Anaesthetic Management of Whole Lung Lavage in a Resource-Limited Setting: Case Report

R Varun[1*], KAP Dhammika[2] R Jayathilaka[2], S Pakeerathan[3]

[1]Registrar in Anaesthesiology, National Hospital for Respiratory Diseases, Welisara*

[2]Consultant Anaesthetist, National Hospital for Respiratory Diseases, Welisara

[3]Senior Registrar in Anaesthesiology, National Hospital for Respiratory Diseases, Welisara

Abstract

Pulmonary Alveolar Proteinosis (PAP) is a rare disease[1] Whole lung lavage (WLL) is the gold standard treatment for pulmonary alveolar proteinosis (PAP)[2]. The process of WLL has complex cardio-pulmonary interactions and is a challenge for an anaesthetist. In Sri Lanka, only a few cases have been reported[3,4] but none have described the experience of anaesthetising for WLL. We report a case of a 32-year-old female with severe PAP who underwent WLL in a resource-limited setting.

Keywords: *Whole Lung Lavage, One Lung Anaesthesia, Pulmonary Alveolar Proteinosis, Anaesthetic issues*

CASE HISTORY

A 32-year-old chemical factory labourer presented with exertional dyspnoea for 01 year, associated with a non-productive cough and weight loss of 3 months duration. She was investigated and diagnosed with Pulmonary Alveolar Proteinosis (PAP). She was referred to the National Chest Hospital for further management. Following a multi-disciplinary team meeting, she was scheduled for a right-sided whole lung lavage (WLL) under general anaesthesia.

On preprocedural examination her BMI was 19units. She had grade ii clubbing and was hypoxic at rest. Her saturation was 81% on room air and 93% on 4L/min oxygen via facemask. Her respiratory rate was 20/min. There were bilateral coarse crepitations on auscultation. Rest of the system examination was unremarkable. Blood gas analysis on 4L/min O_2 revealed P_aO_2 of 63.1mmHg, P_aCO_2 of 35.5mmhg and a pH of 7.422. Her FEV_1 was 32%, FVC was 28% of the predicted and FEV_1/FVC was 0.86, her haemoglobin was 14.3g/dL and DLCO was 63%. Chest X-ray and HRCT (Fig 01 & 02) showed bilateral ground glass appearance in all lobes. All other blood work, ECG and 2D echocardiogram was normal.

Standard monitoring according to AAGBI was established. Two cannulae, 18G and 16G were inserted to the forearm and right external jugular vein respectively and infused 500ml of Ringer's lactate solution. Patient was catheterised and urine output was measured hourly. The patient was preoxygenated with 100% oxygen via facemask for 5 minutes. Anaesthesia was induced with 100µg of fentanyl, 150mg of

*Correspondence: R Varun
Email: dudevraj@gmail.com
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propofol and paralysed with 40mg of atracurium. A left sided 35FG double

lumen endotracheal tube (DLT) was inserted, and the position was confirmed with sequential auscultation and paediatric fibre optic bronchoscopy (FOB). The right lung was isolated and only left lung was ventilated. Patient was positioned in the left lateral decubitus position and tube position was re-confirmed. One lung ventilation with tidal volumes between 250-300ml at a rate of 15 breaths per minute with 100% Oxygen was commenced. Anaesthesia was maintained with isoflurane with a MAC between 1.2 – 1.5 Oxygen saturation was above 94% and E_TCO_2 between 35-40mmHg throughout the procedure, with mean arterial pressure around 90mmHg.

Warm saline -700ml was instilled slowly into the right lung using the tracheal opening of the DLT. The lung was then percussed for 7-10 minutes by the physiotherapist following which the fluid was drained out of the lungs. Total of 5 litres of warm saline was instilled. A total of 4200 ml of white proteinaceous fluid was recovered.

The DLT was removed, and a single lumen ETT was inserted .Patient was sent to ICU for observation. On the postoperative day two, patient was extubated on to a CPAP mask and was gradually weaned off over 2 days to a nasal oxygen and sent to ward with 2L/min Oxygen. Patient was discharged on sixth postoperative day. He was devoid of any critical events.

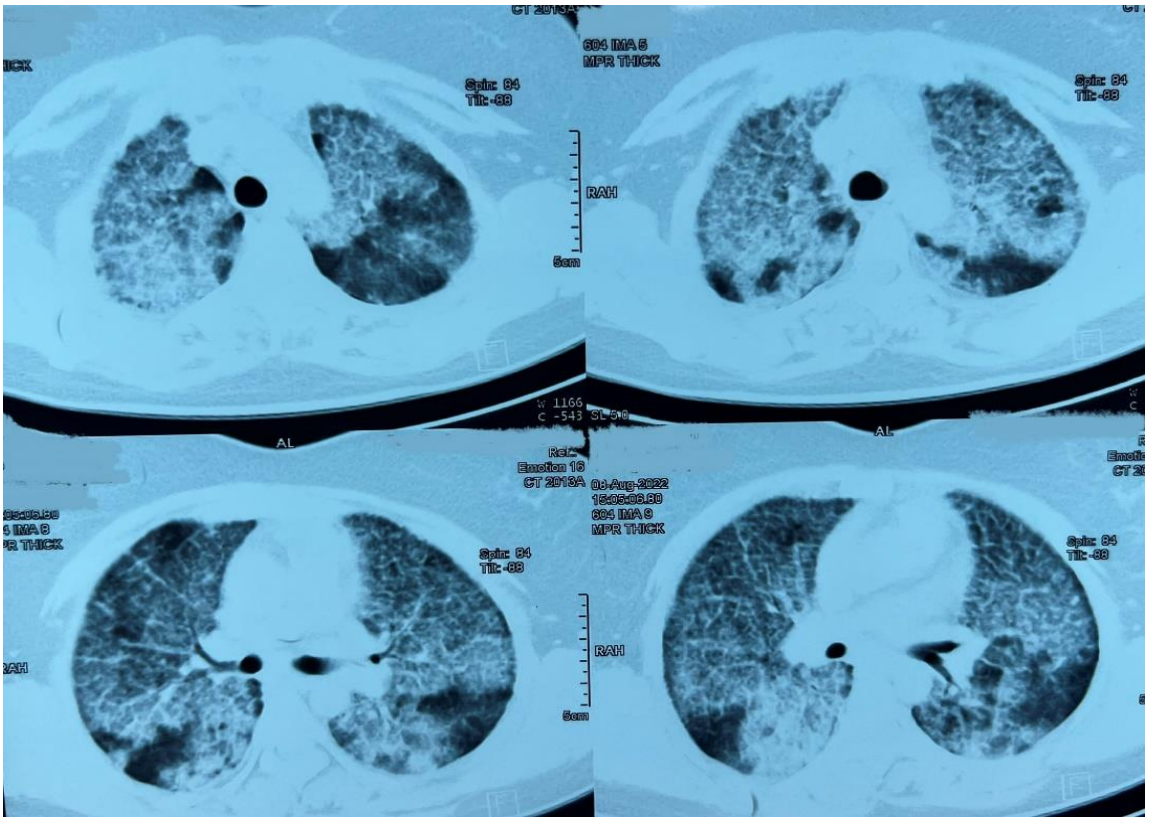


Figure 1: *Preprocedural High Resolution CT showing ground glass appearance.*

DISCUSSION

Pulmonary Alveolar Proteinosis (PAP) is a rare disease first described by Rosen *et al* [1], which is characterised by accumulation of surfactant in the alveoli. Different pathophysiological processes have been described[5]. There is a strong association with inhaled industrial fumes, toxins and tobacco smoking[3,5,6]. Symptoms are often non-specific ranging from mild dyspnoea to type 2 respiratory failure[1,3,4,6]. Prevalence and incidence vary depending on geographical location between 0.1 to 40 per million and 0.2 per million, respectively by several authors mainly amongst caucasians[3,5,6]. Majority of the patients are between 20-50 years of age with a male preponderance[3]. Contrary to these findings, the only 3 reported cases in Sri Lanka, were all middle aged females [3,4,7]. Our patient was middle-aged, and the likely causative factor was related to her occupation.

Figure 1: *Preprocedural chest radiograph showing bilateral shadowing consistent with PAP*



Segmental and selective lobar lavage under local anaesthesia using FOB has shown promising results[8,9].However whole lung lavage (WLL) is considered the mainstay of treatment involving repeated cycles of filling and emptying the lung with normal saline[2,10].

Anaesthesia for WLL is challenging and a rewarding experience for an anaesthetist.

The possibility of chronic hypoxia induced organ damages should be assessed preoperatively and lung functions should be optimized as much as possible. Cardiovascular integrity, hepato-renal functions and cerebral functions should be assessed and optimised accordingly.

Regarding conduct of anaesthesia for WLL, general anaesthesia with total intra-venous anaesthesia has been shown promising specially in paediatric population where gaseous agent uptake is not predictable[11], but literature suggest gaseous agents are also equally effective[8,10,12,13]. Major problems during one lung ventilation are hypoxia and hypercapnoea. General anaesthesia itself will reduce lung compliance and functional residual capacity (FRC) of the lungs. Ventilation perfusion mismatch is greater during one lung ventilation (OLV). During lung collapse, hypoxic vasoconstriction causes near complete diversion of blood to the ventilated lung[14] as opposed to WLL where the lung is filled and emptied with saline. Webb *et al* describes compression of non-ventilated lung during filling which is reversed during drainage, causing large shunts leading to hypoxia[8].

Various literature suggest the use of extra-corporeal membrane oxygenation, hyperbaric oxygen, ventilation of partially fluid filled lung, intermittent double lung

ventilation and occlusion of pulmonary artery to overcome hypoxia during WLL[12,13,15]. Use of nitric-oxide has been shown to improve preconditioning of the pulmonary vasculature for an effective hypoxic pulmonary vasoconstriction of non-ventilated lung by some authors[15,16].



Figure 3: *Lavage samples showing washouts. First sample (Far right) showing thick milky appearance and last sample showing clearer fluids*

Rabid blood pressure fluctuations is well-documented, needing IV vasopressors[17]. Exact pathophysiology is not known. Similarly dilutional acidosis is a problem, mainly due to absorption of lavage fluid [18]. Serial ABGs and invasive monitoring is helpful in overcoming these problems. The importance of invasive blood pressure monitoring, cardiac output monitoring and serial arterial blood gas analyses are well described [8,10,12], but some have shown with minimal resources and careful monitoring, PAP patients can be anaesthetised safely[8]. During recovery in ICU, application of continuous positive airway pressure and administration of IV diuretics were used for to maintain a negative fluid balance and improve ventilation which has shown to be beneficial[8,14,18].

Since this patient had more infiltrates in the right lung, right lung WLL was performed first. Complete isolation of the lungs is critical, as small amount of spillage into the ventilated lung may further compromise ventilation. Monitoring of airway pressures and tidal volumes is very important to detect fluid leak into ventilated lung[8]. Left sided DLT and confirmation with FOB is essential. Right sided DLT was avoided as it has a higher chance of occluding the upper-lobe and lavaging will not be complete[8,14]. Regarding patient positioning, none of the positions are proven to be superior. To improve ventilation the left lung was kept down[2,10,14]. Similarly, hypothermia should be prevented. Lavage fluid should be warmed. All IV fluids were warmed, and the patient warming was achieved using conventional methods and there was minimal change in temperature. Furthermore, communication and functional synchrony between the members is crucial from inception, during procedure and post procedural care is inexorable in

preventing complications and improving outcome[8]

CONCLUSION

Anaesthetic management of a patient with PAP and undergoing WLL is a challenge for an anaesthetist. We have described our experience of safely anaesthetising a patient with good preoperative optimization, basic monitoring with existing equipment and proper communication between all stake holders whilst being in a resource limited setting,

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