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Non-surgical Treatment for Secondary Spontaneous Pneumothorax Associated with Bacterial Pneumonia in a Beagle Dog

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Abstract : One year old, male beagle dog was presented with acute onset of severe dyspnea, cyanosis, and anorexia. He had no trauma history. Five days earlier, the dog had been diagnosed as bacterial pneumonia caused by *Pseudomonas aeruginosa* and *E. coli*. He exhibited a restrictive respiratory pattern and at admission, immediately oxygen supplementation given. On a ventrodorsal (VD) radiographic view, right lung was collapsed and contrasted with the air-filled pleural space. The mediastinum, heart, and great vessels were shifted to the left. On a right-lateral radiographic view, the heart appeared to be elevated from the sternum. The dog was diagnosed as secondary spontaneous pneumothorax resulting from bacterial pneumonia. The chest tubes were placed on the right and left pleural cavity under general anesthesia. At 3 days after treatment, on a VD radiograph, air of right pleural cavity disappeared while left pleural cavity showed radiolucent area filled with air, and the heart was shift to the right. Therefore, the left tube thoracostomy was performed too. The right chest tube was maintained for 5 days and the left chest tube was maintained for 45 days. During the period, antibiotics and vitamin E were used for managing of bacterial pneumothorax and preventing of retroinfection through the tubes. As the result, bacterial pneumonia was well managed by medicines and secondary SP was completely treated that air in bilateral pleural cavity disappeared on radiographs. During the follow-up for 2 years, patient showed normal condition without recurrence.

Key words **:** Secondary spontaneous pneumothorax, bacterial pneumonia, tube thoracostomy, dog.

Introduction

Spontaneous pneumothorax (SP) is comprised in closed pneumothorax that there is air leakage from lung parenchyma without history of trauma (2,9-11,14,19,24,25). SP is rare in dogs, whereas traumatic pneumothorax is relatively common (10,20, 24,25). In particular, SP is rarely occurred in small breeds compared with large and deep-chested breeds (9). SP can be subclassified as primary or secondary based on history, clinical signs, and whether an underlying pulmonary disease is present (24,16). Secondary SP resulted from underlying pulmonary disease while primary SP resulted from pulmonary blebs or bullae without underlying disease. Reported causes of secondary SP in dogs include bacterial pneumonia (10,13,22), pulmonary abscess (8), neoplasia (2,6), dirofilariasis (5,21,23), tracheal rupture due to overinflation of endotracheal tube (17), and bullous emphysema (13,14). Bullous emphysema has been cited as the most common cause of SP in dogs (14). Alternatively, SP associated with bacterial pneumonia has been rarely documented in dogs.

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This report describes the diagnostic features and treatment approaches using drug and prolonged tube thoracostomy in a dog of secondary SP resulting from bacterial pneumonia.

Case presentation

One year old, 11 kg, male beagle dog was referred to Veterinary Medical Teaching Hospital of College of Veterinary Medicine at Konkuk University, showing severe dyspnea. Five days earlier, the dog had been diagnosed as bacterial pneumonia caused by *Pseudomanas aeruginosa* and *E. coli* on the basis of the complete blood count (CBC), thoracic radiographs, and bacterial culture from the tracheal flushing fluid. The dog had been treated for bacterial pneumonia with antibiotics and fluid therapy at local hospital, and then dyspnea was suddenly progressed just before being referred. There was no history of trauma.

At admission, the dog was severely dyspneic and cyanotic showing a restrictive respiratory pattern. The dog exhibited cough, panting, anorexia, exercise intolerance, and bilateral mucopurulent nasal discharge. Thoracic auscultation revealed muffled heart sound. The dog was immediately given oxygen supplementation by nasal oxygen, and then radiographs were

taken. Thoracic radiography revealed pneumothorax in right thoracic cavity. On the ventrodorsal radiographic view, collapsed right lung lobe appeared radiopaque when contrasted with the air-filled pleural space, the heart and mediastinum were shifted to the left, and bronchial and interstitial pattern were showed in the left lung lobe. On the right-lateral radiographic view, the heart appeared to be elevated off the sternum (Fig 1).

On laboratory findings, neutrophilic leukocytosis (white blood cell count: 25,000 /μl, neutrophil percentage on differential count; 93%), and mild increase of alanine transaminase, creatinine, and glucose revealed.

First, thoracocentesis with #20 butterfly needle was performed to the right 6th intercostal space of the dog. The needle attached to a 3-way cock and syringe and 1500 ml of air was aspirated by syringe from right thorax. However, the dog's breathing was rapidly labored again within one hour. Therefore, the chest tube was placed through the 7th intercostal space of right thorax under general anesthesia with isoflurane providing oxygen supplementation and positive pressure ventilation. The 16 French silicone rubber tube was used, attached via a five-in-one connector (Christmas tree adaptor) to tubing from a continuous suction device with three-bottle system. Continuous pleural drainage was maintained for a day offering 15 cm H_2O negative pressure on the thorax.

And then, intermittent drainage using a syringe was performed twice a day for 4 days. Initial air suction volume of right pleural cavity was 1500 ml and it was gradually decreased, so that the air of right pleural cavity completely disappeared at 3 days after treatment. On the other hand, at that time, air began to fill in the left pleural cavity that the heart was shifted to the right on ventrodorsal radiographic view. Therefore, left tube thoracostomy and intermittent drainage were performed twice a day (Fig 2).

On 5 days after treatment, air suction volume of right pleural cavity remained as 0 ml and thoracic cavity was observed normally on radiograph, so right chest tube was removed. However, the air suction volume of the left thorax continu-

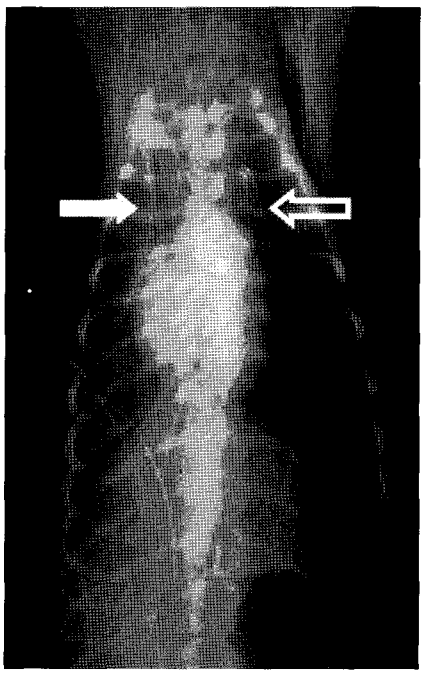

Fig 2. The magnitude of pleural air in left hemithorax is observed on ventrodorsal radiographic view. It caused the mediastinal shift to the right. The right (closed arrow) and left (open arrow) chest tube were also present.

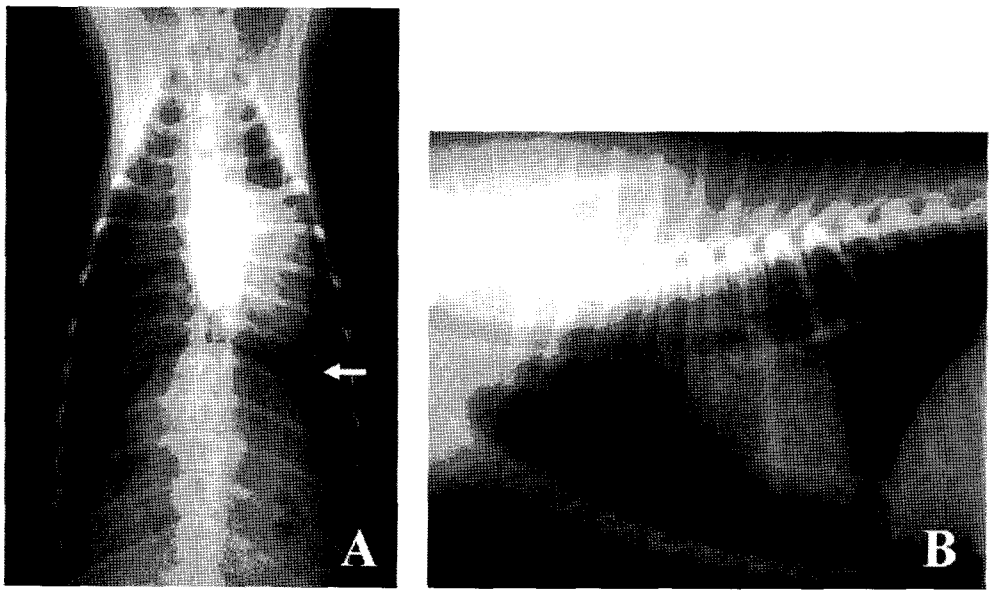

Fig 1. Ventrodorsal (A) and right-lateral (B) radiographs depicting right pneumothorax. A: Right lung is collapsed and contrasted with the air-filled pleural space, and pulmonary infiltration is observed in left caudal lobe (white-delete arrow). The mediastinum, heart, and great vessels are shifted to the left. B: There is increased separation between the heart and the sternum owing to atelectasis of the dependent right lung.

ously increased that pneumomediastinum and subcutaneous emphysema was occurred. The left pleural air of 50-1000 ml was removed daily for 42 days (Fig 3). At 42 days after treatment, the air of left pleural cavity markedly decreased suddenly. Finally, at 45 days, suction volume was 0 ml followed by remove of left chest tube. On final radiographs, air accumulation in thoracic cavity completely disappeared, however mild lung infiltration was still observed (Fig 4). At that time, all clinical signs were resolved that no restrictive respiration, normal appetite and activity were regained.

For managing of bacterial pneumonia resulting from *Pseudomanas aeruginosa* and *E. coli*, antibiotics were selected on the basis of antibiotic sensitivity test from the tracheal wash fluid. Ampicillin (Panbrax®, Yungjin Pharm Co. Ltd., Korea; 22 mg/kg TID) and enrofloxacin (Baytril®, Bayer Healthcare Co., Germany; 3 mg/kg BID) were administered intravenously for a week, followed by those were administered orally for two weeks. In addition, vitamin E (Vitamin-E®, Country life Co., USA; 400 IU/head) was used orally twice a day. As the result, cough and nasal discharge were disappeared at 10 days after treatment, and white blood cells were reduced to normal value below 15,000/μl simultaneously.

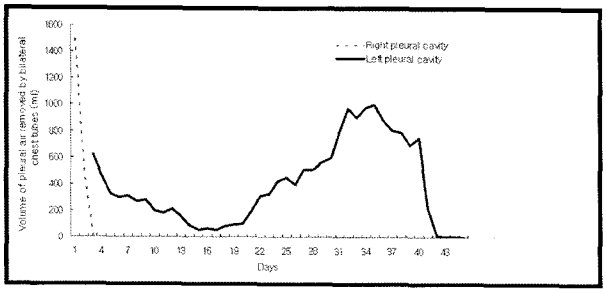

Fig 3. Alteration of volume of bilateral pleural air removed by bilateral tube thoracostomy for 45 days.

To prevent retroinfection through the chest tube, cephalexin (Cefulen®, Newgenpham CO. Ltd., Korea; 20 mg/kg, BID) was administered orally during period of tube thoracostomy after withdrawal of therapeutic antibiotics for bacterial pneumonia. In addition, tube opening site was thoroughly sterilized using 10% povidone-iodine solution and antibiotic ointment including bacitracin, neomycin, and polymyxin, and soft bandage was applied to completely cover the site. Inflammation was not detected grossly on insertion site of the chest tube, and CBC abnormalities were not detected either. As complications, mild dermatologic problem and pressure sore at bandage site were observed, however those were soon resolved after removal of the chest tube and the thoracic bandage. During the follow-up of 2 years, patient remained normal condition without recurrence signs such as dyspnea and cyanosis.

Discussion

The classification of SP is suggested by clinical history, physical examination, and radiographic findings (11). Primary SP has no underlying disease, and pulmonary blebs or bulla even though those are observed equivocally on radiograph (14,24). It is extremely rare disease in the dog while it has been well documented in the human literature (14). On the other hand, secondary SP resulted from underlying pulmonary disease, so radiographic findings associated with underlying disease are observed. In this case, the dog diagnosed as secondary SP based on clinical history and radiography because the dog has suffered from bacterial pneumonia, and any bullous lung disease was not confirmed radiographically.

Management of SP involves thoracocentesis, tube thoracostomy, surgical intervention such as exploratory thoracot-

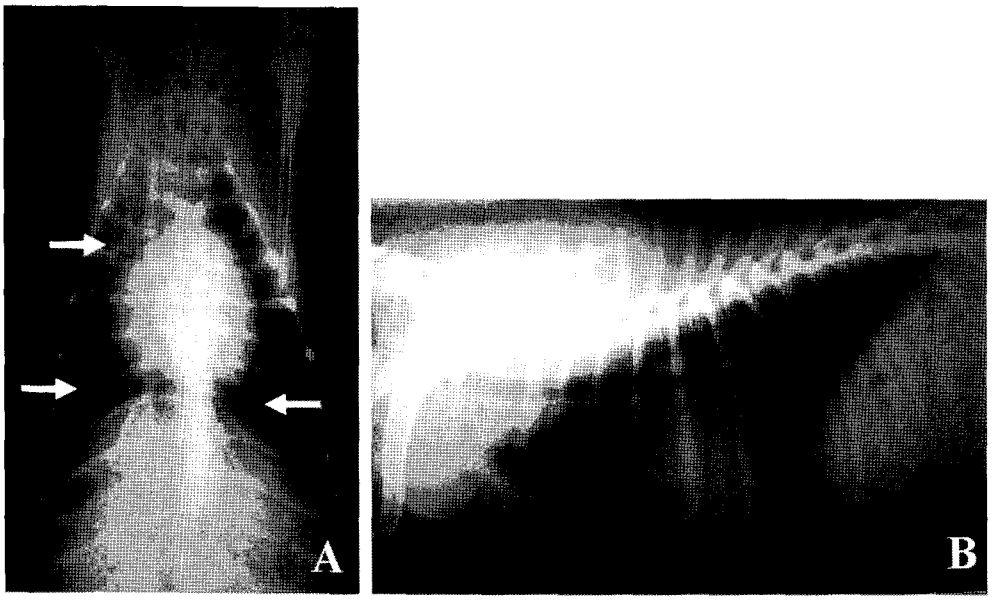

Fig 4. No pleural air accumulation is detected longer although there was mild pulmonary infiltration yet (arrows).

omy, pleurodesis, or thoracoscopy and treatment of underlying pulmonary disease (4,10,14,20,24). In humans, most patients are successfully treated with rest, thoracocentesis or tube thoracostomy and their recurrence rates are ranged from 10% to 60% (7,24). Alternatively, in dogs, non-surgical treatment such as thoracocentesis or tube thoracostomy is not derived satisfactory outcome because those methods have high recurrence rates (18). The recurrence rate of thoracocentesis in dogs was reported 100%, one of tube thoracostomy was reported 81% while one of surgery was 25% (4,9,10,18). Recent studies reported that stabilization with thoracocentesis or tube thoracostomy followed by exploratory thoracotomy was better than use of thoracocentesis or tube thoracostomy without surgery (10,20,24). Therefore, exploratory thoracotomy is recommended to dogs with SP, however it is not always possible due to some limitations. First, owners may decline surgical treatment for financial reasons or due to concerns about complications. Excruciating postoperative pain and potential wound complications such as seroma formation, sternal dehiscence and superficial wound infection were reported as complications of thoracotomy (3,10). Second, efficacy of surgical treatment in case of diffuse pulmonary lesion has been questioned yet. Single lesion such as pulmonary blebs or bulla could be treated well by partial or complete lobectomy while diffuse or unidentified lesion is required to chemical or mechanical pleurodesis (4,18,24). However, the value of pleurodesis to limit recurrence has still been controversial and it was reported that could not to obliterate effectively the pleural space in dogs (4,10,12,20,25). In particular, in secondary SP, treatment of underlying disease is the most important for complete resolution regardless of the treatment modalities. Dogs which are successfully treated underlying pulmonary disease have a favorable prognosis, so that appropriate medical or surgical management of underlying disease results in long-term resolution of the SP. And, in those cases, recurrences are rarely reported irrespective of treatment methods (24). Therefore, surgical treatment without managing of underlying pulmonary disease may be risk and ineffective in secondary SP.

In this case, chest tubes had kept air from accumulating in the pleural space until bacterial pneumonia resolves. Exploratory thoracotomy could not be applied to this dog. Because owners declined median thoracotomy, median thoracotomy was recommended to the dog since bilateral pulmonary approach was required not detecting distinct pulmonary lesions on radiograph, for financial reasons and due to concerns about surgical invasiveness. Owner did not want to bear the risk of anesthesia and surgery for her dog, and expensive surgical fee. Besides, underlying causes could not be completely removed by surgery so that prognosis of surgical treatment was not favorable. Therefore, this dog was treated pneumothorax and bacterial pneumonia by antibiotic and tube thoracostomy.

Fortunately, bacterial pneumonia was well managed by antibiotics and vitamin E administration. The choice of antibiotics based on culture and sensitivity testing was reliable and additional use of vitamin E was fully assisted to recover and protects pulmonary function. Vitamin E was well-known as a biological free radical scavenger capable of providing antioxidant protection against lung reperfusion injury caused by lung ischemia (15,26). As the result, WBC was normalized at 10 days after treatment and clinical signs such as cough and nasal discharge were alleviated at that time. Besides, no complication of bacterial pneumonia such as pulmonary abscess was observed radiographically.

Air leakage in right thoracic cavity was ceased at 3 days after placement of chest tube, followed by rapid air accumulation in left thoracic cavity. Generally, air or fluid is permeable to mediastinum in the dog and cat, so that single chest tube could remove air accumulation in both sides of thoracic cavity (9). However, in this case, air in left side was not disappeared through the right chest tube, so that left thoracostomy had to be performed to remove air in left thoracic cavity. It appeared to be attributed to serious and rapid air accumulation of left thoracic cavity and decrease of mediastinum's permeability resulting from pneumonia.

The volume of air leakage of left thorax seemed to be decreased at 15 days after tube thoracostomy, however it rose again soon. There were many reasons but it was considered in this case that diffuse pulmonary lesions resulting from bacterial pneumonia were ruptured consecutively. In the second time of air leakage, the volume was much greater than the first time. Therefore, if surgical thoracotomy could not be applied, the chest tube should not be removed impatiently and be kept going thoroughly, even if pleural air was not present any longer.

Major complication of the tube thoracostomy was iatrogenic pneumothorax caused by a leak in the apparatus (19). It can be occurred by the patient (biting or scratching the tube) or loosening of the connections of the tube to the adapters (9). Any leaks in the system can result in a life-threatening penumothorax within minutes, so that dogs with chest tubes must be carefully monitored at all times (19). Another complication is retroinfection in thoracic cavity from the chest tube (9). Therefore, the entering site of the chest tube should be kept clean and any signs of inflammation were closely monitored in the chest tube and its entering site (19). In this report, the chest tube had to be placed for 45 days because of prolonged air leakage in left thorax. To prevent retroinfection through the chest tube, prophylactic antibiotic was used continuously after recovery from bacterial pneumonia, and the entering site of the tube was thoroughly sterilized using povidone iodine and antibiotic ointment on a daily basis. As the result, significant signs of inflammation were not detected, based on CBC and gross examination at the site. In addition, to prevent tube trauma, the dog was closely monitored with applying of complete bandage and Elizabethan collar. As the result, pneumothorax resulting from air leakage in the tube was not occurred although the dog was not adjusted to the chest tube and bandage at initial period that he tried to bite and take off the bandage. These behaviors were disappeared with time. Consequently, even though prolonged placement of the

chest tube is not recommended due to above complications, if inflammation is controlled well by proper management and the chest tube is kept safely, period of chest tube placement could be prolonged following the degree of air leakage.

In this case, secondary SP resulting from bacterial pneumonia of the dog was treated successfully with non-surgical method including antibiotic and tube thoracostomy. Any complication and recurrence were not observed for monitoring period of 2 years. Therefore, adjust management for underlying disease and tube thoracostomy can be a treatment option for secondary SP. However, careful monitoring for preventing retroinfection and air leakage from tube trauma is necessary in this case.

Acknowledgement

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비글견에서 세균성 폐렴으로 인한 속발성 자발 기흉의 비외과적 치료

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요 약 : 1년령 수컷 비글견이 심한 호흡곤란, 청색증, 식욕감소로 내원하였다. 외상의 병력은 없었으며, 내원 5일전에 *Pseudomonas aeruginosa*와 *E. coli*로 인한 세균성 폐렴의 진단을 받았다. 제한적인 호흡 양상을 보여 즉각적으로 산소를 투여하고 방사선검사를 실시하였다. 배복 촬영상에서 우측 흉강에 공기가 차 있었고, 우측 폐엽의 허탈, 종격, 심장과 대혈관의 좌방 변위가 관찰되었다. 외측상에서는 심첨이 흉골로부터 떨어져 있는 것이 관찰되었다. 이상의 결과로 세균성 폐렴으로 인한 속발성 자발 기흉으로 진단하고, 우측 흉강에 흉강 튜브를 삽관하였다. 삽관 3일후에 방사선 배복 촬영상에서, 우측 흉강의 공기는 제거되었으나 좌측 흉강에 기흉이 발생하여 심장이 우방변위된 것이 확인되었다. 따라서, 흉강튜브를 좌측 흉강에도 삽관하였다. 기흉이 완전히 회복되기까지, 우측 흉강 튜브는 5일간, 좌측 흉강튜브는 45일간 유지하였다. 추가로 세균성 폐렴의 치료와 튜브로 인한 역행성 감염을 방지하기 위해 항생제와 비타민 E를 처치하였다. 결과적으로, 환자는 완전히 회복되었고, 2년동안의 관찰기간 동안 재발증상 없이 정상 생활을 유지하였다.

주요어 : 속발성 자발 기흉, 세균성 폐렴, 흉강내 튜브 삽관, 비글견