

Pulmonary atelectasis in a young dog with Cor pulmonale: clinical and radiographic follow-up

Atelectasia pulmonar em um cão jovem com Cor pulmonale, acompanhamento clínico e radiográfico

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Abstract

Pulmonary atelectasis is a disease characterized by the collapse of the pulmonary alveoli, leading to partial or total loss of function in the affected lung, and is mostly described in older dogs. It occurs due to chronic inflammatory and obstructive processes such as pneumonia. In infants who do not feed directly from the mother, it is common to develop aspiration pneumonia due to inhalation of a milk replacer. Once aspirated, food generates an inflammatory process in the airway that alters the function of the pulmonary surfactant, increases mucus production, and causes consequent airway obstruction, which may progress to alveolar and bronchial collapse. The aim of the present study was to report a case of a 4-month-old canine with pulmonary atelectasis secondary to bronchopneumonia and the outcome of the clinical case. The patient presented with cough, exercise intolerance, tachypnea, and progressive weight loss. Thoracic radiographic examination was performed to identify displacement of the mediastinum and heart overlapping the collapsed lung, interstitial-alveolar pattern associated with atelectasis of the middle lobe of the right lung, and a diffuse interstitial bronchial pattern throughout the other lung fields. Pulmonary support treatment was administered with antibiotics, bronchodilators, mucolytics, and inhaled corticosteroids, with resolution of clinical and radiographic symptoms after 60 days of treatment. Therefore, adequate treatment of chronic bronchopneumonia is effective in resolving pulmonary atelectasis and its associated clinical complications.

Keywords: cough, bronchopneumonia, radiography.

Resumo

A atelectasia pulmonar é uma enfermidade caracterizada pelo colapso dos alvéolos pulmonares levando a perda de função parcial ou total do pulmão acometido, sendo mais frequente em cães mais velhos. Ocorre devido a processos inflamatórios crônicos e obstrutivos como as pneumonias. Em filhotes que não se alimentam diretamente da mãe, é comum o desenvolvimento de pneumonia aspirativa devido à inalação de fórmula de leite. Uma vez broncoaspirado, o alimento gera um processo inflamatório que altera a função do surfactante pulmonar, aumento na produção de muco e consequente obstrução das vias aéreas, podendo progredir para colapso de alvéolos e brônquios. O objetivo do presente estudo foi relatar um caso de um canino, de 4 meses de idade, com atelectasia pulmonar secundária a broncopneumonia e a evolução do caso clínico. O paciente apresentava sinais de tosse, intolerância a exercícios, taquipneia e emagrecimento progressivo. Realizado exame radiográfico de tórax, identificou-se deslocamento de coração sobrepondo-se ao pulmão colapsado, padrão interstício-alveolar associado a atelectasia do lobo médio do pulmão direito, além de padrão intersticial brônquico difuso pelos demais campos pulmonares. O tratamento de suporte pulmonar foi realizado com antibióticos, broncodilatadores, mucolíticos e corticosteroides inalatórios, com resolução dos sintomas clínicos e radiográficos após 60 dias de tratamento. Portanto, o tratamento adequado para broncopneumonia crônica foi eficaz na resolução da atelectasia pulmonar e suas complicações clínicas.

Palavras-chave: tosse, broncopneumonia, radiografia.



How to cite: Mendonça, D. A., Ballot, S., Saiki, D. C., Santos, G. F., Junior, L.C.F, Amorim, C. O., Bendas, A. J. R., & Alberigi, B. (2022). Pulmonary atelectasis in a young dog with Cor pulmonale: clinical and radiographic follow-up. *Brazilian Journal of Veterinary Medicine*, 44, e004921. <https://doi.org/10.29374/2527-2179.bjvm004921>

Received: November 16, 2021.

Accepted: March 26, 2022.

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Introduction

Pulmonary atelectasis is characterized by the collapse of the pulmonary alveoli, leading to partial or total loss of function in the affected lung. It occurs because of changes in intrapleural pressure, inflammatory processes with loss of surfactant, obstructive processes, trauma, anesthetic procedures, and alveolar compressions (Lopes & Nunes, 2010). Thus, it can occur in patients with chronic respiratory diseases such as pneumonia. Aspiration pneumonia is common in puppies that do not feed directly from their mothers, and when not properly treated, it can progress to bronchopneumonia and pulmonary atelectasis (Johnson, 2020). Although aspiration pneumonia is common in puppies, pulmonary atelectasis is more frequent in middle-aged to older dogs (Johnson, 2020). According to Aldrich (2004), the most common risk factor for atelectasis is anesthesia due to reduced chest wall movement or thoracotomy-related pain and impairment of phrenic nerve function. Other causes, such as asthma complications and prolonged recumbency, have been reported at a lower frequency (Dear, 2020).

Pulmonary atelectasis is diagnosed based on history and clinical signs associated with thoracic radiographic or computed tomography (CT) findings. On thoracic radiography, displacement of the mediastinum and heart overlapping the collapsed lung can be observed along with the alveolar pattern of the affected lung (Thrall, 2014). In addition, the collapsed lung may be denser than the normal lung. Hyperinflation of the healthy lung may occur in a compensatory manner in response to hypoxia generated by the collapsed lung (Norris, 2004). When available, CT scans provide more detailed information and are sensitive to lung density abnormalities. Therefore, CT allows a more accurate evaluation of pulmonary alterations (Thrall, 2014).

Another consequence of atelectasis is the development of Cor pulmonale, which is characterized by pulmonary overload in the heart, leading to enlargement of the pulmonary trunk (with loss of ideal distensibility) and, in severe cases, right atrioventricular pressure overload. This syndrome occurs due to the remodeling of the pulmonary vasculature and chronic inflammatory processes (Reinero et al., 2020).

Atelectasis treatment must be directed towards resolution of the primary cause (Alonso, 2008; Norris, 2004). In cases of atelectasis due to pneumonia, broad-spectrum antibiotics are used when no culture is available, or when the clinical condition does not allow waiting for culture time. In addition, supportive treatment for the lungs, such as bronchodilators, can be used to improve airflow and the quality of mucociliary activity that, when associated with mucolytics, promotes improved breathing (Clercx, 2017). The prognosis depends on the underlying cause; when treated appropriately, a satisfactory response is expected with improvement in the clinical condition (Cohn, 2017).

The aim of the present study was to report the case of a young canine patient with pulmonary atelectasis secondary to bronchopneumonia and its clinical evolution with improvement of concurrent Cor pulmonale.

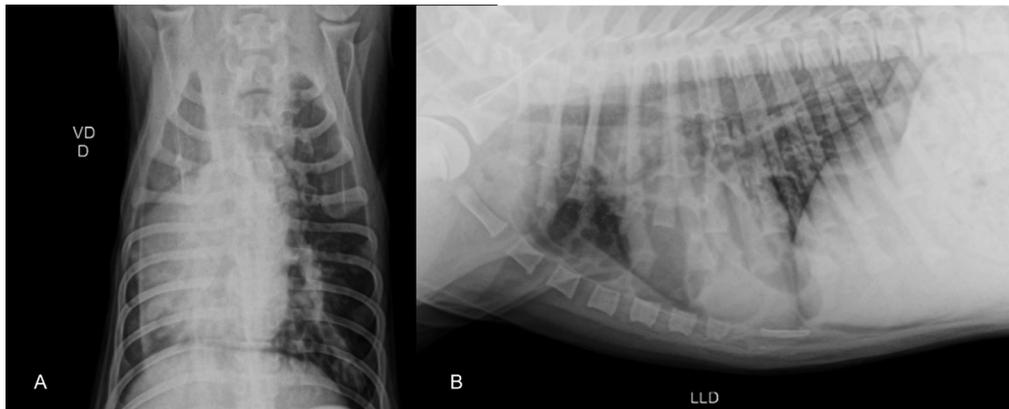
Case report

A 4-month-old, unvaccinated female Labrador retriever was treated at the veterinary clinic Rj Vet Diagnóstico, presenting with coughing, exercise intolerance, and tachypnea at rest, and was skinny with difficulty gaining weight. According to the owner, the patient was born prematurely and needed to be bottle-fed with a milk replacer after the mother's rejection and the death of the siblings. According to the owner, aspiration pneumonia was detected by another veterinarian 30 days after birth.

The patient had been under treatment since the first month of life with amoxicillin/clavulanic acid (15 mg/kg/BID/PO) for 10 days, followed by enrofloxacin (5 mg/kg/SID/PO) for 7 days, and prednisone (1 mg/kg/SID/PO) for 7 days, with unsatisfactory clinical response. The most recent complete blood count (CBC) test that was brought to the appointment was done when the patient was 90 days old, and revealed neutrophilic leukocytosis with a left shift, in addition to the presence of reactive lymphocytes and activated monocytes (Table 1). The previous radiograph was performed concurrently as the CBC and showed an interstitial-alveolar pattern associated with atelectasis of the middle lobe of the right lung, in addition to a diffuse interstitial bronchial pattern throughout the other lung fields (Figure 1A and 1B).

Table 1. Alterations in complete blood count (CBC) test demonstrating neutrophilic leukocytosis with a left shift.

| LEUKOGRAM | Relative value | Absolute value | Reference value |
|------------------|----------------|----------------|-----------------|
| Leukocytes | | 27.200 | 6.000-17.000 |
| Neutrophils Rods | 5% | 1.360 | 0-540 |
| Segmented | 55% | 14.960 | 3.000-11.000 |
| Eosinophils | 0% | 0.000 | 100-1.250 |
| Lymphocytes | 27% | 7.344 | 1000-4.800 |
| Monocytes | 13% | 3.536 | 150-1.350 |

**Figure 1.** (A) Radiograph showing atelectasis of the middle lobe of the right lung; (B) Radiograph showing an interstitial-alveolar pattern and diffuse interstitial bronchial pattern throughout the lung fields. VD: ventrodorsal; LLD: right lateral.

On physical examination, the patient had tachypnea through thoracic auscultation of pulmonary crackles in the inspiratory moment, with no other abnormalities detected on physical examination. Echodopplercardiography was also performed to rule out possible congenital heart disease that could be present at the same time. No congenital abnormalities were detected; however, signs of pulmonary hypertension, such as an increase in the main pulmonary artery and decreased distensibility of the right pulmonary artery (27%), were present, consistent with cor pulmonale.

Although antimicrobial therapy was previously unsuccessful, the owner did not consent to bronchoalveolar lavage due to financial issues. Therefore, empirical therapy was instituted with doxycycline (10 mg/kg/BID /PO) for 30 days, aminophylline (5 mg/kg/BID /PO) for 30 days, acetylcysteine (10 mg/kg/BID /PO) for 30 days, maropitant (2 mg/kg/SID/PO) for 14 days, and fluticasone propionate 50 µg (SID/INHALATION) for 14 days. The patient was re-evaluated after 30 days of treatment and showed clinical improvement of symptoms at home according to the owner. This clinical recovery was also observed during pulmonary auscultation, although slight abnormal sounds were still present. Treatment was sustained for 60 consecutive days with aminophylline, acetylcysteine, and doxycycline. Chest radiography and CBC were performed at the end of 2 months of treatment. Radiographic examination showed improvement in the pulmonary pattern with resolution of pulmonary atelectasis (Figure 2A and 2B), no suggestive signs of infection were seen, and the CBC was within the normal range. On echocardiography, previous signs of pulmonary hypertension were absent. The patient no longer had symptoms related to pulmonary alterations, was released from treatment, and has remained stable so far.

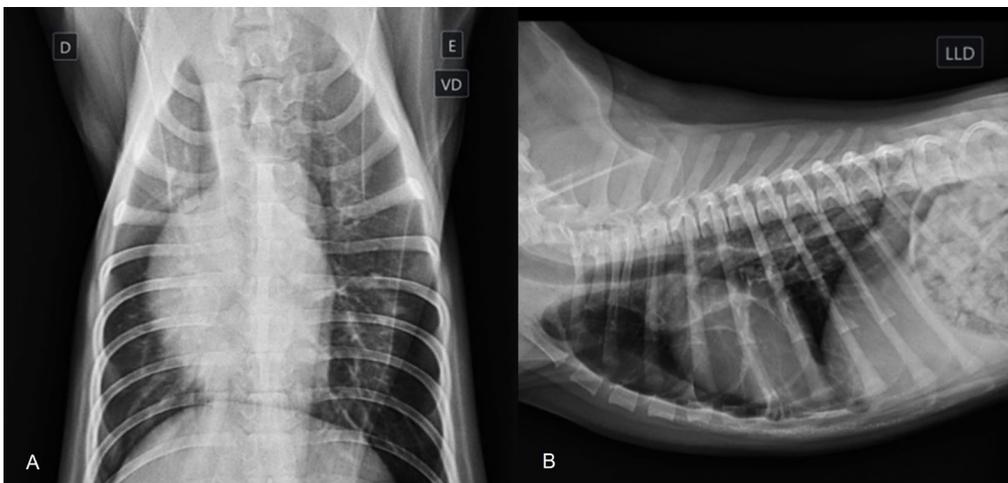


Figure 2. (A) Radiograph showing improvement of the atelectasis of the middle lobe of the right lung; (B) Radiograph showing improvement of the interstitial-alveolar pattern and diffuse interstitial bronchial pattern throughout the lung fields.

VD: ventrodorsal; LLD: right lateral.

Discussion

The inflammatory process seen in puppies due to milk replacer aspiration (Ruaux, 2011) has probably affected the pulmonary surfactant, increasing mucus production and consequent obstruction of the airways (Johnson, 2020). This mechanism probably led to the collapse of the bronchi and alveoli (Winegardner et al., 2008) and the presentation of clinical signs by the patient (Alonso, 2008). It is interesting to point out that although tachypnea may be related to physical examination stress, when associated with alterations in pulmonary auscultation such as crackles, they may indicate an exacerbated attempt to capture oxygen because of the collapse of the alveoli (Domínguez-Ruiz et al., 2021; Norris, 2004).

The immune response to infection is suggested by the presence of neutrophilic leukocytosis with a left shift (Honda et al., 2016). Although other inflammatory conditions could cause this type of change in CBC (Lyrad et al., 2015), it seems reasonable to infer infection as the cause, since the other clinical alterations presented reiterate this possibility (Cohn, 2017; Ishimine et al., 2013).

Although the patient had received previous treatment, it was not enough to resolve the clinical condition, and this may be due to the lack of bronchoalveolar lavage, preventing etiological identification and consequently the choice of the ideal antibiotic (van Duijkeren et al., 2018). The remaining clinical signs indicated the need for therapeutic adjustment; therefore, doxycycline was the antibiotic of choice. Although doxycycline must be used with caution in growing animals and pregnant bitches (Owen, 1963; Reuelto & Loza, 2010), side effects has been not been reported (Alberigi et al. 2020). Since doxycycline is recommended to be administered at 4 weeks of age or older in the treatment of respiratory tract disease in dogs (Lappin et al., 2017), the age of the patient in this case was not an issue. Nevertheless, owners have been warned about the possible side effects on growth and tooth enamel (Boy et al., 2016; Owen, 1963).

Radiographic changes in the right cranial lobe and medial lung are common in patients with aspiration pneumonia (Thrall, 2014). Although only 25% of affected patients present a diffuse interstitial pattern, other patterns, such as bronchial, alveolar, and interstitial, may be present in chronic processes, such as pneumonia and bronchiectasis (Johnson, 2020; Côté, 2015).

The pulmonary hypertension developed by the patient was probably due to the long period of bronchopneumonia, since this syndrome can occur in patients with chronic respiratory changes that progress to airway obstruction and inflammation (Simonneau et al., 2009; Reiner et al., 2020). The echodopplercardiography findings and the patient's clinical symptoms corroborate those previously shown in the characterization of pulmonary hypertension and the improvement of these parameters in the follow-up examination demonstrates that pulmonary disease was the cause of the increase in pulmonary pressure and cor pulmonale (Reiner et al., 2020).

Although complementary examinations, such as bronchoalveolar lavage, are the gold standard method to define the class of antibiotics that should be used (Golan et al., 2012; Martinez et al., 1996), this was not performed in this case due to financial issues; therefore, doxycycline was used because it is a broad-spectrum antibiotic that has benefits in the treatment of respiratory tract disease, as previously reported (Lappin et al., 2017). Pediatric patients may not respond adequately to conventional therapy, mainly because of age-related immunological impairment, and in these cases, they need prolonged therapy, as in the present report (Brady, 2004). Furthermore, the use of doxycycline for chronic bronchopneumonia is recommended for at least 4 to 6 weeks, needing new clinical and radiographic evaluation with improvement before quitting the treatment (Lappin et al., 2017), as done in this case upon 60 days.

Although the patient had been previously medicated, failure in initial therapy predisposed him to clinical worsening due to worsening of the inflammatory process. Chronic inflammation may be the cause of pulmonary atelectasis, as has been reported in other studies (Hoffman, 2001; Johnson, 2020).

The benefits of bronchodilators (aminophylline) associated with the use of mucolytic (acetylcysteine) therapy support the treatment of the lungs, promoting better airway flow (Clercx, 2017; Norris, 2004). Therefore, with the facilitated airflow through the airways, greater respiratory comfort is possible, which is an important therapy to promote patient well-being, while the primary cause is not resolved (Clercx, 2017; Cohn, 2017).

Although the mechanism by which maropitant reduces cough is not fully understood, this use is based on previous studies that demonstrated a reduction in the frequency of coughing (Grobman & Reiner, 2016). Due to the combination of drugs, it is not possible to infer that maropitant caused the improvement of clinical signs. However, no side effects were observed in this case.

Because the patient had already used oral corticosteroids before, fluticasone propionate was chosen as it is an inhaled corticosteroid and, therefore, aims to reduce its systemic absorption with a consequent decrease in side effects in the patient still under development (Sumner & Rozanski, 2013).

Pulmonary atelectasis is considered difficult to reverse (Norris, 2004); however, the patient showed radiographic and clinical improvement with long-term treatment, suggesting that these results may be associated with chronic bronchopneumonia and pulmonary hypertension.

Conclusion

Adequate treatment of chronic bronchopneumonia is effective in resolving pulmonary atelectasis and its clinical implications. This demonstrates that early identification of complications and their treatment is crucial for a good outcome.

Ethics statement

This study was authorized by the animal's owners through formal consent for disclosure of data and images for academic purposes.

Financial support

DAM The present work was carried out with the support of the Coordination of Improvement of Higher Education Personnel - Brazil (CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) - Financing Code 001. SB, DCS, GFS, LCFJ Received a scholarship from MEC (Ministério da Educação e Cultura). COA, AJRB, BA - None.

Conflict of interests

DAM, SB, DCS, GFS, LCFJ, COA, AJRB and BA had no conflict of interest.

Authors' contributions

DAM, GFS, LCFJ and COA assisted the reported patient and contributed to the writing of the manuscript. SB and DCS - Contributed to the writing of the manuscript and to the translation into English. AJRB and BA - contributed to the idealization and writing of the manuscript.

Availability of complementary results

All information obtained as a result of the study is included in the manuscript.

The patient was treated at Veterinary Service – Rj Vet Diagnóstico, Rio de Janeiro, RJ, Brasil.

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