TECHNIQUE OF THE TRANSCERVICAL-SUBXIPHOID-VIDEOTHORACOSCOPIC MAXIMAL THYMECTOMY

TRANSSERVİKAL-SUBKSİFOİD-VİDEOTORAKOSKOPİK MAKSİMAL TİMEKTOMİ TEKNİĞİ

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Abstract

The aim of this study was to present the new technique of transcervical-subxiphoid-videothoracoscopic "maximal" thymectomy for myasthenia gravis introduced by the authors of this study. From 1.9.2000 to 31.12.2011, 415 patients with nonthymomatous Myasthenia Gravis (MG) and 22 patients with thymoma were operated on. Patients with MG and with an Osserman score I-III were included. The operation is performed through four incisions: a transverse 5-8 cm incision in the neck, a 4-6 cm subxiphoid incision and two 1 cm incisions for videothoracoscopic (VTS) ports. The cervical part of the procedure is performed with an open technique, the intrathoracic part of the procedure is performed with the videothoracoscopy assisted (VATS) technique. The whole thymus with the surrounding fatty tissue containing possible ectopic foci of thymic tissue is removed. An operation can be performed by one surgical team or by two teams working simultaneously. The early and late results and the incidence and localization of ectopic thymic foci are presented. Mean operative time was 201.5 min (120-330 min) for the one-team approach and 146 (95-210 min) for the two-team approach ($p<0.05$). There was no postoperative mortality and the postoperative morbidity was 9.2%. The incidence of ectopic thymic foci was 65.9%. The rates of complete remission after 1-, 2-, 3-, 4- and 5-years of follow-up were 25.0%, 36.8%, 43.2%, 47.8% and 51.2%, respectively. The transcervical-subxiphoid-VTS maximal thymectomy is a complete and highly effective treatment modality for myasthenia gravis and for early-stage thymomas

Key words: Myasthenia, thymectomy, thymus, mediastinum, videothoracoscopy (VTS), videothoracoscopy-assisted (VATS)

Özet

Bu çalışmanın amacı bu çalışmanın yazarları tarafından ortaya konan myastenia gravis için transservikal- subksifoid videotorakoskopik maksimal timektomi tekniğini sunmaktır. 01.09.2000 tarihinden 31.12.2011 tarihine kadar 415 timoması olmayan Myastenia Gravis hastası ve 22 timomalı hasta opere edilmiştir. Myastenia gravis'i olan ve Osserman skoru 1-3 arasında olan hastalar çalışmaya dahil edilmiştir. Operasyon; boyuna yapılan 5-8 cm'lik transvers insizyon, 4-6 cm'lik subksifoid insizyon ve iki adet 1 cm'lik, videotorakoskopik portlar için açılan insizyonlar olmak üzere 4 insizyonla yapılır. Prosedürün servikal kısmında açık teknik, intratorasik kısmında ise VATS tekniği kullanılır. Ektopik timik doku odağı içerme ihtimali olan çevre yağlı doku ile birlikte timus dokusunun tamamı çıkarılır. Bir operasyon tek bir cerrahi ekip ya da eş zamanlı çalışan iki cerrahi ekiple gerçekleştirilebilir. Burada erken ve geç dönem sonuçları, ektopik timik odakların insidansı ve lokalizasyonları sunulmaktadır. Tek cerrahi ekip yaklaşımında ortalama operasyon süresi 201.5 dk. (120-330 dk) olurken, iki cerrahi ekip yaklaşımında ise 146 dakika olmuştur (95-210 dk) ($p<0.05$). Postoperatif mortalite olmayıp, postoperatif morbidite ise %9.2 oranında görülmüştür. Ektopik timik odak insidansı %65.9 olarak bulunurken. Sırasıyla 1-, 2-, 3-, 4- ve 5- yıllık tam remisyon oranları %25, %36.8, %43.2, %47.8 ve %51.2 olmuştur. Transservikal-subksifoid-VTS maksimal timektomi Myastenia Gravis ve erken evre timomalar için eksiksiz ve oldukça etkin bir tedavi yöntemidir.

Anahtar kelimeler: Myastenia, timektomi, timus, mediasten, videotorakoskopi (VTS), videotorakoskopi-yardımlı (VATS)

INTRODUCTION

The beneficial effect of thymectomy on myasthenia gravis (MG) has been generally recognized by most neurologists and thoracic surgeons, although no prospective randomized studies have never been performed to compare the results of operative and conservative treatment of the disease (1-3). The choice of the best technique for thymectomy is still a matter of debate. There are several methods of thymectomy

performed through the transsternal, transcervical, videothoracoscopic (VTS) and subxiphoid approaches (4-8). In this report we present the technique of transcervical-subxiphoid-VTS "maximal" thymectomy, developed by the authors of this study (9).

Surgical Technique

The operative technique of this procedure is as follows: a patient is positioned supine on the operating table with a roll placed beneath the thoracic spine to elevate the chest and to hyperextend the patient's neck. Under general anaesthesia, an endobronchial tube is inserted to conduct selective lung ventilation during the latter part of the procedure. To shorten the operative time and to facilitate performance of the procedure, an operation may be performed by two teams-one called the "cervical team" working from above and the second called "the subxiphoid team" working from below the sternum with control of the videothoracoscope (VTS). The position of all four members of both surgical teams and the scrub nurse is shown in Figure 1. The concept of performing simultaneous dissection by two surgical teams is shown in Figure 2. Alternatively, the whole operation is performed by one surgical team performing "the cervical" and "the subxiphoid" parts of the operation sequentially.

All operative steps are described without specifying whether one or two teams are involved.

The cervical part of the operation: A transverse 5-8 cm incision is made in the neck above the sternal notch. The platysma and superficial cervical fascia are divided, the anterior jugular veins are divided and suture-ligated. The strap muscles are split along their median raphe and retracted laterally. The whole thyroid gland is visualized and all foci of adipose tissue are removed downwards from the level of the upper poles of the thyroid gland. The parathyroid glands and both laryngeal recurrent nerves are visualized and carefully preserved (Figures 3 and 4). The fatty tissue containing the superior poles of the thymus is separated from the lower poles of the thyroid gland with 1-4 inferior thyroid veins ligated and divided (Figure 5). Alternatively, such devices as a harmonic knife, LigaSure or vascular clips can be used to secure the vessels throughout the procedure. The thymus with the surrounding fat is then separated from the sternohyoid and sterno-

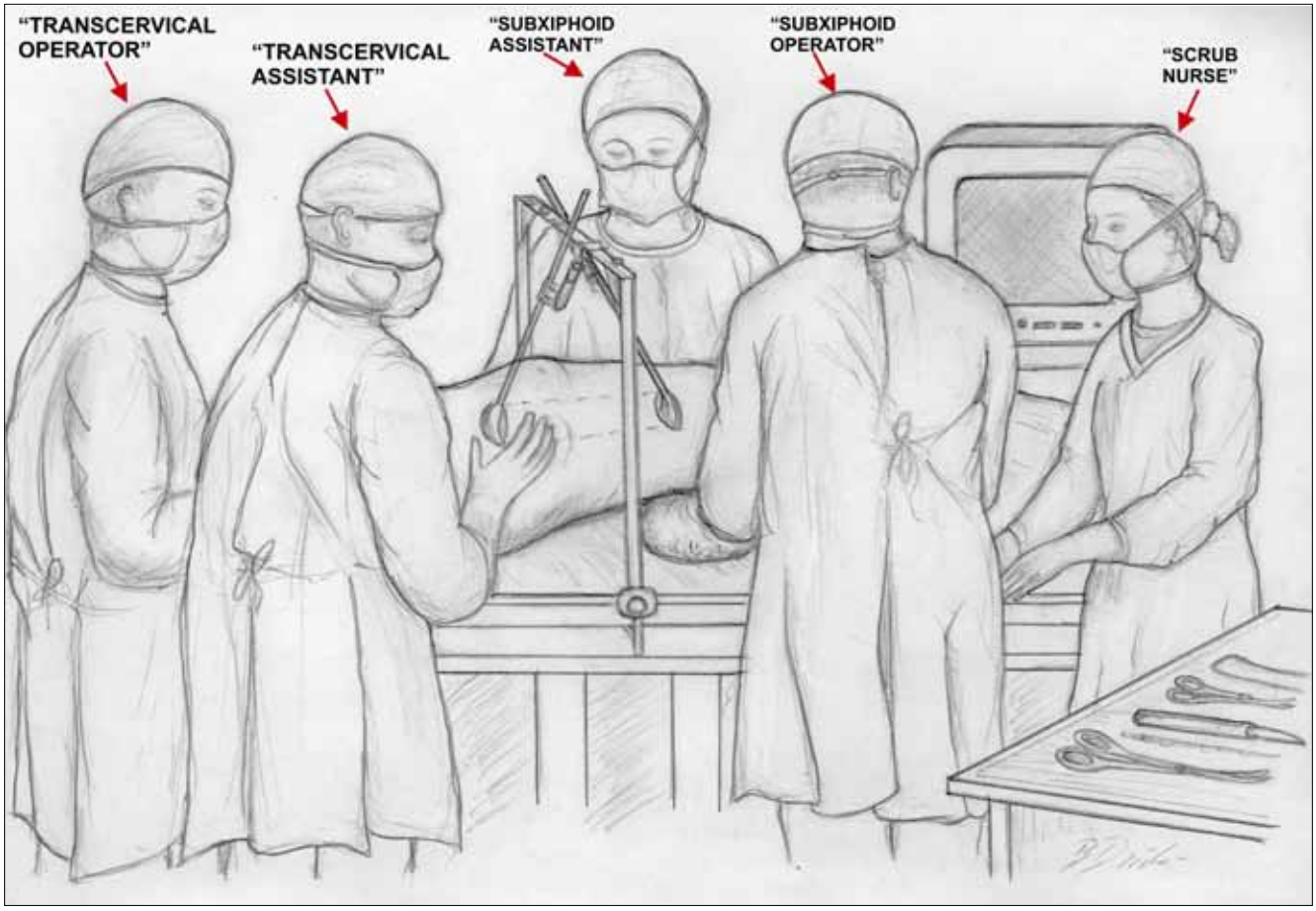

Figure 1. The position of all four members of both teams. (Reproduced from Surgery of the Thymus. Thymectomy Springer Verlag 2008)

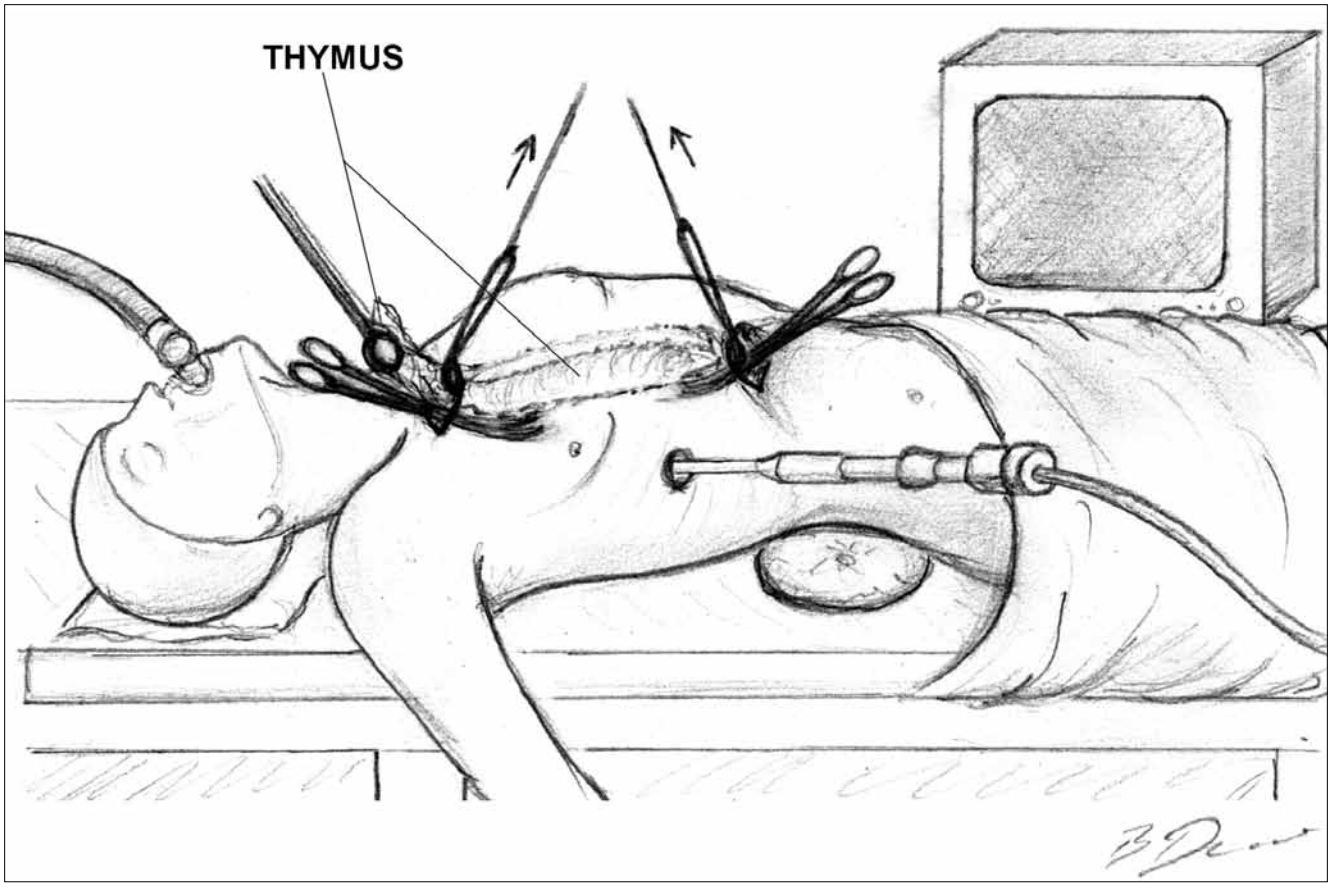

Figure 2. Simultaneous dissection performed by two surgical teams

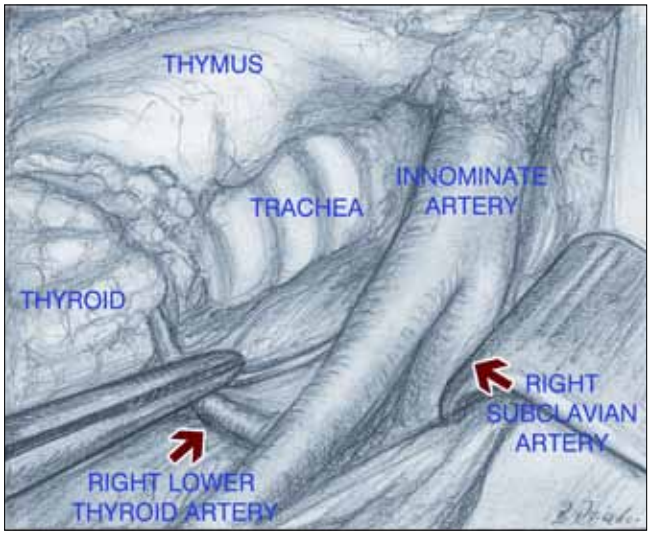

Figure 3. Dissection of the right laryngeal recurrent nerve. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

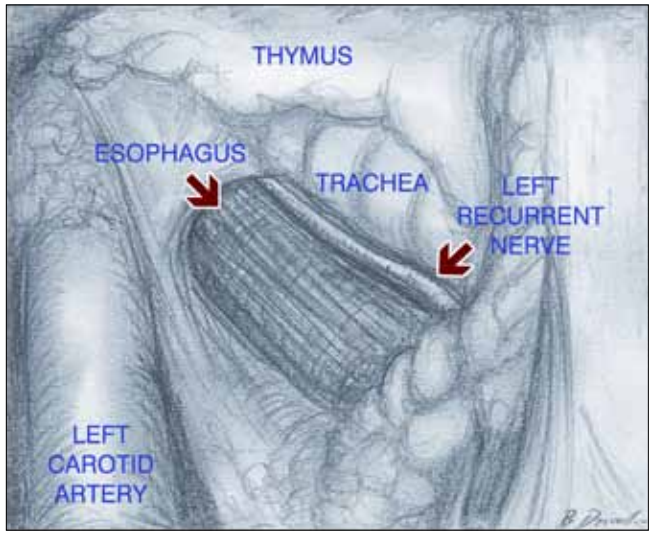

Figure 4. Dissection of the left laryngeal recurrent nerve. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

thyroid muscles, the trachea, internal surface of the sternum, the carotid arteries, the innominate artery, the aorta and the right innominate vein. At this point, a sternal retractor connected to the firm frame with a traction mechanism is inserted under the manubrium of the sternum elevating it several centimeters in order to provide access to the anterior mediastinum. The lower thyroid veins (1-4) and the thymic veins

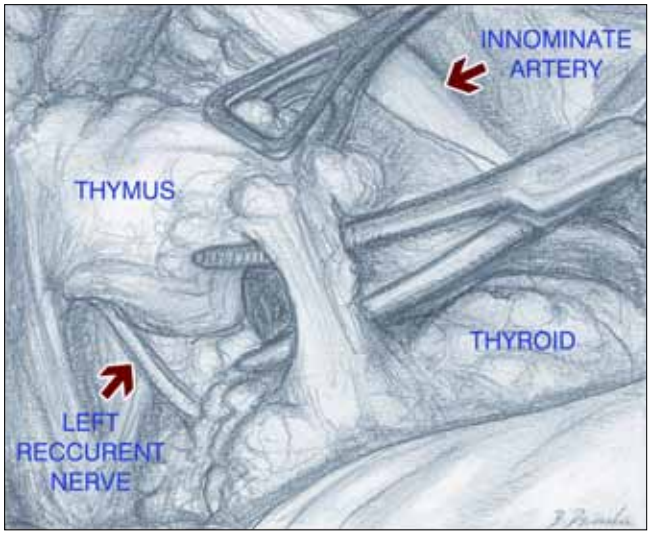

Figure 5. The fatty tissue containing the superior poles of the thymus is separated from the lower poles of the thyroid gland with 1-4 inferior thyroid veins ligated and divided. (Reproduced from MMCTS (April 25, 2005). oi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

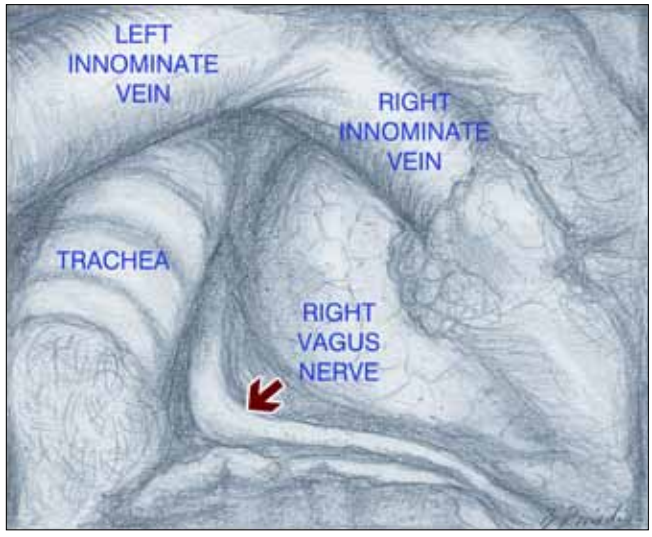

Figure 7. View of the aorta-caval groove after removal of its adipose, lymphatic and thymic contents. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

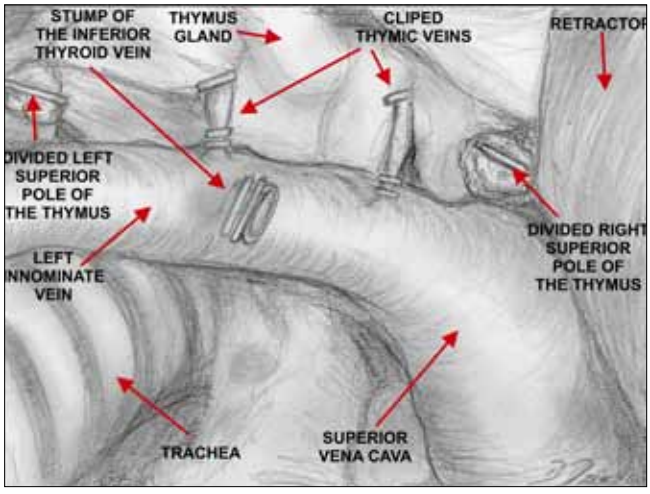

Figure 6. Division of the thymic veins. . (Reproduced from Surgery of the Thymus. Thymectomy Springer Verlag 2008)

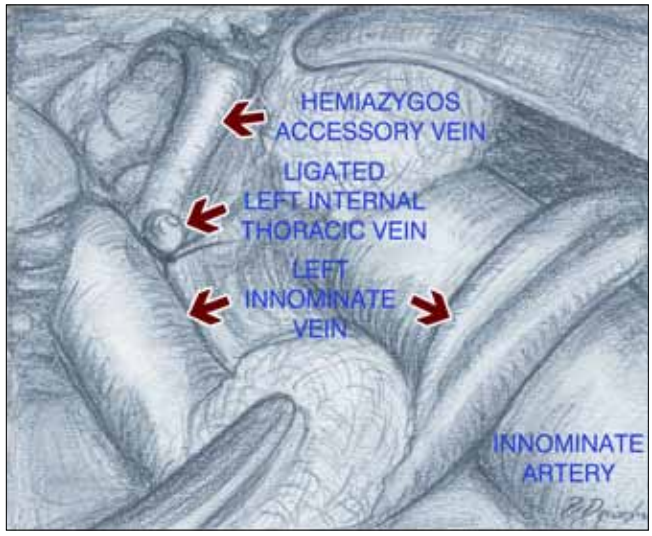

Figure 8. Division of the left hemiazygos accessory vein. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

(1-4) are dissected, clipped and divided close to the left innominate vein (Figure 6). The fatty tissue from the area called “the aorta-caval groove” is removed. The boundaries of this space are the division of the innominate artery and the aorta (medially), the trachea (posteriorly) and the right innominate vein and the right mediastinal pleura (laterally) and the right main bronchus, the azygos vein and the superior vena cava (inferiorly) (Figure 7). The dissection proceeds caudally below the left innominate vein and the specimen is separated from the pericardium at a distance of several centimeters. The most difficult, but very important, part of this operation is the dissection of the adipose tissue from the aorta-pulmonary window.

Further dissection of two other branches of the left innominate vein, namely the left internal thoracic vein and the accessory hemiazygos vein is mandatory. These two veins are subsequently divided and their ends are secured with clips or sutures (preferably) (Figure 8). The division of these veins provides much better access to the aorta-pulmonary window above the left innominate vein, which is retracted towards the aorta. The next step is the visualization of the left phrenic nerve, which runs very close to the left inter-

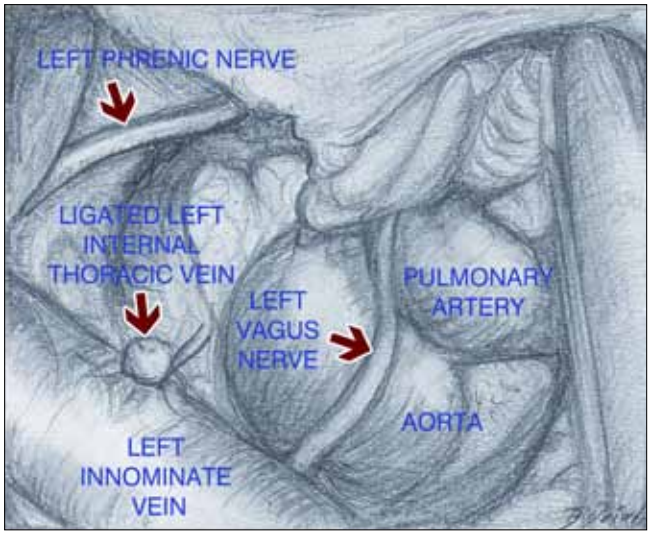

Figure 9. View of the aorta-pulmonary window after removal of its adipose, lymphatic and thymic contents. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

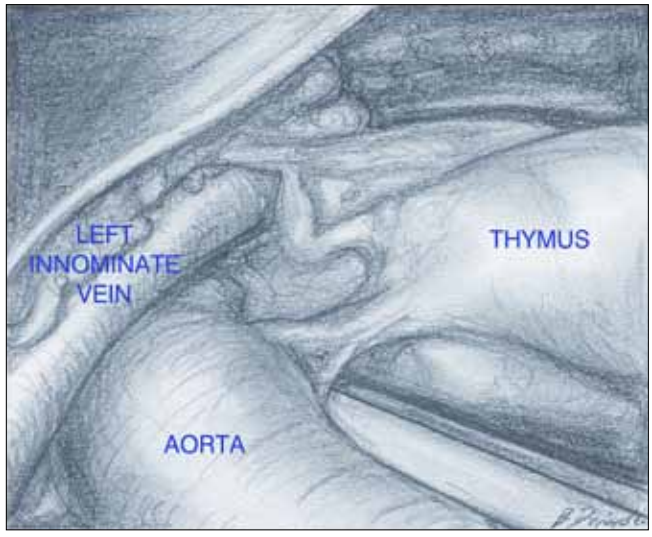

Figure 10. Dissection of the prepericardial fat containing the thymus gland. (Reproduced from MMCTS (April 25, 2005). doi:10.1510/mmcts.2004.000836 with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005.)

nal thoracic vein and the left vagus nerve, which runs laterally to the left common carotid artery. With blunt dissection using a peanut sponge, the fatty tissue containing the aorta-pulmonary window is dissected from these nerves, the aorta and the left mediastinal pleura. The left pulmonary artery is visualized at the bottom of the aorta-pulmonary window (Figure 9). In difficult cases, the dissection of the aorta-pulmonary window is completed at a later stage of the operation with a videothoracoscopic camera inserted inside the chest.

The subxiphoid part of the operation: A transverse 4-6 cm incision is made above the xiphoid process. The subcutaneous tissue is cut and the medial parts of the rectus muscles are cut near the insertions to the costal arches. The xiphoid process is divided transversely and left without removal. The selective left lung ventilation is initiated, resulting in the collapse of the right lung. The anterior mediastinum is opened from below the sternum. A second sternal retractor connected to the traction frame (the same as the one used for traction of the manubrium) is placed under the sternum, which is elevated to facilitate access to the anterior mediastinum from below. A thoracoscopic port for a 5 mm, 30 degree oblique thoracoscope is inserted into the right pleural cavity in the 6th intercostal space in the anterior axillary line. The right mediastinal pleura is cut near the sternal surface up to the level of the right internal thoracic vein, which is left intact. The prepericardial fat and right and left epiphrenic fat pads are dissected from the pericardium and diaphragm with blunt dissection using a peanut sponge and a sharp dissection using scissors. Dissection of the prepericardial fat containing the thymus gland proceeds upwards under the control of the VTS camera in an en bloc fashion, without any attempt to dissect the thymus gland separately (Figure 10). The right phrenic nerve is a margin of dissection. At this stage, the thymus is attached to the pericardium only by its left lower pole. Ventilation of the right lung is resumed and the ventilation of the left lung is disconnected. A thoracoscopic port for a 5 mm, 30 degree oblique thoracoscope is inserted into the left pleural cavity, as on the right side. The operating table is rotated on the right side with elevation of the left side, which lowers the mediastinum, improving access to the left pleural cavity. Under the control of the VTS camera, the left mediastinal pleura is divided along the sternum and the left prepericardial fat is dissected from the pericardium above the level of the previously divided left internal thoracic vein. The left lower pole of the thymus is separated from the pericardium and the specimen is removed. Dissection of the aorta-pulmonary window is completed, if necessary, at this stage of the operation. Hemostasis is checked, the VTS ports are removed and the chest tubes are inserted into both pleural cavities through the incisions made for insertion of the ports. Ventilation of both lungs is resumed. The cervical and subxiphoid incisions are closed in the standard manner. Generally, a patient is extubated immediately after the operation.

METHODS

Starting from September 1st 2000 all patients with type I-III nonthymomatous myasthenia according to the Osserman-Genkins Classification were operated on with the described technique of transcervical-subxiphoid-VTS "maximal"thymectomy (10). During the first part of this period, patients with thymoma and patients undergoing repeated thymectomy (rethymectomy) were operated on with technique of extended transsternal thymectomy, similar to the technique described by Bulkley (11). Starting from January 1st 2007, the technique of transcervical-subxiphoid-VTS "maximal" thymectomy has also been introduced for the treatment of early stage thymomas. If the myasthenia was severe and the clinical state of the patient was unstable, the preliminary treatment modalities, such as steroids (in a dose of 1mg/kg/day of prednisone), immunosuppressive drugs (azathioprine), intravenous immunoglobulins or plasmapheresis were used until the patient's clinical state became optimal. Operating time and intraoperative and postoperative complications were recorded.

To estimate late results of treatment of myasthenia, questionnaires with questions regarding the clinical state and antimyasthenic drugs intake were sent to all patients at 1-year intervals. Based on the answers to the questionnaires, the complete remission rates (lack of myasthenic symptoms with no need for any myasthenic drugs, including corticosteroids and other immunosuppressive drugs), the improvement rates, the no-improvement rates, deterioration rate and the late mortality rates (death from MG or other causes) were calculated.

RESULTS

There were 216 patients including 178 women and 38 men. The ages of the patients were between 11-69 years (mean 29.7 years). Duration of myasthenia was from 2-180 months (mean 28.3 months). The Osserman score was I-III. 27.3% of patients were taking steroids or immunosuppressive drugs preoperatively. Mean operative time was 201.5 min (120-330 min) for the one-team approach and 146 (95 - 210 min) for the two-team approach ($p<0.05$). There was no postoperative mortality and the postoperative morbidity was 9.2%. The complications are listed in Table 1. The incidence of ectopic thymic foci was 65.9% overall, with localization of the ectopic foci shown in Figure 11. The rates of complete remission after 1-, 2-, 3-, 4- and 5-years of follow-up were 25.0%, 36.8%, 43.2%, 47.8% and 51.2%, respectively (Figure 12).

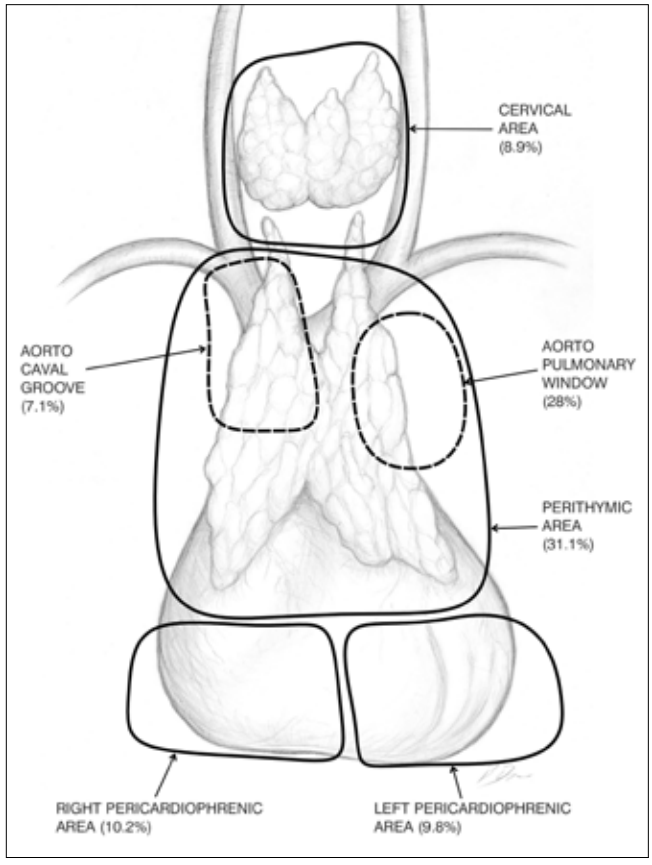

Figure 11. The incidence of ectopic foci of the thymic tissue in the areas of the neck and mediastinum

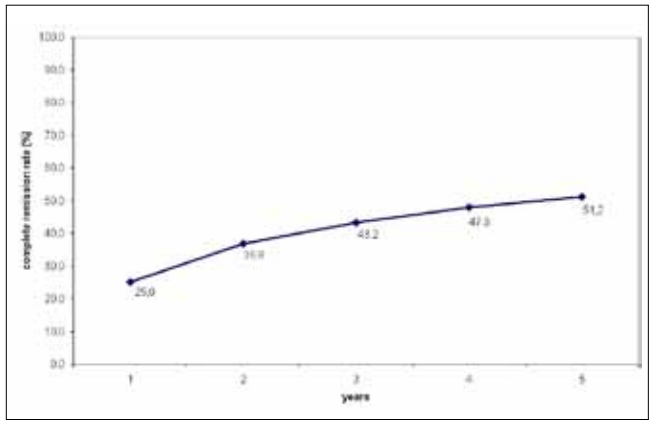

Figure 12. The complete remisssion rates of myasthenic symptoms after 1-, 2-, 3-, 4- and 5-year follow-up after transcervical-subxiphoid-VATS "maximal" thymectomy

DISCUSSION

The general principle is that thymectomy should provide removal of the whole thymus gland, which was shown to generate an autoimmunologic process leading to the occurrence of myasthenic symptoms.

Transcervical-subxiphoid-VATS maximal thymectomy is the technique developed in our institution to

Table 1. Complications in 437 patients with myasthenia gratis operated on with transcervical-subxiphoid-VATS "maximal" thymectomy

Type of complication	N(%)
Superior vena cava or left innominate vein laceration (managed with clips or sutures without sternotomy)	2 (0.5%)
Postoperative bleeding necessitating revision	8 (1.8%)
Temporary laryngeal recurrent nerve paresis	3 (0.7%)
Permanent laryngeal recurrent nerve paresis	0
Pleural hematoma necessitating VTS	1 (0.2%)
Pleural hematoma necessitating needle aspiration	2 (0.5%)
Respiratory insufficiency-ventilator	13 (3.0%)
Pneumonia without respiratory insufficiency	1 (0.2%)
Minor wound complications	6 (1.4%)
Subarachnoid hemorrhage	1 (0.2%)
Pneumothorax	1 (0.2%)
Incisional hernia (late complication)	2 (0.5%)
Overall	40 (9.2%)

achieve two aims, namely to avoid sternotomy and to enable the maximal completeness, similar to the technique described by Jaretzki et al. (12).

A combination of four incisions in the described technique-the transcervical, subxiphoid and two incisions for VATS port-enabled perfect access to all regions of the neck and mediastinum. The use of two separate surgical teams performing the transcervical and subxiphoid parts of the procedure simultaneously helped to shorten the operative time significantly. Besides, cooperation between both teams made the procedure technically easier.

We are critical of the unilateral or even bilateral videothoracoscopic approach, including thymecomy performed with the use of robots, which do not enable complete removal of the upper poles of the thymus as was shown by Shigemura et al, who found parts of the thymic poles in 70% of patients undergoing cervicotomy after VATS thymectomy (13).

The upper poles of the thymus ends just at the level of the thyroid and the specimen should be cut at this level. Any technique of thymectomy, that does not enable good visualization of the thyroid is not sufficiently complete and leaves parts of the upper thymic poles behind in the neck.

The other issue of whether the extent of the thymectomy can affect the results of the treatment of MG-in the other words, whether more extensive techniques of thymectomy including removal of the surrounding fatty tissue are more effective than basic thymectomy including only resection of the thymus without the fatty tissue is still an ongoing discussion. If we look at the current literature we can observe that there are almost no publications promoting basic thymectomy, with all authors proposing performance of the extended thymectomy. If this is true, it is extremely important to define what the extended thymectomy is.

In our opinion, such a technique must include removal of adipose tissue surrounding the thymus, the tissue from the neck area, the tissue of aorta-pulmonary window and the tissue from the epiphrenic pads areas. The innovation introduced by us was the removal of the aorta-caval groove area (which is in fact the right paratracheal area).

Pathologic studies revealed proven ectopic foci of thymic tissue (containing Hassall's corpuscles) or highly probable ectopic foci of thymic tissue (resembling thymic tissue, but without Hassall's corpuscles) in 65.9% of specimens after the transcervical-subxiphoid-VATS maximal thymectomy treatment (Figure 11).

The incidence of ectopic foci of thymic tissue in the adipose tissue of the neck and the mediastinum reported by Jaretzki et al. (12) was 98.0%, 72.2% by Masaoka et al., (14) 42.2% by Ponseti et al. (16) and 39.5% by Ashour.

Any reliable technique of thymectomy must also provide access to the aorta-pulmonary window, which was shown to contain ectopic thymic foci in 28.0%, as well both the pericardiophrenic fat pads. The area we also dissect is the area we call "the aorta-caval groove", which is an equivalent of the right paratracheal space. Dissection of this area, which was shown to contain ectopic thymic foci in 7.1% of specimen, has not been described before by the other authors.

We are also critical of the transcervical thymectomy, which does not enable complete removal of the left and right epiphrenic fat pads containing ectopic thymic foci in 9.8% and 10.2%, respectively as we showed previously. Besides, de Perrot et al reported that 19% patients operated on using this approach had to be converted to the upper median sternotomy (17).

Minimally invasive techniques of thymectomy recently became accepted operative techniques in early-stage thymomas (18). The experience gained by our team and other surgeons supports this policy (19).

CONCLUSIONS

The transcervical-subxiphoid-VTS "maximal" thymectomy is a highly extensive procedure, performed

partly in the open fashion, avoiding use of sternotomy. The two-team approach helps to shorten operative time

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