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# Surgical Approach to the Intrathoracic Goiter

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**Objective:** In a retrospective study, the authors analyzed the surgical approach to the intrathoracic goiter to avoid sternotomy or thoracotomy.

**Methods:** We selected 70 intrathoracic cases of multinodular goiter out of 988 cases of thyroidectomy and compared them with cervical goiter cases. Surgical technique, results, and postsurgical complications were assessed.

**Results:** The analyzed cases presented the retrosternal goiter (n = 53; 75.7%), the retrotracheal goiter (n = 9; 12.8%), and the retroesophageal goiter (n = 8; 11.4%). Complaining of chest pressure or discomfort was specific for intrathoracic cases (50%; 35 of 70). All goiters except one were removed via cervical incision. The surgeons used head reclination and isthmus dissection when removing sizable goiters. Mean weight of goiters was 180 g. The recurrent laryngeal nerve was more often temporarily damaged in intrathoracic cases in comparison with cervical cases (4.3% vs. 2.8%, $P = .04$), but the difference in permanent injury was less significant ($P = .09$). The incidence of temporary hypoparathyroidism was significantly higher in intrathoracic cases ($P = .01$).

**Conclusion:** In cases of multinodular goiter the goiters of various extensions can be successfully removed via the cervical incision in most of the cases even if they occupy the retrosternal, retrotracheal, or retroesophageal position. The transthoracic approaches and sternotomy might be justified in malignant cases.

**Key Words:** Intrathoracic goiter, retrosternal goiter, surgery, thoracotomy.

**Level of Evidence:** 4.

## INTRODUCTION

As a rule, the intrathoracic goiter (ITG) takes its origin in the lower poles of the thyroid gland. There were both successful and unsuccessful attempts to remove such goiter via neck incision in the nineteenth century. Since Howard Lilienthal described his case of mediastinal thyroid removed by transsternal mediastinotomy in 1915, followed by a description of removing the costochondral cartilage of the first and second ribs for the same purpose in 1922, the surgeons operating on such goiters received several options to choose from.[1,2] It is generally accepted that most of the cases of benign ITG can be safely resected through a standard cervical approach.[3–5] Yet, currently, there is a broad discussion in the emerging literature on "do we still need sternotomy?" and "when is a sternotomy required"?[6–9]

Some opinions vary because there is no uniform definition of goiters located below the superior thoracic aperture (the thoracic inlet) and various terms like substernal, retrosternal, intrathoracic, retrotracheal, or mediastinal goiter are used, to date.[7,8,10] Terms like posterior mediastinal goiter and anterior mediastinal goiter were also applied.[11,12]

Summarizing the above-mentioned approaches to definitions and classifications,[3–12] ITG is understood as a goiter which lies in the thorax, ie, below the superior thoracic aperture. The term of partly intrathoracic is applied to goiters mainly located in the mediastinal space with its smaller portion in the cervical region. The term corresponds to the World Health Organization (WHO) 1993 modified classification Grade 3: Goiter palpable and visible in normal head position. As the name indicates the totally ITG lies almost completely in the thorax without any external evidence of thyroid enlargement in the cervical region. The term corresponds to WHO 1993 modified classification Grade 2: Goiter palpable but not visible in normal head position.

The aim of this retrospective study was to add our cases and opinions to the developing discussion on the necessity of the sternotomy.

## MATERIALS AND METHODS

The charts of all cases of thyroidectomy admitted to the Department of Otolaryngology–Head and Neck Surgery were retrospectively reviewed. We analyzed 988 patients (M 419, F 569, and mean age 37 y) with a preoperative diagnosis of the multinodular goiter (MNG) who underwent thyroidectomy between 1990–2016 and were being followed-up. We selected 70 cases with ITGs (M 29, F 41, mean age 39 y). The rest of the 867 cases with cervical goiter (excluding cases with malignancy) were used for comparison purposes. We analyzed the diagnostic approach, the applied surgical technique, and the rate of postsurgical complications. This study was approved by the Institutional



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TABLE I.
Enrollment Procedure for the Study.

| |
|---|
| Assessed for eligibility (n = 988) |
| Excluded (n = 918) |
| Of them: |
| a) had malignant pathology (n = 51) |
| b) underwent cervical thyroidectomy (n = 867) assessed for the control group |
| Operated for ITG (n = 70) |
| Lost to follow-up (n = 0) |
| Analyzed (n = 70) |

Review Board and the Medical Ethics Committee. The enrollment procedure for the study is presented in Table I.

In the current paper we classified the retrospectively analyzed cases of the ITG into retrosternal (that corresponds to substernal for a reclining patient), retrotracheal, and retroesophageal. Retroclavicular goiters were understood as variations of retrosternal goiters because they were identified in the anterior mediastinum. Other approaches to the classification will be addressed in the Discussion section.

The cases with ITGs were compared to the cases of cervical goiters on diagnostic parameters (compromised airway, dysphagia, etc.) and on the incidence of postsurgical complications. Due to the large sample size, the groups were analyzed with the $\chi^2$ test (95% confidence interval). $P$ values $<.05$ were considered significant.

## RESULTS

### *Diagnostic Approach to the Cases*

The analyzed charts indicate that the goiters were clinically defined as ITG cases when the lower pole of the goiter was not palpable even after full head extension backward. The confirmation of this clinical finding by CT/MRI data was obligatory for establishing of the diagnosis of the ITG. CT was performed in a position with the patient's arms by their sides for all patients. The 3D reconstruction of the CT images was performed to evaluate the area of the upper thoracic aperture. All specimens were examined preoperatively by ultrasound-guided fine-needle aspiration cytology and postoperatively histologically to exclude malignancy. All patients were hospitalized and the routine calcium measurements were performed. The indirect laryngoscopy was used to evaluate functions of the recurrent and the superior laryngeal nerves. This procedure was performed preoperatively on the same day as surgery and on the first postoperative day. In all cases, the position and size of the goiter were identified by CT scans and in many cases of ITG an additional MRI investigation was also needed to specify the retrosternal, retrotracheal, or retroesophageal position of the goiter and its extension. The airway assessment was an obligatory part of the clinical investigation. The radiological investigation with Barium was performed in cases when the patients complained about dysphagia (n = 22). The thyroid and parathyroid functions were assessed by endocrinologists before surgery and during follow-up. The TSH level of $>5.5$ U/ml was understood as preoperative hypothyroidism. During follow-up, the dose of L-thyroxine could be changed according to the current patient's TSH level in order to maintain it within normal limits.

A globus sensation and/or dysphagia, choking, stridor, cough, or dyspnea were the main symptoms indicated in the analyzed charts with no statistically significant difference in their frequency between cervical and intrathoracic cases (cervical vs. intrathoracic $P = .15$ to $P = .24$ for various symptoms). Complaining of chest pressure or discomfort was specific for intrathoracic cases (50%, 35 of 70). The tracheal compression was clinically suspected and confirmed by CT images in 62 cases (88.6%). The esophageal compression was found in nine cases (12.8%) confirmed by barium CT investigation. The combined trachea/esophagus compression was diagnosed in 18 cases (25.7%). In 10% of cases, patients were clinically asymptomatic (7 of 70) and decision for surgery was made because of endocrinologists' assessments.

### *Surgical Technique*

During 1990–2016 the surgical technique for removal of ITGs was not significantly changed. The obligatory steps included a standard cervical approach, ligation of the superior thyroid vein and artery prior to the deliverance of intrathoracic component, subsequent upward movement of the thyroid with goiter from the retrosternal to a cervical position with an attention to the external branch of the superior laryngeal n. close to the superior thyroid a. In 14 cases (20%) with large goiters, the sternohyoid muscle was dissected to secure wider approach to the goiter.

However, at the end of 1990s, the head reclination (head and neck extension backward) was introduced. Further modifications included the thyroid split through the isthmus with separation of the upper pole of the thyroid. That permitted to manipulate both lobes of the gland separately. Special care was taken to identify the external branch of the superior laryngeal n, the superior parathyroid glands, and the recurrent laryngeal n. The recurrent laryngeal n was separated from the gland through all its way above the mediastinum. Additional effort was applied to identify and preserve the inferior parathyroids, when dissection was performed as close to the capsule as possible. The gland tissue was completely separated from the trachea. Only after these separations and the thyroid split being performed, the traction was applied. With continued traction, blunt dissection, and the scooping manipulation the mass was brought forth. As the vessels entering the gland appeared they were caught and ligated.

Overall 70 surgeries were performed for ITG (7% from 988 cases) with cases of retrosternal goiter (n = 53; 75.7%), retrotracheal goiter (n = 9; 12.8%), and retroesophageal goiter (n = 8; 11.4%). The goiter arose from one lobe of the gland in 53 cases (75.7%) and from both lobes of the gland in 17 cases (24.3%). In 49 cases (70%) the total thyroidectomy was performed and the hemithyroidectomy was performed in 21 cases (30%).

Altogether 69 goiters were removed via cervical incision by the head-and-neck surgeons. However, the

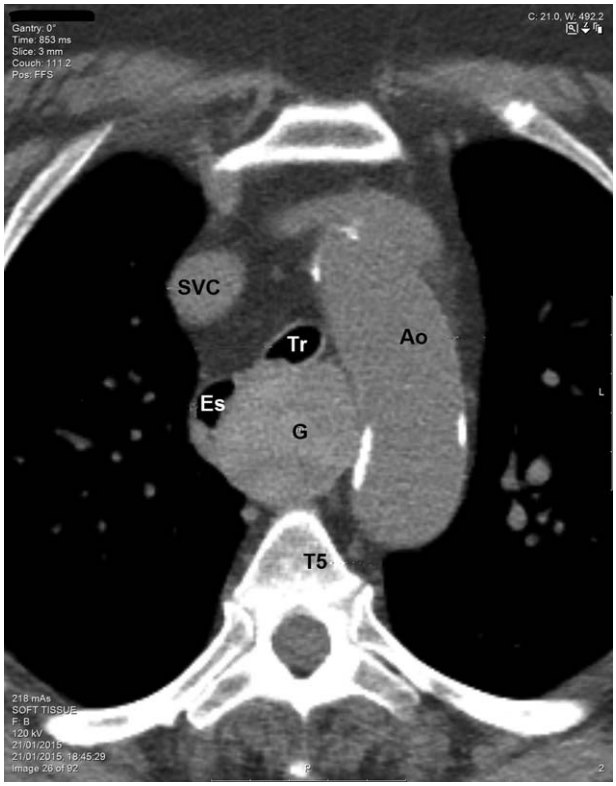


Fig. 1. The unremoved portion of the intrathoracic goiter (G) is located retrotracheally, pushing the trachea (Tr) forward and displacing the esophagus (Es). Ao = the arch of the aorta; SVC = superior vena cava; T5 = the fifth thoracic vertebra.

charts indicated that in cases of complicated and/or sizable ITGs (n = 39, 55.7%) a thoracic surgeon and thoracic facilities were available at the site of surgery. In one case the goiter was removed via posterior thoracotomy. This goiter was located retroesophageally in the posterior mediastinum and nerve involvement was detected. In addition to this, the area of the thoracic inlet of this patient was found as small as 36 $cm^2$ and the thoracic inlet anteroposterior diameter was only 4 cm. Assessing all these data surgeons decided to use the posterior thoracotomy.

Mean weight of goiters was 180 g. Partial or near-total calcification of the goiter's capsule was found in three cases (4.3%). In one case the surgery can be defined as reoperation. This patient arrived from a foreign country after total thyroidectomy, during which the operating surgeons overlooked the intrathoracic part of the gland. This ITG had the retrotracheal position pushing esophagus aside (Fig. 1). This independent portion of the goiter was also removed via the cervical approach. Contrary to the neck cases, the postsurgical drainage was necessary for all thoracic cases.

### *Postsurgical Complications*

The rates of complications are listed in Table II. The postoperative mean follow-up was 8 years 9 months with no significant differences between the groups. No recurrences were found during follow-up clinical evaluations, ultrasound and blood tests for TSH, FT4, and TT3. CT and radioisotope evaluations were performed when indicated.

The tracheal compression resolved surprisingly quickly in most of the patients who had this sign (64 of 69, 92.8%) but in five patients (7.2%) it remained and additional measures were taken. The tracheal balloon dilation was applied to two patients and proved to be an effective palliative procedure. However, a performance of serial dilation procedures was necessary to achieve long-term results. In two patients tracheal stenosis was successfully treated by one-stage surgical correction. One patient remained untreated by his own will.

Pathologic examination of samples incidentally revealed two cases of follicular carcinoma and two cases of capillary carcinoma in cases operated for MNG (5.8%). While all these cases were operated by total thyroidectomy, no reoperations were needed.

## DISCUSSION

The claims that all ITGs can be excised via cervical approach exist but they are very rare.[5,13] This corresponds to our experience but we analyzed only cases with MNG. Numerous papers explain the necessity for manubriotomy, partial sternotomy, full sternotomy, anterior, lateral, and posterolateral thoracotomies for both malignant and benign complicated cases.[6–10,14–16] In cases when malignancy of a nodule is established or even suspected we can agree with such approach. Sometimes when the gland is hard and the goiter is large and calcareous, even benign cases might require additional thoracic approach and we cannot rule out this possibility completely. Such cases, however, are exceptionally rare and deserve to be presented in case reports.

Analyzing the above-mentioned papers, two main predictors for the thoracic approach are goiters located in the posterior mediastinum (retrotracheal and retroesophageal) and goiters that extend below the aortic arch. Successful removals of posterior mediastinum goiters were reported earlier.[17,18] Other authors advocate either

TABLE II.
Complications (in %) of Cervical, Partly Intrathoracic, and Totally Introthoracic Cases for MNG.

| Variable | Cervical | Introthoracic |
|---|---|---|
| Temporary RLN injury | 2.8 | 4.3 ($P$ = .04) |
| Permanent RLN injury | 1.0 | 1.4 ($P$ = .09) |
| Temporary SLN injury | 1.1 | 1.4 ($P$ = .23) |
| Permanent SLN injury | 0.9 | 1.4 ($P$ = .15) |
| Temporary hypoparathyroidism* | 6.4 | 20.2 ($P$ = .01) |
| Permanent hypoparathyroidism | 1.8 | 2.8 ($P$ = .07) |

*Hypocalcaemia was defined at a serum calcium level lower than 8.2 mg/dL (2.05 mmol/L) or an ionized calcium level lower than 4.4 mg/dL (1.1 mmol/L).

Percentage figures are given for patients. $P$-values are given in comparison to the cervical group.

MNG = multinodular goiter; RLN = recurrent laryngeal nerve; SLN = superior laryngeal nerve.

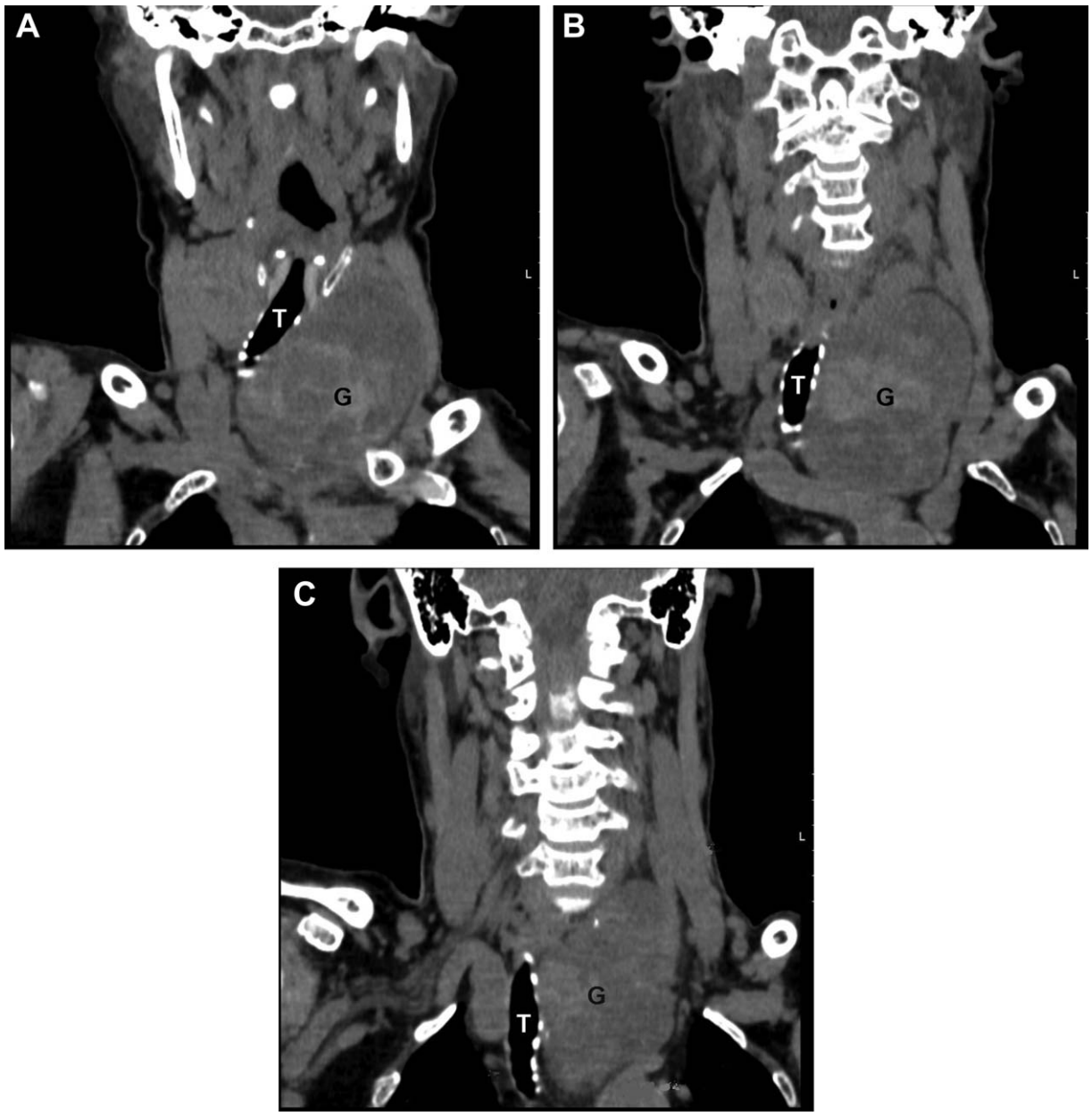


Fig. 2. A–C. The displacement of the trachea (T) by the goiter (G) can be clearly observed at CT scans.

combined thoracic and cervical approach or thoracotomy alone even if the goiter is benign.[19,20] We believe that MNGs can be removed via cervical incision even if they were positioned retrotracheally or retroesophageally. Careful study of CT scans is needed, preferably with 3D reconstruction, to understand the position of such goiters. The area of the upper thoracic inlet is to be taken into account. The 3D reconstruction of the CT images is needed for this purpose because the inlet is oblique and cannot be assessed properly at the initial CT images. It was recently demonstrated that "the area of the thoracic inlet, the neck size, and the anteroposterior diameter of the inlet do not affect the development of the ITG".[21] This research indicates that "the smaller tracheal-diameter-to-thoracic-inlet ratio and the lower position of the thyroid gland are the main indicators for the development of the ITG" and that anatomical considerations are to be taken into account when the surgery for ITG is planned. We confirm the importance of such approach and indeed in the only case when the posterior thoracotomy was performed the anatomical peculiarities of the given patient influenced the surgical decision making.

The position of the trachea is to be studied most carefully (Figs. 2A, 2B, and 2C). It was recently demonstrated that tracheal compression but not deviation was related to shortness of breath.[22] The displacement of the trachea is always accompanied by a certain amount of curving of the trachea upon itself, and frequently by some twisting of the trachea upon its long axis. In very rare cases the trachea is displaced directly or obliquely

forwards. These peculiarities help to understand the "logic" of goiter's expansion and forces it applies to neighboring organs. Operating such goiters we have noticed the existence of small prolongations of the gland tissue behind the pharynx and esophagus. Usually, they do not present any problem during removal. Our personal experience and collected retrospective data confirm that the esophagus is much less often compressed than the trachea. It is not uncommon, however, for one or other lobe of the gland, or even both lobes, to extend behind the trachea and displace the esophagus to one side or to compress it on both sides.

We pay much more attention to the position of the goiter against the sternum, the vessels, the trachea, and the esophagus rather than its extension towards the aortic arch and below. Mercante et al. suggested CT cross-sectional imaging classification system for substernal goiter based on its extension.[23] These authors suggested the following grading: "grade 1 (above aortic arch), grade 2 (level of aortic arch), and grade 3 (below aortic arch)". While we appreciate the effort of these authors to improve classification of ITGs, we doubt that the aortic arch is an ideal anatomical landmark for this purpose. The aortic arch is perhaps the most variable element in human morphology.[24,25] The aortic arch can be right-sided and it can be double.[26,27] Nine types of normative (asymptomatic) aortic arch branching exist.[28] The counter-position of the goiter and the arch is very important in CT scan evaluation of the ITG but the arch hardly can be a reliable landmark to be taken into account when the surgical approach is planned. If the topography of the goiter was well understood, if the goiter is benign, if a surgeon uses delicate traction with careful alternation of blunt and sharp dissection, the goiter of any extension can be successfully removed via the cervical approach. However, every patient should be considered independently and we cannot make a blanket statement about ITGs (Fig. 3).

We want to stress the importance of the patient's head reclination in surgical position. Together with collar incision, it provides an adequate approach to the operating area. We noticed that the operation is more difficult in patients with cervical spine problems that limit the reclination of the head. The postsurgical drainage was necessary in all cases. In cases when sizable goiters were removed, the drainage tube is to be inserted deeper into the remaining cavity to prevent possible accumulation of blood in the cavity.

The thyroid split through the isthmus is especially helpful in cases of large goiters. As the results showed, the majority of the goiters (75%) arise from one lobe of the gland and this approach helps to manipulate both lobes separately. This technique combined with the dissection of the sternohyoid muscle permits to remove sizable goiters via the neck incision thus avoiding sternotomy or thoracotomy.

Other problematic issues expressed in the literature concern the recurrent laryngeal nerve, the inferior parathyroid glands, and the possible calcification of the capsule of the goiter or the goiter itself.[29–31] Occasionally, the recurrent laryngeal nerve might be spread out upon

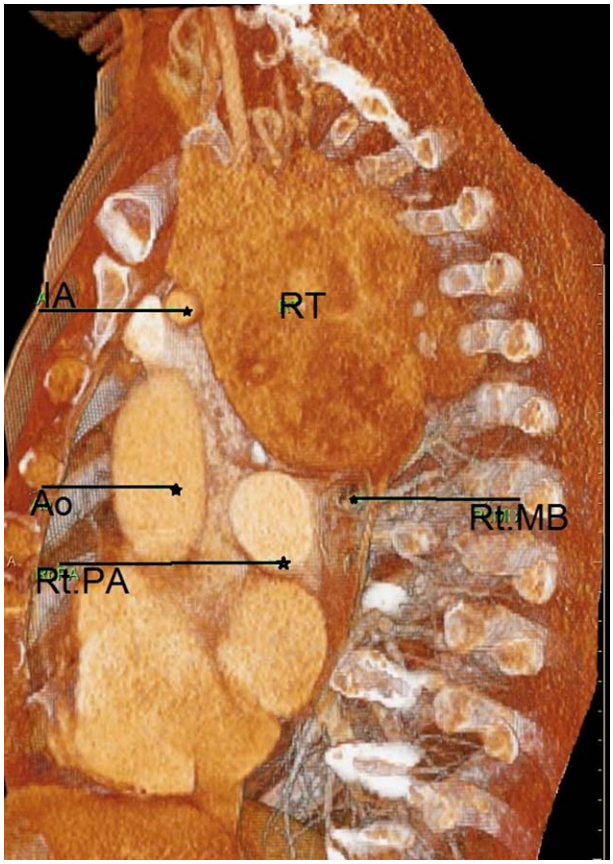


Fig. 3. The case of the goiter that was removed via posterior thoracotomy. This goiter was located retroesophageally in the posterior mediastinum. Ao = the aorta; IA = the innominate artery; RT = the goiter from the right thyroid lobe, Rt.MB = the right mainstream bronchus, Rt.PA = the right pulmonary artery.

the posterior surface of a goiter. When this is the case, a very accurate dissection should be performed as close to the capsule as possible. More often, however, the nerve is pushed inwards and is not stretched by the goiter. In cases of a malignant disease, the nerve, as might be expected, is frequently found involved in the tumor and that is why in such cases transthoracic approach is justified. Our statistics indicate that the recurrent laryngeal nerve is more often damaged in intrathoracic cases in comparison with cervical cases (Table II) but this difference is not alarming (1.4% against 1%). Randolph et al. (2011) reported temporary recurrent laryngeal nerve paralysis in 1.8% of their cases.[32] These authors indicated that bilateral cervical goiter emerged as a definitive risk factor for recurrent laryngeal nerve injury. The inferior parathyroid glands can be identified and preserved if the dissection is done very close to the capsule sparing all pieces of thyroid tissue and fatty tissue around it.

Finally, calcification of a goiter or of its capsule was seemed to present an additional problem. Usually, this condition is associated with long-standing MNGs in elderly people. This situation, however, is not alarming. First, such pathology is well diagnosed by imaging techniques for decades.[33,34] Second, if the calcification occurs

the goiter has a tendency to shrink and usually is not large in size, the condition known as dystrophic calcification.[35–37] We encountered with such condition in three cases (4.3%) but usually it was not a complete egg shell calcification but separate calcified areas of the capsule. Only in one case, the calcification formed a firm union with the trachea. ITGs frequently have calcified areas but extended calcification of the gland is rare and deserves to be presented as a case report.[38] The calcified portions of the capsule can be crushed and delivery effected. This can usually be done without provoking any considerable hemorrhage. According to our experience, calcifications are more often present either in longstanding Hashimoto type goiters or in goiters with developing carcinoma.

### *Limitation of the Research*

As it was said above, we state that with very few exceptions sternotomy is unnecessary in cases of MNG. We can speculate that the same approach might be applied to other benign conditions of the thyroid but not to malignant cases. A comprehensive prospective quality assurance study of 5195 cases was performed on surgeries for benign multinodular goiter.[39] The authors mentioned that "in the hands of well-trained surgeons using an appropriate intraoperative technique", total thyroidectomy is justified if the patient has an increased risk of recurrent goiter. The same approach can be applied to cases of ITG and we limit our results to "well-trained surgeons using an appropriate intraoperative technique".

## CONCLUSION

In cases of benign MNG, the goiters of various extensions can be successfully removed via the cervical incision in most of the cases even if they occupy the retrosternal, retrotracheal, or retroesophageal position. The transthoracic approaches and sternotomy might be justified in malignant cases.

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