



Interventional Radiology Treatment for Postoperative Chylothorax

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Postoperative chylothorax is a rare occurrence after various thoracic surgical procedures, but it poses a substantial risk of morbidity and mortality. Thoracic duct embolization (TDE) is currently deemed the optimal treatment due to its safety and efficacy. This review offers an introduction to interventional options in this setting, detailing the steps of TDE for the edification of those engaged in postoperative care.

Keywords: Intervention, Chylothorax, Thoracic duct, Postoperative care

Introduction

The lymphatic system primarily serves to collect and return interstitial fluid to the venous system [1]. Its bodily components (i.e., retroperitoneal, intestinal, and hepatic) ultimately fuse at the cisterna chyli, traversing the mediastinum via the thoracic duct and eventually draining into the left internal jugular or subclavian vein [2]. The anatomic location of the thoracic duct leaves it vulnerable to injury during various thoracic surgical procedures, such as esophagectomy, lung resection, and mediastinal or aortic surgery, all of which typically are invasive in nature. Fortunately, the incidence of clinically significant chylothorax is relatively low, ranging from 1% to 9% [3-5]. However, chylothorax poses a considerable risk of morbidity and mortality if not appropriately managed at the onset because chylous leakage contains higher nutrient concentrations than non-chylous lymphatic leaks, and the seepage is usually excessive.

Conservative and surgical management of postoperative chylothorax

The optimal clinical management of postoperative chylothorax has yet to be established. At present, therapeutic strategies generally include the following: (1) conservative management, using total parenteral nutrition or medium-chain triglyceride diets; (2) somatostatin and octreotide administration; and (3) surgical intervention involving talc pleurodesis, pleurectomy, or thoracic duct ligation [6]. Surgical ligation of the thoracic duct is an effective means of managing high-output or recurrent chylothorax, with impressive success rates, but the reported rates of procedural morbidity and mortality are as high as 38.8% and 25%, respectively [7-9].

Interventional radiology treatment

In treating chylothorax, the minimal invasiveness and excellent safety profiles of interventional options have fueled their growing popularity [10-13].



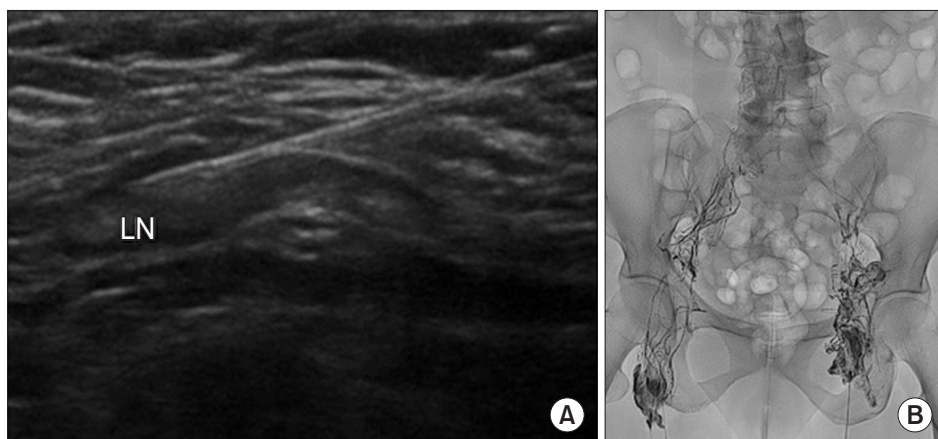


Fig. 1. Lipiodol lymphangiography. (A) Ultrasound-guided inguinal LN puncture and (B) Lipiodol lymphangiography of the iliolumbar region. LN, lymph node.

Thoracic duct embolization

First introduced in the late 1990s, thoracic duct embolization (TDE) has gradually gained acceptance as first-line therapy for traumatic chylothorax [14]. Some physicians may still be averse to passing a needle through vital abdominal organs, but data on the safety of such procedures continue to mount. There are three major steps to this approach: (1) Lipiodol lymphangiography, (2) thoracic duct access (TDA), and (3) TDE.

Lipiodol lymphangiography

For many years, lymphangiography was synonymous with X-ray imaging of lymphatics opacified by Lipiodol (ethiodized oil, Lipiodol Ultra-Fluid; Guerbet, Villepinte, France). The first use of Lipiodol for this purpose was in the 1960s. Unlike water-soluble iodinated compounds that dissipate rather quickly, Lipiodol remains in the lymphatic system. The transpedal technique was once the mainstay of lymphangiography, entailing direct cannulation of a surgically exposed, minuscule lymphatic channel in the foot. This laborious approach was limited by the sophistication of the requisite operative skills and experience. It was also very time-consuming, slowed by obvious injection constraints and the protracted course of flow from the leg to the trunk.

Intranodal lymphangiography is an effective alternative method of direct lymphatic access that relies on ultrasound guidance. Its launch in 2011 essentially rendered transpedal injections obsolete [15]. In addition to providing very reliable and secure access to the lymphatics, only fundamental skills and standard equipment are called upon for the puncture of centimeter-sized structures. Furthermore, the time invested in lymphatic imaging is dramati-

cally reduced by the ready injectability of contrast agents and the ability to bypass the lower extremity.

In this procedure, the lymph nodes of both inguinal areas are directly pierced under ultrasound guidance by a 26G needle pre-connected to a short accessory tube and a 3-mL polycarbonate syringe. The needle tip is positioned at the transition between the nodal cortex and hilum. Lipiodol is then manually injected at a slow rate, using intermittent fluoroscopy until the lymphatics along the upper lumbar region and the cisterna chyli are opacified (Fig. 1) [16,17].

Thoracic duct access

A 15-cm or 21-cm 21G Chiba needle is advanced to the target structure (cisterna chyli, its major tributary, or an even lower segment of the thoracic duct) under fluoroscopic guidance, and puncture is achieved. A relatively stiff guidewire (0.3556 mm or 0.4572 mm) is then passed through the needle into the cisterna chyli and, eventually, the thoracic duct. Next, a microcatheter is inserted over the guidewire into the thoracic duct. While injecting 5–10 mL of iodinated water-soluble contrast (0.3–1 mL/sec) via a microcatheter, digital subtraction lymphangiography is performed to identify the point(s) of leakage.

Embolization

Once leakage of lymphatic fluid is confirmed by lymphangiography, the entire segment of the thoracic duct is embolized using a combination of microcoils and *n*-butyl-2-cyanoacrylate (NBCA) liquid glue (Histoacryl; B. Braun Medical Inc., Melsungen, Germany) plus Lipiodol at a ratio of 1:1.5–1:3 (usually 1:2). This is the most commonly applied technique (Fig. 2).

In a meta-analysis, the clinical success rate of TDE in

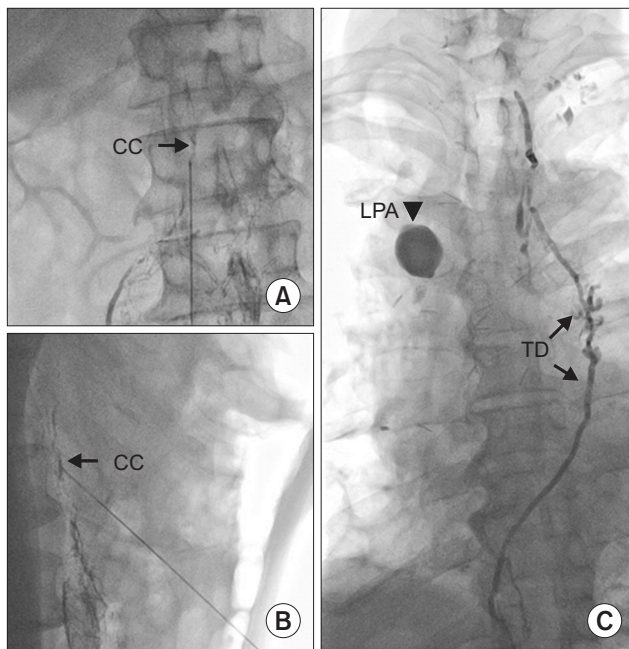


Fig. 2. TD access and embolization. (A, B) Puncture of the CC, anteroposterior and lateral views. (C) Spot image upon completion of TD embolization. TD, thoracic duct; CC, cisterna chyli; LPA, lymphopseudoaneurysm.

treating traumatic chylothorax proved to be 92.4%, assuming no technical impediments. The problem is that the pooled technical success rate of TDE, on a per-protocol basis, was only 63.1% [18]. Of the 3 steps involved in the process, TDA is paramount in terms of difficulty and thus dictates the technical outcomes of TDE. However, it is our contention that technical success approaches 90% at experienced centers offering advanced lymphangiography and other forms of interventions.

Despite the high clinical success rate of TDE, some patients do not respond well, and the chylothorax persists. There are several explanations for this, the first being incomplete ductal occlusion due to the inappropriate usage of embolic agents. A dilute mixture of NBCA or a steeper Lipiodol ratio (beyond 1:4) might account for this [19]. Another reason may be the existence of collateral channels that continue to leak chylous fluid. Finally, translocation of chylous ascites is quite conceivable, and can manifest as chylothorax, especially if the diaphragmatic barrier between compartments is damaged during the original surgery. In such circumstances, occlusion of the thoracic duct by embolization or ligation may substantially aggravate symptoms. The decision to perform TDE should, therefore, proceed cautiously if evidence of leakage is not found on Lipiodol lymphangiography or digital subtraction lymph-

angiography.

Contraindications and complications of thoracic duct embolization

TDE may be contemplated in any situation amenable to thoracic duct ligation. The goal of each procedure is the same. However, conditions that increase TDA risk may be relative contraindications. Pertinent examples are active abdominal infection, aortic aneurysm, and pancreatitis.

In general, needle penetration of various abdominal organs during TDA is considered safe. However, the gallbladder should be avoided, because there is a potential for bile peritonitis [20]. As with surgical ligation of the thoracic duct, leg swelling (7%) or diarrhea (8%) may develop after TDE during long-term follow-up [11]. Other possible complications include systemic or pulmonary embolization of Lipiodol/glue, bleeding, and allergic reactions to the contrast agent.

Therapeutic Lipiodol lymphangiography

Originally, Lipiodol lymphangiography was intended to visualize leakage points or the cisterna chyli during TDE. Nevertheless, its therapeutic ramifications for refractory lymphatic leakage have since drawn attention [21-26]. Lipiodol-induced selective blockade of pathologic lymph ducts and the sterile inflammatory reactions that occur are believed to produce scarring, encouraging the resolution of lymphatic leakage within several days or weeks [27]. A hypothetical scenario is the saturation of central lymphatics with viscous Lipiodol, with the goal of redirecting flow through existing peripheral lymphovenous connections [2]. Unfortunately, a high proportion of patients fail to respond as anticipated, especially those with higher drainage volumes who are most in need of definitive treatment.

Thoracic duct disruption

Thoracic duct disruption (TDD) is usually performed as a bail-out procedure if TDA is prohibited by technical issues. The aim is to macerate the cisterna chyli or the main retroperitoneal lymphatic channels through multiple needle punctures, thereby reducing downstream lymphatic flow and allowing leaks to heal spontaneously [10,14,28]. Alternatively, the mechanism of action may well be the Lipiodol effect, the inflow of venous blood through disrupted lymphatic vessels, or the pressure exerted upstream on thoracic duct by hematomas formed at puncture sites [28]. In a meta-analysis, the pooled TDD clinical success

rate on a per-protocol basis was 60.8%, which is much less than that of TDE (79.4%) and only slightly better than that of lymphangiography (56.6%) [18]. This suggests that the efficacy of TDD derives fundamentally from lymphangiography, and that it confers no real clinical benefit by itself.

Conclusion

Among the various options for radiologic lymphatic intervention, TDA and TDE are optimal measures, preferable to other available methods (i.e., Lipiodol lymphangiography or TDD) when feasible, as they show superior clinical efficacy. They represent less invasive alternatives to open surgical strategies, such as pleurodesis or thoracic duct ligation, in the treatment of high-output chylothorax.

Conflict of interest

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

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