

Case Report

Minimally invasive triumph: the role of thoracic duct embolization in managing severe post-esophagectomy chylothorax

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Abstract: Chylothorax, a rare and severe complication of esophageal cancer surgery, results from damage to the lymphatic system. We report on a 70-year-old female with esophageal cancer and a history of poorly managed diabetes who developed high-flow chylothorax following esophagectomy. Initial conservative measures, including pleural drainage, lymph production reduction medication, and nutritional support, failed to improve her condition. Subsequent surgical attempts to ligate the thoracic duct were also unsuccessful due to extensive pleural adhesions. This led to a referral for percutaneous thoracic duct embolization (TDE). At another medical facility, the patient underwent lymphangiography, cisterna chyli puncture embolization, and cavity puncture drainage. The TDE successfully embolized the thoracic duct, markedly reducing the leakage of chylous fluid. Subsequent CT scans and follow-up assessments confirmed the patient's recovery with no recurrence of chylothorax. This case illustrates the complexities of managing post-esophagectomy chylothorax and highlights the importance of individualized treatment strategies. It also emphasizes the potential of minimally invasive TDE as an effective alternative for treatment-resistant chylothorax cases.

Keywords: Chylothorax, lymphangiography, thoracic duct embolization (TDE)

Introduction

Chylothorax is a rare and severe complication that can arise following chest and esophageal surgeries, typically caused by the obstruction or rupture of lymphatic vessels in the lower body and gastrointestinal tract. Characterized by the buildup of lymphatic fluid high in triglycerides and chylomicrons within the pleural cavity, chylothorax is diagnosed when triglyceride levels surpass 1.24 mmol/l (or 110 mg/dl) [1]. Early-stage chylothorax can lead to severe cardiopulmonary and circulatory issues, while chronic cases may result in malnutrition and immune disorders, with a mortality rate as high as 50% [2]. Treatment strategies encompass conservative management, surgical intervention, and radiotherapy. Conservative treatment should be initiated immediately after diagnosis. It boasts a 50-70% success rate. Then, surgical re-operation is considered for high-flow cases

or when conservative measures are ineffective [2].

In the context of post-esophageal cancer surgery, chylothorax treatment lacks a unified standard, varying from conservative approaches to interventional and surgical options. Percutaneous thoracic duct embolization (TDE), guided by lymphangiography, has emerged as a promising method for treating chylothorax since its initial reporting by Cope in 1998 [3]. In the late 2010s, retrograde cannulation via the jugular vein emerged as a novel technique [4]. This technique has gained traction in recent years, with an increasing number of applications documented internationally [5]. Ultrasound-guided direct puncture of the cervical thoracic duct achieved a high success rate, and establishing a retrograde pathway through a chest drainage tube is particularly effective for cases of distal thoracic duct disconnection, with a clinical success rate of 87.8% [6]. In a 2020 case report,

Table 1. Postoperative pleural effusion drainage and interventions timeline

Time Point	Total Effusion (ml)	Right Pleural Effusion (ml)	Left Pleural Effusion (ml)	Related Interventions
Postoperative Day 1	1160	260	900	Initial conservative treatment with chest tubes placed
Postoperative Day 2	1580	860	720	Continued conservative treatment
Postoperative Day 3	1720	1200	520	Ongoing conservative treatment
Postoperative Day 4	950	850	100	Initiation of jejunal nutrition
Postoperative Day 5	1770	1660	110	Continued jejunal nutrition
Postoperative Day 6 and onwards	1800 (±)	1700 (±)	50-100	Continued jejunal nutrition
Night after Thoracic duct ligation surgery	2000	700	50	Ongoing monitoring
One Week post Second Surgery	2000-2300	2000 (±)	50-100	Alternative therapies considered

the caudal end of the thoracic duct was embolized through the abdomen, and the head end was embolized through the jugular vein retrogradely to achieve full-length embolization [7].

In this case, the minimally Invasive treatment method was employed, combining intragroin lymph node injection (intranodal lymphangiography) with retrograde cannulation through the jugular vein for TDE. Specifically, under ultrasound guidance, the parenchyma of the inguinal lymph nodes was directly punctured and an oily contrast agent (iodized oil) was slowly injected. The contrast agent entered the main lymphatic vessels and chylous cisterna chyli via the inguinal lymph nodes and finally developed the thoracic duct. This method does not require the separation of lymphatic vessels and is easy to operate. The purpose of this case report is to highlight the complexities in managing postoperative chylothorax, and emphasizing the need for tailored treatment strategies and the potential utility of minimally invasive procedures like TDE in addressing this challenging condition.

Case report

We present the case of a 70-year-old female who underwent a radical resection of esophageal cancer in November 2023. The procedure was performed under general anesthesia and involved three incisions in the neck, chest, and abdomen. Intraoperative findings indicated that the tumor was situated beneath the aortic arch, exhibiting a hard consistency and indistinct margins with adjacent tissues, indicative of local invasion and adhesion. Despite these complexities, the surgical team successfully resected the tumor, performed esophagogastric anastomosis and lymph node dissection, and placed drainage tubes in the chest and

abdomen. The medical history of the patient included a 20-year history of diabetes, which had been suboptimally managed with oral metformin and dapagliflozin tablets. She had also recovered from a brain infarction, adding the medical profile complex.

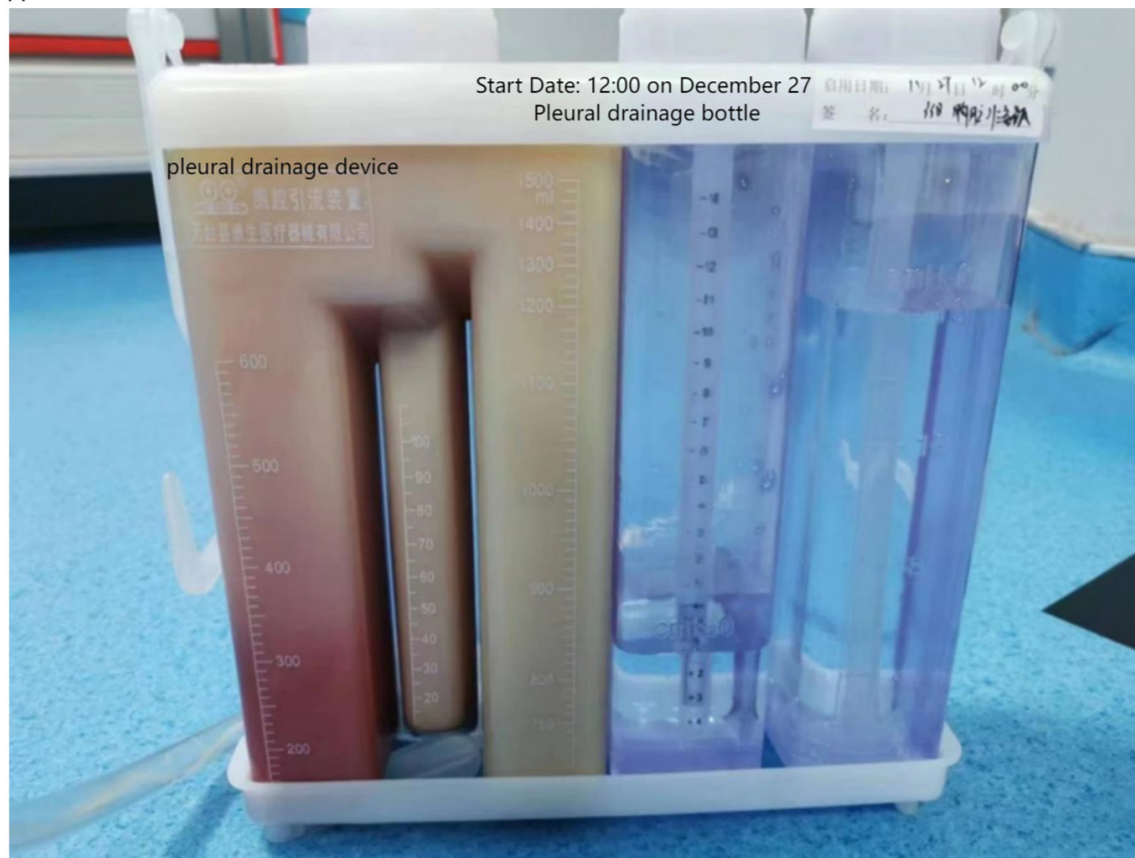
Postoperative condition

During the initial three-day postoperative period, the patient exhibited the development of pale yellow pleural effusions bilaterally. A volume of 1,160 ml of effusion yielded from the pleural cavity on the first postoperative day. By the second postoperative day, there was an escalation in the volume of drainage to 1,580 ml. Progressing to the third postoperative day, the pleural cavity drained a total of 1,720 ml of pale yellow effusion. A detailed summary of the changes in the drainage volume of the left and right pleural cavities and the corresponding treatment measures after surgery can be found in **Table 1**. The patient received 20 g albumin daily after surgery. However, serial assessments revealed albumin levels around 22 g/L, concurrent with hyponatremia. All test results pointed toward potential issues with nutritional absorption and an electrolyte imbalance.

On day four, we initiated jejunal nutrition and ameliorated the drainage to 950 ml. However, by the fifth postoperative day, with continued jejunal nutrition, the output of chylous fluid escalated to 1,770 ml. Thereafter, the patient consistently drained around 1,800 ml of chylous fluid daily.

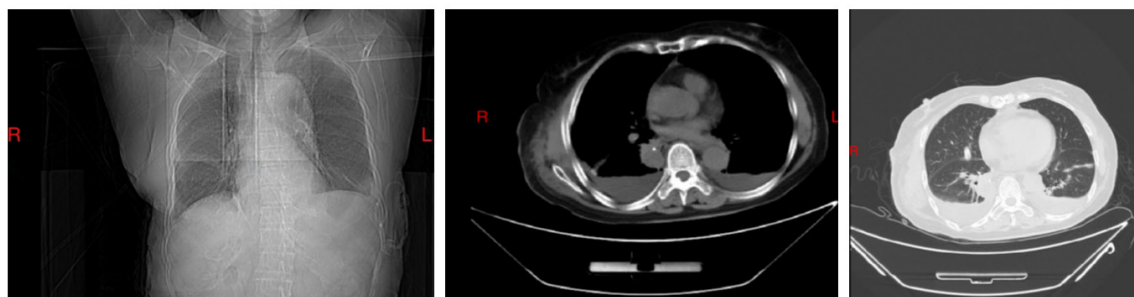
The chyle test returned a positive result (+), confirming a diagnosis of postoperative chylothorax, as depicted in **Figure 1A**. In response, we implemented conservative management strategies: prioritized her pleural drainage, uti-

A



B

2023-11-24:



2023-11-28:

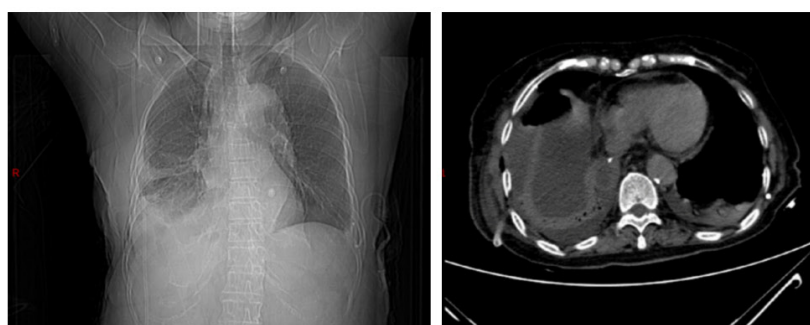


Figure 1. A. Chylous leakage from chest drainage after the second surgery; B. Comparison of chest CT before and after the second operation, suggesting that the problem of pleural effusion still exists.

lized medications such as octreotide to curtail lymphatic fluid production, enforced a strict limitation on dietary fat intake, and offered nutritional support through a carbohydrate-rich diet, with insulin administration when necessary. Unfortunately, 20 days later, there was no marked decrease in the volume of chylous fluid, indicating ongoing chylous leakage.

Secondary operation

Following a thorough departmental discussion, we decided to proceed with a second surgical intervention. On November 25th 2023, the patient was subjected to thoracoscopic exploration, followed by a thoracotomy for thoracic duct ligation, under general anesthesia. Upon initiation of the procedure, a thoracoscope was introduced, revealing substantial adhesions between the parietal and visceral pleural layers. Due to the obstacles in thoracoscopic adhesiolysis, we proceeded to an open thoracotomy. Notable local infiltration was observed between the lower esophagus and thoracic vertebrae after adhesion separation. The ruptured thoracic duct, leaking chylous lymph intermittently, was identified and ligated using 4-0 silk sutures, with two additional sutures placed 2 cm distally. After confirming no further leakage, the pleural cavity was irrigated and the ligation site sealed with biological glue (Coseal Surgical Sealant; Success Bio-Tech Co., Ltd.). A closed thoracic drainage tube was left in place, and the surgery was completed successfully.

However, on the evening of this surgery, approximately 800 ml of chylous fluid was drained from the pleural cavity, with an up to roughly 2,200 ml within 24-hour period. In the first week post-second surgery, the pleural cavity continued to yield about 2,000-2,300 ml of fluid daily, coloring from pale yellow to chylous in nature. The CT before & after re-operation (**Figure 1B**) indicated the need for alternative therapeutic approaches.

Thoracic duct embolization

The patient was then transferred to another hospital for specialized treatment, where she received lymphangiography and cisterna chyli puncture embolization. Under ultrasound guidance, the interventional procedure successfully targeted the bilateral inguinal lymph nodes.

Iodinated oil was then injected to trace the lymphatic vessels. An uptake movement in the lymphatic channel was revealed when they assessed the oil flow rate (**Figure 2A**). A total of 20 ml iodinated oil was administered to both sides, fully mapping out the lymphatic system. The patient reported no significant discomfort post-procedure and received local pressure bandaging.

Continuing the intervention, the cisterna chyli was punctured, and a precise dose of a biological glue (Coseal Surgical Sealant; Success Bio-Tech Co., Ltd.)/iodinated oil suspension (1 ml) was introduced, as shown in **Figure 2B, 2C**. Post-procedure, the patient was admitted to the ward and recovered smoothly. A schematic representation of the entire interventional procedure can be seen in **Figure 3A**.

A subsequent CT scan confirmed no thoracic duct dilation post-embolization. The patient was discharged with a favorable recovery, indicating successful management of postoperative chylothorax and complications. Currently, the patient undergoes regular follow-up. A comprehensive review on February 23, 2024, including multi-slice CT scan and 3D chest reconstruction (**Figure 3B**), showed no fluid or air accumulation. A follow-up chest CT on May 13, 2025 (**Figure 3C**) further revealed that the patient had no significant pleural effusion or inflammation. No long-term adverse reactions have been identified, and combined with the findings of this imaging examination, it more strongly indicates that the patient's recovery trajectory continues to be positive with stable overall health status.

Discussion

This case highlights the imperative nature of a meticulous preoperative physical assessment for all patients, especially those with pre-existing medical conditions. Given the patient's extensive history of diabetes and suboptimal glycemic control, she is at an increased risk for postoperative complications, notably infections and hindered wound healing. Identifying and addressing potential health risks preoperatively is crucial, as they can significantly influence postoperative outcomes and may precipitate complications, as exemplified by the chylothorax in this instance. The comprehensive approach to preoperative evaluation not only

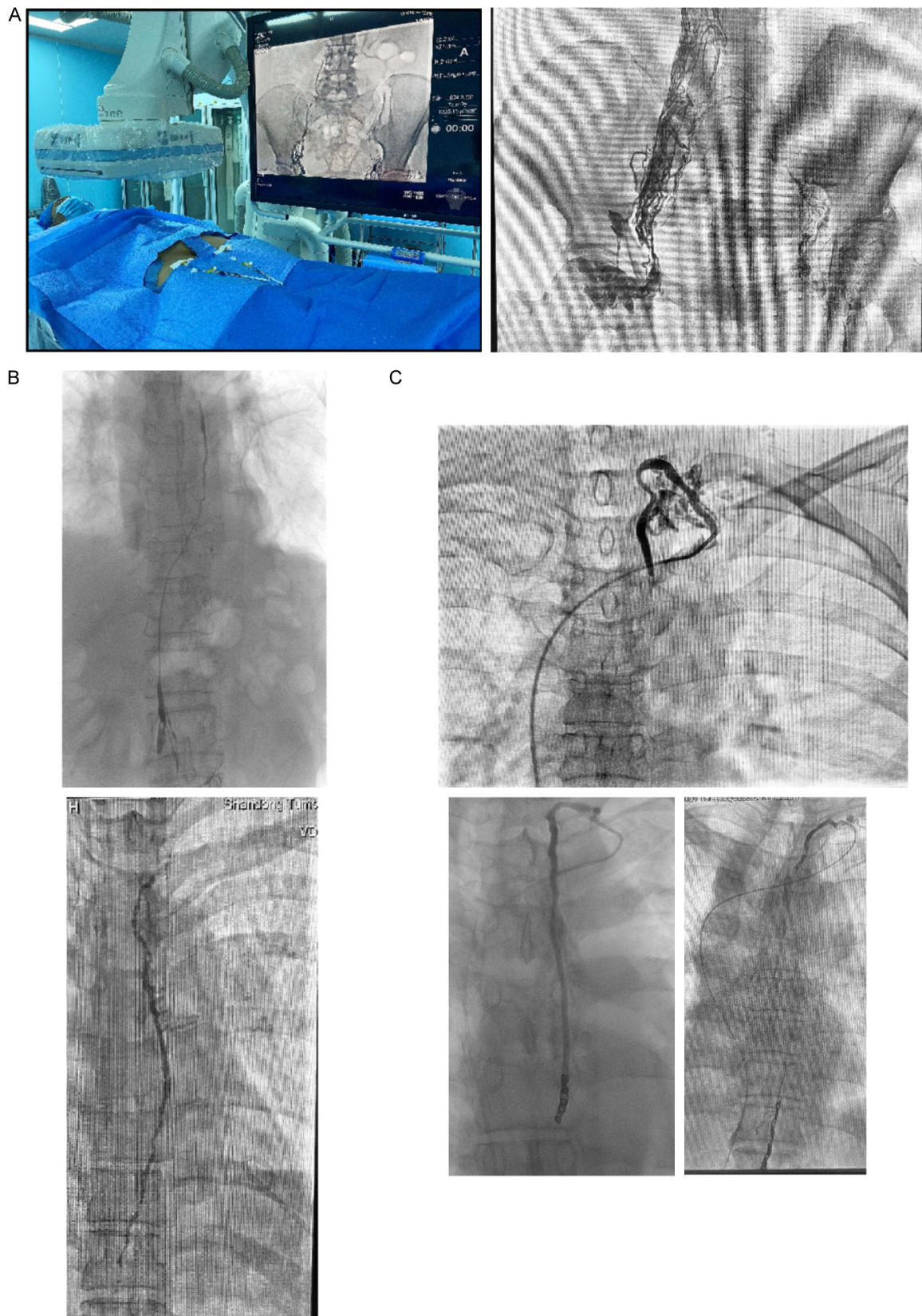
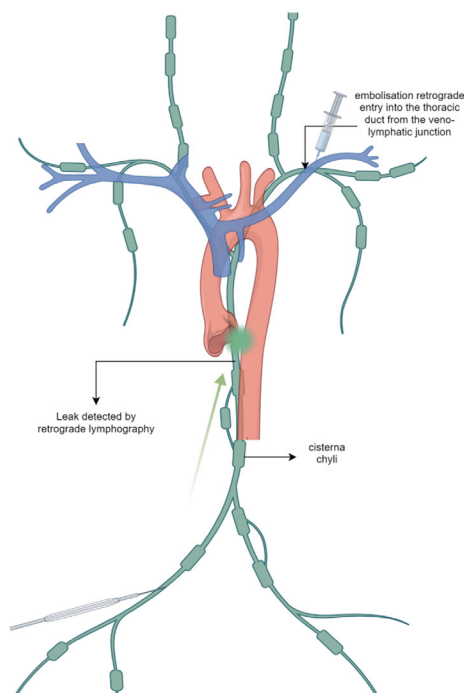


Figure 2. A. Photographs of transinguinal lymphangiography. Iodinated oil was injected via bilateral inguinal lymph nodes; B. Thoracic duct being visualized. The location of the lymphatic leak, the entire course of the thoracic duct and the approximate location of the thoracic duct into the vein were shown, providing a guide for retrograde catheter

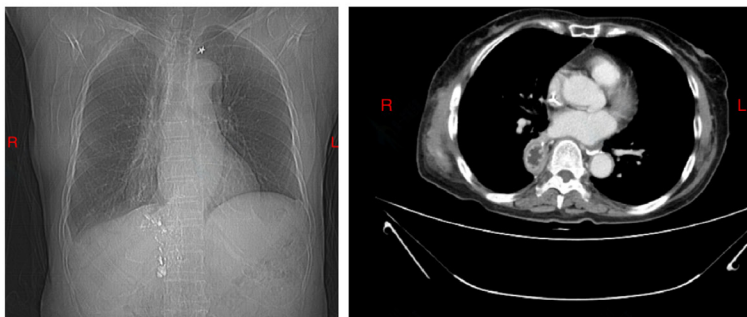
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insertion; C. Retrograde access to lymphatics via subclavian vein and embolization; Retrograde access via the lower extremity venous route using a 4-5F single-curve catheter and a cut pig-tail catheter. Subsequently, a microcatheter is placed into the thoracic duct.

A



B 2024-2-23:



C 2025-5-13:

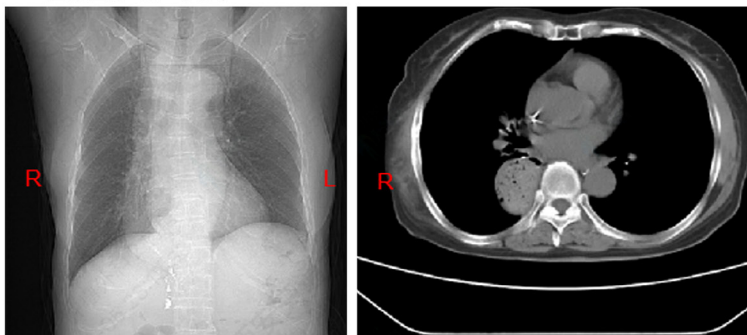


Figure 3. A. Schematic illustration of the interventional procedure for thoracic duct embolotherapy (This diagram is drawn by Figdraw platform: www.figdraw.com); B. Post-interventional chest CT showed a significant reduction in pleural effusion; C. Follow-up chest CT showed that the patient had no significant pleural effusion or inflammation.

aids in anticipating and mitigating risks but also in formulating a personalized treatment plan that considers the patient's unique health profile. This meticulous monitoring and documentation of the patient's postoperative course were essential for timely intervention and optimization of her recovery. The escalating volumes of pleural effusion underscored the need for close observation and potential for further diagnostic evaluation to ascertain the nature of the fluid and address any underlying complications effectively. This proactive strategy is key to optimizing surgical outcomes and ensuring a smoother recovery process.

Even with the continuous refinement of surgical methods, this case of tumor treatment presented distinct challenges. The operation achieved complete tumor resection, but the unclear demarcation between the tumor and adjacent tissues indicates that the preoperative evaluation of tumor invasion might have been suboptimal. This highlights the need for more precise preoperative assessments to fully understand the extent of tumor infiltration. Moreover, the risk of thoracic duct injury, which can lead to chylous leakage, is a complex issue that is not always preventable. Such an injury in this case complicated the postoperative course, emphasizing the delicate balance required during surgery to minimize collateral damage. Addressing this challenge requires a combination of surgical skill, care-

ful planning, and possibly the use of advanced imaging techniques to better delineate the tumor and surrounding structures preoperatively.

In our case of high-flow chylous leakage, the initial conservative treatment strategy did not yield the anticipated outcomes. Literature suggests that the efficacy of conservative management varies significantly, contingent upon the specific etiology of the condition, with success rates ranging from as low as 16% to over 75% [8-11]. Particularly, when the chylous output surpasses 1,000 mL/day, the likelihood of success with conservative measures plummets [12, 13]. The ineffectiveness of our initial conservative approach could be due to the limitations of medications in curtailing lymph production and the restrictions on intestinal lipid intake might have been insufficient to address the leakage effectively. The failure of our second surgical intervention can potentially be attributed to the extensive pleural adhesions encountered between the parietal and visceral pleural layers. These adhesions complicated the surgical procedure, hindered the achievement of a secure ligation of the thoracic duct, and may have heightened the risk of secondary injury.

These observations emphasize the critical nature of carefully considering the approach to managing such complications. A second surgical intervention should not be hastily pursued as a primary option. Instead, there should be a concerted effort to explore and implement more effective minimally invasive treatment approaches. This strategy is essential for enhancing patient outcomes and reducing the risk of further complications in the management of postoperative chylothorax.

In this case, embolization therapy has proven particularly effective in addressing high-flow chylothorax. In fact, interventions within the lymphatic system have shown promising results in managing chylothorax [14]. Thoracic duct lymphangiography combined with TDE serves as a minimally invasive and viable alternative to surgical ligation of the thoracic duct, owing to its documented efficacy and practicality [4]. Early TDE used an antegrade transabdominal approach, which required antegrade lymphangiography to locate the location of the chylous leak and embolize the thoracic duct

[15]. However, this approach poses technical challenges for cases of thoracic duct rupture or anatomical variation, with a success rate of approximately 63.1% [7]. With the development of interventional radiology, TDE combined with retrograde lymphangiography has gradually become a less invasive alternative. This method enters the thoracic duct via a retrograde approach (such as through the jugular vein or pleural cavity) and combines embolic materials to achieve closure of the leak site, providing a new treatment option for patients with complex anatomical structures [16]. First reported by Bundy et al. in 2019, they successfully completed TDE via a retrograde transjugular approach [17]. In 2020, Kim's meta-analysis systematically evaluated the efficacy of the combined approach, marking the entry of the technology into the standardized application stage [14]. In 2021, the technical details of the retrograde transpleural approach were further improved, expanding the scope of application for complex cases [18]. Recent data showed that the success rate of retrograde TDE technology was 100%, and the clinical success rate was 79.4%, which was 16.3% higher than the traditional antegrade route [14, 19]. The average time for drainage tube removal after surgery was shortened to 5.7 days [6].

The success of embolization therapy hinges on the clarity of the initial lymphangiography, which is crucial for accessing the lymphatic system through standard vascular interventional techniques. This enables the strategic deployment of embolic agents. For imaging the lymphatic system, the predominant methods are Direct Lymphangiography (DLG) and Computed Tomography Lymphangiography (CTL). DLG offers a dynamic view of lymphatic characteristics such as vessel tortuosity, leakage, or reflux, and is considered the gold standard for visualizing lymphatic vessels, chylous cisterns, and the thoracic duct. It is instrumental in diagnosing lymphatic disorders and anatomical irregularities [20]. Following DLG, conducting chest and abdominal CTL can overcome the limitations of overlapping DLG images, providing valuable insights into pulmonary changes, abnormal iodinated lipiodol deposition, pleural effusion, extrathoracic lymphatic anomalies, and their extent.

Mastering the technique of retrograde lymphangiography through inguinal lymph node

puncture could pave the way for less invasive treatments for lymphatic system diseases and potentially for tumor-related surgeries in the future [21]. This measured approach ensures that treatment strategies are tailored to individual patient needs and conditions, maximizing therapeutic outcomes while minimizing risks. However, it is essential to recognize that the embolization treatment guided by retrograde lymphangiography, as presented in this case, should not be automatically adopted as a one-size-fits-all approach for all chylothorax cases. Further scientific inquiry and assessment are necessary to determine its appropriate application and long-term effectiveness.

In conclusion, this case underscores the significance of acknowledging patients' comorbidities in assessing postoperative complications, highlighting the requirement for comprehensive treatment approaches and individualized plans. Retrograde lymphangiography coupled with embolization therapy demonstrates promising outcomes for refractory chylothorax, featuring minimal invasiveness. It is applicable to recalcitrant, recurrent, and intricate lymphatic injuries, advocating for its promotion. Nevertheless, prudence is advised, necessitating thorough evaluation of its applicability and long-term consequences.

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Disclosure of conflict of interest

None.

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