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Chylothorax complicating adult cardiovascular surgery: Multi-centres experience

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ABSTRACT

Background: Chylothorax is a rare complication after adult cardiovascular surgery. Chylothorax directly affects postoperative course and morbidity. *Methods:* Data for this prospective study was collected between July 2017 and August 2021. Twenty patients who had adult cardiac surgery were included in our study. Demographic characteristics, operative and postoperative data were collected and analyzed. Somatostatin injections were used to control chyle leakage. Failure of conservative treatment was the indication of surgery. *Results:* This study included 20 patients, 13 males and 7 females, who recently underwent adult cardiovascular surgery. The mean age was 47.7±13.27 years. The mean duration for chyle effusion was 4.35±1.98 days, while the mean duration of drainage was 12.15±2.56 days. Analysis of pleural fluid revealed mean pH value = 7.3±0.05, mean total protein =2.7±0.3 g/dL, mean pleural glucose concentrations =123±33 mg/dl, mean cholesterol level =43±17 mg/dL, mean triglyceride level =489±39 mg/dL, and mean chylomicron level =7±0.4 mg/dl. There was a statistical significance regarding the response of postoperative chylothorax to somatostatin therapy (p=0.001). Surgery (mass ligation) was indicated in 4 cases secondary to failure of conservative treatment. There was a significant difference between ICT drainage/day in patients who were managed conservatively and those who were managed surgically (p =0.0001). *Conclusion:* Chylothorax is more common following CABG and Aortic arch surgeries, and it has a significant impact on the postoperative course and morbidity. The diagnosis and therapy should be initiated as soon as possible. Conservative management is feasible in 80% of cases.

Keywords: chylothorax, adult cardiac surgery, somatostatin.

1. INTRODUCTION

Chylothorax is a very uncommon complication of adult heart surgery. It is frequently observed following congenital heart surgery. It occurs in adults at a rate that may reach up to 0.5%, whereas it occurs at a rate of up to 5% in children (Riquet et al., 2002). It may cause severe complications related to chyle leak into the pleural cavity, including respiratory complications resulting from lung collapse, starvation and electrolyte imbalance, and sepsis (Bojanapu & Khan, 2021). The presence of chylomicron in pleural fluid, in

conjunction with low cholesterol and increased triglycerides, can be used to perform a diagnostic test (Nordestgaard & Varbo, 2014). From a surgical standpoint, chylothorax could be classified as traumatic or non-traumatic. Traumatic chylothorax is caused by direct damage of the thoracic duct or one of its lymphatic branches, such as damaging the thoracic duct during cardiopulmonary bypass cannulation, surgical trauma to the thoracic duct, and/or disruption of accessory lymphatic vessels during dissection. It might also occur when the central venous pressure is elevated (greater than lymphatic pressure) after partial or complete cavo-pulmonary anastomosis and after central venous thrombosis (both are preventing the normal flow of the thoracic duct) (Aspelund et al., 2016). Non-traumatic chylothorax could be due to poor hemodynamics, lymphatic vessel malformation, or congenital genetic disorders such as Turner syndrome and Noonan syndrome (Ok et al., 2018).

The primary goals of post-surgical chylothorax management are to reduce respiratory symptoms by draining the pleural space and preventing or minimizing chyle accumulation. Management strategies depend on the etiology, rate of effusion accumulation, volume, and the associated diseases and comorbidities. Traditional conservative treatments included diet changes and octreotide infusions, while surgical procedures included thoracic duct mass ligation and pleurodesis (Ok et al., 2018). Conservative treatment is used first in all situations, whileinterventional therapy is applied for resistant cases (Kelly et al., 2020). The current study reports our experience in managing patients following adult cardiac surgery complicated by chylothorax at Zagazig and Benha University Hospitals.

2. METHODS

Study design

This prospective study included 20 patients who had chylothorax following adult cardiovascular surgery at Zagazig and Benha University Hospitals, Egypt, between July 2017 and August 2021. Data on demographic characteristics, operative and postoperative data, and management of chylothorax were carefully collected and analyzed. The statistical analysis was achieved by using SPSS 20.00 software package (Chicago, IL, USA). Continuous variables were shown as means and standard deviations. Pearson χ^2 test and Fischer's exact test were utilized to compare categorical variables. Student's *t*-test was used to compare continuous variables. A P value less than 0.05 was considered statistically significant.

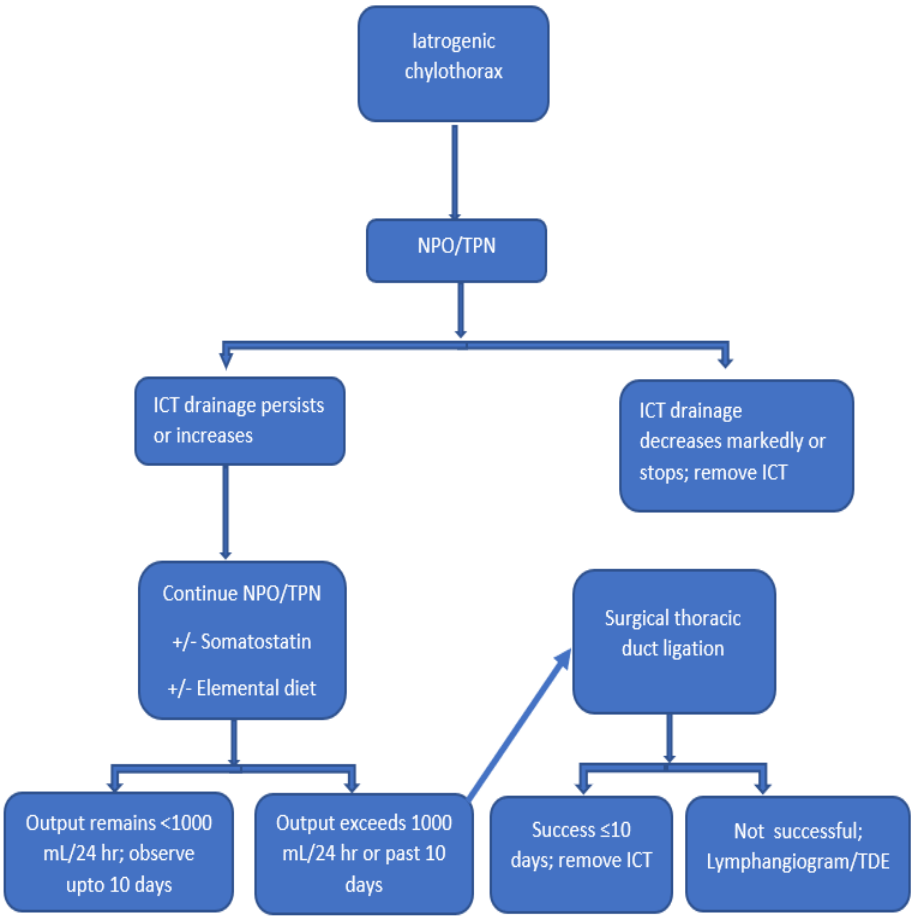

Figure 1 Algorithm of management of postoperative chylothorax. TDE: Thoracic duct embolization

Management of chylothorax

Drainage of pleural fluid with NPO (nothing per os) is the first line in our treatment. Once drainage is less than 200 ml per day, oral intake with a low-fat diet or rich in medium-chain fatty acid is given. When drainage is less than 150 ml/d, adjunct pleurodesis with povidone-iodine solution or doxycycline is applied. But if the daily pleural drainage remains high, somatostatin is administrated either subcutaneous or intravenous for 1-3 days. Surgery is indicated if there was a failure to control the drain after ten days (Fig.1).

Surgical closure of the thoracic duct is done through a standard right posterolateral thoracotomy in the 5th intercostal space. Mass ligation is performed near the level of the aortic opening of the diaphragm. Closure of the thoracotomy after inserting one drain is finally done (Figures 2 and 3).

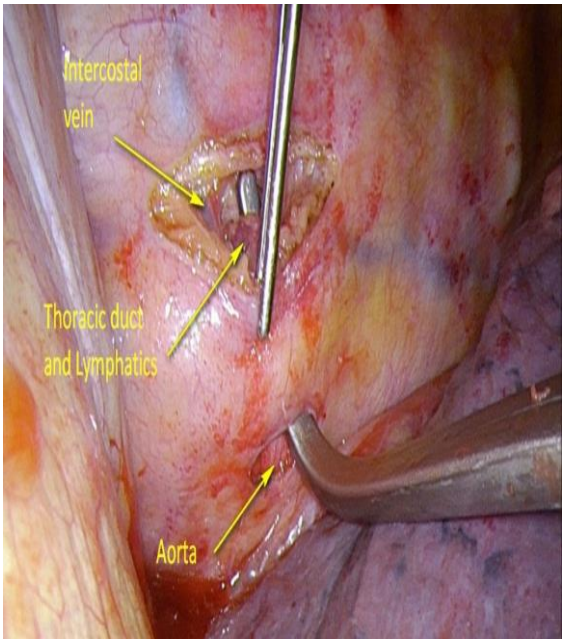

Figure 2 Mass ligation of the thoracic duct (before ligation)

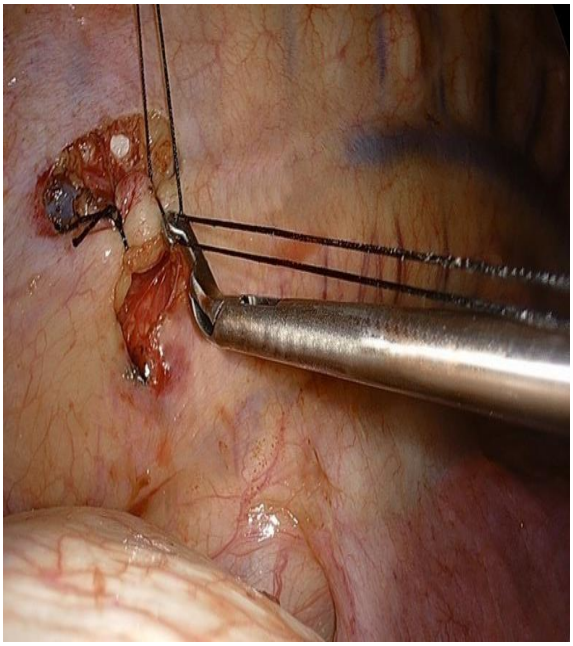

Figure 3 Mass ligation of the thoracic duct (after ligation)

Ethical approval

The research ethical committee of the Faculty of Medicine, Zagazig, and Benha Universities, Egypt, gave their approval for this study (IRB#2951/15-6-2017 and IRB#3667/19-6-2017, respectively). Moreover, the current study was done in concordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

3. RESULTS

The current study included 20 patients, 13 males and 7 females. The mean age was 47.7±13.27 years. This research comprised the following cases: 6 cases had adult congenital heart surgery, 8 cases had CABG, 3 cases had aortic valve replacement (AVR), 1 case had aortic dissection (AD), 1 case had an aortic arch replacement surgery, and 1 case had a road traffic accident (RTA) involving azygos vein injury. Sixteen cases had left side effusion, and four cases had right side effusion. The mean duration for the onset of detection of chyle effusion was 4.35±1.98 days, while the mean overall duration of pleural drainage was 12.15±2.56 days. Only 5 cases were managed successfully by NPO and TPN without the need for somatostatin injection. Those 5 cases (3 cases with CABG, 1 case with AVR, and 1 case with aortic coarctation) showed clinical improvement with gradual reduction of the daily drainage of chylothorax. Somatostatin was given to 15 patients, 11 patients responded to it, and surgery was indicated in the remaining 4 cases secondary to failure of the conservative treatment (Table 1 and Figure 4 and 5). We used 0.1 micrograms of somatostatin subcutaneously for one to three days in those 15 patients.

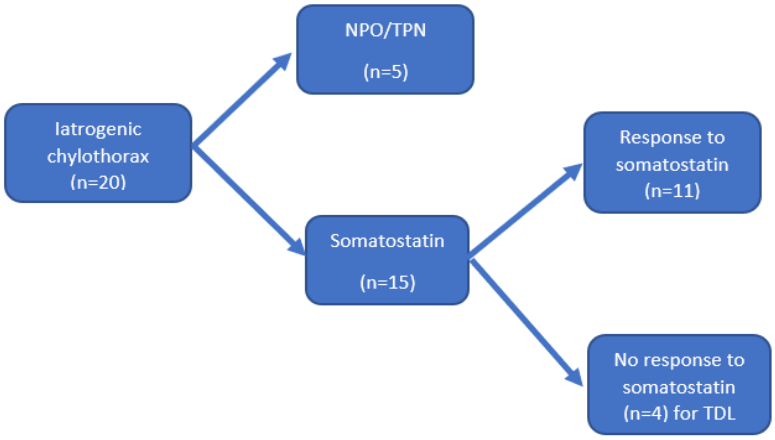

Figure 4 Initial and subsequent treatment modalities in the study

NPO: Nil per os; TPN: Total parental nutrition; TDL: Thoracic duct ligation

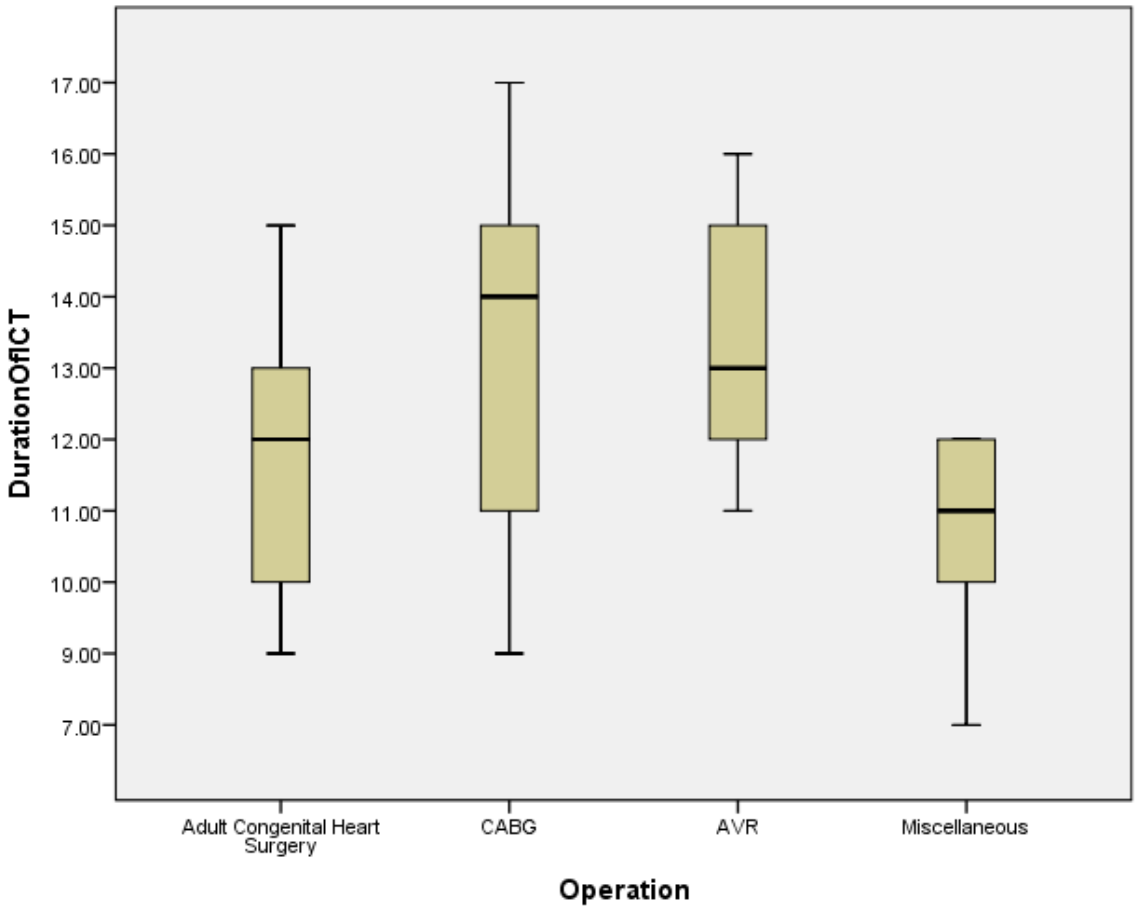

Figure 5 Box plots of the durations of chylous output in days after different types of operations. The line within each box represents the median in each group.

Table 1 Demographic data of the 20 patients and the postoperative management

	Gender	Age	Operations	Time of chyle	Side of effusion	Treatment	Durations of ICT
1	M	31	AVR	5th day	Left	Conservative	11days
2	F	53	Post RTA + azygos vein repair	2nd day	Right	Conservative	7 days
3	F	67	Arch replacement	3rd day	Left	Conservative	12 days
4	M	21	AVR+ extra-anatomic bypass to aortic coarctation	9th day	Right	Conservative	9 days
5	F	23	VSD+aortic coarctation	3rd day	Left	Conservative	10 days
6	M	49	Severe AS	5th day	Left	Conservative	13 days
7	M	57	CABG+MVD	3rd day	Left	Surgical ligations	17 days
8	M	54	CABG in a uremic patient with thrombosed RSVC	7th day	Left	Conservative	14 days
9	M	61	Aortic Dissection type A	5th day	Left	Conservative	11 days
10	F	37	PDA	2nd day	Left	Conservative	11 days
11	F	61	CABG	5th day	Left	Surgical ligations	15days
12	M	59	CABG	3rd day	Left	Conservative	13days
13	M	55	CABG	7th day	Left	Conservative	10 days
14	M	49	PDA	5th day	Left	Conservative	13 days
15	M	50	AVR	3rd day	Left	Surgical ligations	16 days
16	F	53	CABG	5th day	Left	Conservative	14 days
17	M	59	CABG	2nd day	Right	Conservative	9 days
18	F	48	CABG	3rd day	Left	Conservative	11 days
19	M	32	Aortic coarctation	3rd day	Left	Surgical ligations	15days
20	M	35	Aortic coarctation	7th day	Right	Conservative	12days

AVR: aortic valve replacement, RTA: road traffic accident, VSD: ventricular septal defect, AS: aortic stenosis, CABG: coronary artery bypass grafting, MVD: mitral valve disease, PDA: patent ductus arteriosus.

As shown in Table 2, six patients had chest pain, ten patients had dyspnea, and four patients had palpitations. Analysis of pleural fluid revealed the following results: mean pH value was 7.3±0.05, mean total protein was 2.7±0.3 g/dL, mean pleural glucose concentrations were 123±33 mg/dl, mean cholesterol level was 43±17 mg/dL, mean triglyceride level was 489±39 mg/dL, and chylomicron was 7±0.4 mg/dl (Table 3).

Table 2 The main presenting symptoms of chylothorax following adult cardiovascular surgery

Symptoms	No. (%)
Chest pain	6 (30%)
Dyspnea	10 (50%)
Palpitations	4 (20%)

Table 3 Analysis of pleural fluid collected from patients

Composition	Level
pH	7.3±0.05
Total protein	2.7±0.3 g/dL
Pleural glucose	123±33 mg/dl
Cholesterol	43±17 mg/dl
Triglyceride	489±39 mg/dl
Chylomicron	7±0.4 mg/dl

There was a significant difference between ICT drainage/day in patients who were managed conservatively and those who needed surgical management (p =0.0001) (Table 4). There was a statistical significance regarding the response of postoperative chylothorax to somatostatin therapy (p=0.001). 11 patients (73.3%) out of 15 patients showed a significant response to somatostatin therapy (Table 5).

Table 4 Clinical findings by type of therapy

Variable	Conservative management N=16	Surgical management N=4	P-value
Triglycerides (g/dL)	577(265-1102)	451(348-781)	0.61
ICT drainage (mL/24h	733(520-1110)	1930(1320-2890)	0.0001
Time to ICT removal (day)	10(7-14)	16(15-17)	0.15

All values are reported as median (interquartile range). ICT = intercostal tube.

Table 5 clinical data of patients with chylothorax responding and not responding to somatostatin therapy

variable	Patients responding to somatostatin therapy N=11	Patients not responding to somatostatin therapy N=4	P-value
Number (%)	11(73.3%)	4(26.7%)	0.001
Age (years)	49 (21-67)	53.5 (32-61)	0.64
Time of chyle leak postoperatively (days)	4.09(2-9)	3.5(3-5)	0.59
ICT drainage before somatostatin injection	1050(850-1750) mL/d	1930(1320-2890) mL/d	0.08
Triglyceride level in pleural fluid (g/dL)	433(388-1102)	451(348-781)	0.73

All values are reported as median (interquartile range). ICT = intercostal tube.

4. DISCUSSION

The thoracic duct is the largest lymph channel that begins in the abdomen and enters the right side of the chest by passing through the aortic opening of the diaphragm, then bends to cross the midline to enter the left side of the chest exactly at the level of T4 to terminate its course in systemic venous blood in the left internal jugular vein with 40% abnormality in its pathway (Riquet et al., 2002). Chylothorax after adult cardiovascular surgery is a rare complication (from 0.3 % to 0.5%) with a poor outcome and a high incidence of morbidity and mortality that may reach up to 30% (Riquet et al., 2002). However, no clear mechanism could explain the postoperative accumulation of the chyle after adult cardiac surgery. However, most of the literature related the causes of chylothorax to extensive dissection by diathermy during internal mammary artery dissection in CABG and also to the higher variability of the expected course of the thoracic duct (Kausel et al., 1957).

Our study reported 8 cases of chylothorax post-CABG without any apparent cause, but we attributed chylothorax to LIMA harvesting. This finding agrees with that of Barbetakis et al., (2006), who documented 23 cases of chylothorax following CABG, 19 of which involved using the LIMA as a graft. Likewise, Fahimi and colleagues had reported 12 cases of postoperative chylothorax, three of which occurred following the implementation of a LIMA graft for CABG (Fahimi et al., 2006). Tasoglu et al., (2012) linked Electrocautery to chylothorax after valve replacement. Chylothorax after adult cardiac surgery had been linked with complex surgery and high venous pressure.

This study reported one case of severe trauma with many rib fractures. This patient was first operated on due to right hemothorax due to azygous vein injury. On the 3rd postoperative day, chyle was found in drainage. Similarly, according to Seitelman et al., (2012), one case of post-traumatic chylothorax was successfully managed by the conservative management, with no chyle after the 8th day. Chylothorax may also complicate arch surgery or aortic dissection surgery owing to severe dissection, either bluntly or with diathermy. Ohtsuka et al., (2005) described five cases of chylothorax after aortic surgery (3 males, 2 females), all of which were effectively treated with minimally invasive VATS duct ligation.

We also reported chylothorax in one patient undergoing CABG with a thrombosed RSVC that was stented secondary to thrombosis, which resulted from the indwelling permcath used for regular hemodialysis. Several strategies are applied in

chylothorax management. The initial line of treatment is the drainage of the accumulating pleural effusion with avoiding oral nutrition and starting parenteral nutrition with electrolyte and trace element supplementations. This strategy is effective in 80% of the cases and avoids respiratory complications and nutrition insufficiency. In case of failure of controlling chyle leaks, we used 0.1 micrograms of somatostatin subcutaneously for one to three days. Many researchers agree to use somatostatin but are concerned about its long-term effects, while others are opposed. Its adverse effects and possible complications may limit its use. Adverse effects that had been recorded include injection-site erythema, bradycardia, arrhythmia, gastrointestinal disturbances such as diarrhea, abdominal pain, nausea, vomiting, gallstone formation, and abnormal glucose metabolism (Nair et al., 2007; Varshney et al., 2020). We did not record any severe side effects during somatostatin therapy. We reported many cases with abdominal distension as the most common side effect.

A conservative strategy was very effective in many studies (Stager et al., 2010). Among the 20 chylothorax patients studied by Fujita and Daiko (2014), fifteen patients had somatostatin-based conservative therapy, whereas only five did not receive somatostatin, resulting in a considerable improvement in the resolution of chylothorax in the somatostatin group (86% improvement in somatostatin group vs. 20 % improvement in patients who did not receive somatostatin, $p = 0.03$). Our study reported a significant improvement and a clinical response to somatostatin therapy. Somatostatin was given to 15 patients. 11 patients (73.3%) responded to somatostatin therapy, while four patients (26.7%) did not ($p=0.001$). Cerfolio (2006) observed that 450 mL or less daily chyle outputs could be managed medically. If chyle drainage is more than that volume, they suggest a further 48 hours of observation and then possibly surgical intervention.

According to Merrigan et al., (1997), surgical intervention should be performed if the chyle drainage in 24 hours is more than 1 liter for five consecutive days. Lagarde et al., (2005) proposed that surgical intervention is indicated if drainage is 2 liters or greater after the first 2 days of intensified conservative management. Reisenauer et al., (2018) reported that patients with daily chyle output greater than 1,100 mL over any 24 hours are more likely to require intervention and should be transferred directly to surgical duct ligation or thoracic duct embolization. Before surgery, some surgeons may recommend fat loading to aid in detecting the thoracic duct (Shackcloth et al., 2001). Fat loading before the procedure is strongly associated with detecting chyle leaks during the procedure. Before the surgery and potentially even during the process, an olive oil injection through a nasogastric tube can increase chyle leak to help detect chyle leakage.

Pleurodesis with povidone-iodine or doxycycline is performed to prevent chyle reaccumulation if drainage is less than 100 to 150 mL per day. Moreover, Fibrin glue (Oishi et al., 2017) might be used by some surgeons. There are no clear guidelines or recommendations for chylothorax management; instead, multiple approaches are used and based on the outcome. This concept is attributed to the uncommon development of chylothorax after adult cardiovascular surgery. Thoracic duct embolization (Jeon et al., 2021) following thoracic duct lymphangiography (Sommer et al., 2020) and transjugular intrahepatic portosystemic stent shunt (Lutz et al., 2013) are all among the non-conservative thoracic duct treatment techniques employed recently.

Surgical therapeutic options involve duct ligation, mass ligation, and pleuroperitoneal shunting (Yamagata et al., 2017; Liu et al., 2020). We performed mass ligations in 4 patients with satisfactory results in preventing chyle leakage. It is also important to note that adjunct pleurodesis with subsequent adhesion between the visceral and parietal pleura is universally beneficial in conservative and non-conservative therapy.

Limitations of the study

The study had some limitations, including the low number of patients due to the rarity of chylothorax after adult cardiovascular surgery, so more cases are needed for evidence-based practice.

5. CONCLUSION

The current study concluded that chylothorax is a rare complication following adult cardiac surgery. It happens more frequently after CABG and Aortic arch procedures and has a major impact on the expected postoperative course and morbidity. The diagnosis and treatment should be made immediately. In nearly 80% of cases, conservative management is feasible. Moreover, it is of great importance to keep the non-conservative management in mind.

Acknowledgment

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Ethical Approval

The research ethical committee of the Faculty of Medicine, Zagazig University, Egypt, and Benha University, Egypt, gave their approval for this study (IRB#2951/15-6-2017 and IRB#3667/19-6-2017, respectively).

Informed consent

Written and informed consents were obtained from patients before study initiation.

Funding

This study has not received any external funding.

Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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