Anatomic variability of the thoracic duct in pediatric patients with complex congenital heart disease

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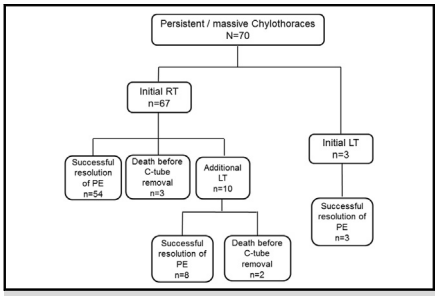
ABSTRACT

Objective: Thoracic duct mass ligation (TDML) through a right thoracotomy (RT), regardless of the side of the pleural effusion, is a standard procedure for chylothorax that is refractory to medical treatment. This procedure may be unsuccessful in patients with complex congenital heart disease, which necessitates additional left thoracotomy (LT) for left periaortic mass ligation. We hypothesized that failure of the right-sided approach is attributable to the anatomic variation of the path of the thoracic duct.

Methods: Of the children who underwent surgery for congenital heart disease between 1992 and 2014, a total of 70 of 8880 (0.8%) underwent TDML by RT (n = 57) or LT (n = 13; LT after RT in 10, and primary LT in 3).

Results: Persistent chylothorax was successfully resolved in 65 patients (65 of 70; 93%) within 15 days (2-79 days) after the first or second TDML; 5 patients died with a chest-tube(s) in situ. After excluding mortality without chest-tube removal, we sought to identify the risk factor(s) necessitating LT in 65 patients (RT group: 54; LT group: 11). On logistic regression analysis, the LT group was more likely to have dextrocardia (odds ratio: 6.38; 95% confidence interval: 1.09-37.25; $P = .04$). The incidence of abnormal atrial situs, great arterial malposition, right descending thoracic aorta, and bilateral superior vena cavae were comparable in the 2 groups.

Conclusions: The path of the thoracic duct may vary in pediatric patients with complex congenital heart disease. Left periaortic mass ligation should be considered in patients with chylothoraces that persist after the right-sided approach, especially in patients with dextrocardia. (J Thorac Cardiovasc Surg 2015;150:490-6)



Outcome of thoracic duct mass ligation for postoperative chylothoraces in 70 patients.

Central Message

If right-sided thoracic duct mass ligation for chylothorax fails in patients with congenital heart defects, especially dextrocardia, a left-sided approach should be considered.

Perspective

Thoracic duct mass ligation through a right thoracotomy is standard procedure for chylothorax that is refractory to medical treatment. However, this procedure is frequently unsuccessful in patients who have complex congenital heart disease, possibly because of the anatomic variation of the thoracic duct pathway. Left periaortic mass ligation should be considered in this setting.

See Editorial Commentary page 497.

Chylous pleural effusion after pediatric cardiac surgery is a life-threatening complication that leads to long hospital stays and sometimes death.[1,2] Recent studies have reported that the incidence of chylothorax after pediatric cardiac surgery ranges from 0.89% to 6.6%.[1-6] Conservative measures, including enteral nutrition enriched with medium-chain triglycerides, total parenteral nutrition, and pharmacologic therapy to restrict mesenteric blood supply,[5] are generally considered for initial treatment.[4,6]

If conservative treatment fails, surgical intervention is needed. Among the various surgical methods for persistent chylothorax,[7-9] thoracic duct mass ligation (TDML) via right thoracotomy (RT), ie, right periaortic tissue mass ligation, is regarded as the standard procedure for prolonged and massive chylous effusion.[6,10-12] However, information regarding the postoperative outcome after TDML in pediatric patients is limited. The rationale for RT in TDML is based on the usual anatomic path of the thoracic duct, which traverses the diaphragm through the aortic hiatus, through the aortic hiatus along the right side of the descending thoracic aorta. Therefore, the success of the right-sided approach depends on the right periaortic path of the thoracic duct being at the level of the diaphragm.

Given that complex congenital heart defects are frequently associated with variations in the path of the thoracic duct,[13-16] the right-sided approach for TDML may not be successful in patients who have a thoracic duct with a reversed or bilateral path. We hypothesized

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Abbreviations and Acronyms
LT = left thoracotomy
RT = right thoracotomy
TDML = thoracic duct mass ligation

that failure of the right-sided approach may be attributable to anatomic variations of the thoracic duct. We sought to determine the risk factors that require the left-sided approach for TDML.

METHODS

Study Populations

Between January 1992 and July 2014, a total of 298 of 8880 (3.3%) children who underwent cardiac surgery for congenital heart disease at our institution were diagnosed as having chylothorax. Among these patients, 70 of 8880 (0.8%) with persistent and massive chylothoraces underwent TDML. Standard right periaortic tissue mass ligation through a RT was performed in most of these patients (n = 67); the primary left-sided approach through a left thoracotomy (LT) was used in 3 patients who had massive left-sided chylothorax. The decision to perform TDML primarily by LT, rather than RT, was made at the discretion of the attending surgeons. Among the 67 patients who underwent RT, additional LT for left periaortic tissue mass ligation was performed in 10 patients who had persistent (>7 days) and extensive (50 mL/kg/day) pleural effusion. Therefore, a standard right-side approach was used for 57 patients, and a primary or secondary left-side approach was used for 13 patients. Demographic data, cardiac morphology, characteristics of chylous drainage, and postoperative outcomes were compared between the 2 groups. This study was approved by our institutional review board (No. S2015-0500), and the need for informed consent was waived because the study is retrospective.

Thoracic Duct Mass Ligation

Laboratory diagnosis of chylothorax was confirmed at the median interval of 9 days (range: 2-110 days) after the initial operation, when the triglyceride level in the pleural fluid exceeded 110 mg/dl.[17] Chylothoraces were initially managed using various conservative measures, including total parenteral nutrition, enteral nutrition enriched with medium-chain triglycerides, and octreotide therapy. Determination of the duration and types of conservative management before TDML was based on the amount and the side of pleural drainage, comorbidities (eg, capillary leakage syndrome, hepatic and renal dysfunction), and more importantly, individual surgeon preference.

Thoracic duct mass ligation was indicated for prolonged (>2 weeks) or excessive pleural effusion (>50 mL/kg/day) despite conservative management. For TDML via RT, mass ligation of all the tissue between the aorta and the azygos vein, at the level of the diaphragm, was carried out through posterolateral RT via the sixth or seventh intercostal space. For TDML via LT, the posterolateral LT was carried out through the 6th or 7th intercostal space.

The inferior pulmonary ligament was divided, and the left lung was retracted superiorly. Mass ligation of the left half (180°) of the periaortic tissue at the level of the diaphragm was performed; extreme caution was used to protect the phrenic and vagus nerves. Seventeen patients (17 of 65; 26.1%) underwent either chemical (n = 3) or mechanical (n = 9), or both chemical and mechanical (n = 5), pleurodesis upon TDML. No intergroup difference was found ($P = .26$) in the proportion of patients with pleurodesis: 12 of 54 (22.2%) in the RT group versus 5 of 11 (45.4%) in the LT group. Dietary restrictions such as institution of total parenteral nutrition, or a low-fat diet, were routinely imposed for all patients during the immediate postoperative period.

Statistical Analysis

Categoric variables are presented as frequencies or percentages, and the intergroup difference of the variables of interest was analyzed using Fisher's exact test. Continuous variables are expressed as medians with ranges, and the intergroup difference of the variables of interest was analyzed using the Wilcoxon rank-sum test or the Mann-Whitney *U* test, as appropriate. To identify the risk factors that require left periaortic mass ligation, the logistic regression model was fitted. All reported *P* values were 2-sided. For statistical analysis, SPSS, version 12 (SPSS, Inc, Chicago, Ill) was used.

RESULTS

The clinical courses of all patients with TDML (n = 70) are summarized in Figure 1. Five patients died before their chest tubes were successfully removed (5of 70; 7.1%: 3 died after RT; and 2 died after the LT that came after RT). The causes of death included sepsis (n = 2), capillary leak syndrome (n = 2), and low cardiac output (n = 1). After excluding these 5 patients, data from 65 patients were used for analysis. Chylothoraces were successfully resolved after RT in 54 patients (RT group), whereas primary or secondary LT was required in 11 patients (LT group). The demographic data of these 65 patients are presented in Table 1. The median age and median weight at the time of the initial cardiac surgery was 172 days (range: 0 days- 62 months) and 6 kg (range: 1.5-15.3 kg), respectively.

The laboratory diagnosis of chylothorax was confirmed at 9 days (range: 2-110 days) after the initial operation, and the first TDML was performed after a median duration of 13 days (range: 0-64 days) after the laboratory diagnosis of chylothorax with a maximal drainage of 42 mL/kg/day (range: 7-232 mL/kg/day). A gradual decrease in drainage occurred after primary or secondary TDML, and the chest tubes were removed, usually within 15 days (range: 2-79 days) after the first TDML, when the pleural drainage became < 2 to 3 cc/kg/day. With respect to the initial cardiac operations, the number of patients who underwent an arterial switch operation was higher in the LT group (45.4% in the LT group vs 7.4% in the RT group; $P = .01$).

The clinical characteristics of the patients who underwent primary or secondary left periaortic mass ligation are summarized in Table 2. Three patients underwent primary TDML through LT for persistent left chylothrax: one was a premature baby (23^{+4} weeks' of gestation; birth weight of 570 g) with an atrial septal defect who had delayed chylous effusion in the left side 4 months after the closure of the atrial septal defect; the other 2 patients had complex congenital heart defects and dextrocardia. Determination to use primary TDML through LT was based on pleural effusion being on the left side, the presence of dextrocardia, and individual surgeon preference.

Eight patients underwent secondary left periaortic mass ligation after the right-sided approach, at a median of 7