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Substernal goiter: when is a sternotomy required?

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Abstract

Background—Sternotomy for substernal goiters (SSG) is associated with greater morbidity than a cervical approach to thyroidectomy. We sought to identify predictors for sternotomy as a surgical approach for the removal of SSG and analyzed the preoperative and postoperative characteristics of patients with SSG compared with those with large goiters contained entirely within the neck or a cervical goiter.

Methods—A retrospective review of a surgical database was performed. We included patients with large (>100 g) thyroids or SSG, regardless of size. Between 1995 and 2013, 220 patients met these criteria. Comparisons were made between patients who had an SSG and patients who had a cervical goiter with particular focus on those who required sternotomy.

Results—Of the 220 patients, 127 patients (58%) had SSG, of whom 7 (5.5%) required sternotomy. All patients who underwent sternotomy underwent preoperative computed tomography scanning and were more likely to have preoperative symptoms of chest pressure and voice complaints and have extension of the thyroid gland below the aortic arch. Sternotomy took an average of 2 hours longer than a cervical incision, was associated with significantly more blood loss (600 *versus* 190 mL, $P = 0.04$), and a longer length of stay (3.1 *versus* 1.8 d, $P = 0.03$) than cervical thyroidectomy.

Conclusions—Sternotomy for SSG is rare. All patients necessitating sternotomy had extension below the aortic arch and were more likely to present complaining of chest pressure and voice issues.

Keywords

Substernal goiter; Sternotomy; Thyroidectomy

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1. Introduction

A retrosternal or substernal goiter (SSG) is an enlargement of the thyroid gland that extends into the mediastinum posterior to the sternum. There is no uniform, widely accepted definition of SSG. One article has identified at least six different definitions [1] that may help explain why the prevalence of SSG ranges anywhere from 2%–19% among all patients with a goiter [1–5]. Two of the most commonly accepted definitions of SSG are a goiter that has descended below the plane of the thoracic inlet and a goiter with more than 50% of its mass lying below the thoracic inlet [2,4]. Regardless of definition, continued growth of an SSG can lead to symptoms from compression of the great vessels, trachea, and esophagus [3,6–11]. Medical management using exogenous thyroxine may reduce gland size slightly [6,12] but this is rarely sufficient [5,7,13]. For this reason, surgical treatment is generally indicated in symptomatic patients, and many advocate for the removal of retrosternal goiters before dangerous compressive symptoms appear [1].

Most thyroidectomies are performed through an incision in the neck, but this may prove challenging if a large portion of the gland is behind the sternum. An SSG may be managed through a cervical incision [14], but a thoracic approach such as a total or partial sternotomy may be required. Previous authors have reported it necessary in 1%–11% of patients with SSG [5,15]. The potential complications of a thoracic approach include hematoma, mediastinitis, abscess, osteomyelitis, chest bone fracture, and sternal dehiscence. Recovery can also take longer and be more painful in comparison with a cervical approach.

Accordingly, predicting which patients will have a difficult operation and potentially require a sternotomy is desirable for preoperative planning, to assure proper personnel and resource allocation and provide information for better informed patient discussions regarding operative risk [5,16]. We performed a retrospective review of our endocrine surgery database to identify pathologic, clinical, or radiologic factors associated with a thoracic approach. There were two objectives of this study. The first was to compare preoperative and postoperative characteristics of patients with SSG compared with those with large goiters contained entirely within the neck or a cervical goiter (CG). The second was to identify predictors for sternotomy as a surgical approach for the removal of SSG.

2. Materials and methods

A retrospective review of our institutional review board-approved endocrine surgery database was performed. We included all patients who underwent a total thyroidectomy who had large thyroids (>100 g) or any mention of a substernal component during their preoperative workup, regardless of the size of the gland. SSG was defined as an enlarged thyroid gland descending below the plane of the thoracic inlet [1,2,17] as this definition is the most inclusive and refers to consistent anatomic landmarks that are easily recognized both radiologically and during surgery [1]. Between 1995 and 2013, 3233 thyroidectomies were performed, and 220 patients had very large or SSG. Demographic data were then compared between patients who had an SSG and those whose thyroid glands were contained entirely within the neck. Further comparisons were made between those with an SSG who required sternotomy to excise their thyroid and those who underwent cervical incision only.

The groups were compared using the chi-square test for categorical variables and the Student t-test for continuous variables. To identify predictors of sternotomy, bivariate comparisons were made and *P* values of ≤0.05 were determined to be significant. All statistical analyses were performed using STATA version 12 (StataCorp, College Station, TX). Data are expressed as mean ± standard error of the mean or as a number (%) as appropriate.

3. Results

Of the 220 patients, 127 patients (58%) had SSG, of whom 7 (5.5%) required sternotomy. The remaining 93 patients (42%) were classified with CG that were not substernal. On bivariate analysis, there were no differences in gender, thyroid weight, estimated blood loss, body mass index, preoperative symptomatology, postoperative complications, operation time, incidence of previous neck surgery, or length of stay for patients who had SSG *versus* CG. However, patients with SSG were older (62 *versus* 51 y, $P < 0.001$) than patients with CG. These features are outlined in Table 1.

The most common preoperative symptoms for patients with CG were dysphagia and shortness of breath, which occurred in 49 patients (54%) and 37 patients (40%), respectively. The preoperative symptoms for patients with SSG were dysphagia in 64 patients (52%), shortness of breath in 64 patients (52%), voice issues in 13 patients (11%), and other complaints such as chest pressure in 15 patients (12%). Postoperatively, 15 patients (17%) with CG had hypocalcemia and 9 hypocalcemia (10%) complained of voice issues. For patients with SSG, postoperative bleeding requiring immediate reoperation occurred in 4 patients (3%), postoperative hypocalcemia occurred in 11 patients (9%), and postoperative voice issues occurred in 13 patients (10%). These features are outlined in Table 2.

Bivariate comparisons were made for patients with SSG who required sternotomy to those with SSG who had their thyroid removed completely through a cervical incision. Patients who underwent a sternotomy showed no difference in terms of gender, age, body mass index, thyroid weight, operating time, incidence of previous neck surgery, preoperative hyperthyroidism, or permanent postoperative complications. All patients who underwent sternotomy underwent preoperative computed tomography (CT) scanning, and they were more likely to have other preoperative symptoms (43% *versus* 10%, $P = 0.01$) such as chest pressure and voice complaints (43% *versus* 9%, $P = 0.004$). Sternotomy took an average of 2 h longer than a cervical incision, was associated with significantly more blood loss (600 *versus* 190 mL, $P = 0.04$), and a longer length of stay (3.1 *versus* 1.8 d, $P = 0.03$) than cervical thyroidectomy. These features are outlined in Tables 3 and 4.

Sternotomy was predetermined in 6 of the 7 cases in which it was required. In only one case, the decision to perform sternotomy was decided intraoperatively. No patients who underwent sternotomy required blood transfusion, had a postoperative wound infection, or were found to have thyroid cancer. Furthermore, all patients who underwent sternotomy had extension of the thyroid gland below the aortic arch. These features are detailed in Table 5.

We compared the CT scans of all the patients who underwent sternotomy to the 30 patients with the largest (by weight) SSG who also underwent preoperative CT scanning. We used the measurement tools within the imaging software to measure several dimensions of the thyroid gland. We found that the widest anterior-posterior dimension at the thoracic inlet was 6 cm for patients who required sternotomy and 6.2 cm for those who did not. The widest point of the thyroid below the thoracic inlet was 8.1 cm for those who required a sternotomy and only 4.9 cm for those who did not. However, this was largely driven by one patient who required a sternotomy who had a thyroid width of 13.5 cm below the thoracic inlet. If we eliminate that outlier, the dimensions are approximately the same. We also estimated how much of the thyroid gland was below the sternal notch and found that patients who required a sternotomy had a mean of 77% of the gland below the sternal notch, whereas patients who did not require a sternotomy had a mean of 27% of the gland below the sternal notch. By visual estimation, all 7 patients who underwent sternotomy had at least 70% of the gland below the notch and only 2 of the 30 patients that did not require a sternotomy had that much of the gland in the chest. All 7 patients requiring sternotomy had extension to or below the aortic arch, whereas only 3 of the 30 patients who did not require sternotomy had extension to, but not below, the sternal notch.

4. Discussion

Sternotomy is rarely required for resection of SSG, and our study found few absolute indicators for when it was required. Patients who ultimately required sternotomy had a higher incidence of preoperative symptoms of chest pressure (43% *versus* 10%, $P = 0.01$) and voice complaints (43% *versus* 9%, $P = 0.004$), but these were not specific. All patients who required sternotomy had thyroid tissue below the level of the aortic arch, but not all patients with thyroid tissue below the aortic arch required sternotomy. CT scan is imperative for operative planning.

Sternotomy as an operative approach requires a vastly higher amount of resources, substantially more planning, and potentially higher perioperative risks for the patient. Identifying which patients may require mobilization of such resources is important to ensure a smooth perioperative encounter. Unfortunately, we, like others [5,6,18,19] have not been able to predict with 100% certainty when this rare event will be needed. Our results are similar to others in that it is often not just the size but the shape (iceberg, hourglass, and dumbbell) or discontinuity of the gland that is important [6,18]. The higher presence of symptoms in our sternotomy group may simply reflect the anatomic location of the gland.

Although perioperative indicators such as blood loss and length of stay were higher for sternotomy patients, this reflects the increased complexity of that surgical approach. When we looked at long-term complications and outcomes, patients who underwent sternotomy had very good outcomes, which are similar to others' findings [6,8,19]. Therefore, it appears that sternotomy, when performed by experienced surgeons, is a safe procedure. This is in agreement with authors who suggest that sternotomy should not be neglected in complicated cases to prevent complications such as hemorrhage caused by traction, recurrent laryngeal nerve damage, or damage to the parathyroid glands [8]. Clinically, it is hoped that these

findings can alleviate patient concerns and lead to improved preoperative planning and resource allocation.

Inherent to any retrospective study are several limitations, and ours is no exception. We only included patients who underwent surgery, and there are variables that are not captured that help inform decisions about operative approach, such as surgeon preference. Furthermore, because this is a very rare event, it would be better studied in a multi-institutional manner. We have a very high volume center with more than 400 thyroidectomies performed per year, and in our experience of over 3000 thyroidectomies, only 7 required sternotomy. Large administrative databases such as the National Surgery Quality Improvement Program lack clinical details about preoperative imaging characteristics and endocrinespecific postoperative complications, so do not give the level of detail needed to make a better predictive model. Furthermore, there is no universally accepted definition of SSG. Of the two most common definitions, we chose to define a SSG as a thyroid gland that has descended below the plane of the thoracic inlet [1,2,17]. We chose this definition because it is the most inclusive and refers to constant anatomic landmarks that are easily recognized during surgery and radiologically [1]. However, until we develop a common language, we will be unable to confidently compare results across studies.

5. Conclusions

In conclusion, sternotomy is rarely indicated for resection of SSG and was required in less than 6% of patients in this surgical series. This is in accordance with the literature, which suggests that a thoracic approach should be used in 1%–11% of cases with SSG [5,15]. Clinical predictors for sternotomy included preoperative symptoms such as chest pressure and voice complaints, and all patients who underwent sternotomy had thyroid tissue below the level of the aortic arch. Sternotomy was associated with higher blood loss and longer length of stay, but no increased risk of long-term postoperative complications.

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Table 1

Patient characteristics, SSG *versus* CG.

Variable	Patients with substernal goiter (*n* = 127)	Patients with cervical goiter (*n* = 93)	*P* value
Male	38 (30)	27 (29)	0.886
Female	89 (70)	66 (71)	
Age, y, mean + SD	61.7 ± 14.6	50.8 ± 16.7	0.001
BMI, mean ± SD	35.4 ± 9.7	34.4 ± 9.1	0.506
Previous neck surgery	13 (10)	5 (5.4)	0.194
Sternotomy	7 (5.5)	0 (0)	0.021
OR time (min)	246.2 ± 129.9	226.7 ± 115.5	0.451
Thyroid weight (g)	170.9 ± 120	172.2 ± 97	0.932
Estimated blood loss (mL)	204.9 ± 391.2	144.7 ± 180.8	0.185
Length of stay (d)	1.87 ± 1.59	1.5 ± 1.69	0.116

Values are presented as number of patients and percentages.

BMI = body mass index; OR = operating time; SD = standard deviation.

Table 2

Complaints and complications, SSG *versus* CG.

Variable	Patients with substernal goiter (*n* = 127)	Patients with cervical goiter (*n* = 93)	*P* value
Preoperative symptoms			
Dysphagia	64 (52)	49 (54.4)	0.728
Shortness of breath or stridor	64 (52)	37 (40.1)	0.099
Voice issue	13 (10.5)	6 (6.5)	0.309
Neck pain	9 (7.3)	7 (7.6)	0.922
Chest pressure	15 (12)	8 (8.7)	0.435
Postoperative complications			
Voice issues	13 (10.3)	9 (10.2)	0.983
Hypocalcemia	11 (8.7)	15 (17.1)	0.067
Bleeding	4 (3.2)	0 (0)	0.092

Values are presented as number of patients and percentages.

Table 3

Patient characteristics, SSG *versus* SSG + sternotomy.

Variable	Patients with SSG + cervicotomy (*n* = 120)	Patients with SSG + sternotomy (*n* = 7)	*P* value
Male	37 (30.8)	1 (14.3)	0.353
Female	83 (69.2)	6 (85.7)	
Age, y, mean ± SD	61.6 ± 14.9	64.1 ± 9.9	0.652
BMI, mean ± SD	35.6 ± 9.8	32.1 ± 8.7	0.432
Previous neck surgery	12 (10)	1 (14.3)	0.716
OR time (min)	240.8 ± 129.4	387.5 ± 12	0.118
Estimated blood loss (mL)	190.5 ± 384.9	600 ± 408.2	0.039
Thyroid weight (g)	170.8 ± 121.8	172.4 ± 102.6	0.976
Length of stay (d)	1.79 ± 1.59	3.14 ± 0.9	0.028

BMI = body mass index; OR = operating time; SD = standard deviation.

Values are presented as number of patients and percentages.

Table 4

Complaints and complications, SSG *versus* SSG + sternotomy.

Variable	Patients with SSG + Cervicotomy (*n* = 120)	Patients with SSG + sternotomy (*n* = 7)	*P* value
CT scan preoperation	76 (67)	7 (100)	0.065
Preoperative patient complaints			
Hyperthyroid	11 (9.7)	1 (16.7)	0.583
Dysphagia	62 (53)	2 (33.3)	0.347
Shortness of breath or stridor	61 (52.6)	3 (42.9)	0.617
Voice issue	10 (8.6)	3 (42.9)	0.004
Neck pain	8 (6.8)	1 (14.3)	0.461
Chest pressure	12 (10.2)	3 (42.9)	0.010
Postoperative patient complications			
Voice issues	11 (9.2)	2 (28.6)	0.102
Hypocalcemia	11 (9.2)	0 (0)	0.400
Bleeding	4 (3.4)	0 (0)	0.622

Values are presented as number of patients and percentages.

Table 5

Patient characteristics—thoracic approach.

Year surgery	Age	Sex	Thyroid cancer	Preoperative symptoms	Permanent postoperative complications	Preoperative CT observations
2005	62	Male	No	Weakness*	None	Ectopic goiter, extension into the anterior mediastinum below the aortic arch, ~80% below sternal notch
2005	73	Female	No	Hoarseness, dysphagia, SOB	Hoarseness, problems swallowing	Severe kyphosis, extension into the posterior mediastinum below the aortic arch, ~70% below sternal notch†
2005	76	Female	No	Dysphagia, SOB	None	Extension into the anterior mediastinum below the aortic arch, ~70% below sternal notch
2007	71	Female	No	Hoarseness, chest pressure	Hoarseness	Extension into the anterior mediastinum below the aortic arch
2009	49	Female	No	Hyperthyroid, chest pressure	None	Extension into the mediastinum to the diaphragm, ~90% below sternal notch
2012	59	Female	No	Dysphagia, SOB	None	Extension into the anterior mediastinum below the aortic arch, ~70% below sternal notch
2013	57	Female	No	Hoarseness, neck pain	None	Extension into the mediastinum below the aortic arch, ~80% below sternal notch

SOB = shortness of breath.

Age is presented as age at the time of operation.

*This patient had nonthyroid cancer and SSG. Patient chart attributes weakness to cancer, otherwise patient is asymptomatic.

†For this patient, the decision to perform sternotomy was decided intraoperatively.