Should peripheral airway closure be named “dysfunction”?

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Topic: 11: Respiration and Airway Management
Abstract text: **Background and Goal of Study**: When the transpulmonary pressure (alveolar pressure minus pleural pressure) decreases, airways tend to close. This was first observed by Laennec[1] and demonstrated by Dollfuss[2] and Hedenstierna[3] in ventilated patients. The proportion of the lung that is closed is named closing capacity, and this is known to increase with age and due to obesity. Airway closure due to rising pleural pressure is a natural behaviour and protects the alveolus against full collapse. Airway closure therefore is to be expected in all occasions that raise pleural pressure such as increased positive airway pressure during positive pressure ventilation.
Materials and Methods: Description of the respiratory system by standard physics modelling.
Results and Discussion: The respiratory system is commonly described as a balloon (the lungs) enclosed by a balloon (thorax cavity). For both balloons the relation between volume V and transmural pressure P is described by V(P) = V(0) + C.P, in which C denotes the compliance. If pleural pressure (the pressure between the balloons) is designed as P_{pl}, airway pressure by P_{aw} and extra-thoracic pressure by P_{et}, the transmural pressure for thorax cavity is $P_{pl} - P_{et}$ and for the lung P_{aw}-P_{pl}. Pleural pressures will change by increasing airway pressure as well as decreasing extra-thoracic pressure. Solving these two situations for thorax cavity and lungs and denoting lung compliance by C_l and thorax wall compliance as C_t, results in
$\Delta P_{pl} = \Delta P_{et} * C_t/(C_l+C_t)$ for negative extra-thoracic pressure and $\Delta P_{pl} = \Delta P_{aw} * C_l/(C_l+C_t)$ for positive airway pressure: any increase in airway pressure will increase pleural pressure proportionally, but decreased extra-thoracic pressure lowers pleural pressure.
Conclusion(s): Negative extra-thoracic pressure results in a reduction in pleural pressure which will help small peripheral airways to open up. Positive airway pressure increases pleural pressure and therefore induces airway closure. Many problems during positive airway pressure mechanical ventilation, atelectasis, pneumonitis, pulmonary emphysema, pneumothorax and other air leaks are related to raised pleural pressure[4]. Negative extra-thoracic pressure ventilation is expected to avoid many of these problems.
References:
1. Milic-Emili JM et al. Eur J Appl Phys 2007; 99:567–8
2. Dollfuss RE et al. Resp Phys 1967; 2:234-46
3. Hedenstierna G et al. Anesthesiology 1976; 2:114-23
4. Zeng C et al. Anesthesiology 2022; 136:181–205
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