Review Article on Subxiphoid Surgery

# Uniportal subxiphoid video-assisted thoracoscopic thymectomy

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**Abstract:** With a uniportal subxiphoid video-assisted thoracoscopic surgery (VATS) thymectomy, the thymus is not accessed through the ribs, which avoids intercostal nerve damage. Furthermore, compared to a VATS thymectomy via the lateral chest, decreased use of postoperative analgesics (lower doses and shorter duration), decreased blood loss, and shorter surgical duration and hospital stay have been reported. Here we report our surgical method and solutions for a uniportal subxiphoid VATS thymectomy. A uniportal subxiphoid VATS thymectomy is indicated for patients with myasthenia gravis and anterior mediastinal tumors who do not require surgical suturing. The operator stands between the patient's legs and the scopist stands to the right of the patient to operate the camera scope. To begin with, a 3-cm transverse incision was made along Langer's lines 1 cm caudal below the xiphoid process. The $CO_2$ insufflation is performed in the mediastinum at 8 mmHg. The pericardial adipose tissue and thymus are detached from the pericardium in an anterior manner from the bilateral phrenic nerves. The resected thymus is placed in a pouch in the mediastinum and removed from the body through the subxiphoid incision. The subxiphoid approach is highly beneficial for the patient in that it results in superior esthetic outcomes considering that there is no sternotomy and no intercostal nerve damage; thus, it is a surgical procedure that surgeons should learn.

**Keywords:** Thymectomy; subxiphoid; thoracoscopy/video-assisted thoracoscopic surgery (VATS)

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## Introduction

Recent studies have reported thymectomy for myasthenia gravis and anterior mediastinal tumors using a minimally invasive approach rather than the conventional median sternotomy. Minimally invasive approaches without a median sternotomy include cervical, lateral thoracic and subxiphoid approaches. The cervical approach was reported by Cooper *et al*. (1) in 1988 as transcervical thymectomy. Because the cervical approach does not pass through the ribs, there is no damage to the intercostal nerves, which is considered to minimize postoperative pain. However, the operation is limited by the size of the neck wound, which is small; therefore, the cervical approach has not become very common. The lateral thoracic approach was first performed by Landreneau *et al*. (2) in 1992, with the thoracoscopic excision of anterior mediastinal tumors. At present, the use of a lateral thoracic approach, including robot-assisted surgery is the most common approach (3). A technical shortcoming of surgery associated with this approach is that the operative field is poor for a cervical resection of the upper pole of the thymus. This complicates the resection procedure, making it difficult to confirm the location of the contralateral phrenic nerve and to resect the thymic adipose tissue anterior to the contralateral phrenic nerve. Furthermore, the placement of the intercostal port will inevitably cause intercostal nerve damage, which can persist as lifelong post-thoracotomy pain syndrome, which is disadvantageous to patients (4). The subxiphoid approach was first performed by Kido *et al*. (5) in 1999. In recent years, advancements in $CO_2$ insufflation and new surgical instruments have resulted in improved operability and enabled a single-port thymectomy (6) (*Figure 1*). With this approach, the thymus is not accessed through the ribs, which avoids intercostal nerve damage. Furthermore, compared to a video-assisted thoracoscopic surgery (VATS) thymectomy via the lateral chest, decreased use of

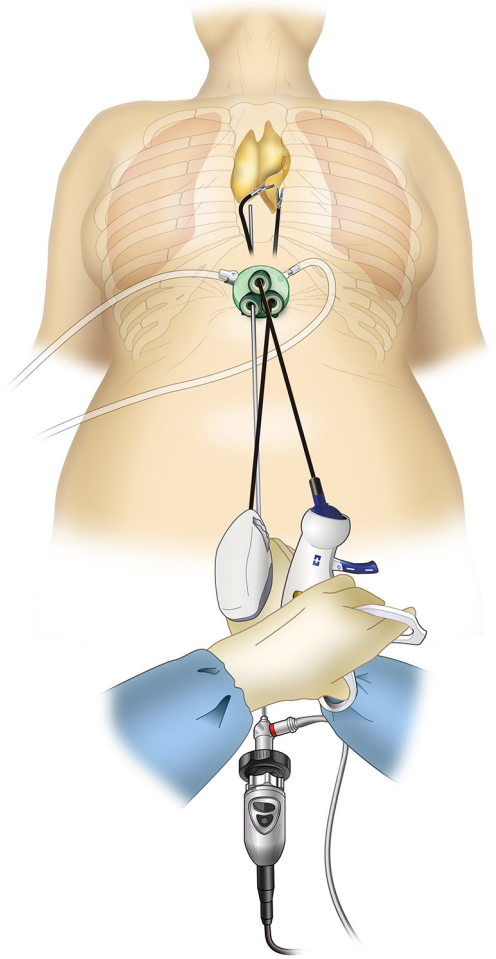

**Figure 1** Uniportal subxiphoid VATS thymectomy. For the left lobe of the thymus, the forceps in the left hand are bent to the right and the thymus is pulled to the right of the patient. At this point, the surgeon's hands are crossed, and detachment is performed using LigaSure™. For the right lobe of the thymus, the forceps are bent to the left and the thymus is pulled to the left of the patient. In this instance the surgeon does not need to cross the hands. VATS, video-assisted thoracoscopic surgery.

postoperative analgesics (lower doses and shorter duration), decreased blood loss, and shorter surgical duration and hospital stay have been reported (7). A shortcoming of this approach is operability. A scope and forceps for the left and right hands, respectively, are inserted via a single port; therefore, a means to decrease instrument interference needs to be devised. The subxiphoid approach is highly beneficial for the patient in that it results in superior esthetic outcomes considering that there is no sternotomy and no intercostal nerve damage; thus, it is a surgical procedure that surgeons should learn. Here we report our surgical method and solutions for a uniportal subxiphoid VATS thymectomy.

## Patient selection

A uniportal subxiphoid VATS thymectomy is indicated for patients with myasthenia gravis and anterior mediastinal tumors who do not require surgical suturing. In the event that suturing is required, similar to the case of pericardial patch closure for a thymoma invading the pericardium, (I) a dual-port subxiphoid VATS thymectomy (8) with an additional port placed in the right 5$^{th}$ intercostal space along with a uniportal subxiphoid VATS thymectomy or (II) a subxiphoid robotic thymectomy using the DaVinci robot (9) is indicated. In the event that vascular anastomosis is required, similar to the case of prosthetic vascular grafting of the left brachiocephalic vein, a median sternotomy is usually indicated. Procedures such as partial resection of the lung, for which a stapler needs to be used, are only possible via the subxiphoid port.

## Pre-operative preparation

The patient is placed in the supine position. The operator stands between the patient's legs and the scopist stands to the right of the patient to operate the camera scope. A monitor is positioned at the patient's head (*Figure 2*). When the operator stands between the patient's legs, it may seem that the distance from their standing position to the surgical port seems far; however, the distance does not actually inhibit the surgical performance.

## Equipment preference card

Various types of ports are commercially available for a single-port surgery. Personally, I prefer to use the GelPOINT Mini (Applied Medical, Rancho Santa Margarita, CA, USA) because the gel seal cap on the port platform prevents over-fixation of the forceps port. This decreases the potential for the forceps to interfere with each other. The practitioner performs the surgery with the vessel-sealing device held in his/her right hand and the gripping forceps in the left hand. There are various types of vessel-sealing devices; however, the LigaSure™ Maryland jaw 37 cm (Covidien, Mansfield, MA, USA) device with a tip shaped for dissecting is user-friendly. We use SILS™ Hand Instruments; SILS clinch 36 cm (Covidien, Mansfield, MA,

 

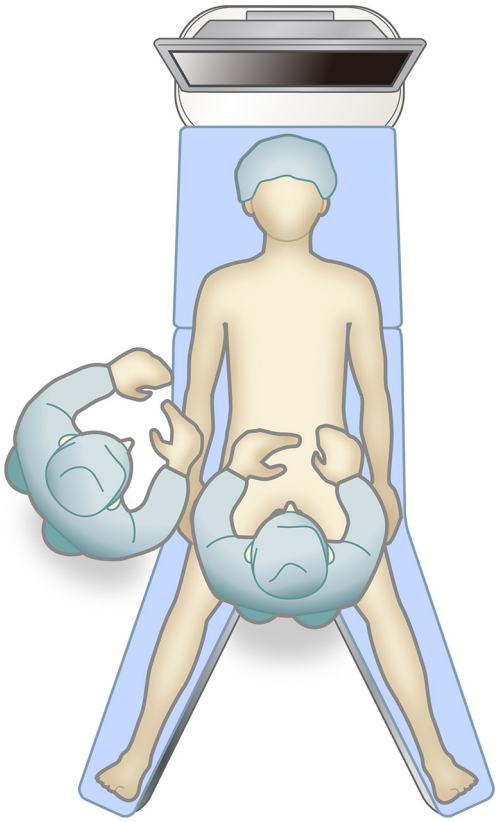

**Figure 2** The surgeon stands between the legs of the patient and the assistant stands to the right of the patient to operate the camera scope.

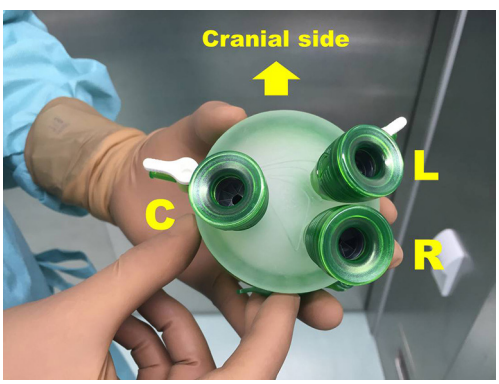


**Figure 3** For the GelPOINT Mini, a mini-port can be inserted regardless of the location of the platform. We inserted a port for the camera on the right side of the patient (C), a port for the surgeon's left hand on the left cranial side of the patient (L), and a port for the right hand primarily used by the surgeon for the vessel-sealing device on the left caudal side of the patient (R).

USA) as a gripping forceps, which has an articulating tip for single-port surgery. Prior to performing this surgery, it is important to thoroughly master the skills of bending the forcep tip with the left hand. We use a rigid camera scope 5 mm in diameter with a 30° viewing angle. A camera head that obtains clear images must be used even when using a 5-mm scope.

## Procedure

Surgery was performed under general anesthesia. Bilateral lung ventilation was performed through a single-lumen endotracheal intubation tube. To begin with, a 3-cm transverse incision was made along Langer's lines 1 cm caudal below the xiphoid process. The incision can also be made in a vertical manner, and when taking out large tumors, this type of wound tends to expand. Caution should be exercised as if the skin incision is made too close to the xiphoid process, it can be difficult for the forceps to reach the posterior aspect of the sternum. The rectus abdominis is dissected where it attaches to the xiphoid process to reach the posterior aspect of the xiphoid process, the thymus is then blindly detached from the posterior aspect of the sternum using a finger. Thereafter, a 0.5–1 cm vertical incision is made on the fascia of the rectus abdominis, without opening the peritoneum, and a space is created to insert the port for single-incision surgery. There is no need to dissect the xiphoid process. The GelPOINT Mini, a port for single-incision surgery with three mini-ports, is inserted into the subxiphoid incision (*Figure 3*). The $CO_2$ insufflation tube is connected to the GelPOINT Mini and $CO_2$ insufflation is performed in the mediastinum at 8 mmHg. The surgeon detaches the thymus from the posterior aspect of the sternum to the neck using the LigaSure™ Maryland device. The positive pressure of $CO_2$ insufflation eliminates pressure on the pericardium and bilateral lungs and, along with the detachment of the thymus, broadens the space at the posterior aspect of the sternum. Bilateral incisions are made into the mediastinal pleura and the thoracic cavity is exposed bilaterally.

Next, the locations of the bilateral phrenic nerves are identified. The location of the left phrenic nerve on the caudal side in the thoracic cavity can be verified by either pulling the pericardial adipose tissue to the right, or by displacing the heart with cotton swabs for thoracoscopic


**Figure 4** Uniportal subxiphoid video-assisted thoracoscopic thymectomy (10).
Available online: http://www.asvide.com/articles/1049

surgery. The pericardial adipose tissue and thymus are detached from the pericardium in an anterior manner from the bilateral phrenic nerves. To prevent collateral damage to the adjacent organs when using a vessel-sealing device, the device should only be used once the dissected thymus is at a safe distance and is sufficiently detached from vital structures, such as the pericardium and brachiocephalic vein. The left lobe of the thymus is pulled toward the right of the patient by bending the forceps of the left hand to the right. At this point in time, the surgeon crosses hands to detach the left lobe with LigaSure™. The right lobe of the thymus is pulled towards the left of the patient by bending the forceps to the left. This time the surgeon does not need to cross hands. The lower pole of the thymus is detached from the pericardium.

A trick to perform this surgery well is to firmly grasp the thymus near the detachment site with the forceps in the left hand and pull. To safely expose the distal side of the left brachiocephalic vein, the superficial adipose tissue is slowly and gradually detached at the area thought to be near the left brachiocephalic vein. The proximal side of the left brachiocephalic vein is close to where it joins the right internal thoracic vein. Similar to the distal side, the proximal side is exposed by slowly and gradually detaching superficial adipose tissue at the area thought to be near the left brachiocephalic vein. Once the proximal side of the left brachiocephalic vein is exposed, the area of the confluence of the brachiocephalic veins is exposed. Thereafter, the neck portion is detached and the thin membrane above the thymus is dissected. Although the right internal thoracic vein is not usually dissected, it can be done if it hinders the operation. While exercising caution to not injure the left brachiocephalic vein, the superior pole of the thymus is grasped using grasper forceps and pulled caudally to push the left brachiocephalic vein and expose a good field of vision of the neck. The superior pole of the thymus and the cervical adipose tissue are dissected from the right brachiocephalic vein on the right side, the thyroid at the upper end, the brachiocephalic artery and trachea on the posterior aspect, and the left brachiocephalic vein on the left side. Due care should be exercised to not damage the inferior thyroid vein. Lastly, the thymus is pulled to either the right or left and dissected from the innominate vein. In the sequential order of the procedure, the thymic vein is dissected using a LigaSure™ device and thymectomy is completed. The resected thymus is placed in a pouch in the mediastinum and removed from the body through the subxiphoid incision. A 20-Fr drain is inserted through the subxiphoid incision and the surgical incision is closed (*Figure 4*).

## Tips, tricks, and pitfalls

When establishing artificial ventilation, use pressure control ventilation delivered at the minimal intratracheal pressure to ensure sufficient ventilation. PEEP is not used as it inflates the lungs and disturbs the operative field. $CO_2$ insufflation in the mediastinum at 8 mmHg provides a good operative field by maintaining lung ventilation and moderately eliminating pressure on the lungs bilaterally.

The use of a long-rigid camera scope prevents interference with the surgeon's hands.

When a LigaSure™ device with an unarticulated tip is difficult to reach the posterior aspect of the sternum, scissors with a flexible tip should be used that can connect with a monopolar or bipolar sealer.

The LigaSure™ tip operated by the right hand of the surgeon can interfere with the camera scope and forceps of the left hand, restricting where the surgeon intends to go. In a single-port surgery, the camera scope and forceps can crossover within the port. The pathway by which the surgeon inserts the LigaSure™ device with his/her right hand can pass either above or below the camera scope and forceps of the left hand; thus, the placement of the LigaSure™ tip held with the right hand will vary greatly. If it seems that the LigaSure™ is not advancing in the intended direction, the pathway should be changed.

In the event that the tumor has invaded into one side of the thoracic cavity, the contralateral thoracic cavity will not be opened to prevent contralateral tumor dissemination

from occurring in some cases; this makes it difficult to identify the location of the phrenic nerves. To prevent injury to the phrenic nerves, it is generally important to identify their location.

Following thymectomy, the thymus/thymoma is placed in a pouch in the mediastinum and removed through the subxiphoid incision. With a shaft-type pouch, the pouch insertion opening will be in the direction of the forceps insertion and tangential direction, which makes it difficult to place the resected thymus into the pouch (*Figure 4*). In such cases, once a non-shaft-type pouch is inserted into the mediastinum, the surgeon should expand the pouch in the mediastinum using forceps so that the thymus can be inserted into the pouch.

For surgeons who are unfamiliar with single-port surgery and the subxiphoid approach, the authors recommend first commencing with a subxiphoid incision and a 5-mm port in the right 5$^{th}$ intercostal space (8). The use of this method greatly decreases the interference between the forceps held by both hands of the surgeon. It also facilitates suturing operations such as the pericardial patch closure.

It is also important achieve hemostasis in case of bleeding. If bleeding occurs from the brachiocephalic vein, pressure is first applied with cotton swabs for thoracoscopic surgery. If pressure hemostasis is achieved, hemostasis is performed with the use of TachoSil® (Takeda Austria GmbH, Linz, Austria) or other hemostatic drugs. Regardless of the whether single-port surgery is being performed, at the time of bleeding an additional port can be inserted in the midclavicular line of the 5$^{th}$ or 6$^{th}$ intercostal space of the right anterior chest to obtain better maneuverability. If pressure hemostasis is not achieved, immediately switch to a median sternotomy. Some institutions perform a thymectomy using an approach from the lateral thoracic side with the patient in the decubitus position. However, there is the risk that in the decubitus position, the distal end of the left brachiocephalic vein cannot be taped. As the subxiphoid approach is performed in the supine position, the surgery can be quickly switched to a median sternotomy if necessary.

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## Footnote

*Conflicts of Interest:* The author has no conflicts of interest to declare.

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