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Review

A review of traumatic chylothorax

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ABSTRACT

Background: Traumatic chylothorax is an extremely rare complication following thoracic trauma or surgery. The aetiology of traumatic chylothorax is dominated by iatrogenic causes, with a reported incidence of 0.5% to 3% following oesophageal surgery. The mortality from a chylothorax post oesophagectomy can be as high as 50%. Iatrogenic causes in total account for approximately 80% of traumatic causes. Non-iatrogenic traumatic chylothoraces are exceedingly uncommon. The complication rate in blunt thoracic trauma is said to be 0.2% to 3%, whilst in penetrating trauma, the incidence is 0.9% to 1.3%. If recognised late or managed poorly, this condition has devastating complications, including nutritional depletion, physiological derangements and immunological depression. This review revisits the anatomy of the thoracic duct, the physiology of chyle production and associated dynamics as well as the current management strategies available for traumatic chylothorax.

Methods: A review of selected English literature from 1980 to 2015 was undertaken. Databases used included Pubmed, Cochrane and Science Direct. Publications of both traumatic and postoperative chylothorax were reviewed. The appropriate literature was analysed by comparing and contrasting content with particular emphasis on management issues. Keywords and phrases were used to achieve a streamlined and focused review of the topic.

Conclusion: Chylothorax remains a rare complication of thoracic surgery and thoracic trauma. The potential complications can result in serious morbidity and can even be fatal. Understanding the pathophysiology of a chyle leak underpins the principles of management. The overall success of conservative management ranges from 20% to 80%. The timing of surgical intervention remains debatable. Benefits of early surgical intervention are clearly documented, resulting in a gradual shift toward early operative treatment with reports suggesting thoracic duct ligation yielding a 90% success rate. Technological advances such as thoracic duct embolisation, with a potential success rate of 90%, and thoracoscopic interventions are attractive alternatives to orthodox open surgery.

Contents

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Introduction

Thoracic duct pathology resulting in a chylothorax was initially described in 1633 by Bartolet. Chylothorax is a rare complication of thoracic surgery, in particular after oesophagectomy with an incidence between 0.5% and 3% [1]. Iatrogenic causes in total account for approximately 80% of traumatic causes [2]. Non-iatrogenic traumatic chylothoraces is a rare phenomenon. The incidence in blunt thoracic trauma is said to be 0.2% to 3%, whilst in penetrating trauma it is said to be 0.9% to 1.3% [3]. This condition often presents as a pleural effusion or milky effluent from the thoracic cavity upon insertion of an intercostal chest drain. The thoracic duct is the main vessel responsible for transporting ingested fat from the gastrointestinal tract as well as lymphatic fluid from the peritoneal cavity and lower extremity [2].

Posing formidable challenges to clinicians, the complications of a thoracic duct injury can be fatal in up to 30% of patients [4]. Complications range from cardiorespiratory compromise to profound nutritional, immunological and physiological impairment. The optimal management strategy remains controversial. In this review, the anatomy of the thoracic duct, the physiological and clinical sequela of a chylothorax as well its treatment strategies are considered.

Anatomy

The thoracic duct was discovered in 1651 by the French anatomist Jean Pecquet. His discovery disproved the traditional Galenic theory that chyle was transported by the intestinal vessels directly to the liver [5]. The lymphatic system is composed of lymphatic vessels, lymph nodes, and the cisterna chyli which ultimately gives rise to the thoracic duct. The cisterna chyli is a triangular dilatation of the lymphatic system which is located posterolateral to the abdominal aorta adjacent to the second lumbar vertebra. The duct is 2–3 mm in diameter and varies in length from 36 to 45 cm in length [4]. It travels in a superior direction posterior to the median arcuate ligament of the diaphragm between the aorta and azygos vein. The supra-diaphragmatic position of the thoracic duct is the site favoured for ligation of the thoracic duct as the anatomy at this point is consistent.

In the thorax, the thoracic duct is closely related to the aorto-oesophageal groove as it proceeds superiorly in the posterior mediastinum until it crosses the midline to the left hemithorax between the levels of the fourth to sixth thoracic vertebrae. In the upper thorax, the duct travels posterior to the arch of the aorta and anteriorly to the left subclavian artery and continues to proceed to the cervical region where it turns laterally and inferiorly forming an arch over the scalenus anterior muscle and terminates at the junction of the internal jugular and left subclavian veins [4,6]. This description of the thoracic duct is consistent in 65% of the population; in consequence, significant embryological variations occur. Variations may include different crossover levels as well as several mediastinal trunks. Duct duplication is a common variant which may give rise to a plexus in the mid-portion of the duct and can have varying terminations into the vascular system [2,4–8]. The histology of the thoracic duct has much in common with blood vessels with a more elastic and muscular outer two layers and a relatively inelastic endothelium. There are a number of valves within the duct which become more frequent as it approaches the cervical region where a valve can be found at the lymphatico-venous junction [9].

Physiology of the thoracic duct and chyle

The word chyle is derived from the Latin word chylus meaning juice. The thoracic duct is responsible for the transport of chyle from the intestinal lacteal system, giving rise to the characteristic milky, opalescent appearance, and lymphatic fluid from the peritoneum, abdominal wall and lower extremities. This slightly alkaline fluid forms three layers when allowed to stand: (i) a dense top layer, (ii) an opalescent middle layer and (iii), an acellular sediment [10]. Travelling through the posterior mediastinum, the duct receives lymphatic fluid from the lung parenchyma as well as the pleura. The flow rate through the thoracic duct is highly variable, ranging between 10 and 100 ml/kg body weight per day. On average, chyle flow is in the region of 2.5 l/day [7].

Multiple factors result in the variation of flow including intestinal absorption, dietary fat content, starvation, drug usage and the degree of mobility. Flow within the thoracic duct is augmented by changes in intra-abdominal and intra-thoracic pressures, intra-luminal hydrostatic forces as well as pulsations from adjacent blood vessels. Respiratory diaphragmatic movements as well as parasympathetic stimulation contribute to tone and muscular wall contraction and also aid chyle propulsion [4,9]. Bernoulli's principle of fluid dynamics prompts emptying at the lymphatico-venous interface by negative suction induced through moving blood [9].

The thoracic duct is primarily responsible for the transport of 60–70% of ingested fat, including fat-soluble vitamins, at a concentration of 0.4–0.6 g/100 ml. Small and medium chain triglycerides (<10 carbon atoms) are broken down into free fatty acids and absorbed directly into the portal venous system. The larger triglycerides combine with phospholipids, cholesterol and cholesterol esters to form chylomicrons in the jejunum with a peak level in the systemic circulation about 3 h postprandially [2,11]. Chyle also has a considerable concentration of immunoglobulins and lymphocytes rendering it bacteriostatic. The characteristics and biochemistry of chyle is outlined in Table 1. The electrolyte composition of chyle is similar to that of plasma, the protein concentration inclusive of prothrombin, fibrinogen, globulin and albumin being usually greater than 3 g/100 ml [4,6,7,12,20].

Aetiology of traumatic chylothorax

The first documented case of traumatic thoracic duct injury was described by Quincke in 1875 [13]. The aetiology (Table 2) can be iatrogenic or non-iatrogenic with the majority of iatrogenic cases being associated with oesophageal surgery. Thoracic duct injury has also been reported with diagnostic and therapeutic procedures such as central venous catheterisation and oesophageal variceal sclerotherapy [14,15].

Non-iatrogenic traumatic causes include penetrating trauma from stab or gunshot wounds, blunt thoracic trauma, thoracic spine fractures, posterior rib fractures and supposedly trivial causes such as coughing or sneezing. Relatively minor trauma resulting in ductal injury may also be associated with a postprandial distension of the duct or an underlying ductal