



# Anterior chest wall lifting methods for mediastinal approach – literature review

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**Background and Objective:** For the purpose of facilitating a wide view and working space during surgery such as a thymectomy procedure, as well as that for treatment of anterior mediastinal lesions, anterior chest wall lifting began to be employed. In this article, previous reports of various kinds of chest wall lifting methods are reviewed.

**Methods:** The present study focused on procedures used for anterior chest wall lifting in a review of related studies primarily available in English. A search of the PubMed database was conducted in 1st March 2016. The first description about lifting method was reported in 1988.

**Key Comments and Findings:** Although objective evaluation regarding the effectiveness of lifting is difficult, in view of a balance among safety, reliability, and minimal invasiveness, surgeons may consider chest wall lifting as an optional method.

**Conclusions:** Anterior chest wall lifting began to be employed for enlarging the working space long before the advent of endoscopic surgery. Some originally developed retractors were used in transcervical thymectomy procedures. After general acceptance of transsternal extended thymectomy for myasthenia gravis, these transcervical approaches remained an important option along with anterior chest wall lifting. Thoracoscopic surgery for the treatment of anterior mediastinal lesions was introduced in the 1990s. Particularly in cases of surgery in the supine position, various creative methods and devices of lifting the sternum body, the anterior part of the rib, or the xiphoid process were reported.

**Keywords:** Thoracoscopic surgery; chest wall lifting; anterior mediastinum; thymectomy

Received: 31 October 2021; Accepted: 08 April 2022; Published: 25 September 2022.

doi: 10.21037/med-21-43

View this article at: <https://dx.doi.org/10.21037/med-21-43>

## Introduction

For the purpose of facilitating a wide view and working space during thoracoscopic surgery such as a thymectomy procedure, as well as that for treatment of anterior mediastinal lesions, various creative methods and devices for anterior chest wall lifting have been developed. The present study focused on procedures used for anterior chest wall lifting in a review of related studies primarily available in PubMed, without consideration of the surgical results. I present the following article in accordance with the Narrative Review reporting checklist (available at <https://>

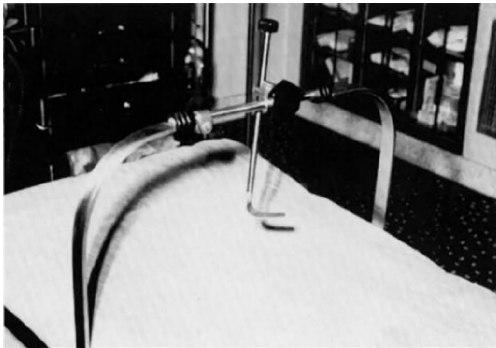
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## Methods

A search of the PubMed database was conducted in 1st March 2016. The following terms were included: ‘chest wall lifting’ or ‘sternal lifting’. The author excluded papers which were not written about surgical procedures for anterior mediastinal lesions and conference abstracts. The first description about lifting method was reported in 1988. The search strategy is summarized in *Table 1*.

**Table 1** The search strategy summary

Items	Specification
Date of search (specified to date, month and year)	1st March 2016
Databases and other sources searched	PubMed
Search terms used (including MeSH and free text search terms and filters)	Free text search using 'chest wall lifting' or 'sternal lifting'. MeSH or any filters were not used
Timeframe	1988–2016
Inclusion and exclusion criteria (study type, language restrictions etc.)	non-systematic review of the English literatures and 4 Japanese articles with English abstracts
Selection process (who conducted the selection, whether it was conducted independently, how consensus was obtained, etc.)	The author conducted and selected independently articles describing a novel lifting method



**Figure 1** Cooper Thymectomy Retractor [cited from (2) with permission].

### Chest wall lifting methods prior to establishment of endoscopic surgery

Anterior chest wall lifting began to be employed for enlarging the working space long before the advent of endoscopic surgery. The method used for accessing the anterior mediastinum (thymus) was originally constructed for a transcervical approach in the early twentieth century. Later, thanks to the progress of anesthesia treatment, a transsternal approach became widely utilized. At Mount Sinai Hospital where the transcervical approach has been frequently employed since the 1970s, the sternum was not specifically lifted when that approach was introduced. It is easy to imagine that surgical manipulation of the lower pole area was not easy because of difficulty with obtaining a good view (1). For improving that situation, Cooper *et al.* developed the Cooper Thymectomy Retractor (Pilling Co., Atlanta, USA) in 1988 and reported results of transcervical thymectomy procedures conducted under direct vision

provided by a cervical incision and lifting the manubrium of the sternum (2) (*Figure 1*). Thereafter, Durelli (3) and Boaron (4) presented a lifting method for obtaining a good view by pulling the sternum with a V-shaped sternal retractor from a few centimeter-sized split made on the sternal head side.

Along with general acceptance of a thymectomy for myasthenia gravis, Masaoka and Monden (5) reported that a transsternal extended thymectomy with a larger resection had a better therapeutic effect as compared to a transcervical thymectomy. Subsequently, that method became the standard operative procedure, though transcervical thymectomy remained an important option because of its minimal invasiveness.

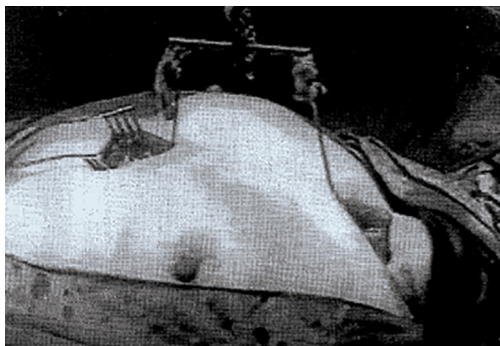
Cases of thoracoscopy-assisted surgery from a cervical incision by use of these methods were reported by de Perrot *et al.* in 2003 (6). Furthermore, Komanapalli *et al.* presented details of a transcervical thymectomy using a Rultract Skyhook retractor (Rultract Inc., Independence, OH, USA) for dissecting the internal thoracic artery, which is more readily available (7).

### Chest wall lifting methods for endoscopic surgery

Thoracoscopic surgery was introduced in the 1990s for cases of mediastinal benign tumor leading to pneumothorax and pulmonary tumor. In the early period, unilateral thoracoscopic surgery in a lateral position was reported. However, this approach for anterior mediastinal lesion was faced with unfavorable conditions, such as narrow working space or insufficient distance between ports. Particularly extensive manipulation was necessary for such surgical

procedures as an extended thymectomy. As a result, cases of thoracoscopic surgery in the supine position, which enables bilateral thoracic manipulation and a transcervical or substernal approach, were reported and various lifting methods devised in accordance with the need of individual approaches.

Among papers regarding thymectomy presented in the relatively early period, Yim and Mack *et al.* (8) reported unilateral three-port surgery without chest wall lifting, and Novellino *et al.* (9) presented a bilateral thoracoscopic surgery + transcervical approach in combination with lifting. In Japan, Ando *et al.* presented details of a bilateral thoracoscopy + transcervical approach without lifting in 1996 (10), then Ito *et al.* reported an extended thymectomy using mediastinoscopy while lifting the sternum as a whole



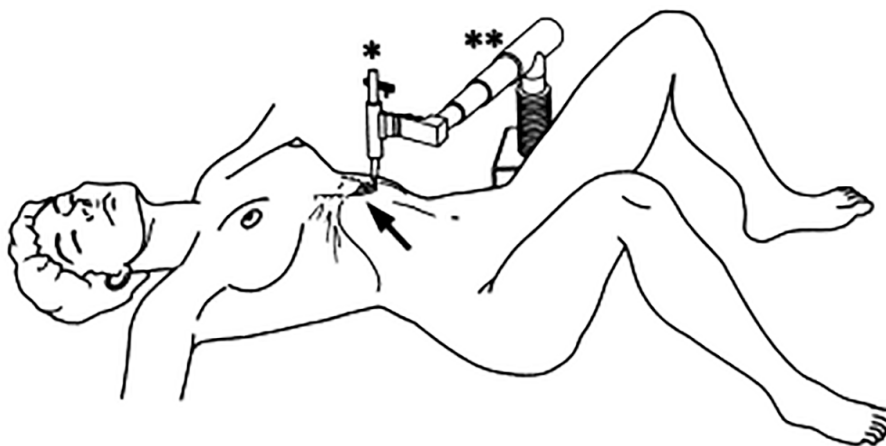
**Figure 2** Sternal lifting with doubled tape passed through backside of sternum [cited from (11) with permission].

by detaching the backside of the bone in a craniocaudal manner and passing doubled tape (11) (*Figure 2*).

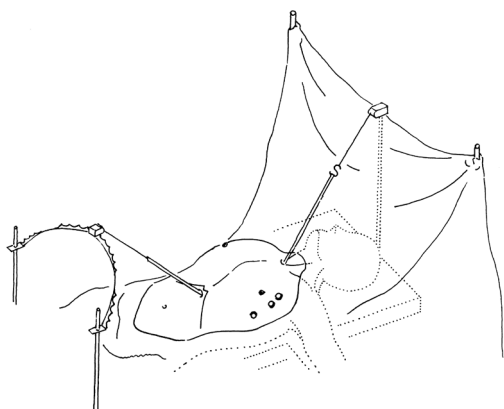
Kido *et al.* reported a thymectomy procedure through an infrasternal approach that includes lifting the xiphoid process with a Laparolift (Origin Co. Ltd., CA, USA), a lifting instrument used for laparoscopic surgery (12) (*Figure 3*). Uchiyama *et al.* (13) also noted a similar method using an infrasternal approach, while Takeo *et al.* (14) (*Figure 4*) and Hsu (15) presented their method combined with a thoracic approach along with clinical outcomes. With both of these methods, the sternum is lifted from the craniocaudal side. Additionally, Zieliński reported a maximal thymectomy, by which the thymus in the mediastinum is extracted maximally using a similar lifting method combined with a transcervical, infrasternal, or thoracic approach (16). Ishikawa *et al.* presented a unique iron retractor, which was shown to extensively grip the backside of the sternum (17).

For further development of mediastinal approach methods, Matsumoto *et al.* noted that they performed a thymectomy in an arousal state under epidural anesthesia in combination with lifting (18). For the purpose of improving the operability of a mediastinal approach, this author used an SILS™ Port (Covidien, Norwalk, CT, USA), an abdominal single port apparatus, and found that it was applicable for single port surgery in combination with sternal lifting for the anterior mediastinum (19) (*Figure 5*).

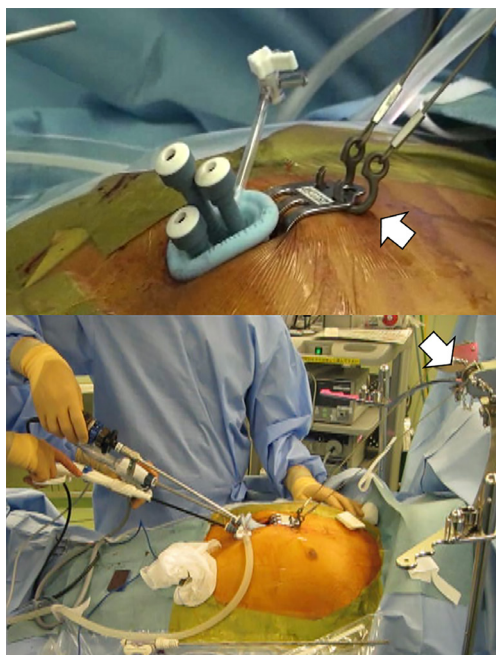
The sternum body cannot be lifted through a thoracic approach. Osako *et al.* reported a thoracoscopic method of lifting by outfitting a metal plate used for treating a bone fracture to the backside of the sternum (20). Also, Kurai



**Figure 3** Infrasternal thymectomy. Anterior chest wall is lifting with the Laparolift system (\*\*) through the Laparofan (\*). Camera and grasper are inserted into the wound (arrow) [cited from (12) with permission].

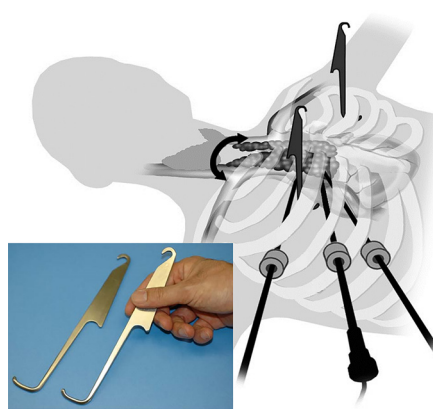


**Figure 4** Infrasternal + thoracic approach [cited from (14) with permission].



**Figure 5** Single port surgery with SILS™ Port. Anterior chest wall is lifting with a retractor system used for laparoscopic surgery (arrows) [cited from (19) with permission].

*et al.* presented a lifting method using a Kirshner steel wire subcutaneously passed to the anterior chest wall (21). At Osaka University, surgeons including this author in 2002 developed a method for pulling upward the frontal rib bone with a metal rib hook, and reported its use and outcomes as part of an extended thymectomy (22) (Figure 6). Later, a puncture-type lifting system (T-lifting system, Sonne



**Figure 6** Lifting by use of a rib hook.

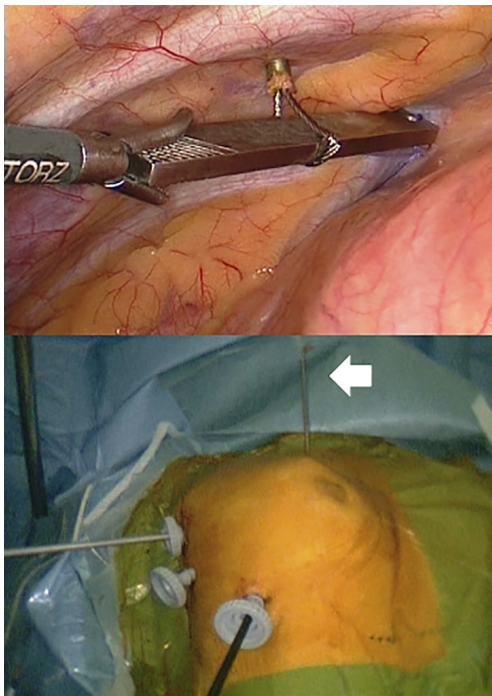
Medical Co., Tokyo, Japan) was designed, and both minimal invasiveness and operability were found to be enhanced while effectiveness was maintained (23) (Figure 7).

## Discussion

With the lifting methods reviewed in this study, the level of surgical invasion somehow increases with an added skin incision or an external force for lifting [according to our measurements, chest wall uplifting of 3 cm can be obtained by a 3-kg pulling force (22)]. Nevertheless, it might be difficult to objectively assess the lifting effect based on surgical factors such as operative time and/or amount of bleeding. A large number of surgeon groups have reported favorable outcomes for their surgical cases without lifting.

On the other hand, it is evident that chest wall lifting is practically helpful for a surgical procedure that requires fine manipulation to dissect the upper pole of the thymus and divide the thymic veins under adverse conditions (24) as compared to other types of endoscopic surgery, such as cases with a low amount of flexibility for port positioning and narrow working space. Recently, endoscopic surgery combined with CO<sub>2</sub> insufflation has been reported. However, problems related to equipment, and cardiovascular and respiratory effects during surgery have yet to be sufficiently dealt with. Accordingly, chest wall lifting might be considered as a possible additional procedure to enhance safety and convenience.

Cases requiring surgery for mediastinal disease are relatively few, thus trials to examine possible alternative procedures are difficult to conduct. Institutions with higher numbers of surgeries have noted the importance of placing emphasis on a unilateral approach with fewer incisions



**Figure 7** T-lifting method (Upper: intrathoracic, Lower/White arrow: lifting wire).

and shorter operative duration, and without adding manipulation such as chest wall lifting. However, reports presented here demonstrate the enthusiasm of attending surgeons to perform relatively difficult anterior mediastinal procedures such as an extended thymectomy by a minimally invasive procedure with a creative approach. Chest wall lifting might continue to be an optional approach, and serve as an auxiliary means to maintain the balance among surgical safety and reliability, and minimal invasiveness.

### Acknowledgments

This article is a translation based on a narrative review study first reported in Japanese in *Lift Endoscopy & Minimal Incision Surgery* (2016;1:59-64), with permission acquired. The language of this paper was edited by an English professional, Mr. Mark Benton, Intermed English Services. *Funding*: None.

### Footnote

*Reporting Checklist*: The author has completed the Narrative Review reporting checklist. Available at <https://med.amegroups.com/article/view/10.21037/med-21-43/rc>

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doi: 10.21037/med-21-43

**Cite this article as:** Shiono H. Anterior chest wall lifting methods for mediastinal approach—literature review. *Mediastinum* 2022;6:24.