A Case of Dog with Lung Lobe Torsion Suspected to Be Related to Tracheal Collapse

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気管虚脱の関与が疑われた肺葉捻転の犬の１例

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SUMMARY : A 10-year-old, ovariohysterectomized female Maltese with tracheal collapse presented with a cough. Thoracic radiographs revealed tracheal collapse from the cervical to pectoral region and less pneumatization of the right middle lung lobe (Day 1). The dog received initial treatment, but the symptoms worsened (Day 2). Lung lobe torsion (LLT) of the right middle lung lobe was diagnosed as a result of ultrasonographic and CT examinations. The affected lobe was resected. Histopathological examination revealed congestion. Immediately after the recovery from the anesthesia, the dog showed severe stridor and lapsed into dyspnea due to tracheal collapse. LLT is a rare disease, while tracheal collapse is a typical respiratory disease. This case suggested the risk of LLT in the dog with airway collapse.

KEY WORDS：dog, lung lobe torsion, tracheal collapse

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要約：気管虚脱のある 10 歳のマルチーズ、避妊雌が咳嗽を主訴に来院した。初診時の胸部 X 線検査では頸部から胸郭前口部の気管虚脱と右肺中葉の含気低下を認めた。状態の安定化を目的とした初期対応を行ったが、翌日に症状の悪化を認めたため精査した。肺エコー検査および CT 検査にて右肺中葉の肺葉捻転と診断し手術した。摘出した肺は病理組織学的にうっ血と診断された。麻酔覚醒直後に気管虚脱による重度の喘鳴と呼吸困難を認めた。肺葉捻転は稀な疾患であるものの、気管虚脱は日常的に遭遇する代表的な呼吸器疾患である。気管虚脱を有する症例は肺葉捻転のリスクを考慮する必要があると考えられた。

キーワード：犬、肺葉捻転、気管虚脱

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Introduction

Lung lobe torsion (LLT) results from displacement and twisting of a lung lobe around its bronchovascular pedicle[1]. LLT is a relatively rare disease. It is common in large dogs and has also been reported in small-breed dogs, pugs, and cats [2-7] . Most reported cases are considered spontaneous, and others are associated with some predisposing conditions, including pleural effusion, pulmonary space disease, neoplasia, thoracic trauma, and prior thoracic surgery [1-7]. LLT has been reported on its diagnosis or prognosis [2-5], but few reports have discussed the cause of LLT.

In this study, we report a case in which airway collapse was suspected to affect LLT in dogs, along with some literature reviews.

Case Description

A 3.78 kg, Body Condition Score 4/9, 10-year-old, ovariohysterectomized female Maltese with tracheal collapse (TC), mitral regurgitation ACVIM stage B1, and separation anxiety presented with a cough that had been occurring for several days. There were no other symptoms.

On general physical examination, the dog had an intermittent honking cough. In auscultation, Levine3/6 systolic murmur at the left ventricular apex was observed (Day 1).

A complete blood count (CBC) revealed a leukocytosis characterized by a neutrophilia and a monocytosis. Serum biochemical analyses revealed slight hypoalbuminemia and increases in aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP).

C-reactive protein (CRP) was within standard value (Table.1).

Thoracic radiographs revealed tracheal collapse from the cervical to pectoral region during the inspiration and exhalation phases. In addition, the right middle lung lobe was decreased pneumatically, and there was an oblique fissure of the lung (Fig. 1A, 1B).

From the above results, the dog was diagnosed with TC and decreased pneumatization of the lung. The cause of pleural effusion was unclear. The dog underwent primary care because it had separation anxiety. The dog received intramuscular dexamethasone (0.1 mg/kg, Aqueous dexamethasone injection, Nippon Zenyaku Kogyo Co., Ltd, Fukushima, Japan) and subcutaneous aminophylline (10 mg/kg, Neophylin injection 250 mg, Eisai Co., Ltd, Tokyo,

Table 1 Hematologic and blood biochemical findings values (Day 1).

RBC (×10⁶/μl)	6.15	NEU (/μl)	21420	TP (g/dl)	5.2	ALP (U/l)	443	K (mmol/l)	5.27
HCT (%)	43.1	LYM (/μl)	3580	Alb (g/dl)	2.21	TCho (mg/dl)	235	Cl (mmol/l)	114
HGB(g/dl)	14.9	MON (/μl)	2060	Glob (g/dl)	3.0	Glu (mg/dl)	116	Ca (mg/dl)	9.2
MCV (fl)	70.1	EOS (/μl)	1730	TBil (mg/dl)	0.1	BUN (mg/dl)	10	P (mg/dl)	6.2
MCHC (%)	34.6	BASO (/μl)	10	AST (U/l)	210	Cre (mg/dl)	1.2	CRP (mg/dl)	0.8
WBC (/μl)	28800	PLT (×10³/μl)	417	ALT (U/l)	991	Na (mmol/l)	145.4		

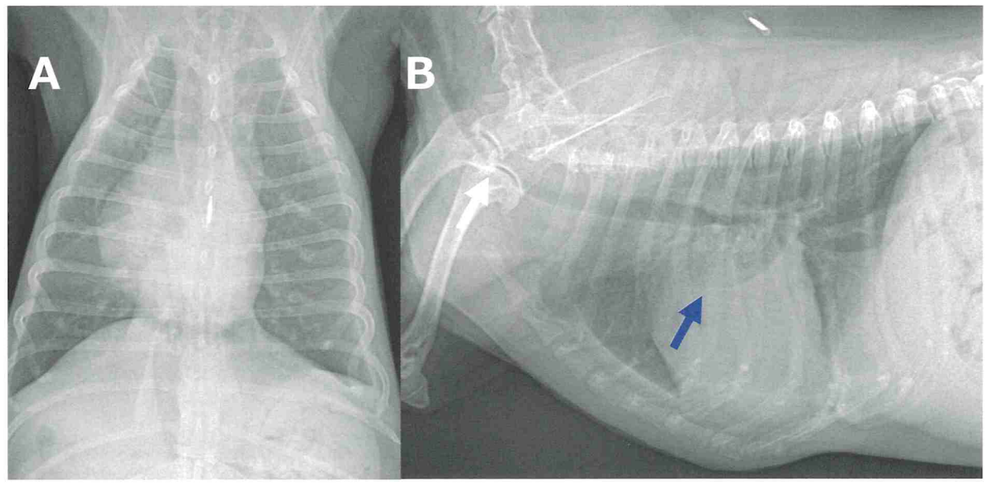

Fig. 1A, 1B Ventrodosal (A) and lateral (B) thoracic radiographs of a maltese at initial presentation (Day 1). Note the marked tracheal collapse from the cervical to pectoral region during the phase of inspiration and exhalation (white arrow). The right middle lung lobe had decreased pneumatism (blue arrow), and there was an oblique fissure of the lung.

Japan).

On the following day (Day2), its symptom got worse. CRP increased to 9.6 mg/dl (reference range 0.0–1.0 mg/dl). Thoracic radiographs revealed consolidation with an alveolar pattern in the right middle lung lobe. There were several bubbles in it (Fig. 2). Ultrasonographic examination of the right middle lung lobe revealed consolidation of the edges and microbubbles of the center (Fig. 3). In B-mode ultrasonographic examination of the heart, there was no enlargement in either the left or right atrium or the left ventricle. A small amount of pleural effusion was revealed by ultrasonographic examination. Mitral regurgitation was revealed by Doppler echocardiography, while tricuspid regurgitation was not observed.

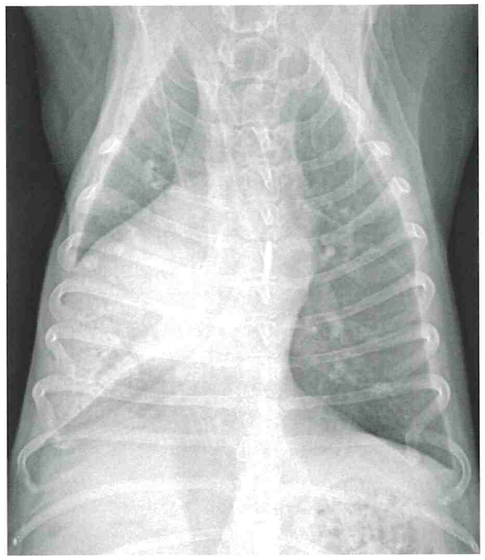

Fig. 2 Ventrodosal thoracic radiographs at the second presentation (Day 2). There was consolidation with an alveolar pattern in the right middle lung lobe. There were several bubbles within it.

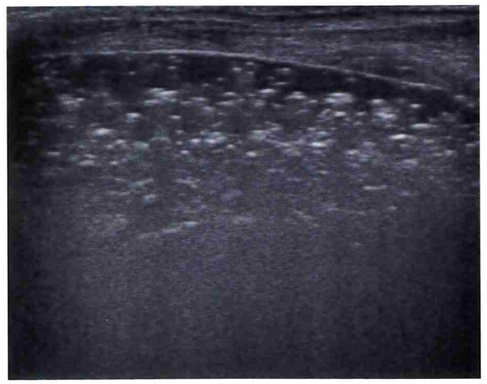

Fig. 3 Ultrasonographic examination of the right thorax of the dog (Day 2). The area of the right middle lung lobe showed consolidation of the edges and microbubbles of the center.

From the above results, LLT was strongly suspected. Therefore, computed tomography (CT) examination was performed on the dog under general anesthesia. The dog was given intramuscular atropine sulfate (0.03 mg/kg, Atropine Sulfate Injection 0.5mg, Fuso Pharmaceutical Industries, Ltd., Osaka, Japan) as a preanesthetic medication, and intravenous propofol (6 mg/kg, Propofol for animals Injection 1%, Mylan Inc., Osaka, Japan) for induction of anesthesia. She underwent tracheal intubation, and was maintained by inhalation anesthesia with oxygen and isoflurane. As a result of CT examination, disruption of the narrowing bronchus was confirmed in the right middle lung lobe, which became atelectasis. There were many microbubbles at the center of the lung lobe (Fig. 4A, 4B). The other lung lobes were expanded, while bronchi of the right cranial lung lobe and the left cranial lung lobe severely collapsed (Fig. 5A, 5B). From the above results, the dog was diagnosed with LLT in the right middle lung lobe. The dog underwent the surgery. In

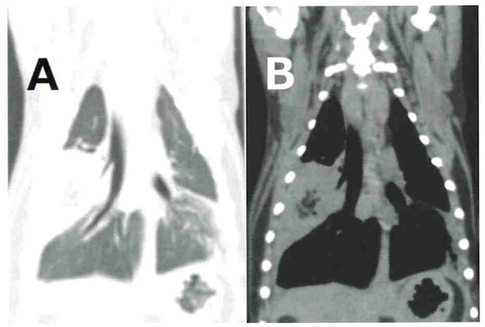

Fig. 4A, 4B CT examination of the thorax of the dog (A, B). There was atelectasis of the right middle lung lobe. Its bronchus was disrupted, and there were microbubbles in the center of the right middle lung lobe.

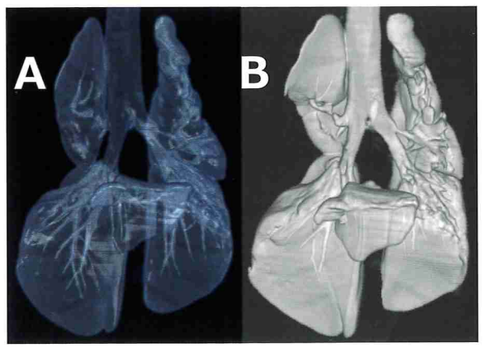

Fig. 5A, B 3D-CT examination (A, B). The lung lobes other than the right middle lung lobe expanded (A). Bronchi of the right cranial lung lobe and the left cranial lung lobe severely collapsed (B).

addition to the anesthetic protocol mentioned above, the dog received intramuscular droperidol (0.25 mg/kg, Droleptan Injection 25 mg, Alfresa Pharma Co., Osaka, Japan) as an anesthetic adjunct and continuous intravenous fentanyl (10 μg/kg/h, Fentanyl Injection 0.25 mg, Daiichi Sankyo Co., Ltd, Tokyo, Japan) as an analgesic in surgery. The dog also received lidocaine (1 mg/kg, Lidocaine Hydrochoride Injection 1%[Pfizer], Mylan Inc., Osaka, Japan) between the cranial and caudal ribs of the scheduled incision line as a local anesthesia. Surgical exploration of the thoracic cavity was performed by the right fourth intercostal approach. The right middle lung lobe was grossly congested and twisted 360 degrees in the clockwise direction on its hilus (Fig. 6). Hematoid fluid was accumulated in the thoracic cavity.

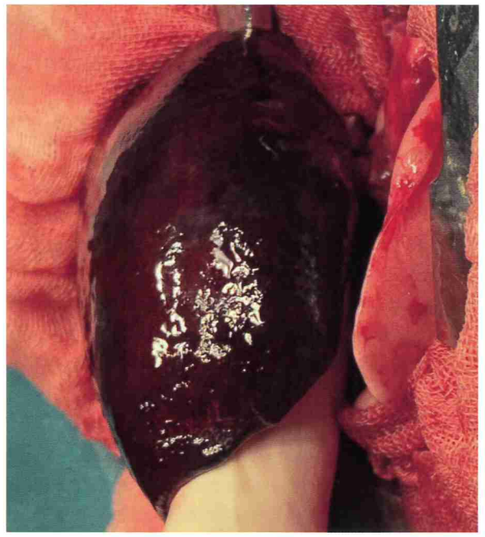

Fig. 6 The right middle lung lobe at the operation. The right middle lung lobe appeared liver-like, and the normal right cranial lung lobe was confirmed in front of it.

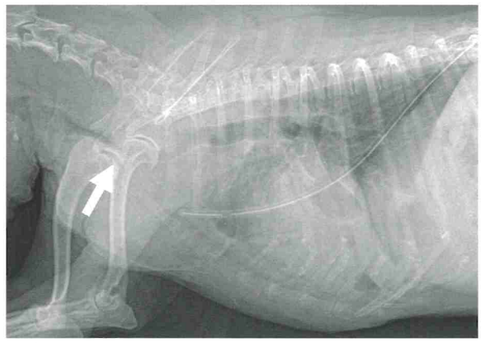

Fig. 7 Lateral thoracic radiograph after the operation. Note that the trachea severely collapsed from the cervical to pectoral region (white arrow).

Absorbent sutures were used to ligate the affected lobe at its hilus. The lobe was excised and submitted for histopathology. Sterile physiological saline solution was added to the thoracic cavity, and the lungs were inflated to check for no air leakage. 8 Fr thoracostomy tube was placed from the eighth intercostal. Routine closure of the thoracic cavity was performed. A continuous infusion of fentanyl (5 μg/kg/h) was kept into the dog for postoperative analgesia. The dog showed severe stridor with cyanosis after tracheal extubation.

Therefore, thoracic radiography was performed on the dog, which revealed tracheal collapse from the cervical to pectoral region (Fig. 7). The dog underwent tracheal intubation since it lapsed into dyspnea. After tracheal intubation, the respiratory conditions of the dog improved. When it improved, the dog resisted tracheal intubation because it was not anesthetized. Immediately after extubation, the dog lapsed into dyspnea from tracheal collapse. It was repeated several times, so the dog was given a continuous infusion of intravenous dexmedetomidine (1 μg/kg/h, Dexdomitor 0.5, Nippon Zenyaku Kogyo Co., Ltd, Fukushima, Japan) additionally, and controlled under sedation.

Four hours after the operation, the dog was carefully extubated without stimulation to its trachea and was controlled in the intensive care unit. No fluid was aspirated through the thoracostomy tube. Thoracic radiographs revealed tracheal collapse, but the tracheal lumen was expanded. The dog was discharged from the hospital since its condition was stable after surgery (Day 5).

Histopathological examination revealed congestion resulting from circulatory failure almost all over the right middle lung lobe. Bronchi and thick blood vessels were distinguished, but the alveolus was not, except under the

Fig. 8 Histopathological examination of the right middle lung lobe of the dog (hematoxylin and eosin, × 200). The alveolus was indistinguishable except under the pleura and was congested with blood.
A small number of leukocytes were mixed among congested erythrocytes.

pleura. Although there were also some leukocytes mixed in between the filled erythrocytes, the inflammation was mild and erythrocytes morphology remained.

It suggests that no time had passed since the torsion (Fig. 8).

Discussion

LLT occurs spontaneously or secondary to pulmonary parenchyma disease, pleural effusion, pneumothorax, thoracic trauma, tumors, and thoracic surgery [1-7]. For most LLT cases in the past studies [2-4], the causes were not identified. Therefore, we can assume that it is difficult to identify the cause of LLT. By evaluating thoracic radiographs and medical treatment progress before LLT occurs, we could build a hypothesis about the cause of LLT in this case.

When lung mobility increases by any cause, LLT is expected to increase in incidence. When a lung lobe collapses locally with pulmonary parenchyma disease or thoracic trauma, its positional relationships among the thoracic wall and mediastinum break up, which leads to distortion of the lung lobe [1].

We considered that airway collapse possibly caused LLT for three reasons in this case. First, the dog had TC. Second, thoracic radiographs did not reveal pneumonia or pneumothorax on the first day. Although there was a small amount of pleural effusion, there was no evidence suggesting heart failure as the underlying disease causing LLT. Third, CT examination revealed bronchial collapse in the right cranial lung lobe, the left cranial lung lobe and the right middle lung lobe.

It is ideal that all lungs ventilate equivalently, but this never happens in reality. Ventilation becomes uneven because lung compliance decreases locally. For example, airway obstruction, such as tracheal collapse, decreases lung compliance [8]. A dog with tracheal collapse often has broncomalacia as a complication [9]. CT examination revealed bronchial collapse in the right cranial lung lobe, the left cranial lung lobe, and the right middle lung lobe in this case. In summary, partially reduced aeration by airway collapse decreases the volume ratio of the lung lobe to the pleural space, and lobes increase mobility. In addition, the vulnerable bronchus along the lung lobe axis can cause LLT, which we assume to be the mechanism of LLT. It is considered that the right middle lung lobe has the most mobility lobe because it has a long and narrow shape, deep interlobar fissures, and loose attachment to its adjacent structures [4, 10]. It has been reported that the right middle lung lobe is the most common area of dog airway collapse[9]. We consider that these factors cause LLT at the right middle lung lobe.

LLT is a rare disease, while airway collapse is a typical respiratory disease. Although more cases should be accumulated, this case suggested the risk of LLT in dogs with airway collapse. This case is interesting to consider the mechanism of LLT occurrence.

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