



# Can mediastinoscopic esophagectomy be a choice of curative surgery? From the viewpoint of the short term outcomes: a clinical practice review

Kazuhiko Mori

Department of Gastrointestinal Surgery, Mitsui Memorial Hospital, Tokyo, Japan

Correspondence to: Kazuhiko Mori, MD. Department of Gastrointestinal Surgery, Mitsui Memorial Hospital, Kanda-Izumicho 1, Chiyoda-ku, 101-8643 Tokyo, Japan. Email: morikaz158@gmail.com.

**Abstract:** To minimize the postoperative pulmonary complications after esophagectomy, transhiatal esophagectomy has been a choice of surgical procedure but regarded as oncologically insufficient surgery for esophageal squamous cell carcinoma, because it omits the mediastinal lymph node dissection, especially in the upper mediastinum. In the past decade, non-transthoracic radical esophagectomy with the combination of transcervical and transhiatal video-assisted surgery have been increasingly reported. This procedure, referred as mediastinoscopic esophagectomy, enables the retrieval of the whole posterior mediastinal regional lymph nodes via cervical and abdominal small incisions. Mediastinoscopic esophagectomy would be advantageous in the prevention of postoperative pulmonary complications because it can be completed without any manipulations on the lungs or the chest wall. However, transcervical part of the mediastinoscopic esophagectomy allows limited assistance from a second surgeon owing to the small skin incision and the narrow operative field. In addition, surgeons have to overcome technical issues, such as unfamiliar surgical view and susceptibility to the recurrent nerve injury. Nowadays, studies on the safety and the feasibility of mediastinoscopic surgery have been accumulated reporting its surgical outcome. A review of literatures on short term outcome was conducted here to clarify the feasibility of mediastinoscopic esophagectomy as an oncologic surgery. Fourteen studies and four review articles hit the PubMed search. Tracheal injury was reported in three studies with a frequency of 3.3–6.3% and no other type of intraoperative adverse event was reported. In-hospital mortality was rarely reported. The reported frequency of the pulmonary complication was less than 10% in the majority of the studies. The mediastinoscopic radical esophagectomy has been demonstrated as safe and feasible. However, its superiority in the short term outcome remains unknown.

**Keywords:** Mediastinoscopy; esophagectomy; non-transthoracic; lymphadenectomy

Received: 31 August 2022; Accepted: 25 May 2023; Published online: 06 June 2023.

doi: 10.21037/dmr-22-63

View this article at: <https://dx.doi.org/10.21037/dmr-22-63>

## Introduction

Esophagectomy has been the mainstay of treatment modalities for esophageal cancer. The optimal surgical approach has been discussed so far; which of the two, the non-transthoracic or transthoracic approach, is superior has been the point of the discussion (1-3). The former approach is associated with reduced pulmonary complications and mainly favored by American surgeons (4). However, the conventional non-transthoracic esophagectomy is

performed mainly by transhiatal approach and omits mediastinal lymph node dissection. Therefore, non-transthoracic esophagectomy has been regarded as an insufficient surgical procedure especially for esophageal squamous cell carcinoma (3,5).

Nowadays, the emergence and the prevalence of the video-assisted surgical procedure have greatly altered the above-mentioned discussion. Minimally invasive transthoracic esophagectomy using video assisted and/or

surgical robot has greatly reduced the surgical mortality of esophageal cancer (6,7). As for non-transthoracic esophagectomy, a video-assisted approach via a cervical skin incision enabled the retrieval of the upper mediastinal regional lymph nodes adjacent to the bilateral recurrent laryngeal nerves (8-10). It also enables the retrieval of subcarinal lymph nodes in the middle mediastinum. The non-transthoracic esophagectomy, combining the transcervical and transhiatal approaches, has been referred as mediastinoscopic esophagectomy. The mediastinoscopic esophagectomy retrieves the whole regional lymph nodes in the mediastinum and can be equally radical to the transthoracic McKeown's esophagectomy (11-13). The mediastinoscopic esophagectomy is free from manipulations on the lungs or the thoracic wall and may have several advantages over the transthoracic esophagectomy. However, the narrow operative field of the mediastinoscopic esophagectomy may restrict the assistance from a second surgeon and, therefore, possible intraoperative injury on the adjacent vital organs such as great vessels or the bronchus cannot be easily managed.

Although the oncologic non-inferiority compared to the transthoracic surgery has been yet to be reported, studies on the safety and feasibility of the mediastinoscopic esophagectomy has been accumulated (9-13). The aim of this review is to highlight the short term outcomes of the mediastinoscopic esophagectomy.

## Methods

### *Procedural outline of the mediastinoscopic esophagectomy*

Earlier to 2010, mediastinoscopic upper mediastinal dissection using rigid endoscope combined with micro instruments has been reported (14,15). This kind of mediastinoscopic technique should be considered as non-radical esophagectomy without systemic dissection of the mediastinal regional lymph nodes. The first study introducing the use of single-incision laparoscopic surgery (SILS) port access device for cervical skin incision was reported by Parker *et al.* in 2011 and the majority of mediastinoscopic esophagectomy performed nowadays follow their method (8). Cervical approach is established via the SILS device placed on the left sided collar incision. While several surgeons use an additional right sided incision (16,17), most of the clinical studies introduced surgery with SILS device in the left. The mediastinum is inflated with 8 to 10 mmHg of carbon dioxide and a strongly magnified

view, especially along the left recurrent laryngeal nerve, is provided by the mediastinoscope. Using two or three surgical ports in addition to the one for camera, the surgical dissections along the esophagus together with regional lymph nodes are performed in the upper and middle mediastinum. The surgical dissection in the cervical field is performed without video assisted approach. Subsequently or simultaneously, the transhiatal surgery is performed by laparoscopy and the dissection fields of the two approaches, namely transcervical and transhiatal, are reached to each other in the middle mediastinal field. In this way, the whole length of the esophageal and the three-field regional lymph nodes were dissected and the specimen was retrieved via a cervical incision or a mini-laparotomy.

### *Surgical indication*

Considering the technical issues described afterwards, most previous studies excluded cases of clinical T4 and cases after definitive chemoradiotherapy. Meanwhile, patients with low pulmonary function regarded as border-line indication of one lung ventilation can be candidates of mediastinoscopic surgery.

### *Technical issues*

Due to a narrow operative field, surgeons at starting-up phase can be confused by an unfamiliar surgical view. This would be the first and biggest issue in starting up mediastinoscopic esophagectomy. Great vessels, especially the azygos and the left pulmonary vein, are unexpectedly close to the esophagus and the regional lymph nodes. These structures as well as the membranous portion of the trachea and the bronchi can be severely injured if the operative field is stained with blood. However, if the operative field is maintained bloodless and clean, the dissections close to these adjacent vital structures can be guided by the view of the loose tissue space spontaneously exposed by the positive pressure inflation. To avoid hemorrhage, even a small one, leading to such intraoperative adverse events, surgeons should be familiar to the mediastinoscopic view of the field in detail, especially the location and the course of the tracheal arteries which gives numeral small branches to the esophagus and the regional lymph nodes (18,19).

Another issue is the susceptibility of the left recurrent nerve to mechanical injury. Its injury can be resulted from the unrecognizable compression or retraction of the nerve outside the narrow vision range of the mediastinoscope.

**Table 1** Studies on short-term outcome of mediastinoscopic esophagectomy (8,11-13,17,21-27)

First author (Ref.)	Year	Country	Number	PMID	Estimated blood loss (mL)	Operation time (min)	Conversion (%)
Wu (13)	2021	China	29	34364369	114.2±17.5; 111.7±16.0	192.9±13.0; 246.8±6.9	0
Zhu (21)	2021	China	39	34659820	NA	NA	0
Gan (22)	2020	China	28	32035045	NA	NA	0
Yamagata (23)	2020	Japan	16	32962718	180 (30 to 665)	489 (430 to 616)	6.3
Daiko (17)	2020	Japan	16	32989533	50 (11 to 920)	231 (157 to 429)	6.3
Egberts (24)	2019	Germany	5	31039586	322 <sup>†</sup>	NA	0
Nakauchi (26)	2019	Japan	6	30074105	179 (118 to 409)	805.5 (563 to 1,145)	0
Fujiwara (11)	2017	Japan	60	28859387	235 (IQR, 120–375)	363 (IQR, 331–412)	3.3
Okumura (27)	2015	Japan	63	26252999	643±310	403±140	1.6
Mori (12)	2015	Japan	22	25809390	385 (30 to 890)	524 (445 to 724)	0
Parker (8)	2011	USA	8	21701920	119 <sup>†</sup> (25 to 400)	292 <sup>†</sup> (194 to 375)	0
Bumm (25)	1997	Germany	47	9327673	NA	NA	0

Studies by Zhu *et al.* (21) and Gan *et al.* (22) reported the perioperative outcome in individual two cohorts of patients undergoing mediastinoscopic esophagectomy. Estimated blood loss and operation time is described in mean ± standard deviation, median (range), or median (IQR). <sup>†</sup>, mean. NA, not available; IQR, interquartile range.

To avoid this “unrecognizable” injury, a continuous intraoperative nerve monitoring system would be an effective device (20).

Possibly due to the publication bias, lethal intraoperative adverse events have been rarely reported in literature. Theoretically, non-transthoracic approach would be advantageous in reducing pulmonary complications due to its minimal invasiveness to the lungs or the thoracic wall. Our main concern would be whether or not the pulmonary complications can be minimized in the postoperative course of mediastinoscopic esophagectomy despite the above-mentioned technical issues.

### Method of the literature review

In this review article, the safety of the mediastinoscopic esophagectomy is reviewed and discussed (estimated intraoperative blood loss, operative time and perioperative adverse events). Literature search was performed using PubMed with keywords “Mediastinoscope AND Esophagectomy” or “Transmediastinal AND Esophagectomy”. Excluded were the literatures on non-malignant esophageal disease, other fields of malignancy (e.g., lung cancer), case reports and non-clinical study (e.g.,

animal model, cadaver surgery). Studies on apparently non-radical esophagectomy such that nothing about the mediastinal lymph node retrieval was discussed were also excluded.

## Results

### Surgical outcomes

The search hit fourteen studies from twelve institutes reporting perioperative outcomes and four review articles. There were two author groups [Zhu *et al.* (21) and Gan *et al.* (22)] reporting two studies. Only newer one of the two from the same author group was included in this review of surgical outcomes. Tables 1,2 list literatures from the twelve author groups together with their perioperative outcomes (8,11-13,17,21-27).

Tracheal injury was reported in three studies with a frequency of 3.3–6.3% and no other type of intraoperative adverse event was reported. Conversion to transthoracic surgery was reported in four studies including the three cases with airway injury and one with cancer invasion to the adjacent vital organs. Median (or mean in several studies) estimated blood loss and operation time (median

**Table 2** Postoperative complication rates after mediastinoscopic esophagectomy (8,11-13,17,21-27)

First author (Ref.)	Year	Number	Hospital stay (days)	Pulmonary complications, %	Laryngeal nerve palsy, %	Anastomotic failure, %	Chyle leak, %	In-hospital mortality, %
Wu (13)	2021	29	7.6±1.3; 6.9±1.2	0	3.4	0	3.4	–
Zhu (21)	2021	39	12.00 (IQR, 11.00); 12.00 (IQR, 5.00)	5.1	21	10	0	–
Gan (22)	2020	28	NA	0	14	11	0	–
Yamagata (23)	2020	16	16 (12 to 67)	0	6.3	0	19	–
Daiko (17)	2020	16	15 (11 to 75)	23	38	6.3	0	–
Egberts (24)	2019	5	NA	0	20	20	20	–
Nakauchi (26)	2019	6	17.5 (15 to 26)	17	0	17	0	–
Fujiwara (11)	2017	60	31 (IQR, 25–48)	6.7	33	15	0	–
Okumura (27)	2015	63	NA	9.5	12	22	0	1.6
Mori (12)	2015	22	18 (11 to 41)	0	4.5	18	4.5	–
Parker (8)	2011	8	7 (5 to 16)	13	25	13	–	–
Bumm (25)	1997	47	NA	19	13	34	–	4.3

Studies by Zhu *et al.* (21) and Gan *et al.* (22) reported two studies. Hospital stay is indicated in mean ± standard deviation, median (IQR), or median (range). NA, not available; IQR, interquartile range.

or mean) ranged 50 to 643 mL and 192.9 to 805.5 minutes, respectively. Compared to the historical data from the cohort of the patients undergoing transthoracic esophagectomy in Japan, the mediastinoscopic surgery seemed to be associated with reduced blood loss and equivalent operation time (7).

### Postoperative course

The reported median length of postoperative stay ranged 6.9 to 31 days and recent studies rarely reported in-hospital mortality (Tables 1,2). High frequency (over 20%) of recurrent nerve palsy was reported in five institutes. However, a majority of the recent studies with sufficient number of patients reported the frequency of pulmonary complications as less than 10%. Although no convincing evidence has been obtained yet, this review study suggested a possible superiority of the mediastinoscopic esophagectomy in the reduction of pulmonary complications despite the high frequency of laryngeal nerve palsy in several institutes. Three studies reported that all cases of the laryngeal palsy in their series were temporary while only one case (6.7%) reported by Fujiwara *et al.* was persistent (11). As for anastomotic leakage and chyle leakage, there were no remarkable findings in this review.

### Superiority in quality of life (QOL)

The QOL after mediastinoscopic esophagectomy was validated by Sugawara *et al.* using two European Organization for Research and Treatment of Cancer (EORTC) questionnaire module, namely QLQ-C30 and QLQ-OES18 (28). In the comparison with open transthoracic esophagectomy, mediastinoscopic esophagectomy provided significantly higher scores of QOL and also resulted in significantly fewer problems such as fatigue, general pain, insomnia and dry mouth. Moreover, the respiratory function was better maintained after mediastinoscopic esophagectomy compared to the open esophagectomy (29).

However, these studies were reported from the same single center and the comparison was the one with open transthoracic esophagectomy. To confirm QOL superiority of mediastinoscopic esophagectomy, a prospective study should provide a comparison to the transthoracic minimally invasive esophagectomy.

### Strength and limitations

In this paper, no statistical analyses were performed. All

of the reviewed studies were retrospective studies or non randomized prospective studies.

## Conclusions

The mediastinoscopic radical esophagectomy has been demonstrated as safe and feasible. It is associated with less frequent postoperative pneumonia and improved postoperative quality of life when compared with the conventional transthoracic surgery. However, a prospective clinical trial providing the comparison of the two types of minimally invasive esophagectomy, thoracoscopic and mediastinoscopic, is needed to conclude the superiority of the mediastinoscopic esophagectomy.

## Acknowledgments

*Funding:* None.

## Footnote

*Peer Review File:* Available at <https://dmr.amegroups.com/article/view/10.21037/dmr-22-63/prf>

*Conflicts of Interest:* The author has completed the ICMJE uniform disclosure form (available at <https://dmr.amegroups.com/article/view/10.21037/dmr-22-63/coif>). The author has no conflicts of interest to declare.

*Ethical Statement:* The author is 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.

*Open Access Statement:* This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

## References

1. Bakhos CT, Fabian T, Oyasiji TO, et al. Impact of the surgical technique on pulmonary morbidity after esophagectomy. *Ann Thorac Surg* 2012;93:221-6; discussion 226-7.
2. Gockel I, Heckhoff S, Messow CM, et al. Transhiatal and transthoracic resection in adenocarcinoma of the esophagus: does the operative approach have an influence on the long-term prognosis? *World J Surg Oncol* 2005;3:40.
3. Kutup A, Nentwich MF, Bollschweiler E, et al. What should be the gold standard for the surgical component in the treatment of locally advanced esophageal cancer: transthoracic versus transhiatal esophagectomy. *Ann Surg* 2014;260:1016-22.
4. Orringer MB. Transhiatal esophagectomy without thoracotomy for carcinoma of the thoracic esophagus. *Ann Surg* 1984;200:282-8.
5. Junginger T, Gockel I, Heckhoff S. A comparison of transhiatal and transthoracic resections on the prognosis in patients with squamous cell carcinoma of the esophagus. *Eur J Surg Oncol* 2006;32:749-55.
6. Luketich JD, Pennathur A, Awais O, et al. Outcomes after minimally invasive esophagectomy: review of over 1000 patients. *Ann Surg* 2012;256:95-103.
7. Yoshida N, Yamamoto H, Baba H, et al. Can Minimally Invasive Esophagectomy Replace Open Esophagectomy for Esophageal Cancer? Latest Analysis of 24,233 Esophagectomies From the Japanese National Clinical Database. *Ann Surg* 2020;272:118-24.
8. Parker M, Bowers SP, Goldberg RF, et al. Transcervical videoscopic esophageal dissection during two-field minimally invasive esophagectomy: early patient experience. *Surg Endosc* 2011;25:3865-9.
9. Fujiwara H, Shiozaki A, Konishi H, et al. Single-Port Mediastinoscopic Lymphadenectomy Along the Left Recurrent Laryngeal Nerve. *Ann Thorac Surg* 2015;100:1115-7.
10. Mori K, Aikou S, Yagi K, et al. Technical details of video-assisted transcervical mediastinal dissection for esophageal cancer and its perioperative outcome. *Ann Gastroenterol Surg* 2017;1:232-7.
11. Fujiwara H, Shiozaki A, Konishi H, et al. Perioperative outcomes of single-port mediastinoscope-assisted transhiatal esophagectomy for thoracic esophageal cancer. *Dis Esophagus* 2017;30:1-8.
12. Mori K, Yamagata Y, Aikou S, et al. Short-term outcomes of robotic radical esophagectomy for esophageal cancer by a nontransthoracic approach compared with conventional transthoracic surgery. *Dis Esophagus* 2016;29:429-34.
13. Wu CL, Dong B, Wu B, et al. The application of rigid and

- flexible mediastinoscopy in esophagectomy: our experience and a new technology. *World J Surg Oncol* 2021;19:234.
14. Bonavina L, Incarbone R, Bona D, et al. Esophagectomy via laparoscopy and transmediastinal endodissection. *J Laparoendosc Adv Surg Tech A* 2004;14:13-6.
  15. Watanabe M, Yoshida N, Karashima R, et al. Transcervical superior mediastinal lymph node dissection combined with transhiatal lower esophageal dissection before transthoracic esophagectomy: a safe approach for salvage esophagectomy. *J Am Coll Surg* 2009;208:e7-9.
  16. Tokairin Y, Nakajima Y, Kawada K, et al. The usefulness of a bilateral trans-cervical pneumomediastinal approach for mediastinoscopic radical esophagectomy: a right transcervical approach is an available option. *Gen Thorac Cardiovasc Surg* 2019;67:884-90.
  17. Daiko H, Oguma J, Fujiwara H, et al. Novel universally applicable technique for performing bilateral transcervical mediastinoscopic-assisted transhiatal laparoscopic esophagectomy: a truly minimally invasive procedure. *Surg Endosc* 2021;35:5186-92.
  18. Mori K, Ino K, Yoshimura S, et al. Mediastinoscopic view of the bronchial arteries in a series of surgical cases evaluated with three-dimensional computed tomography. *Esophagus* 2018;15:173-9.
  19. Maeda T, Fujiwara H, Konishi H, et al. Preoperative 3D-CT evaluation of the bronchial arteries in transmediastinal radical esophagectomy for esophageal cancer. *Esophagus* 2022;19:77-84.
  20. Wong I, Tong DKH, Tsang RKY, et al. Continuous intraoperative vagus nerve stimulation for monitoring of recurrent laryngeal nerve during minimally invasive esophagectomy. *J Vis Surg* 2017;3:9.
  21. Zhu S, Zhang G, You Q, et al. Sternal lifting increases the operating space in esophagectomy via mediastinoscopy: a prospective cohort study. *J Thorac Dis* 2021;13:5546-55.
  22. Gan X, Wang X, Zhang B, et al. Lymphadenectomy Along Bilateral Recurrent Laryngeal Nerves Under Single-Incision Mediastinoscopy. *Ann Thorac Surg* 2020;109:e449-52.
  23. Yamagata Y, Saito K, Hirano K, et al. Long-term outcomes and safety of radical transmediastinal esophagectomy with preoperative docetaxel, cisplatin, and 5-fluorouracil combination chemotherapy for locally advanced squamous cell carcinoma of the thoracic esophagus. *World J Surg Oncol* 2020;18:252.
  24. Egberts JH, Schlemminger M, Hauser C, et al. Robot-Assisted McKeown Procedure via a Cervical Mediastinoscopy Avoiding an Abdominal and Thoracic Incision. *Thorac Cardiovasc Surg* 2019;67:610-4.
  25. Bumm R, Feussner H, Bartels H, et al. Radical transhiatal esophagectomy with two-field lymphadenectomy and endodissection for distal esophageal adenocarcinoma. *World J Surg* 1997;21:822-31.
  26. Nakauchi M, Uyama I, Suda K, et al. Robot-assisted mediastinoscopic esophagectomy for esophageal cancer: the first clinical series. *Esophagus* 2019;16:85-92.
  27. Okumura H, Uchikado Y, Matsumoto M, et al. Clinical significance of mediastinoscope-assisted transhiatal esophagectomy in patients with esophageal cancer. *Langenbecks Arch Surg* 2015;400:699-706.
  28. Sugawara K, Yoshimura S, Yagi K, et al. Long-term health-related quality of life following robot-assisted radical transmediastinal esophagectomy. *Surg Endosc* 2020;34:1602-11.
  29. Yoshimura S, Mori K, Ri M, et al. Comparison of short-term outcomes between transthoracic and robot-assisted transmediastinal radical surgery for esophageal cancer: a prospective study. *BMC Cancer* 2021;21:338.

doi: 10.21037/dmr-22-63

**Cite this article as:** Mori K. Can mediastinoscopic esophagectomy be a choice of curative surgery? From the viewpoint of the short term outcomes: a clinical practice review. *Dig Med Res* 2024;7:3.