Original Article

Management of chylothorax and chylopericardium in pediatric patients: experiences at Siriraj Hospital, Bangkok

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Chylothorax and chylopericardium are rare conditions occurring in infants and children. Both may be traumatic or nontraumatic in origin. We reviewed our experiences with the management of sixteen pediatric cases (10 males, 6 females; 11 days to 14 years old) of chylothorax and chylopericardium from 1997 to 2003. There were fifteen cases of chylothorax (9 left, 2 right, 4 bilateral) and two cases of chylopericardium (1 isolated and 1 associated with chylothorax), and their incidences of occurrence after cardiothoracic surgery were 0.89% and 0.12%, respectively. Of the fifteen cases occurring after cardiothoracic surgery, thirteen patients had corrective or palliative surgery for complex congenital heart disease, and two patients had removal of thymolipoma and neuroblastoma, respectively. Included also in this review was an 11-day old preterm infant with hydrops fetalis and congenital heart disease who developed chylothorax. Characteristics of chylous effusion included a presence of whitish opaque fluid in the pleural cavity and the pericardial cavity, having a triglyceride content ranging from 59 to 1689 mg/dl which was higher than a plasma triglyceride, a protein content of 2.4 to 7.4 g/dl, and a presence of lymphocyte predominance. The average latent period for diagnosis of chylothorax or chylopericardium was 13 days (range 3–30). All patients were treated primarily with nutritional modification using medium-chain triglycerides (MCT) instead of long-chain triglycerides in their diet; and only a few cases needed bowel rest with total parenteral nutrition (TPN). Twelve patients completely responded to a MCT-rich diet; two cases resolved after switching to TPN and another case needed surgery for ligation of lymphatic vessels around the thymus gland. The mean duration of lymph drainage was 12.1 days (range 3-29) and the average length of time of continued conservative treatment (MCT-rich diet and TPN) was 29.8 days (range 18–47). Fourteen patients (87.25%) had good outcome, i.e. resolution from chylothorax or chylopericardium and return to normal diet. Two of the fourteen patients developed severe infections; one was diagnosed with suspected bacterial endocarditis and the other had candidemia. However, both responded well to antibacterial and antifungal drugs, respectively. One case succeeded after surgery. A case that had low compliance with dietary recommendations and required repeated placement of drainage devices died due to infection with enterococcal septicemia. Early and good compliance with MCT-rich diet is essential for achieving a favorable outcome in the management of chylothorax and chylopericardium in children.

Key Words: chylothorax, chylopericardium, total parenteral nutrition, MCT-rich diet, pediatric, Bangkok, Thailand

Introduction

Chylothorax, which is an effusion of lymph in the pleural cavity, and chylopericardium, an effusion of lymph in the pericardial cavity, are characterized by fluid with a milky appearance due to high triglyceride content and the presence of chylomicron as detected by lipoprotein electrophoresis.[1-3] The etiology of chylothorax can be divided into two categories: nontraumatic and traumatic.[4] Nontraumatic chylothorax is frequently caused by a malignant tumor and infection. Lymphoma, also the most common etiology of chylothorax in the nontraumatic category, is the main malignant cause; other nonlymphomatous malignancies are the result of metastatic cancers from other organs.[2] Other rare causes of nontraumatic chylothorax include lymphangiectasis, lymphangioleiomyomatosis,[5,6] thrombosis of the superior vena cava resulting in elevation of systemic venous pressure transmitted back into the lymphatic system,[7] congenital chylothorax, and malformation of the thoracic lymphatic system.[8-10] Traumatic chylothorax is commonly resulted from postintrathoracic

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operation, which is a principal cause of chylothorax in children.[9,11] The direct laceration of the thoracic duct from penetrating injury and fracture may be another cause of traumatic chylothorax. Chylopericardium, as well as chylothorax, is a rare complication following surgery for congenital heart disease that is complicated by elevated venous pressure or trauma to the thoracic duct. Such cases may be diagnosed as either isolated chylopericardium or concurrent with chylothorax.[12,13]

In childhood, the incidence of postoperative chylothorax varies from 0.56% to 1.9%.[14] Chylopericardium after cardiac surgery is very rare and was reported in only one to three cases (0.22%) of a 12-year review of 16 children.[12] In Thailand, only one case report of congenital chylothorax has been described[15] and the incidences of chylothorax and chylopericardium in children remain unknown. In this study we reviewed a group of pediatric patients diagnosed as chylothorax or chylopericardium and the incidences, etiologies, therapeutic management, and outcomes of these cases were reported.

Materials and methods

We retrospectively reviewed the medical records of 16 pediatric patients who were diagnosed as chylothorax or chylopericardium at Siriraj Hospital between January 1997 and March 2003. The diagnosis of chylothorax and chylopericardium was made clinically by the presence of milky drainage fluid from the pleural and pericardial cavity respectively and confirmed by analyzing the fluid for the following parameters: triglyceride level in the drainage fluid >110 mg/dl, a predominance of lymphocyte, sterile in culture. Pediatricians from the Nutrition Division were consulted to co-manage these cases with the pediatric cardiologists and cardiothoracic surgeons. Initial treatment of both conditions included pleural or pericardial drainage and use of a MCT-rich diet that limited the intake of long-chain triglycerides. All sixteen patients were nutritionally treated with non-fat milk or food supplemented with MCT oil, vitamins and minerals. The diet was given for at least 28 days in each case, unless there was no positive response to the diet, in which case TPN or surgery was considered. The use of total parenteral nutrition with bowel rest was started when there was re-accumulation of chyle or no improvement 1 to 2 weeks after MCT-rich diet treatment. Surgical procedures included pleurodesis or ligation of the thoracic duct when TPN was unsuccessful.

Results

Demographic data, underlying diseases and procedures before the occurrence of chylothorax or chylopericardium were illustrated in Table 1. The ages of sixteen children (10 males and 6 females) who were diagnosed as chylothorax or chylopericardium ranged from 11 days to 14 years. Most of them had underlying complex congenital heart diseases treated by corrective or palliative surgery; two cases diagnosed with thymolipoma and neuroblastoma had undergone tumor removal. One case was a preterm infant with hydrops fetalis and congenital heart disease. Chylothorax occurred in fifteen patients; nine of left side, two of right side and four of both sides whereas chylopericardium was found in two cases who underwent bidirectional cavopulmonary anastomosis and a modified Fontan operation.

Table 2 showed the characteristics of chylous effusion of each patient. Most of them presented with whitish opaque fluid. The chylous fluid was analyzed for triglyceride level (compared to that of serum), protein content and white cell count including cell type. Triglyceride levels in the chylous fluid ranged from 59 to 1689 mg/dl, which were higher than serum triglyceride concentrations except in case 16. Protein contents varied from 2.4 to 7.4 g/dl. The white blood cell count varied from 90 to 30500 cells/mm^3 and was lymphocyte-predominant (range 50-100%). There were several methods used for the treatment of chylothorax or chylopericardium which included chylous drainage to relieve the effect of pressure on the lungs and heart, the conservative treatment and surgical intervention. Thoracocentesis was done in three cases of chylothorax and followed by intercostal drainage; the others only underwent intercostal drainage (Table 3). In the first case, repeated pericardiocentesis relieved the symptoms of cardiac tamponade whereas in case 2, a placement of a pericardial catheter for continuous complete drainage was required. Initially, all were treated by nutritional therapy with MCT-rich diet given by oral or enteral routes. Three of sixteen patients had to be starved and received TPN after MCT-rich diet due to no cessation of drainage. Two patients failed to improve with the conservative treatment and underwent surgical procedures, which included ligation of the thymus gland after unsuccessful pleurodesis because of excessive leakage from lymphatic vessels around the thymus gland, and ligation of the thoracic duct.

The interval between the surgical procedure and diagnosis of chylothorax or chylopericardium ranged from 3 to 30 days (mean 13) and the diagnosis of chylothorax in the case of the preterm infant was made 11 days after birth. In order to definitely diagnose and completely drain chylothorax and chylopericardium, the physicians must perform thoracocenthesis or insert chest tube in dwelling, perform pericardiocentesis or put a pericardial catheter in place. If these conditions were detected, nutritional modification should be initiated promptly. Lymph drainage took an average of 12.1 days (range 3-29) and conservative treatment lasted an average of 29.8 days (range 18 - 47) in cases having good outcome.

The outcome of various treatments for chylothorax and chylopericardium are as follows: resolution after conservative treatment, success following surgery, and occurrence of complication and death. Fourteen patients (87.5%) with chylothorax or chylopericardium recovered after treatment with conservative treatment and could later consume a normal diet without re-accumulation of chyle. Two of the patients developed fungal and bacterial infections. Case 8 had Candida-positive blood culture after MCT-rich diet for 9 days and TPN via a central catheter for 6 days. Case 12 developed suspected bacterial endocarditis, new vegetation at a pulmonic valve but negative hemoculture, after repeated insertion of the intercostal catheter three times due to its accidental displacement and loculated effusion. Both infections resolved with antifungal and antibacterial drugs, respectively.

Table 1. Underlying diseases and procedures in 16 patients with chylothorax or chylopericardium.

Patient No	Age	Sex	Underlying diseases	Procedure	Presence of chylothorax and/or chylopericardium
1	7 mo	M	TA, d-TGA, VSD, ASD	Bidirectional cavopulmonary anastomosis	Chylopericardium
2	5 y	M	TA, ASD, PS, VSD	Modified Fontan operation	B chylothorax, chylopericardium B
3	5 y	F	DORV, VSD, PS, ASD, IVC interruption, bilateral SVC	(1st) Total repair (intraventricular tunnel supraannular pericardial patching), enlargement of VSD, closure of ASD	B chylothorax
				(2nd) Detachment of left SVC, end-to-side anastomosis to left PA.	B chylothorax
4	6 y	M	TOF, ASD	Total correction	B chylothorax
5	10 y	M	Common atrium, common ventricle, d-TGA, PS post RMBTS	Extracardiac Fontan operation	L chylothorax
6	14 y	F	TOF	Total correction	L chylothorax
7	1 y	M	VSD, PDA, CoA	Closure of VSD and ligation of PDA	L chylothorax
8	6 mo	M	Common ventricle, dextrocardia, situs inversus	Bidirectional cavopulmonary anastomosis, division of MPA, ligation of PDA, atrial septectomy	L chylothorax
9	8 mo	M	Common atrioventricular canal	Total correction	L chylothorax
10	6 y	F	Common atrium, common ventricle, dextrocardia post bidirectional cavopulmonary shunt	Modified Fontan operation	R chylothorax
11	5 y	F	TOF	Total repair	R chylothorax
12	2 y	M	TOF	Total correction	L chylothorax
13	7 y	F	Down syndrome, TOF, ASD	Total repair, closure ASD	L chylothorax
14	8 y	M	Thymolipoma	(1st) Thymectomy	
				(2nd) Clot removal, suture of bleeding point	L chylothorax
15	4 y	F	Neuroblastoma	Total tumor removal	L chylothorax
16	11 d	M	Preterm infant (32 wk GA), hydrops fetalis, ASD, PDA		

F = female, M = male, TA = tricuspid atresia, d-TGA = d-type transposition of great arteries, VSD = ventricular septal defect, ASD = atrial septal defect, TOF = Tetralogy of Fallot, CoA = coarctation of aorta, DORV = double-outlet right ventricle, PS = pulmonary stenosis, IVC = inferior vena cava, RMBTS = right modified Blalock-Taussig shunt, AGA = appropriate for gestational age, GA = gestational age, L = left, R = right, B = bilateral

Table 2. Characteristics of chylous effusion

Patient No.	Triglyceride (mg/dl)		Protein (g/dl)	Cell (/mm^3)	Lymphocyte (%)
	Chylous effusion	Serum			
1	1689	NA	7.4	19300	100
2	Rt 331, Lt 125, Pericardial 120	138	3, 4.1, 4.6	90, 5600, 540	99, 98, 100
3	791	NA	2.6	3400	NA
4	147	91	NA	NA	NA
5	197	69	4	30500	50
6	634	102	5.3	14440	93
7	181	NA	2.6	4220	NA
8	1381	NA	6	NA	NA
9	948	NA	3.1	475	100
10	190	109	2.4	NA	NA
11	158	NA	4.4	NA	NA
12	625	143	NA	980	99
13	362	142	5.8	4350	100
14	223	NA	3.1	340	80
15	1368	NA	NA	NA	NA
16	1, 45, 59	77, NA	2.7	3750	96

NA = not available

Table 3. Methods and duration of treatment and outcomes of 16 patients with chylothorax or chylopericardium

Patient No.	Chylous drainage					Conservative treatment		Surgical treatment	IT (day)	D_1 (day)	D_2(day)	D_3 (day)	Outcome
	TC	TC+CD	CD	PC	PD	MCT-rich diet	TPN (after MCT)						
1				+ (2)		+			13	-	24	24	Resolve
2			+		+	+			30	4, 7, 4,	28	28	Resolve
3			+			+	+	Ligation of the thoracic duct	9	9	34, 12	-	Die with septicemia
													Resolve
4			+			+			10	19, 20	34	34	Resolve
5			+			+			13	7	28	28	Resolve after
6			+			+		Pleurodesis and -ligation of the thymus gland	18	10	10	12	surgery
													Resolve
7			+			+			9	7	18	18	Resolve
8			+			+	+		8	22	42	42	Resolve
9			+			+			3	11	30	30	Resolve
10			+			+			9	3	31	31	Resolve
11		+				+			23	15	30	30	Resolve
12		+				+			5	14	28	28	Resolve
13		+				+			20	16	31	31	Resolve
14			+			+			25	18	26	26	Resolve
15			+			+			6	3	20	20	Resolve
16			+			+	+		10	29	47	47	

TC = thoracocentesis, CD = continuous intercostal drainage, PC = pericardiocentesis, PD = pericardial drainage, MCT = medium-chain triglyceride, TPN = total parenteral nutrition, IT = interval either between operation and diagnosis or between birth and diagnosis of chylothorax or chylopericardium,- D_1 = duration of drainage tube indwelling after conservative treatment, D_2 = duration of conservative treatment
D_3 = duration of complete treatment

One patient (6.25%), case 6, required surgical management. One of the sixteen cases, case 3, resulted in death. She not only had low diet compliance, but also required the repeated placement of an intercostal catheter. She developed a high fever even before the ligation of the thoracic duct and died from sepsis 52 days after presenting with bilateral chylothorax. Sepsis was con-firmed with enterococci-positive hemoculture in four specimens.

Discussion

In this study, we reviewed fifteen pediatric cases that were diagnosed as chylothorax; most of them presented after undergoing cardiothoracic surgery whereas one case had congenital chylothorax, and two patients of chylopericardium. The incidence of pediatric post-operative chylothorax and chylopericardium following 1683 cardiothoracic procedures on children at Siriraj Hospital were 0.89% and 0.12%, respectively during a review of cases from the past 6 years. One study reported the incidence of chylothorax of 0.56% to 1.9%.[14] Another report demonstrated the incidence of chylopericardium of 0.22%.[12] Like several reports,[1-9,11,12,16] we found that the most common etiology of chylothorax and chylopericardium in children was cardio-thoracic surgery resulting from an inadvertent cutting of the large tributaries of the thoracic duct or, less frequently, from injury to the thoracic duct.[17] This finding is in contrast to a study presenting three of four children with chylopericardium secondary to mediastinal lymphangiomahygroma and one following cardiac surgery.[18] In our study the most common cause of chylothorax was an operation for total correction of tetralogy of Fallot, whereas one study reported chylothorax following surgery for the resection of a coarctation of the aorta.[16] Chylothorax also occurred following the surgery of systemic to pulmonary shunts, PDA ligation, complex intracardiac repairs, and removal of thymolipoma and mediastinal neuroblastoma. This report documented that the surgical procedures leading to the occurrence of chylopericardium were bidirectional cavopulmonary anastomosis and modified Fontan procedure for tricuspid atresia. Another study presented chylopericardium in 16 children following cardiac surgery.[12] Chylopericardium occurred frequently following superior cavopulmonry or total cavopulmonary anastomosis, atrioventricular septal defect repair and repair of tetralogy of Fallot. Chylothorax that is complex and difficult to manage, accompanied by chylopericardium, usually occurs following operations through a median sternotomy incision such as in venous switch procedures for TGA, superior vena cavaright pulmonary artery anastomosis, and the Fontan procedure.[17] In this study, a case of refractory chylothorax (case 6), which was unresponsive to conservative treatment, was then approached surgically and the finding showed there was effused chyle leaking from lymphatic vessels in the thymus gland. The chylothorax probably resulted from the combination of the inevitable transection of very small lymph channels (probably in the thymus gland) and the elevation of superior vena caval pressure.[17]

A diagnosis of chyle in our patients was based on the examination criteria of pleural and pericardial fluid.[1-4] Initially, a clue for diagnosis chylous effusion was the milky appearance of the fluid acquired by thoracocentesis, intercostal tube placement, pericardiocentesis, or pericardial tube indwelling. All cases that had whitish, opaque, variously turbid fluid were suspected. Secondly, biochemical parameters and cellular component were obtained. Triglyceride contents of chylous fluid were measured in all patients even though serum triglyceride analysis was done in 8 cases; triglyceride concentrations were higher than 110 mg/dl and greater than the serum triglyceride levels except in case 16. In this case, an early pleural effusion was still straw-colored, not turbid due to starvation, which correspondded to its low triglyceride value. While he was originnally consuming little volume of a semi-elemental formula containing 50% MCT and 50% LCT, his pleural effusion appeared more turbid and had a higher triglyceride level. A triglyceride level greater than 110 mg/dl highly suggests chyle, whereas a level less than 50 mg/dl usually rules it out, unless the patient has no enteral fat intake. If the triglyceride level is indeterminate, between 50 and 110 mg/dl, lipoprotein electrophoresis is required.[2,3,19] Thus, the milky aspect can only serve as a hint for further investigations.[11] Protein contents in chylous effusion, one of the biochemical parameters, were usually greater than 3 g/dl (range 2.4-7.4). In this data, electrolyte concentrations were not evaluated. Although the cell counts and the percentage of lymphocytes were not measured in all cases, we found that lymphocytes were still the major cellular component of chylous effusion in an average of 90% (range 50-100). Chylothorax typically contains lymphocytes of 400-6800/μl, predominantly of the Tcell type.[2,16] Thirdly, all chylous specimens were cultured to confirm aseptically and our data initially showed that they were sterile (data not shown). Finally, lipoprotein electrophoresis showing a chylomicron band was unavailable in our data.

The latent period, or the time between trauma to the thoracic duct or its tributaries and the development of chylous effusion, which leads to the diagnosis of chylothorax or chylopericardium is variable. This interval is usually 2 to 10 days; however, it may be weeks to months. The reasons for delayed diagnosis probably were the decreased oral intake, limited patient movement during the early postoperative period and slow accumulation of chyle.[19] In the postoperative group, this period ranged from 3 to 30 days (mean 13.4) from the time of cardiothoracic procedure. The report of fifty-one children with chylothorax showed that the latent interval was significantly shorter in cases of direct injury to the thoracic duct than in cases of having thrombosis and/or high venous pressure in the superior vena cava (7.3 ± 1 versus 14 ± 2 days, $P < 0.005$).[1] These cases illustrated that an increased central venous pressure was transmitted to the lymphatic system.[20] A patient with isolated chylopericardium presented the symptoms of cardiac tamponade 13 days after cardiac surgery compared to another case with chylopericardium associated with chylothorax which was diagnosed late (30 days). This is in contrast to one study, which found that patients with isolated chylopericardium tended to present symptoms late (17 versus 14.5 days).[12]

On diagnosis, malnutrition, metabolic and immunologic abnormalities should be considered. The conservative treatment with oral or enteral MCT-rich diet accompanying the adequate draining of the pleural space and pericardial space (in order to provide lung expansion, decrease cardiac tamponade, and reduce the lymph flow) should be early managed. Successfully conservative treatment occurred in twelve patients. Two patients were completely cured after they were switched from conservative management to enteric rest and use of TPN. Surgical treatment with pleurodesis and ligation of lymphatic vessels around the thymus gland was successfully performed in case 6 after failure of conservative management. One case failed by treatment with MCT diet, TPN and ligation of thoracic duct and finally died from an associated complication. The conservative treatment was effective in 87.5% of our study compared to 80% of another study.[1] Usually, initial therapy for chylothorax and chylopericardium consists of decompressing the pleural and pericardial cavity and use of MCT-rich oil, fat-free oral alimentation.[1,2,11] When conservative treatment reduced the chyle loss, the nutritional state was maintained.[21] MCT-rich diet not only provides adequate nutrition, but also decreases the lymph leak in order to support healing. If lymphatic effusion does not decrease, oral or enteral feeding should be stopped and TPN should be initiated. There was a recommendation that the indications for surgical approach included the following: (1) the chyle loss of more than 100 ml/kg/year of age in children for a 5-day period, (2) no decrease of chyle flow after 14 days of conservative treatment, or (3) an evidence of nutritional complications.[22] Several authors recommended that surgical treatment should be performed after no response to 4 weeks of conservative treatment because most patients responded to the conservative treatment within 30 days.[1,14,23] Our data showed that the duration of lymph drainage ranged from 3 to 29 days and the response of those who continued conservative treatment varied from 18 to 47 days. A case of refractory chylothorax (case 3) may be caused by high pressure in SVC, low compliance of diet control and secondary bacterial infection, in spite of a presence of previously sterile chylous pleural fluid, from repeated intercostal tube placement leading to pneumonia, bacteremia, and eventual death. Thus, secondary infection is another danger that can result in late complication such as loculation of the effusion. In our experiences, other complications including skin rash resulting from essential fatty acids deficiency and lymphopenia did not occur.

In conclusion, early recognition of chylous leakage, prompt treatment with a MCT-rich diet and good compliance are still found to be effective in the initial management of chylothorax and chylopericardium leading to favorable outcome without complications.

References

1. Beghetti M, La Scala G, Belli D, Bugmann P, Kalangos A, Le Coultre C. Etiology and management of pediatric chylothorax. J Pediatr 2000; 136: 653-8.
2. Valentine VG, Raffin TA. The management of chylothorax. Chest 1992; 102: 586-91.
3. Panitch HB, Papastamelos C, Schidlow DV. Abnormalities of the Pleural Space. In: Taussig LM, Landau LI, eds. Pediatric Respiratory Medicine. St. Louis: Mosby, Inc, 1999; 1178-96.
4. Efrati O, Barak A. Pleural effusions in the pediatric population. Pediatr Rev 2002; 23: 417-26.
5. Carrington CB, Cugell DW, Gaensler EA, Marks A, Redding RA, Schaaf JT, Tomasian A. Lymphangioleiomyomatosis. Physiologic-pathologic-radiologic correlations. Am Rev Respir Dis 1977; 116: 977-95.
6. Taylor JR, Ryu J, Colby TV, Raffin TA. Lymphangioleiomyomatosis. Clinical course in 32 patients. N Eng J Med 1990; 323: 1254-60.
7. Dhande V, Kattwinkel J, Alford B. Recurrent bilateral pleural effusions secondary to superior vena cava obstruction as a complication of central venous catheterization. Pediatrics 1983; 72: 109-13.
8. Stringel G, Mercer S, Bass J. Surgical management of persistent postoperative chylothorax in children. Can J Surg 1984; 27: 543-6.
9. Bond SJ, Guzzetta PC, Snyder ML, Randolph JG. Management of pediatric postoperative chylothorax. Ann Thorac Surg 1993; 56: 469-73.
10. Chernick V, Reed MH. Pneumothorax and chylothorax in the neonatal period. J Pediatr 1970; 76: 625-32.
11. Buttiker V, Fanconi S, Burger R. Chylothorax in children: guidelines for diagnosis and management. Chest 1999; 116: 682-7.
12. Campbell RM, Benson LN, Williams WW, Adatia I. Chylopericardium after cardiac operations in children. Ann Thorac Surg 2001; 72: 193-6.
13. Rheuban KS. Pericardial Disease. In: Allen HD, Clark EB, Gutgesell HP, Driscoll DJ, eds. Moss and Adams' Heart Disease in Infants, Children, and Adolesents: Including the Fetus and Young Adult. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2001; 1287-96.
14. Le Coultre C, Oberhansli I, Mossaz A, Bugmann P, Faidutti B, Belli DC. Postoperative chylothorax in children: differences between vascular and traumatic origin. J Pediatr Surg 1991; 26: 519-23.
15. Lim N, Lekchunsakul K, Yantadelok T. Congenital chylothorax: a case report. Thai J Pediatr 2001; 40: 34-6.
16. Fairfax AJ, McNabb WR, Spiro SG. Chylothorax: a review of 18 cases. Thorax 1986; 41: 880-5.
17. Kirklin JW, Barratt-Boyes BG.- Cardiac Surgery. 2nd ed. New York: Churchill Livingstone, 1993; 195-248.
18. Chan BB, Murphy MC, Rodgers BM. Management of chylopericardium. J Pediatr Surg 1990; 25: 1185-9.
19. Seilheimer DK, Fakhoury KF. Pulmonology. In: Garson A Jr, Bricker JT, Fisher DJ, Neish SR, eds. The Science and Practice of Pediatric Cardiology. 2nd ed. Baltimore: Williams & Wilkins, 1998; 2813-32.
20. Szabo G, Magyar Z. Effect of increased systemic venous pressure on lymph pressure and flow. Am J Physiol 1967; 212: 1469-74.
21. Puntis JW, Roberts KD, Handy D. How should chylothorax be managed? Arch Dis Child 1987; 62: 593-6.
22. Selle JG, Snyder WH, Schreiber JT. Chylothorax: indications for surgery. Ann Surg 1973; 177: 245-9.
23. Allen EM, van Heeckeren DW, Spector ML, Blumer JL. Management of nutritional and infectious complications of postoperative chylothorax in children. J Pediatr Surg 1991; 26: 1169-74.