

# Transhiatal Chest Drainage Reduces The Frequency of Postoperative Thoracentesis In Transmediastinal Esophagectomy For Esophageal Cancer: A Retrospective Study

Katsuji Hisakura (✉ [ssnsur@md.tsukuba.ac.jp](mailto:ssnsur@md.tsukuba.ac.jp))

University of Tsukuba

Koichi Ogawa

University of Tsukuba

Yoshimasa Akashi

University of Tsukuba

Jaejeong Kim

University of Tsukuba

Shoko Moue

University of Tsukuba

Yusuke Ohara

University of Tsukuba

Yohei Owada

University of Tsukuba

Shinji Hashimoto

University of Tsukuba

Tsuyoshi Enomoto

University of Tsukuba

Tatsuya Oda

University of Tsukuba

---

## Research Article

**Keywords:** Transhiatal chest drainage, Transmediastinal esophagectomy, esophageal cancer

**Posted Date:** December 6th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-1118303/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)



# Abstract

**Background:** Transmediastinal esophagectomy for esophageal cancer occasionally results in the postoperative accumulation of pleural effusion despite the preservation of the mediastinal pleura. Transhiatal chest drainage has reported utility in thoracic esophagectomy; however, its use in transmediastinal esophagectomy remains unelucidated. This study aimed to evaluate the effectiveness and safety of transhiatal chest drainage in transmediastinal esophagectomy.

**Methods:** This retrospective study included patients who underwent transmediastinal esophagectomy for esophageal cancer from 2018 to 2020. The transhiatal chest drainage involved the insertion of a 19-Fr Blake® drain from the inferior hepatic space to the left thoracic cavity through the hiatus. The drainage group comprising 13 patients was compared with the non-drainage group comprising 13 patients in whom a transhiatal chest drainage tube was not placed during transmediastinal esophagectomy.

**Results:** The frequency of thoracentesis in the drainage group was significantly lower than that in the non-drainage group ( $p = 0.03$ ). There were no significant differences between the two groups in terms of the occurrence of other postoperative complications, duration of oxygen administration, and postoperative hospital stay.

**Conclusions:** Transhiatal chest drainage could evacuate pleural effusion effectively and safely after transmediastinal esophagectomy. Therefore, this procedure is clinically useful in transmediastinal esophagectomy for esophageal cancer.

## Background

Chest drainage is essential for full lung expansion in postoperative management of esophagectomy due to the clinical consequences of pleural effusion [1]. Transmediastinal radical esophagectomy for esophageal cancer is performed without the thoracic approach [2, 3]. Theoretically, this surgical procedure limits and prevents the exposure of the pleural cavity. However, transmediastinal esophagectomy also results in the accumulation of pleural effusion, despite the preservation of the mediastinal pleura, especially in the left thoracic cavity [4]. Therefore, the placement of an effective chest drainage tube is essential for esophagectomy, even with a transmediastinal approach.

Although the placement of an intercostal chest drainage tube is a standard practice in transthoracic esophagectomy, the intercostal approach is not appropriate for the transmediastinal approach, where the surgical field is far from the thoracic wall. Transhiatal chest drainage, which was reportedly used for transthoracic esophagectomy, can be inserted into the thoracic cavity via laparoscopy without manipulating the thoracic wall [5, 6]. However, we have found no studies assessing its use in transmediastinal esophagectomy.

Thus, this study evaluated the effectiveness and safety of transhiatal chest drainage in transmediastinal esophagectomy by comparing the incidence of thoracentesis and other complications with or without a

transhiatal chest drainage tube.

## Methods

This retrospective study included all the patients who underwent transmediastinal esophagectomy for esophageal cancer at Tsukuba University Hospital from 2018 to 2020. We excluded patients who converted to thoracotomy, developed pneumothorax and required tube drainage at the time of wound closure, underwent simultaneous surgery for a second cancer, or whose gastric conduit could not be used.

## Surgical procedure

All patients underwent transcervical, transmediastinal esophagectomy with radical lymph node dissection, followed by the laparoscopic transhiatal approach, as described previously [2, 3]. In almost all patients, the abdominal and transhiatal procedures were performed laparoscopically; in seven patients, the procedures were hand-assisted. In the drainage group, the transhiatal left chest drainage tube was placed after esophagectomy and lymph node dissection; the drainage tube was inserted from the inferior hepatic space to the left thoracic cavity through the hiatus by intentional left pleural incision before hiatal closure (Fig. 1, 2). In the non-drainage group, the pleura was preserved, and the hiatus was closed directly. We used a 19-Fr Blake® (Ethicon, Inc., Somerville, NJ, USA) drain connected to a portable vacuum system (J-Vac®; Ethicon). Reconstruction was performed using gastric conduit via the retrosternal route with cervical anastomosis. The transhiatal left chest drainage, introduced in February 2020, has been used in all patients since that time. Using the immediate postoperative radiograph (Fig. 3), patients were distributed to the drainage or non-drainage group.

The following data were collected from clinical database: age, sex, body mass index (BMI), tumor location, T stage based on the 7th edition of the AJCC/UICC TNM classification system [7], lymph node metastasis status, histological type and neoadjuvant chemotherapy, operation time, blood loss volume, frequency of postoperative thoracentesis and its complications, drained volume of pleural effusion, occurrence of postoperative complications (grade 3 or more based on the Clavien–Dindo classification [8]), duration of oxygen administration, percentage of body weight loss on postoperative day (POD) 14, and duration of postoperative hospital stay. In the drainage group, the procedure time to insert the transhiatal drainage tube was measured. The study's retrospective protocol was approved by our institutional review board (No. R1-017), and written informed consent for publication of their details was obtained from the patients.

## Statistical analyses

Comparisons between the drainage and non-drainage groups were performed using the chi-square test for categorical variables (sex, tumor location, T stage, lymph node metastasis, histological type, occurrence of postoperative complications), and Mann–Whitney U test for continuous variables (age, BMI, operation duration, blood loss volume, number of dissected and metastatic lymph nodes, duration of

oxygen administration, body weight loss rate on POD 14, postoperative hospital stay). All analyses were performed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA). *P* values <0.05 were considered statistically significant.

## Results

### Patient characteristics

During the study period, 32 patients underwent transmediastinal esophagectomy. We excluded six patients owing to conversion to thoracotomy (n=2), pneumothorax at wound closure (n=2), simultaneous surgery for hypopharyngeal cancer (n=1), and unusable gastric conduit (n=1). A total of 26 patients were enrolled; in 13 patients, a transhiatal drainage tube was placed intraoperatively (drainage group), and in the other 13 patients, a drainage tube was not placed (non-drainage group). Patients' clinical characteristics are shown in Table 1. There were no significant differences in clinical parameters between the groups.

Table 1  
Clinical data of the drainage and non-drain groups

	<b>Drainage n = 13</b>	<b>Non-drainage n = 13</b>	<b><i>p</i>-value</b>
Age, years	70 (69–73)	71 (67–75)	0.64
Male/female	12/1	8/5	0.06
BMI	23.2 (19.8–24.3)	22.0 (18.9–23.4)	0.37
Thoracic esophagus / esophagogastric junction	6/7	9/4	0.23
cT 1/2/3/4	4/2/6/1	2/5/6/0	0.56
cN (+)/(-)	10/3	9/4	0.66
Squamous cell carcinoma /adenocarcinoma	6/7	9/4	0.23
Neoadjuvant chemotherapy	10	11	0.62
BMI: body mass index.			

### Intraoperative outcomes

Table 2 shows the intraoperative outcomes. The operative time was significantly longer in the drainage group than in the non-drainage group. However, the median and interquartile range (IQR) time to insert the

transhiatal drainage tube was 4 (3–5) minutes in the drainage group. There were no significant differences between the two groups in terms of blood loss volume.

Table 2  
Operative data of the drainage and non-drainage groups

	<b>Drainage n = 13</b>	<b>Non-drainage n = 13</b>	<b>p-value</b>
Operation time (min)	477 (454–527)	415 (390–459)	0.02
Blood loss volume (mL)	136 (88–270)	124 (79–158)	0.61
Thoracentesis	1	6	0.03
Left	0	6	0.005
Right	1	0	0.31
Pneumothorax caused by thoracentesis	0	1	0.31
Drained volume of pleural effusion (mL)			
POD 1	237 (165–275)	700 (700–700)	
POD 2	385 (255–516)	425 (363–488)	
POD 3	345 (175–600)		
POD 4	247 (166–350)		
POD 5	174 (122–245)		
POD 6	162 (104–460)		
Other complications	4	3	0.23
Respiratory	2	0	
Anastomotic leakage	1	1	
SSI	1	1	
Chylothorax	0	1	
Duration of oxygen administration (days)	3 (1–4)	4 (2–6)	0.43
Body weight loss rate at POD 14	6.1(1.0–7.0)	6.3 (4.2–7.0)	0.73
Postoperative hospital stay, days	15 (13–19)	14 (12–18)	0.61
POD: postoperative day; SSI: Surgical sight infection			

## Postoperative outcomes

Postoperative thoracentesis was required 7 times for 6 patients in the non-drainage group until POD 2. One patient in the non-drainage group developed pneumothorax after thoracentesis. All the six patients required left-side thoracentesis. In contrast, one patient in the drainage group, who also had anastomotic leakage, required right thoracentesis; this number was significantly less than that in the non-drainage group ( $p=0.03$ ). Further, the patient in the drainage group did not require left thoracentesis, which also varied from the findings in the non-drainage group ( $p=0.005$ ). The daily drainage output is shown in Table 3. The median volume of drainage output decreased by <200 mL after POD 5. The transhiatal drainage tube was removed after a median time of POD 6. There were no significant differences between the two groups in terms of the occurrence of postoperative complications, duration of oxygen administration, rate of body weight loss on POD 14, and length of postoperative hospital stay.

## Discussion

Transhiatal chest drainage in transmediastinal esophagectomy effectively evacuated pleural effusion and significantly reduced the frequency of postoperative thoracentesis, which carries the risk of iatrogenic pneumothorax. In addition, the transhiatal chest drainage system did not employ an underwater seal but a portable vacuum system, which was reportedly easy to insert and safe in terms of other complications. To date, we know of no studies that have discussed the suitability of an indwelling transhiatal chest drainage tube in transmediastinal esophagectomy. This is the first study we know of to assess the effective and safe evacuation of pleural effusion via intraoperative placement of a chest drainage tube in transmediastinal esophagectomy.

A single Blake drain inserted through the abdominal wall effectively evacuated pleural effusion in this study. The utility of a mediastinal drainage tube from the abdominal wall through the hiatus after thoracic esophagectomy has recently been reported [9]. Transhiatal chest drainage using a Blake drain has also been reported to be effective and safe in Ivor Lewis esophagectomy [6]. The insertion of a chest drainage tube intraoperatively via the intercostal space is difficult in transmediastinal esophagectomy, and in such cases, transhiatal chest drainage is appropriate. Additionally, the use of a portable vacuum system connected to the Blake drain is a viable alternative to the underwater seal [6, 10, 11]. A single Blake drain inserted from the right intercostal space into the left thoracic cavity across the mediastinum is useful for drainage of the left pleural effusion after thoracic esophagectomy [12]. The transhiatal chest drainage in transmediastinal esophagectomy has similar effects to these drainage systems.

The placement of the transhiatal chest drainage tube was a simple procedure, which was completed in <6 min. Despite not being able to control the drain tip position from the transabdominal view, pleural effusion was evacuated effectively. However, the adequate duration of drainage after surgery was unclear in this study. In the non-drainage group, thoracentesis was required until POD 2. In the drainage group, median volume of drainage output decreased to <200 mL after POD 5. In addition, the amount of transhiatal drainage might be attributed not only to pleural effusion but also to ascites. The indwelling period for the drainage tube could potentially be shortened. Despite other studies describing the use of a 15-Fr drain, we used a 19-Fr drain [6, 12]. The 15-Fr drain is more beneficial than the 19-Fr one in terms of

preventing dislocation, excessive drainage, and pain caused to patients [12]. Further clinical experiences are needed to clarify the appropriate duration of drainage and drain size.

This study had some limitations. First, this study was a retrospective analysis with a small sample size; thus, the characteristics of patients, such as sex and the decision for drain placement were not homogenous, and selection bias is possible. Second, this study did not compare transhiatal chest drainage with conventional thoracic drainage. However, the inferiority of thoracic drainage might be definitive in terms of the difficulty of the thoracic approach in transmediastinal esophagectomy. Third, the diagnosis of pleural effusion and necessity for thoracentesis were decided by the attending physician. Evaluations associated with oxygenation, such as the duration of oxygen administration, respiratory complications, and postoperative hospital stay, did not differ significantly between the two groups. Further studies are required to validate these findings.

## **Conclusion**

We demonstrated that transhiatal chest drainage is an effective, safe, and simple procedure to evacuate pleural effusion after transmediastinal esophagectomy. In addition, the frequency of postoperative thoracentesis was reduced. A large, randomized controlled trial is required to completely assess the benefits and limitations of transhiatal chest drainage.

## **Abbreviations**

BMI: Body mass index, POD: Postoperative day, IQR: Interquartile range

## **Declarations**

### **Ethics approval and consent to participate**

This study was performed in accordance with the principles of the Declaration of Helsinki and its later amendments, and was approved by the Ethics Committee of Tsukuba University Hospital (No. R1-017).

### **Consent for publication**

Written informed consent for publication of this case report was obtained from the patients.

### **Availability of data and materials**

Not applicable.

### **Competing interests**

The authors declare that they have no competing interests.

### **Funding**

The authors declare that they received no financial support pertaining to this manuscript.

## Authors' contributions

KH, KO, and YA performed the surgery. KH acquired the data and drafted the manuscript. KH, KO, YA, SM, YO, YO, SH, TE and TA revised the article. JK drew the diagrams for the figures. All authors have read and approved the final manuscript.

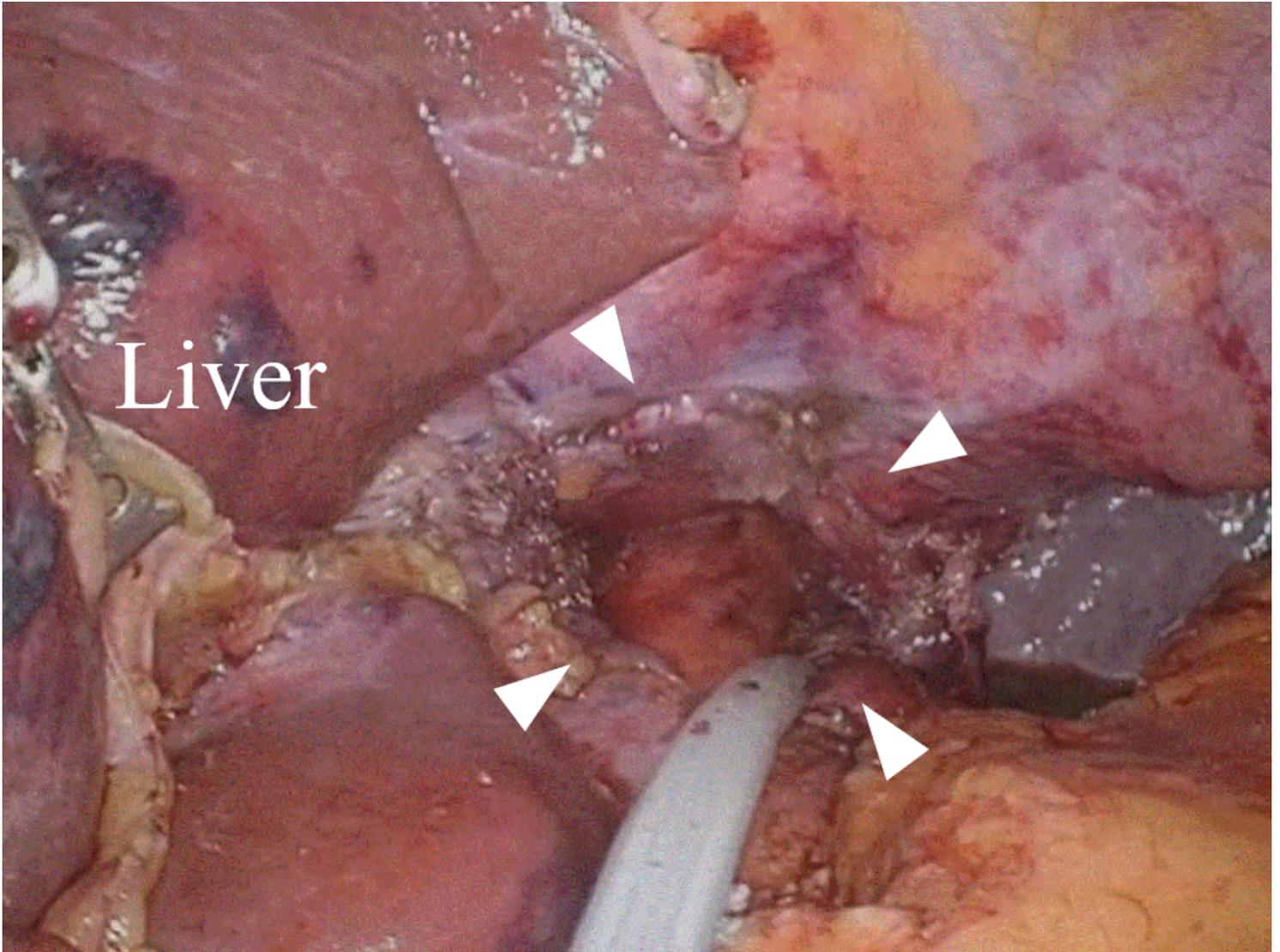
## Acknowledgments

We would like to thank Dr. Fujiwara (Division of Digestive Surgery, Department of Surgery, Kyoto Prefectural University of Medicine) for his help in transmediastinal esophagectomy procedures.

## References

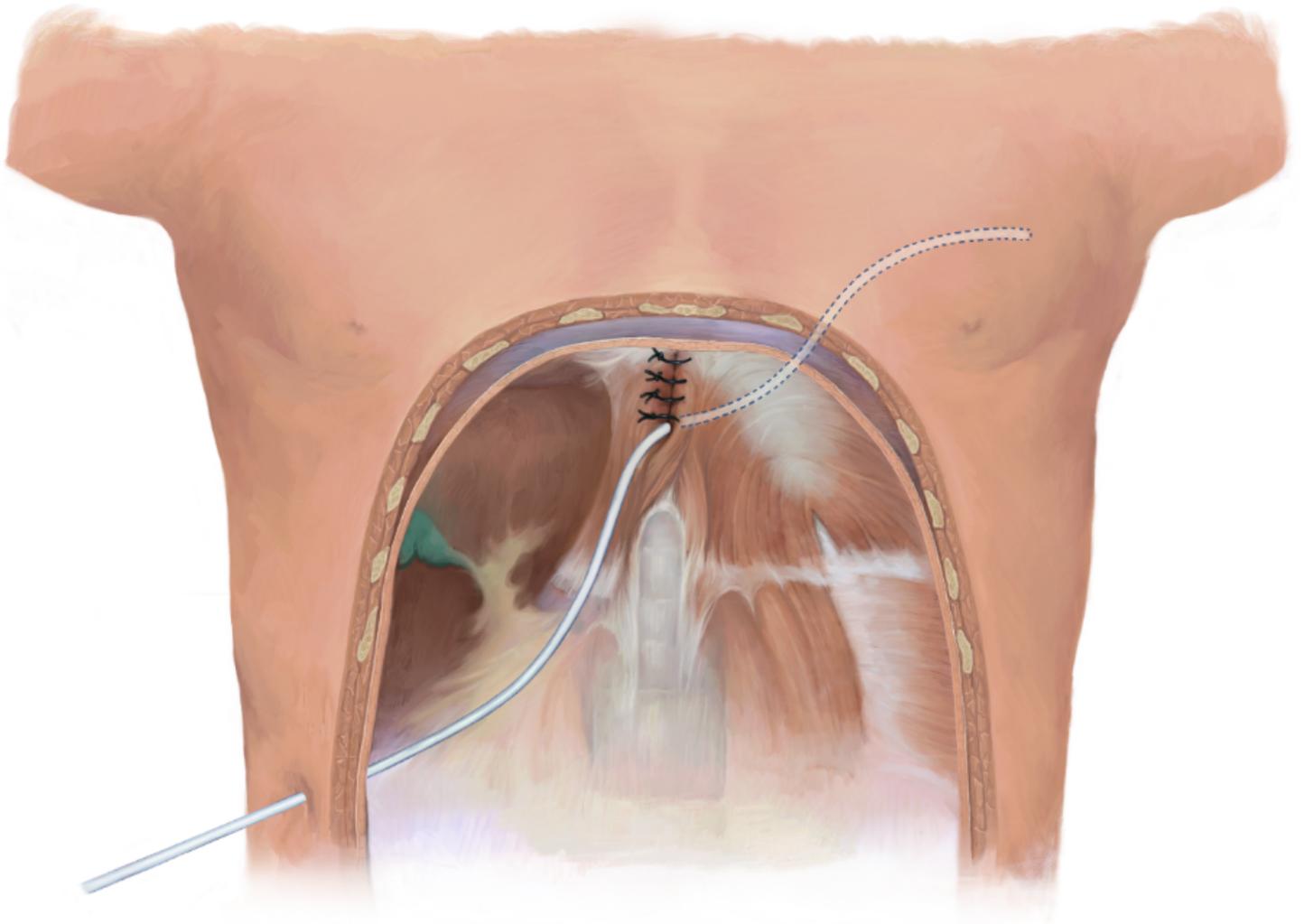
1. Sakurai M, Morinaga K, Shimoyama K, Mishima S, Oda J. Effects of pleural drainage on oxygenation in critically ill patients. *Acute Med Surg.* 2020;7:e489.
2. Fujiwara H, Shiozaki A, Konishi H, Otsuji E. Mediastinoscope and laparoscope-assisted esophagectomy. *J Vis Surg.* 2016;2:125.
3. Fujiwara H, Shiozaki A, Konishi H, Kosuga T, Komatsu S, Ichikawa D, et al. Perioperative outcomes of single-port mediastinoscope-assisted transhiatal esophagectomy for thoracic esophageal cancer. *Dis Esophagus.* 2017;30:1–8.
4. Hamada J, Konishi H, Shiozaki A, Fujiwara H, Shoda K, Kosuga T, et al. Management of pleural effusion after mediastinoscopic radical esophagectomy. *Anticancer Res.* 2018;38:6919–25.
5. Gogalniceanu P, Crewdson K, Khan AZ, Botha AJ. Transhiatal chest drainage after oesophagectomy. *Ann R Coll Surg Engl.* 2007;89:535–6.
6. Asti E, Sironi A, Bonitta G, Bernardi D, Bonavina L. Transhiatal chest drainage after hybrid Ivor lewis esophagectomy: Proof of concept study. *J Laparoendosc Adv Surg Tech A.* 2018;28:429–33.
7. Sobin LH, Gospodarowicz MK, Wittekind C. TNM classification of malignant tumours. 7th ed. Oxford: Wiley-Blackwell; 2010. p. 66–72.
8. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240:205–13.
9. Zheng Y, Li Y, Liu X, Zhang R, Wang Z, Sun H. Feasibility of a single mediastinal drain through the abdominal wall after esophagectomy. *Med (United States).* 2018;97:4–8.
10. Law S, Boey JP, Kwok KF, Wong KH, Chu KM, Wong J. Pleural drainage after transthoracic esophagectomy: Experience with a vacuum system. *Dis Esophagus.* 2004;17:81–6.
11. Wang D, Xu L, Yang F, Wang Z, Sun H, Chen X, et al. The improved mediastinal drainage strategy for the enhanced recovery system after esophagectomy. *Ann Thorac Surg.* 2021;112:473–80.
12. Niwa Y, Koike M, Oya H, Iwata N, Kobayashi D, Kanda M, et al. Method of bilateral pleural drainage by single blake drain after esophagectomy. *World J Surg.* 2015;39:727–31.

## Figures



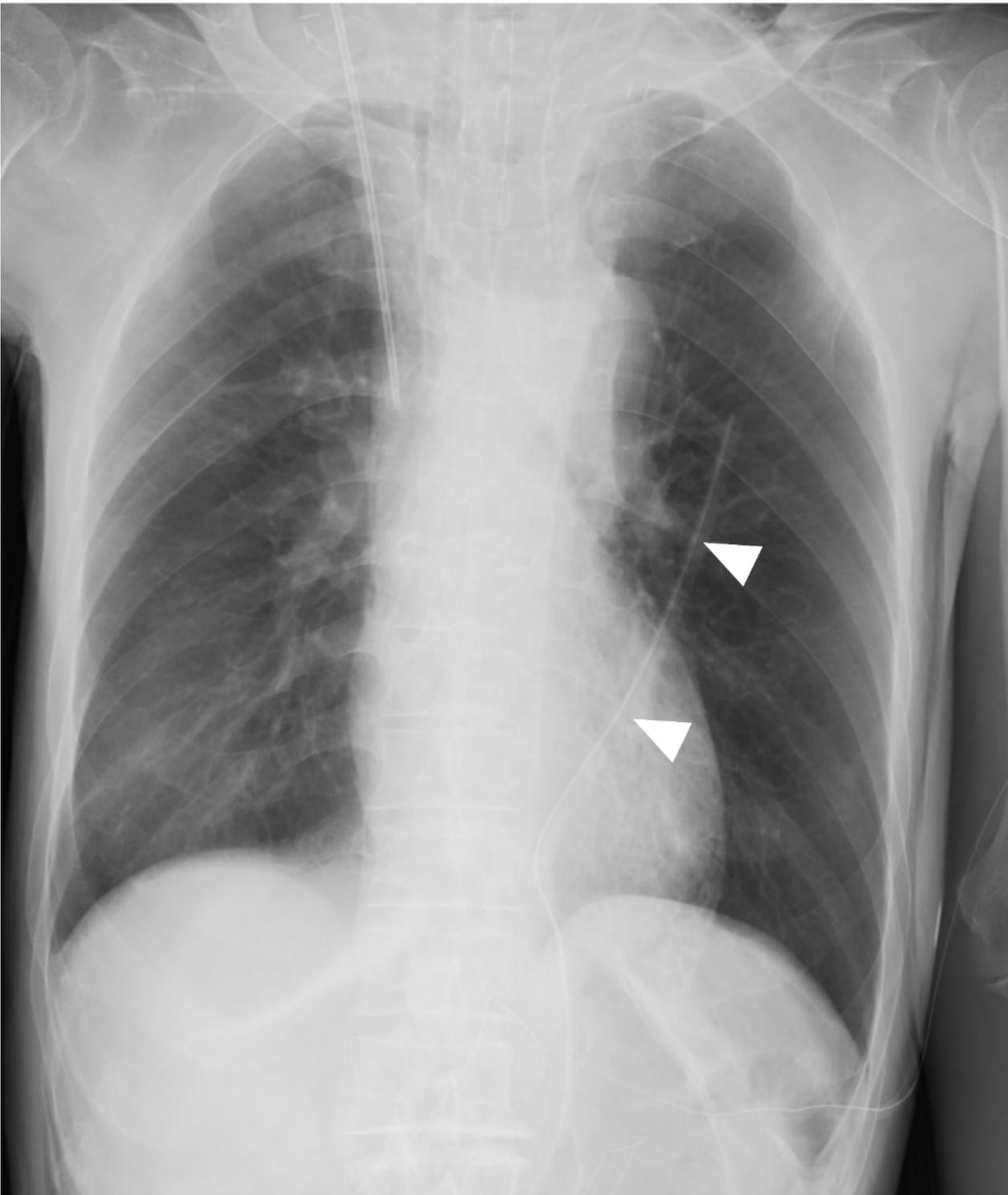
**Figure 1**

Intraoperative photograph showing the Blake drain inserted from the inferior hepatic space to the left thoracic cavity through the hiatus. Arrowhead: esophageal hiatus



**Figure 2**

Representation of the intraoperative insertion of the Blake drain from the inferior hepatic space to the left thoracic cavity through the hiatus. Arrowhead: esophageal hiatus



**Figure 3**

The immediate postoperative X-ray film. Arrowhead: Transhiatal left pleural drainage tube