

Leak from Duplicated Thoracic Duct Treated with Embolization

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Abstract

Injury to the thoracic duct leads to the leakage of chyle into the pleural space causing a chylothorax. The most common cause of chylothorax in children is injury from cardiac surgery when the mediastinum is dissected. It is important to diagnose and localize the chyle leak. Today, intranodal lymphangiography with MRI is the gold standard for diagnostic imaging and guidance of therapy. Medical management is often the initial therapy. If unsuccessful, image-guided embolization is the initial treatment of choice and is an effective treatment for a persistent chylothorax after unsuccessful medical management.

Keywords: thorax, trauma, lymphatic, lymphatic embolization

Case Summary

A teenaged male with hypertensive crisis was found to have an aortic interruption. Within days following repair of the aortic interruption, there was development of a left chylous pleural effusion. A dynamic contrast-enhanced MR lymphangiogram was performed, demonstrating localized accumulation of contrast near the thoracic duct at the aortic arch level and accumulation of contrast in the left pleural effusion. Afterward, an MR lymphangiogram was performed, with transabdominal cannulation of the thoracic duct, and embolization of the leaking duplicated thoracic duct.

Imaging Findings

A 3D CTA of the chest with a posterior view demonstrated an interrupted thoracic aorta (Figure 1). A dynamic contrast-enhanced MR lymphangiogram

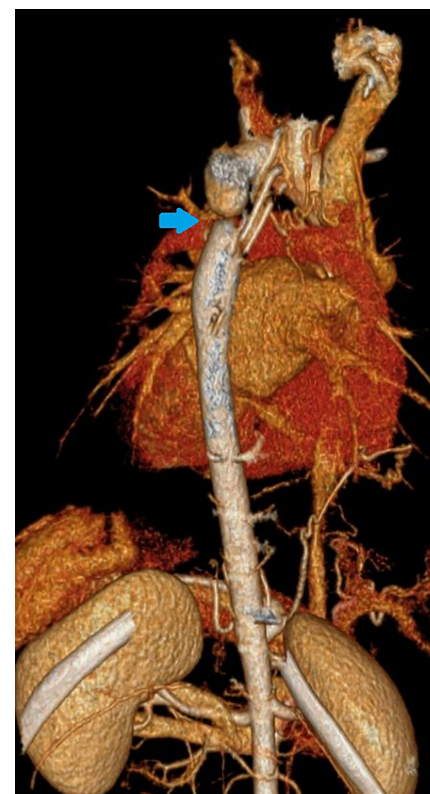
33 minutes later showed the thoracic duct (TD) (Figure 2A) and accumulation of contrast near the TD at the T3 level (blue arrow, Figure 2B). Transabdominal TD access with contrast injection demonstrated duplication of the TD (Figure 3A), with leakage of contrast from the left-sided duplication. The TD was cannulated with a microcatheter. The catheter tip was positioned in the inferior-most aspect of the left-sided TD duplication. There was successful coil embolization with resolution of the leak.

Diagnosis

Duplicated TD with associated laceration and chylothorax.

The differential diagnosis includes hemothorax, exudative pleural effusion, pseudochylothorax (cholesterol effusion), empyema, parapneumonic pleural effusion, and rarely rheumatoid and lipid pleural effusions.

Figure 1. 3D CTA of the chest with a posterior view demonstrating a severe coarctation/interruption of the aorta (blue arrow).



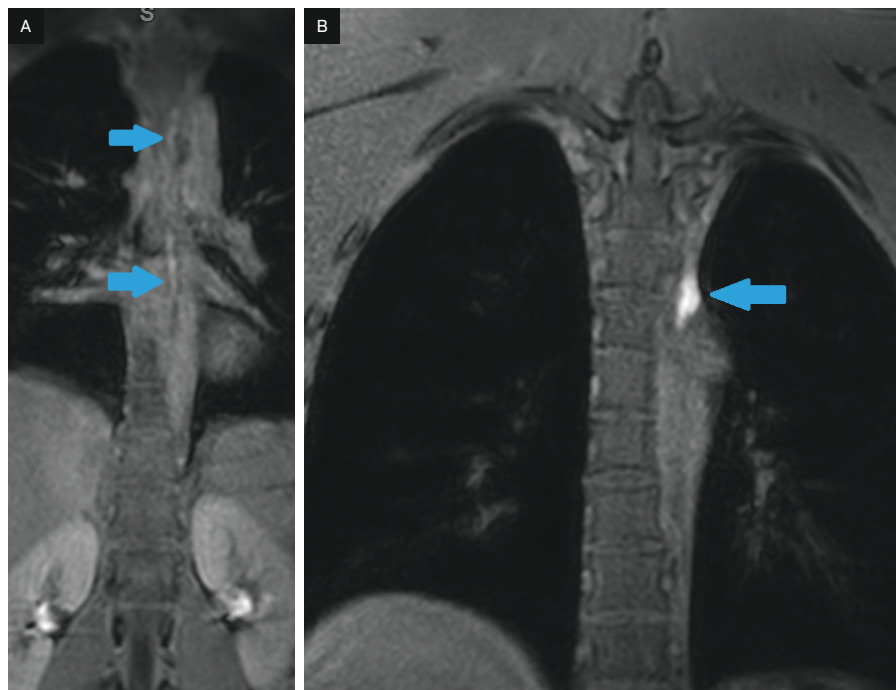
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Discussion

Chyle is a milky fluid that is formed in the small intestines and consists of fats

Figure 2. (A, B) Dynamic contrast-enhanced MR lymphangiogram demonstrating visualization of the thoracic duct (TD) at 33 minutes (blue arrows, A) and accumulation of contrast near the TD at the T3 level (blue arrow, B).



or free fatty acids. Normally lymph drains from the lacteals of the small intestines into the lymphatics. The lymphatic vessels drain chyle from the intestine and join with lymphatic fluid from the lower extremities flowing into the TD system, which ultimately drains approximately 75% of the lymph originating from the cisterna chyli and empties into the venous system at the junction of the left subclavian vein and left jugular vein.¹ The right lymphatic duct is smaller than the TD and drains about 25% of the lymphatic fluid originating from the right side of the head and neck, the right upper extremity, right thorax, and right breast. This duct independently drains into the right subclavian vein/internal jugular junction. The right duct can be injured in right-sided neck dissections or other trauma, presents with right-sided fluid collections, and occurs in about 0.75-8.9% of cases. The TD is the longest and largest lymphatic channel, which drains into the left subclavian vein. It courses through the trunk and may be affected by congenital anomalies and trauma, especially from surgical procedures. Anatomic variation

can be found in nearly one-third of children, adding to the risk of surgical injury. A partial duplication of the TD occurs in about 15-20% of cases. TD duplication or triplication can also be seen. Chylothorax is a rare condition that results from TD damage, with chyle leakage from the lymphatic system into the pleural space.² As approximately 2.4 L of chyle is transported through the lymphatic system every day, damage to or rupture of the TD can give rise to a large and rapid accumulation of fluid in the pleural space.²

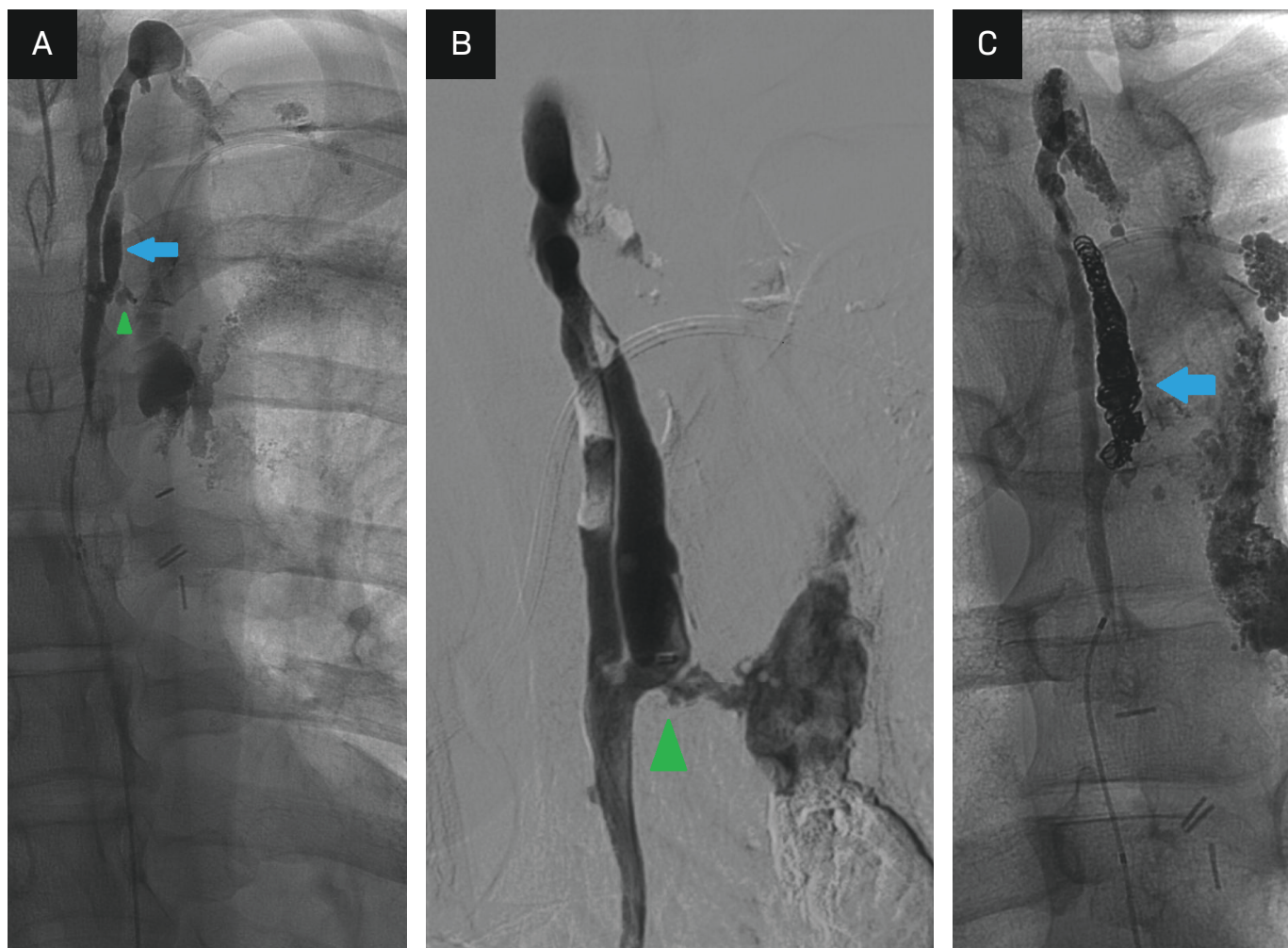
Clinical features of chylothorax depend on the rate of chyle loss as well as the concomitant effect of the etiology.² Rapid fluid loss is associated with hypovolemia and respiratory difficulty as the pleural space fills with fluid.³ Prolonged chyle drainage can also impact immune function and result in impairment in both cell-mediated and humoral immunity.³

Chylothorax can be traumatic, spontaneous, and idiopathic. Traumatic chylothorax results from disruption of the right lymphatic duct or TD at any point along its course in the body cavity and

mediastinum.¹ Postoperative chylothorax is the most common form of traumatic chylothorax in modern medicine.¹ In children, the most common causes of injury are cardiac surgery (0.2-2%) (Figure 1) and pediatric surgery, followed by injuries causing high intrathoracic pressure. The primary cause of spontaneous or nontraumatic chylothorax can arise from congenital, neoplastic, or infectious etiologies.¹ While esophageal resection is considered the most common iatrogenic cause in adults, case reports have also documented idiopathic chylothorax occurring during pregnancy, triggered by labor.¹ Iatrogenic causes of chylothorax in the pediatric population are usually the result of congenital lymphatic dysplasia, malformations, severe infection, and Turner and Noonan syndrome. Operative correction of an aortic coarctation was the most common single cause of a subsequent chylothorax.⁴

Investigation of suspected chylothorax begins with the confirmation of the diagnosis by fluid analysis, followed by the identification of the leakage point where possible.² On fluid analysis, usually the total lipid varies from 4 to 40 g/L and characteristically has a high triglyceride and a low cholesterol concentration.⁴ MR lymphangiography (MRL) (Figure 2) and nuclear medicine lymphangiography (NML) are the key imaging modalities used for diagnosis and localization of chyle leaks.³ For NML, the usual site of tracer injection for lymphatic imaging is the web space between the first and second toes.⁵ Despite a resurgence in pedal lymphangiography, it remains technically challenging and time-consuming, and NML has lower anatomic resolution.⁶ Currently, the lymphatic system is most frequently accessed via inguinal lymph nodes (intranodal lymphangiography [INL]).⁶ INL with lipiodol followed by MRI is the diagnostic tool of choice. Lipiodol also has therapeutic value for closing a chyle leak.⁷ When a TD fistula is present, MRL can demonstrate its location by visualization of contrast extravasation from the duct with pooling in the

Figure 3. (A-C) Transabdominal thoracic duct access with contrast injection demonstrating duplication of the thoracic duct (TD) in (A) (blue arrow), with leakage of contrast from the left-sided duplication (green arrowhead). (B) The microcatheter tip is in the inferior-most aspect of the left-sided TD duplication, and there is contrast exiting the caudad aspect of the duplicated TD (green arrowhead). Successful coil embolization of the leaking duplicated TD with cessation of contrast leak (blue arrow) can be seen.



adjacent pleural space.³ A post-lymphangiography noncontrast CT may be a useful adjunct and can precisely localize the source and location of the chyle leak.³ However, MRL using heavily T2-weighted images has demonstrated greater sensitivity in identifying the cisterna chyli compared with lymphangiography or CT and is currently the diagnostic modality of choice.⁸

Chylothorax after congenital heart surgery occurs in approximately 2-5% of cases and can be associated with significant morbidity, especially in the repair of single ventricles.⁹

Traditionally, treatment options included diet modification and octreotide infusion as conservative management.⁹ The management of chylous effusions requires the maintenance of nutrition, reduction of flow in TD lymph, and maintenance of full expansion of the affected lung.⁴ This may be accomplished via thoracentesis or chest tube placement.¹⁰ Dietary modifications can help reduce the volume of chyle production and allow the site of injury to heal.¹⁰ Medium-chain triglycerides by mouth resolve approximately 50% of congenital or traumatic chylothoraces.² Somatostatin constrict smooth muscles in

the lymphatic vessels to decrease lymph production and flow.¹⁰ When medical management fails, minimally invasive image-guided intervention and surgical intervention are needed.⁹ Image-guided embolization of the TD is an effective treatment for postoperative chylothorax⁹ and is currently the initial procedure of choice. TD and/or channel embolization is performed by interventional radiologists (Figure 3).⁹ Inguinal lymph nodes are accessed under real-time US guidance with a 25-gauge needle and lipiodol is slowly injected.⁹ After visualization of the TD and identification of a target lymphatic

vessel, a 21-gauge-long Chiba needle is placed in the target lymphatic vessel under fluoroscopic guidance.⁹ A microcatheter is directed over a guidewire into the lymphatic vessel, and contrast is injected to identify the chylous leak.⁹ The TD is embolized on both sides of the lymphatic injury with coils and/or a mixture of cyanoacrylate glue and lipiodol.⁹ The minimally invasive approach is successful, with a technical success rate of approximately 70-89% and a clinical success rate of 85-94% in closing the leak.¹¹

Conclusion

Injury to the TD leads to the leakage of chyle into the pleural space, causing a chylothorax. The most common cause of chylothorax in children is injury from cardiac surgery when the mediastinum is dissected. It is important to diagnose and localize the chyle leak. Today, INL with MRI is the gold standard

for diagnostic imaging and guidance of therapy. Medical management is often the initial therapy. If unsuccessful, image-guided embolization is the initial treatment of choice and is an effective treatment for a persistent chylothorax after unsuccessful medical management.

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