

SURGICAL MANAGEMENT OF SUBSTERNAL GOITER

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Purpose: We describe the clinical results and complications associated with different surgical approaches to the treatment of substernal goiter.

Methods: We retrospectively reviewed the medical records of 56 patients treated for substernal goiter from 1983 through 1999. Eight had undergone previous thyroidectomy. Posterior mediastinal goiter was diagnosed in eight patients, hyperthyroidism in seven, acute respiratory failure in three, and superior vena cava syndrome in two. All but one of the patients underwent thyroidectomy.

Results: Thyroid scan revealed that 88% of patients had substernal goiter. A cervical incision alone was used in 46 of 55 patients. Nine patients underwent thyroidectomy via a thoracic approach. Both lobes were resected in 16 patients. Two deaths occurred: one patient suffered a stroke and another patient developed pneumonia after surgery. The most frequent complication was recurrent laryngeal nerve injury, followed by removal of a normal parathyroid gland and pneumonia. Multinodular goiter occurred in 52 patients. Resected goiter with occult malignancy was found in three patients, two of whom underwent lobectomy only. These three patients had survived at 5, 7, and 11 years postoperatively, respectively. All patients with tracheal lumen narrowing showed a normal sized tracheal lumen 2 to 3 months postoperatively.

Conclusion: Our data indicate that the presence of a substernal goiter should be considered an indication for resection based on risk of acute respiratory distress, risk of malignancy, and lower surgical morbidity. Most secondary substernal goiters can be simply resected through cervical incision and curettage.

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The incidence of endemic goiter, due to iodine deficiency and thyroid-stimulating hormone (TSH) hypersecretion, has diminished with improved iodine salt supply in many countries. The pathogenesis of sporadic goiter, which contributes to most substernal goiters, is highly complex. The discovery of factors such as epidermal growth factor, insulin-like growth factor, and thyroid growth-stimulating immunoglobulins (other than TSH) involved in the regulation of thyroid growth has provided a deeper insight into the pathogenesis of sporadic goiter [1, 2]. Treatment and prevention of postoperative recurrence with thyroxine is usually doomed to failure [3], and remains a surgical topic of considerable importance.

It is generally agreed that most secondary substernal goiters (ie, those that obtain blood supply from the

cervical thyroid vessel and have some connection to the thyroid gland in the neck), but not primary substernal goiters (ie, those that obtain blood supply from the mediastinum without connection to the neck thyroid gland), can be removed safely through a cervical incision [4-6]. The use of a combined cervical and thoracic approach for patients with giant, recurrent, posterior mediastinal goiter, with superior vena cava syndrome, or who require emergency surgery for airway obstruction is still controversial [7-9].

In this study, any goiter with more than 50% of its mass inferior to the thoracic inlet was classified as substernal or intrathoracic [5, 8, 10]. We retrospectively reviewed the results of management of substernal goiter and the appropriateness of therapeutic strategies used in patients treated during a 15-year period.

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Patients and Methods

Patients

Fifty-six patients with large substernal goiter were treated at our hospital from August 1983 through September 1999. The population included 25 men and 31 women, with a mean age of 62.3 years (range, 36–88 yr). Twenty-seven of these patients had received thyroid suppressive medication before referral, but without benefit. Eight patients had undergone previous thyroid surgery for benign goiter 5 to 31 years prior to their current evaluation and treatment.

Preoperative work-up

Preoperative evaluation included complete history, physical examination, chest radiography, hematologic biochemical studies, bronchoscopy, ¹³¹I or technetium thyroid scan, computed tomography (CT) of the chest and neck, pulmonary function tests, and thyroid function tests. A barium meal was given only if esophageal compression was suspected.

Operative procedure

A standard cervical operative approach was used for almost all patients undergoing thyroid surgery. Essential steps were ligation of the superior thyroid artery and freeing of the upper pole of the thyroid before beginning delivery of the gland from its retrosternal position to the neck. Numerous vessels running from the inferior thyroid pedicle and the trachea were also carefully ligated, with dissection and division of vessels as close to the thyroid parenchyma as possible, to avoid injury to the recurrent laryngeal nerve and to protect the blood supply to the parathyroid glands. Mobilization was in a subcapsular plane of the thyroid capsule, using a blunt dissection technique deep to the pretracheal fascia. With gentle upward traction of the substernal part, dissection was meticulously continued until the lowest pole of the goiter mass could be touched and the mass could be delivered into the neck after transection of the thyroid isthmus. After thyroidectomy was completed, the substernal dead space was obliterated with sutures. Two Penrose tubes were then placed in the thyroid bed for drainage.

In cases of giant post-mediastinal goiter, superior vena cava syndrome, or acute airway obstruction, partial or full sternotomy and right side posterior lateral thoracotomy via the fourth intercostal space were performed with or without a cervical approach, largely depending on the inconclusive outcome of preoperative investigations. When a thoracic approach was used, suction drains were also placed in the mediastinum or pleural cavity.

Postoperative evaluation

Chest radiography or CT was performed monthly for 2 to 3 months postoperatively. Clinical results were evaluated on the basis of examination at a return visit or by communication (telephone or letter) with the patient or a relative.

Results

Presentation

The signs and symptoms at initial presentation are shown in Table 1. Three patients presented with acute respiratory distress requiring emergency intubation to relieve tracheal compression. Two patients presented with superior vena cava syndrome manifested by facial swelling and prominent veins on the chest and neck. Twenty-five patients had significant associated disease; 11 had a history of cardiovascular disease. Three of seven patients with pulmonary manifestations had fresh pneumonia on admission, and three of five patients with non-insulin dependent diabetes mellitus (NIDDM) had poor blood sugar control. Cirrhosis of the liver was diagnosed in two patients. CT scan demonstrated retrovascularly located posterior mediastinal goiter in eight patients. The substernal goiters varied in their degree of downward displacement, but reached the aortic arch or carina in 23 patients. CT scan showed evidence of tracheal compression or stenosis in 23 of 29 patients with tracheal deviation, with an average \pm standard deviation tracheal diameter of 9 ± 3.5 mm (range, 4–17 mm). Seven patients were found to have hyperthyroidism on the basis of thyroid function tests. Radionuclide thyroid scanning demonstrated substernal goiter in 37 of 42 patients. Pulmonary function tests were abnormal in 26 of 44 patients.

Table 1. Symptoms and signs at initial presentation in 56 patients with substernal goiter

Symptoms and signs	No.	%
Palpable neck mass	41	73
Dyspnea	22	39
Frequent upper respiratory infection	16	29
Chest pain	9	16
Dysphagia	7	13
Hyperthyroidism	7	13
Hoarseness	4	7
Hemoptysis	3	5
Acute respiratory failure	3	5
Superior vena cava syndrome	2	4
None	6	11

Operative results

All but one patient underwent surgical treatment, and all of these patients had secondary substernal goiter. Unilateral lobectomy plus isthmusectomy was performed in 30 patients with a lesion on one side only. Lobectomy plus subtotal contralateral lobe resection was carried out in nine patients and bilateral subtotal resection was carried out in seven patients with enlargement of both lobes. All patients with left substernal goiter underwent cervical incision only. One patient with occult malignancy diagnosed using a tissue specimen obtained at initial surgery underwent additional total thyroidectomy 3 weeks after the initial operation. The results of thyroidectomy are categorized, according to treatment approach, in Table 2.

Pathology

The results of histopathology in resected specimens are shown in Table 3. Occult carcinoma was detected in three patients, two with follicular carcinoma and one with papillary carcinoma.

Mortality and morbidity

The postoperative complications are listed in Table 4. Postoperative stroke and pneumonia, followed by death 10 days later, occurred in a 68-year-old woman with atrial fibrillation and impending heart failure. A 72-year-old patient with chronic obstructive pulmonary disease and cor pulmonale developed postoperative pneumonia and heart failure, and died of multiple organ failure 13 days later. Both of these patients underwent thyroidectomy through a cervical incision

only. Unilateral recurrent laryngeal nerve palsy was investigated in two patients who underwent thoracotomy. An obese 71-year-old woman with chronic lung disease and NIDDM remained intubated for more than 3 weeks for pneumonia and respiratory failure after median sternotomy. Hoarseness due to transient recurrent laryngeal nerve injury, which resolved without treatment, developed in three patients who underwent lobectomy via a cervical approach. Two patients had transient symptomatic hypocalcemia treated with oral supplementation for several weeks. Two patients had wound seroma treated with aspiration and external compression without recurrence. One patient had transient respiratory failure and was kept intubated for 4 days after sternotomy. Right-side pleural effusion was found in one patient 5 days after sternotomy, which subsided with chest tube insertion.

Postoperative follow-up

The symptoms of all surviving patients improved after surgery. Patients with hoarseness and hemoptysis due to upper respiratory tract infection induced by tracheal compression recovered within 1 week postoperatively. At follow-up 2 to 3 months postoperatively, the average diameter of the trachea at the compressed site had increased markedly, from 9 ± 3.2 to 15.7 ± 2.7 mm. No patient received thyroxine postoperatively or had detectable recurrence of substernal goiter during 1 to 11 years' follow-up (average, 7.2 ± 1.5 yr). Three patients with resected goiter and occult malignancy (2 unilateral lobectomy, 1 total thyroidectomy) remained well 5, 7, and 11 years after surgery, respectively.

Table 2. Results of thyroidectomy categorized by surgical approach in 55 patients with substernal goiter

	Surgical approach				Total, No.
	Cervical	Thoracotomy	C + S	C + T	
Number	46 (83.6%)	1 (1.8%)	7 (12.7%)	1 (1.8%)	55
Thyroid weight, g	129 (71–295)	250	193 (125–350)	186	141 (71–350)
Previous thyroidectomy	6	0	2	0	8 (14.5%)
Location					
Anterior	44	0	3	0	47 (85.4%)
Posterior	2	1	4	1	8 (14.6%)
Lobe excision					
Right	17	1	7	1	26 (47.2%)
Left	13	0	0	0	13 (30.9%)
Both	16	0	0	0	16 (29.1%)
Operation time, hr	2.8 (1.5–4.2)	2.7	3.5 (2.7–5.3)	3.9	2.9 (2.6–5.3)
Blood loss, mL	115 (45–280)	270	690 (360–4,300)	370	130 (45–4,300)
Complication	10	1	4	1	16 (29.1%)
Mortality	2	0	0	0	2 (3.6%)
Postoperative hospitalization, d	5.4 (3–9)	8.0	11.5 (6–27)	10.0	

C + S = cervical + sternotomy; C + T = cervical + thoracotomy. Data are number or mean (range) except where otherwise indicated.

Table 3. Histopathologic characteristics of 55 patients with substernal goiter

	No.	%
Mutinodular goiter	52	94.5
Cystic degeneration	39	70.9
Calcification	28	50.9
Old hemorrhage	23	41.8
Necrosis	14	25.5
Fibrosis	13	23.6
Focal thyroiditis	5	9.1
Follicular adenoma	3	5.5
Follicular carcinoma	2	3.6
Papillary carcinoma	1	1.8

Incidence of malignancy, 5.5%

Discussion

Surgical resection of substernal goiter is widely agreed to be a safe treatment except for the highest-risk patients. Some high-risk patients with substernal goiter suffer from acute asphyxiation necessitating endotracheal intubation. Long-standing multinodular goiter generally responds poorly to prolonged thyroid suppression [11]. There is little evidence that radiotherapy, ¹³¹I, propylthiouracil, and levothyroxine are effective in relieving mechanical symptoms. If the patient's general condition permits, early surgical intervention is advisable to avoid the development of uncontrollable goiter [7].

Airway problems secondary to goiters can occur before, during, or after surgery. In this series, four patients with postoperative failure required ventilator support. None of these patients had tracheomalasia or postoperative tracheal collapse as precipitating factors. Even with large and long-standing goiters, this condition is rare [10, 12]. Nevertheless, pre- and postoperative evaluation of the trachea should be performed; the trachea should be evaluated to determine the possible presence of airway problems, for which fiberoptic bronchoscopy can be used. Fiberoptic bronchoscopy is essential for direct preanesthetic evaluation of dynamic airway anatomy and for accurate endotracheal tube placement at induction of anesthesia, and to prevent cervical tracheal collapse and immediate respiratory obstruction upon extubation [13]. Appropriate measures should then be taken to ensure airway patency in the postoperative period and that postoperative hoarseness is due to either laryngeal edema or vocal cord paralysis. In this series, the deviated trachea had resumed a normal midline position and the compressed lumen had increased to almost normal size within 2 to 3 months postoperatively in all surviving patients. At regular follow-up, the frequency and duration of upper respiratory infections had obviously diminished compared with preoperative status.

With rare exception, substernal goiters receive their blood supply from the cervical thyroid vessels and maintain some connection to the thyroid gland in the neck. Many authors recommend a cervical approach as the primary method for resection of substernal goiter [4, 5, 14]. Because of the possibility of neovascularization, neurovascular adhesion, or inability to touch

Table 4. Postoperative complications in 55 patients with substernal goiter categorized by surgical approach to thyroidectomy

Complication	Surgical approach				Total
	Cervical	Thoracotomy	C + S	C + T	
Total complications	12	1	4	1	18
Major	2	1	2	1	6
Recurrent laryngeal nerve palsy	0	1	0	1	2
Stroke*	1	0	0	0	1
Pneumonia*	1	0	0	0	1
Bleeding	0	0	1	0	1
Pneumonia with acute respiratory failure	0	0	1	0	1
Minor	9	0	3	0	12
Transient recurrent laryngeal nerve injury	3	0	0	0	3
Removal of normal parathyroid	3	0	0	0	3
Transient hypocalcemia	1	0	1	0	2
Wound seroma	2	0	0	0	2
Transient respiratory failure (4 days)	0	0	1	0	1
Pleural effusion	0	0	1	0	1

*Two patients died 10 and 13 days postoperatively. C + S = cervical + sternotomy; C + T = cervical + thoracotomy.

the lowest pole of the goiter, a number of surgeons believe that a combined cervical/thoracic or cervical/sternotomy approach is indicated for safety reasons in patients with giant, recurrent, posterior mediastinal goiter, or emergency surgery for airway obstruction or superior vena cava syndrome [15, 16]. Removal by the cervical approach in such patients is thought to increase the risk of uncontrollable hemorrhage, injury to the recurrent laryngeal nerves, and incomplete removal of the goiter [10].

In one patient in this series, disastrous bleeding from laceration of the left innominate vein during sternotomy was caused by anterior displacement of the vein by the goiter and adherence of the vein to the sternum. Permanent recurrent laryngeal nerve injury, which was difficult to identify, occurred in two patients who underwent thyroidectomy via a thoracotomy approach. We successfully removed a giant posterior mediastinal goiter through cervical incision in two patients, one of whom had developed superior vena cava syndrome. Six patients who had previously undergone thyroidectomy had a low incidence of postoperative morbidity. In 1960, Judd et al expressed the view that increasing interest in and familiarity with thoracic surgical technique had led to an overemphasis of the thoracic approach in the treatment of substernal goiter [17]. They noted that even large substernal goiters can be removed by the standard cervical approach with lower morbidity than by sternotomy or thoracotomy.

When substernal goiter causes superior vena cava syndrome or acute respiratory failure, there is increased difficulty in diagnosis and treatment. Precise diagnosis of the nature and site of the mass, as well as precise evaluation of the presence of communication with the cervical thyroid, are of great importance in the management of substernal goiter. Because iodine is specifically trapped by thyroid tissue, scintigraphy with radioiodine should be an excellent confirmatory test to determine the nature of the goiter. In some patients, the connection to the cervical gland may become attenuated and be apparent only as a fatty or fibrous band or vascular pedicle, causing a misleading diagnosis of primary substernal goiter. In this series, marked degenerative changes, including cyst formation, necrosis, fibrosis, and calcification were noted in all of the resected goiters, as in previous series [5]. These changes can also be investigated by CT preoperatively [18].

Park et al reported that thyroid scan had 93% sensitivity, 100% specificity, and 94% accuracy in 54 patients with substernal goiter [19]; their study mirrored the results of Irwin et al [20]. There is no doubt that CT scan is the most valuable diagnostic tool for routine evaluation of the mediastinum. Sometimes, thyroid carcinoma with mediastinal extension may be indistinguishable from a benign multinodular goiter

on thyroid scan, but the presence of poorly defined margins, invasion of adjacent structures, and cervical/mediastinal lymphadenopathy or pulmonary nodules allows differentiation on CT imaging. Thyroid scan in combination with CT can provide information about the nature and composition of the goiter and its structure, and also demonstrate other possible anomalies.

The size of the remnant goiter left by the surgeon depends on the underlying pathogenesis. We endeavored to resect any nodular tissue irrespective of the size of the remnant. Lobectomy plus isthmusectomy was the most common procedure in our series. Although the possibility of thyroxine substitution favors a more positive attitude toward extensive resection, most patients with nodular goiter do well without extensive resection [21].

Whether patients with resected substernal goiter containing occult malignancy should receive total thyroidectomy with or without radical neck lymph node dissection remains unclear. In this series, two patients with occult malignancy (one papillary carcinoma, one follicular carcinoma) refused additional operation after lobectomy, and had survived at 5 and 11 years after surgery, respectively.

In conclusion, the presence of a substernal goiter is an indication for resection and most secondary substernal goiters can be resected through a cervical incision alone, with lower morbidity than with a thoracic approach.

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