Endoscopic Thyroidectomy is Safe in Patients with a High Body Mass Index

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Background: Obesity is associated with a number of medical comorbidities and is considered a risk factor for surgical complications. However, the impact of obesity on the safety of minimally invasive video-assisted thyroidectomy (MIVAT) has not been well defined. We sought to determine the relationship between obesity and the risk of complications in patients undergoing MIVAT.

Method: A prospectively maintained database of all thyroid surgeries performed from January 2006 through June 2012 was searched and all cases of MIVAT were identified. Patients were stratified into three body mass index (BMI) groups according to the National Institutes of Health classification for obesity: normal (BMI ≤ 24.9 kg/m²), overweight (BMI 25–29.9 kg/m²) and obese (BMI ≥ 30 kg/m²). The total number of complications was compared among the three groups, and MIVAT patients were also compared to a cohort of patients undergoing conventional thyroid surgery.

Results: There were 233 MIVATs performed on 223 patients. The mean overall BMI for the study population was 25.4 kg/m². There were 123 procedures (52.8%) in the normal group, 76 procedures (32.6%) in the overweight group, and 34 procedures (14.6%) in the obese group. Complications included 1 case of cellulitis (0.4%), 6 cases of temporary hypocalcemia (2.6%), and 6 cases of transient vocal fold paresis (2.6%). No patients suffered permanent hypocalcemia or a permanent recurrent laryngeal nerve injury. There were 9 complications in the normal group (7.3%), 4 complications in the overweight group (5.3%), and no complications in the obese group. Due to the low number of complications in this series, the overweight and obese groups were combined into a high BMI group for further analysis. Statistical analysis using simple logistic regression models revealed that there was no significant difference in the number of complications in patients with a high BMI compared with patients with a normal BMI (odds ratio [OR] 0.48 [confidence interval (CI) 0.14–1.63], $p=0.2$). The MIVAT group had fewer overall complications than the conventional thyroidectomy group.

Conclusions: Overweight and obese patients undergoing MIVAT in this series were not at an increased risk for surgical complications. The MIVAT procedure may be considered safe in patients with a high BMI, who may derive particular benefit from a minimally invasive approach.

Introduction

MORE THAN HALF OF THE ADULTS in the United States are overweight or obese (1). Obesity is associated with a number of medical comorbidities and results in a significant healthcare cost burden (1). Despite its negative impact on health care as a whole, there has been inconsistency in the medical literature as to the role obesity plays in postoperative morbidity. Multiple studies from a spectrum of surgical specialties suggest that some perioperative morbidity, particularly wound complications, can be attributable to obesity (2–6). One large evaluation of American College of Surgeons

National Surgical Quality Improvement Program (NSQIP) data confirmed that obese patients undergoing thyroid and parathyroid surgery were at increased risk for a wound complication (7). However, other reports suggest that surgery does not uniformly condemn the obese patient to an operative complication (8,9).

The minimally invasive video-assisted thyroidectomy (MIVAT) was described in 1999 (10). As this procedure was cautiously implemented in North American centers, obesity was considered a relative contraindication (11,12). Over time it appears that concerns about the potential adverse effects of obesity on the surgical outcomes have abated (13), but there

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has not been a study assessing the safety and feasibility of MIVAT in the obese population. This study specifically addresses the complication profile of MIVAT in overweight and obese patients.

Materials and Methods

An Institutional Review Board–approved retrospective review of a prospectively maintained database containing thyroid surgeries performed by a single surgeon (D.J.T.) at an academic center was performed. All cases of MIVAT for the 6.5-year time frame from January 2006 through June 2012 were identified. If a patient had more than one operation, each procedure was considered separately, so that the final analysis reflects the total number of procedures performed. Selection criteria for MIVAT include a thyroid volume ≤ 20 mL, the presence of a dominant nodule ≤ 3 cm, and no evidence of thyroiditis or substernal extension. Patients with small multinodular goiters were included, as well as patients with cytologic findings suggestive of benign nodules, follicular neoplasms of uncertain malignant potential or low-risk well-differentiated carcinomas. All MIVAT procedures were performed using general anesthesia. Flexible laryngoscopy was performed on all patients in the recovery room to assess postoperative vocal cord function.

Patients were divided into three body mass index (BMI) groups based on the National Institutes of Health (NIH) obesity classification scheme (14). The normal weight group included both normal and underweight patients with a BMI up to 24.9 kg/m^2 . The overweight group included patients with BMIs of $25\text{--}29.9 \text{ kg/m}^2$. The obese group contained patients whose BMI was 30 kg/m^2 or greater. Demographic data including sex, age, ethnicity, and medical comorbidities (hypertension, diabetes, renal disease, and pulmonary disease) were recorded. Surgical information such as the extent of surgery (thyroid lobectomy or total thyroidectomy), primary or revision surgery, operative time, concurrent central neck dissection, and final pathology (benign or malignant) were determined for all patients. The occurrence of any complication was noted, including all instances of temporary and permanent recurrent laryngeal nerve (RLN) injury and hypocalcemia. For the purposes of a cohort comparison, 233 patients who had incisions in excess of 4 cm and a nonendoscopic resection (conventional thyroidectomy) were identified. Operative times, incision length, medical comorbidities, and complication rates were compared between patients undergoing MIVAT and a cohort of patients undergoing conventional thyroid surgery during the same time frame.

Patients generally returned for a postoperative visit 4–6 weeks after surgery, unless they had a specific concern. Patients who travel a great distance to our tertiary care center, however, often received their follow-up care with the referring provider in their local area. No formal scar assessment was performed for the purposes of this study.

Descriptive statistics and analysis by overall complication status were performed. Because of low frequencies of complications in this series, additional analysis for specific complication risk was not undertaken. Simple logistic regression was used to determine whether those who were overweight or obese were at greater risk of complications compared to normal weight individuals. Simple logistic regression models

were also used to examine potential covariates and confounders of complication status. χ^2 and t tests of the potential covariates and confounders were used to explore their relationship with overweight and obesity status. A backward stepwise model-building strategy was used to arrive at a final model of the impact of overweight and obesity status on complication risk, controlling for potential covariates or confounders.

A power analysis was performed to determine the number of patients required to show a difference in complication rates based on BMI. Given a prevalence of overweight or obesity of 0.4 or 0.45, respectively, a sample size of approximately 2500 patients would be required to detect a clinically relevant association between overweight and obese complication rates at an odds ratio (OR) of 0.5. For this reason, the patients in the overweight and obese groups were combined together into an elevated BMI group and compared to patients in the normal weight group to permit descriptive statistical analysis. All statistical analysis was performed using SAS 9.3 (SAS Institute Inc., Cary, NC). An α level of 0.05 was used to determine statistical significance unless otherwise noted.

Results

There were 1071 thyroid procedures performed during the 6.5-year study period, including 233 (21.8%) MIVATs. Table 1 lists the patients' demographic, disease, treatment, and complication profiles for this series. There were 205 females (88%) and 28 males (12%) with a mean age of 47.3 ± 15 years.

TABLE 1. MINIMALLY INVASIVE VIDEO-ASSISTED THYROIDECTOMY PATIENT DEMOGRAPHICS

Variable	n (%)
Sex	
Female	205 (88)
Male	28 (12)
Race/ethnicity	
Caucasian	184 (79)
African American	35 (15)
Other	14 (6)
Pathology	
Benign	176 (75.5)
Malignant	57 (24.5)
Surgery extent	
Hemithyroidectomy	195 (83.7)
Total thyroidectomy	41 (16.3)
Surgery type	
Initial	221 (94.8)
Completion	12 (5.2)
BMI (kg/m^2)	
≤ 24.9	123 (52.8)
$25\text{--}29.9$	76 (32.6)
≥ 30	34 (14.6)
Complication	
Permanent RLN dysfunction	0 (0)
Permanent hypocalcemia	0 (0)
Temporary RLN dysfunction	6 (2.6)
Temporary hypocalcemia	6 (2.6)
Cellulitis	1 (0.4)

BMI, body mass index; RLN, recurrent laryngeal nerve.

One hundred eighty-four patients (79%) were Caucasian, 35 (15%) were African American and 14 (6%) were of other ethnic backgrounds. The mean BMI was $25.4 \pm 4.9 \text{ kg/m}^2$. There were 123 patients (52.8%) in the normal BMI group, 76 patients (32.6%) in the overweight BMI group and 34 patients (14.6%) in the obese group, for a total of 110 patients (47.2%) in the high BMI group. Patients in the overweight and obese groups tended to be older (49.3 ± 13.7 vs. 45.6 ± 15.9 years, $p=0.07$) and were more likely to be African American (24.6% vs. 6.5%, $p<0.001$; Table 2). There was no difference between the high and normal BMI groups in terms of overall comorbidity (33% vs. 30%, $p=0.3$) or for any specific comorbidity assessed (Table 2).

MIVAT was performed on an outpatient basis in 213 cases, while 20 patients were admitted for postoperative care (91.4% vs. 8.6%, $p=0.01$). No patient required admission to the intensive care unit. There was no difference in the proportion of outpatient procedures based on BMI class (91.8% vs. 91.1%, $p=0.8$). Surgery was performed for benign disease in 176 cases (75.5%) and for malignancy in 57 cases (24.5%). Thyroid lobectomy was performed in 195 cases (83.7%) with total thyroidectomy performed for the remaining 38 cases (16.3%). Twelve patients (5.2%) had completion procedures after prior thyroid surgery and 3 patients (1.3%) had a central neck dissection. The mean incision length was $2.3 \pm 0.4 \text{ cm}$. There was a statistically significant 1 mm difference in the mean incision

length between patients in the normal and high BMI groups (2.3 ± 0.4 vs. $2.4 \pm 0.4 \text{ cm}$), although this difference was not associated with an increased risk of complication (OR 0.85 [confidence interval (CI) 0.16–4.65], $p=0.85$). There was no difference in the mean operative times for the normal and high BMI groups (97.7 ± 29.2 mins vs. 100.8 ± 30 mins. $p=0.4$), and operative time did not impact the risk of complication (OR 1.02 [CI 0.99–1.03], $p=0.1$).

As shown in Table 2, there was no difference between the normal BMI group and the high BMI group when considering malignancy (22.8% vs. 26.4%, $p=0.5$), the type of surgery performed ($p=0.3$), the need for central neck dissection (0.8% vs. 1.8%, $p=0.6$), and the number of reoperative (0% vs. 1.8%, $p=0.2$) or completion (5.7% vs. 4.6%, $p=0.7$) procedures.

There were no cases of permanent hypocalcemia or permanent RLN paralysis. There were 6 cases (2.6%) of temporary hypocalcemia, 6 cases (2.6%) of transient RLN dysfunction and 1 case (0.4%) of cellulitis, for an overall complication rate of 5.6%. Three cases of temporary hypocalcemia occurred in the normal BMI group and 3 cases occurred in the overweight group. Five cases of transient RLN weakness occurred in the normal BMI group and 1 case occurred in the overweight group. The case of cellulitis occurred in a patient in the normal BMI group. No complications occurred in the obese group. There was no difference in the overall complication rate between the normal BMI group and the high BMI group (OR 0.48 [CI 0.14–1.63], $p=0.2$), and logistic regression revealed no association between BMI status and complication rate (OR 0.42 [CI 0.11–1.56], $p=0.2$). The low rate of specific complications in each BMI group precluded more detailed statistical analysis.

BMI status was not significantly associated with occurrence of complications after controlling for admission status, the one covariate that remained in the final logistic regression model. Admission status was significantly associated with complication rate. Patients who were admitted were 5.68 times more likely to have a complication than those who had outpatient surgery, controlling for high BMI status (OR 5.68 [CI 1.56–20.71], $p=0.01$). A subset review of the inpatient group did not reveal any clear reason for admission in the majority of these patients, and only one patient was admitted for a surgery-related cause (monitoring for possible neck swelling).

Patients undergoing MIVAT were compared to a control group of 233 patients undergoing conventional, non-minimally invasive thyroid surgery during the same period. Table 3 summarizes the demographic differences between these two groups. The conventional group had a larger proportion of high BMI patients than the MIVAT group. There were also more males and African Americans in the conventional group. The MIVAT group was younger than the conventional group. There was no difference in the rate of malignancy between the MIVAT and conventional groups. The conventional thyroidectomy group was more likely to have a medical comorbidity than the MIVAT group. Specifically, the rates of hypertension, diabetes, and pulmonary disease were higher in the conventional group.

Table 3 compares the surgical data between the MIVAT and conventional thyroidectomy groups. Conventional thyroidectomy patients were more likely to have a total thyroidectomy, have inpatient surgery, have completion surgery,

TABLE 2. COMPARISON OF NORMAL AND HIGH BODY MASS INDEX MINIMALLY INVASIVE VIDEO-ASSISTED THYROIDECTOMY GROUPS

Variable	Normal BMI	High BMI	p-Value
Age (years)	45.6 ± 15.9	49.3 ± 13.7	0.07
Sex			
Female	111 (90.2)	94 (85.5)	0.3
Male	12 (9.8)	16 (14.6)	
Race/ethnicity			
Caucasian	106 (86.2)	78 (70.9)	<0.01
African American	8 (6.5)	27 (24.6)	
Other	9 (7.3)	5 (4.6)	
Comorbidity			
Any	30 (24.4)	33 (30)	0.3
Hypertension	26 (21.1)	23 (20.9)	0.97
Diabetes	6 (4.9)	7 (6.4)	0.6
Renal disease	2 (1.6)	2 (1.8)	0.9
Pulmonary disease	4 (3.3)	8 (7.3)	0.2
Pathology			
Benign	95 (77.2)	81 (73.6)	0.5
Malignant	28 (22.8)	29 (26.4)	
Surgery extent			
Hemithyroidectomy	100 (81.3)	95 (86.4)	0.3
Total thyroidectomy	23 (18.7)	15 (13.6)	
Surgery type			
Completion	7 (5.7)	5 (4.6)	0.7
Reoperative	0 (0)	2 (1.8)	0.2
Incision length (cm)	2.3 ± 0.4	2.4 ± 0.4	<0.01
Operative time (min)	97.7 ± 29.2	100.8 ± 30	0.4
Central neck dissection	1 (0.8)	2 (1.8)	0.6
Outpatient	112 (91.1)	101 (91.8)	0.8
Complication	9 (7.3)	4 (3.6)	0.2

Data are presented as mean $\pm$ standard deviation or as *n* (%).

TABLE 3. COMPARISON OF MINIMALLY INVASIVE VIDEO-ASSISTED AND CONVENTIONAL THYROIDECTOMY GROUPS

Variable	MIVAT	Conventional	p-Value
Age (years)	47.3 ± 15	52.9 ± 14.5	<0.01
Sex			
Female	205 (88)	181 (77.7)	<0.01
Male	28 (12)	52 (22.3)	
Race/ethnicity			
Caucasian	184 (79)	118 (50.6)	<0.01
African American	35 (15)	112 (48.1)	
Other	14 (6)	3 (1.3)	
BMI (kg/m ²)			
Normal	123 (52.8)	26 (11.2)	<0.01
High	110 (47.2)	207 (88.8)	
Comorbidity			
Any	63 (27)	143 (61.4)	<0.01
Hypertension	49 (21)	123 (52.8)	<0.01
Diabetes	13 (5.6)	64 (27.5)	<0.01
Renal disease	4 (1.7)	5 (2.2)	0.7
Pulmonary disease	12 (5.2)	34 (14.6)	<0.01
Pathology			
Benign	176 (75.5)	170 (73)	0.5
Malignant	57 (24.5)	63 (27)	
Surgery extent			
Hemithyroidectomy	195 (83.7)	75 (32.2)	<0.01
Total thyroidectomy	38 (16.3)	158 (67.8)	
Surgery type			
Initial	221 (94.9)	201 (86.3)	<0.01
Completion	12 (5.2)	32 (13.7)	
Incision length (cm)	2.3 ± 0.4	8.6 ± 2.3	<0.01
Operative time (min)	99.2 ± 29.6	128 ± 60.5	<0.01
Central neck dissection	3 (1.3)	16 (6.9)	<0.01
Outpatient	213 (91.4)	107 (45.9)	<0.01
Complication			
Any	13 (5.6)	39 (16.7)	<0.01
Transient hypocalcemia	6 (2.6)	17 (7.3)	0.02
Transient RLN weakness	6 (2.6)	13 (5.6)	0.1

Data are presented as mean ± standard deviation or as *n* (%).
MIVAT, minimally invasive video-assisted thyroidectomy.

and have a central neck dissection than MIVAT patients. As would be expected, the mean incision length was longer in the conventional group (8.6 cm) than the MIVAT group (2.3 cm). The mean operative time was also longer in the conventional group.

The overall risk of complication was higher in the conventional thyroidectomy group (16.7% vs. 5.6%, *p* < 0.01), with a higher incidence of transient hypocalcemia (7.3% vs. 2.6%, *p* = 0.02) and a non-significant increased risk of transient RLN injury (5.6% vs. 2.6%, *p* = 0.1).

Discussion

The proportion of patients with excessive body weight is increasing in the United States, with over half of the adult population overweight and over one-third meeting obesity criteria (1). It is expected, then, that a growing number of surgical patients will also be obese. Surgeons will find

themselves increasingly having to contend not only with the physical challenges of successfully navigating around excess body tissue intraoperatively, but must also be prepared to manage the myriad of medical comorbidities that accompany obesity. Although it is clear that many obese patients will not experience any adverse outcomes (8,9), numerous studies from multiple surgical disciplines have demonstrated that these patients are at increased risk for postoperative wound complications (2,4–6,15). Buerba *et al.* (7) specifically demonstrated that obese and morbidly obese patients are at increased risk for wound complications after thyroid and parathyroid surgery. However, their study did not report the type of surgical approach used and the clinical relevance of these findings are unclear.

Overweight and obese patients may derive particular benefit from minimally invasive and endoscopic procedures. A high BMI is associated with microvascular impairment and poor wound healing (16,17). Shorter incisions and less soft tissue dissection inherent in minimally invasive procedures may therefore be of importance in improving postoperative outcomes in overweight and obese populations. This has been demonstrated in certain cardiac procedures (18) and a review of parathyroid surgery through a small incision in the morbidly obese showed that while there was an increase in anesthesia and airway management difficulties in these patients, there was no significant increase in morbidity (19). The incision length did not impact the complication rate among MIVAT patients in this series, and any differences in incision lengths between the BMI groups is likely clinically insignificant. In addition to decreased tissue disruption, endoscopic procedures such as MIVAT allow improved visualization of critical structures underneath the more superficial adipose tissue that would potentially obscure part of the operative field in an open surgery.

The overall low complication rate in this series (5.6%) and the fact that there were no complications in the obese group prompted a secondary assessment wherein the obese and overweight patients were grouped together for statistical analysis and precluded a more detailed examination of the profiles of specific complications. Therefore, only the overall complication rates could be compared between MIVAT patients with a normal BMI and a high BMI, and there was neither any difference in the complication rate between these two groups nor any association between BMI status and overall complication rate. A *post-hoc* power analysis suggested that, at the current complication rates, approximately 2500 patients would be required to detect a clinically significant association between three separate BMI groups (normal BMI, overweight BMI, obese BMI) and the risk of complication in MIVAT. Our practice is devoted solely to thyroid and parathyroid surgery, with an emphasis on minimally invasive surgery. Two hundred thirty-three MIVATs were performed over the 6.5 year study period, for a mean rate of 38.8 procedures annually. It would therefore take more than 64 years in a high-volume endocrine surgery practice to recruit 2500 patients. Two previously published series investigating minimally invasive endoscopic thyroidectomy from China (20) and Italy (21) included 300 and 833 patients, respectively, but there was no comment on body habitus and it is unclear if the population in these areas share the same proportion of overweight and obese patients seen in the United States. While a multi-institutional trial would help

improve enrollment, the largest such series in North America to date was comprised of 216 patients in 4 endocrine surgery practices (12). It is doubtful, therefore, that a large enough study population of MIVAT patients reflecting the obesity prevalence in the United States will be available to meet the criteria for further statistical analysis.

To better assess the influence of MIVAT on these outcomes, the MIVAT patients were compared with a cohort of conventional thyroidectomy patients from the same study period. MIVAT candidates are a highly selected patient population (as described), so it is not surprising that they tended to be healthier patients who required less extensive surgery. MIVAT patients experienced fewer complications than conventional thyroidectomy patients, even when MIVAT patients with a high BMI were included in the analysis. Given these outcomes, we conclude that in the appropriately selected patient, a high BMI does not appear to impart any additional risk of complication for patients undergoing MIVAT.

Conclusion

This study represents the largest MIVAT population reported in North America, and is the only one to address the question of safety in overweight and obese patients. The results indicate that a high BMI is not associated with an increased risk of complication during minimally invasive video-assisted thyroidectomy.

Author Disclosure Statement

No competing financial interests exist.

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