

## Medical and Surgical Treatment of Chylothorax in a Dog with Right-Sided Heart Failure

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**Abstract:** Chylothorax due to right-sided heart failure was diagnosed in a 3.5-year-old, male Rottweiler, based on the clinical, radiological, and echocardiographic examinations, and serum biochemical test results (pleural fluid cytology and triglyceride levels of the serum and pleural fluid). En bloc ligation of thoracic duct along with its branches and pleural abrasion were performed after the failure of the initial medical management including pleural drainage via tube thoracostomy, and enalapril, furosemide, and low-fat diet (Prescription Diet Canine r/d, Hill's Pet Product, Topeka, Kansas, USA). Combination medical and surgical therapy resulted in an excellent postoperative outcome. Six months after surgery the dog had no evidence of clinical signs of right-sided heart failure or chylothorax and the severity of echocardiographic abnormalities (right atrial dilatation and tricuspid regurgitant jet velocity) was reduced.

**Key Words:** Chylothorax, right-sided heart failure, dog, en bloc ligation of the thoracic duct

### Sağ Kalp Yetmezliği Olan Bir Köpekte Şilotoraksın Medikal ve Cerrahi Sağıltımı

**Özet:** 3,5 yaşında, erkek bir Rottweiler'da klinik, radyolojik, ekokardiyografik muayene ve serum biyokimyasal test sonuçlarına dayanarak (plevral sıvı sitolojisi ve serum ve plevral sıvı trigliserid düzeyleri) sağ kalp yetmezliğine bağlı şilotoraks tanımlandı. Tüp torakostomi ile plevral drenaj, enalapril, furosemide ve düşük yağlı diyeti (Prescription Diet Canine r/d, Hill's Pet Product, Topeka, Kansas, ABD) içeren ilk tedavi planının etkisiz olmasından sonra torasik kanal ve kollarının en-blok ligatürü ve plevral abrazyon operasyonu yapıldı. Medikal tedavi ile birlikte operasyon mükemmel postoperatif sonuç gösterdi. Postoperatif 6. ayda köpekte şilotoraks ve sağ kalp yetmezliğinin klinik bulguları görülmeyen, ekokardiyografik anormalliklerin şiddeti (sağ atrial dilatasyon ve trikuspid regurgitant jet hızı) azaldı.

**Anahtar Sözcükler:** Şilotoraks, sağ kalp yetmezliği, köpek, torasik kanalın en-blok ligatürü

### Introduction

Chylothorax is a disease rarely encountered in dogs and characterized by accumulation of chylous fluid in the pleural cavity (1-5). Underlying causes of the chylothorax include cardiomyopathy, heartworm disease, pericardial disease, right-sided heart failure (5), tetralogy of fallot, tricuspid dysplasia, cor triatriatum dexter, lung lobe torsion, diaphragmatic hernia, systemic lymphangiectasia,

mediastinal/heart base masses, and idiopathic causes (1-9). Pulmonic stenosis was also reported to cause right sided heart failure and chylothorax in cats (10). There are limited reports on chylothorax secondary to heart failure in humans and animals. Chylothorax and chylous ascites due to heart failure in a 84-year-old woman were reported by Villena et al. (7), and surgical management of a double-chambered right ventricle in a Labrador retriever

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with chylothorax was reported by Tanaka et al. (11). To the best of our knowledge, this report of chylothorax in a Rottweiler with right-sided heart failure is the first descriptive case. The purpose of this report is to describe the diagnosis, treatment, and outcome of chylothorax due to right-sided heart failure in a 3.5-year-old Rottweiler.

**Case History**

A 3.5-year-old, male, 30 kg Rottweiler was referred to the Clinics of the Faculty of Veterinary Medicine, Uludağ University, Bursa, Turkey with the history of reduced exercise tolerance, wheezing, and dyspnea for 2 months. The dog had no previous trauma or illness.

**Results and Discussion**

Physical examination revealed tachypnea with a respiratory rate of 64 breaths per minute, rectal temperature of 38.2 °C, heart rate of 150 bpm, and capillary refill time of 2 s. Thoracic auscultation revealed decreased lung sounds ventrally, muffled heart sounds, and a cardiac arrhythmia. A cardiac murmur was not detected. Lateral and ventrodorsal thoracic radiographs revealed radiopaque appearance of thorax, loss of cardiac silhouette, and moderate pleural effusion (Figure 1). Electrocardiography (ECG) revealed small QRS complexes (<0.9 mV) and a first degree atrioventricular block (PR interval: 0.16 s/lead II; reference range: 0.6 - 0.12 s/lead II) consistent with pleural effusion, pericardial effusion, or both (Figure 2A). Sinus block was also observed, based on the fact that sinus pause (about 8 large boxes) was equal to twice the normal R-R interval (about 4 large boxes) in

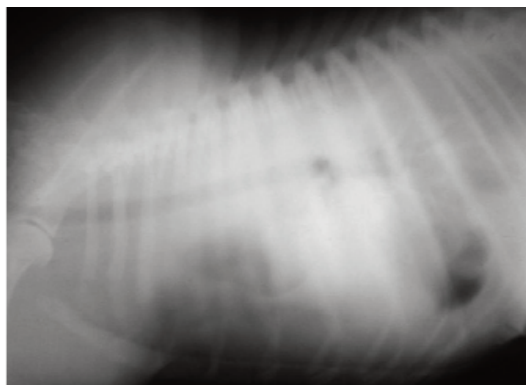


Figure 1. Lateral thoracic radiograph taken during initial examination (the day referred) shows the radiopaque appearance of thorax and loss of cardiac silhouette resulting from pleural fluid.

Lead II. Diagnostic tests beneficial in determining potential underlying diseases responsible for pleural and/or pericardial effusion include thoracic radiography, ultrasonography, computed tomography, magnetic resonance imaging, and thoracoscopy (1,4). Moreover, if underlying cardiac disease is suspected, echocardiography is recommended. Echocardiography was performed using standard imaging techniques including M-mode, 2-dimensional, color Doppler and continuous wave Doppler echocardiography (Caris Plus; Esaote Biomedica, Florence, Italy). Right parasternal short-axis view at the mitral valve level revealed a D-shape consistent with right ventricular enlargement (RVE) and a flattened interventricular septum. Right ventricular enlargement (4.5 cm) was confirmed by right parasternal long-axis 4-chamber view, with M-mode. The right atrium is considered to be dilated if the diameter (6.5 cm) is

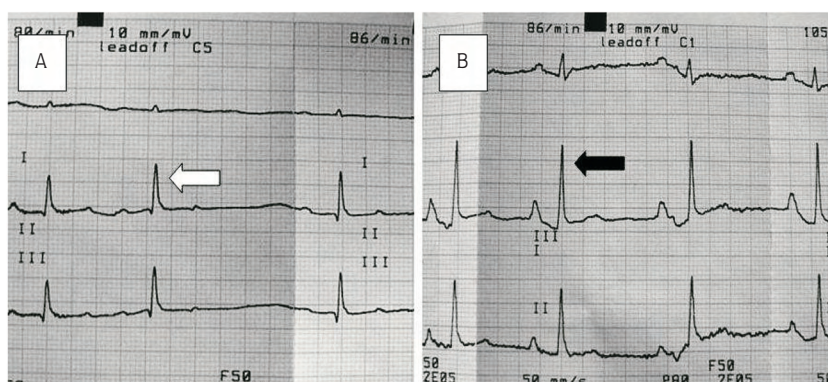


Figure 2. Derivations I, II, and III before (A) and after thoracocentesis (B). The amplitudes of QRS complexes, 0.9 mV/lead II, (white arrow) increased to 1.8 mV/lead II (black arrow) after thoracocentesis (10 mm/mV, 50 mm/s).

greater than or equal to the diameter of the left atrium (3.1 cm). Left-sided cardiac measurements were within normal limits (Table 1). These findings were consistent with right-sided heart failure in this dog. Mitral and aortic valves were normal on continuous wave Doppler echocardiography, but pulmonary artery and tricuspid regurgitations were detected. Pulmonary hypertension (35 mmHg) that was estimated using an accepted formula (4,12) was thought to be a specific cause for RHF. Tricuspid regurgitations in combination with the pulmonary hypertension may be related with increased right ventricular systolic pressure, and increased right ventricular afterload.

Hematological findings included moderate neutrophilia (84.1%) and lymphopenia (4.5%) (Table 2) and serum biochemical abnormalities included hyponatremia (133 mmol/l, reference range: 143-151 mmol/l), hypercholesterolemia (340 mg/dl, reference range: 125-270 mg/dl), and increased total cholesterol/triglyceride ratio (4.04, reference value <4.0). Total protein, total bilirubin, glucose, blood urea nitrogen, creatinine, triglyceride, phosphorus, calcium, potassium, and enzyme activities (ALT, ALP, and amylase) were within reference ranges. Diagnostic thoracocentesis performed under local

anesthetic blockage of the 7th intercostal space with lidocaine (Jetocaine amp, Adeka, Turkey) revealed a milky fluid. Pleural fluid biochemistry values are listed in Table 3. The fluid cytology was consistent with chronic chylous effusion (63% neutrophils, 19% lymphocytes, and 18% macrophages). Chylothorax is confirmed if the pleural fluid triglyceride level is above 110 mg/dl (7) and the serum cholesterol to triglyceride ratio is <1:1, or fluid triglyceride concentration (436 mg/dl) is higher than the serum triglyceride concentration (84.1 mg/dl) (1,4). Once chylothorax has been diagnosed, further diagnostic tests such as microfilaria examination and adult antigen testing for heartworm disease in addition to routine diagnostic tests should be performed to identify the potential underlying disease (4). Neoplastic cells were not seen, and bacterial culture and occult heartworm test (Dirocheck, Symbiotics) were negative. Based on these findings, a diagnosis of chylothorax secondary to right-sided heart failure was made. Of the possible causes of non-traumatic chylothorax, increased venous pressure, and obstruction of the TD are physical causes that lead to lymphatic hypertension and subsequent transmural leakage of the chyle (lymphangiectasia) (3,4). High central venous pressure increases the lymph production, and lymph flow

Table 1. Pre- and post-operative right and left ventricular related echocardiographic parameters.

Parameters	Post-operative	Pre-operative		
		1 <sup>st</sup> week	1 <sup>st</sup> month	6 <sup>th</sup> month
Right atrium (cm)	6.5	6.3	6.0	4.4
Right ventricle (cm)	4.5	4.4	4.2	4.0
TRJ velocity (m/s)	2.5	2.4	1.5	0.6
IVSDd (cm)	0.9	1.0	0.9	1.1
IVSSd (cm)	1.2	1.1	1.2	1.3
LVDd (cm)	3.7	3.9	3.8	4.3
LVSD (cm)	2.8	2.7	2.9	3.1
LVPWDd (cm)	0.9	0.8	0.9	1.2
LVPWSd (cm)	1.1	1.2	1.1	1.4
LA / AO*	0.9	0.8	1.1	1.0

Measurements were performed using M-mode echocardiography, right parasternal long-axis 5-chamber view.

TRJ: Tricuspid regurgitant jet (left parasternal apical 4 chamber view); IVSDd: interventricular septum end-diastole thickness; IVSSd: interventricular septum end-systole thickness; LVDd: Left ventricular (LV) end-diastole diameter; LVSD: LV end-systole diameter; LVPWDd: LV posterior wall thickness end-diastole; LVPWSd: LV posterior wall thickness end-systole; LA: Left atrium; AO: Aorta

\* LA/AO ratio was estimated using 2-dimensional echocardiography with right parasternal short axis view, aortic level.

Table 2. Pre and post-operative hematological findings.

Parameters	Post-operative	Pre-operative			Reference ranges
		1 <sup>st</sup> week	1 <sup>st</sup> month	6 <sup>th</sup> month	
WBC $\times 10^3/\mu\text{l}$	10.8	69.4	13.9	8.4	5.5-16.9
Neutrophil (Seg.) (%)	84.1	98.7	ND	68.2	60-77
Lymphocyte (%)	4.56	0.901	ND	24.5	12-30
Monocyte (%)	9.21	0.259	ND	2.3	3-10
Eosinophil (%)	0.399	0.00	ND	4.4	2-10
Basophil (%)	1.71	0.099	ND	0.6	0-1
RBC ( $\times 10^6/\mu\text{l}$ )	6.27	3.59	4.70	5.70	5.6-8.5
Hemoglobin (g/dl)	15.6	9.94	11.3	13.5	12-18
Haematocrit (%)	39.4	21.6	26.3	36.9	37-55
MCV (fl)	62.9	60.2	56.0	64.7	60-75
MCH (pg)	24.8	25.6	24.1	22.8	18-26
MCHC (g/dl)	35.5	36.0	33.0	36.5	30-36
RDW (%)	15.6	14.2	16.5	14.3	12-17
Platelet count ( $\times 10^3/\mu\text{l}$ )	370	475	651	352	175-500
MPV (%)	14.5	16.3	21.6	17.2	12-18

WBC: white blood cell; RBC: red blood cell; MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin; MCHC: mean corpuscular hemoglobin concentration; RDW: RBC distribution width; MPV: mean platelet volume; ND: not determined

Table 3. Biochemistry values of the pleural fluid.

Parameters	Fluid analysis
pH	8.0
Glucose	83 mg/dl
Total protein	4.8 g/dl
Albumin	2.6 g/dl
LDH	180 IU/l
Cholesterol	167 mg/dl
Triglyceride	436 mg/dl
C/T	0.38
Amylase	708 IU/l
Lipase	455 IU/l
Potassium (mmol/l)	5.2
Creatinine (mg/dl)	1.01
Density	1.000
Rivalta	Positive

C/T: cholesterol/triglyceride ratio

up to 12 fold the normal rate. The stiffness of the venolymphatic junction limits lymphatic flow. This causes reduced lymphatic drainage into the venous system and potentially results in chylothorax (1,2,5,7,8).

The prognosis was considered favorable based on the degree of changes in hematological and serum biochemistry findings, as well as the fact that the electrocardiographic and echocardiographic indices of left ventricle were normal. Medical management including furosemide (4 mg/kg, per os q 12 h), enalapril (1 mg/kg, per os, q 12 h), pleural drainage, low-fat diet (Prescription Diet Canine r/d, Hill's Pet Product, Topeka, Kan) and ampicilline sulbactam (20 mg/kg, IV) (Combisid 1 g, Bilim İlaç, İstanbul-Turkey) were administered. A thoracostomy tube was inserted into the right pleural cavity and the thorax drained using a Heimlich valve drainage system. A total of 4.7 l of chylous fluid was drained during the 7 day hospitalization period. Immediately after the thorax was drained, repeat ECG revealed the amplitude of the QRS complexes had increased from 0.9 mV to 1.8 mV (Figure 2B). After 7 days, drainage was terminated, the thoracostomy tube was removed. The dog was monitored at home for another 21 days.

One month later, the dog was reexamined for the same clinical signs. Clinical and laboratory examinations were repeated, and increased heart (148 bpm) and respiratory rates (42/min) were observed. The

accumulation of chylous fluid in thorax was identified radiologically. There was no improvement in tricuspid regurgitation and pulmonary hypertension. If the non-invasive methods (intermittent pleural drainage, dietary management, and medical therapy) are unsuccessful in treating chylothorax, surgical treatment may be considered (1,2,4,11). In this case, a thickening of the pericardium that is associated with chronic irritation induced by chyle, leading to increased right-sided venous pressures (2), may be a reason why it was unresponsive to medical treatment. Based on the lack of improvement in the chylothorax with medical management, surgical ligation of the thoracic duct (TD) was pursued. The dog was anesthetized with 2% isoflurane (Forane, Abbott, UK) after the administration of ketamine HCl (10 mg/kg, i.v.) (Alfamine® 10%, Alfasan-Egevet, Turkey) with diazepam (0.5 mg/kg, i.v.) (Diazem®, Deva, İstanbul-Turkey) combination. Respiration was maintained with mechanical ventilation (15 ml/kg tidal volume, respiration rate 15/min, and 25 cm H<sub>2</sub>O airway pressure). During surgery, SPO<sub>2</sub>, capnography, and ECG were monitored. A right 8<sup>th</sup> intercostal thoracostomy was performed and the mediastinal tissue dorsal to the aorta and ventral to the thoracic vertebrae was dissected to allow en bloc ligation of the TD with 2-0 silk suture material. Pleural excision and abrasion of the mediastinum were also performed to promote local fibrosis between the visceral and parietal pleura (pleurodesis). En bloc ligation of dorso-caudal mediastinal tissue or mass ligation of the TD and its branches have been advocated as alternative methods including pleuroperitoneal or pleurovenous shunting, fenestration of the diaphragm, thoracic omentalization, injection of the thoracic duct with surgical adhesives, and pleurodesis with mechanic abrasion (1-4,8,13,14). Other surgical approaches mentioned include TD ligation combined with subtotal pericardiectomy (2) and TD ligation combined with cisterna chyli ablation (8). Mechanical abrasion and talc slurry were used to induce diffuse adhesions between the parietal and visceral pleura as a means to manage malignant effusions (14). Although pleurodesis per se is not an effective treatment in dogs, en-bloc ligation of the TD along with its branches and pleural abrasion were performed in this case as reported previously (15). Mechanic pleural abrasion was resulted in pleurodesis, as well. A 26 F thoracostomy tube (Argyle, USA) was placed caudal to the thoracotomy incision and attached to a Heimlich valve for drainage (13). Postoperatively, carprofen, 5 mg/kg (Rimadyl® 50 mg

injectable, Pfizer, İstanbul-Turkey) (SC, q24h, 5 days) was administered and the same medical therapy for right-sided heart failure was continued for 30 days. Thoracic drainage was continued for 5 days after surgery and a total of 220 ml pleural fluid was removed. Repeat thoracic radiographs revealed no pleural fluid.

Clinical examination findings and hematological and serum biochemical profiles returned to normal 1 week after surgery, except for a marked leukocytosis and anemia (Table 2). The antibiotic protocol was changed to ampicillin sulbactam (20 mg/kg, i.v.) (Combisid 1 g, Bilim İlaç, İstanbul-Turkey) plus metronidazole (20 mg/kg i.v.) (Flagyl, Eczacıbaşı, İstanbul-Turkey) and the WBC count improved. Seven days after surgery, Hct, Hgb, and RBC indices changed, revealing normocytic normochromic anemia. Despite the fact that observed clinical and laboratory abnormalities of hyponatremia, hypercholesterolemia, and increased cholesterol/triglyceride ratio were improved with treatments, anemia was consistent and changed from normocytic to microcytic in 30 days. This was thought to be a non-regenerative anemia, due to the presence of smaller sized RBC (microcytosis), but high WBC and platelet counts as well as increased mean platelet volume (MPV) suggested active bone marrow responses to anemia (16). The platelet count could be carefully evaluated in relation to peripheral blood cell parameters during diagnostic works, because the presence of megathrombocytosis (elevated MPV) and microcytic RBC may be a reason for erroneous estimations of platelet and/or RBC count (16). This means that, in case of microcytosis (lower MCV), the MPV may have been over-evaluated as smaller RBC can be counted as platelets. Because of the fact that RBC microcytosis has been related to iron deficiency or loss, ferrum sulfate (10 mg/kg, IM, weekly; Ferrum Hausman Amp., Abdi İbrahim, İstanbul) was added to the treatment plan, resulting in improvement of RBC indices.

One month after surgery, clinical signs and serum biochemistry profile remained normal. Repeat lateral and ventrodorsal thoracic radiographs revealed that the pleural effusion had resolved with evidence of pleurodesis on the right hemithorax. Compared to left hemithorax, expansion of the right lung lobes was limited, and there was minimal right mediastinal shift. These findings were consistent with possible pleurodesis or focal adhesions of the right lung lobes (Figure 3). At this point, all other medications were discontinued except for enalapril (0.5

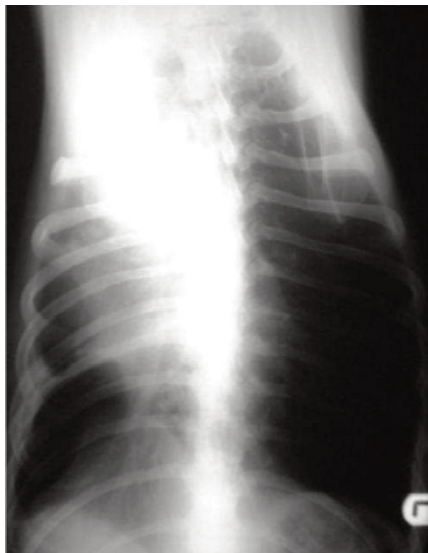


Figure 3. Ventrrodorsal thoracic radiograph taken 30 days after surgery revealed limited expansions of the right lung lobes and minimal right mediastinal shift, which was consistent with possible pleurodesis.

mg/kg, bid, P.O.). Six months after surgery, the dog had no further clinical signs or evidence of RHF and returned to normal activity. Medical therapy was continued at home, as suggested (enalapril, 0.5 mg/kg, q24 h, PO, for a long period).

In conclusion, right-sided heart failure should be considered as a potential cause for chylothorax in dogs which can be treated successfully with a medical and surgical therapy combination. That a triglyceride level of the pleural fluid is higher than that of serum is thought to be an important finding in the diagnosis of chylothorax. Cardiac evaluation, especially echocardiographic examination, should be performed during diagnostic work-up to find out the possible reason(s) for chylothorax, and to monitor patient status during treatment procedure in clinical setting.

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