CHAPTER 20

Open Videoassisted Techniques: Thoracoscopic Extended Thymectomy with Bilateral Approach and Anterior Chest Wall Lifting

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Rationale

A thymectomy is now generally accepted as a major option of treatment for myasthenia gravis (MG) patients, both with and without thymomas. In recent years, developments in endoscopic surgical procedures have achieved the benefit of less invasiveness, though that has led to discussion regarding the most suitable surgical approach. The rationale for choosing a thymectomy for nonthymomatous MG is based on its function to remove the germinal centers (GCs) in the thymi, where acetylcholine receptor (AChR)-specific B cells clonally proliferate, and differentiate into antibody producing cells with a high affinity, as demonstrated by the author when working with Willcox [1, 2]. In addition, we found that a decrease in antibody titer 1 year after a thymectomy had a significant inverted correlation with the number of GC B cells in thymic lymphocytes in those patients [3]. Further, the author and Willcox reported that lymphocytes in remnant thymi adjacent to tumors spontaneously produce anti-AChR antibodies in MG patients with a thymoma [4]. Importantly, thymic glands are widely scattered in gross adipose tissue even outside of the mediastinal thymus [5, 6]. Therefore, the final goal of surgery is a total thymectomy, which means removal of as much thymic tissues as widely as possible in the mediastinum. Masaoka and Monden examined the prognoses of patients thymectomized in Osaka University Hospital and defined an extended thymectomy procedure for MG treatment by proposing a benchmark of the feasible area [7]. Since then, that procedure under a median sternotomy has been performed for MG at Osaka University. When introducing an endoscopic approach for a thymectomy used to treat MG patients in 2002, we confirmed that the same amount of clearance of the thymus including adipose tissue could be achieved under a thoracoscopic surgery approach. One of the authors reported the first experiences of video-assisted thoracoscopic surgery (VATS) with a novel chest wall lifting method for some benign mediastinal tumors [8], after which we added some modifications to apply it for an extended thymectomy for MG.

Indication and Preoperative Management

Patients with generalized symptoms and positive for the anti-AChR antibody are encouraged to undergo a VATS thymectomy. Those with a thymoma who have anti-AChR antibodies, even without myasthenic symptoms, also require an extended thymectomy including the tumor using a VATS procedure, unless image findings clearly show tumor invasion. At the present time, we do not plan an operation for the patients with anti-muscle-specific kinase (MuSK) autoantibodies. We usually plan the operation as soon as possible after diagnosis without introducing steroids. However, patients with severe bulbar symptoms are treated with low-dose steroids before the operation.

Techniques for Video-assisted Thoracoscopic Extended Thymectomy

Anesthesia Management

General anesthesia with an endotracheal double-lumen tube is necessary for selective unilateral pulmonary ventilation. Muscle relaxants are not allowed, because some MG patients are hypersensitive to them. Further, intravenous glucocorticoids are administered to patients treated with steroids before the operation.

Operative Position

The patient is placed in a supine position, and after a small pillow is inserted behind the back, both arms are placed just beside the chest (Fig. 20.1). This position is important to provide a wide area at the side chest walls for instrument and scope excursion. Outward rotation of the arms often disturbs free excursion during the diaphragm procedures. This back pillow forces the neck to become slightly extended, allowing easy access to the cervical procedures, and is also effective in emergency sternotomy cases. The operating table is rotated for easy access to the anterior mediastinum, thus both sides of the hips should be firmly guarded. Draping to gather fatty breasts medially can be useful for wide exposure of side chest wall. We successfully operated on a woman with breast implants without causing an injury by using such a draping maneuver.

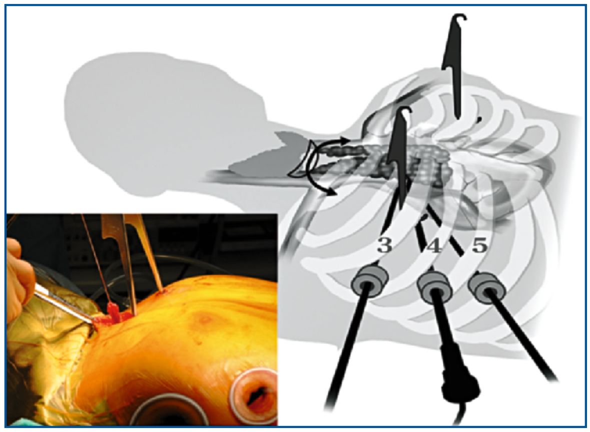

Fig. 20.2 An open direct approach for the dissection of the upper poles of the thymus, which provides a clearance of 3.2% more for cervical fat tissues [9]. The photo shows the upper poles isolated through a neck incision, which cannot be achieved from the pleural cavity

Operative Approach

Our standard procedure comprises (1) a bilateral intrathoracic approach, (2) lifting of the anterior chest wall to attain a wide view and an easy access in the anterior mediastinum, and (3) a direct open approach through a neck incision to counter the disadvantage of VATS by providing a better access to the upper poles of the thymus [9]. Basically three trocars are positioned in the bilateral pleural cavities. Recently, we prefer a mini-thoracotomy in place of the two cranial trocars with wound edge protectors (Lap-Protector, Hakko, Japan) (Fig. 20.2). The original custom-made costal hooks can now be purchased from Sonne Medical Instruments (Tokyo, Japan) after a slight modification (Fig. 20.1). Both hooks are connected with a laparoscopic lifting device (VarioLift, Aesculap, Tokyo, Japan) and the chest wall can usually be lifted about 3 cm with a power of 10 kg. An assistant surgeon holding an endoscope stands alongside the operator. Direct dissection of the upper poles is performed after a bilateral VATS procedure. We always make sure to isolate the thymic tissues from the backside of the sternum during the last stage of the operation, in order to keep the effect of lifting at maximum.

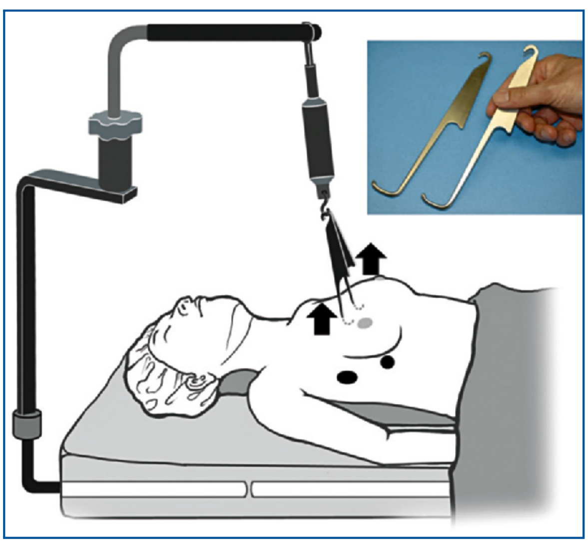

Fig. 20.1 Operative position. Our basic approach utilizes 3 trocars, though recently we prefer to use a mini-thoracotomy and 1 trocar positioned through the bilateral side chest wall. The anterior chest wall is lifted about 3 cm upward using the costal hooks connected to a lifting device

The most difficult manipulation during thymectomy is safe dissection of the thymic veins and exposure of the left brachiocephalic vein (LBV). Thus, preoperative identification of these veins using multidetector-low CT scanning is useful, as we reported previously [10] (Fig. 20.3).

Surgical Technique

In cases that undergo bilateral VATS, fewer switches are required for unilateral ventilation. We prefer to start with exploration of the right cavity. A 10-mm trocar is introduced through the fifth intercostal space at the anterior axillary line for a 30° oblique camera. After confirming that lung collapse is adequate and there are no anesthesia complications, a vertical skin incision of about 3 mm is made 2 cm lateral of the sternum at the upper edge of the third rib. These scars become indistinct late after the surgery. We make sure not to injure the internal thoracic artery and intercostal vessels when inserting the costal hooks, which catch

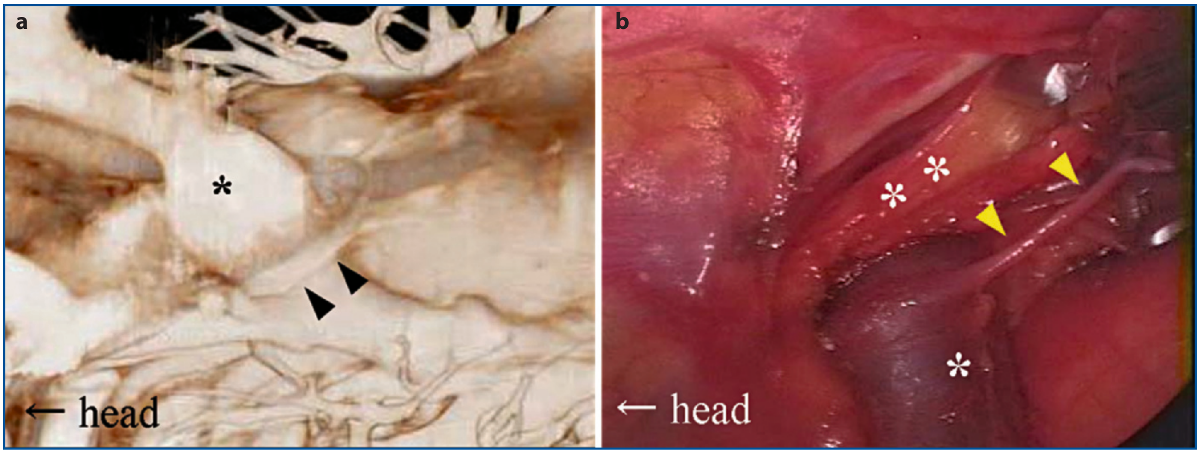

Fig. 20.3a,b **a** Three-dimensional image based on multidetector-low CT imaging showing the thymic vein (*arrowheads*) is shown in a position identical to that found during VATS in the right pleural cavity (**b**). Preoperative information regarding actual numbers and branching patterns is helpful for safer manipulation during this most delicate stage [10]. *Left brachiocephalic vein. ** The thymus (used with permission of Springer-Verlag, Heidelberg)

the third ribs. After switching the collapse of the right lung to the left, the left costal hook is inserted in the same manner by visualization through the left fifth intercostal space. Two more trocars are then placed through the third and fourth intercostal spaces, and dissection of the left lobe can be started after a full lift of the anterior chest wall.

The left mediastinal pleura is incised just anterior to the phrenic nerve: the lateral boundary of an extended thymectomy. The thoracoscopic view can easily identify the nerves, even if the thick fat tissues are extended beyond it, in which case an ultrasound energy source is useful for bloodless division. By careful dissection of cephalad thymic tissues in the left cavity, the most upper part of the LBV can usually be identified. During exposure of the LBV when medially extended, the thymic veins can be identified and then divided using a recently introduced ultrasound energy device (Fig. 20.4). When the LBV cannot be easily found, we try to expose it in the right pleural cavity. Blunt dissection can be safely performed on the pericardium and the diaphragm, so that isolation of the thymus extends to the right side. However, identification of the contralateral phrenic nerve is difficult at this moment. Leaving the upper portion extending to the neck, we finally dissect along the backside of the sternum.

The collapsed side is then switched and two more trocars are added to the right cavity. The pleura anterior of the phrenic nerve are incised and the thymic tissues are separated from the underlying pericardium extending onto the aorta. The bridging vein from the internal thoracic vein to the superior vena cava (SVC) can be preserved, unless it severely disturbs access to the upper portion. The SVC is a good landmark for identification of the LBV in the right cavity. Exposure of the LBV is carefully extended to the left side and some remaining thymic veins may be identified. When the mediastinal pleura is dissected behind the sternum, the thymus and fat tissue, except for the upper poles, become free from the mediastinum. The connective tissues around the upper poles should be dissected before neck manipulation.

Next, we add a 2-cm low collar incision, which is usually caught up in a wrinkle later. After the neck muscles are divided, the fibrous cords between the thyroid and thymus are exposed. We dissect it using

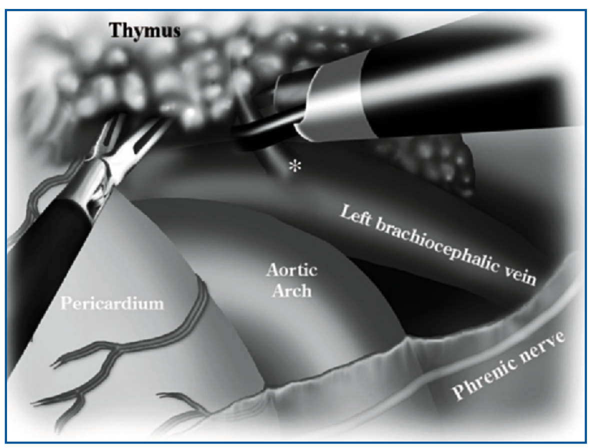

Fig. 20.4 View of the anterior mediastinum through the left pleural cavity. The thymus is mobilized upward and the left brachiocephalic vein is exposed. The thymic veins (*) are cut using an ultrasound energy device. The phrenic nerve is easily visible with a thoracoscope

electric cauterization, and mobilize the upper poles by inserting a finger in front of the trachea and behind the manubrium. Both lateral sides of the poles are carefully dissected with an electric cautery to ensure that the recurrent laryngeal nerves are not injured (Fig. 20.2). A combination of thoracoscopic views makes this stage more comfortable to perform. Finally, all thymic tissue can be removed from the cavity. After removal of the costal hooks, both cavities are explored to ensure hemostasis and complete resection. A silicon chest tube is then placed from one cavity to another through the anterior mediastinal bed, which is usually removed the next day.

Postoperative Management

The patient is extubated immediately after the operation when respiration is fully recovered. Cholinesterase inhibitors are resumed at a half dose and steroids are only introduced when the symptoms are not well reduced by their administration. Immunosuppressants are resumed at the same dose after the operation.

Results

A total of 42 patients have undergone a bilateral VATS extended thymectomy with our anterior chest wall lifting method as a standard procedure since 2002 at Osaka University Hospital, of which 28 were nonthymomatous MG cases, and the remaining 14 patients had thymomas. In 2 female MG patients without tumors, conversion to a sternotomy was necessary, because of bleeding at the confluence of the thymic vein with the LBV. VATS could not be performed in another patient, because unilateral ventilation caused intolerable hypoxia during the thoracoscopic exploration. In that case, it seemed likely that severe obesity disturbed ventilation while in the supine position. As for patients with a thymoma, 2 needed a sternotomy, because of tumor invasion to the pericardium. In another with lung invasion by a thymoma, a partial lung resection was done using endoscopic staplers and VATS was completed.

The median diameter of tumors resected from our patients was 3.5 cm (range, 1.5 to 9.5 cm). No deaths within 90 days of surgery occurred and no transfusion was needed, including converted cases. Further, there was no significant morbidity, except for a pulmonary embolism that occurred in a female patient, who recovered well with oxygenation and anticoagulation therapy. A neck incision was not performed in 3 patients, because of either a tracheotomy scar, a short neck caused by severe obesity, or patient choice. One male patient suffered from hoarseness caused by the recurrent laryngeal nerve paralysis, which may have originated during the neck procedure. The average time period for the operation was 237 min for nonthymomatous patients and 273 min for those with a thymoma, while, the average blood loss in those groups was 135 and 252 g, respectively, including converted cases. Five patients without and 1 with a thymoma required reintubation in the operating or recovery room because of deterioration of MG.

The postintervention symptoms in 38 of the patients who underwent a thymectomy and completed by VATS were evaluated using MG-ADL score. The median length of follow-up was 38 months (range, 3 to 69 months). Status was classified into 5 groups, i.e., remission, improvement, no change, more medication and/or worse symptoms, and death caused by MG, then remission rate (RR) and palliation rate (PR) were calculated as described previously [11] (Fig. 20.5). Three patients without a tumor and 2 with tumors attained remission for at least 1 year, and were classified as Complete Stable Remission (CSR) as defined by the MGFA (Myasthenia Gravis Foundation of America) Postintervention Status classification [12].

Controversy remains regarding which approach is most suitable for a thymectomy used to treat MG [12]. What makes it complicated seems that there are no objective or integrated parameters for MG symptoms, and that other treatment modalities are usually combined. The MGFA proposed some valued clinical classifications and advocates life-table analysis as the best method for follow-up of MG patients [12]. However, we still doubt the application of their

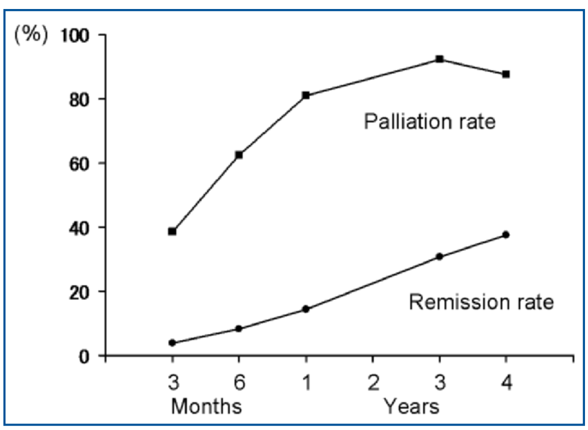

Fig. 20.5 Remission and palliation curves of nonthymomatous MG patients who underwent a thoracoscopic extended thymectomy

recommendation, because relapsed patients after remission cannot be evaluated. Another reason is that improved status is not taken into account in long clinical courses of MG. Particularly in Japan, both medical staff and patients tend to be against treatment with steroids, thus a longer period of time may be required to attain remission. We have adopted the evaluation described by Masaoka for comparison between endoscopic and transsternal approaches in larger series.

Unfortunately, the Thymectomy Classification by the MGFA grouped together various surgical procedures only according to the primary approach. Further, Jaretzki states that removal of the thymo-fatty tissue on the pericardium is not certain in "T-2: Videoscopic Thymectomy" [12]. However, skillful use of a thoracoscope allows better operative views and manipulation as compared to open surgery, i.e., along the phrenic nerve and near the diaphragm. Considering the final goal of the operation, which is total removal of as much thymic gland as possible, the most objective parameter for evaluation of surgical approaches is the amount of removed tissue by the procedure. We previously reported results of a prospective study that indicated the necessity of an additional open approach in the neck, which would lead to the removal of additional fat tissue including the glands below the thyroid [9]. Also, it is important to note that the average weight of the removed tissue in the present series was slightly higher than that in our previous series of patients who underwent a transsternal extended thymectomy, though the difference were not statistically significant (data not shown). Therefore, we consider that our endoscopic approach should be substantially classified into the same category as "T-3(b), Transsternal Extended Thymectomy" in MGFA classification [12].

We believe that use of our thoracoscopic thymectomy method can achieve a proper balance between invasiveness and radicality, leading to improved acceptance and benefits for MG patients.

Acknowledgement

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