

# Subxiphoid approach for video-assisted thoracoscopic surgery: an update

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**Abstract:** The transthoracic video-assisted thoracoscopic surgery (VATS) is considered as standard operation for various thoracic diseases. With the development of single-incision VATS, the thoracic surgery becomes less traumatic. However, chronic chest wound pain still an issue despite the less invasive approach. Therefore, subxiphoid VATS was proposed to overcome this problem. In this article, we review current applications, pros and cons, and potential developments of VATS through subxiphoid approach.

**Keywords:** Subxiphoid video-assisted thoracoscopic surgery (subxiphoid VATS); thymectomy; pulmonary resection

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## Introduction

The transthoracic video-assisted thoracoscopic surgery (VATS) is considered as standard operation for various thoracic diseases. Comparing to conventional thoracotomy surgery, VATS can provide less postoperative pain, shorter hospital stay and more rapidly recovery (1,2). Traditionally, VATS was conducted through 2–4 transthoracic incisions. The single-incisional VATS, considered as the least traumatic thoracic surgery, provide comparable outcomes with multi-incisional VATS (3,4). Despite decreased chest wall trauma in VATS, there are no difference in the incidence and severity of chronic chest wound pain between thoracotomy surgery and VATS (5).

With the nature of lacking intercostal nerve in the subxiphoid area, chronic chest wound pain potentially can be prevented by subxiphoid VATS. In animal model, subxiphoid VATS was demonstrated as a feasible and effective procedure (6). Since introducing of thymectomy and pulmonary resection through subxiphoid incision, there are several studies focused on this novel approach (7-9).

In this article, we sought to review current applications,

pros and cons, and potential developments of VATS through subxiphoid approach.

## Clinical application of VATS via subxiphoid approach

### *Anterior mediastinal surgery*

There are various approaches for thymectomy in treating myasthenia gravis and resection of anterior mediastinal tumors. Although median sternotomy is a traumatic procedure, complete thymectomy and/or tumor removal through this approach has been considered as standard procedure due to this can offer optimal surgical field. Several minimal invasive procedures, such as transcervical thymectomy or transthoracic VATS thymectomy, can achieve comparable outcomes (10-12). However, these minimal invasive procedures have some drawbacks. In transcervical thymectomy, lower mediastinal fat dissection will be inadequate. In unilateral transthoracic VATS thymectomy, surgeons may encounter poor view of mediastinal fat and phrenic nerve at contralateral side.

**Table 1** Summary of published series focusing on the of subxiphoid approach for pulmonary resection

First author/year	Number	Type of surgery	Surgery time (min)	Conversion rate*
Wang/2016 (25)	14	Pneumothorax surgery	61.07±15.96	0%
Hernandez-Arenas/2016 (26)	153	Lobectomy/segmentectomy	166.9±12.6	5.2%
Song/2016 (27)	105	Lobectomy	164.97±39.10	8/105
Hernandez-Arenas/2016 (28)	200	Lobectomy/segmentectomy	170±45	19/200

\*, thoracotomy or additional port creation was considered as conversion.

Comparing to thymectomy via median sternotomy, the rate of phrenic injury is higher in transthoracic VATS thymectomy (12).

In 2012, Suda *et al.* reported thymectomy through subxiphoid VATS without transthoracic incisions (7). The complication of sternal osteomyelitis can be totally prevented through this operation (13). Comparing to transthoracic VATS, this novel minimal invasive approach can provide better surgical view in upper pole of thymus and bilateral phrenic nerves (7,14-18). Besides, shorter hospital stay, less blood loss, decreased acute postoperative pain severity and shorter postoperative pain duration were noted in subxiphoid VATS (19). Once massive bleeding encounter during operation, median sternotomy can be rapidly performed for bleeding control without changing patient's position (19). However, complex procedure or large thymic tumor should be avoided due to poor surgical manipulability in this approach (16,20).

Trans-subxiphoid robotic thymectomy was first reported by Suda *et al.* in 2015 (14). All advantages of subxiphoid VATS thymectomy also exist in trans-subxiphoid robotic approach. Besides, surgeons can perform operation more easily with the help of articulated arms in robotic surgical system (17). More complex procedure, such as pericardium resection and reconstruction, may be performed through this maneuver (17). However, two additional small transthoracic incisions are needed for trans-subxiphoid robotic thymectomy (14,17,18). The patient did not experience more severe pain comparing subxiphoid VATS thymectomy despite additional wounds (18). Newly developed single incision robotic platform may further decrease trauma in current robotic system.

In conclusion, subxiphoid VATS thymectomy is a feasible procedure with several advantages. With coming of robotic system, thymectomy through subxiphoid incision becomes easier.

### Pulmonary surgery

Transthoracic VATS is the acceptable approach for pulmonary resection surgery, including wedge resection, segmentectomy, lobectomy and pneumonectomy. Nowadays, single-incision VATS is considered as the least invasive thoracic surgery. It is demonstrated as a feasible procedure and provides comparable perioperative outcomes with multi-incisional VATS (3,4). Besides, patients receiving single-incision VATS experience less postoperative pain (21,22). However, chronic chest wound pain is still noted despite decreased chest wall trauma in transthoracic VATS (5).

Bilateral pulmonary metastasectomy performed by combination of transthoracic VATS and tumors palpation through subxiphoid incision was first reported in 1999 (23). In animal model, subxiphoid VATS for pulmonary resection was demonstrated as a feasible and effective procedure (6). Until 2014, Suda *et al.* and Liu *et al.* were demonstrated that bilateral pulmonary resection through single incision subxiphoid VATS was a feasible procedure (9,24). This less invasive approach can provide bilateral pulmonary resection through single subxiphoid incision. Besides, it is unnecessary to change patient's position for bilateral procedure and thereafter shorten operation time. Since then, there are several studies focused on subxiphoid VATS for pulmonary lung resection (*Table 1*).

Less postoperative pain in the subxiphoid VATS comparing to transthoracic VATS was demonstrated in several studies (25-27). The feature of lacking nerve in subxiphoid area can contribute to this advantage in subxiphoid VATS. Except simple pulmonary resection, major pulmonary resection, such as lobectomy or segmentectomy, can also be completed in subxiphoid VATS (6,8,26-30). However, the shift from transthoracic approach to subxiphoid approach makes surgery become more technique demanded. Hernandez-Arenas *et al.*

reported the learning curve of subxiphoid VATS is longer and more difficult than transthoracic single-incision VATS in their subxiphoid VATS experience in 200 patients (28). The caudal-cranial and anterior-posterior view makes visualization and dissection of posterior lesions more challenge (8,26,28,29). Some newly developed instruments may help to overcome these problems. For example, longer VATS instruments may facilitate good surgical field exposure and curved-tip staplers make passage some structures without difficulty (28). Besides, subcutaneous and mediastinal adiposity may impede tunnel creation between subxiphoid wound and pleural space. Therefore, obesity (body mass index >30 kg/m<sup>2</sup>) is considered as contraindication for subxiphoid VATS (28). Furthermore, the effect of cardiac pulsation and arrhythmia induced by intra-operative heart compression make left-sided procedure more challenge in subxiphoid VATS (24,26-28). It is not helpful to extend subxiphoid wound for major bleeding control and another thoracotomy is necessary. This is the main drawback of subxiphoid VATS (26-29). Despite high technique demand, subxiphoid VATS for complex pulmonary resection is feasible for skilled and experienced surgeons (30). Newly developed longer instruments or scopes may facilitate subxiphoid VATS pulmonary resection.

In summary, subxiphoid VATS for pulmonary resection is feasible despite it is high technique demand. The features of bilateral lesions approach and less postoperative pain make subxiphoid VATS to be the potential of the least invasive procedure in pulmonary resection.

## Conclusions

Subxiphoid VATS is a safe and feasible procedure in terms of thymectomy, anterior mediastinal mass resection and major pulmonary resection. Despite it is a highly technique demanding procedure with steep learning curve, subxiphoid VATS provides several advantages that transthoracic VATS can't reach. However, most studies about subxiphoid VATS are small-scale and retrospective, further large-scale prospective study is necessary to confirm the benefit of subxiphoid VATS.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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