Original Article

Ambulatory robotic thymectomy: preliminary analysis of 18 cases

Anna Ureña[1,2]^, Inés Serratosa[2], Iván Macía[2], Francisco Rivas[2], Carlos Déniz[2], Anna Muñoz[2], Camilo Moreno[2], Ignacio Escobar[2], Ricard Ramos[1,2]

[1]Thoracic Surgery Department, Hospital Clinic of Barcelona, IDIBAPS (Institut d'Investigacions Biomèdiques August Pi i Sunyer), Barcelona, Spain; [2]Thoracic Surgery Department, Bellvitge Hospital, L'Hospitalet de Llobregat, Spain

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Correspondence to: Anna Ureña, MD, PhD. Thoracic Surgery Department, Hospital Clinic of Barcelona, IDIBAPS (Institut d'Investigacions Biomèdiques August Pi i Sunyer), Villarroel Street 170, 08036 Barcelona, Spain; Thoracic Surgery Department, Bellvitge Hospital, Feixa Llarga street s/n, L'Hospitalet de Llobregat, 08907 Barcelona, Spain. Email: aurenal@clinic.cat.

Background: Robotic thymectomy is a highly precise, minimally-invasive procedure with rapid postoperative recovery, which is why it has become treatment of choice. In this study, we describe our experience with robotic thymectomy performed on an outpatient basis to better understand the feasibility of an ambulatory robotic thymectomy program.

Methods: Retrospective, descriptive study of 18 patients who underwent thymectomy via robot-assisted thoracic surgery on an outpatient basis at Bellvitge University Hospital in Barcelona, between June 2019 and December 2022. We describe the following: outpatient surgery rate with inclusion criteria; surgical technique; drain removal criteria; postoperative complications; and return visits to the emergency department.

Results: Of a total of 54 patients that underwent robotic thymectomy, 17 were not eligible for ambulatory surgery due to myasthenia gravis. Of the remaining 37 patients, 19 required scheduled admission prior to surgery. Consequently, only 18 patients met previously established criteria for ambulatory surgery. Of the 18 individuals who underwent outpatient intervention, two were readmitted within 30 days (11.1%), one for removal of a foreign body at 24 hours. Four patients (22.2%) presented to the emergency room for pain control.

Conclusions: This is the first study to evaluate treatment outcomes and complications in patients undergoing ambulatory thymectomy. The results suggest that this procedure could be both feasible and safe. However, large prospective studies are needed to confirm these findings.

Keywords: Thymectomy; robot; major ambulatory surgery

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Introduction

Thymectomy is the main treatment for diseases of the thymus gland and myasthenia gravis. Traditionally, the main surgical approach was median sternotomy (1), which was later replaced by the transcervical approach (2). However, the introduction of video-assisted thoracic surgery (VATS) in the early 1990s revolutionized the surgical approach by allowing surgeons to perform complex procedures through smaller incisions, with all the clinical benefits that this implies for the patient (3).

In the 2020s, robotic-assisted thoracic surgery (RATS)

^ ORCID: 0000-0002-4505-9917.

has emerged as a highly precise tool, associated with better intraoperative safety and improved postoperative outcomes in both the short and medium term. For these reasons, it has become the preferred surgical technique for the treatment of mediastinal disease (4).

Major ambulatory surgery plays a fundamental role in delivering cost-effective care without compromising patient safety and comfort. A growing number of thoracic procedures are performed on an outpatient basis, including sympathectomy, mediastinal lymphadenectomy, and lung biopsy by VATS (5-7). To our knowledge, however, the possibility of performing ambulatory thymectomy has not been described to date (8).

In this context, the main aim of this study was to describe our experience with robotic thymectomy in an outpatient regimen to better understand the feasibility of an ambulatory robotic thymectomy program. We present this article in accordance with the STROBE reporting checklist (available at https://vats.amegroups.com/article/view/10.21037/vats-24-15/rc).

Highlight box

Key findings

- This study evaluated the feasibility and safety of performing robotic thymectomy on an outpatient basis. Of 54 patients, 18 met the criteria for ambulatory surgery. Among these, 11.1% were readmitted within 30 days due to minor complications, primarily pain management. The overall complication rate was 16.7%, with no major adverse events, indicating that robotic thymectomy can be performed safely in selected patients without overnight hospitalization.

What is known and what is new?

- While robotic thymectomy is recognized for its safety and effectiveness in inpatient settings, there is limited data on its feasibility as an outpatient procedure.
- This manuscript adds new evidence by suggesting that outpatient robotic thymectomy is both feasible and safe, potentially reducing hospital stay and healthcare costs. It is the first study to focus on outpatient outcomes, indicating that this approach can be viable in a well-selected patient group.

What is the implication, and what should change now?

- The study indicates that robotic thymectomy could be more widely performed on an outpatient basis with appropriate patient selection and preoperative education. Hospitals should develop criteria to identify candidates and optimize care protocols. Future research should involve larger, multicenter studies to confirm these findings and establish broader guidelines for outpatient robotic thymectomy.

Methods

In this study we describe our preliminary experience performing ambulatory robotic thymectomy. This was a retrospective, descriptive study of 18 patients who underwent thymectomy via RATS as an outpatient procedure at our hospital (Bellvitge University Hospital) between June 2019 and December 2022. The follow-up period was 30 days, as the primary endpoint was to assess outcomes in the early postoperative period.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). In accordance with Bellvitge Hospital regulations, the Clinical Research Ethics Committee waived the need for ethics approval and informed consent due to the study design (retrospective cohort study based on anonymous patient data).

Since the study does not introduce any new interventions, experimental treatments, or modifications to patient care, and only utilizes pre-existing anonymized data, it does not pose additional risks to patients. Consequently, this study is considered exempt from Institutional Review Board review as it adheres to ethical standards for retrospective data analysis and does not impact current or future patient management.

Patient selection

Patients considered candidates for surgery were consecutively selected from the Thoracic Surgery unit. Eligibility for day surgery was determined according to the criteria extracted from the recommendations of the European Society of Medical Oncology (ESMO) (8). Our center's criteria for surgery in ambulatory regimen are detailed in *Table 1*.

Major ambulatory surgery is defined as a surgical procedure carried out under general or regional anesthesia in which the postoperative recovery time may vary, but discharge is always on the same day of the intervention (9).

The surgical process starts during an outpatient visit. If the patient meets eligibility criteria for major ambulatory surgery, the attending surgeon will offer this option to the patient. Patients who agree to this approach are required to provide signed informed consent. Subsequently, a nursing assessment and pre-anesthetic assessment is performed in which written instructions for specific rehabilitation are

Table 1 Criteria for ambulatory surgery

Category	Criteria
Patient-related	• Patient agreement
	• Explicit informed consent signature
Social environment	• Presence of a responsible individual during the 24 hours following the procedure
	• Residence with basic accommodations (telephone, no architectural barriers, etc.)
	• Convenient communication with the hospital (<40 km or 45 minutes by car)
Anesthetic risk	• ASA Scale
	• Anesthetic duration <90 minutes
	• Recovery time <5 hours
Surgical risk	• Minimal blood loss
	• No requirement for complex dressings
	• Postoperative pain control with oral analgesia
Other	• Patients with myasthenia gravis are excluded

ASA, American Society of Anesthesiologists.

Table 2 Objectives of prehabilitation visit

Category	Objectives
Health information and education	• Adjust patient expectations
	• Emphasize the importance of early mobilization
	• Provide instructions on preoperative medication and physiotherapy
	• Educate on pain and its management
	• Promote smoking and alcohol cessation
Nutritional assessment and optimization	• Perform screening using the MUST scale, requesting dietary assessment if the score is >2
	• Otherwise, prescribe a high-protein diet in the days leading up to the procedure
Transfusion risk detection	• Through preoperative blood tests identify patients that could benefit from iron supplementation
	• Strive to achieve an appropriate hemoglobin level (around 13 g/dL)
Physical conditioning	• Improve the patient's functional capacity to better cope with the stress of surgery
	• Address sarcopenia using the SARC-F questionnaire and initiate rehabilitation measures and respiratory education in the weeks prior to surgery
	• Emphasize the importance of ongoing physical exercise

MUST, malnutrition universal screening tool.

provided. The aim of these preoperative visits is to ensure that the enhanced recovery after surgery (ERAS) criteria are met (*Table 2*) (10,11).

On the day of surgery, the patient presents to the ambulatory surgery unit and is transferred to the operating room. After surgery, the patient returns to the unit for recovery. The minimum stay is 4 hours and the discharge deadline is 10:00 p.m. The pre-discharge assessment is performed by an anesthesiologist according to the Aldrete' scale (12). The anesthesia and nursing units both have a thoracic surgeon on call in case an in-person or telephone evaluation is required.

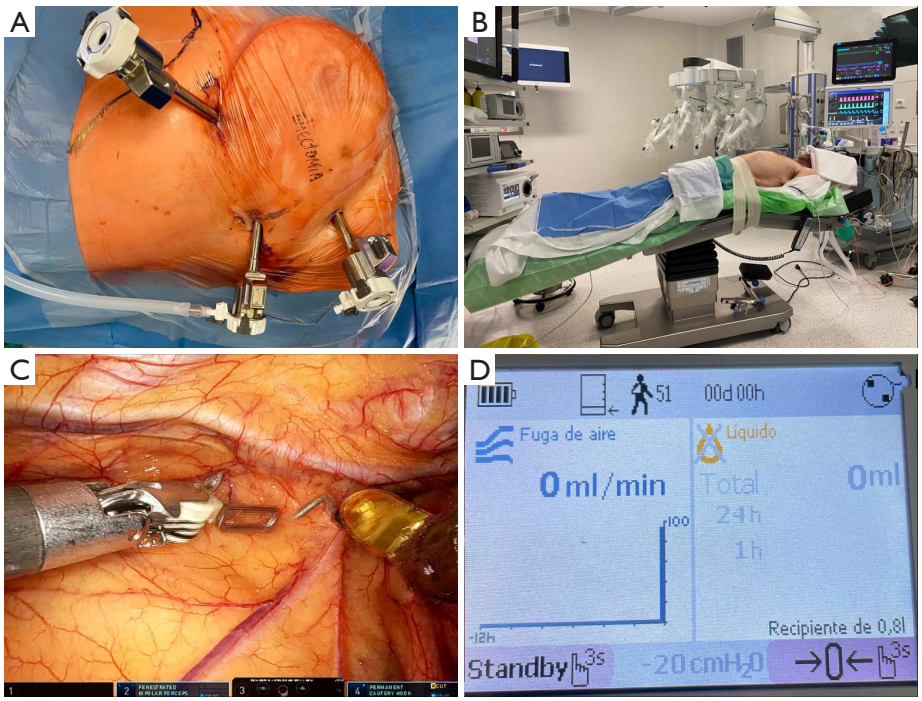

Figure 1 Surgical technique. (A) Trocar placement in the left hemithorax. (B) Patient positioning on the surgical table. (C) Commencement of dissection at the confluence angle between the internal thoracic artery and the vasculonervous bundle of the phrenic nerve. (D) Absence of air leakage on the electronic drainage system screen at the time of extubation.

At discharge, the patient is given a written document with general recommendations and detailed instructions on the following: surgical wound care; analgesic regimen; indications for activity and diet; and the date of the follow-up appointment. In addition, patients are informed of potential warning signs (fever; pain not controlled by the prescribed analgesia; respiratory difficulty; increase in subcutaneous emphysema; and/or general malaise). Patients are provided with a 24-hour telephone number in case they have any questions.

Surgical technique

The surgical procedure is carried out under general anesthesia, with double-lumen intubation to a single lung. Fiberoptic bronchoscopy is used to confirm tube positioning. A single dose of prophylactic antibiotic therapy is administered 60 minutes prior to the intervention in accordance with our routine protocol. The patient is placed in the supine position, and slightly lateralized at 30° (13). Once in position, three 8 mm ports are inserted in the following locations: (I) 4th–5th intercostal space in the anterior axillary line, through which the 30° optic is introduced; (II) 5th intercostal space in the mid-clavicular line; (III) 3rd intercostal space, medial to the anterior axillary line. Thus, all three trocars are positioned along the inframammary fold. The phrenic nerve is established as a reference point to initiate the resection and to determine the rotation of the robot arms. From 8 to 12 mmHg of CO_2 are insufflated into the thoracic cavity to facilitate lung collapse, better expose the relevant structures, and to identify the dissection planes until the thymectomy has been completed including inferior and superior horns in all cases. Once the surgical piece has been removed, an Argyle-type chest drain is placed and connected to a Thopaz device (Medela Inc., Baar, Switzerland) with suction (20 cmH_2O). The lung is examined under direct vision through one of the surgical ports to confirm successful re-expansion.

The chest tube is removed by a member of the thoracic surgery team immediately after extubation (*Figure 1*) provided that all of the following conditions are met: (I) air leak through the drainage is <5 mL/min, (II) the anesthesiologist has confirmed that no respirator leaks are present, and (III) the output is low (<50 cc), without signs of active bleeding (14,15).

After extubation and once the patient has regained

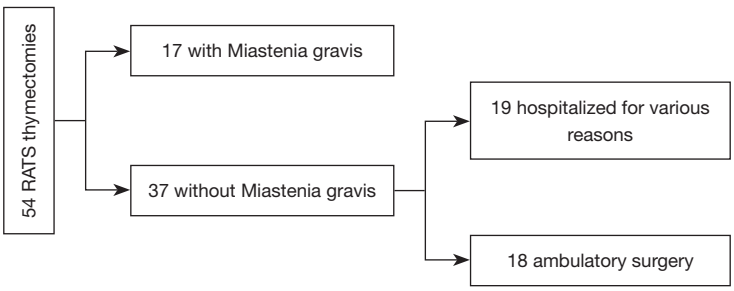

Figure 2 Selection algorithm. RATS, robotic-assisted thoracic surgery.

Table 3 Selection criteria

Reason for ruling out ambulatory surgery	N	Σ	%
Myasthenia gravis	17	17	41
Surgery characteristics			
Size >7 cm	3	13	24
Paraneoplastic syndrome: paraneoplastic myositis (intensive care unit admission)	1		
Comorbidity	2		
Disease extent: infiltration of pericardium, pleural implants, neoadjuvant treatment	4		
Combined surgery (with segmentectomy or lymphadenectomy)	1		
Social situation/medical team decision	3	3	6
Patient's decision	3	3	6
Total patients excluded		36	66.7

consciousness, he or she is re-admitted to the post-anesthesia care unit (PACU), where oral tolerance testing is started, together with progressive sitting and ambulation. A portable chest X-ray is performed to ensure correct lung expansion and the absence of intrathoracic complications after drain removal.

The day after surgery, a clinical nurse from the unit contacts the patient by telephone to check on their status. Seven days after discharge, patients are scheduled to return to the outpatient clinic for a follow-up visit with a member of the thoracic surgery team.

Statistical analysis

For the variables measured pre- and post-intervention, we determined frequencies with percentages and means with standard deviation (SD), as appropriate for each type of variable. To identify the factors associated with emergency room visits following the intervention, we performed binary logistic regression analysis with the odds ratios (ORs) and 95% confidence intervals (CIs). All calculations were performed using the IBM-SPSS Statistics for Windows, v.20 (IBM Inc., Armonk, NY, USA).

Results

Of the 54 robotic thymectomies performed during the study period, 17 were not eligible for ambulatory surgery due to myasthenia gravis, given the risk of disease exacerbation following the intervention. Of the remaining 37 patients, 19 required scheduled admission due to comorbidity or social challenges that precluded same-day discharge. Consequently, only 18 (33.3%) robotic thymectomies were performed as outpatient procedures (*Figure 2*, *Table 3*).

Sociodemographic data of the patients that did meet the inclusion criteria of the study is showed in the *Table 4*. Approximately two-thirds (67%) of the patients were female, with a mean age of 60.3 years (range, 35–76 years). The majority of examined patients exhibited appropriate respiratory function, with an average forced

Table 4 Demographic and clinical data

Variable	Mean (SD)/N [%]
Age (years)	60.3 (13.1)
BMI (kg/m^2)	27.8 (3.6)
FEV_1 (%)	107.5 (17.5)
DLCO (%)	90.1 (14.5)
FVC (%)	110.2 (19.9)
Sex	
Male	6 [33]
Female	12 [67]
Hypertension	9 [50]
Diabetes mellitus	2 [11]
Dyslipidemia	9 [50]
COPD	2 [11]
Nephropathy	2 [11]
Vasculopathy	0
Ischemic heart disease	0
Atrial fibrillation	2 [11]
Smoking	
Never	7 [39]
Former smoker >6 months	4 [22]
Current smoker	7 [39]
Other neoplasm	5 [28]
Autoimmune pathology	5 [28]

SD, standard deviation; BMI, body mass index; FEV_1, forced expiratory volume during the first second; DLCO, diffusing capacity for carbon monoxide; FVC, forced vital capacity; COPD, chronic obstructive pulmonary disease.

Table 5 Surgery characteristics

Variable	Value
Laterality	
Left	16 [89]
Right	2 [11]
Ports	3
Number of drains	1
Surgical time (min)	72.8 (55.5)
Bleeding (mL)	0.5 (2.4)

Data are presented as N [%], n, or mean (standard deviation).

Table 6 Tumor-related data

Variable	Value
Size (mm), mean (SD)	26.17 (7.8)
Histology, n [%]	
Thymic cyst	13 [72]
Thymoma	4 [22]
Other	1 [6]

SD, standard deviation.

expiratory volume in 1 second (FEV_1) of 107.5% and diffusing lung capacity for carbon monoxide (DLCO) of 90.1%. Common comorbidities among the participants included hypertension (50%), dyslipidemia (47%), chronic obstructive pulmonary disease (11%) and diabetes mellitus (11%). Additionally, 11% of subjects had atrial fibrillation and 11% suffered from nephropathy. Smoking status varied, with 39% never smokers, 22% former smokers and 39% currents smokers.

Regarding the surgical characteristics, the majority of interventions were performed on the left side (89%), while only a small percentage were on the right side (11%). Postoperative outcomes did not differ between the two groups.

The surgeries typically involved the use of three ports as it was previously described and only one drainage was placed.

The mean surgical duration, including the robot docking, was 72.8 minutes and bleeding was practically nonexistent as it is shown in *Table 5*. The estimated blood loss in the study is determined by the volume of blood collected in the suction canister used during the surgery.

Table 6 presents the characteristics of the surgical specimens obtained from robotic thymectomies performed under the ambulatory surgery regimen. The average size of the lesions was 26.17 mm, with thymic cysts being the predominant pathology. In 22% of cases, the pathological result of the specimen was thymoma, with all identified thymomas classified as stage pT1a. Additionally, a single case revealed an incidental finding of thyroid metastasis in the surgical specimen following the thymectomy.

Tables 7,8 detail the events following the intervention.

Two cases were readmitted within 30 days, accounting for 11% of the total. One patient who presented to the clinic 24 hours after surgery complaining of pain symptoms was admitted for removal of a surgical gauze. Another patient was admitted for pleural effusion compatible with chylothorax. Additionally, three patients returned to the

Table 7 Unplanned admission, emergency room consultation, readmission

Type of event	N (%)	Reason
Unplanned admission	2 (11.1)	Surgeon's decision
Emergency room consultations	4 (22.2)	Poor pain control
Readmission	2 (11.1)	1 chylothorax 1 foreign body

Table 8 Complications and rehospitalization rate

Variable	N	%
Pleuropulmonary infection	0	0
Wound infection	0	0
Respiratory insufficiency	0	0
Pneumothorax	0	0
Subcutaneous emphysema	0	0
Hemothorax	0	0
Chylothorax	1	6
Phrenic nerve injury	0	0
Recurrent laryngeal nerve injury	0	0
Myocardial infarction	0	0
Postoperative atrial fibrillation	0	0
Ischemia/stroke	0	0
Reintervention	1	6
Mortality	0	0
Readmission within 30 days	2	11

clinic for pain and another for dyspnea; however, re-admission was not necessary in these cases.

It is important to clarify that the majority of emergency visits related to pain control did not require adjustments in the analgesic regimen and were more associated with patients' anxiety about being discharged too early. Additionally, upon reviewing the follow-up data at 30 days post-surgery, none of these patients presented with chronic pain.

Among all potential complications studied, only the chylothorax and the reintervention previously mentioned were recorded. Not a single case of pleuropulmonary or wound infection, pneumothorax or subcutaneous emphysema, hemothorax, respiratory insufficiency, nerve injury, atrial fibrillation or mortality was reported.

Discussion

In this study, we sought to determine the feasibility and safety of performing thymectomy on an outpatient basis. Of the 54 patients in this cohort, only 18 patients met previously established criteria for ambulatory surgery. Of these, two patients were readmitted within 30 days (11.1%), one for removal of a foreign body at 24 hours and the other presented a quilothorax. Four patients (22.2%) presented to the emergency room for pain control.

Ambulatory surgery is defined as a surgical procedure performed under general, regional, or local anesthesia or sedation that does not require intensive care or an overnight hospital stay. Consequently, patients can be discharged a few hours after the intervention. This type of surgery has experienced a continuous growth and now accounts for 50% of surgeries performed in the United States (16). However, there is a notable lack of data on thymectomies performed as an ambulatory procedure.

In recent years, numerous studies have been performed to evaluate the complications of robotic thymectomy. Xu *et al.* conducted a meta-analysis of 21 studies (930 patients), finding an overall complication rate of 12.2% (95% CI: 10.0–14.8%) (17). The results of our small study were largely in line with those findings, with a complication rate of 16.7% in the 18 patients who underwent outpatient robotic thymectomy.

We observed some notable differences between our study and those included in the meta-analysis by Xu and colleagues with regard to the type of complications. For example, in that meta-analysis, the incidence of air leak was 2.9% (95% CI: 1.8–4.8%) versus 0% in our sample. Similarly, the incidence of symptomatic pleural effusion and atrial fibrillation were 2.5% (95% CI: 1.5–4.0%) and 2.5% (95% CI: 1.5–4.1%), respectively, compared to 0% for both conditions in our cohort. By contrast, we observed a higher incidence of thoracic duct fistula (1/18; 5.6%) versus 1.7% (95% CI: 1.0–2.9%) in the meta-analysis.

Some authors argue that the substitution index and the unplanned admission index could be valid, easy to calculate indicators of the management and quality of care in major ambulatory surgery (18,19). In the present study, we determined the percentage of patients who required an unplanned admission, those who presented to the emergency room for any reason, and those who were re-admitted after discharge (*Table 8*). In all three of these cases, the results were comparable to other reports (20). In our cohort, we decided to admit two patients because

they voluntarily refused outpatient care. These two were excluded from the studied group (according to the criterion: "patient decision") but we plan to include them in future studies to enhance the overall representation and provide a more complete picture.

It is worth emphasizing that most of the emergency visits that did not require hospital admission were due to poor postoperative pain control. It seems likely that at least some of these cases were attributable to a lack sufficient information regarding what to expect in terms of postoperative symptoms (21-23). In this regard, we believe that the number of consultations for common symptoms could be reduced by ensuring that patients receive a detailed explanation (both written and oral) during the preoperative visit about the most common postoperative symptoms, and any symptoms that require a telephone or in-person consultation (24).

The findings of this study suggest that, in selected patients who have been fully informed of the risks, benefits, and likely side-effects prior to surgery, ambulatory robotic thymectomy is a viable alternative to conventional hospitalization. Moreover, this approach could have a non-negligible economic impact on conventional robotic surgery programs. However, to determine the true impact of thymectomy performed on an outpatient basis, larger prospective studies with long-term follow-up are needed.

Study strengths and limitations

This study has several limitations, mainly the retrospective, single-center study design and limited number of patients. In this regard, to better characterize the profile of patients most likely to benefit from ambulatory robotic thymectomy, it would be advisable to conduct a prospective, multicenter study with a larger sample. Similarly, it would be valuable to assess the association between the patients' level of anxiety and postoperative pain. By contrast, an important strength is that this is the first study to show the feasibility of performing thymectomy as an outpatient procedure, thus opening new possibilities in the field of thoracic surgery.

Conclusions

In recent years, continuous advances in moderately-to-highly complex surgery, together with improved anesthetic techniques, have contributed to the rapid growth of major ambulatory surgery. This trend is expected to continue as these advances, together with proper patient selection, further reduce surgical time.

Ambulatory surgery is already widely used in most thoracic surgery departments to perform procedures such as bilateral sympathectomy, mediastinoscopy, pleural biopsy, and even some lung biopsies. Mediastinal surgery in well-selected, well-informed patients could be a reality in the near future if we improve patient selection and postoperative care protocols. Despite the relatively small number of patients in this study, we believe that these results support the feasibility of performing robotic thymectomy on an outpatient basis.

However, serious complications following a thymectomy are rare but can occur, so we believe it is premature to speak about safety. Further studies with a larger sample size and long-term follow-up are needed to determine the risk profile of this new approach in thoracic surgery.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://vats.amegroups.com/article/view/10.21037/vats-24-15/rc

Data Sharing Statement: Available at https://vats.amegroups.com/article/view/10.21037/vats-24-15/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://vats.amegroups.com/article/view/10.21037/vats-24-15/coif). R.R. serves as an unpaid editorial board member of *Video-Assisted Thoracic Surgery* from June 2024 to June 2026. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). In accordance with Bellvitge Hospital regulations, the Clinical Research Ethics Committee waived the need for ethics approval and informed consent due

to the study design (retrospective cohort study based on anonymous patient data).

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