



# The future of minimally invasive thymectomy: the uniportal subxiphoid video-assisted thoracic surgery technique—a case series

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**Background:** Thymectomy for early thymic tumours is rarely performed by sternotomy in the current era of minimally invasive thoracic surgery. With standard video-assisted thoracic surgery (VATS) it can be difficult to visualise the entire thymus. Subxiphoid VATS (SVATS) has been developed as an alternative surgical approach which is particularly suited to performing thymectomy due to providing visualisation of both pleural cavities. This study reports a large case series of uniportal SVATS extended thymectomy.

**Methods:** Over the period of study, 39 patients underwent uniportal SVATS extended thymectomy for a thymic nodule at the Shanghai Pulmonary Centre. Seventeen patients were female, and the mean age of the cohort was 60 years. The mean size of nodule was 30.27 mm.

**Results:** The mean operative duration was 2.1 hours, with one conversion to thoracotomy for bleeding. The mean operative blood loss was 93 mL. The median length of hospital stay was 4 days. There were no episodes of phrenic nerve palsy and the 30-day survival was 100%. Comparing the first and second cohorts, there was reduced operative time ( $P=0.005$ ), reflecting the learning curve.

**Conclusions:** The uniportal SVATS technique is safe and feasible for performing extended thymectomy. It allows the surgeon to perform a radical oncological thymectomy with lower risk of damaging adjacent nerves and vessels. The procedure can be performed safely during the learning curve period.

**Keywords:** Thymectomy; single incision laparoscopic surgery; subxiphoid; video-assisted thoracic surgery (VATS); subxiphoid VATS (SVATS)

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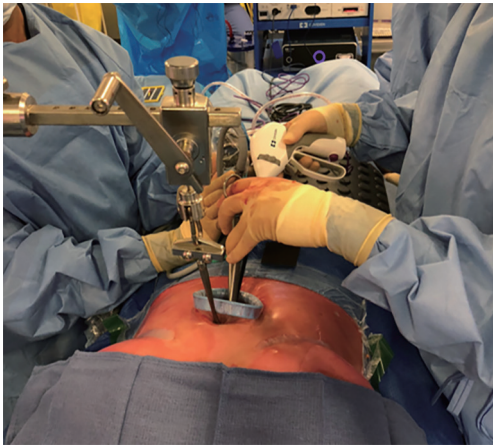
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## Introduction

Thoracic surgical techniques have evolved significantly over the last two decades. For anterior mediastinal masses, of which thymoma is the most frequent, very often surgical treatment is recommended as the principal management. The gold standard surgical approach to anterior mediastinal masses like thymomas, has been median sternotomy.

Nowadays, alternative less invasive surgical techniques are possible thanks to video-assisted thoracoscopic surgery (VATS). Thoracoscopy offers the benefit of reduced postoperative pain allowing for earlier mobilisation which facilitates shorter hospital lengths of stay. It is reported that recovery to normal function is faster and patients experience fewer post-operative complications (1-3).



**Figure 1** Uniportal subxiphoid incision and position of instruments intraoperatively.

For thymectomy, cervical and standard lateral thoracic VATS has been described. The cervical approach has not become popular because of the small size of the neck wound (4).

At present, the lateral approach through a thoracoscopic incision is the most common surgical approach; however, it can be challenging to achieve a satisfactory visualisation of the whole thymus from 'phrenic to phrenic' and passing through the intercostal space could lead to postoperative acute and chronic pain due to intercostal nerve injuries (4).

Uniportal subxiphoid VATS (SVATS) approach has been proposed to potentially reduce the invasiveness and the surgical stress providing exposure of entire thymus and a bilateral vision of the phrenic nerves. In this technique, a single vertical incision is made in the subxiphoid region, allowing muscle-sparing and avoiding intercostal incisions and intercostal nerve damage (5).

The SVATS technique is becoming established as an alternative thoracoscopic approach increasingly utilised for a range of thoracic surgical procedures including lobectomies, segmentectomies, pneumonectomy (6-12). Here we present our case series of SVATS thymectomy demonstrating that this technique should be considered as an alternative approach to anterior mediastinal masses.

## Methods

The reported surgeries were performed in Shanghai Pulmonary Hospital, Shanghai, China, between October 2014 and January 2018.

Patient demographics, intraoperative and postoperative data were collected from patients notes and electronic records. The following are considered contraindications to SVATS:

- (I) stage 3–4 thymic tumours;
- (II) body mass index  $>30 \text{ kg/m}^2$ ;
- (III) impaired ventricular function and/or cardiomegaly;
- (IV) severe arrhythmia.

## Surgical technique

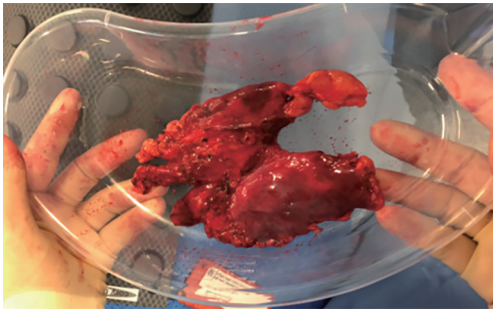
Our technique for SVATS thymectomy has been previously described (8). In summary: the operation is performed with the patient positioned supine on the operating table ventilated through a double lumen tube to permit selective ventilation to facilitate the procedure. Access is through a 4 cm subxiphoid vertical incision and a wound retractor positioned upon entry into the pleural spaces. The xiphoid process can be resected to provide an optimal view if required. The sternum is elevated using a table mounted retractor to maximise the anterior mediastinal operating space (*Figure 1*). A 10 mm  $30^\circ$  angle thoracoscope (Karl Storz, Tutlingen, Germany) was used. Subxiphoid VATS instruments are used to perform the procedure (Shanghai Medical Instruments Group Ltd, Shanghai, China).

The right pleural cavity is opened initially, with the left lung being selectively ventilated. Electrocautery dissection is used to mobilise the right lobe of the thymus and any pericardial and epiphrenic fat pads, with clear visualisation of the phrenic nerve provided by SVATS. The large neck veins are well visualised using this approach and guide the superior dissection. Subsequently, the left pleural cavity is opened and the thymus dissected from the pericardium in a similar manner. The resected specimen can then be retrieved through the subxiphoid incision (*Figure 2*).

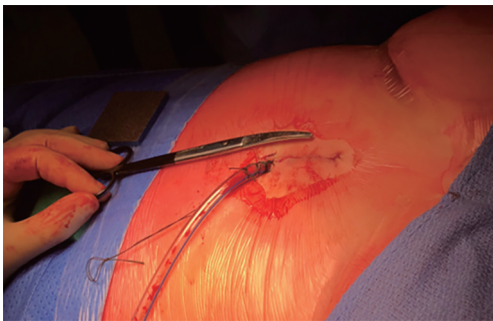
At the end of the procedure, one or two chest drains are placed through the subxiphoid incision (*Figure 3*). The patients are usually extubated on the operating table.

## Data collection

Data was retrieved from a prospectively maintained database with additional data retrieved retrospectively from patient notes and electronic patient records. Data concerning patient demographics, intraoperative details and post-operative course were collected.



**Figure 2** Example thymic specimen resected by SVATS. SVATS, subxiphoid video-assisted thoracic surgery.



**Figure 3** Position of drains following closure of uniportal subxiphoid incision.

**Table 1** Preoperative entire cohort characteristics

Characteristic	Values
Sex	
Male	22
Female	17
Age, mean [range]	60 [26–80]
Smoking	
Yes	13
No	26
BMI	24.3 [14.37–32.46]
FEV <sub>1</sub> , L	
Actual	2.33±0.73
% predicted	88.72±18.68
Albumin, mg/L	38.79±3.90
Haemoglobin, g/dL	133.0±13.63
Lesion size, mm	30 [12–77]

BMI, body mass index.

## Results

### *Patient characteristics*

Over a period of study, 39 SVATS thymectomies were performed for thymic lesions. Patient characteristics are summarised in *Table 1*. The mean age of patients was 60 years.

### *Intraoperative details*

Intraoperative details are summarised in *Table 2*. The mean length of surgery was 2 hours with a range of 1–4 hours. Injury to the innominate vein resulted in one patient requiring conversion to thoracotomy in the series. There was a low intra-operative blood loss with a mean loss of 93 mL. Comparing the first 20 cases to the more recent 19 cases, it is evident that there was a significant improvement in terms of reduced operative duration (2.55 vs. 1.68 hours,  $P=0.005$ ).

### *Postoperative course*

One patient's postoperative course was complicated by a myasthenic crisis. The patient required intubation and respiratory support for 1 week. The patient was discharged on day 9. The median length of hospital stay was 4 days. There were no instances of phrenic nerve palsy. There was no 30-day mortality in this patient series.

Post-operative pathological examination of the resected thymic lesions is summarised in *Table 3*. Thymic cysts were the commonest pathology observed.

## Discussion

This report demonstrates that the uniportal subxiphoid VATS approach can be considered as an alternative approach to performing thoracoscopic resection of anterior mediastinal masses. The approach provides excellent visualisation of the entire thymus from phrenic-to-phrenic allowing for radical resection under direct vision, whilst performing a minimally invasive surgery.

In recent years, VATS has been increasingly used as a surgical approach for thymectomy using a lateral approach. While the lateral approach is ideal for lobectomy and tumour resections, performing a total thymectomy via the lateral approach can be challenging. In particular, the lateral approach does not allow a complete vision of the

**Table 2** Operative characteristics

Characteristic	Entire cohort	First 20 cases	Last 19 cases	P value
Surgical duration (hours)	2.13±0.98	2.55±1.01	1.68±0.74	0.005
Conversion to thoracotomy	1	1	0	0.99
Operative blood loss (mL)	93.33±74.31	111.0±92.90	74.73±42.86	0.21
Drainage in first 24 hours (mL)	244.21±179.82	271.0±183.73	214.44±175.70	0.39
Postoperative length of stay (days)	4.33±2.84	4.20±1.79	4.47±3.68	0.64

Statistical analysis comparing first 20 and last 19 cases—Mann-Whitney U test.

**Table 3** Postoperative histopathology

Type	Frequency
Thymic cyst	21
Thymic bronchial cyst	6
Thymic hyperplasia	2
Ectopic thyroid tissue	2
B2 thymoma	3
AB thymoma	5

contralateral phrenic nerve (4). However, in comparison to sternotomy there are many advantages reported including reduced intraoperative blood loss, earlier removal of chest drains, reduced requirement for blood products, reduced inflammatory cytokine response, shorter hospital stay and superior cosmetic result (13), without compromising the oncological outcome.

In an attempt to further refine the thoracoscopic technique and improve post-operative outcomes, the SVATS approach has been developed with the advantage of avoiding intercostal incision and manipulation (6-11,14). Since the postoperative chest drains do not enter the thoracic cavity through intercostal spaces postoperatively, they do not impinge on the intercostal neurovascular bundle. This has the potential benefit of allowing early aggressive mobilization which is recognised to be associated with reduced risk of venous thromboembolism and may facilitate a reduction in pulmonary atelectasis and development of lower respiratory tract infections. Together this offers the potential for reduced hospital length of stay (15). To date, there is only one randomised controlled trial comparing SVATS to standard VATS—in patients undergoing bullectomy and pleurectomy. They observed a significant reduction on postoperative pain in the SVATS

group which was associated with earlier mobilisation and reduced risk of complication (16).

The SVATS approach is particularly suited to thymectomy as it provides excellent views of the anterior mediastinum as well as of the two pleural spaces including the phrenic nerves. This access and view provide the surgeon the opportunity to perform an oncologically radical and safe resection of the thymus with low risk of injuring the phrenic nerves or other intrathoracic structures. To date there have been a small number of reports of SVATS thymectomy, but our study represents the largest case series to date (7,17-19). One recent series has reported performing robotic SVATS thymectomy (20), highlighting the versatility of the subxiphoid incision. In all of the published series there have been no mortality to date, and the incidence of intraoperative and postoperative complication is very small.

Our case series adds further to the evidence that the uniportal SVATS approach is a safe and appropriate method for thymic resection particularly in non-obese patients with Masaoka stage I tumours and without significant underlying cardiorespiratory disease. In our practice, comparing this case series with our early experience, the surgical duration, operative blood loss, 24-hour drainage and hospital stay have all decreased. This observation supports the concept that there is a learning curve and that over time with increased skill, outcomes can continue to improve. We would predict that this approach is associated with reduced pain and earlier postoperative mobility and discharge and intend to examine this further in a randomised controlled trial.

## Conclusions

The uniportal SVATS technique should be considered as an alternative approach to thoracoscopic resection of an anterior mediastinal mass. The uniportal SVATS technique



is particularly suitable for thymectomy since it allows an extended view of the anterior mediastinum as well as the right and left pleural spaces from phrenic-to-phrenic. It allows the surgeon to perform a radical oncological thymectomy with lower risk of damaging adjacent nerves and vessels.

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## Footnote

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/jovs.2018.10.13>). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Shanghai Pulmonary Hospital Ethical committee (No. 010029) and informed consent was obtained from all patients.

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