Protective ventilation and alveolar recruitment maneuver in a patient with leptospirosis-induced acute respiratory distress syndrome

Estratégia ventilatória protetora e manobra de recrutamento alveolar em paciente com síndrome do desconforto respiratório agudo por leptospirose

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To the Editor:

Leptospirosis is an infectious disease that is characterized by vasculitis, the underlying cause of the clinical manifestations being capillary endothelial cell injury. Leptospirosis can involve multiple organ systems and cause renal tubular dysfunction, hepatic dysfunction, myocarditis, and alveolar hemorrhage.[1] Pulmonary involvement can manifest as acute respiratory distress syndrome (ARDS), in which the need for mechanical ventilation is associated with a mortality rate of 30-60%.[2]

The controversy regarding the various alveolar recruitment maneuvers (ARMs) and their role in patients with ARDS motivated us to describe the case of a patient with ARDS secondary to leptospirosis, in whom a CT-guided ARM with sustained high pressure was successfully performed.[3,4]

A previously healthy 21-year-old male patient was admitted to the emergency room with a one-week history of headache, myalgia, and fever (39 °C), as well as with a two-day history of progressive dyspnea. The patient developed respiratory failure requiring orotracheal intubation and ventilatory support, being transferred to our hospital. He reported occupational exposure to soil during gardening activities. The patient presented with poor general health status, being on mechanical ventilation and hemodynamically stable without the use of vasoactive drugs. He also presented with right conjunctival hemorrhagic suffusion.

The initial laboratory test results were as follows:

- hematocrit, 29.8%
- hemoglobin, 11 g/dL
- leukocytes, 14,000 cells/mm^3 (12,082 segmented neutrophils and 1,040 lymphocytes)
- platelets, 145,000 cells/mm^3
- C-reactive protein, 95.1 mg/L
- sodium, 143 mEq/L
- potassium, 3.1 mEq/L
- urea, 38 mg/dL
- creatinine, 1.2 mg/dL
- indirect bilirubin, 0.66 mg/dL
- direct bilirubin, 1.65 mg/dL
- prothrombin time, 1.19
- activated partial thromboplastin time, 111%
- albumin, 2.5 g/dL
- glutamic-oxaloacetic transaminase, 96 U/L
- glutamic-pyruvic transaminase, 43 U/L
- lactate dehydrogenase, 883 U/L
- creatine phosphokinase, 995 U/L
- urinalysis, normal

Arterial blood gas analysis results were as follows: pH, 7.34; PaO_2, 79.8 mmHg; $PaCO_2$, 55.3 mmHg; bicarbonate, 29.2 mEq/L; SaO_2, 95.1%; FiO_2, 0.8; and PaO_2/FiO_2 ratio, 99. A chest X-ray revealed bilateral homogeneous diffuse opacity. An echocardiogram revealed normal cardiac function.

The patient was started on antibiotic therapy with ceftriaxone, clarithromycin, and oxacillin for severe community-acquired pneumonia. Because the patient was suspected of having influenza A (H1N1) infection, he was started on antiviral treatment with oseltamivir.

Because the patient presented with refractory hypoxemia, a CT scan was taken. During the procedure, an ARM was performed. The patient remained properly sedated and was hemodynamically stable. He was submitted to pressure-controlled ventilation (PCV), as follows: RR, 15 breaths/min; inspiratory time, 2 s; inhalation/exhalation ratio, 1:1; FiO_2, 1; and pressure, 15 cmH_2O above a positive end-expiratory pressure (PEEP) of 25 cmH_2O for 2 min. The functional and radiological responses were evaluated immediately before the ARM

(PaO_2/FiO_2 ratio = 65; PaO_2 = 58.9 mmHg; and FiO_2 = 0.9) and approximately 20 min after the ARM (PaO_2/FiO_2 ratio = 102; PaO_2 = 71.9 mmHg; and FiO_2 = 0.9). The CT scans revealed aeration of the areas of alveolar collapse, with persistent ground-glass areas in the recruited lung (Figure 1). After having performed the ARM, we calculated the ideal PEEP with the patient still on PCV. The PEEP that resulted in the highest tidal volume and therefore the best static compliance was determined on the basis of a PEEP of 25 cmH_2O reduced by 2 cmH_2O every 2 min and was found to be 15 cmH_2O, to which 2 cmH_2O were subsequently added. In order to guarantee the stability of tidal volume and alveolar pressure, we chose to switch from PCV to volume-controlled ventilation, in accordance with the protective ventilatory strategy (tidal volume = 6 mL/kg of ideal weight). Plateau pressure was monitored and maintained at less than 30 cmH_2O.

Serology for dengue, HIV, hepatitis B, and hepatitis C was negative. On postadmission day four, serology for leptospirosis was positive, IgM antibodies being present. On the basis of that finding, all of the antibiotics were discontinued, with the exception of ceftriaxone. The patient responded well to the treatment and was weaned from continuous positive airway pressure ventilation to pressure support ventilation, being extubated within one week after admission.

Leptospirosis is a zoonosis caused by *Leptospira interrogans*. Pulmonary involvement is common and has increased in recent years, occurring in 20-70% of the cases. It has been suggested that there are two major mechanisms of lung injury: one is toxin-mediated and the other is mediated by an exacerbated immune response of the host. Alveolar hemorrhage results from a toxin-mediated vasculitis, given that the number of *Leptospira* spirochetes is far lower in lung tissue than in the liver and blood cells. This suggests that lung injury is mediated by circulating toxins produced by the pathogen from a remote location. In this context, it has been suggested that *Leptospira* spirochetes disseminate through rapid cell translocation.[5,6]

The principal pulmonary manifestation of leptospirosis is alveolar hemorrhage, which

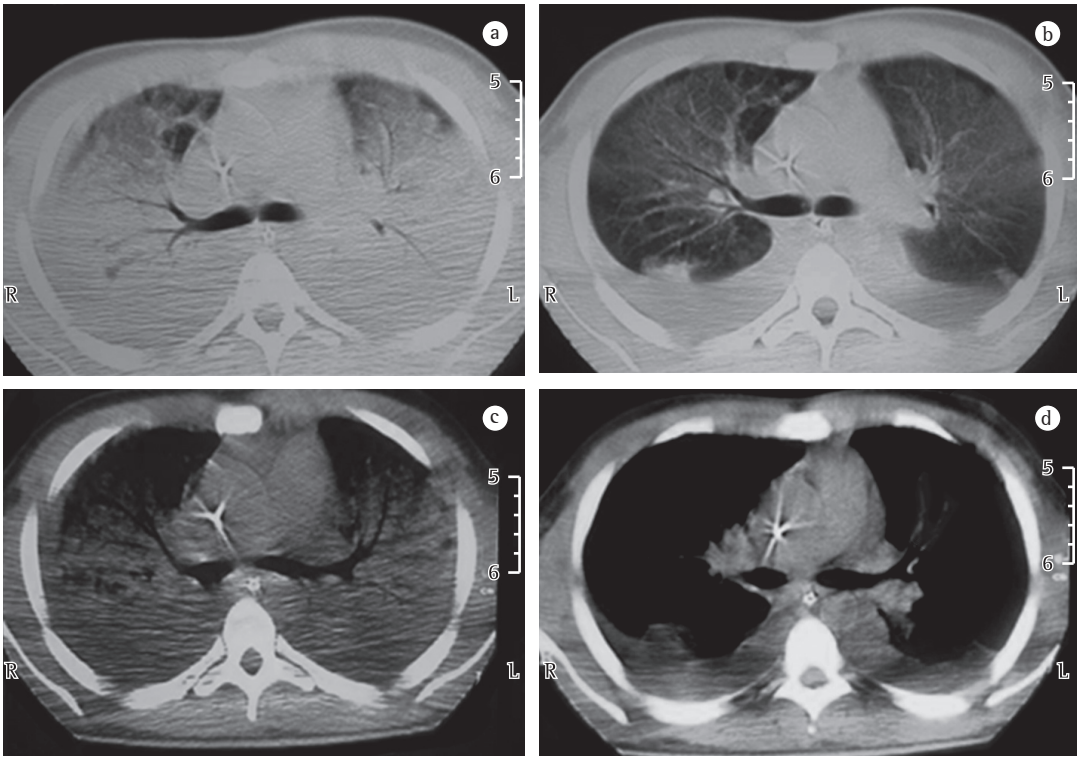

Figure 1 - Noncontrast CT scans of the chest prior to (A and C) and after (B and D) an alveolar recruitment maneuver with sustained high pressure. In A and B, lung window. In C and D, mediastinal window. Note resolution of the areas of alveolar collapse, a ground-glass pattern remaining in the recruited lung. Note also bilateral pleural effusion.

presents as dyspnea and hemoptysis in most cases; however, some patients develop ARDS (sometimes without hemoptysis).[5,6] The onset of the respiratory symptoms is approximately five days after the onset of the disease. Alveolar hemorrhage (with or without ARDS) is the leading cause of death in patients with severe disease, the mortality rate ranging from 30% to 60%.[6]

Patients with ARDS (regardless of the etiology) have been shown to benefit from protective mechanical ventilation with a low tidal volume (6 mL/kg of ideal weight) and a plateau pressure < 30 cmH_2O. The objective of lung recruitment is to improve oxygenation and therefore prevent refractory hypoxemia, as well as potentially preventing or attenuating ventilator-induced lung injury.[7]

Lung recruitment, through a transitory increase in PEEP, has previously been described in patients with leptospirosis. In the case reported here, we used an ARM that was described in 2006 by Borges et al.[3]; however, we used only the initial phase of the ARM, maximal alveolar recruitment not being achieved.

Even when they are successfully performed, ARMs need the support of higher PEEP values in order to promote alveolar stability in the newly recruited lung regions. In the case reported here, the ideal PEEP was determined by titration in function of the variation in static compliance in the PCV mode.[7]

The damage to the lung parenchyma and the distribution of inhaled gas volume associated with acute lung injury and ARDS are heterogeneous. Chest CT scans allow the evaluation of the following:

- areas of the lung parenchyma in which aeration is preserved, principally in the nondependent regions
- areas of consolidation, with fluid or atelectasis, principally in the dependent regions
- a transition area, in which atelectasis occurs during exhalation and opening occurs during inhalation

In the case reported here, CT revealed heterogeneous lung aeration. The objective of protective ventilation is to prevent lung injury due to alveolar overdistension (volutrauma), which occurs primarily in areas of normal lung, given that the volume delivered goes to the area of least resistance and compliance. It is important to calculate the ideal PEEP in order to prevent lung injury due to recurrent atelectasis or cyclical alveolar reopening (atelectrauma). The two mechanisms of lung injury can trigger the release of inflammatory mediators and favor bacterial translocation.[4]

The case reported here reinforces that leptospirosis can cause ARDS and that there is a potential synergy between the use of low tidal volumes and ARMs followed by titration of the ideal PEEP by static compliance in patients with leptospirosis.

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