Characterization of the recruitment-to-inflation ratio and the airway opening pressure among surgical patients at risk for respiratory complications: The LURA observational study

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Introduction

Postoperative pulmonary complications (PPC) are associated with increased morbidity, length of hospital stay, and mortality after surgery. Lung-protective ventilation (LPV) has been shown to reduce PPC, but the evidence is heterogeneous. There is no consensus on the definition of the LPV components, which include tidal volume, positive end-expiratory pressure (PEEP) and recruitment maneuvers. Moreover, LPV has not been assessed among patients at increased baseline risk for PPC except obesity. Low tidal volumes are considered to be protective by most, although they have not been thoroughly studied on their own. Recruitment maneuvers have been found to improve secondary outcomes but seldom PPCs on their own.

The last component of LPV is PEEP. There are many ways to asses for a "best PEEP", and the literature is still divided. Regardless of the method used, the results across patients are heterogeneous and cannot be accurately determined with simple demographics and anthropometrics. Therefore, it is clear that **PEEP needs to be titrated individually according to the patient and procedure.** The effect of PEEP is not linear; as PEEP increases two effects occur: recruitment of previously closed alveoli and inflation of alveoli that are already open. These two effects balance each other, with recruitment increasing lung compliance and (hyper)inflation decreasing it. Existing methods to titrate PEEP balancing between recruitment and inflation are complex and time consuming, making their universal adoption for all mechanically ventilated patients in the operating room impractical.

In response to this problem, a new parameter has been described, **the recruitment-to-inflation ratio (RIR), which aims to quantify the effects of increasing PEEP in terms of lung recruitment (beneficial effect) vs lung (hyper)inflation (detrimental effect).** To accurately determine the RIR, the **airway opening pressure (AOP)** needs to be established as well: the AOP is **the pressure at which the lower airways close**; below the AOP there is no ventilation. Both procedures are performed together and require 1-2 minutes to perform, using regular ventilators.

In this study we propose to retrospectively collect the data on the RIR and AOP, comparing their association with PPC among patients with and without pre-operative risks for PPC. This will serve as an initial hypothesis-generating study towards future prospective and interventional studies on PEEP titration to reduce PPC in the operating room.

Research questions

- Is there a difference in lung recruitment potential or airway opening pressure above 5 cm H_2O between patients at risk and not at risk for PPCs at the beginning, during or at the end of anesthesia care?
- Is there a correlation between lung recruitment potential or airway opening pressure above 5 cm H_2O at any time during anesthesia care and the development of respiratory complications during anesthesia care or PPCs?

Design

Retrospective observational study of patients undergoing general anesthesia in the operating room.

Study population

All patients age 18 and above coming for surgery, separated into "at risk for PPC" and "not at risk for PPC", according to standard criteria.

Methods and procedures

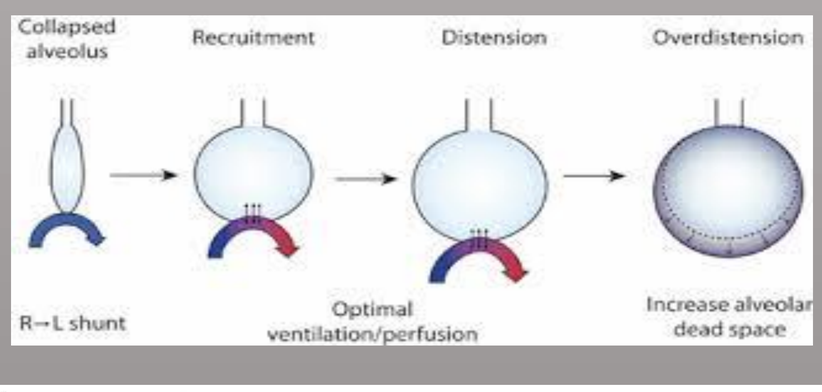
- Airway opening pressure and recruitment to inflation ratio (see graphics).
- Data collection: demographics, past medical history, details on anesthesia and surgery, respiratory complications during anesthesia care, respiratory complications after anesthesia care and POD2, mechanical ventilation during anesthesia care, laboratory and imaging.

Novelty

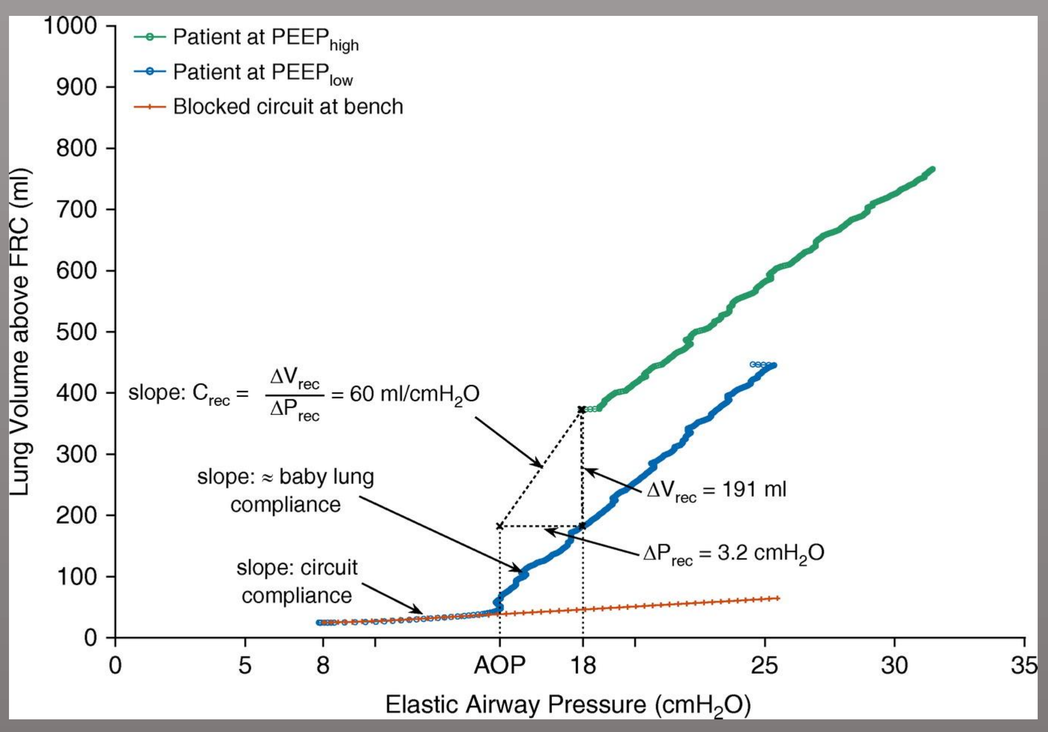
- There are no studies of the AOP and only one study of RIR in during anesthesia.
- There are few studies detailing the incidence of PPC among at-risk patients, and they are not well described.
- There are no studies describing the association between measures of lung recruitability and PPCs among patients at risk, beyond obesity.

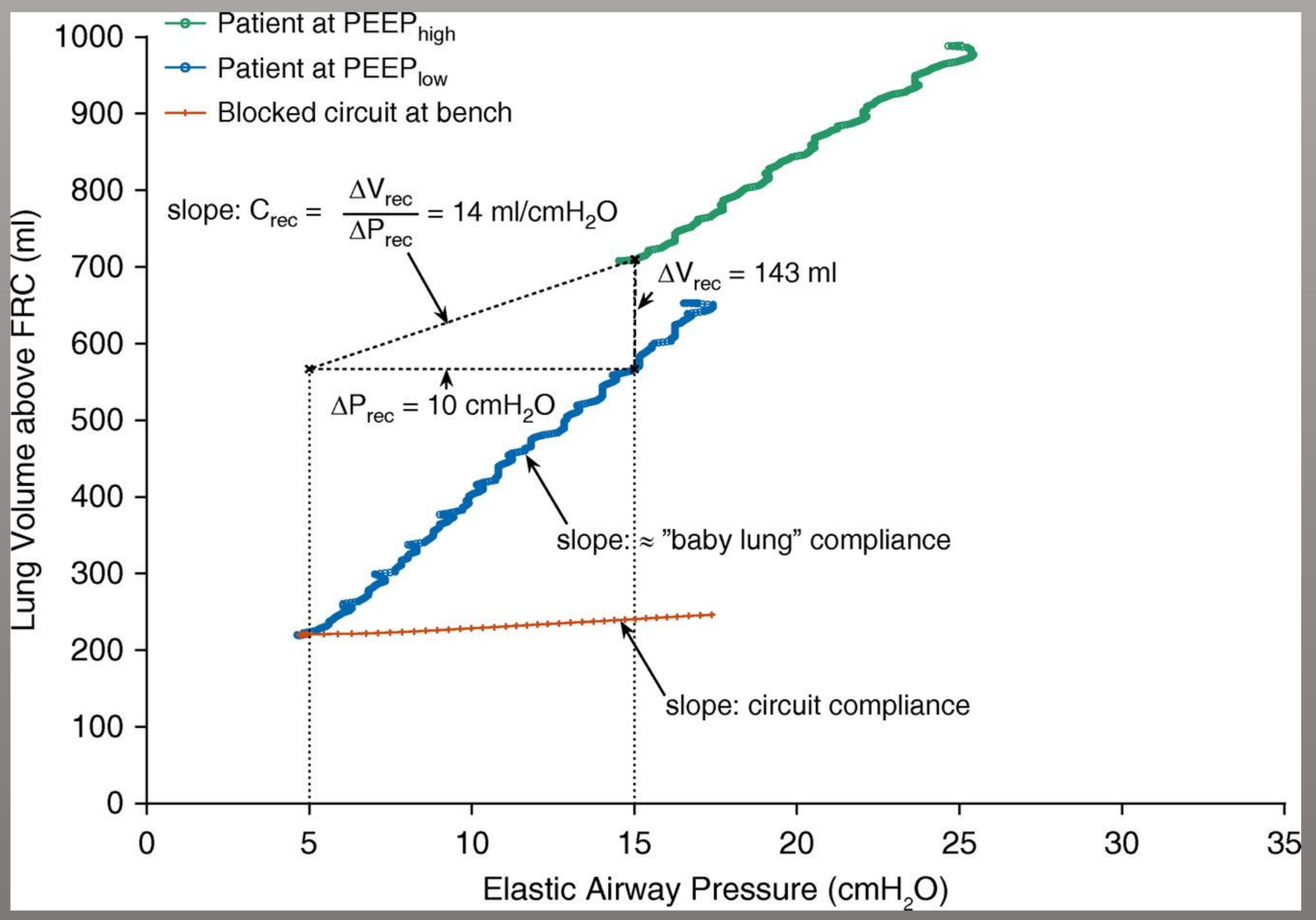
Impact

Previous trials have used blanket interventions aimed at optimization of lung mechanics to reduce PPC with limited success. **The identification of an association between measures of lung recruitability, risk factors for PPCs and PPCs would allow for the development of a personalized ventilation strategy during anesthesia to decrease PPC.**



$$\frac{R}{I}\ \text{ratio} = \frac{Crec}{Crs\ \text{at}\ PEEP_{low}\ \text{or above AOP}}$$





Key references:

- Chen, Lu et al. "Potential for Lung Recruitment Estimated by the Recruitment-to-Inflation Ratio in Acute Respiratory Distress Syndrome. A Clinical Trial." American journal of respiratory and critical care medicine vol. 201,2 (2020): 178-187. (source for the figures).
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