surgical intervention. The decision tree for performing a neck dissection in pediatric thyroidectomy is an area of continuing investigation.[15,16] Ultrasound and FNA are established as indispensable tools for determining the need for neck dissection. Current recommendations include therapeutic central and lateral neck dissections in patients with pathology-proven papillary thyroid carcinoma.[17] This emphasizes the importance of the preoperative workup, including radiology and FNA. The radiology data for this review were inconsistently available. Many patients in our study were referred from outside providers, which often rendered efforts of an exhaustive review futile. This would be a critical next step in assessing the influence of workup in patient outcomes.

Confining our study to the focused regional referral patterns allowed us to follow patients who required repeat surgeries, observing 6 patients who required completion thyroidectomy and 11 patients who required a second surgery (**Table 3**). The median time to reoperation was 34 days, with a range of 4 to 1134 days, demonstrating that some patients had recurrent, indolent disease remote from their primary surgery. While the preponderance of patients required repeat surgery within approximately 1 month of their primary surgery, thorough and comprehensive care should be offered to these patients as true oncologic cases.

In the case of the 1134-day interval, the patient had recurrent disease of papillary thyroid carcinoma. No central neck dissection was performed at the initial operation. No record was found indicating whether an ultrasound had been performed preoperatively. The patient had been managed initially by a lower-volume surgeon who then referred on to a higher-volume surgeon after neck disease was manifested.

Length of stay has emerged as an accessible measure common between studies and serves as a surrogate for resource utilization and cost management.[18] Lowering LOS has been shown to decrease infection rates and increase patient satisfaction.[19,20] In a large review of a national database, Tuggle et al[6] evaluated pediatric endocrine surgeons and stratified surgical specialty into higher-volume, pediatric, and other. Their higher-volume group was also found to have a shorter LOS (1.5 vs 2.3 and 2.0 days, $P < .01$). Others have found that younger age and minority status were predictive of increased LOS. While total thyroidectomy versus hemithyroidectomy has also been found to increase LOS, the presence of malignant versus benign disease has not been found to be a significant factor.[9,21]

We hypothesized that a dedicated children's hospital would have more fluid transition to discharge after surgery given its infrastructure service for children such order sets, teaching materials for families, and so forth. However, we found LOS was influenced by the volume of surgeries performed, not by surgeon training background or institution (**Table 2**). Because our analysis was based on rank data and not continuous data, this prohibited undue influence by any statistical outliers. Yet, given the low number of major complications, the meaning of this result remains speculative. We suggest this outcome may reflect more conservative management by those who perform the surgery less frequently.

A unique feature of this cohort is that the limited referral patterns available within the community funneled the caseload of a relatively uncommon procedure to a limited number of surgeons. This allows for more direct comparisons of practice for a single population, thereby avoiding confounding features inherent to national database queries, such as inferences of surgical background made based on case logs. Acknowledging that the results may be an artifact from preguideline practice, we nonetheless find the outcomes meaningful. Although guidelines are updated with regularity, state-of-the-art medicine is continuously evolving. Those caring for pediatric thyroidectomy patients on a consistent basis would be naturally inclined to optimize their disease management, including use of ultrasound, FNA, and appropriate staging of surgeries. Repeated exposure to this patient population may also refine the subtle, tacit elements involved in managing these patients as well as idiosyncrasies that remain undefined and subject to further study.

It is critical to note that the study time frame preceded recently published guidelines,[17] and while several institutions have initiated multidisciplinary clinics per recommendations by Francis et al,[17] such a program did not yet exist at either UNMC or CHMC. Since the study date, such a team has been constructed to include pediatric surgery, head and neck surgery, and pediatric endocrinology.

Ancillary Findings

The demographics of the participants in this study closely resemble the population of pediatric patients with thyroid pathology detailed in prior studies. The cohort analyzed for this study includes a total of 64 girls and 17 boys with a mean age of 13.2 years (**Table 1**). Of the patients with thyroid malignancy in this study, PTC was the most common malignancy. Twenty-two (84% of all malignancies) patients in this study had PTC (**Table 1**). Prior studies indicate that the incidence of thyroid pathology is greater in females, and furthermore, most patients with carcinoma had PTC on tissue analysis.[2,5,8,14,22]

Concern for RLN injury remains a preoccupation of the diligent thyroid surgeon. Rates of permanent nerve injury within the pediatric population rest below 1%.[8,23,24] Evidence from both the pediatric and adult literature emphasizes experience and surgical volume to minimize nerve injury, while the recent guidelines have suggested RLN monitoring for patients younger than 10 years, those undergoing a neck dissection, and in the case of repeat surgeries.[8,17] Our study presents 2 successful practice patterns with dichotomous use of nerve monitoring. Those with OHNS background employed its use more frequently while the general/pediatric surgery group deferred. The incidence of RLN injury between the 2 was insignificant, although this was underpowered for refined analysis.

Hypocalcemia after thyroid surgery is also a concern in this patient population. Far more commonly seen in total thyroidectomy patients compared with lobectomy patients, rates are cited between 1.4% and 4%.[25] Accounting for transient hypocalcemia postoperatively has become a challenge for thyroidectomy surgeons, especially in the era of decreased cost-effective medicine and attempts to decrease LOS. Cost-analysis studies in adults have questioned employing postoperative calcium therapy in all thyroidectomy patients as unnecessary and expensive.[24,26] Guidelines have advocated for intact parathyroid hormone or serial serum calcium levels postoperatively, while other authors recommend beginning empiric calcium and calcitriol on all patients undergoing total thyroidectomy.[27] In our study, we found no patients with permanent hypocalcemia.

Limitations

The most significant limitation to this study is its applicability to similar studies evaluating surgical volume and outcomes. Our volume is like other institutional studies over similar time periods, but this study is limited in its power, especially compared with large database queries, which makes it difficult to detect small differences in complication rates. However, the data accurately describe the practice patterns of our region, including preponderance of patients referred to the higher-volume surgeons. Because the reported rates of pediatric thyroidectomy were lower than other studies, we have purposely designated our groups as "higher" and "lower," indicating that comparisons are between the study groups only.[8,22] This drawback is ameliorated by 2 features. First, we found that LOS was associated with our definition of surgical volume, a finding previously reported in large database studies. Second, the OHNS group includes several head and neck surgeons who perform high-volume >50/y adult thyroidectomies. If there was a confounding advantage to be gained from performing adult thyroidectomies, we would have expected it to appear here.

Additional limitations include the retrospective nature of the study, which carries inherent difficulties in data collection and accuracy. This was noticed in following patient outcomes after they left the hospital. It is possible that some patients required additional surgery after the time frame of our study. Pediatric patients possess compensation mechanisms that may mask injury to the RLN. Subtle vocal cord dysfunction may be unmasked with flexible laryngoscopy. A confounding factor includes specific institutional training background. Subspecialty training centers may include different levels of exposure to pediatric thyroidectomy, inclining a new surgeon for or against integrating this procedure into their practice. We have assumed that all patients underwent appropriate workup and treatment for their disease process. We were limited in our assessment of preoperative ultrasound, limiting any substantial speculation about preoperative assessment and workup. Guidelines have placed significant emphasis on the role of ultrasound in the stratification of risk for carcinoma.[17] It is the practice of the 2 senior authors to personally evaluate their patients with high-frequency ultrasound as part of the standard workup of a pediatric thyroid nodule.

Conclusion

Surgeon volume may affect LOS and the need for reoperation. Other features such as surgical training background and hospital site had no impact on complication rate or LOS.

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Author Contributions

Paul D. Judge, design, acquisition, analysis of data, drafting, revision, final approval of publication, accountability for all work; **Joseph Menousek**, acquisition, drafting of work, final approval, accountability for all work; **Jordan C. Schramm**, conception and design, critical revision, final approval, and accountability for all work; **Robert Cusick**, conception and design, critical revision, final approval, and accountability for all work; **William Lydiatt**, conception and design, critical revision, final approval, and accountability for all work.

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