The Comparison of Outcomes between Video-assisted Thoracoscopic and Open Surgery for Esophageal Cancer

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Abstract

Background: Minimally invasive esophagectomy theoretically has advantages over open esophagectomy. The purpose of the present study was to compare the short- and long-term outcomes of patients who underwent video-assisted thoracoscopic esophagectomy (VATE) or conventional open esophagectomy (OE) for esophageal carcinoma.

Methods: A total of 122 patients who underwent radical esophagectomy via VATE (VATE group, N = 87) and OE (OE group, N = 35) for esophageal carcinoma between 2005 and 2018 were retrospectively enrolled in this study, and the postoperative outcomes were compared.

Results: The OE group had younger patients and more patients who received neo-adjuvant therapy than the VATE group. The procedure time in the OE group was also shorter than that in the VATE group (8.22 vs. 10.28 h, $P < 0.001$). Intraoperative blood loss was similar between the groups ($P = 0.775$). There were no significant differences in the total number of dissected lymph nodes between the groups (OE: 33, VATE: 37, $P = 0.482$). The incidence of severe complications was lower in the VATE group than in the OE group (44.8% vs. 65.7%, $P = 0.037$). With a median follow-up of 26 months, the 3-year overall survival and disease-free survival were similar between the two groups.

Conclusion: VATE for esophageal carcinoma is associated with more favorable short-term outcomes and equal oncological outcomes compared with OE.

Keywords: Esophageal cancer; Video-assisted thoracoscopic surgery; outcomes; Open surgery

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Introduction

Esophageal cancer is the eighth-most common type of cancer and the sixth-most common cause of death due to cancer in the world¹⁾. More than 456,000 new esophageal cancer diagnoses and 400,000 deaths per year were reported to occur worldwide in 2012¹⁾. The combination of neoadjuvant chemoradiotherapy and complete surgical resection has become the standard treatment of advanced esophageal cancer²⁾. However, although the resection rate has increased gradually, patients with esophageal cancer often develop tumor recurrence. The prognosis for esophageal cancer patients after curative resection remains poor with a 3- and 5-year overall survival (OS) of 44% and 26%, respectively³⁾. Furthermore, radical

esophagectomy is a major undertaking and is associated with significant morbidity and mortality, especially in elderly patients⁴⁾. Therefore, it is important to control the postoperative complications.

Video-assisted thoracoscopic esophagectomy (VATE) is an established minimally invasive procedure that was first reported in 1992 by Cuschieri⁵⁾. VATE has been reported to improve the short-term outcomes in terms of less blood loss and analgesic requirements, quicker recovery and a shorter hospital stay⁶⁾. However, some reports have shown various results in the comparison of the short-term results between VATE and conventional open surgery (COS)⁷⁻¹⁰⁾, and the survival outcomes of VATE for esophageal carcinoma are still unclear.

The present study therefore compared the short- and long-term operative outcomes between VATE and COS in patients with esophageal cancer with a retrospective cohort analysis.

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Patients and Methods

Patient data

A database with primary esophageal cancer patients who underwent surgical treatment at Yokohama City University from January 2005 to September 2018. The patients who had undergone palliative or non-curative surgery were excluded. All patients were pathologically determined to have squamous cell carcinoma of clinical stage IB to III (excluding T4).

Surgical procedure

Conventional open transthoracic esophagectomy via right thoracotomy or video-assisted surgery with two- or three-field lymphadenectomy was performed, along with reconstruction through the retrosternal route or posterior mediastinal route and cervical or intrathoracic anastomosis. A feeding tube was routinely placed at the stomach or duodenum. A jejunostomy catheter was routinely placed for postoperative enteral nutrition.

Perioperative care

All of the patients received the same perioperative management. Antibiotics were administered 30 min before surgical incision and every 3 h during the operation as well as on postoperative day (POD) 2. On POD 1, enteral nutrition and ambulation training were started. On POD 5, oral intake with water and gelatinous foods was initiated, and solid food was started on POD 10.

Follow-up

All patients were followed-up for five years after surgical curative resection. The serum SCC, CEA and CA19-9 levels and radiological examination findings by computed tomography were checked at least every three months for five years at outpatient clinics. Disease recurrence was diagnosed based on tumor marker levels and radiographic evidence of a new suspicious low-density mass.

Evaluations and statistical analyses

The significance of the associations between the operative approach and clinicopathological parameters was determined using the χ^2 test or Fisher's exact test. The overall survival (OS) was defined as the period from surgery until death. The recurrence-free survival (RFS) was defined as the period from surgery until recurrence or death. The OS and RFS curves were plotted according to the Kaplan–Meier method, and statistical differences between different groups were compared using the log-rank test. P values of <0.05 were considered statistically significant.

Statistical analyses were performed using the statistical software program SPSS, ver. 23.0 (IBM, Chicago,

IL, USA). This study was approved by the Institutional Review Board (IRB) Committee of the Yokohama City University. Informed consent to use clinical data without identifying personal data was obtained in all cases.

Results

Patient characteristics

A total of 122 patients underwent esophagectomy for esophageal cancer and preoperatively between October 2005 and September 2018. The patients' ages ranged from 40 to 82 years old (median: 68 years old); 106 were male, and 16 were female. Eighty-seven patients were classified into the VATE group, and 35 patients were classified into the OS group.

Clinicopathological features

Table 1 summarizes the patients' background with the VATE group and OS group in the present study. There were significant differences in the distribution of age and presence of neo-adjuvant chemotherapy between the two groups. However, there were no significant differences in the gender, body mass index, site of tumor, lymph node dissection or pathological T and N factors.

Short-term outcomes

The short-term outcomes are shown in Table 2. The operation time was significantly longer in the VATE group than in the OS group (10.28 vs. 8.22 h, $p < 0.001$), but the findings were similar between the groups with regard to blood loss (542 vs. 500 ml; $p = 0.775$) and the rate of transfusion (31.0% vs. 25.7%; $p = 0.560$). More lymph nodes were dissected in the VATE group than in the OS group, but the difference was not statistically significant (37 vs. 33; $p = 0.482$). The postoperative complication rate was lower in the VATE group than in the OS group, with more cases with a Clavien-Dindo classification of grade III (44.8% vs. 65.7%; $p = 0.037$). In addition, respiratory complications were less prevalent in the VATE group than in the OS group (40.1% vs. 60.0%; $p = 0.047$). The postoperative hospital stay duration and duration of intensive-care unit (ICU) stay were similar between the groups. The type of recurrence and median time to first cancer recurrence were also similar between the groups. The mortality rate was 0.8% in this study. There was not significant difference between two groups.

Survival analyses

The median duration of follow-up was 27 months for the whole cohort (range: 0–116 months). The OS and RFS curves are shown in Fig. 1. The OS rate at 3 years after surgery was 69.1% in the VATE group and 53.8% in the OS group, which was not significantly different ($p = 0.161$). The RFS rate at 3 years after surgery was 52.2% in the VATE group and 39.4% in the OS group, which

Table 1 Comparison of patient background factors between video-assisted surgery group and open surgery group

Variables	All patients (n = 122)	VATS (n = 87)	Open (n = 35)	p value
Age (years), median (range)	66 (40–82)	70 (40–82)	65 (49–78)	0.020
Gender				0.403
Female	16 (13.1%)	10 (11.5%)	6 (17.1%)	
Male	106 (86.9%)	77 (88.5%)	29 (82.9%)	
Body mass index, median (range)	21.0 (14.5–29.0)	20.9 (14.5–29.0)	21.2 (16.1–27.6)	0.598
ASA-PS				0.580
1	11 (9.0%)	2 (5.7%)	9 (10.3%)	
2, 3	111 (91.0%)	33 (94.3%)	78 (89.7%)	
Site of tumor				0.784
Upper thoracic	31 (26.3%)	21 (25.3%)	10 (28.6%)	
Middle thoracic	53 (44.9%)	39 (47.0%)	14 (40.0%)	
Lower thoracic	34 (28.8%)	53 (27.7%)	11 (31.4%)	
Nodal dissection				0.803
Two fields	69 (57.0%)	49 (56.3%)	20 (58.8%)	
Three fields	52 (43.0%)	38 (43.7%)	14 (41.2%)	
Neo-adjuvant chemotherapy				<0.001
Absent	51 (43.2%)	45 (53.6%)	6 (17.6%)	
present	67 (56.8%)	39 (46.1%)	28 (82.4%)	
Pathological T factor				0.103
pT1-2	63 (51.6%)	49 (56.3%)	14 (40.0%)	
pT3	59 (48.4%)	38 (43.7%)	21 (60.0%)	
Pathological N factor				0.753
Absent	62 (50.8%)	45 (51.7%)	17 (48.6%)	
present	60 (49.2%)	42 (48.3%)	18 (51.4%)	
Follow up period, median (range)	808 (4–3479)	829 (39–2909)	732 (4–3479)	0.934

ASA-PS American Society of Anesthesiologists physical status

Table 2 Relationship of short-term outcomes between video-assisted surgery group and open surgery group

	VATS (n = 87)	Open (n = 35)	p value
Operation time (hour)	10.28 (6.11–15.11)	8.22 (3.56–11.43)	<0.001
Intraoperative bleeding (g)	542 (70–2992)	500 (95–3000)	0.775
Transfusion	27 (31.0%)	9 (25.7%)	0.560
Number of dissected LN	37 (13–118)	33 (3–86)	0.482
Complications (grade3-)	39 (44.8%)	23 (65.7%)	0.037
Respiratory complications	35 (40.1%)	21 (60.0%)	0.047
Anastomous leakage	31 (35.6%)	11 (31.4%)	0.658
Recurrent laryngeal nerve palsy	23 (26.7%)	7 (20.4%)	0.483
ICU stay (day)	5 (0–367)	4 (0–373)	0.607
Hospital stay (day)	31 (0–412)	24 (4–376)	0.626
Recurrence site			
Liver	8	2	0.526
Lung	9	5	0.537
Local	5	4	0.278
Lymph node	21	10	0.611
Brain	3	0	0.266
Bone	3	1	0.868

Fig. 1 A comparison of the recurrence-free survival (1-a) and overall survival (1-b) rate in the VATE group and OS group who underwent potentially curative surgery for esophageal cancer.

was not also significantly different ($p = 0.296$).

Discussion

The present study examined whether the approach of operation methods was associated with short- and long-term outcomes in patients who received radical esophagectomy for esophageal cancer. Most of our findings clearly indicated that the site of cancer recurrence, OS and RFS were similar between the two groups during long-term follow-up. In the short-term follow-up, VATE reduced the rate of both postoperative pulmonary complications and severe postoperative complications.

The main concern associated within VATE for esophageal carcinoma is the risk of inadequate tumor resection. However, no marked difference was observed in the rate of margin-free resection or lymph node dissection between VATE and open resection in several comparative studies^{11, 12}. Furthermore, there are some reports that VATE is superior to OS with regard to the long-term prognosis. Iguchi et al.¹⁰ reported that the 5-year OS was significantly better in the VATE group than in the OS group (69.0% vs. 35.5%; $p = 0.004$) and a multivariate analysis showed that VATE was a prognostic factor of the OS ($p < 0.001$) and RFS ($p = 0.032$) in patients with stage II/III esophageal cancer. In the present study, the long-term prognosis of VATE was better than that of OS, although no statistically significant difference was observed. The greatest potential benefit of VATE is a reduced incidence of pulmonary complications, which are the most common adverse events following esophageal surgery, with a reported rate as high as 67% following IS¹³⁻¹⁵. Tamagawa et al.¹⁵ reported that the development of postoperative pneumonia is a risk factor for the OS in patients who undergo esophagectomy for esophageal cancer, and it is necessary to prevent these patients from developing postoperative pneumonia in order to improve their survival. In the present study, the postoperative severe complication rate was lower in the VATE group and respiratory complications in particular were significantly less prevalent in the VATE group than in the OS group. This is thought to be one reason why the prognosis of VATE is better than that of OS. However, the optimal explanation of this discrepancy was unclear. Thus further analysis will focus on this issue.

One of the advantages of VATE for esophageal carcinoma is less blood loss than with the open method^{7, 8}. In the present study series, the operation time in the VATE group was significantly longer than that in the OS group, although the blood loss and rate of transfusion were similar between the groups. Furthermore, more lymph nodes tended to have been dissected in the VATE group, and the frequency of recurrent laryngeal nerve injury was higher than in the OS group. Boone et al.¹⁶ attributed this finding to the extensive en-bloc lymph node dissection

performed in the superior mediastinum. The improved accessibility with VATE allows surgeons to operate further on the deeper side of the thoracic cavity, which cannot be achieved with conventional OS.

Several limitations associated with the present study warrant mention. First, it was a retrospective study with a relatively small sample size, so the results must be confirmed in another cohort or in a prospective multicenter study. Second, there was a time bias in this study, as the data were collected between 2005 and 2018. The surgical procedures, postoperative chemotherapy, and perioperative care might have changed over this period. Furthermore, the test method, detection reagent, and testing time might have differed among studies. Third, we did not correct the times for thoracic part. Thus, the clinical impact of the thoracic part was unclear. Considering these limitations, the current results should be validated by another study.

In conclusion, the present study showed that VATE is feasible and oncologically safe in select patients and can lead to acceptable surgical results with less postoperative severe or respiratory complications and similar survival outcomes in terms of the long-term outcomes compared with OS.

Consent to publish:

The study does not involve any personal identifiable data.

Competing interests:

The authors declare no competing interests in association with the present study

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