Chylothorax

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Injury/Disease Demographics

- The thoracic duct transports up to 4 L of chyle from the intestines, liver and lower extremities to the systemic venous circulation daily.
- Chylothorax occurs when the thoracic duct is disrupted or obstructed and chyle accumulates in the thorax.
- Chylothorax is classified as either spontaneous or traumatic:
    - Spontaneous chylothorax may be congenital, infectious, neoplastic or secondary to obstructive causes such as superior vena cava thrombosis, sarcoidosis or amyloidosis.
    - Traumatic chylothorax is most commonly a complication of thoracic surgery. Chylothorax can occur following blunt or penetrating trauma or with placement of central venous catheters.
- One-half of blunt traumatic thoracic duct injuries are on the right, one-third of injuries are on the left and the remainder are bilateral.

Clinical Presentation

- Symptoms of chylothorax include hypovolemia, dyspnea, cough, chest pain and fatigue. Chyle is non-irritating and rarely causes discomfort or fever. Clinically, chylothorax resembles a sterile pleural effusion.
- Chylothorax may present with persistent chest tube output or recurrent pleural effusion.
    - Chylothorax fluid may be serous in a patient who is NPO or serosanguinous in the post-operative or trauma patient. Chylothorax is milky in less than one-half of patients.
- Blunt thoracic duct injury can occur following a hyperextension injury or an axial load to the thoracic spine. It can also result from shear injury at the level of the right crus of the diaphragm or from posterior rib fractures.
- Penetrating thoracic duct injury can occur in transmediastinal gunshot wounds or with violation of the thoracic inlet.
- Metabolic acidosis, hyponatremia and hypocalcemia are the most common laboratory abnormalities.
- Immunosuppression can result from a chronic leak. Historically, thoracic duct drainage was used as a mechanism to deplete the lymphocyte count in kidney transplantation.
- Malnutrition can result from the chronic loss of proteins, fat-soluble vitamins, lipids and electrolytes.

Evaluation/Diagnostics/Imaging

- A delay in diagnosis of 2-7 days is common. Chyle leaks can be slow and initially contained within the mediastinum.

- Chest radiograph (PA and lateral) to assess volume of effusion should be the first diagnostic test.
- Definitive diagnosis requires a pleural fluid analysis:
    - pH 7.4 to 7.8
    - Lymphocyte predominance
    - Specific gravity greater than 1.012
    - Low cholesterol level
    - Triglyceride level is typically > 110 mg/dl
        - Triglyceride level >110 mg/dl has a 99% chance of being chylous.
        - Triglyceride level < 50 mg/dl has a 95% chance of not being chylous.
        - When triglyceride level is between 50 mg/dl and 110 mg/dl, lipoprotein electrophoresis should be completed to evaluate for the presence of chylomicrons and is the gold standard for diagnosis. Alternatively, chylomicrons will stain with Sudan III, if lipoprotein analysis is not available at your institution.
- Lymphangiography or lymphoscintigraphy can be used to localize lymphatic leaks, assess the extent of the tear (complete vs partial) and allow for catheter directed embolization.

Role of Conservative Management and Associated Considerations

- Non-operative treatment should achieve three goals:
    - Mitigate dyspnea
    - Replenish fluid and nutrient losses
    - Reduce chyle output.
- Nil-per-os (NPO), total parenteral nutrition (TPN), chest tube drainage, and observation are the mainstay of non-operative therapy. This approach may be effective in up to 88% of cases.
- Diets containing only medium chain fatty acids are used because they are absorbed directly into the portal circulation and not the lymphatics. They should be included as part of a conservative strategy. Any enteral feeding can increase lymph flow, and if this occurs, TPN should be used exclusively.
- Non-operative management should not exceed 2 weeks to minimize the risk of metabolic, nutritional and immunologic sequelae. Long term chyle losses put patients at risk of bacterial and/or fungal sepsis and should be avoided.
- Octreotide can be an effective adjunct and typically reduces chyle volume within 2-3 days of initiation. The precise dose and duration required is not known. Etilefrine is a new agent that causes smooth muscle contraction and can also facilitate thoracic duct injury closure.

Indications for Intervention

- Adults: Chyle leak greater than 1 L/day x 5 days or more than 1.5 L/day on average.
- Children: Chyle leak greater than 100 mL/kg/day x 2 weeks
- Persistent chyle leak for more than 2 weeks.
- Progression of malnutrition or uncontrolled electrolyte or metabolic derangements.
- Thoracic duct ligation should be conducted if the thoracic space has to be entered for another procedure.

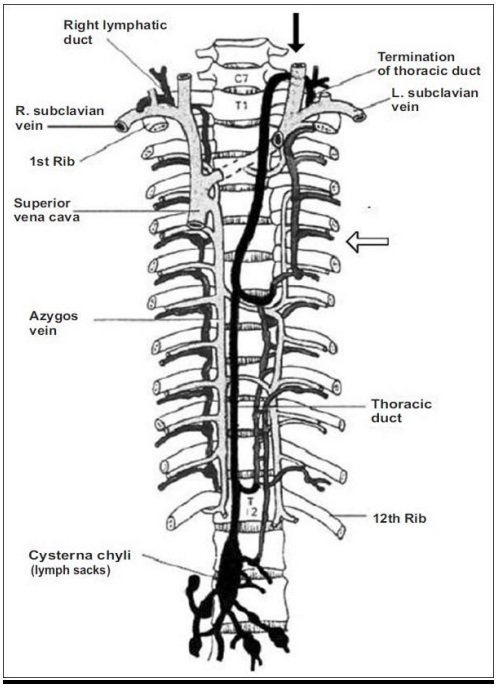
Thoracic Duct Embolization for Management of Chyle Leak:

- Most centers recommend initial attempt at coil embolization. The thoracic duct is typically cannulated through the cisterna chyli or at the level of the subclavian vein.
    - Bipedal lymphangiography is necessary to identify the thoracic duct injury and successfully opacify the system.
    - Cannulation is generally below the level of the cisterna chyli into one of the lumbar lymphatic ducts (generally the right)
    - Successful cannulation is achieved in two-thirds of patients.
    - Coil embolization provides a matrix for glue polymerization.
    - Occlusion of the thoracic duct is achieved in 90% of those successfully cannulated.
    - Complications of thoracic duct embolization are uncommon, but include chronic leg swelling, abdominal swelling without ascites and chronic diarrhea.

Pre-Operative Preparation/Impact of Associated Injuries

- Metabolic, electrolyte and nutritional abnormalities should be corrected prior to administration of anesthesia.
- Administration of butter or cream through an NG or J tube 30 minutes prior to induction of anesthesia should be administered to help identify the leak. Most surgeons do not recommend the use of methylene blue as it stains adjacent tissue.
- Lymphangiography can be used pre-operatively to determine the level, side and extent of the injury.
- If traumatic chylothorax is suspected acutely, injury to the adjacent structures such as the esophagus or aorta should be ruled out.
- Traumatic chylothorax is associated with spine fractures in one-fifth of cases. These injuries should be addressed first if unstable or if neurologic deficits are present.
- Given the infrequency of this injury, the anatomy should be reviewed pre-operatively.

- The thoracic duct originates at the cisterna chyli on the anterior surface of the first and second lumbar vertebrae. The duct passes through the diaphragmatic hiatus with the aorta and azygous vein to enter the mediastinum. The duct lies between the aorta and azygous vein and crosses the midline at T5 or T6 and drains into the junction of the left subclavian vein and internal jugular vein.



Operative Techniques/Intraoperative Considerations

- Ligation can be done percutaneously, thoracoscopically or open.
- VATS with clip ligation of the duct, above and below the leak, is the gold standard for surgical therapy. Fibrin glue can be applied to the leak site when the exact location of the injury cannot be identified. Administration of heavy cream via the nasogastric tube can facilitate with intra-operative identification of the lesion.
- In cases where the leak site cannot be identified, ligation of the thoracic duct just proximal to the aortic hiatus should exclude left and right sided leaks.
- When the duct cannot be identified, talc, bleomycin, tetracycline or minocycline pleurodesis can be completed and has a reported success rate as high as 95%. Many surgeons complete a mechanical pleurodesis even if the duct is identified and ligated to promote re-expansion of the lung.
- Conversion to open may be required if the thoracic duct cannot be located or thick pleural adhesions prevent adequate visualization.
    - Mortality for open duct ligation increases from 2.1% to 16% in those who have delayed ligation by more than one month.

    - An abdominal approach should be considered when the thoracic approach is not feasible.
    - Ligation above and below the leak should be done. This should be completed with pledgeted sutures that are placed around the duct and not through the duct, which is typically paper thin.
- Pleuroperitoneal shunt or less often pleurovenous shunt can be attempted as a last resort if other measures fail. A passive LeVeen shunt over an active Denver shunt is typically favored.

Post-Operative Management/Complications

- Patients should be kept NPO post-operatively to minimize flow through the duct. The exact duration required is not known, but many surgeons employ this for 7 days and utilize TPN during that time.
- Positive pressure ventilation 24 hours post-operatively to promote re-expansion of the lung should be considered.
- Failure of operative intervention can occur and sometimes requires re-operation. Assessment for ongoing leak via thoracostomy tubes should be conducted.
- Lymphedema can occur after thoracic duct ligation. This resolves quickly once new venous lymphatic collateral circulation develops.
- Long term complications of leak include lymphopenia, decrease in cellular and humoral immunity and susceptibility to infections and sepsis. Further, patients may enter a catabolic state from a chronic chyle leak.

Considerations for Special Populations

- Thoracic duct embolization is technically very demanding in the pediatric population and may have a higher rate of failure. VATS is typically very well tolerated in the pediatric population.
- Geriatric and immunocompromised patients will not tolerate high volume chyle losses and early intervention should be considered in these high-risk patients.

Proposed Reading List/Recent Articles

Textbooks:

1. Asensio JA, Trunkey DD. Current Therapy of Trauma and Surgical Critical Care. Mosby; 2008. Page 303.
2. Britt LD, Barie PS, Peitzman AB et al. Acute Care Surgery. Lippincott Williams & Wilkins; 2012. Page 352-3.
3. Vincent JL, Fink MP. Textbook of Critical Care. Saunders; 2011. Page 445.

Articles:

1. Bender B, Murthy V, Chamberlain RS. The changing management of chylothorax in the modern era. Eur J Cardiothorac Surg. 2015; 1-7.
2. Chen E, Itkin M. Thoracic duct embolization for chylous leaks. Semin Intervent Radiol 2011; 28: 63-74.
3. Kumar S, Mishra B, Krishna A, et al. Nonoperative management of traumatic chylothorax. Indian J Surg. 2013;75(Suppl 1):465-8.
4. Lyon S, Mott N, Koukounaras J, Shoobridge J, Hudson PV. Role of interventional radiology in the management of chylothorax: a review of the current management of high output chylothorax. Cardiovasc Intervent Radiol. 2013;36(3):599-607.
5. Martucci N, Tracey M, Rocco G. Postoperative Chylothorax. Thorac Surg Clin. 2015;25(4):523-8.
6. Merrigan BA, Winter DC, O'sullivan GC. Chylothorax. Br J Surg. 1997;84(1):15-20.
7. Sendama W, Shipley M. Traumatic chylothorax: A case report and review. Respir Med Case Rep. 2015;14:47-8.