

Surgical approach to retrosternal goitre: do we still need sternotomy?

Il trattamento chirurgico del gozzo mediastinico: la sternotomia è ancora necessaria?

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SUMMARY

Retrosternal goitre is defined as a goitre with a portion of its mass $\geq 50\%$ located in the mediastinum. Surgical removal is the treatment of choice and, in most cases, the goitre can be removed via a cervical approach. Aim of this retrospective study was to analyse personal experience in the surgical management of retrosternal goitres, defining, in particular, the features requiring sternotomy. Over a 5-year period (2004-2008), 986 patients underwent thyroidectomy in the ENT Department of the University Hospital of Udine, Italy; in 53 patients, 37 females, 16 males (mean age: 64 years, range: 35-85), thyroidectomy was performed for a retrosternal goitre, which extended, at computed tomography at least 3 cm below the cervico-thoracic isthmus. Retrosternal goitres were removed via a cervical approach in 49 patients; a sternotomy was necessary in 4 patients (7.5%), due to an ectopic intra-thoracic thyroid in one patient, and a very large thyroid reaching the main bronchial bifurcation in the other 3 (mean weight of goitres: 883 g, range: 520-1600). Histo-pathological studies revealed a benign lesion in 50 patients and a carcinoma in 2 (3.7%). The incidence of transient and permanent hypoparathyroidism was 13% and 3.7%, respectively. Transient recurrent laryngeal nerve palsy occurred in one patient (1.8%), post-operative bleeding in 3 patients (5.6%) and respiratory complications, requiring a tracheotomy in one case, in 2 patients (3.7%). Surgical removal of a retrosternal goitre is a challenging procedure; it can be performed safely, in most cases, via a cervical approach, with a complication rate slightly higher than the average rate for cervical goitre thyroidectomy, especially concerning hypoparathyroidism and post-operative bleeding. The most significant criteria for selecting patients requiring sternotomy are computed tomography features, in particular the presence of an ectopic goitre, the thyroid gland volume and the extent of the goitre to or below the *tracheae carina*. In conclusion, if retrosternal goitre thyroidectomy is performed by a skilled surgical team, familiar with its unique pitfalls, the assistance of a thoracic surgeon may be required only in a few selected cases.

KEY WORDS: Thyroid • Retrosternal goitre • Surgical treatment • Sternotomy • Complications

RIASSUNTO

La terapia di scelta del gozzo cervico-mediastinico consiste nell'asportazione chirurgica, realizzabile nella maggior parte dei casi per via cervicotomica. Allo scopo di valutare quali siano i criteri in grado di predire la necessità di esecuzione di sternotomia, abbiamo eseguito una analisi retrospettiva della nostra casistica relativa agli anni 2004-2008. In questo periodo, presso la nostra Struttura Operativa, sono state eseguite 986 tiroideomie; in 53 di questi pazienti (37 donne, 16 uomini, età media: 64 anni, range: 35-85) l'indicazione alla chirurgia era la presenza di un gozzo a importante e prevalente estensione mediastinica (limite inferiore del gozzo situato alla tomografia computerizzata almeno 3 cm al di sotto del manubrio sternale). In 49 casi, l'asportazione del gozzo è stata realizzata per via cervicotomica, mentre in 4 casi (7,5%) è stato necessario procedere all'esecuzione di sternotomia in collaborazione con il Cardiochirurgo. La sternotomia è stata eseguita in 3 casi per la presenza di un gozzo ipermagno (peso > 500 g) con estensione fino alla biforcazione tracheale, ed in un caso per un nodulo tiroideo ectopico localizzato in prossimità della biforcazione dell'arteria polmonare. In 2 casi (3,8%) l'esame istologico ha evidenziato la presenza di un carcinoma. Le complicanze post-operatorie sono state: ipoparatiroidismo transitorio nel 13% dei casi, permanente nel 3,7%, paralisi ricorrente transitoria nell'1,8%, emorragia post-operatoria nel 5,6%, complicanze respiratorie nel 3,7% (esecuzione di tracheotomia in un caso). In conclusione, nella maggior parte dei casi la tiroideomia totale per gozzo mediastinico può essere realizzata per via cervicotomica, con un'incidenza di complicanze lievemente superiore rispetto ai valori riportati per le tiroideomie cervicali, soprattutto per quanto concerne l'ipoparatiroidismo e l'emorragia post-operatoria. I nostri risultati evidenziano che i criteri più significativi indicanti la necessità di sternotomia sono deducibili dalla tomografia computerizzata, e sono rappresentati dal volume globale della ghiandola e della sua porzione retrosternale, dal livello raggiunto dal limite inferiore del gozzo e dalla presenza di un gozzo ectopico. In tutti i casi è comunque necessario che la tiroideomia venga eseguita da un'equipe chirurgica "esperta", con la necessità della presenza del Cardiochirurgo solo in casi selezionati.

PAROLE CHIAVE: Tiroide • Gozzo mediastinico • Trattamento chirurgico • Sternotomia • Complicazioni

Introduction

Retrosternal goitre (RG) was first described by Albrecht von Haller in 1749, as the extension of the thyroid tissue below the upper opening of the chest¹. Since then RG has always been considered a challenge for the surgeons, because of the difficulties that may be encountered during surgical removal.

The definition of RG is still not uniform, and varies between the different Authors. However, the most commonly accepted definition of RG describes a goitre as substernal or retrosternal when a $\geq 50\%$ portion of the mass is located in the mediastinum^{2,3}. The presence of RG is documented in 2-19% of all thyroidectomies^{4,6}. Diagnosis of RG is most frequently made in the fifth or sixth decade of life, with a female/male rate of 4:1. RGs can be classified as either primary or secondary. Primary intra-thoracic goitres arise from aberrant thyroid tissue which is ectopically located in the mediastinum, receive their blood supply from mediastinal vessels and are not connected to the cervical thyroid. They are rare, representing less than 1% of all RGs⁷.

Secondary RGs develop from the thyroid located in its normal cervical site. Downward migration of the thyroid into the mediastinum is facilitated by negative intra-thoracic pressure, gravity, traction forces during swallowing and the presence of anatomical barriers preventing the enlargement in other directions (thyroid cartilage, vertebral bodies, strap muscles, especially in patients with a short, large neck). These secondary RGs are, characteristically, in continuity with the cervical portion of the gland and receive their blood supply, depending on cervical vessels, almost always through branches of the inferior thyroid artery.

RGs show, in most cases, a slow-growing enlargement, which usually remain asymptomatic for many years; about 20-40% of RGs are discovered as an incidental finding on a radiographic examination⁸. The most common symptoms are related to compression of the airways and the oesophagus, and are represented by dyspnoea, choking, inability to sleep comfortably, dysphagia and hoarseness. Less commonly, signs of compression of vascular and nervous structures are present, such as superior vena cava obstruction (superior vena cava syndrome) and/or Horner's syndrome (compression of sympathetic chain). The diagnosis of RG is based upon clinical history, clinical examinations, and imaging findings⁹. Computed tomography (CT) scanning is, at present the most exhaustive examination for assessment of the extent of the goitre and compression effects on adjacent anatomical structures¹⁰. Magnetic resonance imaging (MRI) adds little additional information to that obtained with CT and is not routinely used¹¹.

There is general agreement that surgical removal is the treatment of choice for RG, even in the absence of clinical

symptoms. There are numerous reasons for performing surgery in such cases:

1. non-surgical treatment of RG with thyroid hormone or radioactive iodine ablation is very rarely successful^{12,13};
2. RG can become a life-threatening emergency if there is a sudden enlargement of the goitre, secondary to haemorrhage or malignant change;
3. a diagnosis of malignancy, reported in 3-21% of RGs¹⁴, could be missed, considering the difficulties and potential dangers in performing fine-needle aspiration cytology in the mediastinal portion of a RG.

Most RGs can be removed through a cervical approach, while a partial or total sternotomy should be performed only in a minority of patients, ranging between 1-11%¹⁵.

In this retrospective study, a review has been made of personal experience in patients who had undergone thyroidectomy for RG over the past five years. The specific aim was to analyse the epidemiological and clinical data of these patients in order to evaluate the presence of pre-operative findings indicating an increased risk of sternotomy.

Materials and Methods

Over a 5-year period (2004-2008), 986 patients underwent thyroidectomy in the ENT Department of the University Hospital of Udine, Italy. In all those patients with clinical suspicion of retrosternal extension of the goitre (lower pole of the cervical goitre not palpable) or with findings of tracheal deviation or a mediastinal mass upon chest X-ray, a CT scan was performed before surgery. Overall, 53 patients (5.2%), 37 female, 16 male (mean age 64 years; range: 35-85), underwent total thyroidectomy on account of a RG. All operations were performed by Head and Neck Surgeons expert in thyroid surgery. The goitre was considered retrosternal when extending at least 3 cm below the cervico-thoracic isthmus, upon CT examination, performed with hyperextension of the neck. All patients with a minor mediastinal extension of the goitre were excluded from this study. The records of these patients were analysed with regard to: clinical symptoms, history of previous thyroidectomy, presence of tracheal deviation (defined as displacement of the trachea from the normal midline position) or tracheal compression (defined as a reduction in size of the tracheal lumen), site of mediastinal extension (anterior or posterior in relation to the centre of the trachea in the antero-posterior plane), type of surgical approach (only cervical or cervical with median sternotomy), histological findings of thyroid, weight of thyroid, post-operative complications.

The chi-square test was used for statistical analysis. A p value < 0.05 was considered significant.

Results

In 49/53 patients (82.5%), thyroidectomy was performed through a cervical incision, while in 4 patients (7.5%), a median sternotomy had to be performed, in collaboration with cardio-thoracic surgeons, in order to achieve safe removal of the goitre. Overall, 34/53 patients (64%) operated for RG were pre-operatively symptomatic, while 19 were asymptomatic except for complaints of a cervical mass. The symptoms most commonly reported were respiratory: various degree of dyspnoea, cough, choking, etc, and were present in 24 patients (45%); 8 patients complained of dysphagia (15%), whereas signs of vena cava syndrome (venous ingorgement in the face or neck at rest) were present in 2 patients (3.7%). In the sternotomy group, only one patient was asymptomatic, while 3 patients complained of dyspnoea, in one patient associated with dysphagia and in another with vena cava syndrome. Five patients (9%) presented recurrent goitre, with a time-breaking of 5-32 years (mean 18.5) after the first thyroid resection. One of these patients presented an ectopic isolated intra-thoracic thyroid nodule, deeply located in the mediastinum and reaching the pulmonary arterial bifurcation (Fig. 1). The patient was completely asymptomatic and the mass was detected incidentally upon chest X-ray. Overall, 38 patients (72%) (35 patients in the cervical group, i.e., 71%, and 3 patients in the sternotomy group, i.e., 75%), presented CT evidence of tracheal compression or deviation (Fig. 2). The presence of tracheal deviation or compression did not significantly correlate with the presence of respiratory symptoms. Goitre was anterior to the trachea, at CT scan, in 45 patients (84.9%), posterior in 7 patients (13.2%), whereas in 2 patients (3.7%), a complex spreading of the thyroid mass involved both areas. The mediastinal extension of the goitres was predominant on the right side in 25 patients (47%), on the left side in 20

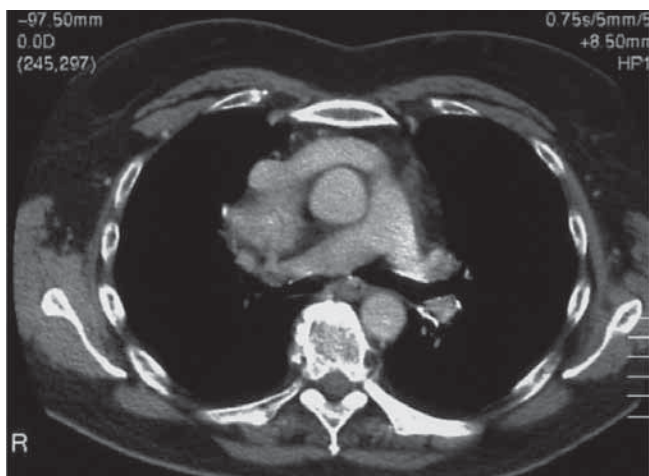


Fig. 1. Axial CT scan showing presence of ectopic intra-thoracic thyroid nodule. The mass is located below the tracheal carina, reaching the pulmonary artery bifurcation.

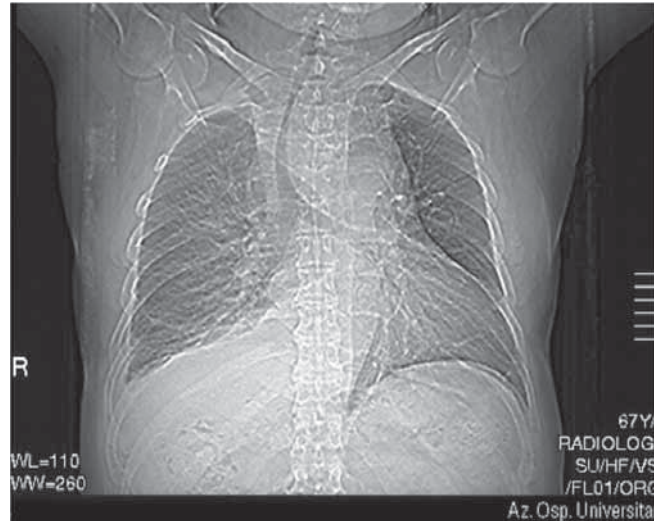


Fig. 2. Coronal CT scan showing RG exerting significant tracheal compression and deviation.



Fig. 3. Axial CT scan showing extension of RG below aortic arch.

patients (37%), and bilateral in 9 patients (16%). As far as concerns the depth of the mediastinal extent of the goitres, 12 patients (22%) presented CT evidence of descent below the aortic arch (Fig. 3): in all these cases, thyroidectomy was performed through a cervical approach, except in the patient with the ectopic goitre, described before. In 4 patients (8%), CT scan showed evidence of the goitre reaching the *carina tracheae*; in 3 out of these 4 patients, sternotomy was required.

The thyroid glands removed showed a mean weight of 192 g (range: 50-1600); the thyroid glands removed via the cervical approach presented a mean weight of 153 g (range: 80-350), while thyroid glands removed via the mediastinal approach showed a mean weight of 682.5 g

Table I. Characteristics of the two groups of patients.

	All patients (n = 53)	Cervical (n = 49)	Sternotomy (n = 4)
Mean age (years)	64 (range 35-85)	65 (range 35-85)	66 (range 64-71)
Sex	Male 16 (30%) Female 37 (70%)	Male 13 (26%) Female 36 (74%)	Male 3 (75%) Female 1 (25%)
Clinical presentation	Asymptomatic 19 (36%) Symptomatic 34 (64%) RD 26 (49%) Dysphagia 8 (15%) VCS 2 (3%)	Asymptomatic 18 (37%) Symptomatic 31 (63%) RD 23 (47%) Dysphagia 7 (14%) VCS 1 (2%)	Asymptomatic 1 (25%) Symptomatic 3 (75%) RD 3 (75%) Dysphagia 1 (25%) VCS 1 (25%)
Recurrent goitre	5 (25%)	4 (8%)	1 (25%)
Tracheal dev./compr.	38 (72%)	35 (71%)	3 (75%)
Mediastinal extension	Below AA 12 (22%) Reaching CT 4 (8%)	Below AA 11 (22%) Reaching CT 1 (2%)	Below AA 1 (25%) Reaching CT 3 (75%)
Side of extension	Right 25 (48%) Left 19 (36%) Bilateral 9 (16%)	Right 23 (48%) Left 18 (36%) Bilateral 8 (16%)	Right 2 (50%) Left 1 (25%) Bilateral 1 (25%)
Histology	Benign 51 (96%) Malignant 2 (4%)	Benign 47 (95%) Malignant 2 (5%)	Benign 4 (100%) Malignant 0
Weight of thyroid (g)	192 (50-1600)	152 (80-350)	682 (80-1600)

RD: respiratory disorder; VCS: vena cava syndrome; AA: aortic arch; CT: carina tracheae.

(range: 80-1600). The mean surgical time was 106 minutes (range: 45-240), 101 minutes (range: 45-215) for surgery via the cervical approach and 175 minutes (range: 100-240) in cases submitted to sternotomy. Histology showed the presence of thyroid carcinoma in 2 patients (3.7%), one medullary carcinoma and one papillary carcinoma, both patients were operated upon via a cervical approach, while in the remaining 51 patients (96.3%) a benign lesion (goitre, follicular adenoma, thyroiditis) was discovered. The features of the two groups of patients are outlined in Table I. None of the features under consideration were significantly correlated with the need to perform sternotomy, except for the mediastinal depth of the goitre and the weight of the thyroids removed ($p < 0.05$).

Post-operative complications occurred in 15 patients (28.3%), 11 patients in the cervical group (22.4%), and 3 patients in the sternotomy group (75%); one patient in this last group had two complications: post-operative bleeding and transient hypoparathyroidism. The most common complication after thyroidectomy, for RG, was transient hypoparathyroidism which occurred in 7 patients (13%), 5 of them in the cervicotomy group (10.2%) and 2 in the sternotomy group (50%). Post-operative bleeding requiring immediate re-operation occurred in 3 patients (5.6%), 2 in the cervicotomy group (4%) and one in the sternotomy group (25%). Permanent hypoparathyroidism occurred in 2 patients (3.7%), both in the cervicotomy group. Two patients (3.7%) had post-operative airway complications, requiring, in one patient (operated through a cervical approach), a temporary tracheostomy due to airway oedema, while in another patient post-operative temporary vocal

cord paralysis (1.8%) occurred; no patients had permanent recurrent laryngeal nerve paralysis. No patients died. Data concerning post-operative complications are outlined in Table II.

Discussion

Surgical removal of RG can be performed by a cervical approach in the majority of patients. It has been reported that skilled head and neck surgeons, with good thyroid surgery experience, need to perform an extra-cervical approach in 2-5% of thyroidectomies for RG¹⁵, but some Authors have reported an incidence of sternotomy in 29% of patients¹⁶. This variability could be correlated with the lack of uniformity in definition of RG. Initially a goitre was generically considered as retro-sternal when extended below the thoracic inlet¹⁷. Later, RG was defined by deSouza and Smith² as a goitre with a portion of its mass $\geq 50\%$ situated in the mediastinum. However, this definition lacks anatomic precision and can be interpreted unspecifically. More precise definitions of RG have been suggested, namely: a goitre lying two fingerbreadths below the thoracic inlet with the patient in a supine position¹⁸, a goitre reaching the aortic arch¹⁹, or the *carina tracheae*²⁰, a goitre with its inferior pole passing through the cervico-thoracic isthmus below the subclavian vessels¹¹. Several classification systems have also been developed in order to better classify RG. Cohen and Cho divide goitres into four grades, depending on the percentage of goitre mass located in the mediastinum²¹. Huins et al. proposed a classification of RG based on the relationship of goitre with anatomical structures of the mediastinum: they defined three grades of goitre de-

Table II. Post-operative complications in the two groups of patients.

	All patients (n = 53)	Cervical (n = 49)	Sternotomy (n = 4)
Transient hypocalcaemia	7 (13%)	5 (10.2%)	2 (50%)
Permanent hypocalcaemia	2 (3.7%)	2 (4%)	0
Transient RNP	1 (1.8%)	1 (2%)	0
Permanent RNP	0	0	0
Post-operative bleeding	3 (5.6%)	2 (5%)	1 (25%)
Respiratory complications	2 (3.7%)	1 (2%)	1 (25%)
Total*	13 (24.5%)	10 (20%)	3 (75%)

RNP: recurrent nerve palsy. * In 2 patients two complications occurred.

pending upon mediastinal extension, namely, to the level of the aortic arch, to the level of the pericardium or below the level of the right atrium²².

In our study, in agreement with de Perrot et al.²³, we considered as retro-sternal those goitres showing an extension of at least 3 cm below the cervico-thoracic isthmus, at CT scan, performed with hyper-extended neck, excluding from the study all the many other goitres showing a less mediastinal extension.

In our series, RG could be removed, using a standard cervical approach, in 49/53 patients, despite the large size and depth of the mediastinal extension of the goitres. Indeed, 12/49 patients showed an extension of the goitre below the aortic arch at CT scan (Fig. 4), and, in one case, the goitre appeared at the level of the *carina tracheae*. In these cases, access to the goitre was facilitated by the vertical extension of the cervical incision downward, towards the sternal manubrium. In this way, the inferior pole of the thyroid could be reached, and using digital dissection safely separated from the mediastinal tissues and gently retracted into the neck. The major risk of this manoeuvre depends on the poor access to the vascular structures, which complicates ligation of the vascular thyroid supply, with, in turn, a higher risk of bleeding.

Nevertheless, the risk of rupture of the veins is considerably reduced by the cervical origin of the vessels, which usually descend in the mediastinum, behind the mediastinal extension of the goitre, thus allowing the digital dissection of the thyroid and its cervical dislocation before ligation or coagulation of the vessels. The ultrasonic instruments, like Harmonic scalpel, can be very useful in the coagulation and resection of small thyroid vessels in the mediastinum.

In all patients, the recurrent laryngeal nerves could be identified and the parathyroid glands preserved. It is well known that post-operative morbidity is more common in patients undergoing RG resection than in patients undergoing thyroidectomy for cervical thyroid disease²⁴; the total complication rate following RG resection via a cervical approach, in our survey, was slightly higher than the average rate reported for cervical thyroidectomy²⁵. No intra- or peri-operative deaths occurred.

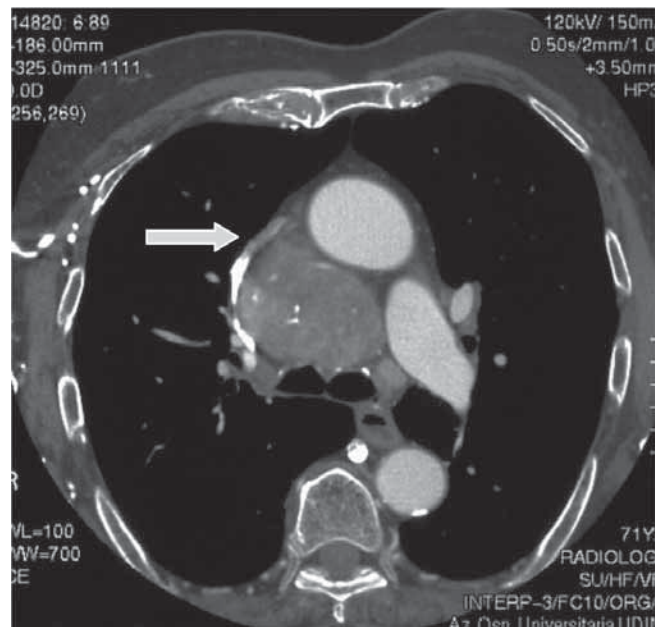


Fig. 4. Axial CT scan showing extension of goitre below main bronchial bifurcation and significant vascular displacement and compression especially of the cava vein (white arrow).

Two cases of post-operative bleeding were recorded (5%), 7 cases of hypoparathyroidism (13%) (5 transient and 2 permanent), and one case of acute dyspnoea. No definitive recurrent laryngeal nerve palsy was recorded, but a transient recurrent laryngeal nerve paralysis was observed in one patient.

In our series, a sternotomy was required in 4/53 patients (7.5%), due to an ectopic intra-thoracic thyroid located close to the pulmonary artery bifurcation in one patient, and a very large thyroid (mean weight 883 g, range: 520-1600), reaching the main bronchial bifurcation in the remaining 3 patients (Fig. 5). This figure represents a slightly higher incidence of sternotomy, compared to values usually reported in the literature; this higher incidence is probably due to the severity strict criteria used in the definition of RG.

For surgeons performing thyroidectomy, it is essential to pre-operatively identify patients requiring sternotomy, in

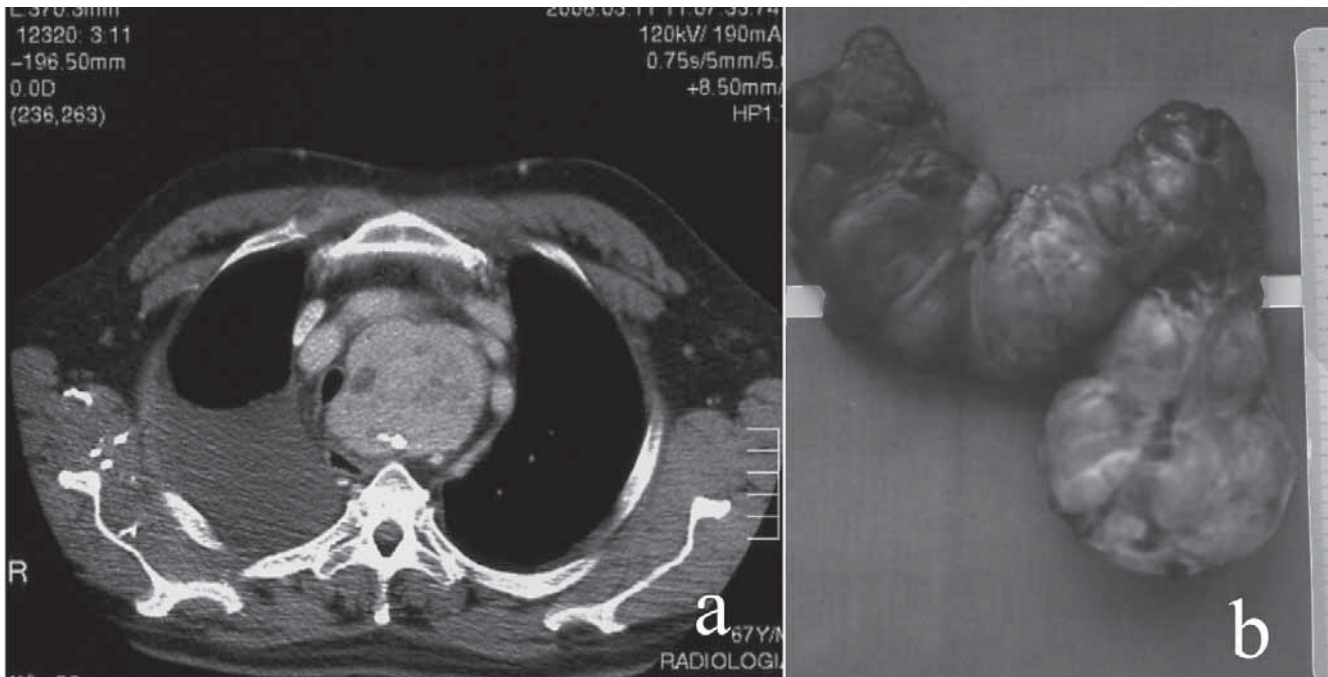


Fig. 5. a. Axial CT showing large mass of RG causing compression of trachea and oesophagus. b. RG of the same patient following surgery (weight of thyroid: 540 g).

order to plan the presence of a multi-disciplinary team, involving also the thoracic surgeon, when necessary, and to correctly inform the patient about the approach which it may be necessary to adopt. Many attempts have been made to specifically define the factors increasing the likelihood of sternotomy, but a general consensus has still not been reached. Flati et al., in 2005, defined the sternotomic approach as “inevitable” in the presence of an iceberg shaped RG with >70% of the mass lying in the mediastinum²⁶. Later, de Perrot et al., in 2007, highlighted the need to perform a sternotomy in goitres > 10 cm, in patients previously submitted to cervical thyroidectomy, and in the presence of invasive carcinoma or ectopic goitre²³. Burns et al. performed a sternotomy in only 3/140 patients with RG, since, in their opinion, the more significant factors giving rise to suspicion of the need to perform sternotomy are CT evidence of adherence to the surrounding mediastinal tissues and extension of the goitre to, or below, the aortic arch²⁷. In 2008, White et al., based on a systematic review of the literature, suggested that sternotomy is more likely to be performed in the presence of a primary RG or a mass larger than the thoracic inlet¹⁵.

More recently, Cohen identified four factors significantly increasing the need to perform sternotomy: 1. the presence of malignancy, 2. involvement of the posterior mediastinum, 3. extension of the goitre below the aortic arch and 4. the presence of ectopic goitre²⁸.

An analysis of our data shows that factors not significantly correlated with the need for a thoracic approach would appear to be the presence and severity of symp-

toms and the CT evidence of tracheal compression or deviation. This observation is in agreement with that of Cohen²⁸, which suggests that the presence of symptoms is correlated more with the amount of growth of the thyroid at the level of the thoracic inlet, where the trachea may be more easily compressed by the presence of the sternal manubrium, than by the total mass of the mediastinal thyroid. Other Authors have found that previous thyroid surgery could be a factor increasing the likelihood of sternotomy, due to the frequent finding of adhesions with surrounding tissues²⁹⁻³¹. In our cohort, this correlation was not found: indeed, the 5 patients submitted to previous thyroid surgery had, all but one (the patient with the residual completely ectopic nodule), their goitres successfully removed via a cervical approach. The possible correlation between the presence of malignancy and the need of sternotomy does not appear to be confirmed by our results, since the 2 patients, in whom a thyroid carcinoma was found, at histological examination, were both successfully submitted to thyroidectomy through a cervical incision. Nevertheless, we still consider malignant neoplasms as a high risk of sternotomy procedure due to the chance of extra-thyroidal extension of the tumour and/or the need to perform dissection of mediastinal lymph nodes.

On the contrary, in agreement with Sancho et al.²⁰, the depth of mediastinal extension of the goitre and the weight of the thyroid removed, have been found to be significantly correlated with the need to perform sternotomy. Concerning the depth of extension, in the 3/4 patients with RG reaching the *carina tracheae*, a ster-

notomic approach was inevitable in order to ensure safe removal of the goitre. Only in one patient could the goitre be mobilized and retracted into the neck via the cervical approach, despite extension until the tracheal bifurcation, thanks to the small volume of the thyroid. A significant difference between the weight of thyroids in the group of patients operated upon via the cervical approach (mean weight 192 g) and the group submitted to sternotomy (mean weight: 883 g, if ectopic goitre is excluded) was found in our cohort. The weight of the specimen is, however, a post-operative finding and may not indicate pre-operatively the approach needed. Nevertheless, pre-operative estimation of thyroid volume, by means of CT scan, can be an effective predictor of which patients are likely to require a thoracic approach. Results of this study have shown that the contribution of CT scan is not limited to an academic classification of RG, but also allows to predict possible surgical difficulties and to define the surgical strategy, according to the mediastinal position and volume of the goitre.

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