RETROSTERNAL GOITRES: A PRACTICAL CLASSIFICATION

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Abstract

Background. There is no standard definition for goitres extending below the thoracic inlet and no clear guidelines for pre-operative planning of surgery. The aim of this study is a practical classification of retrosternal goitres (RSG) based on the anatomical, radiological shape and size of the thyroid.

Methods. Retrospective analysis of all thyroidectomies performed in a referral centre between January 2012 and December 2016. Patients with RSGs had a pre-operative CT scan of neck/thorax. Imaging was reviewed to establish features to predict the difficulty of delivering the goitre through the neck incision and to advise the best surgical approach.

Results. 847 thyroidectomies were performed with n=98 involving RSGs. TypeA (n=47) are RSG with a shape of a "cone" or pyramid with the apex pointing down. Cervicotomy is the usual approach. TypeB (n=39) are goitres with a shape of a "pyramid" with the apex pointing up, cervicotomy with $\pm$ manubriotomy or sternotomy $\pm$ thoracotomy maybe required. TypeC (n=6) are thyroid enlargements in the mediastinum connected by a pedicle with the thyroid in the neck. A cervical approach $\pm$ manubriotomy or sternotomy $\pm$ thoracotomy is needed. TypeD (n=6) are true intrathoracic or "forgotten" goitres. Sternotomy is indicated for thyroids in the anterior mediastinum though a thoracic approach for those located in the posterior mediastinum might be needed.

Conclusion. The shape and size of goitres is important in carefully planning surgery. CT imaging with cross-sectional reconstruction should be analysed before operation. The proposed classification helps treatment planning and allows comparison of outcomes by anatomical complexity.

Key words: retrosternal goitre, classification, surgical approach.

INTRODUCTION

Even though the first successful operation for retrosternal goitres (RSG) goes back to the year 1820

by Klein (1), there is no standard definition or clear guidelines for pre-operative planning of the surgical approach. Radiology reports often give a simple description or state the distance the goitre extends below the sternal notch.

RSG is an enlarged thyroid gland which extends below the clavicle and sternum. Alternative used names include substernal, cervicothoracic, intrathoracic, mediastinal or endothoracic goitres. It has a 3 to 1 female predominance, with the highest incidence (1 in 2000) reported in women above the age of 45 (2).

RSG incidence is reported to be between 1.7% and 45% of thyroidectomies (3,4), probably due to the various definitions used by the different authors (5). While some authors consider that every thyroid which extends below the manubrium is a RSG (5,6), others only include goitres which extend $>50\%$ (7) or 3cm (8) below the thoracic inlet. Other definitions include thyroid gland which in some portion remains permanently retrosternal (Kocher), a goitre with its lower position permanently remaining below the sternal notch (Torre), a thyroid growth up to the level of the fourth thoracic vertebrae on X-ray (Lindskog), a thyroid growth up to the aortic arch (Crile) or a goitre in which at least 50% is retrosternal (Katlic) (6, 9).

Of the classifications of RSGs in the literature, most try to predict whether or not sternotomy is needed based on CT cross-sectional imaging measuring the depth of the goitre in the chest (above or below the aortic arch), the anteroposterior dimension (prevascular, retrovascular-paratracheal, retrotracheal) or the lateral dimension (mono or bilateral) (5,10,11). Other authors describe goitres based on their anatomical location (right, left or posterior) (4) or being primary (ectopic thyroid tissue) or secondary (extending from the neck) (4). Posterior mediastinal goitres extending below the carina with 'conical' shape, iceberg shaped goitres with $>70\%$ of the mass lying in the mediastinum (12) and

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goitres with >10 cm in thorax (13) were described as significant factors for sternotomy (14). Other proposed classifications are based on transverse CT images of the four mediastinal compartment (15) (superior, anterior, middle and posterior) or on a review of their complications and management (16). However most RSG will come out through a neck incision and we felt a more practical classification is needed. The limiting step is dislocating the mediastinal component of the goitre into the neck. Many “tips” have been revealed that may help accomplish this and surgeons can have different levels of confidence based on past experiences. The key feature of the RSG that predicts it will be difficult through a cervical incision is that the mediastinal component is wider than the space in the thoracic inlet.

While a neck operation is the most used approach for RSG, some cases will need a sternotomy or thoracic approach. In this paper, we are proposing a new classification of RSG based on our case series. This classification is based on the anatomical shape and location of the goitre which can be obtained using CT images pre-operatively with recommendations on best surgical approach based on the RSG type.

METHODS

We reviewed retrospectively all thyroidectomies performed in our department between January 2012 and December 2016 to find all enlarged thyroids extending below the sternum and clavicle. Patients with no palpable lower pole of thyroid or retrosternal extension on neck ultrasound were evaluated with a CT scan of the neck and chest. The CT scan images were reviewed before the operation by the operating surgeon. Intra-operative nerve monitoring (IONM) was routinely used

in all operations performed after July 2015. We used continuous neuromonitoring for selected retrosternal goitre cases. Patients were investigated biochemically (including thyroid function tests), cervical ultrasound and needle aspiration if needed (according to BTA classification) and if the goitre extended into the thorax a CT neck/thorax was performed. Thin section CT with contrast, 1.5 mm sections with 10% overlap and multiplanar reconstruction was used routinely.

The aim of our study was to describe a practical classification of goitres extending in the chest, to predict which cases will need thoracic approach.

The CT scans of the patients with RSGs who had undergone surgery were reviewed to try to establish which features predicted the difficulty of delivering the goitre through the neck incision. Based on the shape of the goitres on cross-sectional alongside reconstructed coronal and sagittal CT images we constructed a classification of the RSGs that predicted the best surgical approach to resect them. Data with regards to the age, gender, weight of thyroid, tracheal deviation, operation type, histology and complications were collected and analysed using the Statistical Package for Social Sciences (SPSS, version 20, Chicago, IL, USA).

RESULTS

Eight hundred forty-seven thyroid operations were performed by three endocrine surgeons over the studied period (284 total thyroidectomies; 563 thyroid lobectomies). 98 of the operations were performed for retrosternal goitres.

Based on the shape of the goitre on coronal CT images we identified 4 types (Figs 1-5). Table 1 summarises the characteristics of the included patients

Figure 1. Type A cervicothoracic goitre (pyramidal with its apex pointing down).

Figure 2. Type B cervicothoracic goitre (pyramidal with its apex pointing up).

Figure 3. Type C cervicothoracic goitre (bilobal goitre with a narrow neck or pedicle).

Figure 4. Type D cervicothoracic goitre (ectopic goitre, primary intrathoracic, no previous surgery, located in anterior compartment of mediastinum).

Figure 5. Type D cervicothoracic goitre (recurrent goitre 'forgotten goitre', located in the anterior compartment of mediastinum).

with the operations and results stratified based on their RSG type.

Type A, $n=47$ (Fig. 1) is a pyramidal goitre with the apex pointing down. Even if the apex is extending well into the mediastinum, the goitre was always removed through a neck operation.

Type B, $n=39$ (Fig. 2) is a pyramidal goitre with its apex pointing up. The wide base below the clavicles can be more challenging to deliver via a cervical approach. Based on the base's width and depth into the mediastinum of the goitre the surgeon should be prepared to offer a manubriectomy or sternotomy. These goitres can cross-over to the opposite side. However, in our series although we consented the patients for a sternotomy we did not need to open the chest.

Type C, $n=6$ (Fig. 3) is a bilobal shape lobe with a narrow neck or a pedicle between the cervical and the mediastinal parts. The mediastinal part here is more difficult to deliver than in type B. If the pedicle between the two parts is thin and unrecognised, the mediastinal part could be mistakenly left behind ('forgotten goitre').

Type D, $n=6$ is an uncommon type of goitre which may be an ectopic thyroid unconnected to the thyroid in the neck ($n=2$) (Fig. 4), or a mediastinal remnant of inadequately resected type C goitre ('forgotten goitre', Fig. 5, $n=4$). A sternotomy was required to resect type D goitres. We included both anterior and posterior mediastinal goitres.

Table 2 summarises the definitions of the different RSG types and the recommended surgical approach.

DISCUSSION

The aim of our study was to establish a new anatomical classification system for RSGs based on CT images. This classification along with the experience gained in our case series has helped improve pre-operative planning for the best surgical approach based on the features of the different.

The treatment of choice for RSGs is usually surgery. Non-surgical treatment, even for asymptomatic goitres, is not recommended as sudden enlargement of goitres could be life-threatening. Besides, malignancy could be missed due to the difficult access of fine-needle aspirations to intra-thoracic portion.

Not all patients with RSGs goitres require surgery but when surgery is indicated the surgeon should have some idea about how likely a sternotomy will be needed and to counsel the patient. Sufficient

Table 1. The characteristics of the cervicothoracic goitre patients, their operations and the outcomes stratified by the goitre type

	Total	Type A	Type B	Type C	Type D
Number of patients	98	47 (48%)	39(40%)	6 (6%)	6 (6%)
Mean age (years)	55±16	50±16	67±8	48±15	70±5
Gender F:M	69:29	32:15	29:10	4:2	4:2
Weight of thyroid (g)	106±78	82±35	100±47	140±96	373±71
Tracheal deviation/compression	86	36(42%)	39 (45%)	5 (6%)	6 (7%)
Side of extension					
Total thyroidectomy	23	12 (52%)	8 (35%)	2 (9%)	1 (4%)
Thyroid lobectomy	75	35 (47%)	31 (41%)	4(5%)	5(7%)
Histology					
MNG	75	35 (47%)	29 (38%)	6 (8%)	5 (7%)
PTC	16	11 (69%)	5 (31%)	0 (0%)	0 (0%)
Follicular Carcinoma	2	2 (100%)	0 (0%)	0 (0%)	0 (0%)
Follicular Adenoma	5	2 (40%)	2 (40%)	1 (20%)	0 (0%)

Abbreviations: F:M female:male, MNG multinodular goitre, PTC papillary thyroid carcinoma.

Table 2. Summary of the cervicothoracic goitres classification and the recommended surgical approach

Grade	Thyroid shape	Surgical approach
Type A	Pyramidal with its apex pointing down	Cervical
Type B	Pyramidal with its apex pointing up	Cervical ± manubriectomy/sternotomy or thoracotomy
Type C	Bilobal goitre with a narrow neck or pedicle	Cervical ± manubriectomy/sternotomy
Type D	Ectopic or remnants not connected to the thyroid in the neck	Sternotomy ± thoracotomy

time on the operating list needs to be allocated and appropriate equipment will need to be available in theatre. Surgeons who are not familiar with performing a sternotomy may need to make sure that help is at hand from a thoracic surgeon if needed. The chest should be prepared for surgery alongside the neck.

The most commonly used classification of RSGs was described by Shahian and is based on mediastinal compartment or primary/secondary goitres (6,17).

Our classification tries to predict the cases which will require sternotomy so the surgical team can be prepared. In our study 6% (n=6) of cases needed sternotomy which is comparable to data from the literature (1-11%)(7) and one case had a combined neck and lateral thoracic approach. Five sternotomies were performed for type D goitres and one for type B, while a combined neck and thoracic approach was needed in one of type D cases. The incidence of substernal or mediastinal extension of goitre ranges between 2.6% and 30.4% of all goitres(5). In our study the prevalence was 11.5 % of all thyroidectomies within the wide spectrum of incidence reported in literature (1.7-45%). This is probably due to the nature of our referral centre which receives referrals from surrounding district hospitals for difficult cases thought to need experienced endocrine and thoracic surgeons.

In our case series 93% (n=91) of the cases were performed through a cervical incision. All type

A, B and C goitres (except one B case which needed sternotomy) were removed through a neck approach. For all these cases we used the same technique: cervical neck incision, dividing transversally the strap muscle if required followed by division of the upper pole of the thyroid and the thyroid isthmus. The thyroid is gradually removed from the chest after concomitant dissection medially and lateral to the thyroid lobe, identification of RLN by the 'toboggan' technique described by Charles Proye was useful (17). IONM is a safe and reliable adjunct for complex thyroid cases and is useful to use for RSGs (18). For the mediastinal approach we involved the thoracic team but started with a neck incision (using continuous IONM) and then proceeding to a sternotomy. Patients who had sternotomy had a slightly longer postoperative hospital stay (4.4 vs. 1.3 days for patients without sternotomy/thoracic approach).

It is important to define the lower aspect of the goitre, the shape on coronal CT images and to correlate with transversal or sagittal CT images in order to define which mediastinal compartment is involved (anterior or posterior). The resected goitre can be compared to the CT scan to minimize the risk of leaving part in the mediastinum.

Type D goitres are very rare descending into the posterior mediastinum. Only a few cases were described in the literature (6). In our series six patients had a type C goitre which required sternotomy as a

References

combined approach with thoracic surgeons. Two cases were for primary ectopic thyroid tissue in the chest and four for a recurrent/'missed' thyroid tissue after a previous subtotal thyroidectomy in another department.

In our experience type A goitres were the easiest to dislocate from the chest. Type B may require a mini/full sternotomy depending on how wide the goitre is in the chest (one case required a sternotomy in our series due to the wide diameter of intrathoracic component of the goitre). Type C is usually removed through the neck but is potentially the type of thyroid which could lead to a 'forgotten' goitre if not properly assessed pre-operatively. Type D goitres are primary (blood supply from vessels in the thorax) or secondary (blood supply from vessels in the neck) and require sternotomy (mini/full or thoracic approach depending of extension - anterior or posterior mediastinum). A combined neck-thorax approach increases patient's morbidity, mortality and length of hospital stay and should be avoided if possible.

Our classification allows appropriate preparation for all cases, especially type B, C and D goitres which may require thoracic approach. These are the types of cases which should be done in a tertiary centre by a multidisciplinary team (endocrine and thoracic or cardiac surgeons) which improves patient's safety and surgical outcome.

CONCLUSION

This classification, based on the preoperative CT findings presents a practical way to classify patients when booking surgery. Sternotomies should be planned when dealing with patients with RSGs. It may remind surgeons to obtain adequate consent from patients prior to surgery, plan additional time for operation, and ensure that special equipment and support from other surgeons if needed. It could potentially reduce the need of sternotomy if the surgeon is confident that the whole goitre has been delivered safely.

It may also be useful as an aide memoire when planning surgery to ensure appropriate staff and equipment are available. Another benefit is that it might also help refine standardisation of RSGs to allow comparison between surgeons outcomes.

Conflict of interest

The authors declare that they have no conflict of interest.

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