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IMAGES IN ANESTHESIA

Understanding an unusual capnography waveform using electrical impedance tomography

Elena Spinelli, MD · Enzo M. Dellino, MD · Tommaso Mauri, MD

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An unusual capnography waveform with a descending "reverse" phase III (Figure, *panel A*) was observed in an intubated, mechanically ventilated, postoperative patient. Although air leaks and pneumothorax were excluded, a preoperative computed tomography (CT) scan showed severe chronic changes in the lung parenchyma (Figure, *panel B*). Heterogeneously distributed, the lesions included bronchiectasis and thickening of the bronchial walls in the right lung and large sub-pleural areas of abnormally low attenuation and destruction of alveolar septa (i.e., bullae) in the left lung. Thus, we reasoned that the altered waveform could be due to heterogeneous regional ventilation.

Electrical impedance tomography (EIT) is a dynamic imaging technique that provides continuous measurements of the tidal volume distribution within the chest.[1] It has been previously used in chronic respiratory patients and has shown potential to guide mechanical ventilation settings.[2] We used EIT during capnographic monitoring in this patient, who was deeply sedated while on volume-controlled ventilation (tidal volume 450 mL, positive end-expiratory pressure 4 cmH_2O, respiratory rate 10 $beats{\cdot}min^{-1}$). The images shown (Figure, *panels C to F*) were obtained during a single breath, with each corresponding to the starting point of deflation (red vertical lines) in various regions of interest (ROIs). This was verified by the highest regional tidal volume in the corresponding EIT regional impedance–time graph (seen in the ROI-1 to ROI-4 graphs on the right side of the Figure). The instantaneous tidal impedance distribution is labelled the "dynamic" image in the upper panel, and the average distribution during one minute is shown as the "minute" image in the lower panel. The EIT showed that the patient's ventilation was characterized by temporal ventilation heterogeneity, as filling and emptying of the various ROIs were out of phase. The ventral right ROI-1 exhibited the fastest inflation and deflation (i.e., shortest time constant), as indicated by the red line positioned first (Figure, *panel C*). The dorsal left ROI-4, occupied by the large bullae seen on the preoperative CT scan, was the last to start deflating (red line in Figure, *panel F*), likely due to the longer time constant.

These images suggest that the reverse phase III capnographic pattern might be explained by late exhalation of gas from the left lower lung bullae, which would have a very high ventilation/perfusion ratio and low alveolar carbon dioxide tension.[3]

E. Spinelli, MD · E. M. Dellino, MD
Department of Anesthesia, Critical Care and Emergency, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy

T. Mauri, MD (✉)
Department of Anesthesia, Critical Care and Emergency, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy
e-mail: tommaso.mauri@unimi.it

Department of Pathophysiology and Transplantation, University of Milan, Milan, Italy

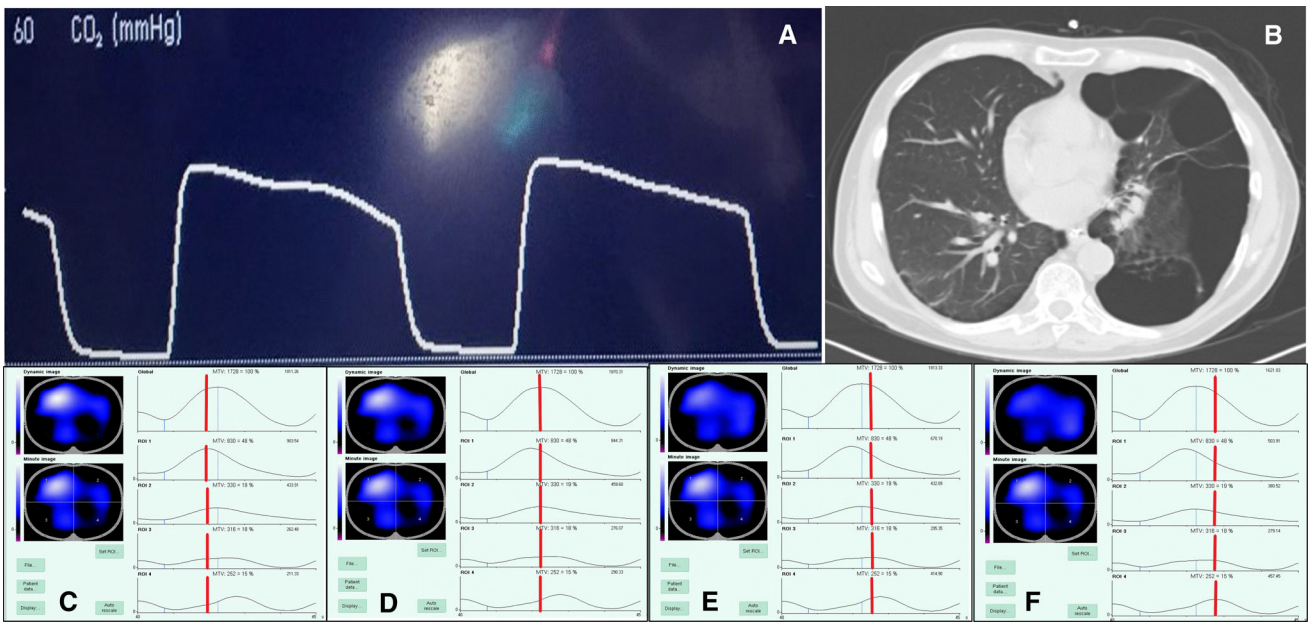

Figure Electrical impedance tomography (EIT) monitoring of a postoperative subject with an unusual descending capnography waveform (*panel A*) and heterogeneous distribution of emphysematous lung changes seen on chest computed tomography (CT) scans (*panel B*). EIT showed that the ventilation was characterized by temporal ventilation heterogeneity, as filling and emptying of different regions of interest (ROIs) in the lung (e.g., ROI-1 to ROI-4, *panels C to F*) were out of phase. Images in *panels C to F* were obtained during a single breath, with each corresponding to the start of deflation (red vertical lines). The ventral right ROI-1 exhibited the fastest inflation and deflation (i.e., shortest time constant), as indicated by the red line positioned first (*panel C*). The dorsal left ROI-4, occupied by the large bullae on the preoperative CT scan, was the last to start deflating (red line, Figure *panel F*), likely due to a longer time constant

Conflicts of interest Tommaso Mauri has received personal lecture fees from Drager outside the submitted work. The other authors declare no conflicts of interest.

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