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The effects of prone positioning

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SITUATION:

As an important therapeutic strategy, in the treatment of the acute respiratory distress syndrome (ARDS), prone positioning may be life-saving, but its effects depend on different patient-specific characteristics [1,2]. It shows that a majority of patients react very positively but one must not neglect the fact that about 20% of all patients are non-responders who lack desired effects completely or show them in a minimal ratio only. [3].

PROBLEMS:

How can we monitor effects in our patients' lungs during prone positioning? What are non-responders' criteria? How much time is involved to come to the conclusion that prone positioning eventually has no effect?

SOLUTION WITH EIT

EIT, an imaging modality for dynamic monitoring of lung ventilation, is the solution: Monitoring the ventilation of a patient after repositioning him can facilitate the assessment of the effectiveness of such manoeuvers.

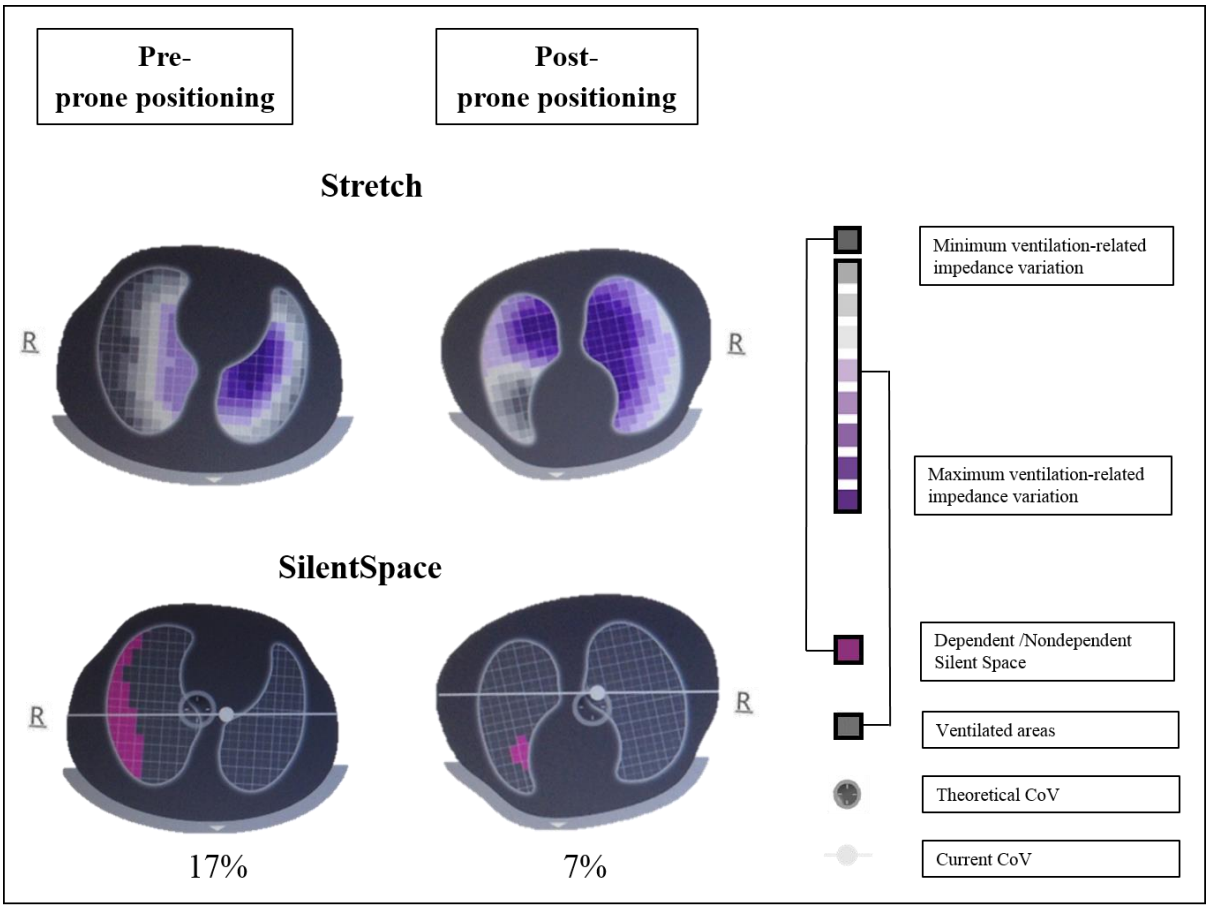

Figure 1: Image courtesy of Dr. Giorgio Iotti, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy

The distribution of ventilation in a normal human lung is not the same in supine or prone position. In our specific imaging study (see “Stretch” images), the ventilation signal in the right lung is significantly reduced before prone positioning. The images underneath “SilentSpaces” show a 17% extension of non-ventilated areas in the whole lung. SilentSpaces are found only in the right lung, and this explains the shift of the current "Centre of ventilation" (CoV) towards the ventilated left lung. SilentSpaces are partly nondependent (possibly expressing alveolar consolidation or collapse) and partly dependent (possibly expressing alveolar over distention).

After having changed the patient’s prone position by a 180° rotation around his body axis, an immediate improvement in the distribution of ventilation was observed. The same tidal volume is now distributed more homogeneously over both lungs and the CoV moves in direction of the theoretically ideal CoV. It also leads to a higher functional lung size and more lung volume, which is associated with an increased option of survival [4]. SilentSpaces in the right lung disappear, most likely as an effect of recruitment of dorsal areas and less distension of ventral areas. However, in the ventral parts of the left lung, obtained measurements displayed a reduction of ventilation. According to SilentSpaces, the corresponding non-ventilated isolated area accounts now for around 7%. Through bronchoscopy, this circumstance is related to a local accumulation of bronchial secretions.

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[2] Guèrin C. et al. (2013): Prone Positioning in Severe Acute Respiratory Distress Syndrome. N Engl J Med; 368:2159-2168.

[3] Nakos G. et al. (2000): Effect of the prone position on Patients with Hydrostatic Pulmonary Edema compared with Patients with Acute Respiratory Distress Syndrome and Pulmonary Fibrosis. Am J Respir Crit Care Med; 161:360-368.

[4] Amato M.B.P. et al. (2015). Driving pressure and survival in the acute respiratory distress syndrom. NEJM. 372(8):747-755.

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