

Mediastinal Goiter from the View of Thoracic Surgery

Tamer Eid Fouda*, Tarek Mohsen, Ahmed Sultan, Mahmoud Gamaleldin Ali, Ali Hetiba

Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, Egypt

*Corresponding Author: Tamer Eid Fouda, Mobile: (+20)1113647910, Email: tamereidfouda@cu.edu.eg

ABSTRACT

Background: Several definitions were used to describe retrosternal goiter (RSG). The most accepted one describes when $\geq 50\%$ of the mass portion of the goiter is in the mediastinum. It is considered a surgical challenge because of the difficulties faced during resection and the potential need for an extracervical approach.

Objective: It is to present some of the operated cases referred to our Thoracic Surgery Department after multidisciplinary discussion and decision to operate such cases in combined team with ENT/General Surgery with analysis of their data.

Materials and Methods: A retrospective analysis of 42 patients who underwent resections in a combined team for RSG between 2018 and 2022 in the theater of Cardiothoracic Surgery, Cairo University Hospitals. The patients were evaluated regarding their demographics, symptoms, level and side of extension in the mediastinum, approach, pathology, and postoperative complications.

Results: The mean age was 57.1 years with male: female ratio 1:4.25. The most common symptom was dyspnea in 54% of cases. History of previous thyroid surgery was found in 17(40%) patients. There were 15(36%) patients who had extensions below the aortic arch. Sternal splitting was performed in 18 cases (43%) while thoracotomy was performed in 3cases (7%). Morbidity occurred in 5cases (11.9%) in the form of RLN palsy, phrenic nerve palsy, need for tracheostomy or Montgomery's tube with no postoperative mortality. The extension of RSG beyond the aortic arch and history of previous thyroidectomy were significant calling for extracervical approach.

Conclusion: Retrosternal goiter is an indication for surgery to avoid airway compression, malignancy and difficult excision if the operation is delayed.

Keywords: Retrosternal, mediastinal, goiter, sternotomy, thoracotomy.

INTRODUCTION

Substernal, retrosternal, intrathoracic, or mediastinal goiters are expressions used to describe a goiter extending below the inlet of the thoracic cavity. Albrecht von Haller in 1749 was the first one to describe retrosternal goiter (RSG) ^(1,2).

There have been many definitions of RSG since then till now. However, the most accepted definition of RSG nowadays describes when $\geq 50\%$ of the mass portion of the goiter is in the mediastinum^(1,3,4). Other different definitions have been also assumed for the expression, e.g., goiter that extends beyond the thoracic inlet into the mediastinum for more than 2 cm is considered retrosternal⁽¹⁾, or when the part of the goiter in the mediastinum is larger than the cervical one and it extends downwards beyond the thoracic inlet by two fingers, or by at least 4 cm⁽⁴⁻⁶⁾.

In endemic areas for goiter, it is found that 20% of the population over 70 have substernal goiter. However, diagnosis of RSG is most frequently made in the fifth or sixth decade of life, with female/male ratio of 4:1^(1,2). Mediastinal goiters are classified as primary or secondary. Primary mediastinal goiters (represent less than 1% of intrathoracic goiters) are those without any direct vascular connection to the cervical part of the gland, whereas the blood supply comes from a mediastinal source, with no history of prior thyroid surgery and a lack of similar pathology in the other portions of the thyroid gland. Secondary goiters are far more common, with a blood supply derived from cervical branches of the thyroid arteries^(7,8).

Several factors favor the downward extension of the goiter into the mediastinum which are downward traction caused by normal swallowing, negativity of intrathoracic pressure, and the force of gravity⁽²⁾.

Others classified mediastinal goiters as follows; Type I (85%) into the anterior mediastinum, Type II (15%) into the posterior mediastinum and Type III (less than 1%) isolated mediastinal goiter⁽⁹⁾.

Retrosternal goiters are closely related to thoracic surgery not only because of the potential need of endocrine surgeons during surgery for an additional help by extending the operation into the thoracic cavity but also due to the close relationship of the goiter to nearby mediastinal structures and the potential, although rare, related complications in some cases, e.g., chylothorax⁽¹⁰⁾.

Some studies stated that RSG usually descends downwards to the right, because it takes the path of the least resistance pathway and grow away from the aortic arch and its branches⁽¹¹⁾. However, other studies mentioned that retrosternal extension is more common on the left than the right side due to a more capacious anterior mediastinum on the left side, anterosuperior to the aortic arch⁽¹²⁾.

Retrosternal goiter has always been considered a surgical challenge because of the difficulties that may be faced during surgical excision⁽¹⁾.

In most cases, retrosternal goiters can be safely delivered and resected through the standard collar incision, but sometimes the resection is problematic to the surgeon and necessitates an extra cervical incision with the assistance by a thoracic surgeon^(3,13).

Among experienced surgeons, the percentage of an extra cervical approach is around 2% in some series; however, rates of 11% or eventually 31% in the past were reported⁽⁷⁾.

This happens with extension of goiter below the aortic arch, in redo surgeries, involvement of the posterior mediastinum, extension of the RSG towards carina, and primary ectopic RSG in the mediastinum^(4,14). Generally, sternotomy combined with a cervical approach is the standard favored approach for resection of anterior mediastinal goiters, while thoracotomy is advised for removal of posterior mediastinal goiters^(1,5,7,12).

There are justifying reasons for surgery in RSG cases even in asymptomatic cases. First the use of radioactive iodine ablation is disappointing. Moreover, RSG can become life-threatening if there is a sudden increase in size of the goiter if hemorrhage and asphyxiation happened. In addition, a transformation to malignancy, reported in 3-21% of RSGs, could be missed, even with performing fine-needle aspiration cytology in the mediastinal portion of RSG^(4,5).

Thus, several studies have been trying to find out which patients may need extra cervical approach. **Wu et al.**⁽¹¹⁾ described three types according to the thyroid position; type I goiters, when the gland is over the arch of the aorta; type II when the gland is below the arch of the aorta and extending into the posterior mediastinum, while type III for giant goiters in the chest or causing superior vena cava syndrome. With type II and III the need for thoracic surgeon is more likely.

It is to present some of the operated cases referred to our Thoracic Surgery Department after multidisciplinary discussion and decision to operate such cases in combined team with ENT/General Surgery with analysis of their data.

PATIENTS AND METHODS

Between 2018 and 2022, 42 cases being diagnosed with retrosternal goiter underwent surgery in our OR either by our team only for isolated intrathoracic goiters or in combination with General Surgery/ ENT team. RSG was diagnosed when the majority (>50%) of

the gland was located below the thoracic inlet in the computerized tomogram (CT) scan. RSGs not corresponding to this definition were excluded from the study. Demographic and clinical data of all patients who underwent surgery for intrathoracic goiter at our theater were collected and registered in the study.

The medical records of these patients were retrospectively analyzed. Clinical examination can only assess the cervical component of the goiter. Inspection might reveal scars of previous neck surgery or dilated veins. Palpation of the neck is useful to assess the cervical component of the gland, and assess for tracheal deviation, although that can be difficult due to the goiter. Dullness on percussion of the manubrium sterni signifies retrosternal extension.

The vocal cords were examined in all patients looking for vocal cord paralysis or other distortions, including vocal cord edema. Also, all patients got sonography as part of the preoperative assessment of goiters, which suspected the retrosternal downward extension in some patients.

Computerized tomographic (CT) scanning is best for assessment of the mediastinal extension and in some patients, CT was done with intravenous contrast injection to display the great vessels better. It is worth noting that CT scan of the chest was routinely done with the arms raised, but a CT scan of the neck region was done with the arms down by the side. Raising the arms raises the thoracic inlet over the thyroid gland, causing a RSG to extend further down into the chest. Neck extension was also modify the position of the goiter.

Thyroid function tests, along with assessment of calcium levels, were also performed because the goiter could be associated with normal, high, or low thyroid function.

Any dominant lump in a multinodular goiter was subjected before referral to fine-needle aspiration under sonar guidance, for cytological assessment, for exclusion of the presence of malignancy.

All cases were analyzed with respect to their demographics, surgical procedures, and thyroid gland localization, during surgery, histopathological results, and postoperative complications.

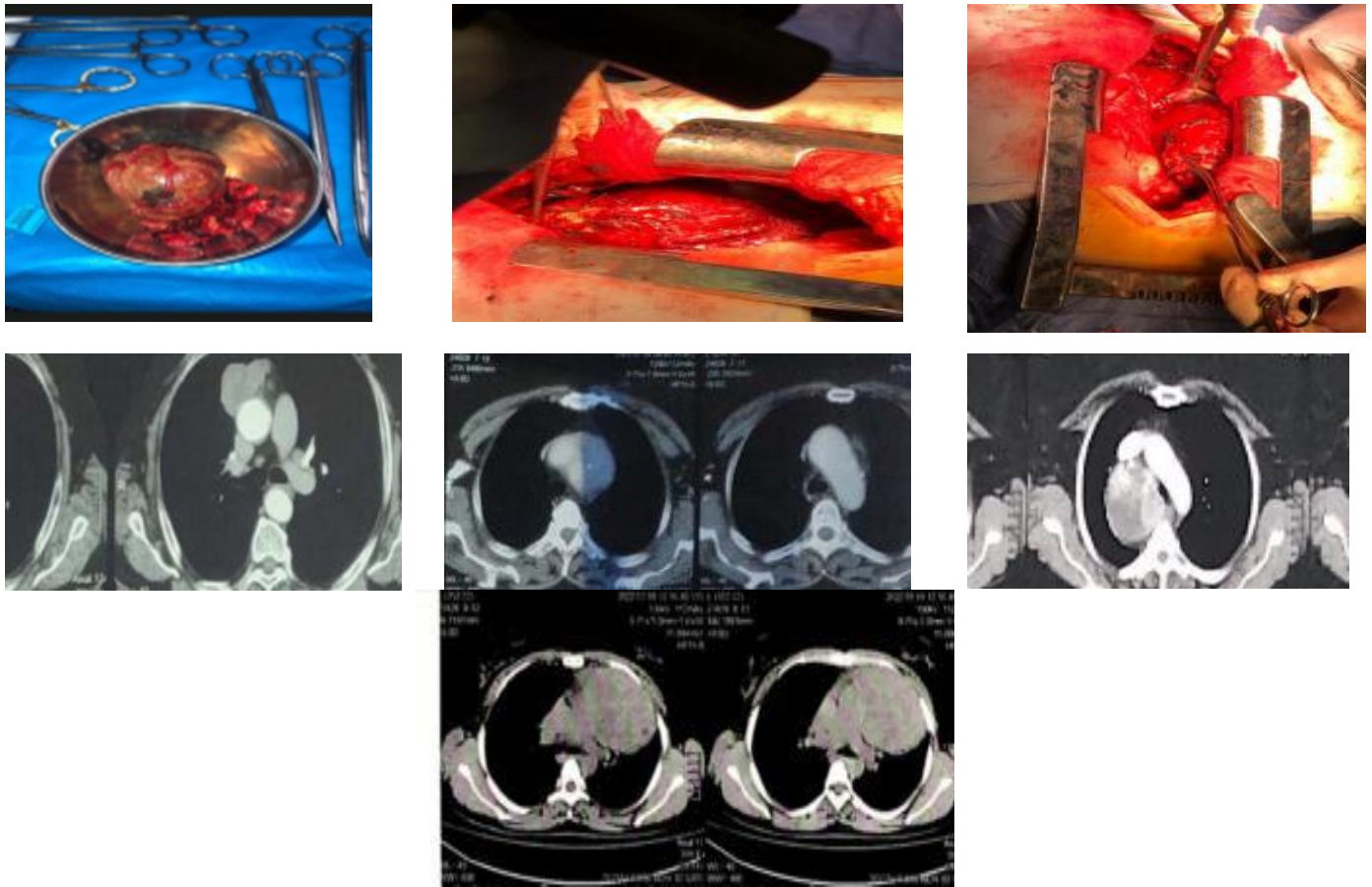


Figure (1): Some of our series of RSGs removed by sternotomy/ thoracotomy

Statistical analysis

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using frequency (count) and relative frequency (percentage).

For comparing categorical data, Chi square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. P-values less than 0.05 were considered as statistically significant.

RESULTS

Our study included the patients operated since 2018 after multidisciplinary discussions with Department of General Surgery/ENT and subsequent decisions were taken to perform these operations in our theater of Cardiothoracic Surgery.

The selected patients had more than 50% of the enlarged goiter located in the mediastinum. During this period 42 patients diagnosed with intrathoracic goiter underwent resection of their goiters with male: female ratio 1:4.25. The mean age at the time of surgery was 57.1 years (range 30–74 years).

Table (1): Patient characteristics.

Clinical data	All Patients (42)	
Mean age (years)	57.1 (30-74)	
Sex	Males 8 (19%)	
	Females 34(81%)	
Symptoms	Asymptomatic 16 (38%)	
	Dyspnea 17 (40%)	
	Dyspnea, hoarseness 6 (14%)	
	Dysphagia 3 (7%)	
Previous thyroidectomy	17 (40%)	
Level of mediastinal extension	Above aortic arch 27 (64%)	
	At and below aortic arch 15 (36%)	
Side of extension	Ant med: 28 (66%)	bilateral 17
		Rt 3
		Lt 8
	Post: 14 (33%)	Rt 10
	Lt 4	
Approach	Cervical: 21 (50%)	
	Manubriotomy: 15 (36%)	
	Sternotomy: 3 (7%)	
	Rt thoracotomy: 3 (7%)	
Histology	Multinodular: 39 (93%)	
	Adenoma: 1 (2.3%)	
	Malignant: 2 (4.7%)	
Complications	None: 37 (88%)	
	RLN palsy: 1 (2.3%)	
	Montgomery's tube: 1 (2.3%)	
	Phrenic palsy: 2 (4.7%)	
	Tracheostomy: 1 (2.3%)	

RSG: retrosternal goiter

Intrathoracic goiter was diagnosed in 16 patients (38%) without symptoms apart from noticed neck swelling. Another 17(40%) patients complained of dyspnea of variable severity, while 6(14%) patients suffered from hoarseness of voice together with dyspnea, while 3(7%) patients only complained of longstanding progressive dysphagia. It is noteworthy that tracheal deviation or compression did not significantly correlate with respiratory symptoms. All patients were euthyroid except one patient who had a toxic goiter.

Out of the 42 cases, 17(40%) patients had history of previous thyroid surgeries done before. In 35(83%) patients, the mediastinal mass was found to be as an extension of the cervical goiter in continuity with the mass in the neck, while the rest of goiters were found to be separate in the chest with no connection to the neck. However, all the cases with these isolated intrathoracic goiters were among the previously operated cases, giving impression that either there was missed goiter during the first operation, or they had recurrence from the other lobe after e.g., hemithyroidectomy. Two thirds of the patients had retrosternal anterior location while the rest of the patients had posterior mediastinal goiters.

The Kocher incision was the surgical approach chosen in all patients from the start except for patients with isolated intrathoracic goiters. In 21 cases (50%), the operations went smoothly, and the masses were enucleated with no need for extracervical incisions, but we had to go for either partial or total sternal splitting in 14(33%). The rest of the cases were incised from the start by either thoracotomy or sternotomy due to the isolated nature of the mediastinal goiter and the incision was chosen according to the location of the mass being anterior or posterior to the vascular structures in the chest and the trachea. Three of them had right thoracotomy while 3 underwent ministernotomy and one was performed through full sternotomy.

There was no mortality among our patients with morbidity of about 11.9%. Recurrent laryngeal nerve palsy causing unilateral vocal cord paralysis occurred in one case. In two cases, phrenic nerve was scarified during excision being inseparable from the mass. Anyhow these 2 cases were diagnosed in the final pathological result to be malignant. One case was tracheostomized for tracheomalacia removed 2 months later, and one similar case of scabbard trachea also had Montgomery tube removed after 1 month. No hypocalcemia was reported, and all patients received the thyroid hormone postoperatively.

Histologically, two cases in our series were diagnosed to be malignant after resection although FNAC done preoperatively in one of them did not detect the real pathology being done from the neck portion. One case underwent an operation after that for lymph node neck dissection. The pathology results in the rest of the cases were benign.

Table (2): Characteristics of RSG in both groups in relation to approach.

Characteristics of RSG		Approach		P-value
		Cervical (21)	Extra-cervical (21)	
Level of mediastinal extension	Till arch of the aorta (27)	20 (74%)	7 (26%)	<0.001
	Below aortic arch (15)	1 (7%)	14 (93%)	
Plane of extension	Anterior (28)	16 (57%)	12 (43%)	0.19
	Posterior (14)	5 (35.7%)	9 (64.2%)	
Previous thyroidectomy	Yes (17)	4 (23.5%)	13 (76.5%)	0.005
	No (25)	17 (68%)	8 (32%)	
Histology	Malignant (2)	0 (0.0)	2 (9.5%)	0.488
	Benign (40)	21 (52.5%)	19 (47.5%)	

RSG: retrosternal goiter.

By analysis of the data, it was found that there is significant relation between the depth of extension of the retrosternal goiters and the need for extracervical approach, being almost all the cases with extension below the arch deeply in the chest were not possible to be delivered through the neck incision only. Dense adhesions in redo surgery strongly impacted the choice of the approach for additional thoracic extracervical incision. Regarding malignancy, due to the presence of only two cases the relation could not prove to be significant. For posterior extensions, the need for an additional thoracic incision was more than in anterior ones although the difference was not that significant.

DISCUSSION

RSG is reported in the literature to range from 3 to 20% of the patients undergoing thyroidectomy operation. This wide range in the incidence is mostly due to the different definitions given for RSG^(1,15). In our study we included only the cases with goiters extending deep in the mediastinum with more than of 50% of its main portion in the retrosternal region.

Regarding the demographics, the incidence of male: female was 1:4.25 with mean age of 57.1 years, which is like that published by Veerabhadraiah and his colleagues where the male: female ratio was 1:4.25 with mean age of 51 years while others like Varshney reported male: female incidence of 1:2.6 but the mean age was of 52 years^(4,15). **Khairy et al.**⁽²⁾ reported mean age of 54 years and the incidence of females was 3.3 times males. **Battistella et al.**⁽⁵⁾ coworkers published a study of 264 patients in more than 30 years with females 4 times males in RSG incidence and the mean age was 54years.

In our study, the most common symptom was respiratory, occurring in 54% of patients, which resulted from compression of the trachea. This is reported with similar incidence in the series of Varshney whereas 46.8% of the cases had dyspnea as the main symptom⁽¹⁾.

Khairy and his colleagues⁽²⁾ reported an incidence of 34.6%. This presentation was caused by the progressive nature of the disease, combined with the narrow passage of the inlet. A classical chest X-ray finding of the RSG included a mediastinal mass with tracheal deviation and compression. However, many patients had normal chest X-ray. Thus, retrosternal goiter should always be suspected in any patient with goiter especially if the patient is complaining of dyspnea even in absence of clinical signs of retrosternal extension by physical examination⁽⁸⁾.

All patients got sonography as part of the preoperative assessment of goiters, which suspected the retrosternal downward extension in some patients. However, the ultrasound failed to give detailed information about the RSG. CT scan was performed routinely for all cases with goiters. It is a useful investigation as it shows the relationship of the goiter to adjacent nearby structures, e.g., the trachea, the esophagus, and great vessels, as well as the depth of the gland in the mediastinum. This is agreed in all the studies which handled the same topic⁽¹³⁾.

FNA biopsy of an RSG is not usually recommended, because it is technically difficult, may be dangerous to perform, and can miss the true pathology especially with multinodular goiter as the result may be deceiving being taken from one of the benign nodules skipping a malignant one.

This happened in one of our patients, whereas postoperatively the final pathological result declared that the goiter had a large malignant component in the chest portion⁽²⁾. **Chia et al.**⁽¹⁶⁾ revealed that the incidence of malignancy in substernal goiters is almost the same as that found in cervical goiters (3% to 21%). In our series, the incidence of malignancy was 4.7% and was diagnosed postoperatively as discussed before. **Khairy et al.**⁽²⁾ in 2012 reported malignancy in 26.9% of cases.

It has been reported that with good surgical experience, the need to perform an extra-cervical incision was 2-5% of thyroidectomies but may be up to almost 30% of patients with RSG. This wide range of incidence could be due to with the lack of sharp definition for RSG. In the past, a goiter was considered as retrosternal if there was extension beyond the thoracic inlet. Later, more precise definitions of RSG had been suggested that went far beyond the famous definition of more than 50% of the main portion in the chest. In some reports a goiter was considered retrosternal only if it is located two finger breadths below the thoracic inlet with the patient in a supine position, a goiter reaching the aortic arch, or the tracheal bifurcation⁽¹⁾.

The mere presence of retrosternal goiter is not necessarily an indication for an additional extracervical approach but it may be required when retrosternal goiter is too large to be enucleated through thoracic inlet; the blood supply source is in the chest; retrosternal goiter extending into the mediastinum causes anatomic

variations in the anatomy of the RLN and the parathyroid glands or the severe venous congestion that may cause severe bleeding or those extending beyond the aortic arch into the posterior mediastinum^(15,17).

Blind maneuvers to attempt to dislocate the mediastinal component of the goiter into the neck via passage of a Foley's catheter into the mediastinum, morcellation of the RSG, and insertion of strong silk sutures into the cervical goiter to apply traction from the neck are discouraged due to the risk of uncontrollable hemorrhage and the possibility of injury to adjacent critical structures in the thoracic inlet^(4,7,13,16).

Therefore, it is essential to identify patients who may need sternotomy to plan for a thoracic surgeon. Moreover, the patient should be counseled properly for the possibility to have a sternal split intraoperatively and should be consented for the possible subsequent morbidities if an extracervical approach is needed.

Thus, several classifications have been published to classify RSG, thus predicting how far can RSG be resected through neck incision. Cohen and Cho divided goiters into four classes, depending on the predominating portion of goiter mass present in the mediastinum⁽¹⁸⁾. **Huins et al.**⁽¹⁹⁾ performed a systemic review that included 34 studies and developed a classification system based on the mediastinal extension of the thyroid goiter: the first level above the aortic arch, the second at the level between the aortic arch and the pericardium, and the third level extending beyond the right atrium. They concluded that the mini or full sternotomy, makes the surgery safer in the second and third types.

Despite these classifications that used to predict difficult cases not suitable for the sole use of cervical incision, most authors still insist on that the need of extracervical aiding incision is as low as 5%⁽²⁰⁾. Others claimed that the need of thoracic surgeon is in only 1% of cases⁽⁹⁾. However, **Flati et al.**⁽²¹⁾, in 2005, stated that the sternotomy approach is "inevitable" in the presence of iceberg like RSG with >70% of the mass lying below the thoracic inlet in the mediastinum. **de Perrot et al.**⁽²²⁾, in 2007, confirmed that the need to perform a sternal split is in goiters > 10 cm, in redo patients after cervical thyroidectomy, and in the presence of malignancy or ectopic goiter. Other criteria have been defined for sternotomy according to CT features which include the volume of thyroid gland, whether the RSG extends beyond the tracheal bifurcation, if the source of its blood supply comes from the mediastinum with subsequent risk of hemorrhage⁽¹³⁾. In other series, it was mentioned that sternotomies were more with patients with a history of cervical thyroidectomy, malignancy, or ectopic goiter^(11,23). Some others stated that the shape of the goiter has an impact. Dumbbell, hourglass, conical or iceberg shaped goiter; with the largest portion of the mediastinal part exceeding the diameter of thoracic inlet or in case being larger than the cervical

part with constriction at the site of inlet; all these shapes also had a higher incidence of sternotomy⁽⁴⁾.

Extracervical approaches for resection of RSG goiters are either through sternotomy, manubriotomy or thoracotomy (anterior or posterior). Anterior mediastinal goiters are operated by sternotomy or anterior thoracotomy, while posterior mediastinal goiters usually require excision through posterolateral thoracotomy^(12,16). A novel was published in 2006 using anterior mediastinotomy together with the cervical incision with performing bimanual manipulation to deliver the troublesome retrosternal goiter⁽²⁴⁾. Thoracoscopy, and more recently robotic assisted thoracoscopy, have also been used to aid in resection of RSG and are described in a few case series^(7,12,14,16).

In our study, we used together with our colleagues from General Surgery/ENT departments to select the patients to be operated preferably in our theater, as all the selected cases had either huge goiters reaching the aorta or even extending below it, some were redo cases with no apparent surrounding plane of dissection and some cases had isolated (either missed or recurrent goiters) in the mediastinum. This may explain the higher incidence of extracervical chest entry than in most of the studies (50% versus 30% in some studies).

We adopted the use of sternal splitting either by partial or full sternotomy because it usually gives access to the mediastinum and both pleural cavities, for lymph node dissection in case of suspicion of malignancy and the superior control it gives in case of retrosternal goiters present bilaterally or with complex extensions occupying both anterior and posterior mediastinum. Posterolateral thoracotomy was saved for isolated masses restricted to right side posteriorly. We did not adopt anterior thoracotomy in any of our cases. **Battistella et al.**⁽⁵⁾ agreed Machado that although anterior thoracotomy is an easy incision and done in supine position, but it is difficult to give a view of the right recurrent laryngeal nerve. He also denied thoracotomy as an access if the mediastinal portion is developed on the left side. Posterolateral thoracotomy according to his opinion prolongs surgical time due to the need of change in position and mentioned that it is done preferably for a large posterior goiter on the right side and with thoracic adhesions to nearby structures^(5,25).

Relation to the aortic arch was found to be the most crucial factor in our study to have strong relation with the need to open the chest in such cases as 93% of the cases with extension beyond the arch of the aorta required a thoracic incision. This was stressed in most of the studies, and this is the cause of the higher incidence of thoracic entrance in our study. **Pata et al.**⁽²⁶⁾ found that extension to aortic root was statistically significant in predicting need for additional assisting thoracic incision. That all the patients in his study who required a sternotomy had an extension beyond the arch aorta. **Casella et al.**⁽²⁷⁾ also reported that 100% of patients needed a sternotomy in his series had

downward extension of RSG to aortic root. Posterior mediastinal involvement increased this relation. Other studies mentioned that extension down to the aortic root and posterior mediastinal involvement were significant factors in predicting need for sternotomy. Therefore, the absence of this finding can predict the probability of successful transcervical excision⁽⁴⁾. We found also that the rate of need for extracervical approach was significantly increased in redo cases. **Sari et al.**⁽²⁸⁾ evaluated 260 patients of RG undergoing surgery and reported that redo surgical treatment was a significant factor as well as if there was history of previous tracheostomy.

Malignancy was also considered as a factor predicting the need for sternotomy or a lateral thoracotomy⁽²⁴⁾. Although we had only 2 cases with malignant RSG but required excision through sternotomy.

In our series there was no mortality, and this was the same as in most studies published in this topic. The morbidity was 11.9% but all of them were temporary. Although being high, but it is well established that post-operative morbidity is more common in patients undergoing RSG resection than in patients undergoing thyroidectomy isolated in the neck. Varshney reported complications of 19% of those operated for RSG⁽¹⁾. This may be attributed that in his series he used to deliver the gland through the neck incision except in 3 cases although he had 6 patients with extension below the arch.

Regarding tracheomalacia, we had in our series only one case (2%). This is the same as in literature as tracheomalacia seems to present with low incidence (0–2%) after thyroidectomy of substernal goiters. There is no agreement on the optimal treatment of tracheomalacia; however, conservative approach yields a favorable outcome in most of cases^(7,9). None of our patients had bleeding or wound infection nor hypoparathyroidism.

LIMITATIONS OF THIS STUDY

As in any retrospective study there were several limitations:

- The patients included in our study were only those who underwent surgery.
- The surgeon factor with regards to experience and readiness to do a sternotomy for more surgical safety should be considered.
- Multi-institutional studies are required to better define the predictive factors for the need of extracervical additional incision.

CONCLUSION

Retrosternal goiter is an indication for surgery to avoid airway compression, malignancy and difficult excision if the operation is delayed. The presence of isolated RSG, previous thyroidectomy, and extension of the goiter below the aortic arch are the most significant criteria for selecting patients requiring extracervical

approach. The CT scan is the standard diagnostic tool, when RSG is suspected. The planned potential need for sternotomy is rendered safe with almost no mortality and acceptable morbidity.

Although excision of RSG is a troublesome surgical procedure that may require an extracervical approach, retrosternal masses should be operated being at increased risk for hidden malignant nature and later severe respiratory problems as well as being at risk if left untreated for troublesome endotracheal intubation during later anesthesia. Predicting which case is at risk of difficult operation and potentially requires a sternotomy is desirable for preoperative planning, to provide proper personnel and resources and give better information for patients counselling regarding the procedure and the potential risks. The most significant criteria for selecting patients requiring extracervical approach are the presence of isolated intrathoracic goiter, previous thyroidectomy, and extension of the goiter below the aortic arch. Thus, the CT scan is the standard diagnostic tool, when RSG is suspected. However, the final decision regarding the need for sternotomy can be made only intra-operatively. When meticulously planned preoperatively, the elective use of sternotomy is rendered when needed is much safer with almost no mortality and acceptable morbidity. New alternative approaches; VATS and robotic surgery; may abolish in the future the need of additional thoracic incisions in RSG operations, allowing them to become the gold standard aid tool in the management of mediastinal goiters.

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