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Hypoxia Management during One-Lung Ventilation in a Patient with Mediastinal Abscess and Mediastinitis for Open Thoracotomy. Case Report

Manejo de la hipoxia durante ventilación unipulmonar en un paciente con absceso mediastinal y mediastinitis para toracotomía abierta. Reporte de caso

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Abstract

Introduction: most of the patients undergoing thoracic surgery fit in the high risk group for hypoxia, especially when deciding to use one-lung ventilation due to the V/Q mismatch; therefore, new ventilation strategies and hypoxia rescue manoeuvres have been developed. **Clinical course:** we present an 85-year old female with no major co-morbidities scheduled for open thoracotomy and managed with one-lung ventilation. During the course of the anaesthetic management, hypoxia presents secondary to V/Q mismatch and haemorrhagic hypovolemic shock, with a positive response to hypoxia rescue manoeuvres. **Conclusion:** it is important to prevent as much as we can the hypoxia in a one-lung ventilation following the new ventilation strategies. Although when facing a crisis, proper hypoxia management with a modern approach should not be delayed.

Keywords: one-lung ventilation, hypoxia, mechanical ventilation, protective ventilation.

Resumen

Introducción: la mayoría de los pacientes que se someten a cirugía torácica pueden ser clasificados en el grupo de alto riesgo para hipoxia, especialmente cuando se decide por una ventilación unipulmonar, debido al desequilibrio V/Q; por lo tanto, se han desarrollado nuevas estrategias ventilatorias y maniobras de rescate para hipoxia. **Curso clínico:** presentamos una paciente de 85 años de edad sin comorbilidades programada para toracotomía abierta y manejada con ventilación unipulmonar. Durante el manejo anestésico, se presenta hipoxia secundaria a desequilibrio V/Q y choque hipovolémico hemorrágico, con respuesta positiva a las maniobras de rescate para hipoxia. **Conclusión:** es importante prevenir en la medida de lo posible la hipoxia en la ventilación unipulmonar, siguiendo las nuevas estrategias ventilatorias. Sin embargo, cuando se presenta una crisis, no debemos retrasar las maniobras de rescate de forma moderna.

Palabras clave: ventilación unipulmonar, hipoxia, ventilación mecánica, ventilación protectora.

Introduction

Hypoxemia is one of the most common complications during one-lung ventilation (OLV) in patients undergoing thoracic surgery, due to fewer gas exchange surface, V/Q mismatch which is produced during non-dependent lung collapse and patient position during surgery.[1,2] Hypoxemia is less common in patients in lateral decubitus rather than in supine position, due to the perfusion flow to the dependent lung because of gravity and hypoxic pulmonary vasoconstriction (HPV).

Here, we discuss a case in which risk factors for hypoxia during OLV are present, therein, protective ventilation following the newest evidence was the most adequate option. Also, we describe proper management after the onset of hypoxemia, with no latter complications.

Medical history

January 2023, an 85-year old female diagnosed with left mediastinal abscess is scheduled for open thoracotomy. As a background, she is allergic to penicillin (causing rash), no history of smoking, heart disease, cancer or any other comorbidity; history of sudden left pleural effusion in December 2022 treated with a chest tube, days of hospital stay not specified. She is discharged and weeks later she presents with fever and respiratory distress. CT shows a mediastinal mass adjacent to the lower left lung (Figures 1 y 2), mediastinal abscess and mediastinitis was suspected. Broad-spectrum antibiotic management is started and she is scheduled to the operating theatre (OT) on January 27th, 2023.

Figura 1.
Mediastinal view showing soft tissue invasion from mediastinal mass.

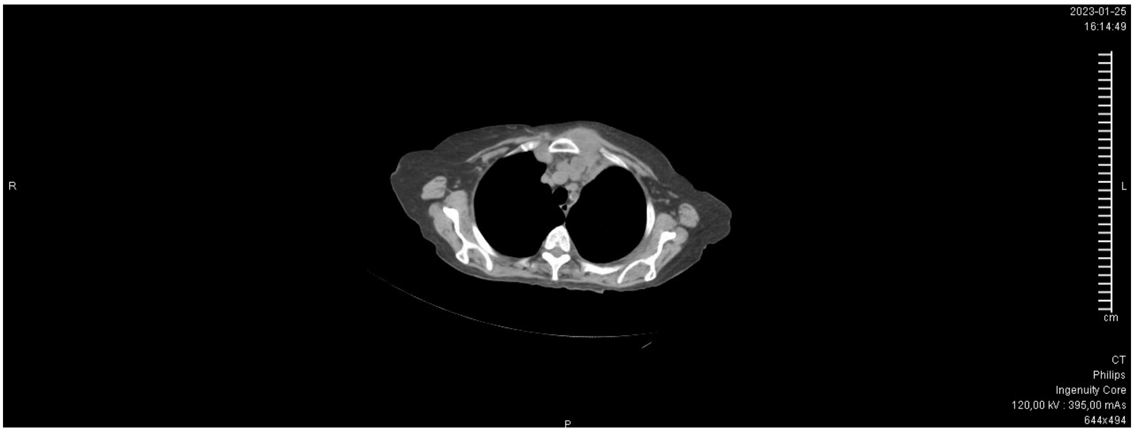


Figura 2.
Chest TC showing a mediastinal mass that suggests pleural effusion and mediastinal abscess

Clinical course

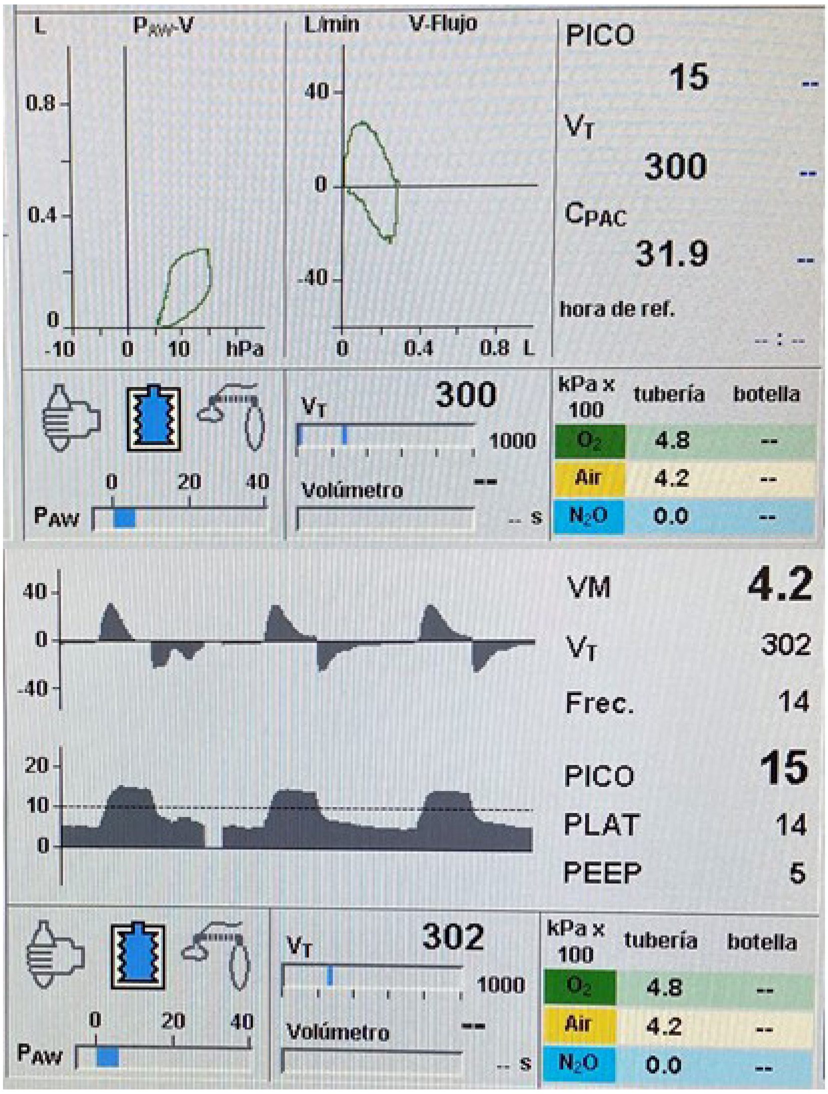
In the OT, initial vitals BP 121/65 mmHg, HR 66 bpm, $SatO_2$ 95% with supporting oxygen by face mask and FiO_2 60%.

Videolaryngoscopy is performed, intubated with a 35 fr Robertshaw right lung tube; placing is corroborated by clinical analysis since bronchoscopy was not available at the moment, assuring the upper right lobe ventilation. Mechanical ventilation is started with PC – CMV with the following settings: Ppeak 15 cmH_20, RR 12 rpm, Tinsp 1.7 s, PEEP 5 cmH_20, FiO_2 60%; achieving an average Vt 5 - 6 ml/kg PBW (Figure 3). Also, surgery is performed in supine position, TIVA is the preferred anaesthetic management, using propofol and fentanyl.

Figura 3.

Ventilatory settings used in OLV, protective ventilation ensured, Vt 6 mL/kg PBW, adequate hysteresis, low Ppeak and PEEP 5 cmH_20 for a Caw 31.9 mL/cmH_20

Caw: Airway compliance; PBW: Predicted Body Weight; Ppeak: Peak Pressure.



After 25 minutes into anaesthesia, surgeon requests left lung collapse, tracheal lumen is clipped and one-lung ventilation is started. Ventilator settings are maintained for a Vt 4 mL/kg PBW. In the first 20 minutes of surgery, average $SatO_2$ is 93% - 96%; then $SatO_2$ and Mean Arterial Pressure (MAP) start dropping to 80% and 55 mmHg respectively, due to vascular injury in the surgical field not responding to fluid management (Figure 4). Therein, hypoxia rescue manoeuvres are started: rising Ppeak to achieve a Vt 6 mL/kg PBW and rising FiO_2 100% for at least 5 minutes, improving oxygenation to 92% and starting low-dose norepinephrine to improve cardiac output. After the vascular injury is repaired, surgeon is asked to pause the procedure for another 10 minutes to gradually re-expand left lung, improving oxygenation up to 98%. After a total of 20 minutes, left lung is collapsed again and FiO_2 is lowered to 60% with brief periods of 100% FiO_2 when $SatO_2$ dropps below 92%, low doses of norepinephrine are maintained throughout the surgery and stop after extubation, recruitment manoeuvres (RM) are not performed.

Figura 4.
Vitals before, during and after hypoxia event.

Anaesthesia time	BP (mmHg)	HR (bpm)	SatO2
10'	100/60	70	94%
20'	95/63	80	94%
30'	100/60	80	95%
40'	70/50	95	88
Hypoxia rescue maneouvers + low-dose Norephinefrine			
50'	90/50	85	92%
60'	100/50	80	95%
70'	100/60	80	98%

Arterial blood gases (ABG) are requested in different times of the procedure:

first one 30 minutes after the beginning of one-lung ventilation pH 7.42, pCO_2 31.4 mmHg, pO_2 133 mmHg, $SatO_2$ 99%, Lac 1.0 mmol/L, HCO3 21.8 mmol/L.

Second one before extubation pH 7.35, pCO_2 39 mmHg, pO2 97.3, $SatO_2$ 97%, Lac 1.8 mmol/L, HCO_3 21.4 mmol/L.

A mediastinal and pleural chest tube is placed before closing, left lung is re-expanded and awake extubation is performed; no complications such as bronchospasm or lung edema presents. She is admitted to the ICU with no need for rescue re-intubation.

Discussion

Prior to the implementation of lung protective ventilation, traditional management for OLV in thoracic surgery was focused on a tidal volume of 10 mL/kg (not using predicted body weight), 100% FiO2, zero-PEEP, and avoiding RM strategy.[3]

Modern protective lung strategies focus on lower tidal volumes 4 – 6 mL/kg PBW (some suggest 5 – 6 ml/kg PBW), use of PEEP improving lung compliance, recruitment manoeuvers, lower FiO_2 and the use of PC – CMV. These strategies have demonstrated minimizing the lung injury, causing less lung inflammation, improving lung oxygenation and lung protection.[2,4,5]

Predictors of OLV hypoxemia include factors related to the patient and related to the procedure; such as chronic vasodilator therapy, poor oxygenation during two-lung ventilation (TLV), supine position, vasodilator use, and excessive use of volatile anesthetics.[6]

Normally hypoxemia presents when there is excessive perfusion to the non-dependant lung and total V/Q mismatch high, especially during supine position. In these situations, first we have to improve oxygenation in the dependent lung by raising FiO_2 and improving cardiac output which in this case was impaired due to the excessive blood loss during surgery. Therein, we should reassure blood flow to the ventilated areas, avoid using vasodilators and minimize the use of volatile anesthetics, also gradually re-expand the non-dependant lung if necessary.[6]

Conclusion

Protective lung ventilation has improved not only the outcomes for patients undergoing OLV, but also, have minimized the risk for hypoxemia. Facing an hypoxemia crisis, rescue manoeuvers should be started, based on improving the oxygenation and perfusion in the dependant lung, optimizing anaesthetic and fluid management.

Statements

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