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Elevated levels of PEEP during spontaneous breathing trial decreases work of breathing in an obese patient allowing extubation at high PEEP

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A 59-year-old man with a body mass index of 47kg/m^2 was admitted to the ICU with septic shock. After intubation, positive end-expiratory pressure (PEEP) was titrated to 16 cmH_2O after measuring the transpulmonary pressure gradient, as previously described[1]. On day 4, the patient failed a standard 30-minute SBT with pressure support (PS) 3 cmH_2O and PEEP 5 cmH_2O[2], due to the development of tachycardia and dyspnea. An esophageal pressure (Pes) tracing obtained during the SBT demonstrated inspiratory pressure swings of more than 30 cmH_2O (Fig.1-A), suggesting increased work of breathing [WOB])[3]. Electrical Impedance Tomography (EIT) during the SBT trial showed a "pendelluft effect"[4], with air flowing within the lungs, from the most dependent to non-dependent areas (Video1-A).

A second SBT was performed minutes later at PS 3 cmH_2O and PEEP 16 cmH_2O. The higher PEEP resulted in an approximately 3-fold reduction in inspiratory Pes swings (Fig.1-B) and EIT showed a regular breathing pattern and reduced pendelluft (Video1-B). Offline analysis of the EIT traces has shown a gain in compliance of about 41% by increasing PEEP from 5 cmH2O to 16 cmH2O, suggesting improved homogenous ventilation, and decreased atelectasis.

The patient was successfully extubated to 16 cmH_2O continuous positive airway pressure (CPAP), discharged from the ICU, eventually being discharged from the hospital *without* the need for reintubation.

Critically ill obese patients often fail SBTs at low PEEP levels, leading to ventilator dependency[5]. The elevated pleural pressure in these patients works as a mechanical load, reducing lung volumes, causing airway closure, increased airways resistance and developing atelectasis, especially within dependent lung regions. This case illustrates the

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importance of a physiology-based approach to PEEP titration in this obese patient.

A SBT at high PEEP showed similar mechanism of WOB unloading described previously by Vitacca et al. [6]. In addition, we showed a reduced pendelluft, resulting in more homogenous ventilation. Future studies should address the safety of extubating at high PEEP levels in obese patients.

This case and images were not previously published.

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Figure 1

Esophageal (red) and airway (blue) pressure traces during: a Spontaneous Breathing Trials (SBT) with a PEEP of 5cmH_2O (failed SBT) (**A**); and with a PEEP of 16cmH_2O (successful SBT) (**B**).

Video 1

Tomographic representation of ventilation distribution with Electrical Impedance Tomography (EIT) during Spontaneous Breathing Trials. At the transition between inspiration and expiration at PEEP of 5cmH_2O (**A**), exhalation begins in the dependent lung regions, then a pendelluft phenomenon appears with gas flowing from the dependent to non-dependent lung regions.

The mechanical load of obesity increases pleural pressure, causing reduced lung volumes with air trapping due to airway closure and increased airways resistance. An increase in respiratory drive due to the elevated pleural pressure is then observed, stimulated by low lung volumes and ineffective ventilation, attempting to overcome the increased mechanical load. The pendelluft phenomenon, showed in this video, suggests a pronounced diaphragmatic contraction, resulting in concentration of force within dependent areas of the lung. This concentration of force generates a pendular movement of air from dependent to non-dependent lung regions, likely resulting in ineffective ventilation. When PEEP is increased to 16 cmH_2O (**B**), a more homogeneous distribution of ventilation is observed with a significantly reduced pendelluft.

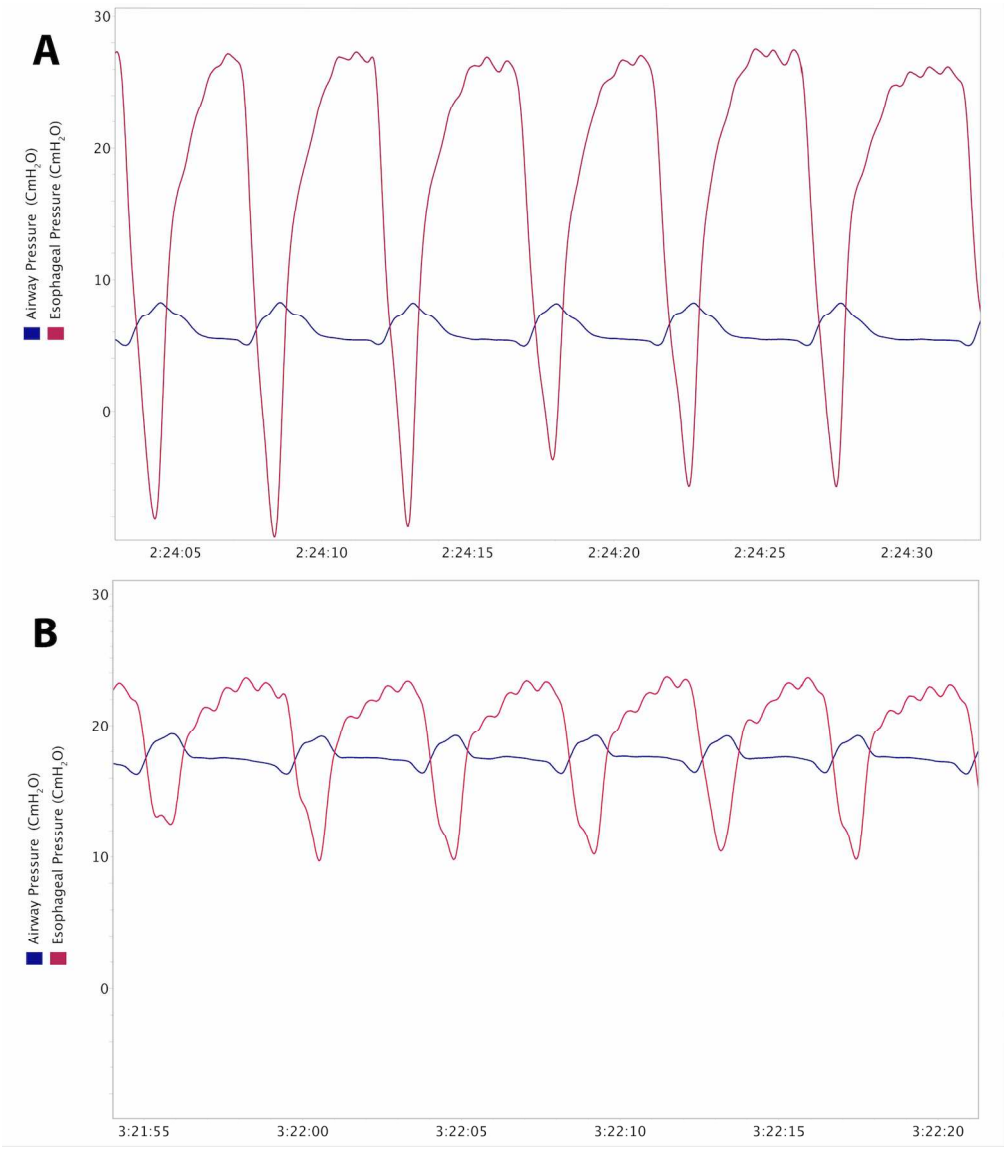

Figure 1. Esophageal (red) and airway (blue) pressure traces during: a Spontaneous Breathing Trials (SBT) with a PEEP of 5cmH2O (failed SBT) (A); and with a PEEP of 16cmH2O (successful SBT) (B).