

THYROID

Extended cervical approach for retrosternal multinodular goiter

Nir Tsur^{1,2}, Lirit Levi^{1,2}, Omry Frig^{1,2}, Noam Koch¹, Yossi Eshel^{1,2}, Gideon Bachar^{1,2}, Thomas Shpitzer^{1,2}, Moshe Yehuda^{1,2}, Yuri Pescovitz^{2,3}, Ory Wiesel^{2,3}, Dean Dudkiewicz^{1,2}, Aviram Mizrachi^{1,2}

¹ Department of Otorhinolaryngology – Head & Neck Surgery, Rabin Medical Center – Beilinson Hospital, Petach Tikva, Israel; ² Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel; ³ Division of Thoracic Surgery, Department of Cardiothoracic Surgery, Rabin Medical Center – Beilinson Hospital, Petach Tikva, Israel

SUMMARY

Objective. Partial or total sternotomy is required for 10% of retrosternal goiter. This study reviewed our experience with an extended cervicotomic approach as an alternative surgical solution for retrosternal goiter.

Methods. A retrospective study was performed on patients who underwent partial or total thyroidectomy for retrosternal goiter between 2014 and 2019 at a tertiary medical centre. Data on clinical, radiologic, and pathologic factors were analysed. Peri- and postoperative outcomes were compared between extended and standard cervical approaches to predict the need for an extended cervical approach.

Results. The cohort included 265 patients, of whom 245 (92.4%) were treated by standard thyroidectomy. In 17 (6.4%), the standard approach proved insufficient, and the horizontal incision was extended to a T-shape to improve access. The remaining 3 patients required a sternotomy. Use of the extended cervical approach was significantly associated with clinical features such as male gender, diabetes, high body mass index and postoperative hypocalcaemia.

Conclusions. The extended cervicotomic approach is an alternative surgical solution for retrosternal goiter, with no increased risk of significant post-operative complications.

KEY WORDS: retrosternal goiter, cervicotomy, hypoparathyroidism, extended approach, sternotomy

Introduction

Some authors ¹ define a thyroid goiter as retrosternal if it descends with its inferior lobes below the thoracic inlet plane, while others ^{2,3} use such a definition when more than 50% of its mass lies inferior to the thoracic inlet. The incidence of retrosternal extension of thyroid goiters may therefore range greatly between 2.6% and 30.4% ⁴⁻⁷ according to the definition used. Causes include various genetic and environmental factors ⁸.

Surgery is indicated for retrosternal goiter in the presence of compression symptoms or potential airway compromise and to treat thyroid malignancy. Thyroidectomy can usually be safely performed via a standard cervical incision. However, if the gland is too large, median sternotomy may be necessary to gain safe access. Compared to cervical incision, both complete and partial sternotomies are associated with a high incidence of morbidity and prolonged hospitalisation, and it can be performed only in centres with a thoracic surgeon ⁹⁻¹¹.

Patients scheduled for thyroid surgery undergo pre-operative computerised tomography (CT) scan to assess mediastinal extension. Several classification systems have been developed to identify patients requiring an extra-cervical approach such as sternotomy ¹²⁻¹⁵ based on the craniocaudal length of the mediastinal extension, the anterior or posterior extension, and the relationship

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Correspondence

Nir Tsur

E-mail: nirtsur19@gmail.com

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between the substernal thyroid and major mediastinal vessels and trachea.

The present study aimed to describe our experience with using an extended cervical surgical approach for retrosternal multinodular goiters that were not amenable to safe removal by the standard approach, thus avoiding the need for partial or complete sternotomy. In addition, we sought to identify clinical, radiologic, and pathological factors associated with the need for an extended cervical approach and to compare outcomes and complications with the standard cervical approach.

Materials and methods

The healthcare database of a tertiary university-affiliated medical centre was retrospectively searched for patients who underwent thyroidectomy for a retrosternal goiter from 2014 to 2019. Data were collected from the computerised medical records and surgical and pathology reports as follows:

- pre-operative - history, physical examination, standard laboratory parameters including thyroid function and calcium level, and radiological studies such as neck ultrasound and chest CT;
 - intra-operative - operative time, surgical approach (standard cervical, extended cervical, or sternotomy);
 - post-operative - length of in-hospital stay, complications.
- The study was approved by the institutional ethics board of Rabin Medical Center (RMC 2020-903) and was reported according to the STROBE¹⁶ guidelines.

Radiology

Retrosternal goiter was diagnosed by routine CT, ultrasound, or intra-operative assessment of the thyroid if more than 50% of the gland lay inferior to the thoracic inlet^{2,3}. Pre-operative CT scans were analysed by head and neck radiologists and focused on the maximal retrosternal area of the goiter, three-dimensional lobe measurements, texture, calcifications, and relation of the goiter to the trachea, oesophagus and major mediastinal vessels. If clinical or sonographic findings were suspicious for thyroid malignancy, a fine-needle aspiration biopsy was performed¹².

Surgical technique

The operative procedure started with neck exploration through a Kocher transverse collar incision from the medial border of one sternocleidomastoid muscle to the medial border of the other, after stretching the strap muscles or dividing the sternothyroid muscle when necessary. The upper thyroid pedicles were then exposed, ligated, and transected. The recurrent laryngeal nerve (RLN) and parathyroid glands were identified and preserved. A neural integrity monitor (NIM) electromyogram tracheal tube (Medtron-

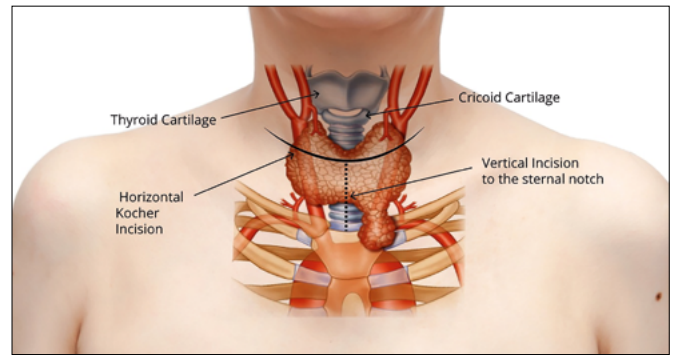


Figure 1. The extended cervical approach; a transverse collar and a midline incision to the sternal notch.

ic® NIM response 3.0) was used in all cases. Afterward, upward gland delivery was attempted using the index and middle finger. If this manoeuvre failed, we extended the approach by making a midline incision from the sternal notch to the lower border of the cricoid cartilage (Fig. 1). If thyroidectomy still could not be accomplished, the thoracic surgeon performed partial or complete sternotomy.

Pathology

The pathological analyses were performed by the Institute of Pathology at our medical centre. Thyroid gland measurements were determined, including weight, length, width, and depth. In addition, specimens were routinely sampled for malignancy.

Data analysis

Statistical analyses were performed using SPSS version 25. Continuous data are presented as mean and inter-quartile range or mean and standard deviation, and categorical data are presented as numbers and percentages where appropriate. Continuous data were compared between groups using Mann-Whitney U-test, and categorical data, using Fisher exact test. A p value of < 0.05 was considered statistically significant.

Results

The cohort consisted of 265 patients with retrosternal goiter who underwent total or partial thyroidectomy during the study period. Standard cervical thyroidectomy (SC group) was performed in 245 patients (92.4%) and extended cervical thyroidectomy (EC group) in 17 patients (6.4%). The remaining three patients (1.2%) ultimately required sternotomy (Tab. I). Table I shows the demographic, clinical, and laboratory data. Compared to the SC group, the EC group had a significantly higher proportion of males (58.8 vs 23.6%, p = 0.003), higher mean age (61.7 vs 55.8 years, p = 0.099), higher mean body mass index (BMI) (31.9 vs 28.6, p = 0.008), and a higher rate of diabetes mellitus (47.1 vs 15.1%, p = 0.003). After logistic

regression analysis, the differences in gender and diabetes remained statistically significant.

There were no significant differences in cytologic findings. Overall, CT scan data were available for 177 patients (68%): 164 (66.9%) in the SC group and 13 (76.4%) in the EC group. The factors that strongly correlated with the extended approach were the descent of the retrosternal goiter below the carina (47 vs 11.4%, $p = 0.014$) and the brachiocephalic vein (35.2 vs 8.5%, $p = 0.036$). There were no significant differences in other radiologic parameters, including extension below the anterior mediastinum and aortic arch, tracheal dislocation, and compression (Tab. II). The EC group was characterised

by a longer mean operative time than the SC group (2.4 vs 1.9 hours, $p = 0.023$), in addition to a longer mean hospital stay (6.1 vs 4.8 days, $p = 0.0002$) and a higher rate of postoperative transient hypocalcaemia (11.8 vs 1.2%, $p = 0.04$) (Tab. III).

Significantly higher values of the following parameters were recorded in the EC group: mean left lobe weight (152.7 vs 67.8 gr, $p = 0.0026$), height (8.9 vs 7.2 cm, $p = 0.0025$), depth (4.3 vs 3.2 cm, $p = 0.016$), and volume (290.4 vs 145.6 cm³, $p = 0.035$) (Tab. III).

Three patients (1 male, two females) underwent thyroidectomy by a sternotomy approach (2 manubriotomy, 1 complete sternotomy). Their mean age was 70 years (range 64-82), and

Table I. Demographic, clinical and laboratory data of patients undergoing thyroidectomy for retrosternal goiter.

		Standard cervical (N = 245)	Extended cervical (N=17)	p value	
Demographics	Male	58 (23.67%)	10 (58.82%)	0.003	
	Female	187 (76.33%)	7 (41.18%)		
	Age (years)	55.8 (23-86)	61.65 (47-84)	0.099	
	Ethnic origin	Ethiopian	15 (6.12%)	1 (5.88%)	1
		Caucasian	30 (12.24%)	1 (5.88%)	0.702
Arab		64 (26.12%)	7 (41.18%)	0.256	
Past medical history	Diabetes mellitus	37 (15.1%)	8 (47.06%)	0.003	
	Ischaemic heart disease	9 (3.67%)	2 (11.76%)	0.154	
	Dyslipidaemia	53 (21.63%)	1 (5.88%)	0.21	
	Pulmonary disease	17 (6.94%)	2 (11.76%)	0.354	
	Hypertension	72 (29.39%)	9 (52.94%)	0.056	
	Smoker	50 (20.41%)	7 (41.18%)	0.064	
	Symptoms	Voice change	17 (6.94%)	2 (11.76%)	0.369
Cough		11 (4.49%)	1 (5.88%)	0.57	
Stridor		0	1 (5.88%)	0.065	
Odynophagia		7 (2.86%)	2 (11.76%)	0.109	
Dysphagia		62 (25.31%)	4 (23.53%)	1	
Dyspnoea		69 (28.16%)	5 (24.41%)	1	
Orthopnoea		21 (8.57%)	0	0.375	
Restricted cervical mobility		5 (2.04%)	2 (11.76%)	0.069	
Cervicalgia		17 (6.94%)	1 (5.88%)	1	
Neck mass		35 (14.29%)	4 (23.53%)	0.295	
Physical examination		Body Mass Index (kg/m ²)	28.57 (17.58-48.61)	31.92 (23.46-40.6)	0.008
Laboratory results	Preop TSH (mIU/L)	1.59 (0-18)	1.85 (0.01-12.3)	0.709	
	Preop free T3 (ng/dL)	4.1 (1.12-13)	3.73 (1.9-6.2)	0.54	
	Preop free T4 (ng/dL)	14.65 (0.9-34)	13.09 (10.2-15.6)	0.074	
	Preop calcium (mg/dL)	8.33 (9.32-11.6)	9.46 (8.57-10.66)	0.248	
	Preop Tg (ng/mL)	353.34 (0.2-2659)	285 (153-417)	0.58	
	Preop anti-Tg (IU/mL)	79.31 (0.01-827)	6381.51 (0.01-8669)	0.275	
	Preop anti-TPO (IU/mL)	279.43 (0.02-7876)	1255.48 (0.02-8669)	0.461	

Tg: thyroglobulin; TPO: thyroid peroxidase; TSH: thyroid stimulating hormone; ng/dL nanograms per deciliter of blood; mIU/L million international units per liter; mg/dL milligram per deciliter of blood; IU/mL international units per milliliter; values given as number and percentage or mean and range.

Table II. Comparison of pre-operative imaging features between patients with retrosternal goiter treated by standard or extended cervical approach.

		Standard cervical	Extended cervical	p value		
Dominant enlarged lobe	Right	88 (35.92%)	7 (41.18%)	0.939		
	Left	98 (40%)	8 (47.06%)			
	Both	18 (7.35%)	1 (5.88%)			
Descent of the goiter	Anterior mediastinum	89 (36.33%)	11 (64.71%)	0.457		
	Carina	28 (11.43%)	8 (47.06%)	0.014		
	Brachiocephalic vein	21 (8.57%)	6 (35.29%)	0.036		
	Aortic arch	10 (4.08%)	3 (17.65%)	0.13		
CT measurements	Length	≥ 10 cm	47 (19.18%)	3 (17.65%)	1	
		< 10 cm	13 (5.31%)			1 (5.88%)
	Width	≥ 5 cm	37 (15.1%)	6 (35.29%)		0.752
		< 5 cm	42 (17.14%)	5 (29.41%)		
	Depth	≥ 5 cm	43 (17.55%)	6 (35.29%)		0.706
		< 5 cm	24 (9.8%)	2 (11.76%)		
Tracheal dislocation	Yes	115 (46.94%)	11 (64.71%)	0.36		
	No	19 (7.76%)	0			
Tracheal pressure	Yes	86 (35.1%)	8 (47.06%)	0.498		
	No	44 (17.96%)	2 (11.76%)			
Calcifications	Yes	68 (27.76%)	5 (29.41%)	1		
	No	19 (7.76%)	1 (5.88%)			
Texture	Homogeneous	4 (1.63%)	0	1		
	Heterogeneous	96 (39.18%)	10 (58.52%)			
Density	Hypodense	82 (33.47%)	4 (23.53%)	0.366		
	Isodense or hyperdense	7 (2.86%)	1 (5.88%)			

Values given as number and percentage.

their mean BMI was 28.9 (range, 28.1-29.8). Two of them had pre-operative CT scans. The goiter descended below the carina and the brachiocephalic vein in one patient. In the remaining two patients, the goiter extended below the level of the carina and the brachiocephalic vein, reaching into the anterior mediastinum. One patient showed tracheal dislocation and compression in pre-operative imaging studies.

Discussion

There is considerable controversy regarding the appropriate surgical approach for retrosternal goiter^{14,17}. The standard cervical approach is sufficient for proper exposure in about 90% of patients; the remainder usually undergo median sternotomy^{15,18}. In this study, we describe an alternative extended cervical approach to retrosternal goiter that might avoid in selected cases the need for sternotomy. The technique involves extending the standard horizontal incision with a vertical tract to form a T-shape, thereby improving the exposure of the thoracic inlet structures, strap muscles along the sternal edge, and the anterior mediastinal component of the thyroid gland without sternotomy morbidity. On analysis of the pre-operative

parameters, we found that male sex, high BMI, and presence of diabetes were associated with a more frequent need for an extended cervical approach. In addition, in previous studies investigating potential predictive clinical factors for sternotomy in goitrous thyroids, dysphonia, stridor, and other compressive symptoms¹⁹ were shown to increase such a risk. However, these characteristics were not significant in our study because our cohort was composed almost entirely of patients treated by a transcervical approach (standard or extended). Furthermore, most articles addressed the pre-operative laryngeal assessment²⁰, whereas we are the first to include BMI and neck mobility as potential predictive factors for the comprehensive cervical approach. This is important because during surgery for retrosternal goiter, a significant amount of cervical extension is needed to expose the thyroid gland and excise the mass, and both high BMI and neck rigidity with reduced extension are limiting factors in this setting. Thus, patients with these features would more frequently require an extended cervical or trans-sternal approach.

CT or MRI is essential to define the relevant anatomical structures in the surgical field and determine the most adequate surgical approach^{21,22}. In the present study, there was a sig-

Table III. Comparison of post-operative complications and pathology between patients with retrosternal goiter treated by the standard or extended cervical approach.

		Standard cervical	Extended cervical	p value	
Post-operative complications	Duration of operation (hours)	1.94 (0-5.48)	2.4 (0.98-3.97)	0.023	
	Hospitalisation period (days)	4.83 (1-12)	6.12 (5-9)	0.0002	
	Haematoma	14 (5.71%)	X	0.609	
	Unilateral RLN paresis- Total	21 (8.57%)	2 (11.76%)	0.656	
	Unilateral RLN paresis- Temporary	9 (3.67%)	1 (5.88%)	0.495	
	Unilateral RLN paresis- Permanent	12 (4.89%)	1 (5.88%)	0.591	
	Amount in drain POD 1 (ml)	56.32 (10-230)	59.55 (20-145)	0.654	
	Maximal amount in drain (ml)	66.95 (10-250)	67.5 (30-145)	0.686	
	Calcium				
	POD 1	9.02 (5.7-10.2)	8.74 (8.1-9.2)	0.152	
	POD 3	9.01 (7.28-10.19)	7.41 (5.62-9.2)	0.357	
	POD 30	8.99 (6.7-10.4)	8.71 (6.5-9.9)	0.536	
	Temporary hypoparathyroidism	3 (1.22%)	2 (11.76%)	0.04	
Permanent hypoparathyroidism	9 (3.67%)	1 (5.88%)	0.495		
Pathology	Total weight (gr)	161.13 (15.5-430)	181.2 (38-484)	0.814	
	Right lobe	Weight (gr)	72.39 (4-490)	99.2 (12-313)	0.302
		Height (cm)	6.98 (0.8-15)	8.35 (4.5-15)	0.231
		Width (cm)	4.6 (0.8-11)	4.81 (3-8)	0.663
		Depth (cm)	3.38 (0.5-8)	3.95 (2-7.5)	0.207
		Volume (cm ³)	150.32 (0.51-843.75)	223.48 (27-900)	0.356
	Left lobe	Weight (gr)	67.77 (42-340)	152.75 (26-475)	0.0026
		Height (cm)	7.2 (2.2-75)	8.94 (5.5-12.5)	0.0025
		Width (cm)	4.65 (1.5-11)	6.11 (3-11.5)	0.093
		Depth (cm)	3.25 (0.5-7)	4.28 (3-6)	0.016
		Volume (cm ³)	145.65 (6.16-918.75)	290.4 (49.5-862.5)	0.035
	Malignancy	80 (32.65%)	2 (11.76%)	0.104	

RNL: recurrent laryngeal nerve; POD: post-operative day. Values given as number and percentage or mean and Inter-quantile range.

nificant difference between the EC and SC groups in terms of extension of the thyroid lobe to the carina and brachiocephalic vessels during imaging.

On post-operative pathological examination, the height of the thyroid lobe was a significant factor determining the use of the extended cervical approach. This finding is in agreement with the literature²³. Not unexpectedly, the surgery duration, hospitalisation time, and rate of transient hypocalcaemia were higher in the EC than in the SC group. Extended surgery was not associated with higher rates of intra- and post-operative complications than traditional surgery. Previous studies have found sternotomy to be associated with increased rates of critical postoperative morbidities, including bleeding requiring transfusion, unplanned intubation, longer post-operative hospitalisation, and potentially higher overall mortality^{24,25}. Thus, with an equivalent retrosternal extension, a transcervical approach should be attempted whenever anatomically possible, regardless of pathology²⁶. Herein, we describe a novel approach for treating retrosternal multinodular

goiters that cannot be accessed through the standard cervical approach without any clinically significant increase in terms of complication rates.

Only 3 patients in our series ultimately required median sternotomy. They were characterised by older age and comorbidities such as diabetes mellitus and hypertension. In all cases, the radiological findings, including the extension of the goiter to the thoracic inlet showed tracheal dislocation and compression¹³. These findings are in concordance with the literature on sternotomy¹³, but have not previously been assessed for extended cervical surgery. Furthermore, the sternotomy group, as expected, had a relatively long operative time and increased hospital stay. Although the sternotomy group was too small to provide statistical insights, these findings also agree with the literature^{7,9,27}. Our study has several limitations. First, we used a retrospective, non-randomised design which has known inherent biases. Second, the intraoperative decision-making was heterogeneous because surgeons with different levels of expertise performed the operations.

Conclusions

Extended cervical thyroidectomy is an alternative surgical solution for retrosternal goiter and is not associated with a significant increase in postoperative complications compared to the standard cervicotomic approach. This approach may be safely used to avoid sternotomy in patients with large retrosternal goiters. Further large-scale research is needed to identify the unique characteristics of patients requiring sternotomy compared to an extended cervical approach.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

NT, AM, GB, TS: conceived and designed the study; OF, NK: provided statistical advice on study design and analyzed the data; LL, OW: drafted the manuscript, and all authors contributed substantially to its revision; NT: takes responsibility for the paper as a whole.

Ethical consideration

This study was approved by the Institutional Ethics Committee (Rabin Medical Center) (protocol number: IRB-RMC 2020-903).

The research was conducted ethically, with all study procedures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki. Written informed consent was obtained from each participant/patient for study participation and data publication.

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