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Case Report

Incomplete Drainage of Total Pulmonary Lavage as a Cause of Double-Lumen Tube Malposition: A Case Report

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Abstract

Introduction: Although a variety of techniques are available to achieve lung isolation in adults, double lumen tube (DLT) placement is essential for performing bronchoalveolar lavage (BAL) because it allows rapid conversion from one-lung ventilation to two-lung ventilation as well as optimal suction and drainage of lavage solution. Nevertheless, one of the main complications that can occur during BAL is retrograde migration of the DLT into the trachea, which can lead to interruption of ventilation and instillation of lavage fluid in both lungs. **Case Presentation**: 60-year-old man underwent total bronchoalveolar lavage under general anesthesia with placement of a DLT. During the procedure, drainage of lavage fluid was less than the amount of fluid instilled into the lung. A neutral position of the cervical spine and a deeper insertion of the bronchial tube were not sufficient to avoid the withdrawal of the DLT. **Results**: BAL could be performed by increasing the passive drainage time, and by active aspiration of the residual lung solution. The procedure was completed after observing that the last aliquot of the lung lavage was transparent. **Discussion**: Fluid retention with the consequent increase in pressure in the tracheobronchial tree favored the withdrawal of the DLT towards the trachea obstructing the airway. **Conclusion**: In case of incomplete drainage of lung lavage fluid accompanied by increased airway pressure, active aspiration of lavage fluid should be performed with a bronchoscope to avoid malposition of the DLT.

Keywords: Bronchoalveolar Lavage; Double Lumen Tube; Alveolar Proteinosis; Lung Lavage Solution

Introduction

Double-lumen endotracheal tube (DLT) is placed to isolate the lungs and provide independent ventilation. Indications for lung isolation include pulmonary contamination due to hemorrhage or infection, bronchopulmonary fistula, pulmonary cyst or bulla, severe hypoxemia due to unilateral lung disease, and whole bronchoalveolar lavage (BAL) [1]. The longer lumen (bronchial lumen) is designed to reach the main bronchus, whereas the shorter lumen (tracheal) ends in the distal trachea [2].

Some authors reported an incidence of malposition of the DLT in 42% of patients undergoing general anesthesia, which was related to postural changes, flexion, and extension of the neck (due to lengthening of the distance from the teeth to the tracheal carina), and surgical procedures around the pulmonary hilum that displace the DLT in a receding direction [3]. Also, although objective guidelines are lacking for the appropriate selection of DLT sizes, it is important to choose the best one for each patient to avoid malposition and respiratory obstruction problems. Generally, 39 Fr and 41 Fr tubes are used in adult men, while 35 Fr and 37 Fr DLTs

are used in adult women; however, sex, age, height, and weight are poor predictors of tube size, [4,5] and direct measurement of bronchial width by chest CT, chest X-ray, or ultrasound are better predictors [6-8].

We present a case of repeated malposition of the DLT in a patient with pulmonary alveolar proteinosis undergoing BAL. The consideration of the measures described in the literature (neutral position of the cervical spine, deeper insertion of the bronchial tube) was not sufficient to avoid the withdrawal of the DLT, and pulmonary ventilation was compromised. Therefore, other causes of DLT malposition should be considered during alveolar proteinosis treatment.

Case Presentation

A 60-year-old man was diagnosed with primary alveolar proteinosis. The chest x-ray showed bilateral peribronchovascular infiltrates. The computerized tomography scan showed progression of bilateral diffuse pulmonary involvement with the appearance of extensive areas in a crazy-paving pattern (appearance of ground-glass opacities with superimposed interlobular and intralobular septal thickening). Bronchoalveolar fluid cytology showed the presence of macrophages (28%) (absence of hemosiderophages), lymphocytes (69%), neutrophils (3%), amorphous extracellular eosinophilic material (Periodic acid–Schiff positive) in nodular formations, and cytoplasmic staining of foam cells. Pulmonary function testing demonstrated normal spirometry with decreased diffusion capacity of the lung for carbon monoxide (35% of predicted). The distance walked in the six-minutes' walk test was 527 m, maintaining a baseline SpO_2 of 94% and a minimum of 89%. Given the recurrence of the disease, BAL was performed under general anesthesia.

At the beginning of the procedure, the equipment was checked, including 20 L of normal saline, an infusion of the serum system with a Y-piece connector and clamps, and a plastic container (Figure 1). The oxygen peripheral saturation (SpO_2) was 90-94% on room air, non-invasive arterial tension was 132/80 mmHg and heart rate 72 bpm. Anesthetic induction was performed using fentanyl (150 µg), propofol (170 mg), and rocuronium (65 mg). We performed direct laryngoscopy and advanced the left-sided DLT to 39 Fr. Before starting lung lavage, pulmonary denitrogenation was performed using two-lung ventilation with 100% oxygen, volume-controlled ventilation (tidal volume of 530 mL), 13 breaths per minute, and positive end-expiratory pressure (PEEP) of 5 cm H_2O for 30 min. The patient was placed in the supine position in an anti-Trendelenburg position (at a 30-degree angle). Thirty minutes before starting the BAL, a fiberoptic bronchoscope was inserted through the right lumen of the DLT to ensure the correct position of the DLT. Pressure-controlled ventilation was initiated for the right lung (maintaining tidal volume between 430-490 mL, 15 breaths per minute, PEEP 5 cm H_20, and FiO_2 0.6%). Then, BAL was started; 200 mL of saline was instilled to fill the left lung, and aliquots of 1000 mL of saline were infused at 38°, keeping the wash bags 40 cm above the mid-axillary line. After infusion of each 1000 mL aliquot, passive drainage of the effluent was performed for 10 min, without achieving a complete return of the instilled liquid despite increasing the drainage time.

After the instillation of 4000 mL of washing solution, we only recovered a total of 3100 mL and a strong increase in the maximum airway pressure up to 52 cm H_2O was obtained without a capnography record. We suspected airway obstruction due to removal of the bronchial tube towards the trachea, confirmed by fiberoptic bronchoscopy. We decided to introduce the DLT more distally (the bronchial cuff was placed 4 cm deeper from the tracheal carina) near the first left bronchial branch, ensuring its patency, but the result was not successful.

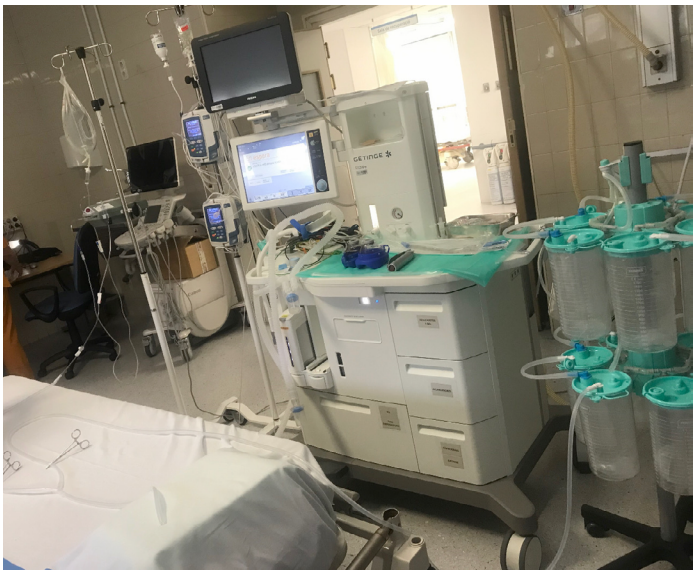

Figure 1: Whole lung lavage equipment.

Finally, we managed to avoid the removal of the DLT after revision of the right bronchial tree with recovery and aspiration of 200 mL of saline, and with active aspiration of the residual solution from the left lung using fiberoptic bronchoscopy. The procedure continued by increasing the inspiratory pressure from 19 to 25 mmHg to maintain the tidal volume in the right lung (400 mL) and increasing the passive drainage time to 20 min after each instillation of lavage solution, followed by active aspiration of the residual solution. Even so, 9000 mL of saline was used to lavage

the left lung, and only 7050 mL was recovered. The procedure was completed after observing that the last aliquot of the lung lavage was more transparent and without a precipitate (Figure 2).

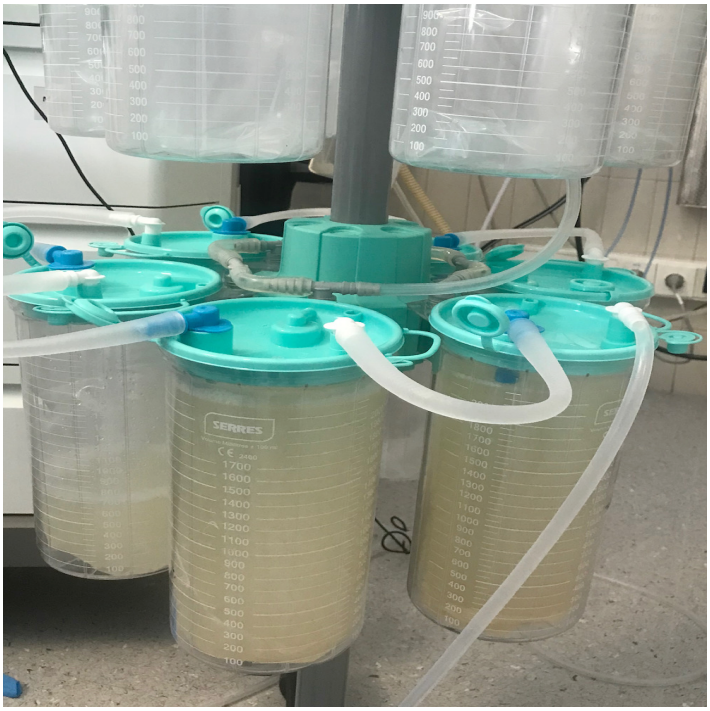

Figure 2: Drained lung lavage.

Results

The total duration of the procedure was 6 hours. A lung ultrasound performed at the end of the procedure showed some B lines (<3 B-lines) in the right basal lung field and ≥3 B-lines in the left basal lung field.

As soon as the procedure was completed, the patient was extubated and transferred to the Intensive Care Unit, where he remained for 24 hours with a Venturi mask (Ventimask, flow rate 6 L/min, 31% oxygen). Once in the hospital ward, oxygen therapy was progressively reduced until it was discontinued, maintaining a SpO_2 greater than 96% on room air. Given that the proteinaceous material extracted in the first BAL of the most affected lung (left lung) was less than expected and that the patient had clear respiratory improvement, we decided to suspend the BAL of the right lung. The postoperative radiological study showed a marked decrease in the ground-glass areas, and lung ultrasound revealed the presence of pleural sliding, B lines in the lung bases (<3 B-lines), and A-lines in the rest of the lung fields.

Discussion

To date, insufficient return of pulmonary lavage fluid has not been described as a cause of DLT malposition during the treatment of alveolar proteinosis. Considering that the airway is highly elastic and mobile, and its shape is easily changed by the surrounding tissue, in our patient, we can attribute the removal of the DLT to changes in the shape of the tracheobronchial tree produced by the instillation of the lavage solution and insufficient return [3]. These changes may be greater when the drainage of lavage fluid is less than the amount of fluid instilled. This would produce fluid retention and an increase in pressure in the tracheobronchial tree that would favor the withdrawal of the bronchial tube towards the trachea, as well as the need to increase the right ventilatory pulmonary pressures, as observed in our patient. Infact, some authors recommend discontinuing diagnostic BAL when the difference between the instilled and aspirated volumes is greater than 100 ml for a given lung area [9]. However, there are no reports that confirm what this difference should be in complete therapeutic BAL for alveolar proteinosis, given the great individual variability of washout return. We had problems with poor placement of the DLT after 900 mL of fluid was retained into the bronchial tree. In any case, hemodynamic and respiratory factors should determine whether the lavage procedure should be continued. So, to avoid the withdrawal of the bronchial tube into the trachea during BAL, a set of small details must be considered to achieve successful results. A deeper insertion of the bronchial tube of the DLT into the main bronchus must be performed such that the tip of the bronchial tube is placed as distally as possible to the carina, ensuring the patency of the upper bronchial branches; thus, fiberoptic bronchoscopy should always be used to confirm the correct position [10]. In addition, it is important to choose the proper DLT and minimize movements of the cervical spine to maintain a neutral position.

Conclusion

We conclude that correct drainage of the washing solution must be guaranteed. This can be achieved by increasing the passive drainage time after infusion of each aliquot and by performing active aspiration of lavage fluid through the fiberoptic bronchoscope. Increased pressure in the airway can alert us to excessive accumulation of fluid that should be drained to avoid poor placement of the DLT and subsequent respiratory compromise.

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Ethical Considerations: Written informed consent from the patient was obtained to present this case.

Conflict of Interest: None .

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