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ORIGINAL ARTICLE

Surgical management of substernal goitre: local experience

以外科治療胸內甲狀腺腫：本地經驗

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Objectives. To examine the presentation, workup, and surgical complications of substernal goitre.

Design. Retrospective study.

Setting. Regional hospital, Hong Kong.

Patients. Twenty-four mostly elderly patients (mean age, 60.1 years) who underwent thyroidectomy for substernal goitres between 2000 and 2003 (substernal goitres were defined as those having either a caudal mass transgressing the fourth thoracic vertebra or having more than 50% of their overall mass residing within the thorax).

Main outcome measures. Symptoms, histopathological diagnoses, morbidities, and complications.

Results. Dyspnoea was the most common symptom (n=8, 33%). Three (12.5%) patients presented with acute airway obstruction; however, 13 (54.2%) were asymptomatic apart from the presence of cervical masses. Computed tomographic scans were performed on all but two patients. Malignancy was present in 12.6% of patients, or 16.8% if occult papillary carcinoma is included. Partial or full sternotomies were performed in two (8.3%) patients. Complications included recurrent laryngeal nerve injury (n=1, 2.7% of nerves at risk), transient hypoparathyroidism (n=2, 13.3% of patients at risk), haematoma (n=1, 2.7%), pneumonia (n=1, 2.7%), and wound infection (n=1, 2.7%). There was no operative mortality or permanent hypoparathyroidism. The complication rate was significantly lower in the asymptomatic patients (P=0.033 by Fisher's exact test); clinicopathological parameters were otherwise statistically comparable between the two groups.

Conclusions. There is rarely any mortality in thyroidectomy for substernal goitre, and the morbidity is also very low, especially in asymptomatic patients. In the absence of contra-indications, substernal goitre should be treated with early surgery rather than having it run the risk of acute airway distress or cancer.

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目的：檢視胸內甲狀腺腫的症狀、檢查和手術後的併發症。

設計：回顧研究。

安排：分區醫院，香港。

患者：由2000至2003年，24位患胸內甲狀腺腫而接受甲狀腺切除術的年老病人（平均年齡為60.1歲）。凡尾狀塊體超越第四節胸椎，或塊體有一半以上位於胸腔內的患者，即被診斷為胸內甲狀腺腫。

主要結果測量：症狀、組織病理學的診斷、合併症和併發症。

結果：呼吸困難是最常見的症狀（n=8, 33%），3名患者（12.5%）出現急性呼吸道阻塞，但有13名（54.2%）患者除了在頸部有硬塊外並無任何症狀，22位患者曾接受電腦體層掃瞄。12.6%患者的腫瘤為惡性，如果連潛隱性乳頭狀癌計算在內，則為16.8%。兩名病人（8.3%）須接受胸骨局部或全切開術。併發症包括喉返神經受損（n=1, 佔可能受損神經的2.7%），

暫時性的甲狀旁腺功能減退（n=2, 佔可能患上該症的病人 13.3%）、血腫（n=1, 2.7%）、肺炎（n=1, 2.7%）及傷口感染（n=1, 2.7%）。手術沒有引致死亡或永久性的甲狀旁腺功能減退。無症狀患者較有症狀患者的併發症比率低（以 Fisher's exact test 得出 P=0.033），臨床病理因子在有症狀和無症狀兩類患者的表現卻是類似的。

結論： 胸內甲狀腺腫手術引起併發症的機會極低，在無症狀患者上的機會更微。在無反效果的情況下，應盡早施行手術以減低急性呼吸道不適或成癌的機會。

Introduction

Although it is possible to achieve very low morbidity and zero mortality for thyroidectomy with contemporary surgery and anaesthesiology, substernal goitre (SSG) continues to challenge surgeons due to the distorted anatomy of the huge masses, the suboptimal accessibility of the intrathoracic location, and the potential for damage to the great vessels or pleura. However, no effective therapeutic alternative to surgery exists. Symptomatic patients are understandably more willing to accept surgery, but patients with no or minimal symptoms are often reluctant to consider surgical therapy, especially when sternotomy may be required.

Because SSG is progressive, can result in sudden airway obstruction, and may harbour carcinoma,[1] we recommend surgery to all patients who present with SSG, regardless of symptoms, excepting only those with contra-indications to surgery. As local data are lacking, we present our experience with the surgical management of SSG for the benefit of local clinicians, as well as for patients weighing the decision to undergo surgical treatment for SSG. We compare symptomatic and asymptomatic patients with the assumption that lower complication rates can be attained in the latter group.

Methods

We retrospectively reviewed the case notes, imaging records, and operation records of all patients who had undergone thyroidectomy between 2000 and 2003 at the United Christian Hospital in Hong Kong. We defined SSG as either the lower extent of the goitre having transgressed the fourth thoracic vertebra[2] or at least 50% of the mass[3] residing within the thorax. Large thyroid masses with inferior borders at the thoracic inlet were not included in this study.

Patients were investigated with a standard pre-operative protocol that included routine thyroid function tests, chest X-ray, and computed tomographic (CT) scans of the neck and thorax. Thyrotoxic patients were rendered euthyroid prior to surgery. The possibility of sternotomy was explained, and informed consent was obtained. Computed tomographic scan delineated the extent of the SSG; the degree and level of tracheal compression or deviation provided by CT scan is imperative to the selection of optimal methods of intubation by the anaesthetist. Fibreoptic endoscope-guided tracheal intubation was performed when there was evidence of significant tracheal displacement or compression. Lung function tests were performed at the discretion of the anaesthetist or pulmonary physician. Flow-volume loop studies were helpful in the diagnosis of extrathoracic airway compression, but they were not critical in the decision to proceed with surgery.[1] Preoperative vocal cord examination was routinely evaluated by flexible laryngoscope and was repeated postoperatively in patients who experienced any degree of voice change. If vocal cord palsy was discovered, out-patient endoscopic monitoring of vocal cord status was carried out regularly as flexible laryngoscopes were available.

After having been anaesthetised, the patients were placed in a supine position with the neck extended and were draped to expose the nipple line so that partial sternotomy could be employed at any time. A collar incision was used, and the strap muscle was transected when necessary to improve accessibility. The thyroid gland was mobilised by capsular dissection, with the superior thyroid vessels controlled individually. Parathyroid glands were either preserved or autografted into the sternomastoid muscle if devascularisation was suspected. The middle and inferior thyroid veins were also carefully ligated to avoid bleeding due to avulsion, as they were often distended and obstructed by the SSG. The thoracic component of the SSG was then manually retracted to the cervical region. The recurrent laryngeal nerve was often not identifiable until the SSG was liberated from the thorax. Manubrium resection or median sternotomy was rarely needed. Drainage was often employed to avert seroma formation in the resulting cavity.

All data were recorded to a specifically designed proforma and entered into a computer. Chi squared

test or Fisher's exact test were performed when appropriate, and categorical variables were analysed with the Statistical Package for the Social Sciences (Windows version 11.5; SPSS Inc, Chicago [IL], United States).

Results

From January 2000 to December 2003, a total of 287 patients underwent thyroidectomy in our hospital. Twenty-four (8.4%) met our criteria for SSG. The patients comprised 19 females and five males. Their mean age was 60.1 years (standard deviation [SD], 15.5 years; range, 26.0-90.0 years). Computed tomographic scan was performed on all but two patients, and varying degrees of tracheal compression or deviation were confirmed in 20 patients.

Cervical masses were detected clinically in 22 (91.7%) patients. No neck masses were found in two (8.3%) patients. The most common dominant symptom was dyspnoea, which was reported by eight (33.3%) patients (Table 1). Of these eight cases, three presented with acute airway obstruction that required urgent intervention: two patients underwent emergency thyroidectomy and the third developed acute airway distress triggered by an upper respiratory tract infection and was scheduled for an early thyroidectomy following marginally beneficial conservative treatment. Other common symptoms included dysphagia (n=1, 4.2%), hoarseness (n=1, 4.2%), and neck discomfort (n=1, 4.2%). Laryngoscopy did not reveal any vocal cord palsy in the patient with hoarseness. Surprisingly, 13 (54.2%) patients had no symptoms apart from the cervical masses, and these patients represented the asymptomatic group in the subgroup analysis. The duration of symptoms ranged from 2 to 120 months with a mean of 43.3 months (SD, 47.5 months).

Most of the patients were euthyroid (n=18, 75.0%), whereas five (20.8%) and one (4.2%) were hyperthyroid and hypothyroid, respectively. The final histopathological diagnoses are shown in Table 2. In the malignant category, there was one papillary, one minimally invasive follicular, and one medullary carcinoma. The malignancy rate was 12.6%, which increased to 16.8% if the occult papillary carcinoma was included.

Twenty-two (91.7%) patients underwent either elective or semi-elective surgery. The other two (8.3%) patients required emergency thyroidectomy for acute airway distress after initial stabilisation. Types of procedures included total thyroidectomy (n=12,

Table 1. Symptoms or signs in patients with substernal goitre

Symptom and sign	No. (%)*
Dyspnoea (including 3 cases of acute airway obstruction)	8 (33.3)
Neck discomfort	1 (4.2)
Dysphagia	1 (4.2)
Hoarseness	1 (4.2)
Asymptomatic	13 (54.2)

* Because of rounding, the percentages do not total 100

Table 2. Histopathological diagnoses of substernal goitre

Diagnosis	No. (%)*
Hyperplastic nodules/nodular hyperplasia	18 (75.0)
Diffuse hyperplasia	2 (8.3)
Hurthle cell adenoma	1 (4.2)
Papillary carcinoma	1 (4.2)
Follicular carcinoma	1 (4.2)
Medullary carcinoma	1 (4.2)

* Because of rounding, the percentages do not total 100

50%), hemithyroidectomy (n=11, 45.8%), and Dunhill procedure (n=1, 4.2%). Two patients had previously undergone hemithyroidectomy at other hospitals. Thus, 15 patients were at risk of postoperative hypoparathyroidism. The mean operating time was 187.1 (SD, 81.1; range, 115-495; median, 165) minutes. The mean blood loss was 165 mL (range, 10-1350 mL; median, 50 mL); two patients had exceptional blood loss of more than 1 L. One patient's benign SSG was so big that the capsule of the mass was breached during the initial attempt at retrieval from mediastinum, resulting in bleeding from the tumour. The bleeding continued until the thoracic inlet could be widened enough by manubrium resection to allow the removal of the mass. The blood loss in this case was 1096 mL. In the second case, a full median sternotomy was required to remove a papillary thyroid carcinoma with extrathyroidal spread and accommodate the mediastinal lymph node dissection. During the mediastinal dissection, one branch of the innominate vein was inadvertently torn causing significant blood loss (1350 mL) within a short period of time. Hence, partial or full sternotomies were required in 8.3% of patients. Parathyroid autograft was performed in six (25%) patients. The postoperative hospital stay ranged from 1 to 15 days with a mean of 4.6 days and median of 4 days.

Complications included transient hypoparathyroidism (2/15, 13.3% of the patients at risk of hypoparathyroidism), haematoma (1/24, 4.2%),

Table 3. Morbidity of thyroidectomy for substernal goitre (n=24)

Morbidity	No. (%)
Mortality	0
Recurrent laryngeal nerve injury	1 (2.7)*
Transient hypoparathyroidism	2 (13.3)†
Permanent hypoparathyroidism	0
Haematoma	1 (4.2)
Wound infection	1 (4.2)
Pneumonia	1 (4.2)

* Nerves at risk, n=37
† Patients at risk, n=15

Table 4. Comparison of complications between asymptomatic and symptomatic patients*

Complications	Asymptomatic (n=13)	Symptomatic (n=11)
Recurrent laryngeal nerve injury	0	1
Transient hypoparathyroidism	1	1
Haematoma	0	1
Pneumonia	0	1
Wound infection	0	1

* Fisher's exact test, P=0.033

sternotomy wound infection (1/24), pneumonia (1/24), and recurrent laryngeal nerve injury (1/37, 2.7% of nerves at risk or 4.2% per case) [Table 3]. The damaged recurrent laryngeal nerve was repaired by direct anastomosis microscopically. The patient with paralysed vocal cords recuperated completely 7 months after surgery; recovery was confirmed by direct laryngoscopy. There was no permanent hypoparathyroidism or mortality in this series. The patient with papillary carcinoma developed sputum retention and pneumonia after median sternotomy coupled with mediastinal lymph node dissection. He required temporary tracheostomy for bronchial suction.

Comparing the asymptomatic group (n=13) with the symptomatic group (n=11), only one patient in the former suffered transient hypoparathyroidism; all the other complications occurred in the symptomatic patients. The difference was statistically significant using one-sided Fisher's exact test (P=0.033; Table 4). The other clinicopathological parameters between these two groups were comparable (Table 5). The symptomatic group was older (65.7 vs 55.3 years), had a higher incidence of prior thyroid surgery, and was more likely to have required emergency thyroidectomy, but these differences were not statistically significant. Likewise, symptomatic patients showed a trend towards longer postoperative hospital stay than their asymptomatic counterparts (P=0.08; Table 5).

Discussion

There is no universally accepted definition for SSG. Katlic et al[4] reported 80 cases of SSG defined as goitres descending inferior to the thoracic inlet. Other authors[3,5,6] have defined SSG as more than 50% of the thyroid mass residing inside the thorax. In our series, the Goldenberg and Lindskog[2] definition (goitres extending to the fourth thoracic vertebra) was used, as all patients but two had been investigated with CT scan. The two patients without CT scans had thyroid masses of more than 50% below the thoracic inlet, which were verified intra-operatively. Thyroid masses with caudal limits just below the thoracic inlet were not considered SSGs in this survey. The rate of SSG among all thyroidectomies in this study is 8.4%, this is well within the reported figures which range from 2.6% to 20%.[4-10]

Most of the SSG occurred in patients older than 60 years, which supports the belief that SSG is a progressive disease.[1] Furthermore, thyroxine suppression fails to retard or reverse the evolution of nodular goitres.[11,12] Owing to its progressive nature and the lack of effective treatment alternatives, surgery remains the mainstay of therapy for SSG.

Thyroid function tests should be a routine part of the preoperative SSG workup as they are readily available and furnish the clinician with information on hormonal status. Likewise, chest X-ray is a requirement of anaesthetic assessment and can sometimes depict tracheal displacement or compression. However, as shown by others' experience[5,10] as well as our own, CT scan is the most valuable imaging examination for SSG prior to surgery. It outlines the extent of the thyromegaly and can differentiate SSG that originates cervically from the aberrant intrathoracic thyroid. This is important as the operative approach is completely different for the aberrant intrathoracic thyroid: sternotomy should be performed because the blood supply stems from the intrathoracic vessel instead of the thyroid arteries.[13] Furthermore, CT scan also displays the degree of tracheal narrowing and displacement, which is crucial to the anaesthetists' determination of the most appropriate mode of tracheal intubation. Other imaging examinations, such as ultrasound and isotope scans, are less useful. A lung function test may indicate the level of airway obstruction (intrathoracic vs extrathoracic), but it is not critical to the decision of surgery and is not routine in many institutions.[1]

Interestingly, about half of our patients were asymp-

Table 5. Comparison of clinicopathological parameters between asymptomatic and symptomatic patients

	Asymptomatic (n=13)	Symptomatic (n=11)	P value
Mean age (years)	55.3	65.7	0.10
Sex (F/M)	10/3	9/2	0.79
Clinicopathological parameter			
Euthyroid/non-euthyroid cases	9/4	9/2	0.60
Mean duration of presentation (months)	38.2	38.0	0.98
Hemithyroidectomy/bilateral resection	5/8	6/5	0.53
Previous thyroid surgery (Yes/No)	0/13	2/9	0.11
Emergency/elective operation	0/13	2/9	0.11
Benign/malignant histopathology	12/1	9/2	0.54
Mean specimen weight (g)	213.2	174.5	0.47
Parathyroid autograft (Yes/No)	3/10	3/8	0.81
Mean operative blood loss (mL)	194.9	223.8	0.86
Mean duration of surgery (min)	178.8	196.8	0.60
Mean postoperative hospital stay (days)	3.2	6.3	0.08

tomatic despite the presence of SSG. This high percentage of asymptomatic SSG may be the result of avoiding leading questions in history taking and our aggressive treatment policy for SSG, as championed by the others.[4,6-10] Nevertheless, many asymptomatic patients are reluctant to undergo surgery until they become symptomatic. Remarkably, three (12.5%) patients in this series were admitted through the Emergency Department due to acute airway compromise, and two of them eventually underwent urgent thyroidectomy. Subgroup analysis showed that the complication rate after thyroidectomy was significantly lower in the asymptomatic group (P=0.033; Table 4). This is consistent with the recent findings of Parra-Menbrives et al[14] and supports early intervention in asymptomatic SSG. The reasons for fewer operative complications in the asymptomatic group are elusive in this study. Though more re-operated and emergency thyroidectomies were performed in the symptomatic group, the difference was not statistically different (Table 5). This may be due to the small sample size in this series. Shen et al[15] recently discovered that older patients and bigger SSGs develop more postoperative airway complications. Surprisingly, the weight of the specimen in the asymptomatic group was actually heavier than that of the symptomatic group (213.2 g vs 174.5 g; Table 5). Asymptomatic patients were also about 10 years younger than their symptomatic counterparts. Though not statistically significant because of the small sample size, this difference may have contributed to the lower complication rate in the asymptomatic group because younger patients have a higher threshold to operative morbidity.

The possibility of malignancy is a secondary indication for thyroidectomy in SSG. The cited frequency of the pathological evidence of cancer in SSGs is between 2.5% and 21%.[4-10] The malignancy rate in our series was 12.6%. If the case of occult papillary carcinoma is counted, the malignancy rate rises to 16.8%. Because fine-needle aspiration cytology is often infeasible in SSG for anatomical reasons, it is not safe to discount malignant potential—even in the slow-growing SSG—as differentiated thyroid carcinomas are often indolent.

The cervical approach suffices for SSG removal in most cases, though sternotomy or thoracotomy are occasionally required (2%-11.7%).[4-10] The 8.3% sternotomy rate in this study approaches the upper limit of the reported figures. In one case of papillary carcinoma, superior mediastinal dissection mandated sternal split in order to attain adequate exposure. In another case of benign SSG, manubrium resection was adequate to widen the thoracic inlet to deliver the big mass from the thorax (the inferior border of the SSG could not be reached by the surgeon's fingers). Blind dissection and retrieval of such an SSG is risky, as illustrated by the excessive blood loss in the latter case during the initial attempt at transcervical removal without manubrium resection. Morcellation has been advocated by some surgeons and has resulted in a low sternotomy rate.[7] However, such a procedure could result in more blood loss, and the threat of disseminating undiagnosed cancer always exists. We would rather remove the manubrium to expose the SSG when the cervical approach alone is insufficient. The additional morbidity of this extra procedure is minimal. The indications for a formal median sternotomy include intrathoracic aberrant thyroid,[13] recurrent SSG, and carcinomas requiring mediastinal lymph node dissection.[6]

Conclusions

There is rare mortality in thyroidectomy for SSG, and morbidity is exceedingly low, especially in asymptomatic patients. Substernal goitre should be treated with early surgery rather than running the risk of having acute airway distress or cancer, unless the patient is unfit for anaesthesia or surgery.

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