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COMPARISON OF EARLY POSTOPERATIVE OUTCOMES OF PATIENTS UNDERGOING ROBOT-ASSISTED AND TRANS-STERNAL THYMECTOMY

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ABSTRACT

Objective: Robot-assisted thoracoscopic surgery (RATS) is a minimally invasive technique that has been used in thymectomy operations in recent years. Minimally invasive surgical techniques offer less postoperative pain, a shorter length of hospital stay, and faster recovery compared to conventional surgical techniques. In our study, we aimed to compare the outcomes of robotic and trans-sternal thymectomies by analyzing the operative and postoperative data of these two approaches. **Methods**: Twelve robotic thymectomy patients and 16 trans- sternal thymectomy patients who were operated on in our clinic in 2018 were included in the study. **Results:** There was no significant difference between the two groups in terms of operative time (p=0.231). The median chest tube duration was 1.5 [range, 1-2] days in robotic thymectomy and 2.5 [range, 1-3.75] days in trans-sternal thymectomy. However, there was no statistically significant difference between the two groups (p=0.082). The amount of chest tube drainage was significantly lower in the robotic thymectomy group (p=0.006). The length of hospital stay was also significantly shorter in robotic thymectomy patients (p<0.001). **Conclusion:** The amount of chest tube drainage was lower and the length of hospital stay was shorter in the robotic surgery compared to the trans-sternal approach. There was no significant difference between the two techniques in terms of operative time. Within today's minimally invasive surgical techniques, robotic thymectomy can be considered a practical, comfortable, and safe technique with better early postoperative outcomes.

Keywords: Robot-Assisted Thymectomy, Thymectomy, Trans-sternal Thymectomy.

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INTRODUCTION

Thymectomy is the surgical excision of the thymus gland to treat anterior mediastinal tumors and myasthenia gravis disease. Total excision of the thymus is recommended even in cases of partial involvement of the gland [1]. Different surgical approaches such as open surgery (sternotomy, thoracotomy) or minimally invasive surgery (cervicotomy, video-assisted thoracoscopic surgery (VATS)), and robot-assisted thoracoscopic surgery (RATS) have been described for this purpose. However, median sternotomy is still considered the gold standard approach for thymectomy operation

[2]. In recent years, with the rapid progress of surgical technology, there have been significant advancements in the field of thoracic surgery [1]. The use of robotic surgery in the field of thoracic surgery, especially for thymectomy, started in the early 2000s [3,4].

RATS systems have the capability of high mobility due to the multi-jointed precise surgical instruments that can move in seven planes. Due to its three-dimensional view, the surgical site can be visualized better and the surgical console helps the surgeon carry out manipulations without having tremors. Additionally, with the help of the three-dimensional view, the thymic tissue can be distinguished from the phrenic nerve and vascular structures more easily, safely, and precisely. The main drawback of robotic surgery is its high cost [5].

Robotic thymectomy causes less intraoperative blood loss and daily pleural drainage compared to the operations performed with sternotomy. The chest tube duration and the length of hospital stay of the patients are also shorter in robotic thymectomy cases [6]. Patients have less early postoperative pain with a faster recovery. Thus, patients return to their routine activities of daily living sooner with better cosmetic results [7].

In this study, we aimed to compare the operative and early postoperative outcomes of Da Vinci robot-assisted and trans-sternal thymectomy approaches.

MATERIAL AND METHODS

Twelve robotic thymectomy patients and 16 trans-sternal thymectomy patients who were operated on in our clinic in 2018 were included retrospectively in this study. The study included patients with an anterior mediastinal mass on the thoracic computed tomography (CT) or those undergoing thymectomy for myasthenia gravis. Patients' ages, genders, presence of myasthenia, comorbid diseases, operation dates and operative times, preparation time of robotic cases, number of chest tubes, amount of drainage from the chest tube and tube removal times, postoperative complications, the requirement for reoperation, length of intensive care and hospital stay were retrospectively analyzed. Statistical Package for the Social Sciences (SPSS) version 21 software was used for the analysis of the data. All patients' CTs were taken within the last month. Following evaluation with the multidisciplinary board, robotic thymectomy operation was recommended to patients with the diagnosis of myasthenia gravis who were thought to benefit from thymectomy and those with a small mass size and without any suspicion of anterior mediastinal invasion on the thoracic CT. All patients were informed about the procedures and consents were taken. All patients preoperatively underwent complete blood count, routine biochemistry examinations, postero- anterior chest x-ray, and electrocardiogram. Patients with comorbid diseases and pathological conditions that were revealed during the routine examinations underwent further preoperative examinations.

SURGICAL PROCEDURE

Robotic Thymectomy

All patients underwent selective intubation of the right main bronchus with a double-lumen endotracheal tube following induction of general anesthesia. The location of the endotracheal tube was confirmed with a bronchoscope. The patients were positioned with the left side up at 30° and the top of the shoulder below the body level. The first port was inserted at the intersection of the fifth intercostal space and the anterior axillary line. A 30° camera was placed through the port for further exploration. CO_2 insufflation was performed at a pressure of 6-8 mmHg and secured during the placement of other ports. Other ports were inserted through the third and seventh intercostal spaces. A spatula (EndoWrist; Intuitive Surgical, Sunnyvale, CA, USA) was utilized on the right arm and ProGrasp forceps (EndoWrist; Intuitive Surgical, Sunnyvale, CA, USA) on the left arm. In addition, an assistant port was placed. After the inspection, the dissection was usually started inferiorly, and the entire thymic tissue was excised without entering the contralateral hemi-thorax. The assistant port incision was approximately expanded (maximum 3 cm) and the thymus tissue was removed out of the thorax with the help of an endo bag. A 28 Fr chest tube was inserted through the same incision. All patients were extubated in the operating room and evaluated with post- operative postero-anterior chest x-ray, blood gas, complete blood count, and routine biochemistry tests.

Trans-sternal Thymectomy

All patients were intubated with a single-lumen endotracheal tube following induction of general anesthesia. All patients were placed in the supine position with their arms next to their bodies and underwent complete midline sternotomy. The thymic tissue, nearby connective and mediastinal adipose tissues were excised en bloc by opening the pleura bilaterally. A chest tube was placed to each

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hemithorax. All patients were extubated in the operating room, postoperatively transferred to the intensive care unit, and evaluated with posteroanterior chest x-ray, blood gas, complete blood count, and routine biochemistry tests. Pain management was same in both groups and included intravenous patient-controlled analgesia (PCA) and non-steroid anti-inflammatory drugs.

RESULTS

Twenty-eight patients included in the study (18 female and 10 male). Robotic thymectomy was performed in 12 patients. The median age of those undergoing robotic thymectomy was 31.5 [range, 28-40] years, while the median age of those undergoing trans-sternal thymectomy was 41.5 [range, 37-45] years.

There was no statistically significant difference between the two groups in terms of operative time (p=0.231). The median operative times were 140 [range, 105-215] and 135 [range, 100-150] minutes in robotic and trans-sternal groups, respectively. However, the robotic setup and the selective intubation time took an extra of 45 minutes in the robotic arm.

The histopathological examinations of the specimens in the robotic group included 3 thymic hyperplasia, 2 non-specific adipose tissue, 2 cysts, 2 thymoma, 1 normal thymus tissue, 1 schwannoma, and 1 papillary thyroid ca metastasis. Similarly. the trans-sternal group included 6 thymoma, 2 lymphoid hyperplasia, 2 thymic hyperplasia, 1 giant cell reaction, 1 thymic cyst, 1 scarce calcified lipoma, 1 thymic carcinoid tumor, 1 parathyroid adenoma, 1 non-specific adipose tissue lipoma (**Tables I and II**).

Table I: Characteristics, operative times and diagnoses of robotic thymectomy patients

(* The time for robotic setup and selective intubation, ** Tthe operative time includes the preparation time for surgery.)

Patient No	Gender	Age	Surgery Preparation Time (minutes)*	Operative Time (minutes)**	Histopathological Diagnosis
1	Female	42	35	95	papillary thyroid ca metastasis
2	Male	34	45	195	thymic cyst
3	Male	45	50	120	schwannoma
4	Male	22	45	150	non-specific adipose tissue
5	Female	52	45	225	non-specific adipose tissue
6	Female	27	50	220	thymus
7	Female	28	55	140	thymoma
8	Male	29	35	215	thymic hyperplasia
9	Female	30	45	135	thymoma
10	Male	31	45	105	thymic cyst
11	Female	32	30	105	thymic hyperplasia
12	Male	33	20	125	thymic hyperplasia

Table II. Characteristics, operative times and diagnoses of trans-sternal thymectomy patients

Patient No	Gender	Age	Operative Time (minutes)**	Histopathological Diagnosis
1	Male	34	115	giant cell reaction, cyst
2	Female	35	135	lymphoid hyperplasia
3	Female	36	90	lymphoid hyperplasia
4	Female	37	100	thymoma
5	Male	38	110	thymic cyst
6	Female	39	75	thymic hyperplasia
7	Male	40	150	scarce calcification adipose tissue lipoma
8	Male	41	135	thymic carcinoid tumor
9	Female	42	100	thymic hyperplasia
10	Female	43	100	thymoma
11	Female	44	165	thymoma
12	Female	45	155	parathyroid adenoma
13	Female	46	150	thymoma
14	Female	47	140	non-specific adipose tissue
15	Female	48	150	thymoma
16	Female	49	135	thymoma

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All trans-sternal thymectomy patients were followed up in the intensive care unit for one day. Conversely, patients who underwent robotic thymectomy were directly sent to the floor following early recovery. Only one trans-sternal thymectomy patient stayed in the intensive care unit for two days due to post-operative atrial fibrillation. None of our patients required perioperative blood transfusion and there was no need for reoperation for exploration.

The median chest tube durations were similar between the groups: 1.5 [range, 1-2] and 2.5 [range, 1-3] days in the robotic and trans-sternal thymectomy groups, respectively. The median chest tube drainage was significantly lower in the robotic group (155 [range, 35-252.5] and 325 [range, 177.5-598.7] ml in the robotic and trans-sternal groups, respectively, p=0.006). Similarly, the median length of hospital stay was significantly shorter in the robotic group (4 [range, 4-5] and 6.5 [range, 6-7] days in the robotic and trans-sternal thymectomy groups, p<0.001) (**Table III**). We were unable to compare pain scores due to missing data at the ward records.

Table III: Comparison of robotic and trans-sternal thymectomy groups

	Robotic thymectomy	Trans-sternal thymectomy	p value
Patient Number	12	16	
Operative Time (minutes)	140 [105-215]	135 [100-150]	0.231
Postoperative Complication	-	1	
Reoperation	-	-	
Chest Tube Duration (days)	1.5 [1-2]	2.5 [1-3.75]	0.082
Drainage Amount	155 [35-252.5]	325 [177.5-598.7]	0.006
Postoperative Transfusion	-	-	
Length of Hospital Stay	4 [4-5]	6.5 [6-8]	<0.001

DISCUSSION

Determination of the surgical strategy for thymectomy operations depends on several factors. These include the size and location of the lesion, the presence of local invasion, the surgeon's experience, and the patient's functional capacity. Until recently, sternotomy was considered the only approach that could guarantee complete removal of the thymus gland. However, robot-assisted thoracoscopic surgery has become common in recent years [5]. Robotic thymectomy operations have been performed since the early 2000s [3]. In 2003, Ashton et al. first performed a robotic thymectomy operation on a 28-year-old patient with myasthenia gravis using the Da Vinci robot system (Intuitive Surgical, Inc., Mountain View, California, USA) [4].

Robot-assisted surgery systems provide a three-dimensional view. They have the capability of high mobility due to the multi-jointed precise surgical instruments that can move in seven planes. Besides, fixing the robotic arms result in better stability during dissection [8]. Long docking time and high cost are the main disadvantages of the robotic surgical systems. The management of emergencies is also difficult in robotic surgery [9]. Robotic thymectomy has the potential to become one of the riskiest operations when performed by an inexperienced surgeon. Even surgeons with extensive experience in minimally invasive thymus surgery may face serious complications such as cardiac arrest, rupture of the aorta, or superior vena cava [10]. In case of an emergency that requires conversion to open surgery, undocking of the robotic system, sterilization of the operator, and extension of the incision by the table surgeon may take time [9].

A study by Casiraghi et al. comparing open and robotic thymectomy patients found no significant difference between the two groups in terms of operative time [11]. In their study, Buentzel et al. compared the data of 215 patients who underwent robotic thymectomy and 274 patients who underwent open thymectomy. Their meta-analysis revealed no significant difference in operative times [5]. Similarly, our study showed similar operative time in the two groups. However, when the learning curves of surgeons performing robotic thymectomy operations are examined, it has been shown that the operative time is significantly shortened as the number of surgeries performed and the experience of the surgeon increase. In a study which was conducted by evaluating operative time and perioperative estimated blood loss, it was stated that the learning curve of a surgeon for robotic thymectomy consisted of 15-20 cases [12].

The definition of "operative time" differs in the studies conducted. Balduyck et al. determined operating room occupation as the operative time [7]. While Casiraghi et al. defined it as the time from the first incision to the time of closure [11]. In general, the robotic setup and selective intubation time takes an extra 45 minutes. This additional time is included to the operative time of robotic thymectomy patients in our study. All trans-sternal thymectomy patients were followed up in the intensive care unit for one day, while robotic thymectomy patients were not followed up in the intensive care unit. Only one trans-sternal thymectomy patient stayed in the intensive care unit for two days due to postoperative atrial fibrillation, which was the only complication developed among all patients included in our study. None of our patients required intraoperative or postoperative blood transfusion, as well as reoperation. Cakar et al. retrospectively compared 10 patients who underwent trans-sternal thymectomy and 9 patients who underwent robotic thymectomy. Three complications developed in the trans-sternal thymectomy patients (30%) and two patients were reoperated. On the other hand, only one complication developed in the robotic thymectomy group [13]. In another study, 35 trans-sternal and 15 robotic thymectomy patients were compared, and it was reported that there were 20 postoperative complications and 1 postoperative death in the trans-sternal group, and 1 postoperative complication in the robot-assisted group [14]. The amount of drainage from the chest tube is less in robotic cases, which provides a shorter duration for the removal of the chest tube [6]. In our study, there was no significant difference in chest tube durations, but the amount of drainage from the chest tube was significantly lower in the robotic thymectomy patients. Most studies have shown that patients undergoing minimally invasive thymectomy have a shorter length of hospital stay compared to trans-sternal thymectomies [15, 16]. In a study by Orsini et al. on 278 patients comparing sternotomy, cervicotomy, and minimally invasive thymectomies, the length of hospital stay of minimally invasive thymectomies was reported to be shorter than that of the others [17]. Videothoracoscopic (VATS) and robotic surgery are both minimally invasive techniques. However, the amount of drainage is less and the length of hospital stay is shorter for robotic surgery compared to VATS [18, 19]. Among the minimally invasive techniques, the length of hospital stay was found to be shorter when solely robotic technique and sternotomy were compared which was also validated with our study [20, 21].

Robotic surgery is considered a superior minimally invasive technique compared to video thoracoscopic techniques. Although the lack of touch and strength sensations, which are very important in thoracic surgery, is problematic, it will be resolved eventually as surgeons gain experience and the technology evolves [22]. Despite these disadvantages, robotic surgery is safer than standard thoracoscopic techniques due to its three-dimensional and larger surgical field of view. In addition, with the help of high mobility of the instruments it facilitates better dissection of the thymic tissue.

LIMITATIONS

Although this study was performed retrospectively in a homogenous cohort of a single institution, the sample size was relatively small compared to the multicenter studies. This small sample size may limit the power of the analysis to detect significant differences. In addition, the robotic group involves patients who had smaller tumors and the pleura opened bilaterally in the trans-sternal group, which may both entail problems of selection bias. Besides, we were unable to compare short-term quality of life measures such as postoperative pain or general conditioning due to insufficient data. Prospective studies are needed to verify our results. Prospective studies are needed to verify our results.

CONCLUSION

In conclusion, we think that RATS is a practicable, comfortable, and safe technique with its ergonomic advantages and should be considered as the primary surgical approach for patients with thymic malignancies of the mediastinum.

ETHICS COMMITTEE APPROVAL:

This project was approved by the Ethics Committee of Hacettepe University (Decision No:2019/14-29).

CONFLICT OF INTEREST:

The authors have no conflict of interest to declare.

FINANCIAL DISCLOSURE:

The authors declare that this study has received no financial support.

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