Is it possible to predict the need for sternotomy in patients undergoing thyroidectomy with retrosternal extension?

Gordon A.G. McKenzie* and William Rook

College of Medical and Dental Sciences, University of Birmingham, Edgbaston, UK

* Corresponding author. Gordon McKenzie, College of Medical and Dental Science, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK. Tel: +44-121-4143858; fax: +44-121-4143971; e-mail: gam065@bham.ac.uk (G.A.G. McKenzie).

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Abstract

A best evidence topic in thoracic surgery was written according to a structured protocol. The question addressed was ‘in patients undergoing thyroidectomy for retrosternal goitre, what factors predict sternotomy?’ Altogether 165 papers were found as a result of the reported search, of which only 3 prospective studies, 1 review paper and 2 retrospective studies represented the best evidence to answer the clinical question. The authors, journals, date and country of publication, patient group studied, study type, relevant outcomes and results of the papers are tabulated. We conclude that a combination of preoperative clinical and radiological risk factors, alongside informed patient choice can be used to predict the need for sternotomy in thyroidectomy for goitre with retrosternal extension. Clinically, a history of goitre with retrosternal extension beyond 160 months is a risk factor for sternotomy. Thyroid tissue density, posterior mediastinal location and subcarinal extension, as measured using computed tomography (CT) imaging, are independent preoperatively obtained risk factors for sternotomy, which are supported by both prospective and retrospective studies. Thyroid tissue density is the strongest factor and increases the risk of sternotomy 47-fold. Minimal upper sternotomy (sternal-split) can be used instead of median sternotomy where there is evidence of retrosternal extension to the aortic root. CT evidence of an ectopic nodule, a dumbbell-shaped goitre, a conical-shaped goitre constricted by an isthmic thoracic inlet or a thoracic goitre component wider than the thoracic inlet can also predict the need to undergo sternotomy. Finally, informed consent should include a discussion that patients with bilateral multinodular goitre and evidence of intrathoracic extension, who are undergoing total thyroidectomy via cervicotomy, have an independently increased risk of complications, specifically recurrent laryngeal nerve injury. After explanation of these risks, a patient may be unwilling to accept the increased risks of cervicotomy per se versus those of combined cervicotomy and sternotomy.

Keywords: Goitre • Risk factors • Sternotomy • Thyroidectomy • Thyroid gland

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the ICVTS [1].

THREE-PART QUESTION

In [patients undergoing thyroidectomy for retrosternal goitre], what [factors] predict [sternotomy]?

CLINICAL SCENARIO

You have been asked by an ear, nose and throat (ENT) consultant to assist with a thyroidectomy for retrosternal goitre. The patient does not want a sternotomy scar and the ENT surgeon has asked whether you think that sternotomy is even necessary. The patient has chronic obstructive pulmonary disease and a body mass index of 31. You are aware of these relative contraindications and the patient benefits of not undertaking a sternotomy, and resolve to check the literature.

SEARCH STRATEGY

Medline was searched from 1946 to January 2014 and EMBASE 1974 to January 2014 using the OVID interface and MeSH headings [Goitre.mp OR Goitres.mp OR exp Goiter/ OR Goiters.mp OR exp Thyroid gland/ OR thyroid.mp OR exp Substernal goitre/] AND [exp Sternotomy/]. To enhance results, reference lists of relevant papers were also searched.

SEARCH OUTCOMES

One hundred and sixty-five papers were found as a result of the reported search. Inclusion criteria were retrospective or prospective studies of any size that evaluated surgical approaches for retrosternal goitre of any definition. Exclusion criteria were case reports and studies with <10 patients undergoing sternotomy.
<table>
<thead>
<tr>
<th>Study Type</th>
<th>Patient Group</th>
<th>Outcomes</th>
<th>Key Results</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Prospective cohort study (level 3)</td>
<td>260 patients with retrosternal goitre (definitions used were clinical, Eschpase’s, Lindskog’s, Crile’s and subcarinal) undergoing thyroidectomy</td>
<td>Factors significantly correlated with need to perform sternotomy: clinical symptoms, history of previous tracheostomy, presence of tracheal deviation, tracheal compression, site of mediastinal extension, thyroid tissue density, histological findings of thyroid, weight of thyroid and postoperative complications</td>
<td>17 of 260 patients (6.5%) required a median sternotomy</td>
<td>Preoperatively obtained evidence of harder thyroid tissue density using contrast-enhanced CT was found to be the strongest independent factor for predicting the need for sternotomy</td>
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<td>Prospective cohort study (level 3)</td>
<td>102 patients with retrosternal goitre (definition used was a preoperative CT scan with a goitre extending 3 cm or more below the suprasternal notch with the neck in hyperextension) undergoing thyroidectomy</td>
<td>Preoperative factors that were significantly associated with need for sternotomy: epidemiological, anamnestic, histological and surgical reports and evidence of postoperative complications</td>
<td>15 of 102 (14.7%) required minimal upper sternotomy (sternal-split)</td>
<td>Retrosternal extension to the aortic root is significantly associated with need for a minimal upper sternotomy (sternal-split)</td>
</tr>
<tr>
<td>Prospective cohort study (level 3)</td>
<td>301 patients with bilateral multinodular goitre where the thoracic approach was not indicated from the outset who were undergoing total thyroidectomy by the cervical approach</td>
<td>To demonstrate that total thyroidectomy for multinodular goitre can be performed with a permanent complication rate of ±1% and to analyse the risk factors for complications with this technique performed in a reference centre by surgeons with experience in endocrine surgery</td>
<td>70 of 301 (23%) patients had sonographic and CT evidence of cervicothoracic goitre compressing but not infiltrating neighbouring structures</td>
<td>Intrathoracic goitre (detected intraoperatively during a total cervical thyroidectomy according to Eschpase’s definition) is associated with increased risk of overall complications, recurrent laryngeal nerve injury and postoperative hypoparathyroidism</td>
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### Table 1: (Continued)

<table>
<thead>
<tr>
<th>Author, date, journal and country</th>
<th>Study type (level of evidence)</th>
<th>Patient group</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riffat et al. (2013), Ann Otol Rhinol Laryngol, UK [5]</td>
<td>Retrospective review (level 4)</td>
<td>97 patients with retrosternal goitre (defined as extension below the plane of the thoracic inlet) undergoing thyroidectomy over a 10-year period</td>
<td>To test whether it is possible to predict when sternotomy may be required on the basis of factors noted on preoperative CT imaging</td>
<td>17 of 97 (17.5%) patients required a sternotomy</td>
<td>CT evidence of extension below the carina, posterior mediastinal extension, presence of an ectopic nodule and a conical goitre constricted by an isthmic thoracic inlet significantly predict the need to undergo sternotomy</td>
</tr>
<tr>
<td>Qureishi et al. (2013), Int J Surg, UK [6]</td>
<td>Review of retrospective studies (level 4)</td>
<td>7 papers (1 retrospective case-controlled series and 6 retrospective case series) were reviewed</td>
<td>To review whether preoperative CT imaging can predict the need for a thoracic approach for removal of retrosternal goitre</td>
<td>Presence of extension of goitre below the aortic arch or into the posterior mediastinum, a dumb-bell shape and a thoracic goitre component wider than the thoracic inlet</td>
<td>Results all predict the need for sternotomy</td>
</tr>
<tr>
<td>Casella et al. (2010), Head Neck, Italy [7]</td>
<td>Retrospective review (level 4)</td>
<td>98 patients undergoing total thyroidectomy for mediastinal goitre, defined as a goitre extending 3 cm or more below the suprasternal notch by preoperative CT scan evaluation with the neck in hyperextension</td>
<td>To identify clinical, radiological or pathological factors that may predict the need for a thoracic approach in patients undergoing thyroidectomy for retrosternal goitre</td>
<td>12 of 98 (12.2%) patients required partial sternotomy</td>
<td>Mediastinal goitre with CT evidence of extension below the aortic arch at the tracheal bifurcation is a risk factor for sternotomy, enhanced by posterior mediastinal extension. Duration of known mediastinal goitres beyond 160 months is also a risk factor for sternotomy</td>
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CT: computed tomography; OR: odds ratio; 95% CI: 95% confidence interval; RR: relative risk; LR: likelihood ratio.
Only six papers were identified as providing the best evidence to answer the question, which are presented in Table 1.

RESULTS

Sari et al. [2] in 2012 undertook a prospective study of 260 patients treated with total thyroidectomy for retrosternal goitre and evaluated factors significantly associated with the need for sternotomy. They used various definitions of retrosternal goitre: clinical, Eschpase’s, Lindskog’s, Crile’s and subcarinal. Seventeen patients (6.5%) required a median sternotomy. They excluded patients with advanced thyroid carcinoma. All of the patients studied underwent preoperative computed tomography (CT) scan to evaluate the location and mediastinal extension of retrosternal goitre. The surgeons were blinded to the preoperative thyroid radiodensity data. They found the strongest positive correlation between sternotomy and three independent factors: harder thyroid tissue radiodensity as predicted using CT imaging (odds ratio [OR] 47.3 [95% confidence interval (CI) 5.8–385.70]; P = 0.001), posterior location (OR 10.5 [95% CI 1.8–60]; P = 0.001) and subcarinal extension (OR 20.5 [95% CI 2.5–168]; P = 0.001). There are several key limitations to this study. Firstly, the use of strict criteria for retrosternal goitre reduced the incidence of retrosternal goitres in this study and therefore the generalizability. Secondly, Photoshop was used instead of Hounsfield units in digital media to calculate thyroid tissue radiodensity. Thirdly, the method for normalizing exposure levels between different CT images was not sufficiently robust.

Pata et al. [3] undertook a prospective study of 102 patients treated by total thyroidectomy for retrosternal goitre and evaluated the hypothesis that minimal upper sternotomy (sternal-split) could safely replace full sternotomy. Mediastinal goitre was defined as preoperative CT imaging showing a goitre extending 3 cm or more below the suprasternal notch with the neck in hyperextension. Fifteen patients (14.7%) required sternotomy after a trial of cervicotomy, all of which had retrosternal extension past the tracheal bifurcation to the aortic root compared with 25 of 87 (28.7%) cases in the cervicotomy only group (P = 0.0001). Limitations include the definition of mediastinal goitre that was used therefore affecting generalizability and small sample size. Further, the use of the Mann–Whitney U-test is not justified by any description of the data distribution, so it is not clear whether this use of statistical tests is appropriate.

Rios-Zambudio et al. [4] undertook a prospective study of 301 patients treated by total thyroidectomy via cervicotomy, to analyse the risk factors for complications with this technique. Procedures were performed in a reference centre by surgeons with experience in endocrine surgery. All patients had bilateral multinodular goitre where the thoracic approach was not indicated at the outset. Seventy (23%) patients had sonographic and CT evidence of cervicothoracic goitre compressing but not infiltrating neighbouring structures. Sixty-two (21%) patients were found to have intrathoracic goitre perioperatively, according to Eschpase’s definition. They found that complications were independently associated with intrathoracic goitre on multivariate analysis (OR 1.55 [95% CI 2.06–1.17]). Postoperative hypoparathyroidism was associated with intrathoracic goitre on bivariate analysis (P = 0.0413). Recurrent laryngeal nerve injury was independently associated with intrathoracic goitre on multivariate analysis (OR 1.9 [95% CI 3.25–1.11]). Limitations include a restrictive definition of retrosternal goitre affecting generalizability and a lack of analysis between preoperatively identified intrathoracic goitre and subsequent complications.

Riffat et al. [5] undertook a retrospective study of 97 patients undergoing thyroidectomy to test the hypothesis that the need for sternotomy can be predicted on the basis of factors noted on preoperative CT imaging. Retrosternal goitre was defined as extension below the plane of the thoracic inlet. Seventeen of 97 (17.5%) patients required a sternotomy after gland delivery via a cervical approach was not possible. When the pure cervical approach and combined sternotomy cohorts were compared, sternotomy was more likely when there was extension below the carina (relative risk [RR] 7.5; P < 0.05), posterior mediastinal extension (RR 16; P < 0.05), presence of an ectopic nodule (RR 6; P < 0.05) and a conical goitre constricted by an ischemic thoracic inlet (RR 14; P < 0.05). Limitations include small sample size, retrospective design, lack of consideration of other clinical factors (e.g. the presence of malignancy) and the absence of confidence intervals.

Qureishi et al. [6] undertook a review of the results of seven retrospective studies (one retrospective case-controlled series and six retrospective case series) to review whether preoperative CT imaging can predict the need for a thoracic approach for removal of retrosternal goitre. They concluded that the presence of extension of goitre below the aortic arch or into the posterior mediastinum, a dumb-bell-shaped goitre and a thoracic goitre component wider than the thoracic inlet all predict the need for sternotomy. Limitations include the review of retrospective studies only and a restrictive definition of goitre.

Casella et al. [7] undertook a retrospective study to identify clinical, radiological or pathological factors that may predict the need for a thoracic approach in 98 patients undergoing thyroidectomy for retrosternal goitre. They defined retrosternal goitre as that extending 3 cm or more below the suprasternal notch by preoperative CT scan evaluation with the neck in hyperextension. Twelve of 98 (12.2%) patients required a partial sternotomy after gland delivery failed during an initial cervical approach. Median duration of known mediastinal goitre in the sternotomy group (193; range 83–360 months) was higher than the cervicotomy group (99; range 44–268 months; P = 0.0002). History of goitre longer than 160 months showed strong positive correlation with need for sternotomy (OR 22.8 [95% CI 5.28–98.53]; P < 0.0001). Radiological extension of mediastinal goitre below the aortic arch was 100% in the sternotomy group versus 27% in the cervicotomy group (P < 0.0001) with a strong correlation with need for sternotomy [OR 32.87 [95% CI 4.04–267.12]] and predicted the need for sternotomy with a sensitivity of 100% (95% CI 73.4–100%) and a specificity of 73.3% (95% CI 62.6–82.2%). Positive likelihood ratio (LR), as an estimate of RR of sternotomy was 3.74; negative LR was 0. This effect was further enhanced by posterior mediastinum involvement by the gland (OR 7.2 [95% CI 1.52–34.14]; P = 0.0244). Limitations included retrospective design, small sample size and selective inclusion criteria limiting generalizability.

CLINICAL BOTTOM LINE

A combination of preoperative clinical and radiological risk factors alongside informed patient choice can be used to predict the need for sternotomy in thyroidectomy for goitre with retrosternal extension. Clinically, a history of goitre with retrosternal extension beyond 160 months is a risk factor for sternotomy. Thyroid tissue density, posterior mediastinal location and subcarinal extension, as measured using CT imaging, are independent preoperatively obtained risk factors for sternotomy, which are supported by both prospective and retrospective studies. Thyroid tissue density is the
strongest factor and increases the risk of sternotomy 47-fold. Minimal upper sternotomy (sternal-split) can be used instead of median sternotomy where there is evidence of retrosternal extension to the aortic root. CT evidence of an ectopic nodule, a dumbbell-shaped goitre, a conical-shaped goitre constricted by an isthmic thoracic inlet or a thoracic goitre component wider than the thoracic inlet can also predict the need to undergo sternotomy. Finally, informed consent should involve a discussion that patients with bilateral multinodular goitre and evidence of intrathoracic extension, who are undergoing total thyroidectomy via cervicotomy, have an independently increased risk of complications, specifically recurrent laryngeal nerve injury. After explanation of these risks, a patient may be unwilling to accept the increased risks of cervicotomy per se versus those of combined cervicotomy and sternotomy.

Conflict of interest: none declared.

REFERENCES


eComment. Substernal goiter. Beware of the thyroidea ima artery

Authors: Nikolaos Barbetakis, Christos Asteriou, Dimitrios Paliouras and Kostas Setzis
Thoracic Surgery Department, Theagenio Cancer Hospital, Thessaloniki, Greece
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We read with great interest the article by McKenzie and Rook concerning pre-operative factors for sternotomy in cases of substernal thyroid extension [1]. We would like to highlight the possible presence of ima artery which can complicate an otherwise straightforward operation.

The thyroidea ima artery arises from the brachiocephalic trunk and ascends in front of the trachea to the lower part of the thyroid gland, which it supplies. It is only present in approximately 3-10% of the population. It varies greatly in size, and appears to compensate for deficiency or absence of one of the other thyroid vessels. Occasionally, it arises from the aorta, the right common carotid, the subclavian or the internal thoracic artery [2].

Finger dissection of the substernal thyroid extension is a classical maneuver in thyroid surgery. The index finger is inserted into the mediastinum outside the thyroid capsule and is swept around until the gland is freed from the pleura or other tissue in the mediastinum. In such cases the presence of an ima artery could cause major bleeding with a need for urgent sternotomy.

The point of our comment is that despite the absence of clinical or radiological risk factors for sternotomy, the surgeon should always be aware of this unusual anatomic variation.

Conflict of interest: none declared.

References