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Case Report

Massive Bronchoalveolar Lavage Applications in a Case of Pulmonary Alveolar Proteinosis

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Abstract

Background: Pulmonary alveolar proteinosis is a pathology that causes ventilation impairment secondary to protein accumulation in the alveoli. Massive bronchoalveolar lavage (MBL) is the main approach in the treatment of pulmonary alveolar proteinosis and is useful in improving ventilation and reducing the need for oxygen support in patients. In this article, we aim to present the anaesthetic approach during MBL performed in the left and right lungs at a 1-month interval in the case of PAP.

Case Presentation: A 40-year-old male patient with a diagnosis of PAP was admitted for therapeutic lavage under general anaesthesia with appropriate hemodynamic monitoring. Two lavage procedures performed with a 4-week interval were successfully completed and the patient showed clinical improvement.

Conclusion: MBL is a rare and complicated procedure. It is important to provide adequate lavage fluid and heating before the procedure. In addition, special preparation is required for the necessary equipment and monitoring. In the presence of an experienced multidisciplinary team, we believe that the procedure will be safe and beneficial and will improve the patient's quality of life.

Keywords

Massive Bronchoalveolar Lavage, Pulmonary Alveolar Proteinosis, Hypoxia

Introduction

Massive bronchoalveolar lavage (MBL) is a method used to remove materials filling the alveoli in conditions such as pulmonary alveolar proteinosis (PAP), alveolar microlithiasis, acute silicosis and inhalation of radioactive particles. Therapeutic bronchoalveolar lavage is performed under general anaesthesia using a double-lumen tube (DLT) [1]. PAP was first described by Rosen et al. [2] in 1958. PAP is a diffuse lung disease characterized by the accumulation of periodic acid Schiff (PAS) positive phospholipid materials in the alveoli preserving the septal structure of the interstitium [3, 4].

In this article, we aim to present the anaesthetic approach during MBL performed in the left and right lungs at a 1-month interval in the case of PAP.

Case Presentation

A 40-year-old male patient with diffuse consolidation on high resolution chest tomography **(Figure 1a)** and dyspnoea on exertion was consulted to us from the chest diseases clinic of our hospital for MBL with a diagnosis of PAP as a result of PAS (+) in lavage samples obtained by fibreoptic bronchoscopy.

Bilateral rales were present in the pre-procedural anaesthetic evaluation of the patient who had progressive dyspnoea and hypoxemia and was initially planned for left MBL. Diffuse alveolar consolidation was observed on chest radiography **(Figure 1b).** Restrictive changes were found in pulmonary function tests (PFT). Preoperative, arterial blood gases (ABG) and PFT values in our patient were as follows: pH:7.50, pCO_2:29 mmHg, pO_2:49 mmHg, forced vital capacity (FVC): 3.01 L, forced expiratory volume at 1st second (FEV_1): 2.45 L, FEV_1/FVC: 81%, Diffusing capacity of the lung (DLCO): 30% **(Table 1).**

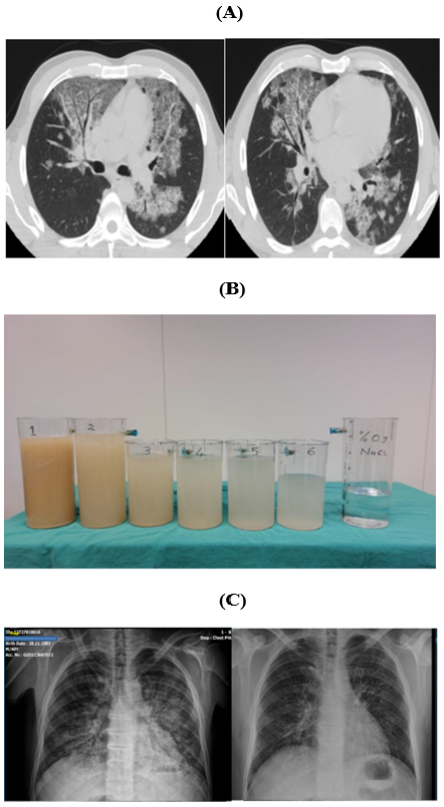

Figure 1: **A:** Chest tomography of the patient prior to left and right MBL **B:** Appearance of drainage fluids at the beginning and end of lavage **C:** Chest radiographs before and after MBL

Table 1: ABG, PFT and DLCO before and after massive bronchoalveolar lavage (MBL)

	Before MBL	After left MBL	After right MBL
pH	7.50	7.45	7.41
P_aCO_2 (mmHg)	29	36	36
P_aO_2 (mmHg)	49	72	84
FVC (L)	3.01(68%)	3.65(83%)	3.89(88%)
FEV_1 (L)	2.45(67%)	3.24(89%)	3.36(92%)
FEV_1/FVC (%)	81%	89%	86%
D_LCO (mmMol/kPa.min)	30%	50%	74%

ABG=Arterial blood gases, *PFT*=Pulmonary function tests *DLCO*=Diffusing capacity of the lung, *FVC*=forced vital capacity; *FEV_1*=forced expiratory volume at 1st second.

General anaesthesia was planned for MBL with ASA (American Society of Anaesthesiologists) 2 risk due to tobacco use in the patient with no diagnosed comorbidities. Informed consent was obtained from the patient before the procedure. After premedication with midazolam, the patient was taken to the operating room and firstly Electrocardiogram, heart rate (HR), blood pressure, and peripheral oxygen saturation (SpO_2) were monitored. Following preoxygenation with 100% oxygen, general anaesthesia was induced with propofol and fentanyl. Paralysis was induced with rocuronium and the position of the tube was confirmed with a fiberoptic bronchoscope (Medcaptain Bry-25) after placement of the left DLT. Anaesthesia was maintained with sevoflurane. Invasive arterial pressure was monitored throughout the procedure and intermittent ECG analyses were performed. In addition, a central venous catheter, oesophageal temperature probe, and foley catheter were placed. During one-lung ventilation using 100% O2, tidal volume was adjusted to 6 ml/kg according to ideal body weight and respiratory rate to 14-16/min ($ETCO_2$=30-35 mmHg). 0.9% NaCl at body temperature was used as lavage fluid. DLT placement was checked periodically with a fiberoptic bronchoscope.

During MBL, a 150 cm long Y-shaped set was used. Saline was infused 50 cm above the carina. The lung was filled with saline in sessions lasting 5-8 min and 700-1000 mL per session. After each filling, one side of the set was clamped and the other side was opened, and the fluid was drained from the lung with manual chest percussion and gravity. After a total of 15 L of saline was used during MBL, the left MBL was terminated uneventfully when the drainage fluid became clear (Figure 1b). After 4 hours of left MBL, total fluid retention in the lung was 400mL. The patient was extubated after neuromuscular blockade antagonism with Suggammadex in the operation room. After being followed up in the intensive care unit (ICU) for 16 hours, he was transferred to the ward without any problems. Improvements in ABG, SFT and DLCO were observed on the ward compared to the preoperative period and are shown in **Table 1**.

Four weeks after left MBL, following a repeat pre-anaesthetic evaluation, the general anaesthesia and MBL protocol were the same for the patient who came for the right MBL. Right MBL lasted 3 hours, a total of 10 L of saline was used and 500 mL of fluid retention was detected. Following extubation, the patient was followed up in the ICU for 18 hours, and no adverse event developed. The next day, the patient was transferred to the ward and improvement was observed in ABG, SFT and DLCO values compared to the first lavage application and shown in **Table 1**.

Table 2 shows perioperative ABG values in MBL procedures. On chest radiographs, a decrease in consolidation areas was observed compared to the preoperative period **(Figure 1c).**

Informed consent was obtained from the patient for the case to be presented and published.

Table 2: ABG parameters during massive bronchoalveolar lavage (MBL)

	Pre	DLV[1]	1. L	5. L	10. L	15. L	DLV[2]	Extub.	Rec.
Left MBL									
pH	7.49	7.46	7.44	7.44	7.43	7.44	7.41	7.43	7.46
P_aCO_2 (mmHg)	29	34	37	37	36	38	39	34	32
P_aO_2 (mmHg)	49	113	92	84	88	82	132	77	74
	Pre	**DLV1**	**1. L**	**5. L**	**10. L**		**DLV2**	**Extub.**	**Rec.**
Right MBL									
pH	7.47	7.41	7.39	7.40	7.39		7.37	7.41	7.43
$PaCO_2$ (mmHg)	32	36	35	40	39		72	36	34
PaO_2 (mmHg)	64	84	81	136	98		94	82	78

ABG=arterial blood gases, *Pre*=prior to left MBL, *DLV1* =20. min of double-lung ventilation, *DLV2* =20. min of double-lung ventilation following lavage, *Rec*=recovery, *Extub*.= post extubation

Discussion

PAP is a rare primary lung disease characterized by the accumulation of surfactant-related lipids and proteins in the alveoli [3, 4]. The main cause of PAP is abnormalities in the clearance and production of pulmonary surfactant by alveolar macrophages and type II alveolar cells. PAP consists of various disorders that can be classified as autoimmune, secondary, or congenital according to their etiology and underlying pathogenesis.

PAP is diagnosed by clinical, radiological, pathological, and laboratory findings. Patients with PAP report progressive dyspnea, a mostly productive cough, and other symptoms such as fatigue, weight loss, chest discomfort, joint pain, and fever. PAP is often initially misdiagnosed as pneumonia. After multiple ineffective empirical antibiotic treatments, physicians begin to reassess the diagnosis and refer the patient for further evaluation. This delay in reaching the correct diagnosis usually averages 1.5 years. Chest X-ray shows bilateral and symmetric patchy consolidations causing progressive hypoxemia and dyspnea [5]. PFT and ABG analysis can be used to assess the severity of the disease and response to treatment [6]. Unlike acute pulmonary edema, PAP does not cause cardiac enlargement or pleural effusion. In our patient who has been followed for 4 months with the diagnosis of PAP, the radiological imaging findings, bronchoalveolar lavage examination, PFT and ABG values were consistent with the current diagnosis of PAP. Thoracic computed tomography (CT) scans play an important role in the diagnosis of PAP. The main CT scan abnormalities in PAP are ground-glass opacities, thickening of the interlobular septum, and thickening of the intralobular septum with consolidation. Reticulations are usually seen as ground glass opacities and produce a distinctive 'crazy pavement' pattern.

Diagnosis of PAP usually involves analysis of the association of symptoms, detailed imaging such as high-resolution CT scans, and bronchoscopy to examine the bronchoalveolar lavage with PAS staining.

MBL is an effective method for treating PAP [7]. Bronchoalveolar lavage fluid in PAP usually shows increased cellularity with a higher proportion of lymphocytes compared to healthy controls. The criterion for performing MBL is a PaO_2 of less than 60 mmHg at rest or with hypoxemia-limited activity [5]. Hydropneumothorax, bronchospasm, and pneumonia are rare complications of MBL [1, 8]. In our patient, MBL was indicated because of a PaO_2 of 49 mmHg on room air and exercise intolerance. The patient was monitored to prevent hemodynamic instability, hypoxemia, and hypothermia. It is essential to monitor body temperature, hemodynamics, and ECG during MBL [3]. In such cases, preoxygenation is necessary before induction [5, 7]. In order to avoid dangerous hypothermia during the procedure, the saline temperature should be 35-37.5 °C [3, 7, 9]. Filling the lungs with large volumes may cause a sudden increase in intrathoracic pressure and CVP due to the hydrostatic pressure created by the fluid, mediastinal shift, and interruption of blood flow in the lavaged lung [10, 11]. No critical changes were observed in hemodynamic and oxygenation in our patient. It has been reported that CVP increases during the filling phase of the lung and returns to its previous levels with the discharge of the fluid [12]. Although fluctuations were observed in CVP during both MBLs in our patient, these changes were within normal limits.

During MBL, the patient can be in the lateral decubitus or supine position [1, 13]. The disadvantage of the lateral position is that if the lavage lung (independent) remains on top, there is a high risk of fluid leakage to the other lung (dependent), while the advantage is the

decrease in blood flow in the independent lung [5, 13]. In a similar case previously published, the supine position was preferred during MBL and the procedures were performed successfully [14]. No side effects related to the patient's position developed during both MBLs performed in the supine position.

A sudden decrease in SpO_2 during MBL, air bubbles in the lavage fluids, and inadequate resistance may reflect inadequate isolation of the two lungs; therefore, the position of the DLT should be checked with a fiberoptic bronchoscope [5]. We checked the position of the DLT with a bronchoscope after intubation and at regular intervals throughout the procedure.

Transient decreases in SpO_2 during drainage (fluid intake) are due to increased blood flow in the lavage and non-ventilated lung [5, 11]. In our patient, for whom we think SpO_2 monitoring is important, SpO_2 slightly decreased. In the patient without hypercapnia, the minimum SpO_2 value during MBL was 93%, while the minimum PaO_2 was 72 mmHg.

Claypool et al. [3] reported 500-1500 mL fluid retention in their patients. However, there are also PAP cases in the literature in which fluid retention was not observed during MBL [13]. In our case, 400 mL of fluid retention was observed after left MBL and 500 mL after right MBL, which is acceptable. We observed significant improvement in clinical and laboratory findings at the end of both MBLs.

Conclusion

MBL is a rare and complicated procedure, and it physically removes lipoproteinaceous material from the alveolar spaces and effectively reverses physiological defects [15]. It is important to provide adequate lavage fluid and warming before the procedure. In addition, special preparation is required for the necessary equipment and monitoring. We believe that with an experienced multidisciplinary team, the procedure will be safe and beneficial and will improve the patient's quality of life.

Author contribution statement

All authors (OK, ÖDI, MEŞ, FÖY, MT, HS) participated in the planning, writing, editing, and review of this manuscript.

Declaration of patient consent

Informed consent was obtained from the patient for the case to be presented and published.

Conflicts of interest

None Declared.

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