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# Analysis of Patients Resected for Primary Mediastinal Mass: Which Surgical Approach is Superior

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## ABSTRACT

**Introduction:** In recent years, robot-assisted thoracoscopic surgery (RATS) and video-assisted thoracoscopic surgery (VATS) has been more frequently preferred in the surgical treatment of mediastinal masses. The number of studies comparing VATS with RATS is limited. In our study comparing the surgical outcomes of RATS and VATS procedures, we tried to determine the ideal treatment method.

**Methods:** Between 2016 and 2022, fifty-two patients who underwent minimally invasive surgical resection (VATS or RATS) for mediastinal mass were retrospectively analyzed.

**Results:** Mediastinal mass resection was performed by RATS (n=29) or VATS (n=23). 57.7% (n=30) of the mediastial masses were localized in the anterior mediastinum. The most common postoperative pathology was thymoma (27%, n=14). There was no surgical mortality. Grade 1 and 2 complications developed in 6 (11.5%) patients according to the Clavien-Dindo classification. Conversion to open surgery was required in a total of 5 patients [VATS group (n=3), 13% versus RATS group (n=2), 6.9%, p=0.644]. The median length of hospital stay was five days [VATS; 4 days interquartile range (IQR): 3-6] versus RATS; 5.5 days (IQR: 4-8), p=0.081]. The median drainage time was four days [VATS; 3 (2-5) versus RATS; 4.5 (3-7), p=0.133], and the mean drainage amount was 110 mL (70-190) (p=0.162). There was no significant difference between the duration of the operation (for VATS; 75.7±18.4 min, for RATS; 73.5±18.0 min, p=0.674). Postoperative pain scores were similar [median 2.19 (1-3) for RATS and 2.20 (1-3) for VATS, p=1.00].

**Conclusion:** RATS and VATS are reliable procedures offering many advantages in treating mediastinal masses. Both procedures have similar results in terms of the complication rate, the length of the hospital stay, and duration of surgery.

**Keywords:** Mediastinal mass, thoracoscopic surgery, thymectomy

## Introduction

Mediastinal surgery presents many challenges due to the anatomical structure of the mediastinum and the large number of vital organs and tissues contained in it. Primary mediastinal masses include benign or malignant thymic tumors, neurogenic tumors, benign cysts, and germ cell tumors (1). Surgical resection of primary mediastinal masses is the gold standard treatment approach (2). As much as possible, minimally invasive surgical procedures should be preferred for resection of mediastinal masses (3).

Compared to open surgery, VATS offers many advantages, such as shorter operation time, lower complication rate, rapid postoperative recovery, minimal trauma, and better cosmetic appearance (4,5). Another method, RATS, has recently become an increasingly preferred minimally invasive surgical approach (6). Due to features such as high maneuverability, 3D visualization, and filtering hand tremor and not transferring it to the instrument, it allows tumor surgery in a narrow area such as the mediastinum to be performed safely and comfortably (1). Although there are many studies in the literature comparing minimally invasive surgical methods with open surgical approaches in treating mediastinal masses, the number of studies comparing VATS with RATS is limited (7).

Although there is a general acceptance that RATS and VATS are the first choice for resection of mediastial masses, there is no consensus on which procedure should be preferred. In our current study, we evaluated the surgical results of VATS and RATS and tried to determine the ideal of these minimally invasive surgical procedures.

## Methods

The ethics committee approval of this study was obtained from the Ethics Committee of Sakarya University Faculty of Medicine Non-Interventional Ethics Committee and was conducted following the principles of the Declaration of Helsinki (approval number: E-71522473-050.01.04-216185-09, date: 31.01.2023).

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The files of 52 patients who underwent minimally invasive surgical resection (VATS or RATS) in the thoracic surgery clinic for mediastinal mass between 2016 and 2022 were retrospectively evaluated. Patients who underwent sternotomy and thoracotomy for mediastinal mass resection were excluded.

Patients were analyzed in terms of gender, age, surgical method, mass location, operative time, operation side, complications, drainage amount, drainage time, pain score, length of hospital stay, and histopathological diagnosis parameters. Preoperative pulmonary function tests, biochemistry, hemogram, coagulation tests, and thyroid function tests (T3, T4, thyroid stimulating hormone were routinely evaluated in all patients. Mediastinal was examined using contrast-enhanced thoracic computed tomography (CT). alpha fetoprotein and ß-human chorionic gonadotropin levels were routinely measured in patients with anterior mediastinal masses. The histopathologic subtype evaluation of thymoma cases was performed according to the WHO classification (8).

### Surgical Method

Mediastinal mass resection was performed by RATS (n=29) or VATS (n=23). All patients were intubated with a double-lumen endobronchial tube under general anesthesia. For anterior mediastinal masses, patients were positioned on the operating table in a 30° semilateral decubitus position (30° anterior inclination) with the side to be treated on the upper side. The right side was preferred for surgical intervention in anterior mediastinal masses. In the RATS procedure, the arms of the robot were draped after sterilization and draping of the patient. Port locations were adjusted. For the left arm port, an 8 mm incision was made at the intersection of the midclavicular line and the 5$^{th}$ intercostal space (ICA); for the video thoracoscope port, a 12 mm incision was made at the level of the midaxillary line 5$^{th}$ ICA, and for the right arm port, an 8 mm incision was made at the intersection of the anterior axillary line and the 3$^{rd}$ ICA. We used three ports in all our cases. The camera port was enlarged and removed when the specimen was removed.

$CO_2$ insufflation of 10 mmHg was used to expand the surgical field. The same procedure was performed in patients undergoing VATS for anterior mediastinal mass. Tumor and thymus tissue were removed en bloc in patients with preoperative diagnosis of thymoma or in whom thymoma could not be excluded, and in patients with a diagnosis of myasthenia gravis (MG). The mediastinal pleura was opened anterior to the phrenic nerve on the lower side. Dissection was performed upwards. The innominate vein was seen, and the thymus veins were seen after a careful dissection. It was divided by placing bilateral clips. Both thymic horns were freed and removed by pulling. All thymus tissue was removed by placing it in an endobag with the surrounding adipose tissue. A number 28 thoracic catheter was placed in the mediastinal region, and the incisions were closed according to the procedure. The lateral decubitus position was preferred for surgery in patients with a mass in the posterior or middle mediastinum. The RATS procedure was performed by placing trocars in the sixth ICA of the midaxillary line, at the intersection of the anterior axillary line and the fourth ICA, and at the intersection of the posterior axillary line and the eighth ICA. The fourth and seventh ICAs were used as the trocar sites for VATS.

### Follow-up

All patients were admitted to the service on the first postoperative day. Intravenous non-steroidal anti-inflammatory drugs and paracetamol were routinely administered to all patients at four-hour intervals for postoperative pain control. Clavien-Dindo classification was used to classify surgical complications (9). Postoperative pain scores were calculated using the Numerical Rating Scale (NRS-11) (10). It was scored from 0 to 10, ranging from the least pain to the most severe pain. No pain was scored as 0, and unbearably severe pain was scored as 10. The NRS-11 score recorded 24 h postoperatively was used to measure postoperative pain (10). Thoracic drains were terminated when the total expansion was observed on the anterior-posterior chest radiograph (PA) of patients with daily drainage ≤100 mL/24 hours. Patients were routinely evaluated with hemograms, biochemical tests, and PA chest radiographs at 1 and 3 months postoperatively. Annual follow-up of the patients was performed using thoracic CT.

### Statistical Analysis

Data were entered into the Statistical Package and analyzes were performed using commercial software (IBM SPSS Statistics, version 23.0. Armonk, NY: IBM Corp.). The normality of the distributions was determined by Shapiro Wilk's test. Normally distributed variables were calculated as mean, non-parametric variables not showing normal distribution were calculated as the median. The numerical variables were presented as the median and interquartile range (IQR). It was decided to use Student's t-test for comparisons of continuous variables between groups. The comparative analysis of qualitative variables was compared by the chi-square test. The Mann-Whitney U test was used to compare the demographic and clinic characteristics of VATS and RATS groups. A p-value <0.05 was considered significant.

## Results

The mean age was 50.6±17.3 years (range: 17-80). 61.5% (n=32) of the patients were female and 38.5% (n=20) were male. 57.7% (n=30) of the mediastial masses were located in the anterior mediastinum. The distribution of clinical characteristics of patients undergoing VATS and RATS is summarized in Table 1.

The most common reason for admission was chest pain (46.2%, n=24). The most common postoperative pathology was thymoma (27%, n=14). According to the Masaoka staging system, [64.2% (n=9) stage 1, 21.4% (n=3) stage 2a], 14.2% (n=2) stage 2b thymomas were reported. Five of the patients with thymoma had a diagnosis of MG.

No surgical mortality was observed in any of our patients. Complications occurred in six patients (11.5%). Two (8.7%) of these complications occurred after VATS and four (13.8%) after RATS (p=0.682). When postoperative complications were evaluated according to the Clavien-Dindo classification, grade 1 complications (arrhythmia, atelectasis, prolonged air leak, wound infection) were seen in 4 patients and grade 2 (pneumonia, pulmonary embolism) in 2 patients. Negative suction with 5-10 mmHg pressure was applied in the patient with prolonged air leakage, and lung expansion was achieved. All patients improved with medical treatment.

**Table 1. The distribution of clinical characteristics of patients undergoing VATS and RATS**

| | | Total, n (%) | VATS, n (%) | RATS, n (%) | p |
|---|---|---|---|---|---|
| Gender | Male | 20 (38.5) | 9 (39.1) | 11 (37.9) | 1.000 |
| | Female | 32 (61.5) | 14 (60.9) | 18 (62.1) | |
| Location | Front | 30 (57.7) | 12 (52.2) | 18 (62.1) | 0.604 |
| | Middle | 6 (11.5) | 2 (8.7) | 4 (13.8) | |
| | Back | 16 (30.8) | 9 (39.1) | 7 (24.1) | |
| Operating position | Lateral decubitus | 33 (63.5) | 16 (69.6) | 17 (58.6) | 0.600 |
| | Semi-lateral decubitus | 19 (36.5) | 7 (30.4) | 12 (41.4) | |
| Postoperative complications | No | 46 (88.5) | 21 (91.3) | 25 (86.2) | 0.682 |
| | Yes | 6 (11.5) | 2 (8.7) | 4 (13.8) | |
| Symptom | No | 16 (30.8) | 11 (47.8) | 5 (17.2) | **0.038** |
| | Yes | 36 (69.2) | 12 (52.2) | 24 (82.8) | |
| Conversion to thoracotomy | No | 47 (90.4) | 20 (87) | 27 (93.1) | 0.644 |
| | Yes | 5 (9.6) | 3 (13) | 2 (6.9) | |

VATS: Video-assisted thoracoscopic surgery, RATS: Robot-assisted thoracoscopic surgery

Conversion to open surgery was required in a total of 5 patients [VATS group (n=3), 13% versus RATS group (n=2), 6.9%, p=0.644]. The distribution of complications, symptoms and surgical pathology results of VATS and RATS patients are summarized in Table 2.

The median length of hospital stay was five days [VATS; 4 days (IQR): 3-6] versus RATS; 5.5 days (IQR: 4-8), p=0.081]. The median drainage time was four days (IQR: 2-6), and the mean drainage amount was 110 mL (70 mL-190). There was no significant difference between the duration of the operation (for VATS; 75.7±18.4 min, for RATS; 73.5±18.0 min, p=0.674). Postoperative pain scores (NRS-11 score) were similar [median 2.19 (IQR: 1-3) for RATS and 2.20 (IQR: 1-3) for VATS, p=1.00]. A comparison of perioperative and postoperative variables in VATS and RATS is presented in Table 3.

The median drainage time was four days [VATS; 3 (2-5) versus RATS; 4.5 (3-7), p=0.133], and the mean drainage amount was 110 mL (70-190) (p=0.162). There was no significant difference between the duration of the operation (for VATS; 75.7±18.4 min, for RATS; 73.5±18.0 min, p=0.674). Postoperative pain scores were similar [median 2.19 (1-3) for RATS and 2.20 (1-3) for VATS, p=1.00].

The median follow-up time was 31 months. Adjuvant postoperative radiotherapy was performed in four patients due to capsular invasion and in one patient due to stage 2 type B3. In the 3rd year of follow-up, recurrence was observed in one patient (1.9%) in the RATS group. Reoperation was performed by the transsternal approach.

## Discussion

RATS and VATS, which are minimally invasive surgical methods, have recently become increasingly preferred in the surgical treatment of mediastinal masses because of their advantages. Compared to traditional open surgical methods, the generally accepted advantages include reduced operation time, less postoperative pain, rapid postoperative recovery, lower complication rate, lower risk of infection, and a better cosmetic appearance (11-13).

The introduction of VATS in the diagnosis of pleural and parenchymal diseases of the lung marked the beginning of a new era in the use of minimally invasive techniques in thoracic surgery. The adoption of VATS as the first choice for cancerous resections of the lung, thymectomy, and mediastinal tumor resections, which require more complex surgical procedures, has greatly increased our experience in minimally invasive methods (7). On the other hand, RATS provides a safer dissection thanks to its high image quality and 360-degree rotating articulated endo-wristed instruments. This technique especially provides great convenience to the surgeon in dissection of locally invaded mediastinal tumors. A limited number of studies have compared the outcomes of VATS and RATS in surgical treatment of mediastinal masses. Studies comparing RATS and VATS procedures were mostly based on thymectomy outcomes. In these studies, RATS was reported to be superior to VATS with less complication rate, less hospitalization time, and less drainage amount (12,14,15). Recurrence rates after thymectomy are reported to be 3-9% in the literature (16). In our series, one patient (1.9%) in the RATS group had local recurrence at 33 months postoperatively. The patient was reoperated by sternotomy.

Early complication rates in mediastinal mass surgery have been reported to be between 5%-14% for VATS and 3%-13% for RATS (6,7). In studies comparing VATS and RATS procedures for the resection of mediastinal masses, the overall postoperative complication rates after RATS have been reported to be significantly lower (7,17,18). In our study, unlike the literature, the postoperative complication rates of both procedures were similar (8.7% vs 13.8%, p=0.682).

Zeng et al. (7) reported that unplanned thoracotomy rates were significantly higher in the VATS group (p=0.04). In the study mentioned above, the total duration of hospitalization was significantly lower in the RATS group. In a study analyzing the early results and efficacy of RATS and VATS regardless of histology, the unplanned thoracotomy rate was 15% for VATS and 5% for RATS. Mortality was 2.3% for VATS and 1.0% for RATS. In that study, RATS was reported to have better outcomes compared with VATS, with a lower incidence of unplanned thoracotomy and a shorter postoperative hospital stay (3.8 d vs. 4.3 d, p=0.01) (19). Another study reported that RATS provided a shorter duration of hospitalization and less amount of postoperative pleural drainage compared with the VATS

**Table 2. The distribution of complications, symptoms, and surgical pathology results of patients undergoing VATS and RATS**

| | | Total, n (%) | VATS, n (%) | RATS, n (%) |
|---|---|---|---|---|
| Pathology | Bronchogenic cyst | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Bronchogenic cyst | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Epithelioid hemangioendothelioma | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Ganglioneuroma | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Cavernous hemangioma | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Lipoma | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Mesothelial cyst | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Müllerian cyst | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Teratoma | 4 (7.7) | 2 (8.7) | 2 (6.9) |
| | Paraesophageal cyst | 2 (3.8) | 1 (4.3) | 1 (3.4) |
| | Pericardial cyst | 12 (23.1) | 5 (21.7) | 7 (24.1) |
| | Schwannoma | 6 (11.5) | 3 (13) | 3 (10.3) |
| | Solitary fibrous tumor | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Thymic hyperplasia | 5 (9.6) | 2 (8.7) | 3 (10.3) |
| | Thymoma micronodular | 2 (3.8) | 1 (4.3) | 1 (3.4) |
| | Thymoma type A | 3 (5.7) | 3 (13) | 0 (0) |
| | Thymoma type AB | 5 (9.6) | 1 (4.3) | 4 (13.8) |
| | Thymoma type B1 | 2 (3.8) | 1 (4.3) | 1 (3.4) |
| | Thymoma type B3 | 2 (3.8) | 0 (0) | 2 (6.9) |
| Postoperative complications | No | 46 (88.5) | 21 (91.3) | 25 (86.2) |
| | Arrhythmia | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Atelectasis | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Pneumonia | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Pulmonary embolism | 1 (1.9) | 0 (0) | 1 (3.4) |
| | Prolonged air leakage | 1 (1.9) | 1 (4.3) | 0 (0) |
| | Wound site infection | 1 (1.9) | 0 (0) | 1 (3.4) |
| Presenting symptom | No symptoms | 16 (30.8) | 11 (47.8) | 5 (17.2) |
| | Chest pain | 24 (46.2) | 8 (34.8) | 16 (55.2) |
| | Shortness of breath | 5 (9.6) | 0 (0) | 5 (17.2) |
| | Cough | 3 (5.8) | 2 (8.7) | 1 (3.4) |
| | Back pain | 3 (5.8) | 1 (4.3) | 2 (6.9) |
| | Difficulty swallowing | 1 (1.9) | 1 (4.3) | 0 (0) |

VATS: Video-assisted thoracoscopic surgery, RATS: Robot-assisted thoracoscopic surgery

**Table 3. The comparison of perioperative and postoperative variables in VATS and RATS groups**

| | Total | | VATS | | RATS | | p |
|---|---|---|---|---|---|---|---|
| | n | Mean ± SD | n | Mean ± SD | n | Mean ± SD | |
| Age | 52 | 50.6±17.3 | 23 | 50.3±17.9 | 29 | 50.9±17.2 | 0.913 |
| Tumor diameter (mm) | 52 | 56.0±40.4 | 23 | 54.9±29.8 | 29 | 57.1± 37.0 | 0.919* |
| Operation duration (minute) | 52 | 74.5±18.0 | 23 | 75.7±18.4 | 29 | 73.5±18.0 | 0.674 |
| The length of stay hospital | 52 | 5 (3-7) | 23 | 4 (3-6) | 29 | 5.5 (4-8) | 0.081* |
| Chest tube removal (day) | 52 | 4 (2-6) | 23 | 3 (2-5) | 29 | 4.5 (3-7) | 0.133* |
| Chest tube drainage (mL) | 52 | 110 (70-190) | 23 | 90 (60-140) | 29 | 130 (80-205) | 0.162* |

*: According to Mann-Whitney U test [descriptive statistics were shown as median (IQR)], IQR: Interquartile range, VATS: Video-assisted thoracoscopic surgery, RATS: Robot-assisted thoracoscopic surgery, SD: Standard deviation

approach. In the same study, only one patient in the VATS group needed conversion to open surgery (20).

There was no surgical mortality in our series. There was no significant difference between the duration of the operation (VATS; 75 min vs RATS; 73 min). The length of the hospital stay was five days (VATS; 4 days vs RATS; 5.5 days, p=0.08). Conversion to open surgery was required in 5 patients. When we compared the RATS and VATS procedures, unlike the literature, we did not observe any difference in terms of the amount of bleeding, duration of operation, duration of hospitalization, amount of postoperative pleural drainage, and conversion rate to open surgery. Given that our RATS procedure results align with the literature, this could be attributed to our center has extensive experience in VATS applications. Major vascular bleeding is the most feared intraoperative complication in both VATS and RATS procedures. The RATS procedure requires more safety precautions than VATS because transitioning from RATS to open thoracotomy in emergencies takes longer than VATS (1). None of our patients had a major vascular injury or blood loss requiring transfusion.

### Study Limitations

The examination of a heterogeneous group with a retrospective design was the main limitation of our study. Since the number of patients was not sufficient, we could not compare the same type of tumor in the same location. However, the strengths of the study are that the same physicians performed standard surgical procedures, and the number of patients was sufficient for an accurate evaluation.

## Conclusion

The minimally invasive surgical methods RATS and VATS are effective and safe procedures offering many advantages in treating mediastinal masses. RATS and VATS procedures have similar results regarding complication rate, length of hospital stay, and duration of surgery.

**Ethics Committee Approval:** The ethics committee approval of this study was obtained from the Ethics Committee of Sakarya University Faculty of Medicine Non-Interventional Ethics Committee and was conducted following the principles of the Declaration of Helsinki (approval number: E-71522473-050.01.04-216185-09, date: 31.01.2023).

**Informed Consent:** Retrospective study.

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