



# Impact of Drain Placement on Postoperative Complications after Thyroidectomy for Substernal Goiter

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## Abstract

**Introduction** Despite the evidence against drain placement after thyroidectomy, there is a lack of consensus on drain use in patients with substernal goiter.

**Objective** To assess the factors that increase the likelihood of drain placement and its impact on postoperative hematoma and other 30-day complications among adult patients undergoing thyroidectomy for substernal goiter.

**Methods** A retrospective cohort study that used data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). Adult patients (aged  $\geq 18$  years) who underwent elective thyroidectomy for substernal goiter from 2016 to 2020 were included. Cases with closed suction neck drains placed upon completion of surgery were included in the drain group, and the remaining cases formed the nondrain group.

**Results** A total of 1,229 patients were included (46.5% with drain placement). The factors that increased the likelihood of drain placement included body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>, score between 3 and 5 on the American Society of Anesthesiologists (ASA) physical status classification, sternal split/transthoracic surgical approach, operative time  $\geq 90$  minutes, and surgery conducted by otolaryngologists. Patients with clean-contaminated or contaminated wound classifications were less likely to be submitted to drain placement. In addition, drain use had no impact on postoperative hematoma formation but was found to independently increase the risk of prolonged length of hospital stay.

**Conclusion** Thyroidectomy without drain placement might be safe for substernal goiter. However, this decision should be individualized for each patient.

Level Of Evidence: 3

## Keywords

- drainage
- hematoma
- substernal goiter
- thyroid
- thyroid surgery

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## Introduction

Postoperative hematoma is among the most clinically significant complications following total thyroidectomy, particularly in patients with substernal goiter.<sup>1,2</sup> In cases of substernal goiter, there is close contact between the thyroid gland and vital aerodigestive and neurovascular structures. This poses several challenges for operating surgeons, including the extremely high risk of hematoma, among other complications.<sup>3,4</sup> A substernal goiter occupies a large space in the neck and in the superior mediastinum, which requires greater dissection of surrounding structures and longer duration of surgery.

Drain placement following thyroidectomy has been a standard practice in many surgical departments worldwide.<sup>5</sup> However, this has been declining as evidence has shown no significant impact of drain placement on the development of postoperative neck hematoma.<sup>5–13</sup> Contrarily, drain use has been associated with higher risks of other adverse outcomes.<sup>5,7,14</sup> Two recent meta-analyses<sup>5,14</sup> based on randomized controlled trials found that drain placement independently increased the likelihood of higher postoperative pain, prolonged hospital stay, and wound infections.

Despite the evidence against drain placement after thyroidectomy,<sup>5–14</sup> there is a lack of consensus on drain use in patients with substernal goiter. This could be attributed to many comparative studies excluding cases with substernal goiter, as identified by a recent systematic review.<sup>14</sup> In addition, substernal goiter has a low incidence, which makes it difficult to conduct adequately powered analyses. Based on the higher risk of hematoma in this cohort, Herranz and Latorre<sup>15</sup> advocate drain use despite a paucity of evidence comparing hematoma development among patients with and without drain placement.

In the present study, we assessed the factors that increase the likelihood of drain placement in patients undergoing thyroidectomy for substernal goiter using a multi-institutional database. We further explored the impact of drain placement on postoperative hematoma and other complications in this cohort.

## Methods

### Data Source, Study Design, and Population

The present was a multicenter, retrospective cohort study based on data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). The ACS-NSQIP is a multi-institutional, nationally-validated database that evaluates surgical outcomes, with more than 700 partnering hospitals. Data are collected prospectively by trained surgical clinical reviewers (SCRs) at each hospital using a standardized protocol. The details on the sampling technique, data collection methodology, and measures of the ACS-NSQIP are described elsewhere.<sup>16</sup>

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed in the present study, which was approved with exemption from consent by the Ethics Review Committee at Aga Khan University, Karachi, Pakistan (reference ID: 2022-7219-20725).

Adult patients (aged  $\geq 18$  years) who underwent elective thyroidectomy for substernal goiter from 2016 to 2020 were included. These cases were identified using the following current procedural terminology (CPT) codes: 60270 (thyroidectomy, including substernal thyroid; sternal split or transthoracic approach) and 60271 (thyroidectomy, including substernal thyroid; cervical approach). Cases with missing data in the ACS-NSQIP Thyroidectomy Targeted Dataset and those undergoing emergency or urgent surgeries were excluded. Since thyroidectomy is mostly performed by otolaryngologists or general surgeons, procedures performed by other principal surgical specialties were further excluded.

### Measures

The perioperative variables for risk adjustment included sociodemographic characteristics, medical comorbidities, and operative details. Sociodemographic characteristics comprised age, gender, race, Hispanic ethnicity, and body mass index (BMI). Race was categorized as white, black or African American, and others (which included Asians, Native Americans, Alaska natives, native Hawaiians, and Pacific islanders).

Comorbidities comprised diabetes mellitus, smoking, hypertension, bleeding disorder, previous neck surgery, and the score on the American Society of Anesthesiologists (ASA) physical status classification. Smoking status was quantified as smoking within one year of surgery. Bleeding disorders included hemophilia, vitamin K deficiency, thrombocytopenia, chronic anticoagulation therapy, and similar disorders predisposing patients to severe bleeding.

The operative characteristics comprised surgical approach, indication, principal specialty, central neck dissection, use of vessel sealant device, wound classification, and operative time. Surgical indications were categorized as benign or malignant based on the codes of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Tenth Revision (ICD-10-CM).

### Drain and Non-Drain Groups

Patients were categorized into drain and non-drain groups. Cases with closed suction neck drains placed upon completion of surgery were included in the drain group. The remaining cases formed the nondrain group.

### Outcomes

The primary outcome included 30-day postoperative neck hematoma. The ACS-NSQIP defines it as development of a hematoma or postoperative bleeding at the neck site. Ecchymosis or bruising alone does not qualify as hematoma.<sup>17</sup> Interventions required for hematoma management were also documented.

The secondary outcomes included any complication within 30 days, major morbidity, and prolonged length of stay. The complications were further divided into infectious and noninfectious. Infectious complications comprised surgical site infection (SSI), urinary tract infection (UTI), sepsis, septic shock, wound disruption, pneumonia, and clostridium difficile colitis. Noninfectious complications included cerebrovascular

accident (CVA)/stroke, cardiac complications (myocardial infarction [MI] or cardiac arrest), pulmonary complications (ventilator dependence for > 48 hours or unplanned reintubation), acute renal failure, deep vein thrombosis (DVT), intra-/postoperative blood transfusion(s), postoperative hypocalcemia, and recurrent laryngeal nerve injury. Major morbidity included any of the following adverse outcomes: deep or organ space SSI, wound dehiscence, pulmonary embolism (PE), prolonged ventilation, unplanned reintubation, sepsis, septic shock, MI, cardiac arrest, or CVA. Prolonged length of hospital stay was defined as stay > 2 days during the index admission.

### Statistical Analysis

Descriptive statistics were reported. The Shapiro-Wilk test was used to confirm the nonparametric distribution of continuous variables, including age, BMI, operative time, and length of stay ( $p < 0.001$  for all). Accordingly, the continuous variables were reported using median and interquartile range (IQR) values and compared across the drain and non-drain groups using the Mann-Whitney U test. The categorical variables were expressed as frequencies and percentages, and the Chi-squared ( $\chi^2$ ) test or the Fisher exact test were computed to compare their differences across the drain and non-drain groups. Missing data were reported in tables to keep the denominators consistent in the calculations.

Multivariable binary logistic regression models were computed to explore independent factors increasing the likelihood of drain placement and to assess the impact of drain placement on postoperative neck hematoma. To select covariates for adjustment, variance inflation factors (VIFs) were calculated for clinically-relevant baseline characteristics, comorbidities, and operative variables with  $p < 0.20$  on the univariate analysis. The threshold for significant multicollinearity was set at  $VIF \geq 10$ , and no significant multicollinearity was observed during the analysis.

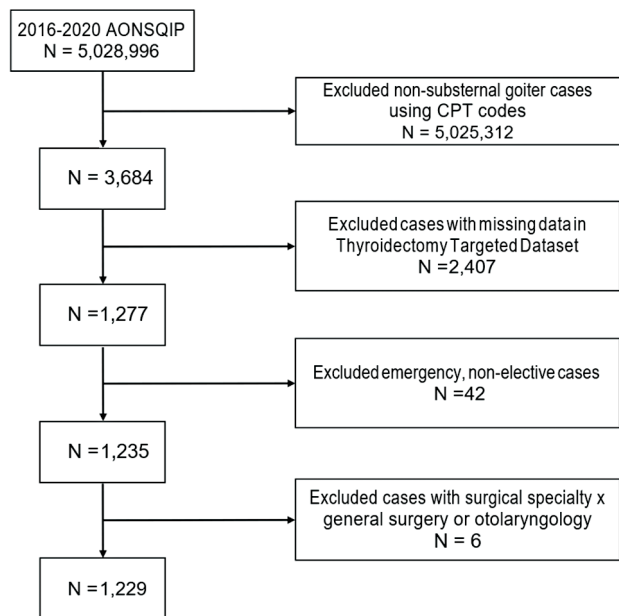
Separate binary logistic regression models were also computed to assess the impact of drain placement on any 30-day postoperative complication, major morbidity, and prolonged length of hospital stay. After ruling out significant multicollinearity, these models were adjusted for age, gender, BMI, ASA score, surgical approach, principal specialty, use of vessel sealants, wound classification, and operative time.

Two-sided analyses were conducted. The threshold for statistical significance was set at  $p < 0.05$ . Adjusted odds ratios (AORs) and their corresponding 95% confidence intervals (95% CIs) were reported. IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY, United States), software, version 26.0, was used to conduct the analyses.

## Results

### Patient Characteristics

A total of 1,229 participants were included in the present study (► Fig. 1). Most patients were female (72.2%), had a median age of 59.0 (IQR 22.0) years, and were operated on for benign indications (89.2%). Other baseline characteristics, comorbidities, and operative details are summarized in ► Table 1.



**Fig. 1** Details of the total cases included and the cases that were excluded based on CPT codes, missing data, emergency/ non-elective procedures, and ineligible surgeon subspecialties.

Drains were placed in 46.5% of the cases. Compared with the non-drain group, a greater proportion of patients in the drain group: were male (32.0% versus 24.2%), had a BMI  $\geq 30$  kg/m<sup>2</sup> (70.6% versus 61.6%), presented ASA scores from 3 to 5 (65.6% versus 53.7%), presented bleeding disorders (3.0 versus 1.2%), had operative time  $\geq 150$  minutes (50.3% versus 27.5%), and underwent a sternal split or transthoracic approach (14.7% versus 10.7%). Similarly, having a clean wound classification was significantly more common among patients in the drain group compared to those in the non-drain group (98.6% versus 95.0%). Additionally, otolaryngologists were more likely to use drains (66.8%) in comparison with general surgeons (33.2%). Use of vessel sealant devices was more common in the non-drain group (78.8%) than in the drain group (68.2%).

### Factors Increasing the Likelihood of Drain Placement

After adjustment for baseline characteristics, comorbidities, and operative details, factors increasing the likelihood of drain placement included BMI  $\geq 30$  kg/m<sup>2</sup>, ASA score from 3 to 5, sternal split/transthoracic approach, operative time  $\geq 90$  minutes, and surgery conducted by otolaryngologists (► Table 2). Patients with clean-contaminated or contaminated wound classifications were less likely to undergo drain placement (AOR: 0.214; 95%CI: 0.089–0.514).

### Postoperative Hematoma

A total of 2.2% of the patients (27 of 1,229) developed postoperative hematoma. Most hematoma cases were underwent additional observation during hospital admission (70.4%; 19 of 27) while 1 patient required tracheostomy (3.7%; 1 of 27). The remaining seven patients did not require additional observation.

**Table 1** Baseline characteristics, comorbidities, and operative variables stratified by drain status

Variable	No drain n = 657	Drain n = 572	p-value
Age in years*	59.0 (22.0)	59.0 (22.0)	0.278
< 65	440 (67.0%)	368 (64.3%)	0.332
≥ 65	217 (33.0%)	204 (35.7%)	
Gender			0.002**
Female	498 (75.8%)	389 (68.0%)	
Male	159 (24.2%)	183 (32.0%)	
Race			0.886
White	337 (56.4%)	286 (57.2%)	
Black or African American	242 (40.5%)	197 (39.4%)	
Others	18 (3.0%)	17 (3.4%)	
Missing	60	72	
Hispanic ethnicity	39 (6.4%)	32 (6.2%)	0.872
Missing	50	55	
BMI (kg/m <sup>2</sup> )*	31.8 (9.6)	34.3 (11.4)	< 0.001**
BMI (kg/m <sup>2</sup>			0.002**
< 25.0	96 (14.7%)	54 (9.6%)	
25.0–30.0	155 (23.7%)	112 (19.8%)	
≥ 30.0	403 (61.6%)	399 (70.6%)	
Missing	3	7	
ASA score			< 0.001**
1–2	304 (46.3%)	196 (34.4%)	
3–5	352 (53.7%)	374 (65.6%)	
Missing	1	2	
Diabetes mellitus	121 (18.4%)	127 (22.2%)	0.099
Current smoker	88 (13.4%)	90 (15.7%)	0.245
Hypertension	351 (53.4%)	323 (56.5%)	0.285
Bleeding disorder	8 (1.2%)	17 (3.0%)	0.030**
Previous neck surgery	53 (8.1%)	48 (8.4%)	0.836
Surgical approach			0.033**
Cervical	587 (89.3%)	488 (85.3%)	
Sternal split or transthoracic	70 (10.7%)	84 (14.7%)	
Indication			0.308
Benign	591 (90.1%)	505 (88.3%)	
Malignant	65 (9.9%)	67 (11.7%)	
Missing	1	0	
Specialty			< 0.001**
General surgery	466 (70.9%)	190 (33.2%)	
Otolaryngology	191 (29.1%)	382 (66.8%)	
Central neck dissection	70 (10.8%)	66 (11.6%)	0.652
Missing	9	4	
Vessel sealant device	508 (78.8%);	379 (68.2%);	< 0.001**
Missing	12	16	
Wound classification			< 0.001**
Clean	624 (95.0%);	564 (98.6%);	
Clean-contaminated or contaminated	33 (5.0%)	8 (1.4%)	
Operative time in minutes*	114.0 (73.0)	150.0 (100.0)	< 0.001**
Operative time/mins			< 0.001**
< 90	211 (32.1%)	80 (14.0%)	
90–120	140 (21.3%)	109 (19.1%)	
120–150	125 (19.0%)	95 (16.6%)	
> 150	181 (27.5%)	288 (50.3%)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

Notes: \*Reported as median and interquartile range values; \*\*statistically significant ( $p < 0.05$ ); percentages are presented in columns.

**Table 2** Univariate and multivariable binary logistic regression for drain placement among patients undergoing thyroidectomy for substernal goiter

Variable	Unadjusted odds ratio	<i>p</i> -value	Adjusted odds ratio	<i>p</i> -value
<b>Age in years</b> < 65 ≥ 65	Reference 1.124 [0.888–1.423]	0.332	–	–
<b>Gender</b> Female Male	Reference 1.473 [1.147–1.893]	0.002**	Reference 1.230 [0.910–1.663]	0.177
<b>Race</b> White Black or African American Others	Reference 0.959 [0.751–1.226] 1.113 [0.563–2.200]	0.739 0.758	–	–
<b>Hispanic ethnicity</b>	0.961 [0.593–1.558]	0.872	–	–
<b>BMI (kg/m<sup>2</sup>)</b> < 25.0 25.0–30.0 ≥ 30.0	Reference 1.285 [0.850–1.941] 1.760 [1.227–2.525]	0.234 0.002**	Reference 1.287 [0.786–2.108] 1.675 [1.078–2.602]	0.316 0.022*
<b>ASA score</b> 1–2 3–5	Reference 1.648 [1.308–2.076]	< 0.001**	Reference 1.415 [1.060–1.887]	0.018*
<b>Diabetes mellitus</b>	1.264 [0.957–1.671]	0.099	1.240 [0.876–1.757]	0.225
<b>Current smoker</b>	1.207 [0.879–1.659]	0.245	–	–
<b>Hypertension</b>	1.131 [0.903–1.417]	0.285	–	–
<b>Bleeding disorder</b>	2.485 [1.064–5.802]	0.035*	2.321 [0.863–6.245]	0.095
<b>Previous neck surgery</b>	1.044 [0.694–1.569]	0.836	–	–
<b>Surgical approach</b> Cervical Sternal split or transthoracic	Reference 1.443 [1.028–2.026]	0.034*	Reference 1.756 [1.167–2.640]	0.007*
<b>Indication</b> Benign Malignant	Reference 1.206 [0.841–1.731]	0.309	–	–
<b>Specialty</b> General surgery Otolaryngology	Reference 4.905 [3.850–6.249]	< 0.001**	Reference 6.932 [5.179–9.278]	< 0.001**
<b>Central neck dissection</b>	1.086 [0.760–1.551]	0.652	–	–
<b>Vessel sealant device</b>	0.557 [0.445–0.749]	< 0.001**	0.803 [0.587–1.099]	0.171
<b>Wound classification</b> Clean Clean-contaminated or contaminated	Reference 0.268 [0.123–0.586]	0.001**	Reference 0.214 [0.089–0.514]	0.001**
<b>Operative time in minutes</b> < 90 90–120 120–150 > 150	Reference 2.053 [1.434–2.940] 2.004 [1.384–2.904] 4.197 [3.055–5.765]	< 0.001** < 0.001** < 0.001**	Reference 2.495 [1.651–3.772] 2.637 [1.714–4.057] 6.323 [4.323–9.248]	< 0.001** < 0.001** < 0.001**

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

Notes: \*\*Statistically significant ( $p < 0.05$ ); only cases with complete data on all covariates were included ( $n = 1,189$ ).

On the univariate analysis, there was no significant difference in the incidence of neck hematoma in the drain and non-drain groups (3.0% versus 1.5% respectively;  $p = 0.083$ ). This was consistent across the multivariable regression analysis after adjustment for clinically relevant characteristics (AOR: 1.289; 95%CI: 0.525–3.168). Instead, black or African American race was identified as a risk factor for postoperative hematoma, while use of vessel sealant devices was found to independently reduce the risk of hematoma development (– **Table 3**).

### Complications

The univariate analyses demonstrated no significant differences in terms of major morbidity, infectious complications, sepsis, wound disruption, pneumonia, cardiac complications, acute renal failure, postoperative hypocalcemia, recurrent laryngeal nerve injury, unplanned readmission, and mortality between the both groups. However, compared with the non-drain group, patients with drain placement presented significantly higher occurrences of surgical site

**Table 3** Univariate and multivariable binary logistic regression analyses for postoperative hematoma

Variable	Unadjusted odds ratio	p-value	Adjusted odds ratio	p-value
<b>Age in years</b> < 65 ≥ 65	Reference 1.336 [0.614–2.906]	0.465	–	–
<b>Gender</b>				
Female Male	Reference 1.304 [0.580–2.932]	0.520	–	–
<b>Race</b> White Black or African American Others	Reference 2.536 [1.055–6.099] 2.254 [0.274–18.540]	0.038** 0.450	Reference 3.239 [1.223–8.574] 2.142 [0.229–20.008]	0.018** 0.504
<b>Hispanic ethnicity</b>	2.787 [0.934–8.319]	0.066	3.572 [0.684–18.652]	0.131
<b>BMI (kg/m<sup>2</sup>)</b> < 25.0 25.0–30.0 ≥ 30.0	Reference 0.738 [0.163–3.342] 1.238 [0.363–4.219]	0.693 0.733	–	–
<b>ASA score</b> 1–2 3–5	Reference 3.101 [1.166–8.244]	0.023**	Reference 2.480 [0.888–6.929]	0.083
<b>Diabetes mellitus</b>	1.681 [0.727–3.886]	0.225	–	–
<b>Current smoker</b>	1.716 [0.683–4.313]	0.251	–	–
<b>Hypertension</b>	1.664 [0.741–3.733]	0.217	–	–
<b>Bleeding disorder</b>	1.881 [0.245–14.437]	0.543	–	–
<b>Previous neck surgery</b>	1.996 [0.677–5.891]	0.210	–	–
<b>Surgical approach</b> Cervical Sternal split or transthoracic	Reference 0.551 [0.129–2.348]	0.420	–	–
<b>Indication</b> Benign Malignant	Reference 0.313 [0.042–2.325]	0.256	–	–
<b>Specialty</b> General surgery Otolaryngology	Reference 1.439 [0.668–3.099]	0.353	–	–
<b>Central neck dissection</b>	1.464 [0.497–4.315]	0.489	–	–
<b>Vessel sealant device</b>	0.249 [0.113–0.549]	0.001**	0.167 [0.070–0.401]	< 0.001**
<b>Wound classification</b> Clean Clean-contaminated or contaminated	Reference Could not be computed	–	–	–
<b>Operative time in minutes</b> < 90; 90–120; 120–150; > 150	Reference; 2.375 [0.706–7.984]; 1.319 [0.326–5.335]; 1.715 [0.541–5.437]	0.162 0.697 0.360	Reference; 2.141 [0.530–8.649]; 1.242 [0.264–5.836]; 0.906 [0.216–3.790]	0.285 0.784 0.892
<b>Drain placement</b>	1.983 [0.901–4.366]	0.089	1.289 [0.525–3.168]	0.580

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

Notes: \*\*Statistically significant ( $p < 0.05$ ); only cases with complete data on all covariates were included ( $n = 1,052$ ).

infections (0.7% versus 0.0%;  $p = 0.047$ ), unplanned reintubation (1.6% versus 0.5%;  $p = 0.047$ ), blood transfusions (1.9% versus 0.3%;  $p = 0.006$ ), unplanned reoperations (3.0 versus 0.9%;  $p = 0.008$ ), and prolonged length of hospital stay (15.9% versus 5.0%;  $p < 0.001$ ) (►Table 4).

The results of the regression analysis of the association of drain placement with postoperative outcomes are shown in ►Table 5. After adjustment for clinically relevant covariates, drain use in patients with thyroidectomy for substernal goiter independently increased the likelihood of



**Table 4** Thirty-day postoperative complications, stratified by drain status

Variable	No drain <i>n</i> = 657	Drain <i>n</i> = 572	<i>p</i> -value
Neck hematoma <i>Missing</i>	10 (1.5%) 2	17 (3.0%) 2	0.083
Any complication	87 (13.2%)	78 (13.6%)	0.840
Major morbidity	11 (1.7%)	11 (1.9%)	0.743
Infectious complications	8 (1.2%)	7 (1.2%)	0.992
Surgical site infection	0 (0.0%)	4 (0.7%)	0.047**
Urinary tract infection	3 (0.5%)	0 (0.0%)	0.253
Sepsis	1 (0.2%)	0 (0.0%)	> 0.999
Septic shock	1 (0.2%)	0 (0.0%)	> 0.999
Wound disruption	2 (0.3%)	1 (0.2%)	> 0.999
Pneumonia	3 (0.5%)	1 (0.2%)	0.628
Clostridium difficile colitis	0 (0.0%)	1 (0.2%)	0.465
Noninfectious complications	83 (12.6%)	74 (12.9%)	0.874
CVA/stroke with neurological deficit	1 (0.2%)	0 (0.0%)	> 0.999
Cardiac complications <i>Myocardial infarction</i> <i>Cardiac arrest requiring CPR</i>	2 (0.3%) 2 (0.3%) 0 (0.0%)	2 (0.3%) 0 (0.0%) 2 (0.3%)	> 0.999 0.502 0.216
Pulmonary complications <i>Ventilator &gt; 48 hours</i> <i>Unplanned intubation</i>	5 (0.8%) 3 (0.5%) 3 (0.5%)	11 (1.9%) 4 (0.7%) 9 (1.6%)	0.073 0.711 0.047**
Acute renal failure	1 (0.2%)	0 (0.0%)	> 0.999
DVT/thrombophlebitis	1 (0.2%)	0 (0.00%)	> 0.999
Blood transfusion	2 (0.3%)	11 (1.9%)	0.006**
Postoperative hypocalcemia <i>Missing</i>	31 (4.9%) 21	24 (4.4%) 28	0.707
Recurrent laryngeal nerve injury <i>Missing</i>	46 (7.0%) 3	39 (6.9%) 5	0.915
Unplanned reoperation	6 (0.9%)	17 (3.0%)	0.008**
Unplanned readmission	18 (2.7%)	17 (3.0%)	0.807
Length of stay*	1.0 (1.0)	1.0 (1.0)	< 0.001**
Prolonged length of stay <i>Missing</i>	33 (5.0%) 0	91 (15.9%) 1	< 0.001**
Mortality	2 (0.3%)	0 (0.0%)	0.502

Abbreviations: CPR, cardiopulmonary resuscitation; CVA, cerebrovascular accident; DVT, deep vein thrombosis.

Notes: \*Reported as median and interquartile range values; \*\*statistically significant ( $p < 0.05$ ); percentages are presented in columns.

**Table 5** Multivariable binary logistic regression analyses for other postoperative outcomes with drain status as the main explanatory covariate

Outcome	Adjusted odds ratio	<i>p</i> -value
Any complication	0.698 [0.469-1.037]	0.075
Major morbidity	0.518 [0.183-1.467]	0.215
Prolonged length of stay	2.047 [1.245-3.368]	0.005**

Notes: No drain group was reference; regression adjusted for age, gender, body mass index (BMI), score on the American Society of Anesthesiology (ASA) physical status classification, surgical approach, principal specialty, use of vessel sealants, wound classification, and operative time;

\*\*statistically significant ( $p < 0.05$ ); only cases with complete data on all covariates were included ( $n = 1,188$  for prolonged length of stay and 1,189 for all other outcomes).

prolonged length of hospital stay (AOR: 2.047; 95%CI: 1.245–3.368). Drain placement was not independently associated with any postoperative complication or major morbidity (►Table 5).

## Discussion

The present study used a large, multi-institutional dataset to compare the incidence of postoperative hematoma and other complications among patients undergoing thyroidectomy for substernal goiter with and without drain use. Our results demonstrate that drain use was associated with 28.9% higher odds of hematoma, but this was not statistically significant. We speculate that this may be due to a higher probability of detecting clinically-insignificant minor hematomas during hospital admission. This hypothesis is supported by the longer length of hospital stay observed among patients with drain compared with the non-drain cohort, which provided more time to detect insignificant hematomas. In contrast, an alternative explanation for the higher likelihood of hematoma formation could be the presence of inherent selection biases for drain placement in high-risk cases. Our analysis demonstrated that ASA scores from 3 to 5, BMI  $\geq 30$  kg/m<sup>2</sup>, and more complex surgical approaches were independently associated with drain use, further supporting this hypothesis. More appropriate variables to assess the risk of hematoma in this population would include size of resection, intraoperative hemorrhage, surgeon experience, and use of preoperative anticoagulation.<sup>7</sup> However, our regression analyses could not be adjusted for these variables, as they are not captured in the ACS-NSQIP, limiting the conclusiveness of our findings. Nevertheless, these results are in accordance with the existing literature on the impact of drain use on postoperative hematoma in thyroidectomies.<sup>5–13</sup>

In the present study, drain use was independently associated with prolonged length of stay. This is consistent among studies on cases of non-substernal goiter undergoing thyroidectomy.<sup>7,14</sup> This could be attributed to surgeon reluctance to discharge patients until the drain output thresholds are met. While beyond the scope of the current study, prolonged length of stay can impose higher monetary costs on patients, lead to patient discomfort, and burden the limited hospital resources available.<sup>18,19</sup> In addition, prolonged hospital stay may predispose patients to nosocomial infections. Even though drain use did not independently increase the risk of developing infectious complications, the univariate analysis revealed a higher likelihood of developing infectious complications among patients with prolonged versus non-prolonged stay (4.0% versus 0.8% respectively;  $p = 0.009$ ).

We found that otolaryngologists were more likely to use drains in thyroidectomy for substernal goiter compared with general surgeons (AOR: 6.932; 95%CI: 5.179–9.278), even after adjustment for relevant baseline, patient, and surgery characteristics. However, there was no significant difference in the rate of postoperative hematoma among their cases (1.8% in general surgery cases versus 2.6% in otolaryngology cases;  $p = 0.351$ ). In addition, patients operated on by otolar-

ynologists were more likely to have prolonged hospital stay compared with general surgery patients (12.9% versus 7.6%, respectively;  $p = 0.002$ ). Chung et al.<sup>20</sup> report similar findings in their comparison of thyroidectomies performed by general surgeons versus otolaryngologists. These apparent differences in length of hospital stay might be a surrogate measure for differences in drain placement practices among these two specialties.

Surgeons were less likely to place drains in clean-contaminated or contaminated wounds. Considering thyroidectomy is a clean procedure, this seems to have occurred in cases in which concomitant procedures such as tracheostomy were performed. We speculate that this would be when tracheomalacia or bilateral cord paralysis was suspected.

Several implications can be inferred from the present study. First, thyroidectomy without drain placement might be safe among patients with substernal goiter. However, this decision should be individualized for each patient, while also accounting for surgeon preference. Specifically considering the similar rates of postoperative hematoma observed among surgeries conducted by otolaryngologists and general surgeons, otolaryngologists may better optimize their practice regarding patient selection for drain placement. The conclusiveness of these recommendations, however, is limited to patients without preoperative anticoagulation therapy or significant intraoperative bleeding, considering these factors could not be explored in the current study.

Second, a shorter hospital stay might be feasible with proper patient education related to drain management in certain cases in which drains are still indicated.<sup>21</sup> Familiarizing surgeons with short-stay protocols might also help avoid unnecessary hospital stays. However, this requires further evaluation, as patient education and short-stay protocols were beyond the scope of the current study.

The present study has multiple limitations which should be considered while interpreting its results. Since we used an existing database, our analyses are limited to variables included within the dataset. The ACS-NSQIP does not include the extent of hematoma, development of seroma, surgeon experience, and hospital volume. In addition, preoperative laboratory assessments could not be included in the statistical analyses because of the substantial number of missing values. These factors might be associated with hematoma formation in this cohort. Lastly, the database might be susceptible to coding and data collection errors.

## Conclusion

Thyroidectomy without drain placement might be safe for substernal goiter, particularly in patients without preoperative anticoagulation use or intraoperative hemorrhage. However, this decision should be individualized for each patient, while accounting for surgeon preference. Otolaryngologists may better optimize their patient selection practice for drain placement. In addition, patient education regarding drain management and short-stay protocols should be further evaluated to help reduce unnecessary hospital stays.



### Author Contributions

UW conceptualized the study. UW, ANH, MA, HI, SAA, and SS designed the study, and all authors drafted the protocol. SAA performed the statistical analyses. UW, ANH, MA, and SK drafted the initial version of the manuscript, which was reviewed and edited by all authors. All authors approved the final version of the manuscript to be published.

### Data Statement

The data acquired was obtained through the ACS-NSQIP database and was used with the permission of The American College of Surgeons.

### Disclaimer

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) and the hospitals participating in the ACS-NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

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### Conflict of Interests

The authors have no conflict of interests to declare.

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