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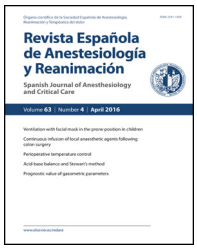

REVIEW

New evidence in one-lung ventilation☆

H. Meleiro[a,*], I. Correia[a], P. Charco Mora[b]

[a] *Serviço de Anestesiologia, Centro Hospitalar de São João, Porto, Portugal*
[b] *Servicio de Anestesiología, Reanimación y Tratamiento del Dolor, Hospital Clínico Universitario de Valencia, Valencia, Spain*

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KEYWORDS
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Protective lung ventilation;
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Abstract Mechanical ventilation in thoracic surgery has undergone significant changes in recent years due to the implementation of the protective ventilation. This review will analyze recent ventilatory strategies in one-lung ventilation.

A MEDLINE research was performed using Mesh term ''One-Lung Ventilation'' including randomized clinical trials, metanalysis, reviews and systematic reviews published in the last 6 years. Search was performed on 21st March 2017. A total of 75 articles were initially found. After title and abstract review 14 articles were included.

Protective ventilation is not simply synonymous of low tidal volume ventilation, but it also includes routine use of PEEP and alveolar recruitment maneuver. New techniques are still in discussion namely PEEP adjustment, ratio inspiration:expiration, ideal type of anesthesia during one-lung ventilation and hypercapnic ventilation.

PALABRAS CLAVE
Ventilación unipulmonar;
Ventilación pulmonar protectora;
Anestesia torácica

Nueva evidencia en ventilación unipulmonar

Resumen La ventilación mecánica en cirugía torácica ha sufrido cambios significativos en los últimos años debido a la implantación de la ventilación protectora. Esta revisión analizará las estrategias ventilatorias recientes en la ventilación unipulmonar.

Se realizó una búsqueda en MEDLINE utilizando el término MeSH «One-Lung Ventilation», incluyendo ensayos clínicos aleatorios, metaanálisis, revisiones y revisiones sistemáticas publicadas en los últimos 6 años. La búsqueda se realizó el 21 de marzo de 2017. Inicialmente se encontraron un total de 75 artículos. Después de la revisión del título y resumen se incluyeron 14 artículos.

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* Corresponding author.
E-mail address: hlmeleiro@gmail.com (H. Meleiro).

La ventilación protectora no es simplemente sinónimo de ventilación de bajo volumen tidal, sino que también incluye el uso rutinario de PEEP y la maniobra de reclutamiento alveolar. Las nuevas técnicas siguen discutiéndose, a saber: ajuste de PEEP, ratio inspiración:espiración, tipo ideal de anestesia durante ventilación unipulmonar y ventilación hipercápnica.

Introduction

Anesthesia in thoracic surgery has some particularities. The need for lung collapse and one-lung ventilation (OLV), and the lateral decubitus position complicate ventilatory management in patient with associated respiratory disease.

Both OLV and lateral decubitus call for modifications in ventilation and pulmonary perfusion. In the dependent lung compliance decreases and airway resistance increases. Furthermore, the collapsed lung will increase intrapulmonary shunt, contributing to hypoxemia. Hypoxic pulmonary vasoconstriction (HPV) is a physiological autoregulation mechanism against hypoxia by which blood flow in unventilated pulmonary areas is actively reduced and derived to well-ventilated areas and reducing ventilation perfusion mismatch (V/Q).

Mechanical ventilation in thoracic surgery has undergone significant changes in recent years due to the implementation of lung protective ventilation.

Lung protective ventilation refers to the use of low tidal volume (TV) (8–6 mL/kg of predicted body weight), lower plateau pressure ($\leq$30 cmH_2O), moderate PEEP ($\geq$5 cmH_2O according to inspired fraction of O_2 to an arterial oxygen tension (PaO_2) between 55 and 80 mmHg), with or without the use of recruitment maneuvers. These different strategies can all reduce mechanical stresses on the lung, which are thought to cause ventilator-induced lung injury, and its benefits in patients with acute respiratory distress syndrome (ARDS) are well established.[1–4] Lung protective ventilation is also used in ICU patients with normal lungs and in patients undergoing abdominal surgery under general anesthesia, who are at high risk for pulmonary complications.[4]

The beneficial effects of lung protective ventilation remain questionable in OLV. This review will analyze recent ventilatory strategies in OLV.

Methods

A MEDLINE search of randomized clinical trials, metanalysis, reviews and systematic reviews published in the last 5 years using the Mesh term ''One-Lung Ventilation'' was performed on 21 March 2017. A total of 75 articles were initially found. The author reviewed the title and abstract of each article and selected those dealing with lung protective ventilation or acute lung injury in one-lung ventilation. Fourteen articles were included after the title and abstract review.

Thoracic surgery and lung injury

Acute lung injury after thoracic surgery is multifactorial. A multiple-hit sequence of deleterious events interacts to injure the alveolar epithelium and the capillary endothelium.[5]

A combination of direct surgical trauma and mechanical ventilation may contribute to postoperative lung injury. Mechanical ventilation can be damaging to the lung, mainly for two reasons. Firstly, the use of high pressures and high tidal volume (TV) cause alveolar overdistension. Secondly, repeated opening and closing of alveoli causes atelectrauma. These two mechanisms will determine the local and systemic release of cytokines and other mediators of inflammation, leading to biotrauma, which contributes to the process of lung injury caused by mechanic ventilation.[5]

Lung protective ventilation: tidal volume (TV)

The ideal tidal volume (TV) to maintain adequate oxygenation during OLV remains controversial. Textbooks and reviews recommend using high TV ($\geq$10 mL/kg) without positive end-expiratory pressure (PEEP) to prevent atelectasis.

Numerous authors have reported that high TV during OLV might increase the incidence of acute lung injury due to large peak inspiratory pressures, end-inspiratory volumes, and shearing forces due to cyclic opening-closing of the alveoli.[5]

There is growing evidence that low TV (<8 mL/kg predicted body weight) during OLV could prevent lung injury. Nevertheless, low TV has been associated with worsening intraoperative atelectasis and intrapulmonary shunt, contributing to hypoxia and hypercapnia. However, low TV combined with additional positive end-expiratory pressure (PEEP) can reduce the incidence of atelectasis by preventing lung collapse.[5]

A study comparing the effects of low TV (5 mL/kg and 5 cmH_2O PEEP) and high TV (10 mL/kg and no PEEP) during OLV showed that arterial oxygenation and shunt fraction were similar with TV of 5 mL/kg and 10 mL/kg in patients undergoing open chest surgery with normal lung function.[6]

In 100 patients undergoing OLV for scheduled lobectomy, conventional OLV (FiO_2 1.0, TV 10 mL/kg, no PEEP, and volume-controlled ventilation) was compared to the lung protective strategy (FiO_2 0.5, TV 6 mL/kg, PEEP 5 cmH_2O, and pressure-controlled ventilation). The latter showed higher postoperative PaO_2/FiO_2 ratio and fewer immediate pulmonary complications in the first postoperative 72 h,