Check for updates

IMAGES IN PULMONARY, CRITICAL CARE, SLEEP MEDICINE AND THE SCIENCES

Bedside Electrical Impedance Tomography Unveils Respiratory "Chimera" in COVID-19

Caio C. A. Morais[1], Bijan Safaee Fakhr[1], Roberta R. De Santis Santiago[1], Raffaele Di Fenza[1], Eizo Marutani[1], Stefano Gianni[1], Riccardo Pinciroli[1], Robert M. Kacmarek[1,2], and Lorenzo Berra[1,2]

[1]Department of Anesthesia, Critical Care and Pain Medicine and [2]Respiratory Care Department, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts

ORCID ID: 0000-0003-2702-2093 (L.B.).

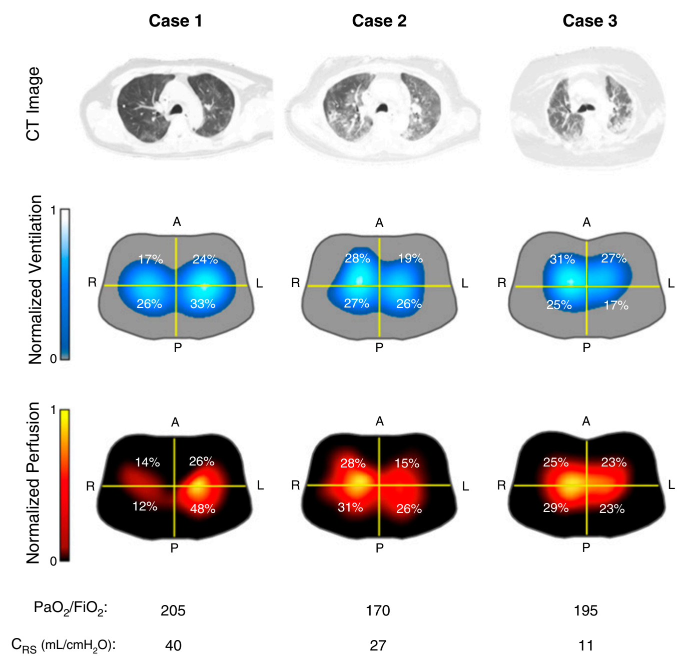

Figure 1. Computed tomography (lung window) images of three cases with severe coronavirus disease (COVID-19) and corresponding electrical impedance tomography ventilation and perfusion images. All patients were assessed while in supine position and receiving protective V_T (5–6 ml/kg of predicted body weight). Positive end-expiratory pressure (PEEP) was set to target the best respiratory system compliance after a decremental PEEP trial (4). No signal of inspiratory effort was identified by esophageal manometry during all assessments. The intubation occurs, on average, 2 days after the onset of respiratory symptoms, and none of the patients required noninvasive ventilation. Images were generated by Enlight 1800 (Timpel SA), with color scale adjusted by linear normalization. Ventilation and perfusion distribution maps were divided in four regions of interest. Electrical impedance tomography perfusion was estimated by the first-pass kinetics method (5). A = anterior; C_{RS} = respiratory system compliance; CT = computed tomography; L = left; P = posterior; R = right.

In 1981, Dr. Reginald Greene and colleagues illustrated extensive pulmonary artery filling defects in patients with different severity of acute respiratory failure by bedside angiographic studies (1). More recently, perfusion distribution and regional lung ventilation can be assessed at bedside by noninvasive, radiation-free electrical impedance tomography (EIT) (2, 3). In this report, we present three patients intubated for acute hypoxic respiratory failure owing to coronavirus disease (COVID-19). The three patients had similar levels of oxygenation but different respiratory system compliance (Figure 1). EIT was used to determine regional ventilation and perfusion distribution. Cases 1, 2, and 3 were assessed after 2, 17, and 19 days of mechanical ventilation, respectively. All patients were assessed by computed tomography (CT) without contrast (Figure 1). Case 1 CT imaging shows peripheral and basilar ground-glass opacities, compatible with known COVID-19 pneumonia. Case 2 and case 3 CT images describe diffuse bilateral ground-glass opacities. Case 1 had threefold higher respiratory system compliance than case 3 (Figure 1). In Case 1, EIT showed severe right-lung

Supported by the Reginald Jenney Endowment Chair at Harvard Medical School (L.B.), by Sundry Funds at Massachusetts General Hospital (L.B.), and by laboratory funds of the Anesthesia Center for Critical Care Research of the Department of Anesthesia, Critical Care and Pain Medicine at Massachusetts General Hospital.

Am J Respir Crit Care Med Vol 203, Iss 1, pp 120–121, Jan 1, 2021

Originally Published in Press as DOI: 10.1164/rccm.202005-1801IM on November 16, 2020
Internet address: www.atsjournals.org

perfusion anomalies, homogenous ventilation, and a moderate decrease in respiratory compliance (40 ml/cm H_2O). Clinical diagnosis of pulmonary embolism was suggested by a high D-dimer (~5,000 ng/ml) and lower extremity dopplers showing deep venous thrombosis. Case 2 and case 3 showed a progressive decrease of respiratory compliance (as low as 11 ml/cm H_2O in case 3), without major perfusion disturbances. This report shows that clinical information of the patient coupled with real-time noninvasive bedside EIT might be helpful to characterize the etiology of hypoxemia of patients with respiratory failure with COVID-19. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

References

1. Greene R, Zapol WM, Snider MT, Reid L, Snow R, O'Connell RS, *et al*. Early bedside detection of pulmonary vascular occlusion during acute respiratory failure. *Am Rev Respir Dis* 1981;124:593–601.
2. Grassi LG, Santiago R, Florio G, Berra L. Bedside evaluation of pulmonary embolism by electrical impedance tomography. *Anesthesiology* 2020;132:896.
3. Bachmann MC, Morais C, Bugedo G, Bruhn A, Morales A, Borges JB, *et al*. Electrical impedance tomography in acute respiratory distress syndrome. *Crit Care* 2018;22:263.
4. Florio G, Ferrari M, Bittner EA, De Santis Santiago R, Pirrone M, Fumagalli J, *et al*.; investigators of the lung rescue team. A lung rescue team improves survival in obesity with acute respiratory distress syndrome. *Crit Care* 2020;24:4.
5. Borges JB, Suarez-Sipmann F, Bohm SH, Tusman G, Melo A, Maripuu E, *et al*. Regional lung perfusion estimated by electrical impedance tomography in a piglet model of lung collapse. *J Appl Physiol (1985)* 2012;112:225–236.