Changes in Body Position is a Feasible Therapy to Promote Pulmonary Recruitment Guided by the EIT

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Introduction

Hypoxemic respiratory failure is a well-known condition in critically ill patients with COVID-19, the majority who develops severe hypoxemia needs mechanical ventilation. Atelectasis has a high occurrence rate and commonly appears in dependent lung zones when the transpulmonary pressure (PL) is negative. Low transpulmonary pressure may lead to lung or airway collapse. By adjusting PEEP, we can achieve positive end-expiratory transpulmonary pressures preventing collapse and optimize lung mechanics[1,2].

Increases in airways pressures with a lung recruitment maneuver (RM) could revert atelectasis because the opening pressure in the dorsal pulmonary areas is overcome, however, there are still concerns about the hemodynamic response and the mechanical stress and strain on the lung tissue caused by the maneuver in this population[3].

Temporary complications during the alveolar recruitment maneuver such as hypotension, desaturation, more severe complications such as barotrauma, and studies with negative outcomes cause the application of elevated pressures even if the transient is less and less used[1].

A feasible strategy for promoting alveolar recruitment is to use body position based on the well-known gravitational effect in PL. Two principles explain its foundation: one postulates that dorsal atelectasis can be recruited by placing this area of the lung in the highest position, which increases the local PL. The other principle follows the Laplace Law, which indicates that once recruited; the opened lung areas will maintain permeability when enough PEEP is applied[4].

Electrical impedance tomography (EIT) is a noninvasive, radiation-free and real-time imaging method that timely measures ventilation distribution, regional changes in lung volumes. The EIT plethysmogram provided by EIT is a waveform derived from the sum of all pixels within a given region of interest (ROI) of a relative image (frame) plotted against time. It represents the amount of air that moves in and out of the ROI[1]. EIT is able to identifies changes in pulmonary aeration (ΔEELZ) caused, for instance, by position changes or positive end-expiratory pressure (PEEP) adjustments (Figure 1).

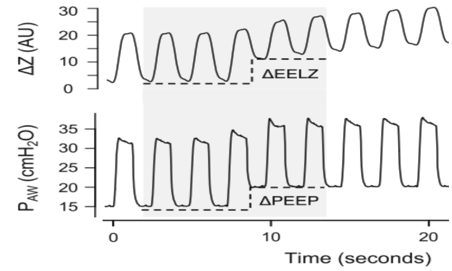

Figure 1 Global plethysmogram and airway pressure (PAW) waveforms. Increment in positive end-expiratory pressure (PEEP) increased end-expiratory lung volume (ΔEELZ).

Case Report

In this case, our patient was diagnosed with COVID-19, after five days he developed a progressive respiratory failure leading to invasive mechanical ventilation. Due a high degree of hypoxemia, in supine position the PEEP titration maneuver using EIT was performed. Over time, oxygenation decreased with a P/F ratio of 98, indicating a prone position was more beneficial for the patient. EIT was able to show high asymmetry of the distribution of ventilation in the right and left lung 91 vs 9 % (Figure 2).

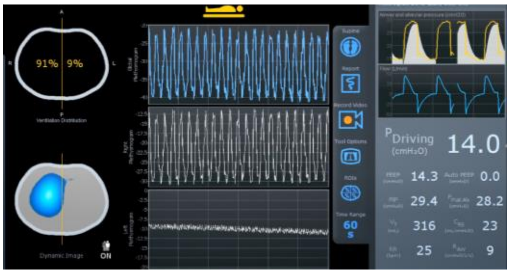

Figure 2 Screen from EIT. Dynamic image showed higher distribution ventilation the right lung. Right plethysmogram present higher variation of impedance than left plethysmogram.

The patient's hemodynamics remained balanced with regular doses of norepinephrine, so the team opted to perform an automatic lateralization programmed at 30 degrees as showed in the figure 3.


Figure 3. Automatic lateralization promoted by LINET bed. Picture provided by LInet®.

The left lung was placed upwards. Immediately EELZ increased (I), and few minutes later the variation of impedance on the left lung started to increase (II), the ventilation distribution in the right and left lung became more symmetrical without changed pressures settings on the ventilator (Figure 4).

Figure 4. I showed the increased of FRC and II showed increased in variation of impedance and consequently increased in lung volume to the left lung.

The effect of the tilt improved the mechanical parameters Driving pressure: 14; VT 316ml; compliance 23ml/cmH_20 and percentage of ventilation distribution in the left lung was 9% vs Driving pressure: 13; VT 366ml; compliance 30 ml/cmH_20 and percentage of ventilation distribution in the left lung 31%.

The impact of the prone position on blood gases was clinically relevant 2 hours positional change, ph: 7.20; PaO_2 63.3; FiO_2 50% and $PaCO_2$: 81.2 vs 1 hour after lateralization ph: 7.36; PaO_2 87.4; FiO_2 50% and $PaCO_2$: 49.5.

Lateralization presented a potential for pulmonary recruitment with improvement of oxygenation and pulmonary mechanics. EIT is able to demonstrate the benefit of lateralization and impact on FRC.

The pulmonary mechanics data may transiently worsen as a drop-in complacency explained by the overdistension of the lung that is up. EIT allowed for the observation of these fine adjustments to treatment when the information provided by the ventilator is not sufficient.

References

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