Thymectomy (VATS, da Vinci)

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Jens C. Rückert, Marc Swierzy, Ralph I. Rückert, and Mahmoud Ismail

Introduction

Thymectomy is relatively indicated and most frequently performed in patients with the autoimmune disease myasthenia gravis. In particular, the indication for thymectomy, as well as the long-term improvement of myasthenia gravis, may depend on patient-derived factors such as gender, age, the severity of myasthenia, the duration of symptoms, the interval between diagnosis and thymectomy, the presence/absence of a thymoma, the serologic investigation (anti–acetylcholine receptor [anti-AChR], anti–muscle-specific kinase [anti-MuSK], or no antibodies), the amount of medication and necessity of immunosuppression, and other comorbidities. There is an absolute indication for thymectomy in patients with thymoma, an epithelium-derived tumor of the anterior mediastinum that may or may not be accompanied by myasthenia gravis. Other rare indications are ectopic mediastinal intrathymic parathyroid glands and different forms of multiple endocrine neoplasia with anticipated thymic carcinoma.

The anatomic location of the thymus gland between the neck and the mediastinum, as well as the stage of medical development, led to controversy in the first half of the twentieth century regarding whether to use a transcervical or transsternal approach to thymectomy. However, all the knowledge gained during subsequent decades on the autoimmune nature of myasthenia gravis, the basic role of the thymus gland, the potentially ectopic mediastinal thymic tissue distribution, and the different subgroups of myasthenic patients has not resolved the debate about the appropriate thymectomy approach.

Thoracoscopic thymectomy has been performed in the surgical department of the Charité University Hospital in Berlin and a few other centers worldwide since 1992. The operative technique was developed through stepwise scientific investigation and adapted for clinical use according to the principles of good clinical practice. The availability of thoracoscopy as a new operative technique has allowed a combination of maximum mediastinal exposure and minimum invasiveness. The guidelines of radical thymectomy according to Jaretzki were applied during the entire development of thoracoscopic thymectomy. All patient data were collected prospectively to evaluate the effectiveness of this approach.

Since then, most of the 14 operative techniques described in the literature were influenced by the success of thoracoscopic thymectomy. In 1997, a task force of the Myasthenia Gravis Foundation of America (MGFA) was assembled to propose a unified method for analyzing the results of thymectomy. Again, the true value of thymectomy was questioned because of the lack of prospective randomized trials proving the effectiveness of thymectomy for myasthenia gravis. The evidence-based review by Gronseth and Barohn of all related but nonrandomized comparative studies had the disadvantage of including only publications in which a nonsurgical group was presented. Therefore, all prospective, successful consecutive thymectomy series from most high-volume centers for

J.C. Rückert (✉)
Thoracic Surgery Division, Charité Campus Mitte, Universitätsmedizin, Berlin, Germany

Clinic for Visceral, Transplantation, Thoracic, and Vascular Surgery, Charité, University Hospital Berlin, Berlin, Germany
e-mail: jens-c.rueckert@charite.de

M. Swierzy
Thoracic Surgery Division, Charité Campus Mitte, Universitätsmedizin, Berlin, Germany

Department of General, Visceral, Vascular, and Thoracic Surgery, Universitätsmedizin Berlin, Charité, Berlin, Germany

R.I. Rückert
Thoracic Surgery Division, Charité Campus Mitte, Universitätsmedizin, Berlin, Germany

Department of Surgery, Franziskus Hospital, Berlin, Germany
e-mail: ralph.rueckert@franziskus-berlin.de

M. Ismail
Thoracic Surgery Division, Charité Campus Mitte, Universitätsmedizin, Berlin, Germany

Department of Radiology, Charité Berlin, Berlin, Germany
e-mail: mahmoud.ismail@charite.de

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myasthenia gravis were excluded. The marginal advantage for thymectomy versus nonoperative treatment of myasthenia gravis from that study was the basis for a complex worldwide prospective randomized study comparing the combination of thymectomy via complete median sternotomy and prednisone treatment for 2 years with prednisone treatment alone. In the 4 years since the study began, 97 active centers enrolled fewer than 100 of the 200 patients required. Thus, the experience of the centers performing at least one thymectomy in this study certainly is limited. If this trial proves a benefit from thymectomy, a minimally invasive approach to this procedure likely would become the method of choice.

Thymoma is the most frequently occurring tumor of the anterior mediastinum. In most cases, these tumors do not show cytologic criteria of malignancy; nevertheless, they have the potential for local infiltration, cellular spillage, intrapleural satellite growth, and recurrence. Their clinical and morphologic behavior led to the classification systems of Masaoka and the World Health Organization. The absolute indication for surgery requires a complete thymectomy, not a

Figure. 32.1

Minimally invasive thoracoscopic surgery using the three-armed da Vinci telemetric robotic system (Intuitive Surgical, Sunnyvale, CA). The procedure is performed under general anesthesia with single-lung ventilation. The patient is placed in the supine position on a vacuum mattress with the operating table tilted slightly to the patient's right. The left arm is positioned below the table level with flexion at the elbow. The surgeon and assistant initially stand left of the patient. The operative field is always prepared and draped for conversion to a median sternotomy or other cervical approach or right-sided thoracoscopy, if necessary. The 12-mm trocar for the binocular camera is placed in the fourth intercostal space at the left anterior axillary line. A thoracoscopic 10-mm camera with a 30° optic is introduced to evaluate the operative field and to help position the other two 8-mm trocars. The cranial trocar is introduced in the third intercostal space anterior to the anterior axillary line; the caudal trocar is located in the fifth intercostal space between the anterior axillary and the midclavicular line. Thus, all three trocars are placed exactly along the submammary fold. The special da Vinci trocars are connected to the three robotic arms of the table cart. Harmonic shears (Ethicon Endo-Surgery, Cincinnati, OH) are placed in the upper trocar and precision bipolar forceps in the lower one. No auxiliary trocars are necessary thymomectomy. Although even transcervical thymectomies have been performed for thymomas depending on their potential aggressiveness, the surgical community traditionally has defended the dogma that a median sternotomy is always required for treating these tumors. However, selected cases of nonadvanced thymoma have been treated successfully with the thoracoscopic approach.

Thoracoscopic thymectomy has a variety of modifications: the unilateral three-trocar approach from the left or right side, the use of additional trocars at the same or contralateral side, additional minithoracotomy, the bilateral approach, and an additional cervical and/or subxiphoid incision.

The latest modification of minimally invasive thymectomy is robot-assisted thoracoscopic thymectomy. This highly precise technique uses wristed instrument tips, provides a three-dimensional enlarged view, and allows a greater operative field, which are highly valuable for an extended radical thymectomy.

Figure 32.1

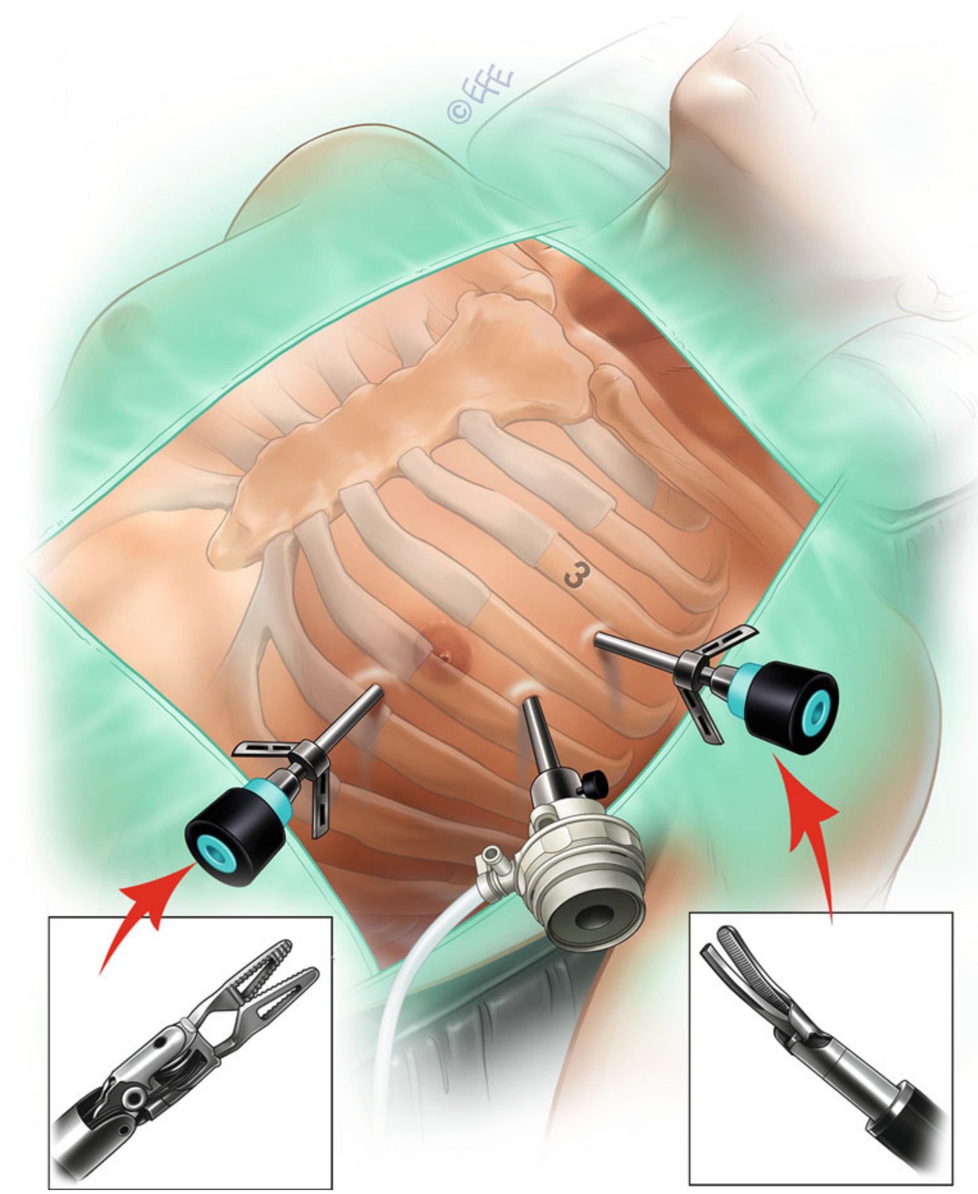


Figure. 32.2

The point of reference at the beginning of the dissection is the left phrenic nerve. The thymus gland may be partially visible depending on the amount of pericardial fatty tissue and the thymic histology. If there is a huge amount of fatty tissue, carbon dioxide may be applied initially. The dissection starts caudally in the middle of the pericardium along the left phrenic nerve. In younger, thinner patients, this area very often is completely free of fatty tissue, but in older, more obese patients, there is a lower fat district in the middle of the pericardium

Figure. 32.3

The dissection is started along the left phrenic nerve. In some cases, the thymus gland extends below or above the phrenic nerve. In these cases, it is necessary to isolate the phrenic bundle and completely mobilize the tissue in the aortopulmonary window. Further dissection is done cranially along the phrenic nerve until the cervical pleura is identified and opened at the entrance to the innominate vein

Figure 32.2

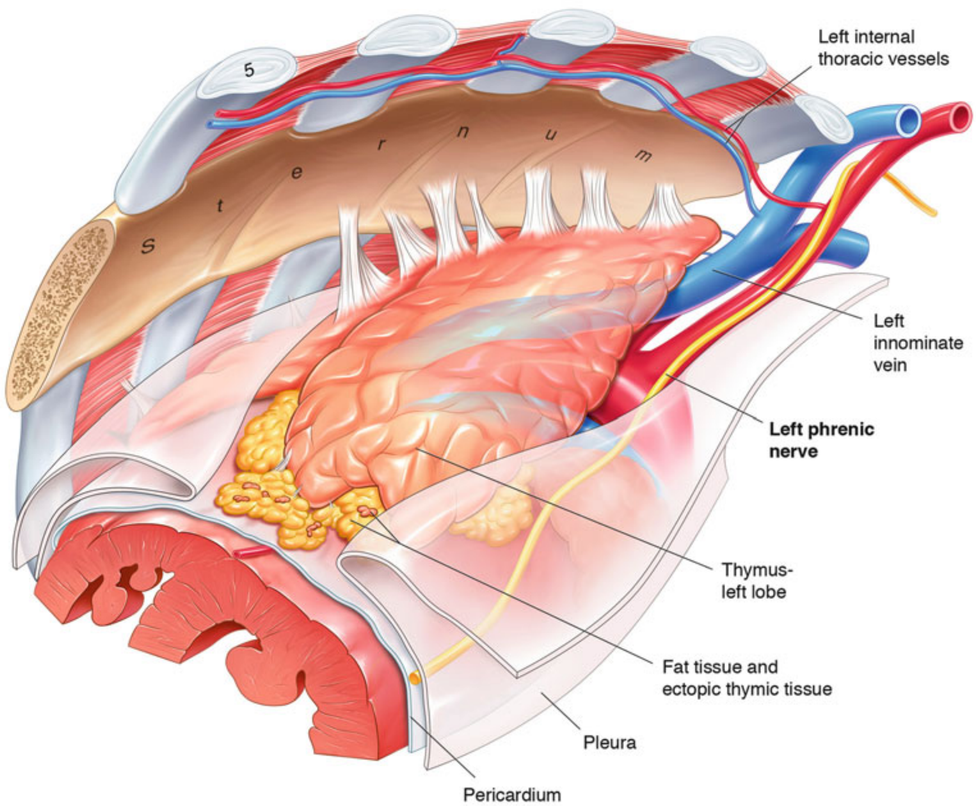


Figure 32.3

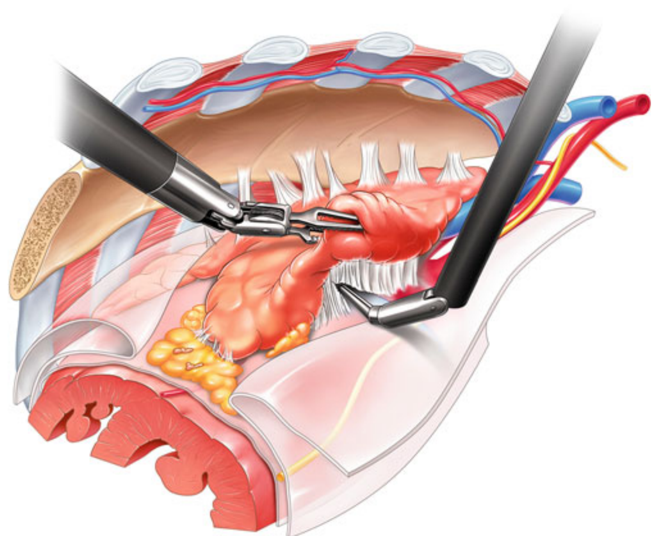


Figure. 32.4

Next, the retrosternal pleural incision is continued up to the jugular fold of the mediastinal pleura. To continue the preparation into the neck from behind the manubrium sterni, the mediastinal fold is incised. At this point, the anterior wall of the innominate vein is visible to the left of the phrenic nerve. Depending on the amount of fatty tissue in the anterior mediastinum, the vein may be located directly beneath the pleura or at a distance of more than 5 mm. Occasionally, a single central vessel, the so-called vein of Keynes, collects all the venous blood from the thymus gland for drainage into the innominate vein. In most cases, however, two to four thymic veins exist and must be dissected without injury to the innominate vein. The veins are divided between clip ligatures, although severing them with an ultrasonic scalpel also may be possible. Although rare, atypical locations of thymic veins must be considered

Figure. 32.5

The cervical pleural fold incision is extended to the median retrosternal line. The dissection is continued to the right side until it reaches the subxiphoid pleural fold. Beginning at the caudal pericardium, the tissue bloc is mobilized further on the pericardium. Depending on the patient's age, constitution, histology, and immune suppression status before surgery, the various local findings will dictate whether to perform an almost complete blunt dissection or a very subtle ultrasonic dissection of small vessels from the pericardium. With gentle blunt dissection, the right lung is made visible and is covered only by the right pleura parietalis. Whenever possible, the right pleural cavity should stay closed during this stage of the operation, which will allow the operative field to be extended by carbon dioxide insufflation

Figure 32.4

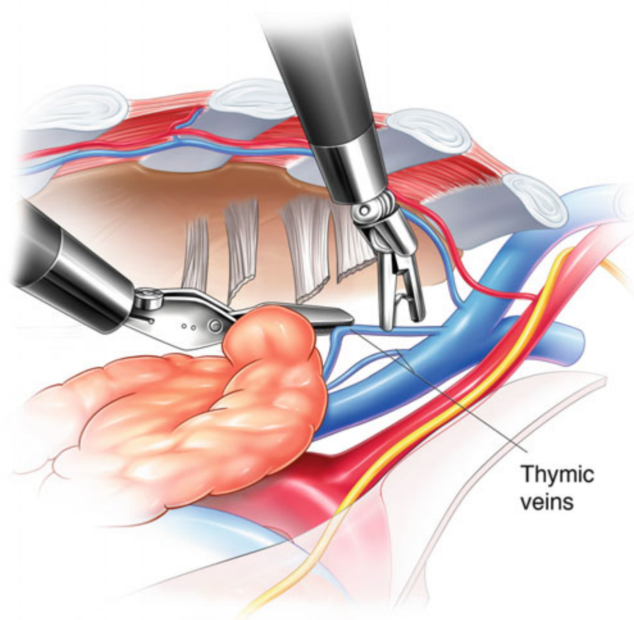


Figure 32.5

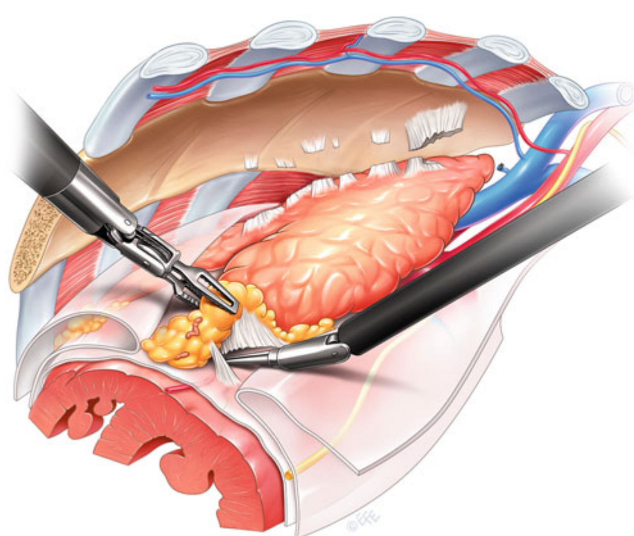


Figure. 32.6

Next, mobilization of both upper thymic poles is continued above the innominate vein. The shape of the upper poles is demarcated from the surrounding fatty tissue and may serve as an orientation. Special attention must be paid to the structures of the upper thymic poles, which in some cases may be located between the aortic arch and innominate vein. This anatomic variation can be handled easily with the da Vinci system's EndoWrist instruments. In most cases, the left lobe of the thymus gland is larger and more strongly configured, which is usually also true for the upper poles. Furthermore, the left thymic lobe is more intimately related to the phrenic nerve. The upper poles, mobilized after careful dissection of their capsule, are grasped gently and pulled downward. Patience is required for complete mobilization of each upper pole. At the cranial end, the thyrothymic ligament becomes clearly visible. Under tension of the completely exposed upper thymic pole, this ligament is severed by ultrasonic dissection or between clip ligatures

Figure. 32.7

The entire median retrosternal tissue portion is mobilized. Often, the right main thymic lobe may be demarcated from the surrounding fatty tissue. The right thymic pole is prepared under carbon dioxide insufflation. The aortocaval groove is dissected free, and the right lung, covered only by the mediastinal pleura, and the right phrenic nerve are exposed

Figure 32.6

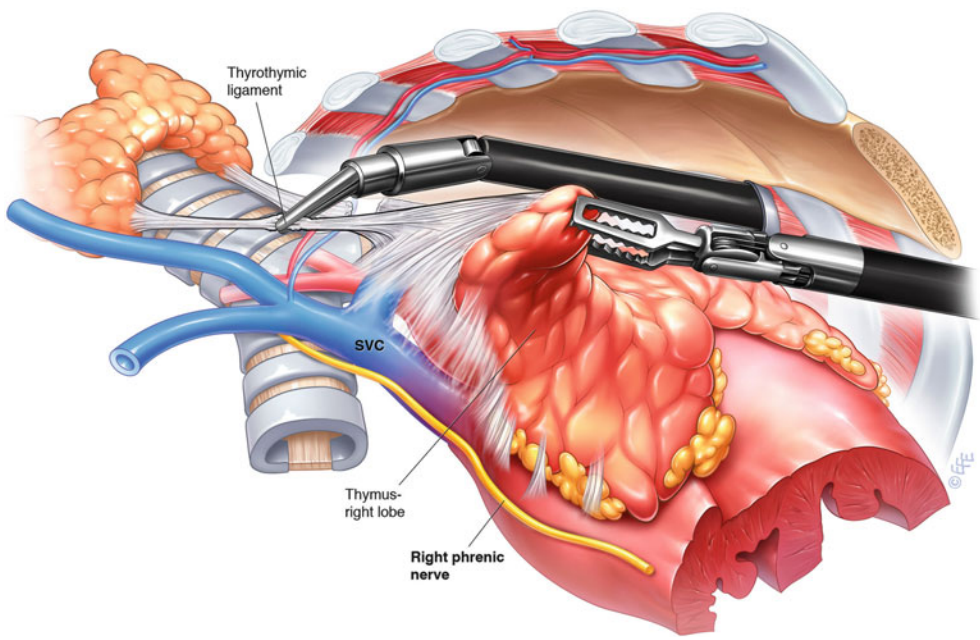


Figure 32.7

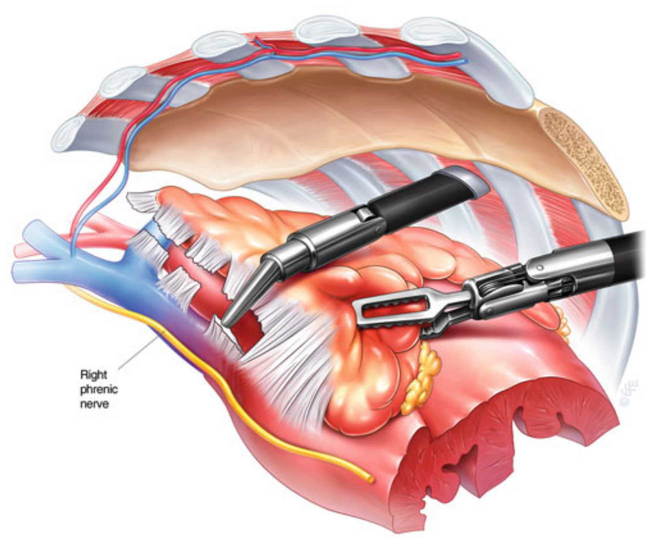
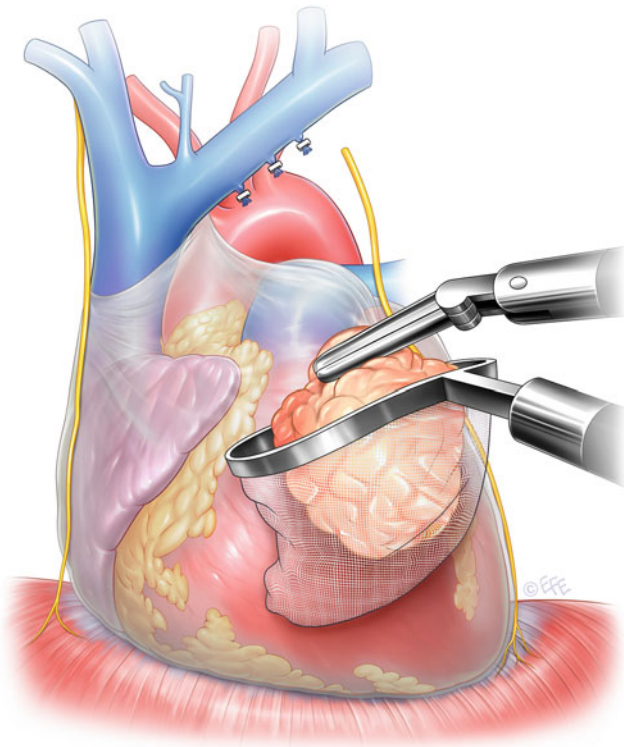


Figure. 32.8

The en bloc resected thymus specimen, including all surrounding fatty tissue, is placed in an Endobag (Covidien Surgical, Mansfield, MA) and removed through the middle trocar incisions. The operative field with the venous confluence, supra-aortal arteries, and parts of the anterior tracheal wall is examined for the presence of residual tissue and hemostasis. A chest tube is placed in the left pleural cavity. Both lungs are reinflated, then the trocar incisions are closed. After the operation, the patient is extubated immediately and placed on patient-controlled analgesia; peridural analgesia is not required. The chest drain is removed if postoperative chest radiography shows normal findings and the amount of secretion is below 100 mL during the first 12 h postoperatively. Patients may be discharged on days 2–4 after thymectomy

Figure 32.8



Conclusion

This chapter describes mainly unilateral, left-sided, three-trocar thoracoscopic thymectomy in detail. This minimally invasive thoracoscopic operative technique for thymectomy has been proven feasible and safe. The perioperative morbidity rate is reported to be less than 2 %. The risks of thoracoscopic thymectomy include incomplete removal of the thymus gland, nerve (phrenic, laryngeal recurrent, and intercostal) injuries, and bleeding (from the innominate vein and tributaries, aortic arch, and mammary vessels). For complete thymic resection, each step of the technique must be controlled. If the procedure cannot be completed satisfactorily, an extension is required; however, this does not necessarily mean a conversion as the first step, perhaps only the effective use of extra incisions or trocars. A rapid conversion to sternotomy, however, should be possible any time during thoracoscopic thymectomy. Exceptional care must be taken during dissection around the mediastinal vessels to prevent bleeding. The cosmetic results are very acceptable and highly appreciated by patients. Moreover, there is no interference with immunosuppression. After robotic thymectomy, a sternotomy may be easier if necessary in the future. Patient impairment due to this operation is minimal. According to our experience, the development of chronic pain at the trocar sites is very rare. Up to 2002, we performed 80 thoracoscopic thymectomies without robotic assistance, and since 2003, we have performed more than 280 robotic thymectomies. In 2009, 360 robotic thymectomies were registered worldwide. The actual number of these operations might be even greater and is increasing rapidly. A special advantage of robotic assistance is its practicability even for limited indications, such as small children, obese patients, and older patients with large amounts of tissue inside the mediastinal area. Robotic thymectomy also can be applied in select cases of thymoma. Meanwhile, in the surgical department of the Charité University Hospital in Berlin, a prospective series of 50 patients is under evaluation. The main outcome parameter after thymectomy for myasthenia gravis is the cumulative complete stable remission rate of myasthenia symptoms. This was prospectively estimated according to MGFA recommendations. After robotic thymectomy, the cumulative complete stable remission rate was 58 %, which is comparable to the results published by the Jaretzki group and others.

Actually, the number of clinics offering robotic thymectomy is increasing. During the past 15–20 years, patients and their neurologists have preferred a less invasive yet radical approach to thymectomy, and robotic thymectomy is suitable for that purpose. Differences in opinion regarding the complexity and application of various modifications of thoracoscopic thymectomy are a result of differences among surgical schools, in the surgeon's experience with a certain technique, in the availability of equipment, and in consideration of patient-related aspects.

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