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Postoperative Complications in Obese Patients After Tracheostomy

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Abstract

Objective. To determine the prevalence of varying classes of obesity in patients undergoing tracheostomy and the associated complication rates as compared with nonobese patients.

Study Design. A retrospective chart review was performed from 2012 to 2018 on all patients who underwent open tracheostomy by the Department of Otolaryngology–Head and Neck Surgery.

Setting. All tracheostomies were performed at a single tertiary care center.

Methods. Patients were classified by body mass index (BMI) according to the World Health Organiza-tion classification system: underweight (<18.5), normal-overweight (18.5-29.9), class I (30-34.9), class II (35-39.9), and class III (>40). Charts were reviewed for patient demographic information, Charlson Comorbidity Index score, surgical indication, operative time, tracheostomy tube type, and postoperative complications.

Results. A total of 387 patients (mean ± SD BMI, 31.3 ± 14.2) were identified per the inclusion/exclusion criteria. Of patients with BMI >30 (n=153), 34.6% were categorized as obesity class I, 29.4% as class II, and 35.9% as class III. The most common indication for tracheostomy was malignancy in nonobese patients (41.5%) and respiratory failure for obese patients (58.2%). Operative time was significantly longer in obese patients, and most of these patients required an extended-length tracheostomy tube. Patients with a BMI >40 had higher rates of multiple postoperative complications or death (P = .009). Underweight patients also had a higher rate of complication than normal-overweight patients (P = .016).

Conclusion. Class III and underweight patients had higher rates of postoperative complications, which should be taken into consideration during perioperative counseling.

Keywords

obese, tracheostomy, complications, body mass index, underweight

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Over the last 3 decades, the rate of obesity, defined as body mass index (BMI) >30, has continued to rise rapidly in the United States. The current prevalence of obesity in the United States is 39.8%, with a higher prevalence in Hispanic and African American adults.[1] Obesity is subdivided by the Centers for Disease Control and Prevention and World Health Organization (WHO) into class I (BMI, 30-34.9), class II (35-39.9), and class III (>40). The prevalence of class III obesity between 2000 and 2010 was 6.6%, increasing 70% from the previous decade.[2]

Increasing rates of obesity have resulted in a patient population with numerous medical comorbidities and increased surgical risk. The prevalence of obesity ranges between 20% and 40% in patients in the intensive care unit, a population in which tracheostomy is commonly performed for various medical indications.[3-6] Obesity has been found to be an independent risk factor for wound infection, bleeding, and prolonged operative times.[7] With regard to tracheostomy, previous studies have shown higher mortality rates, complications rates, and operative times in obese patients.[8-13]

Due to the potential increased perioperative risk in this population, anticipation of potential complications is crucial in providing appropriate surgical counseling and improving patient safety. While numerous studies have examined tracheostomy complications in obese patients, to our

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knowledge, this is the first large-scale study to report complication rates of open tracheostomy in patients across the spectrum of the WHO classification system to include obese as well as underweight patients. The primary objective of this study is to determine the prevalence of class I, II, and III obesity in patients undergoing tracheostomy at a tertiary care hospital, as well as the associated complication rates for each group.

Methods

Patient Selection

Institutional review board approval was obtained at the UT Health San Antonio. A retrospective review of inpatient billing records was performed to identify patients undergoing open tracheostomy (*Current Procedural Terminology* codes 31600 and 31610) between 2012 and 2018 by the Department of Otolaryngology–Head and Neck Surgery at a level 1 trauma center. Patients aged <18 years, those with inadequate BMI data, and those who did not leave the operating room with a tracheostomy (ie, tracheostomy immediately followed by laryngectomy) were excluded.

Data Collection

Medical records were reviewed for patient demographic information, Charlson Comorbidity Index score,[14] surgical indication, operative time, tracheostomy tube type, and postoperative complications within 30 days of tracheostomy. Patients who underwent surgical procedures in addition to tracheostomy were not included in analysis of mean operative time.

Patient height and weight were obtained, and BMI was calculated per the formula of weight in kilograms divided by meters squared (kg/m^2).[15] The Charlson Comorbidity Index was used to classify and weigh the comorbidities predicting risk of mortality within 1 year of hospitalization and is widely demonstrated to be a valid prognostic indicator for mortality.[14] Patients were initially separated into groups of BMI >30 or <30. Patients with a BMI <18.5 were categorized as underweight and those between 18.5 and 29.9, normal to overweight. Patients with a BMI >30 were subdivided into WHO obesity class I (30-34.9), class II (35-39.9), and class III (>40). Complications were divided into various categories, including death, accidental decannulation, bleeding (if surgical intervention required), and infection.

Statistical Analysis

All statistics were performed with SPSS software (IBM). The association of BMI with nominal data (ie, complications) was evaluated with χ^2 analysis. Operative time association with BMI category was analyzed with parametric testing for the obese versus nonobese groups (*t* test) and the various WHO classifications (analysis of variance).

Results

Review of medical records initially revealed 417 patients, which were limited to 387 based on exclusion criteria. The mean ± SD BMI for the entire cohort was 31.3 ± 14.2. Sixty percent of patients had a BMI <30 (n = 234; mean BMI, 23.8 ± 3.9). Patients with a BMI >30 constituted approximately 40% of the cohort (n = 153; mean BMI, 43.1 ± 16.2). Demographic information revealed similar mean age, sex, and ethnicity distribution, with the majority of patients being male and Hispanic (**Table 1**).

Table 1. Demographics: Obese and Nonobese Subgroups. [a]

	Body mass index	
	<30 (n = 234)	>30 (n = 153)
Age, y	54.2 ± 16.1	52.8 ± 13.2
Race/ethnicity		
White	97 (41.4)	55 (35.9)
Hispanic	121 (51.7)	80 (52.3)
African American	11 (4.7)	13 (8.5)
Asian	2 (0.9)	1 (0.7)
Other	3 (1.3)	4 (2.6)
Male	167 (71.4)	103 (67.3)

[a]Values are presented as mean ± SD or No. (%).

Obese vs Nonobese Classification

Respiratory failure and malignancy were the most common indications for tracheostomy in the obese group (BMI >30) and nonobese group (BMI <30), respectively (**Figure 1**). Indications grouped in the ''other'' category included angioedema and infection.

A total of 163 operative times were collected for those patients who underwent tracheostomy alone. The mean operative time was significantly longer in obese patients as compared with nonobese patients (54.9 ± 19.3 vs 39.6 ± 16.0 minutes, $P = .024$). Among nonobese patients, 97% had a regular-length tracheostomy tube placed, as compared with 63.4% of the obese patients. The remaining patients required extended-length tracheostomy tubes.

The overall postoperative complication rate for the entire cohort was 20.9%, with a higher rate (28.8%) in the obese subgroup than the nonobese group (15.8%). The most common complication in both groups was accidental decannulation (n = 32), occurring in 5.6% of nonobese and 13.7% of obese patients and accounting for 35.1% and 47.7% of all recorded complications, respectively (**Figure 2**). Of the patients who experienced decannulation, 75% (n = 24) previously underwent Bjork flap modifications. The overall mortality rate among the entire cohort was 3.1% (n = 12 patients). Among these, 3 deaths (25%) were secondary to tracheostomy-related complications; 3 deaths (25%) were secondary to progression of malignancy; and 6 (50%) deaths were due to respiratory failure/multisystem organ failure.

WHO Classification

When patients were subdivided according to WHO classification, 53 were categorized as class I, 45 as class II, and 55 as class III. There were 212 patients classified as

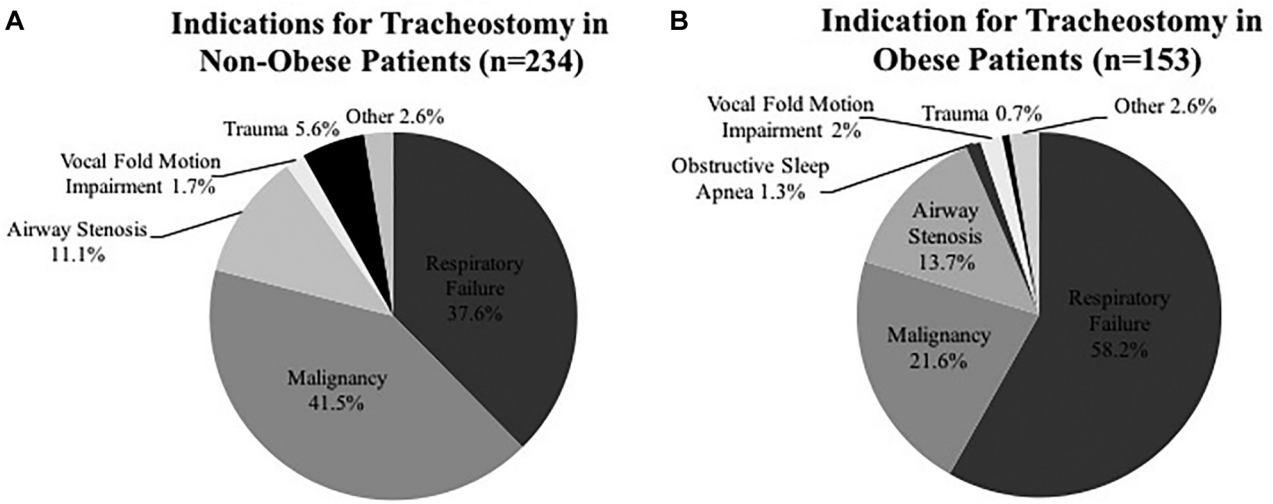

Figure 1. Indications for tracheostomy in (a) nonobese patients (n = 234) and (b) obese patients (n = 153).

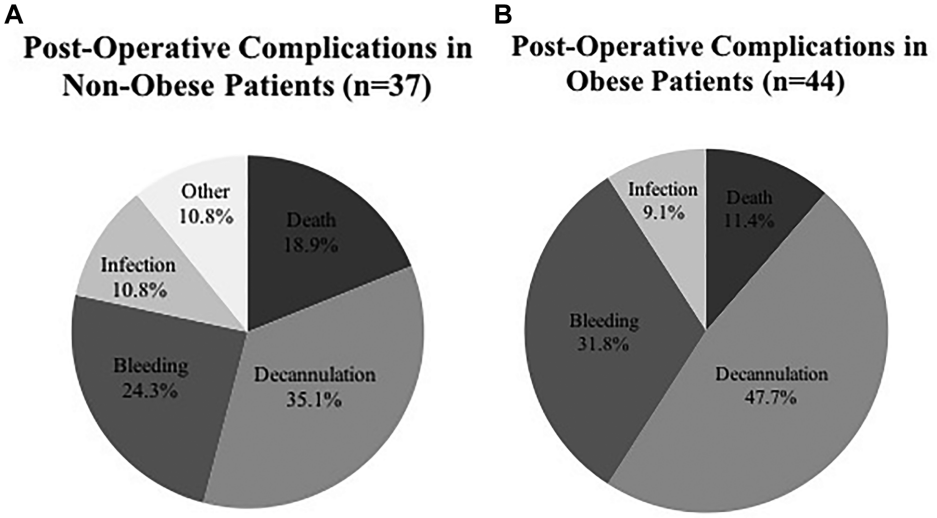

Figure 2. Postoperative complications in (a) nonobese patients (n = 37) and (b) obese patients (n = 44).

normal-overweight (BMI, 18.5-29.9) and 22 as underweight (BMI <18.5). Demographic information is shown in **Table 2**.

Respiratory failure was the most common indication in all classes of obese patients and represented the reason for tracheostomy in >80% of the class III subgroup (**Table 3**). The overall complication rate was highest in class III (36.4%), with accidental decannulation composing 50% (**Table 4**). Death occurred in 5.5% (n = 3) of class 3 patients, in which 2 occurrences followed accidental decannulation with subsequent cardiac arrest. The most common complication in the underweight group was infection, including pneumonia, cellulitis, and tracheitis.

Statistical Analysis

Chi-square analysis did not reveal any significant differences in complication rates when subgroups were analyzed according to the WHO classification. Obese patients (BMI > 30) as a whole did not demonstrate significantly higher rates of complication when compared with underweight or normal-overweight patients (BMI, 18.5-29.9). However, patients with a BMI >40 had a significantly higher likelihood of multiple complications or death than patients with a BMI <40 (P = .009). Underweight patients were also more likely to experience a postoperative complication than normal-overweight patients (P = .016) but did not differ significantly from obese patients (BMI >30). Charlson Comorbidity Index score was calculated in the underweight and normal-overweight groups, with mean values of 6.5 and 3.6, respectively (1-tailed t test, P = .0005). Additionally, mean operative time was significantly shorter in patients with a BMI <30 as compared with those with a BMI of 30 to 39.9 (P < .001) and BMI >50 (P < .001).

Table 2. Demographics by World Health Organization Classification. [a]

	Underweight (n = 22)	Normal-overweight (n = 212)	Class I (n = 53)	Class II (n = 45)	Class III (n = 55)
Age, y	55.7 ± 13.7	54.1 ± 16.3	53.5 ± 12.7	56.2 ± 13.6	49.5 ± 12.8
Body mass index	16.1 ± 1.7	24.6 ± 3.1	32.3 ± 1.5	37.1 ± 1.4	58.8 ± 18.3
Race/ethnicity					
White	14 (63.6)	83 (39.2)	20 (37.7)	15 (33.3)	20 (36.4)
Hispanic	7 (31.9)	114 (53.8)	25 (47.2)	26 (57.8)	29 (52.7)
African American	1 (4.5)	10 (4.7)	5 (9.4)	4 (8.9)	4 (7.3)
Asian	0	2 (0.9)	1 (1.9)	0	0
Other	0	3 (1.4)	2 (3.8)	0	2 (3.6)
Male	17 (77.3)	150 (70.8)	41 (77.4)	30 (66.7)	32 (58.2)

[a]Values are presented as mean ± SD or No. (%).

Table 3. Indications for Tracheostomy by World Health Organization Classification. [a]

	Underweight (n = 22)	Normal-overweight (n = 212)	Class I (n = 53)	Class II (n = 45)	Class III (n = 55)
Respiratory failure	6 (27.3)	82 (38.7)	20 (37.7)	24 (53.3)	45 (81.8)
Airway stenosis	2 (9.1)	24 (11.3)	12 (22.6)	5 (11.1)	4 (7.3)
Obstructive sleep apnea	0	0	0	2 (4.4)	0
Malignancy	13 (59.1)	84 (39.6)	17 (32.1)	11 (24.4)	5 (9.1)
Vocal fold motion impairment	0	4 (1.9)	1 (1.9)	2 (4.4)	0
Trauma	1 (4.5)	12 (5.7)	1 (1.9)	0	0
Other	0	6 (2.8)	2 (3.8)	1 (2.2)	1 (1.8)

[a]Values are presented as No. (%).

Table 4. Postoperative Complications by World Health Organization Classification. [a]

	Underweight (n = 22)	Normal-overweight (n = 212)	Class I (n = 53)	Class II (n = 45)	Class III (n = 55)
Total	7 (31.8)	30 (14.2)	11 (20.8)	13 (28.9)	20 (36.4)
Death	2 (28.6)	5 (16.7)	0	2 (15.4)	3 (15.0)
Decannulation	1 (14.3)	12 (40.0)	7 (63.6)	4 (30.8)	10 (50.0)
Bleeding	0	9 (30.0)	2 (18.2)	5 (38.5)	7 (35.0)
Infection	3 (42.8)	1 (3.3)	2 (18.2)	2 (15.4)	0
Other	1 (14.3)	3 (10.0)	0	0	0

[a]Values are presented as No. (%).

Discussion

Tracheostomy is a common procedure performed in critically ill patients as it reduces laryngeal injury, decreases airway resistance, and assists with weaning from positive pressure ventilation.[6,9] Performing tracheostomy in obese patients presents unique challenges, including difficult anatomy, decreased lung volumes, and increased airway resistance.[12,16]

While the prevalence of obesity in our study (40%) was consistent with the national average, our prevalence of class III obesity was higher at 14.2%.[1,2] Our sample size, including the large number of class I-III patients, makes this the largest study to date that uses the WHO weight-based classification to analyze posttracheostomy complications. By exclusively examining open tracheostomies performed by a single otolaryngology department, our study provides a more homogeneous population than those including various techniques, such as percutaneous tracheostomy.

The most common indications for tracheostomy in our non-obese and obese subgroups were malignancy and respiratory failure, respectively, consistent with other studies.[12] Class III patients had the highest rate of respiratory failure leading to tracheostomy. Obesity is associated with reduced lung and chest wall compliance and increased lung resistance, which explains why these patients were less likely to successfully wean from the ventilator.[16,17] This could suggest that class III patients are also at risk for prolonged mechanical ventilation after tracheostomy placement, as found in super obese patients.[13]

Transfer and positioning of obese patients on the surgical table are often difficult and require more resources, such as

an increased number of staff and increased time in the operating room. As with any surgery, increased operative duration increases the risk of complications.[18] In our study, mean operative time was significantly longer in obese patients. Patients with BMIs of 30 to 39.9 and >50 also had longer operative times as compared with nonobese patients. These findings are reflective of the technical challenge that tracheostomy poses in obese patients. These intraoperative challenges include identification of key laryngotracheal landmarks and additional modifications, such as cervical lipectomy and Bjork flap.[19] As most obese patients in our cohort required extended-length tracheostomy tubes, having these special tubes readily available in the operating room could reduce surgical time, as well as time under general anesthesia.

The overall postoperative complication rate for our cohort was 20.9%, which is slightly lower than the range (21.5%-47%) reported in the literature.[11,20] Analysis did not reveal any significant differences in complication rates when categorized by WHO classification subgroups. This may be limited by the relatively small size of each subgroup. Because of this limitation, our analysis combined subgroups to compare patients by BMI >40 and <40.

When class III obese patients were compared with those with a BMI <40, there was a significantly higher likelihood of multiple complications or death. In class III patients, our rate of death following accidental decannulation (66%) was higher than the 30% reported by El Solh and Jaafar.[11] This illustrates the great risk associated with decannulation in this patient population with suspected poor pulmonary reserve. It is crucial that precautions be taken to prevent accidental decannulation, including use of extended-length tracheostomy tubes, suturing the tube flanges to the neck, and educating medical staff on the appropriate tightness of trach collar ties.

This study emphasizes the importance of identifying high-risk populations, as this could influence medical decision making and allow physicians the opportunity to provide appropriate perioperative counseling. Previous studies have shown increased mortality risk in underweight and obese populations.[21,22] To our knowledge, there are no previous studies observing tracheostomy-related complications in underweight patients. In our series, underweight patients had a complication rate of 31.8%, which was significantly higher than normal-overweight patients. The most common complication in the underweight group was infection, which could be related to poor nutritional status, leading to insufficient energy stores needed for organ function, immune function, and wound-healing capability.[22] Underweight patients also experienced the highest rate of mortality following tracheostomy (9.1% of the total population). While none of the deaths in this subgroup were directly related to tracheostomy complications, it still demonstrates the increased risk associated with extremes in weight, including underweight and obese patients. A high mortality rate in the underweight subgroup was an unexpected finding, which we believe can be explained by the higher prevalence of comorbidities affecting the survival. Moreover, the elevated Charlson Comorbidity Index score in this subgroup was largely attributed to a diagnosis of malignancy.

Our study has several limitations, including its retrospective nature, which limited the accuracy of data to what was documented in electronic medical records. A multi-institutional study would increase the size of subgroups and possibly lead to significant differences in complication rates based on the WHO classification. Although all tracheostomies were performed by a single otolaryngology department, different surgeons may have different techniques, which could affect operative time and complication rates. Last, complications were recorded within only 30 days of tracheostomy, limiting our assessment of long-term complications such as tracheal stenosis.

This study reiterates the need for further investigation into the postoperative complications associated with varying classes of obesity as well as underweight patients. Preoperative counseling is important for all patients but may be crucial for underweight and obesity class III patients who potentially are at a greater risk of complications after tracheostomy. Additional research is necessary to understand postoperative outcomes for these patient populations so that preoperative counseling can be tailored to each risk category.

Conclusion

While our overall rates of obesity were similar to the US population, the prevalence of class III obesity was higher. Extremes of BMI, including underweight and class III patients, may be at higher risk of complications and death after tracheostomy. It is important to recognize patient populations at particularly high risk so that they may receive appropriate perioperative counseling and care.

Author Contributions

Shelby C. Barrera, acquired and organized retrospective data, drafted initial rough draft of work and revised based on corresponding author comments, approved final version; **Evan J. Sanford**, acquired and organized retrospective data, drafted initial rough draft of work and revised based on corresponding author comments, approved final version; **Sarah B. Ammerman**, analyzed retrospective data, revised work (especially results section), approved final version; **Jay K. Ferrell**, interpreted data, revised multiple drafts, approved final version; **C. Blake Simpson**, interpreted data, revised multiple drafts, approved final version; **Laura M. Dominguez**, formulated research question, collected retrospective data, drafted and revised manuscript, approved final version.

Disclosures

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