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Clinical Research

A 19F Blake Drain versus a 28F Conventional Drain Following Video-Assisted Thoracoscopic Esophagectomy for Esophageal Cancer: A Comparative Retrospective Study

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Background: Pleural drainage is essential for preventing and managing respiratory complications after video-assisted thoracoscopic esophagectomy (VATE). Conventional large-bore drains often cause significant pain. Small-bore drains (e.g., 19F Blake drains) may reduce discomfort; however, evidence regarding their use in VATE is limited. This study compared drainage effectiveness and pain between 19F Blake drains and conventional 28F drains after VATE for esophageal cancer.

Methods: This retrospective study included 77 male patients with middle- or lower-third esophageal cancer who underwent VATE with laparoscopic retrosternal tunneling from November 2018 to November 2022. Fifty-five patients received a 28F conventional drain, and 22 received a 19F Blake drain. Outcomes included drainage duration and volume, pain levels (Visual Analog Scale [VAS]), postoperative pneumonia rates, and pulmonary function (forced vital capacity [FVC], forced expiratory volume in 1 second [FEV1]) on postoperative day 3.

Results: The 19F group reported significantly lower pain scores on postoperative days 1–3 (VAS: 2.95–3.25 vs. 4.07–4.62, p<0.001). Drainage duration and pneumonia rates were similar between groups. The 19F group demonstrated a trend toward higher drainage volume and significantly better preservation of pulmonary function, with smaller declines in FVC (ΔFVC: 0.24±0.20 L vs. 0.63±0.17 L, p<0.001) and FEV1 (ΔFEV1: 0.38±0.25 L vs. 0.58±0.25 L, p=0.02).

Conclusion: 19F Blake drains provide similar drainage effectiveness to that of 28F drains, with reduced postoperative pain and better pulmonary function preservation. These findings support the use of 19F Blake drains to improve patient comfort and recovery following VATE.

Keywords: Drainage, Esophageal neoplasms, Esophagectomy, Pain, Video-assisted thoracoscopic surgery

Introduction

Esophageal cancer remains one of the leading causes of cancer-related mortality worldwide, and esophagectomy continues to be a cornerstone in the management of localized disease [1]. Video-assisted thoracoscopic esophagectomy (VATE) has emerged as a minimally invasive approach, reducing operative trauma and postoperative complications compared to open surgery [2]. After VATE, pleural drainage plays a critical role in evacuating fluid and air from the pleural cavity, facilitating lung re-expansion and decreasing the risk of complications such as pleural effusion or postoperative pneumonia [3,4].

Traditionally, large-bore silicon chest tubes (e.g., 28F) have been widely used for their ease of manipulation and effective drainage in thoracic surgery [5]. However, the large diameter and rigidity of these tubes often cause significant pain when inserted through the intercostal space, which can limit respiratory movement and the ability to cough, thereby impeding postoperative recovery [6,7]. Additionally, large chest tubes traversing narrow intercostal

spaces increase the risk of intercostal nerve injury, potentially leading to prolonged or chronic pain [8].

To address these limitations, smaller drains such as the 19F Blake drain have been proposed as alternatives, aiming to reduce pain and enhance patient experience without compromising drainage efficacy [6,9]. Despite these potential benefits, evidence specifically supporting the use of small chest tubes for esophagectomy is sparse, as most studies have focused on less complex thoracic procedures, such as lobectomy. Thus, their efficacy in managing the larger fluid volumes or severe complications seen with VATE remains uncertain.

At 108 Military Central Hospital, Vietnam, most patients initially received 28F conventional drains. However, during the later period of the study, we transitioned to using the 19F Blake drain, influenced by emerging evidence and institutional initiatives to reduce pain, which appeared to enhance both efficacy and patient comfort [6]. To our knowledge, this study is among the first to directly compare the 19F Blake drain with the 28F conventional drain in VATE, addressing a significant gap in procedure-specific evidence for pleural drainage optimization [6,9]. Here, we evaluate their effectiveness and patient tolerability to inform optimal drainage strategies for VATE.

Methods

Study design and population

This comparative retrospective study included 77 male patients with histologically confirmed middle- or lower-third esophageal cancer who underwent VATE at 108 Military Central Hospital between November 2018 and November 2022. No female patients underwent this procedure for esophageal cancer at our center during this period, which is consistent with global epidemiological trends for this disease [10]. Patients were allocated into 2 groups: 55 received a 28F conventional silicone drain, while 22 received a 19F Blake drain. The adoption of the 19F Blake drain during the later part of the study period was driven by emerging evidence supporting its efficacy in thoracic surgery and by institutional efforts to reduce postoperative pain. The study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of 108 Military Central Hospital (IRB #2023-108-01), with a waiver of informed consent due to the retrospective study design.

Drain placement

All procedures were performed by the same surgical team. During the thoracic phase of the operation, patients were positioned supine, with a left lateral decubitus tilt at an angle of 30° [11]. The primary surgeon and assistant were positioned on the patient's left side. Four trocars were used for surgical access. The camera port (10 mm) was inserted at the seventh intercostal space along the mid-axillary line. Three working ports were placed as follows: a 10–12 mm port in the third intercostal space at the mid-axillary line, a 5 mm port in the fifth intercostal space at the mid-axillary line, and a 5 mm port in the seventh intercostal space at the posterior axillary line (Fig. 1).

Upon completion of the thoracic phase, chest drains were inserted. The 28F conventional drain was placed through the 10 mm camera port, with its tip at the base of the pleural cavity. In cases requiring a 19F Blake drain, insertion was performed via a 5 mm trocar at the fifth intercostal space along the mid-axillary line (Fig. 1). Due to its substantially greater length compared to the conventional drain (120 cm vs. 40 cm, with a fluted section up to 30 cm), the 19F Blake drain was advanced into the right pleural space and positioned along the esophageal bed to ensure effective drainage (Fig. 2).

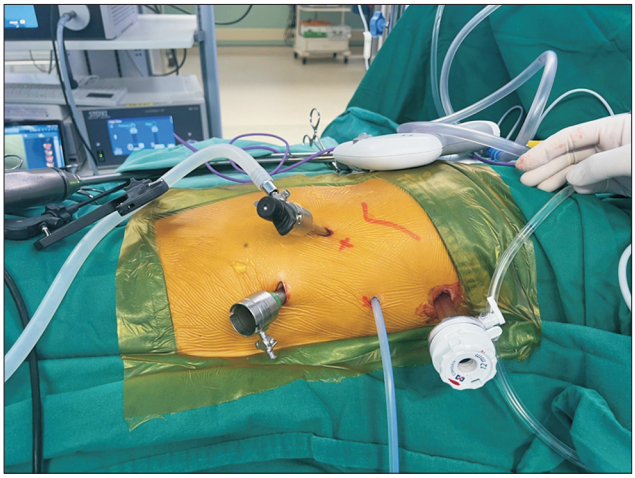

Fig. 1. Trocar positions during the thoracic phase. The camera port (10 mm) was inserted in the seventh intercostal space along the mid-axillary line. The 3 working ports were positioned as follows: a 10–12 mm port in the third intercostal space at the mid-axillary line, a 5 mm port in the fifth intercostal space at the mid-axillary line, and a 5 mm port in the seventh intercostal space at the posterior axillary line.

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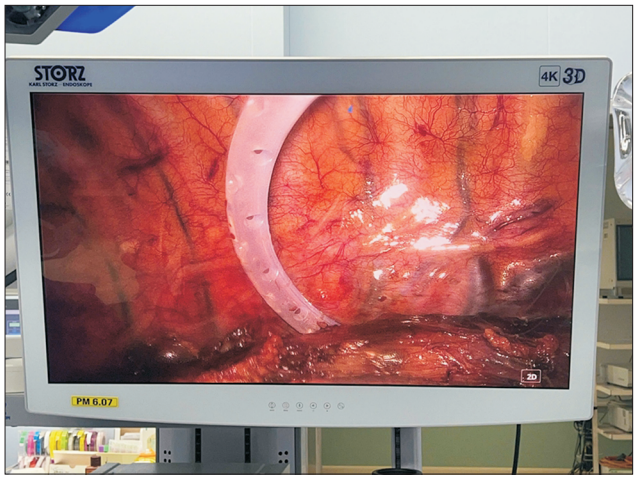

Fig. 2. Positioning of the 19F Blake drain. The drain was advanced into the right pleural space and optimally positioned along the esophageal bed to facilitate effective drainage.

Postoperative management

A standardized postoperative protocol was applied to all patients throughout the study period. Both drain types were connected to continuous suction at –20 cmH_2O, and drainage volume, color, and consistency were monitored daily. Drains were removed after 3–6 days when clinical criteria were satisfied: daily output below 200 mL, absence of air leak, and radiographic confirmation of lung re-expansion on chest X-ray.

Pain management followed a standardized protocol, including epidural patient-controlled analgesia for all patients and intravenous paracetamol (1 g every 8 hours). As-needed morphine (5–10 mg) was available for breakthrough pain but was rarely required due to effective epidural and paracetamol-based pain control.

Patients were monitored daily for complications, including pneumonia (defined by clinical signs such as fever >38°C, productive cough, leukocytosis, and new infiltrates on chest X-ray) and pleural effusions (assessed by imaging). Oral feeding was resumed when patients reported passage of flatus or stool and no clinical evidence of anastomotic complications, typically within 2–4 days. Early mobilization was encouraged from postoperative day 1 to support recovery. Respiratory function was assessed by spirometry on postoperative day 3, recording forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1).

Data collection

Primary outcomes included drainage duration (number of nights from insertion to removal), total drainage volume (mL), incidence of postoperative pneumonia, and pain levels on postoperative days 1–3. Pain was assessed using the Visual Analog Scale (VAS; range, 0–10) by nursing staff [12].

Secondary outcomes included length of hospital stay (in nights), time to resume oral intake (in nights), and respiratory function metrics (FVC and FEV1). Data were extracted from electronic medical records, including daily clinical evaluations, imaging reports, and pain management documentation.

Statistical analysis

All analyses were performed using IBM SPSS ver. 27.0 (IBM Corp.). Continuous variables, including drainage volume and VAS scores, were expressed as mean±standard deviation and compared using the Student t-test. Categorical variables, such as pneumonia and pleural effusion rates, were compared using the chi-square test or the Fisher exact test, as appropriate. A p-value<0.05 was considered statistically significant.

Results

Patients' characteristics

Table 1 summarizes the characteristics of the patients included in this study. All 77 patients were male, with the majority (60 patients, 77.9%) receiving neoadjuvant chemoradiotherapy. The 19F Blake drain group (n=22) and the 28F conventional drain group (n=55) were comparable in age (58.73±8.58 years vs. 57.04±7.58 years, p=0.91), body mass index (21.59±3.25 kg/m^2 vs. 21.35±2.65 kg/m^2, p=0.89), smoking history (100% vs. 94.5%, p=0.436), comorbidities (including gout, diabetes, hypertension, cirrhosis, hypoadrenalism), American Society of Anesthesiologists (ASA) classification (72.7% ASA 1 in both groups, p=0.61), and preoperative tumor stage.

With regard to respiratory function, there were no baseline differences between the 2 groups. At our center, all candidates for video-assisted thoracic surgery underwent preoperative pulmonary rehabilitation for at least 1 week before surgery to improve respiratory function [13].

Table 1. Patients' characteristics

Characteristic	19F Blake drain (n=22)	28F drain (n=55)	p-value
Age (yr)	58.73±8.58	57.04±7.58	0.91
Body mass index (kg/m^2)	21.59±3.25	21.35±2.65	0.89
History of surgery	3 (13.6)	4 (7.3)	0.24
Smoking	22 (100.0)	52 (94.5)	0.44
Comorbidities			0.42
Gout	2 (9.1)	7 (12.7)	
Diabetes	1 (4.5)	2 (3.6)	
Hypertension	1 (4.5)	0 (0)	
Cirrhosis	0 (0)	1 (1.8)	
Hypoadrenalism	1 (1.8)	0 (0)	
ASA classification			0.61
ASA 1	16 (72.7)	40 (72.7)	
ASA 2	6 (27.3)	15 (27.3)	
Respiratory function			
FVC (L)	4.13±0.53	3.95±0.70	0.34
FEV1 (L)	3.33±0.57	3.18±0.60	0.45
T-stage			0.06
T0	7 (31.8)	13 (23.6)	
T1	3 (13.6)	15 (27.3)	
T2	3 (13.6)	18 (32.7)	
T3	2 (9.1)	4 (7.3)	
T4a	7 (31.8)	5 (9.1)	
N-stage			0.54
N0	14 (63.6)	36 (65.5)	
N1	4 (18.2)	18 (32.7)	
N2–3	4 (18.2)	1 (1.8)	
Stage group			0.06
0	6 (27.3)	11 (20.0)	
I	4 (18.2)	20 (36.4)	
IIA	1 (4.5)	1 (1.8)	
IIB	2 (9.1)	15 (27.3)	
IIIA	5 (22.7)	6 (10.9)	
IIIC	4 (18.2)	2 (3.6)	
Neoadjuvant chemoradiotherapy	20 (90.9)	40 (72.7)	0.13

Values are presented as mean±standard deviation or number (%).
ASA, American Society of Anesthesiologists physical status classification; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second.

Postoperative results

Thoracic duct injury was observed in 1 patient in the 19F group and in 5 patients in the 28F group, with no significant difference between groups (p=0.668). The 19F group reported significantly lower pain levels, with VAS scores on postoperative days 1–3 consistently lower than those in the 28F group (p<0.001 for all days) (Fig. 3). Morphine was rarely required for pain control in either group due to effective management with epidural analgesia and paracetamol, with no notable differences in usage between the 19F and 28F groups. Drainage duration was similar between the 2 groups (19F: 4.13±0.93 days; 28F: 4.45±1.57 days; p=0.27). The 19F group showed a higher mean drainage volume (966.36±617.37 mL) than the 28F group (694.02±356.42 mL), but this difference was not statistically significant (p=0.06) (Table 2).

The 19F group resumed oral intake significantly earlier (2.6±0.8 days vs. 3.4±1.3 days, p=0.04) and demonstrated higher FVC (3.88±0.58 L vs. 3.32±0.07 L, p=0.03). In addition, the 19F group exhibited a significantly smaller reduction in FVC from preoperative to postoperative values (ΔFVC: 0.24±0.20 L vs. 0.63±0.17 L, p<0.001) and in FEV1 (ΔFEV1: 0.38±0.25 L vs. 0.58±0.25 L, p=0.02), indicating better preservation of pulmonary function. However, no significant differences were observed in length of hospital

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stay (13.3±5.9 days vs. 14.1±6.0 days, p=0.60), postoperative pneumonia rates (4.5% vs. 18.2%, p=0.12), or pleural effusion rates (72.7% vs. 60.0%, p=0.29) (Table 2).

Discussion

This study demonstrates that the 19F Blake drain is as effective as the conventional 28F drain for pleural drainage in VATE, with the distinct advantage of significantly reducing postoperative pain across days 1–3 (p<0.001). These findings contribute to a growing body of evidence supporting the use of smaller, flexible drains in thoracic surgery, aligning with trends toward minimizing patient discomfort and optimizing recovery [3,6,9,14-17].

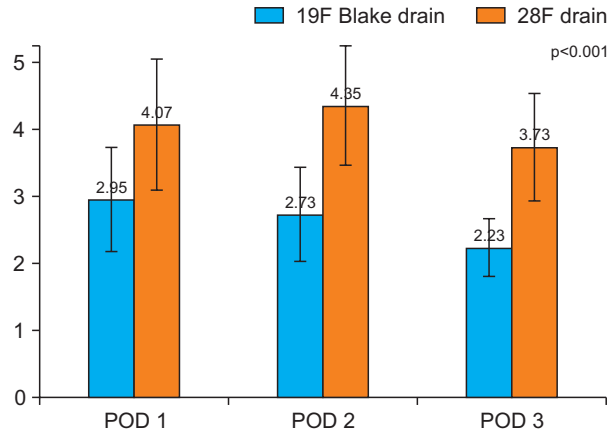

Fig. 3. Comparison of postoperative pain levels: Pain levels, measured by the Visual Analog Scale (VAS), between the 19F Blake drain group and the 28F drain group on postoperative days (POD) 1 to 3. The 19F group consistently reported significantly lower VAS scores than the 28F group across all days (p<0.001 for each day). Values are presented as mean values.

Multiple studies have highlighted the pain-reducing benefits of small-bore drains. Nakamura et al. [6] in 2009 reported lower pain with 19F Blake drains compared to 28F conventional drains after lung lobectomy, demonstrating equivalent drainage efficacy and improved wound healing. Niwa et al. [14] in 2015 showed that a single 15F Blake drain effectively managed bilateral pleural effusion after esophagectomy, reducing both left pleural effusion and atelectasis compared to conventional approaches. Another study by Nakamura et al. [17] in 2009 evaluated Blake drains across 420 thoracic procedures, including esophagectomy, confirming their reliability for both fluid and air evacuation. Bull et al. [3] in 2022, in a systematic review, concluded that narrow-caliber Blake drains effectively drain air and fluid following esophageal resection, supporting their use in VATE. Filosso et al. [16] in 2016 reviewed the shift toward small-bore drains in thoracic surgery, emphasizing reduced pain and discomfort. Our study extends these findings to VATE, with VAS pain scores of 2.95±0.78 versus 4.07±0.98 on day 1 (p<0.001) for the 19F and 28F groups, respectively, underscoring the benefit of reduced tissue trauma [6,8].

The 19F group's earlier resumption of oral intake (2.6±0.8 vs. 3.4±1.3 days, p=0.04) and higher FVC (3.88±0.58 L vs. 3.32±0.07 L, p=0.03) suggest that lower pain levels facilitate faster nutritional recovery and improved respiratory function, which are key components of enhanced recovery after surgery (ERAS) protocols [15]. The significantly smaller reductions in FVC (0.24±0.20 L vs. 0.63±0.17 L, p<0.001) and FEV1 (0.38±0.25 L vs. 0.58±0.25 L, p=0.02) further support the potential of smaller drains to enhance postoperative pulmonary function, likely due to reduced pain and

Table 2. Postoperative results

Variable	19F Blake drain (n=22)	28F drain (n=55)	p-value
Thoracic duct injury	1 (4.5)	5 (9.1)	0.67
Drainage duration (nights)	4.13±0.93	4.45±1.57	0.27
Drainage volume (mL)	966.36±617.37	694.02±356.42	0.06
Length of hospital stay (nights)	13.27±5.92	14.05±6.02	0.60
Time to resume oral intake (nights)	2.59±0.79	3.36±1.25	0.04
Respiratory function			
FVC (L)	3.88±0.58	3.32±0.70	0.03
FEV1 (L)	2.94±0.59	2.60±0.61	0.28
ΔFVC (L)	0.24±0.20	0.63±0.17	<0.001
ΔFEV1 (L)	0.38±0.25	0.58±0.25	0.02
Pneumonia	1 (4.5)	10 (18.2)	0.12
Pleural effusion	16 (72.7)	33 (60.0)	0.29

Values are presented as number (%) or mean±standard deviation.
FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second.

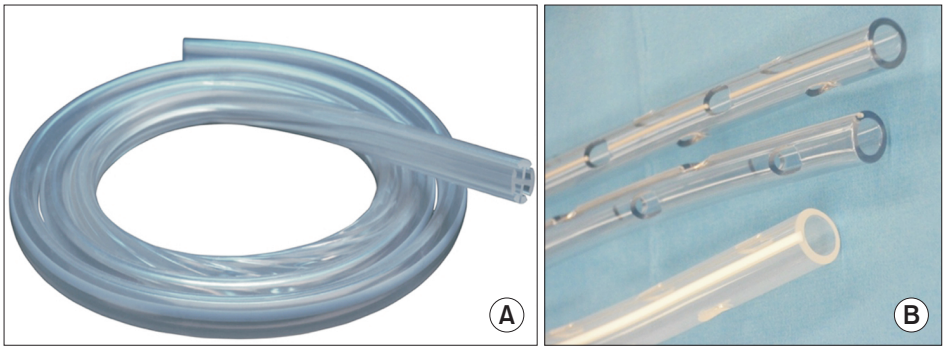

Fig. 4. Differences in chest drain designs: The 19F Blake drain features a fluted structure that enhances fluid evacuation and reduces tissue trauma (A), while the 28F conventional drain has a cylindrical shape with side holes for drainage (B).

tissue trauma. Low et al. [15] in 2019 emphasized that ERAS strategies, including optimized pain management, accelerate recovery after esophagectomy. Lower pain likely enabled deeper breathing and earlier ambulation, potentially contributing to the non-significant trend toward lower pneumonia rates in the 19F group (4.5% vs. 18.2%, p=0.12) [3].

Of note, the 19F group demonstrated a higher mean drainage volume (966.4±617.4 mL vs. 694.0±356.4 mL, p=0.06) despite the smaller diameter drain. This trend may reflect the fluted design of the Blake drain, which enhances fluid evacuation and resists clogging compared to cylindrical tubes [9,14,17] (Fig. 4). Niwa et al. [14] in 2015 reported significantly higher drainage with Blake drains in esophagectomy, suggesting their efficiency. Bull et al. [3] in 2022 noted that effective chest drainage is critical post-esophagectomy to prevent complications such as pleural effusion. These observations challenge the assumption that larger tubes are inherently more effective, suggesting that small-bore drains may be sufficient for complex procedures such as VATE [3,9]. The lack of statistical significance in drainage volume warrants further study with larger cohorts.

The adoption of 19F Blake drains offers practical advantages in VATE. Reduced pain supports ERAS goals, potentially improving patient satisfaction and lowering opioid use [15]. Smaller incisions for 19F drain placement may reduce infection risk and accelerate wound healing [7]. If confirmed by prospective studies, these findings could support broader adoption of small-bore drains, thereby optimizing postoperative care in esophageal cancer surgery [3].

This study has several limitations that warrant consideration. The retrospective, non-randomized design introduces potential selection bias, as 19F drains were implemented later in the study period (2018–2022), possibly reflecting increased surgical expertise. The small sample size of the 19F group (n=22) limited the statistical power for secondary outcomes such as pneumonia. Long-term outcomes—including chronic pain and recurrent effusion—were not assessed, and respiratory metrics were limited to postoperative day 3. Future randomized trials with larger samples and extended follow-up are needed to validate these results and to explore additional recovery measures, such as opioid consumption and quality of life.

In conclusion, the 19F Blake drain provides drainage effectiveness equivalent to that of the 28F conventional drain in VATE. Notably, the 19F drain was associated with significantly reduced postoperative pain and better preservation of pulmonary function, likely enabling earlier mobilization and respiratory recovery. These findings support the integration of the 19F Blake drain into clinical practice to enhance outcomes following esophageal cancer surgery.

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Conceptualization: HVP. Study design: HVP. Data collection and interpretation: TMT. Formal analysis: TAN. Writing–original draft: TAN, TMT. Critical revision of the manuscript for important intellectual content: HVP. Final approval of the manuscript: all authors.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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