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Surgical Treatment of Substernal Goiter: An Analysis of 59 Patients

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Abstract

Purpose. Substernal goiter is defined as a thyroid mass of which more than 50% is located below the thoracic inlet. In this article we report the diagnosis, symptoms, thyroid function, treatment, and postoperative complications of 59 patients with substernal goiter.

Methods. Between 1992 and 2005, 59 patients underwent surgery for substernal goiter at our institution. The indications for surgery were multinodular goiter in 46 cases, follicular adenoma in two cases, and Hashimoto's thyroiditis in one case. Ten patients were operated on for recurrent thyroid disease.

Results. The leading preoperative symptoms were dyspnea (49.2%), dysphagia (13.6%), hyperhidrosis (10.2%), and cardiac dysfunction (6.8%). All but two thyroid glands could be removed through a Kocher transverse collar incision. The most common postoperative complications were persistent (5.1%) or temporary (3.4%) paresis of the recurrent laryngeal nerve, transient hypocalcemia (3.4%), and hematoma (3.4%). A tracheotomy was required in one patient with bilateral vocal cord paresis (1.7%).

Conclusions. (1) We conclude that a subtotal thyroidectomy is also the treatment of choice for asymptomatic benign substernal goiter. (2) Transverse collar incision should be the standard approach for most patients. (3) The visual identification of at least two parathyroid glands is essential to prevent permanent postoperative hypoparathyroidism.

Key words Substernal goiter · Thyroid surgery · Recurrent laryngeal nerve · Collar incision · Complication rate

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Introduction

Multinodular goiter is a common disease characterized by an excessive growth of the thyroid gland. Substernal extension was first described in 1749 by Haller[1] and later defined by a thyroid mass of which more than 50% is located below the thoracic inlet.[2] Differentiation can be made between primary substernal goiters deriving from ectopic thyroid tissue (1%)[3,4] and secondary substernal goiters that are characterized by a downward extension of normally located thyroid gland tissue into the thoracic inlet (99%).[2,4] A substernal thyroid mass can be found unilaterally or bilaterally and is mostly located in the anterior mediastinum. Only 10%–15% of substernal goiters are located in the posterior mediastinum. In the literature, the number of patients with substernal goiters varies between 3% and 20% of all patients undergoing thyroid surgery.[5,6] The risk of malignancy reported ranges from 4% to 22%.[7–16] Leading symptoms result from airway compression by the thyroid mass.[5,6]

Surgery is the treatment of choice for symptomatic patients with endemic multinodular or malignant substernal goiter.[1,17] Although it is associated with a low morbidity and very low mortality, the role of surgical treatment in asymptomatic patients remains controversial.[18] Today, almost all substernal goiters can be removed through a Kocher transverse collar incision. In some patients with giant lesions, malignancy, retrotracheal goiter or major intraoperative complications median sternotomy or lateral thoracotomy may be necessary.[6,9,19] The most commonly observed complications following thyroid surgery are transient or persistent hypocalcemia and injury of the recurrent laryngeal nerve.[7–16] Therefore, the preservation of the parathyroid glands as well as the recurrent laryngeal nerve is an important goal in thyroid surgery. In the present study we report 59 patients who were operated on for substernal goiter while focusing on the diagnosis, preoperative

symptoms, thyroid function, surgical therapy, and postoperative complications.

Patients and Methods

Between 1992 and 2005, 1682 patients with various benign and malignant thyroid disorders underwent thyroid surgery at the Department of Surgery of the University of Regensburg Medical Center. Fifty-nine of them had substernal goiters (3.5%). For the diagnosis of substernal goiter the definition of Katlic et al.[2,13] was used as described above. The extension of the thyroid gland was determined by preoperative ultrasound, computed tomography, magnetic resonance imaging, or intraoperatively. Figure 1 shows a representative computed tomograph of one of the patients operated on for substernal goiter. Ectopic intrathoracic goiters were excluded from the present series. Of all operated patients 36 were female (61%) and 23 were male (39%). The median age of the patients was 65 years (range 39–87 years).

Preoperative Diagnostics

A physical examination was performed and standard laboratory parameters including serum calcium, thyroid stimulating hormone (TSH), fT3, and fT4 were measured in all patients. Preoperative thyroid ultrasound and scintigraphy was routinely carried out. In case of suspicious findings for thyroid malignancy additional fine-needle aspiration biopsy (FNAB) was performed. In one patient with parathyroid adenoma additional parathyroid scintigraphy was performed. Patients with an age of 60 years or older and patients with symptoms caused by airway obstruction underwent chest X-ray. In seven patients additional computed tomography (CT) had already been initiated by the referring physician or hospital. In two cases, additional computed tomography was performed to evaluate tracheoesophageal compression and relation to major vessels. Moreover, two patients with malignant diseases (malignant melanoma/renal cell carcinoma) underwent computed tomography as routine follow-up examinations. In one symptomatic patient magnetic resonance imaging (MRI) had been performed by the referring hospital. The vocal cord function was routinely studied by indirect laryngoscopy.

Operative Procedure

The upper part of the thyroid gland was mobilized and the superior thyroid vessels were ligated. The retrosternal part of the thyroid gland was digitally mobilized and luxated by cervical manipulation. In some patients the isthmus was divided in order to facilitate mobilization. Some parts of the operation procedure are shown in Fig. 2. The recurrent laryngeal nerve (RLN) was visually identified in all but one patient. Intraoperative neuromonitoring (IONM) was introduced in the year 2001 and performed in 18 patients (30.5%) of the study. Since 2002, intraoperative neuromonitoring has become an inherent part of the operation procedure (Table 5a). Intraoperative neuromonitoring was performed by stimulation of the recurrent laryngeal nerve and electrophysiological recordings using needle electrons impaled into the laryngeal muscles. At least two parathyroid glands were identified and preserved. In four cases the parathyroid glands were reimplanted into the sternocleidomastoid muscle (STM). Postoperatively, the serum calcium levels were routinely monitored for 2 days.

Results

As shown in Table 1, most patients were operated on for primary multinodular goiters (78%) and recurrent thyroid disorders (16.9%). In two patients adenomatous goiters were diagnosed and one patient was operated on for Hashimoto's thyroiditis. Histologically, no malignancies including incidental thyroid microcarcinomas were found in our series.

Two thirds of our patients were symptomatic at the time of surgery (66.1%). The leading preoperative symptom was dyspnea (49.2%) followed by dysphagia

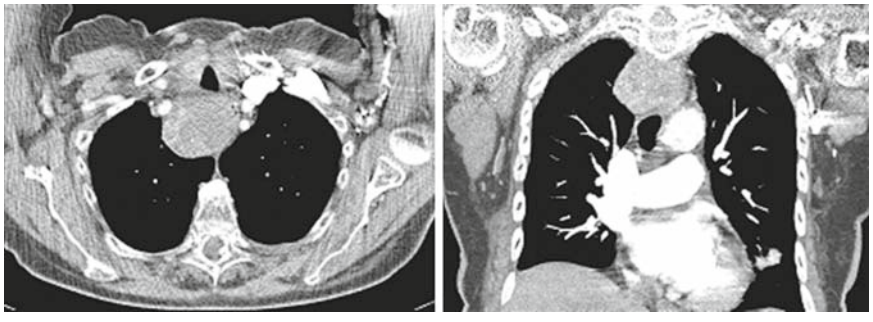

Fig. 1. Substernal goiter, preoperative computed tomography. Preoperative computed tomography shows the extension of the thyroid mass into the thoracic inlet in a patient operated on for substernal goiter

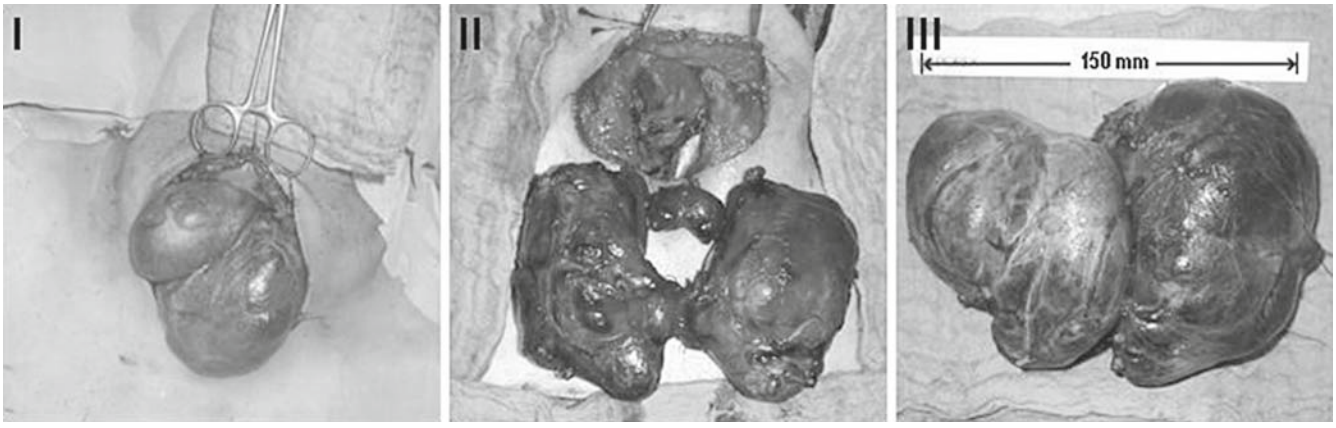

Fig. 2. Total thyroidectomy through Kocher transverse collar incision. The intraoperative photography shows three steps of the operative procedure in a patient with a large substernal goiter. *I*, mobilization of the lower part of the thyroid gland through the cervical approach; *II*, total thyroid gland in relation to the cervical collar incision; *III*, extent of the resected thyroid gland

Table 1. Underlying diseases ($n = 59$)

Diagnosis	No. of patients	Percentage (%)
Primary multinodular goiter	46	78.0
Recurrent thyroid disorder	10	16.9
Follicular adenoma/adenomatous goiter	2	3.4
Hashimoto's thyroiditis	1	1.7

Table 2. Leading symptoms ($n = 59$)

Symptoms	No. of patients	Percentage (%)
Dyspnea/airway obstruction	29	49.2
Dysphagia	8	13.6
Hyperhidrosis	6	10.2
Arrhythmia/tachycardia	4	6.8
Others	9	15.3
Total	39[a]	66.1

[a] Fourteen patients showed combined symptoms

Table 3. Preoperative thyroid metabolism ($n = 59$)

Metabolic state	No. of patients	Percentage (%)
Normal thyroid function	40	67.8
Latent hyperthyroidism	12	20.3
Manifest hyperthyroidism	7	11.9
Hypothyroidism	0	0

(13.6%), hyperhidrosis (10.2%), cardiac arrhythmia, or tachycardia (6.8%), and other symptoms like hoarseness, nervousness, weight loss, tremor, or pain (Table 2). Twenty patients were symptom-free (33.9%). Of these patients 13 were operated on because of progressive thyroid growth. The mean weight of resected specimen in these patients was 138 g. Enlargement of cervical mass or slight neck discomfort were not considered to be clinical symptoms.

Forty patients (67.8%) had normal thyroid function at the time of surgery (Table 3). Twelve patients showed subclinical hyperthyroidism with normal serum levels of fT3 and fT4 and suppressed thyroid stimulating hormone (20.3%). In these patients scintigraphy was performed

and in some cases TSH receptor antibody was measured to exclude Graves' disease. Manifest thyroid hyperfunction was found in 7 patients (11.9%), while hypothyroidism occurred in none of the 59 patients.

In our series 56% of the patients showed intrathoracic goiter localization on the left side (33 patients). In 15 patients (25%) the right thyroid lobe and in 11 patients (19%) both sides were localized below the thoracic inlet. The mean sonographic volume was 133 ml (range 33–330) and the mean weight of resected specimen was 165 g (range 26–500) including all operative procedures. The mean weight of the resected part of the right and left thyroid lobe was 85 g (range 1–301) and 89 g (3–201), respectively. In patients with total thyroidectomy the mean weight of specimen was 246 g (range 110–502). The mean weight of the completely resected right and left thyroid lobe was 120 g (range 26–301) and 114 g (range 18–277), respectively.

In all but two (3.4%) patients the thyroid gland could be removed through a Kocher transverse collar incision without an additional median sternotomy or lateral thoracotomy. The preoperative and intraoperative findings of one of these two patients are shown in Fig. 3. In 33 patients a lobectomy was performed, partly in combination with a contralateral partial lobectomy (55.9%). Seventeen patients underwent a total thyroidectomy (28.8%) and 9 patients had a subtotal resection of the thyroid gland (15.3%). The median operative time was 109 min (range 27–205 min). The median postoperative hospital stay was 5 days (range 2–34 days). The longest hospital stay (34 days) was not caused by postoperative complications but by severe cardiac arrhythmia requiring resuscitation and prolonged intensive care therapy. The mean amount of intraoperative bleeding was 179 ml (range 0–900). No blood transfusions were required in our series.

As shown in Table 4, postoperative complications occurred in seven of 59 patients (11.9%). Two patients developed transient (3.4%) and three patients persistent (5.1%) vocal cord paresis. Two of them had been operated for recurrent multinodular goiter. In one case the recurrent laryngeal nerve could be identified neither visually nor by intraoperative neuromonitoring. In one case with bilateral RLN dysfunction a tracheotomy was required because of respiratory insufficiency. Moreover, this patient developed transient postoperative hypocalcemia. The two patients with transient paresis of the recurrent laryngeal nerve showed complete recovery of vocal cord function within six months after surgery. In two patients recurrent unilateral laryngeal nerve paresis

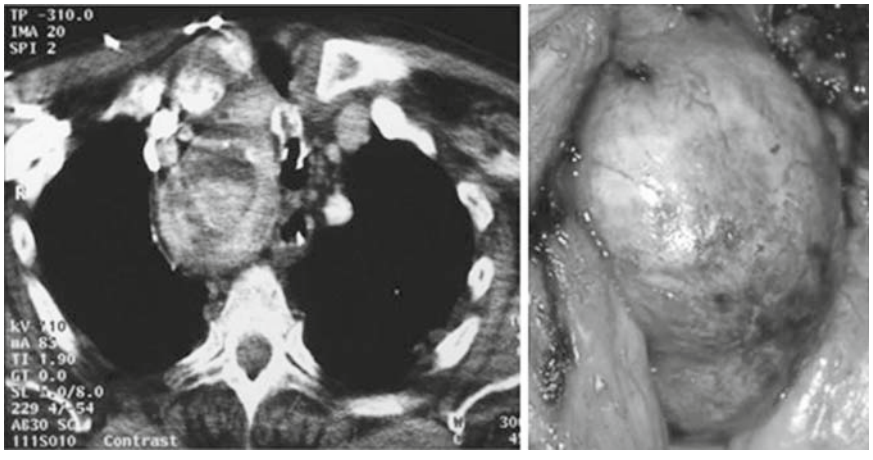

Fig. 3. Substernal goiter with large intrathoracic extension. The figure shows a preoperative computed tomography and an intraoperative photography of a patient who underwent a total thyroidectomy for large substernal goiter

Table 4. Postoperative complications (n = 59)

Complications	No. of patients	Percentage (%)
Recurrent laryngeal nerve paresis	5	8.5
transient	2	3.4
persistent	3	5.1
Hypocalcemia	2	3.4
transient	2	3.4
permanent	0	0
Postoperative bleeding/hematoma	2	3.4
Overall complication rate	7[a]	11.9

[a] One patient developed combined complications (bleeding and hypocalcemia); one patient developed vocal cord paresis in combination with hypocalcemia

had been pre-existent prior to surgery due to nerve stretching by large thyroid mass. The weight of ipsilateral thyroid specimen after the lobectomy was 130 g and 150 g, respectively. Two patients developed transient postoperative hypocalcemia (3.4%). Persistent hypoparathyroidism was not observed in any of the patients. In three cases parathyroid autotransplantation into the sternocleidomastoid muscle (STM) was performed because of an insufficient blood supply. Self-limiting postoperative bleeding occurred in two cases (3.4%). Hematoma was combined with hypocalcemia in one of these patients. There was no operative mortality and no necessity of a re-operation in our series.

Discussion

Indication

Substernal goiter has been considered to be an indication for surgical treatment independent of clinical symptoms because of the risk of malignancy.[1,2,12,14,18] Moreover, Bonnema et al. have shown that ^{131}I treatment as an alternative therapy does not lead to a sufficient reduction of goiter size in patients with large benign cervical or substernal goiters.[20] In contrast to most other series, there was no incidence of thyroid malignancy in our patients. All patients came from endemic goiter regions with moderate iodine deficiency. Although the influence of iodine deficiency on the incidence of thyroid cancer remains controversial,[19,21–23] the lack of malignancy in our series may be partly explained by variations as regards iodine intake in different geographic regions. However, the development of goiter and subsequent thyroid cancer certainly depend on multiple environmental and genetic factors. Although there was no thyroid malignancy in our patients we recommend surgery as the treatment of choice for substernal goiter because of progressive growth. In our series all patients with transient or persistent postoperative vocal cord paresis had had symptomatic goiters. These results suggest that symptomatic goiter provides a higher operative risk in comparison to asymptomatic goiter. Moreover, the two patients with preoperative recurrent laryngeal nerve paresis were symptomatic. Therefore, surgery at an early time point may prevent intraoperative as well as preoperative complications.

Surgical Approach

In contrast to the 1980s, nowadays, transverse collar incision is the standard approach for benign substernal goiters. Previous reports have shown that depending on the surgeon's experience either a median sternotomy or lateral thoracotomy is necessary only in patients with deep intrathoracic thyroid mass or severe intraoperative complications that cannot be controlled through the cervical approach.[1,24] In the literature, sternotomy rates have been reported to range from 0% to 10% in patients with substernal goiter. In our series, a median sternotomy was necessary in two patients (3.4%). In both cases there were no postoperative complications. The postoperative hospital stay was 10 and 12 days, respectively, in comparison to an overall median hospital stay of 5 days. This observation suggests a prolonged recovery but no increase in morbidity after a sternotomy in comparison to patients with exclusive transverse collar incision. However, the data from only two patients are not statistically significant. Nevertheless, previous reports have also shown that a median sternotomy does not increase the mortality but it does lead to an increased morbidity after thyroid surgery and is also associated with a prolonged stay in hospital.[25]

Postoperative Hypocalcemia

The preservation of the parathyroid glands is crucial in the management of thyroid diseases.[26] In the literature, the risk of persistent hypocalcemia after surgical treatment of substernal goiters ranges from 0% to 6%. In the present series two patients developed transient postoperative hypoparathyroidism (3.4%). In both cases postoperative hypocalcemia was associated with other complications resulting of difficult operating conditions. In one of these two patients surgery was complicated by massive adhesions because of preoperative thyroiditis. This patient additionally developed bilateral vocal cord paresis requiring a tracheotomy. There was no permanent hypoparathyroidism in our series, thus suggesting that accurate preparation technique and visual identification of the parathyroid glands are essential to avoid postoperative hypocalcemia and permanent hypoparathyroidism.

Preservation of the Recurrent Laryngeal Nerve

Thomusch et al. showed that the risk of RLN injury increases with the extent of surgical resection. The risk of vocal cord paralysis was lower after subtotal thyroidectomy than after total thyroidectomy.[27] On the other hand, surgery for recurrent goiter was associated with a higher risk of recurrent laryngeal nerve paresis (up to 3.4 fold).[27] Consistent with this report, in our series two of the ten patients with recurrent goiter developed postoperative vocal cord paresis (20%). Nevertheless, in contrast to other reports[17] we do not strictly recommend a total thyroidectomy in all patients with substernal goiters because in the present series all RLN injuries occurred in patients with total thyroidectomy or total lobectomy. In the case of severe adhesions due to

Table 5a. Intraoperative neuromonitoring (IONM)

	Patients operated for substernal goiter				
	Total	with IONM		without IONM	
Year	*n*	*n*	%	*n*	%
1992–2001	37	1	2.7	36	97.3
2002–2005	22	17	77.3	5	22.7
Total	59	18	30.5	41	69.5

Table 5b. Transient and persistent paresis of the recurrent laryngeal nerve

	Recurrent laryngeal nerve paresis					
	Total		with IONM		without IONM	
Year	*n*	%	*n*	%	*n*	%
1992–2001	4	10.8	0	0	4	11.1
2002–2005	1	4.5	1[a]	5.9	0	0
Total	5	8.5	1	5.6	4	9.8

[a] Recurrent laryngeal nerve could be identified neither intraoperatively nor by IONM

Table 6. Postoperative complications and the incidence of malignancy in patients with substernal goiter

First author, year[Ref.]	No. of patients	Persistent RLN injury (%)	Transient hypocalcemia (%)	Permanent hypocalcemia (%)	Sternotomy/ thoracotomy (%)	Mortality (%)	Thyroid malignancy (%)
Arici, 2001[7]	52	4	8	6	4	0	12
Dedivitis, 1999[8]	32	3.1	6.3	0	6.3	3.1	12.5
Goudet, 1996[10]	97	3	3	1	0	0	—
Erbil, 2004[9]	170	2	7	0	7	0	13
Hedayati, 2002[11]	116	0.9	39.7	0	1.7	0.9	22
Maruotti, 1991[12]	51	7.8	—	—	7.3	2	5.8
Netterville, 1998[13]	23	0	8.7	0	0	0	17
Rodriguez, 1999[14]	72	1.4	—	1.4	10	0	4
Torre, 1995[15]	237	3.6	2.9	0.4	3.4	0.8	6.8
Vadasz, 1998[16]	175[a]	8	—	—	(45)	1.1	4.2
Present study	59	5.1	3.4	0	3.4	0	0

[a] Including 37 complete aberrant intrathoracic goiters

previous thyroid surgery and/or an insufficient identification of the RLN, subtotal resection as well as secondary contralateral surgery should be taken into consideration.

Thomusch et al. further showed that intraoperative identification of the recurrent laryngeal nerve reduces the risk of injury by 1.6-fold.[27] The role of IONM in thyroid surgery has been evaluated in a large prospective multicenter study.[28,29] There was no clear advantage of additional IONM in comparison to exclusive visual identification of the recurrent laryngeal nerve. In our experience IONM is a helpful tool to confirm the RLN function intraoperatively. In the present study the complication rate decreased from 4 of 36 patients (11.1%) operated before 2002 to 1 of 17 patients (5.9%) operated after the introduction of IONM into the standard operation procedure (Tables 5a,b and 6). Two patients were preoperated and therefore already had a higher risk of RLN injury.[27] In one of these patients RLN could not be identified by IONM (Table 5b). Consistent with other reports,[28,29] we conclude that visual identification is essential for RLN protection. However, the decrease in RLN injury after IONM was routinely performed may be explained by the necessity of visual identification and surgical preparation of the recurrent laryngeal nerve. Moreover, the visual identification can immediately be confirmed and the nerve function can be checked by IONM. Therefore, IONM may reduce the

risk of RLN injury and it should be performed in all high-risk patients although it cannot replace visual RLN identification and accurate surgical techniques.

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