Review Article

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Retrosternal goitre, do humans need a sternotomy?

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ABSTRACT

Retrosternal goitre as a surgical thyroid pathology is diminishing in incidence. Though surgery is the generally accepted treatment modality, lot of uncertainties exist regarding the approach for surgery in consideration with the prognostication, surgical morbidity and the post-operative outcome. Median sternotomy, in addition to being more morbid, is generally out of the general surgeons' perview and therefore its need necessitates preoperative arrangements for assistance by a thoracic surgeon. Cervical approach is sufficient for most of the lesions but the surgeon should be conversant with median sternotomy as to perform it expediently and without hesitation when it is indicated. The generally indications for sternotomy are extension of goitre below the aortic arch, involvement of the posterior mediastinum, large thyroid tissue extending towards tracheal bifurcation, and primary ectopic thyroid tissue in the mediastinum. Here the available literature was reviewed to identify the preoperative predictors of a sternotomy in the management of substernal goitre in order to provide better preoperative planning and patient consent in managing the patient with reference to a recently encountered case.

Keywords: Retrosternal goitre, Sternotomy, Thyroid surgery

INTRODUCTION

We recently encountered a case of goitre with a large retrosternal extension. The mass was extending up to the level of carina, behind the arch of aorta, abutting the right main bronchus. This case was preoperatively evaluated clinically and on CT and need for a median sternotomy was contemplated. The relatives were accordingly counselled and the patient taken up for surgery. With a proper neck extension position, a standard cervical incision was taken and thyroidectomy proceeded with. As the right lobe was mobilised from the bed, gradual blunt dissection was done into the mediastinum, applying optimum traction on the gland. All the necessary arrangements for a median sternotomy were in place and we proceeded through the neck incision. Eventually the

lobe was safely delivered through the neck incision. The vessels supplying the mediastinal extension were clipped and divided through the neck itself and no worrisome bleeding was encountered. This seemingly improbable resection made it necessary for us to review the factors which really decide whether a median sternotomy is ever required for a retrosternally extending thyroid lesion, and if so, for what exact indications.

REVIEW OF LITERATURE

An extension of the thyroid gland below the thoracic inlet is labelled as substernal, retrosternal, intrathoracic, or mediastinal goitre. 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 chest.

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It was Klein who is credited with the first successful surgical excision of a RG in 1820.⁵

Definition

There is no standard definition for a retrosternal goiter, however, various different criteria have been suggested by authors. Few of the commonly accepted definitions of RG are:

- A goitre that has descended below the plane of the thoracic inlet.
- A goitre with more than 50% of its mass lying below the thoracic inlet.²
- A thyroid gland extending 3 cm below the sternal notch.^{3,4}
- Extension of the gland below the fourth thoracic vertebra
- Extending upto or below the aortic arch.^{3,4}
- Having greatest dimension of the gland inferior to the thoracic inlet.^{3,4}

The first of this list is generally accepted as this definition is the most inclusive and refers to consistent anatomic landmarks that are easily recognized both radiologically and during surgery.⁴

RGs are classified as either primary or secondary.

Primary

These arise from aberrant thyroid tissue ectopically located in the mediastinum. They receive their blood supply from mediastinal vessels and are not connected to the cervical thyroid. They are rare and represent less than 1% of all RGs.⁵ Primary intrathoracic goitres most of the time end up with need of a sternotomy for excision.

Secondary

These develop from the normal cervical thyroid. Downward migration being promoted directly by negative intrathoracic pressure and gravity, further assisted by traction forces during swallowing. Also the presence of anatomical barriers (thyroid cartilage, vertebrae, strap muscles, especially in patients with a short, large neck) prevent the enlargement in other directions. These are generally contiguous with the cervical thyroid and receive their blood supply almost always through branches of the inferior thyroid artery. Other classifications based on intrathoracic volume percentage of the goitre or on relation to thoracic structures have also been described but involve practically reproducible to variables not guidelines.^{1,6}

EPIDEMIOLOGY

The reported incidence of RG is 1-20% amongst all patients undergoing thyroidectomy. In a recent review,

Moten et al reported that among a total of 110,889 patients who underwent thyroidectomy for goitre 5,525 had a retrosternal disease while 105,364 had only cervical goitre. Absence of a standard definition probably explains the wide range of incidence in literature. Diagnosis of RG is usually made in the 5th-6th decade of life, with a male:female ratio of 1:4. Majority of RGs (85-90%) are located in the anterior mediastinum with only (10-15%) located in the posterior mediastinum. RGs mostly have a slow-growing enlargement and can remain asymptomatic for years. In a large review of 174 patients of RG, the most common symptoms were a cervical mass (88%) and dyspnoea (35%), while 26% of the patients were asymptomatic. In another study, 34/53 patients (64%) operated for RG were pre-operatively symptomatic, while 19 (36%) were asymptomatic except for complaints of a cervical mass. About 20-40% of substernal goitres are discovered as an incidental radiologic finding.⁸ Patients with larger mediastinal goitre are rarely asymptomatic. The common symptoms are related to compression of the airways and the esophagus, and present as dyspnoea, choking, inability to sleep comfortably, dysphagia, and hoarseness.9 RGs carry a 3-21% risk of malignancy and late presentation is common. Some patients even present as an emergency with superior vena cava obstruction. Horner's syndrome due to compression of sympathetic chain is also reported.

EVALUATION

Clinical examination is most important but occasionally deceptive in diagnosis of a RG. An ultrasound is limited by presence of the bony clavicle and sternum in assessing the retrosternal extent though it can define its presence, suggest etio-pathogenesis and decline vascularity of the RG.

Clinically, presence of large gland with inaccessible lower border with patient lying supine, stridor, history of dysphagia, hoarseness and dilated neck veins are important findings. CT scanning is, at present, the gold standard and the most exhaustive examination for assessment of the extent of the goitre and compression effects on adjacent anatomic structures. Location and size of major feeding and draining vessels can help planning the surgery in patients. A preoperative CT scan is mandatory in every suspicion of a substernal goiter. Magnetic resonance imaging (MRI) adds little additional information to that obtained with CT and is not routinely used except in some special circumstances. CT volumetry is also known to help in predicting the surgical approach in many patients.

TREATMENT

Surgery is the most accepted and effective treatment for RG, primarily because

 Treatment with exogenous thyroxine or radioiodine involves large doses and is rarely effective, though partial reduction in size is achieved.¹¹

- Large lesions present with life threatening symptoms like stridor, dysphagia and SVCO which need emergent relief mandating surgical excision. Many advocate removal of RG before dangerous compressive symptoms appear.
- Malignancy 3-21% is liable to be missed or suboptimally treated without surgery.
- In experienced hands morbidity of surgery, even if needing sternotomy is fairly low and acceptable.

Generally most of the RGs can be excised from the neck incision. White et al reported that skilled surgeons, with good thyroid surgery experience, need to perform an extracervical approach in only 2-5% of thyroidectomies for RGs. 12 The reported necessity of median sternotomy varies between 1-11% in most studies. Nakaya et al reported a review of 351 patients undergoing thyroidectomy where 44 had a retrosternal disease and none required median sternotomy. 13 Rolighed L et al report that in 55 out of 2065 thyroid operations (2.7%), median sternotomy was performed. 1

In a review by Nankee et al in an experience of over 3000 thyroidectomies, only 7 required sternotomy. ¹⁴ In a study by Sakkary et al, out of 1481 patients who underwent thyroidectomy only 73 (4.93%) had retrosternal extension and only 1 needed sternotomy for excision. ¹⁵ Sari et al needed sternotomy in only 6.5% patients in 260 patients with a RG. ¹²

DISCUSSION

Various clinical and radiological factors have been identified to determine the need of sternotomy in patients undergoing surgery for a RG. Most important of these (not in that order) are discussed below:

- Clinical symptoms and history
- Extent upto or beyond root of aorta
- Subcarinal extension
- Posterior mediastinal extension
- Thyroid tissue density
- Recurrent RG
- Shape of the goitre
- Duration of RG
- Presence of ectopic/primary mediastinal goitre
- Presence of Malignancy

Clinical history, evaluation and a dialogue with the patient and kin are predominantly important as an informed patient choice is pertinent to go ahead with a surgery with an unpredictable chance for the need for sternotomy, which can significantly affect the surgical morbidity and outcome. Clinical features of interest are presence of retrosternal goitre diagnosed clinically, symptoms of compression viz. dysphagia, dyspnoea, stridor, hoarseness of voice, and features of superior vena cava obstruction, presence of bilateral disease, recurrent lesion with

retrosternal extension and history of presence of RG for a long duration.

Presence of compression symptoms and tracheal deviation does increase the chance of sternotomy but was not statistically significant and, less so, specific in various studies. Postoperative recurrent nerve palsy and hypoparathyroidism were more frequent in these patients but the need for sternotomy was generally equivocal.

Sari et al prospectively evaluated 260 patients of RG undergoing surgery and reported that recurrent disease after earlier surgical treatment was a significant factor and so was the history of previous tracheostomy. ^{16,17} Clinically and radiologically present tracheal deviation also was found to be an important predictive factor.

Duration of presence of the RG was a significant factor for predicting need for sternotomy in a study. ¹⁸ In a review of 98 patients, they found that patients with a history more than 160 months of diagnosis of RG needed sternotomy more frequently than those with a lesser duration of having the disease (p<0.05).

In the era of advanced imaging, clinical findings surely take a back seat in predicting need for sternotomy and need radiological substantiation for authenticity.

Cross sectional imaging by a CT scan provides the most important predictors for need for sternotomy in surgical management of RG. Presence of a clear tissue plane around the nodule in the mediastinum is singularly most predictive of success in its excision via a cervicotomy. Absence of such plane suggests dense adhesion or invasion of surrounding tissues precluding the safety of the cervical approach.

Extension of the lesion upto the aortic root, beyond the arch of aorta, extension to the tracheal bifurcation and posterior mediastinal involvement are also important factors predicting sternotomy.

Pata et al in a study of 102 patients found that extension to aortic root was statistically important in predicting need for median sternotomy.¹⁹ All 15 patients (100%) who required a sternotomy had a disease beyond the arch aorta and reaching the tracheal bifurcation. Riffat et al reported that 17 out of 97 patients had extension of disease to the carina and eventually needed sternotomy (p<0.05).²⁰ Qureshi et al in a review of 6 studies commented that extent upto aortic root and posterior mediastinal involvement were significant factors in predicting need for sternotomy.²¹ Casella et al reported that 100% of patients needing a sternotomy had an extension of disease to the root of aorta and it predicted the same with 100% specificity and 73.3% specificity. 19 Posterior mediastinal involvement further enhanced this effect (p<0.024). Thus, in converse, absence of extent upto aortic root can predict successful transcervical excision.

Shape of the goitre has been studied frequently. Dumbbell, hour-glass, conical or iceberg shaped goitre with the largest dimension of the mediastinal part more than that either thoracic inlet or the cervical part with constriction at the site of inlet also had a higher chance of needing a sternotomy.21 CT defined size of the mediastinal component of more than 15-20cm predicted need for sternotomy.16 Presence of more than 70% mass in mediastinum and conical shape of goitre were reported to be significant in a study. A CT calculated thyroid volume of ≥ 162 cc extending below the thoracic inlet was a significant predictor for a sternotomy with a negative predictive value approaching 100% for retrosternal goiter in an analysis by Balkan et al.¹⁷ Weight of the resected gland (192 gmavg in cervical excision vs 880 gmavg in sternotomy patients) retrospectively highlighted the role of preoperative volume calculation in determining the need for thoracotomy in a study done by Rugiu et al (p<0.05).¹⁰

Primary intrathoracic goitres are another group who usually need the transthoracic approach for successful excision. These can have supply from mediastinal vessels and occasionally can be gently shelled out only if they are accessible from neck and have a good tissue plane for dissection, absence of which mandates thoracotomy for a safe excision. These lesions occasionally even need a lateral thoracotomy.



Figure 1: A typical retrosternal goitre with classical radiological features. CT scan showing extension below arch of aorta upto carina.

Presence of malignancy on preoperative evaluation, radiologically and/or histologically was another factor predicting the need for sternotomy or a lateral thoracotomy. In a review of pathology of RGs Kilic et al commented that using median sternotomy and

thoracotomy, we get better surgical exposure, we can avoid catastrophic results, such as hemorrhage, and completely remove malignancies and the draining nodes.²²

Thyroid tissue density is said to predict the need for sternotomy in a RG. Sari et al in a prospective study of 260 patients, noted that patients with harder thyroid tissue density needed sternotomy 47 times more frequently than those with softer thyroids (P=0.001).¹² They documented tissue density of thyroid using Photoshop on CT imaging and concluded that preoperative thyroid tissue density assessment can predict need for sternotomy.²³

CONCLUSION

Median sternotomy is a complicated invasive procedure involving opening of the mediastinum and exposure of critical structures like major vessels, tracheobronchial tree and pericardium. The potential complications of the thoracic approach include hematoma, mediastinitis, abscess, osteomyelitis, chest bone fracture, and sternal dehiscence. Surgical time and intraoperative blood loss is more; recovery takes longer and can be more painful in comparison with a cervical approach. Optimally trained surgeons should only take up this procedure with proper informed consent of the patient and caretakers. Given equivalent retrosternal extension, a transcervical approach should be attempted whenever anatomically possible, regardless of pathology. In trained hands the risk of hypoparathyroidism or recurrent laryngeal nerve injury is not significantly increased compared to cervical thyroidectomy. Accordingly, predicting which patients will have a difficult operation and potentially require a sternotomy is desirable for preoperative planning, to assure proper personnel and resource allocation and provide information for better informed patient discussions regarding operative risk.

The important factors which predict need for a median sternotomy we outlined from our experience and a review of the available literature were as follows:

- Classical primary intrathoracic goitres.
- Invasive thyroid lesions with no clear tissue plane
- Mediastinal extension below root aorta upto tracheal bifurcation or beyond.
- Posterior mediastinal involvement
- Recurrent lesions
- Mediastinal mass with maximum diameter more than the size of thoracic inlet; conical or iceberg shaped lesion.
- Mediastinal size more than 15 cm
- Harder thyroid tissue density.
- Malignancy.
- Long standing goitre
- Tracheal compression and deviation

Except the first four from the list, all other factors are relative and have been found to be significant only in few

studies. The first four factors have a significant impact on possible need for sternotomy and should be considered in preoperative counselling and preparedness for the surgery of a retrosternal goitre.

As in any retrospective analysis there are several limitations to this review:

- The patients included in most studies are only those who underwent surgery. Patients deemed inoperable on evaluation need inclusion to corroborate the findings in all comers.
- The surgeon factor with regards to expertise and willingness to do a sternotomy also needs consideration, especially in borderline cases.
- Furthermore, considering the dwindling incidence and rarity of a need of sternotomy in present imaging era, large multi-institutional database is required to better define the predictive factors for this surgery.

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