Critical Care

LETTER

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PEEP-induced alveolar recruitment in patients with COVID-19 pneumonia: take the right time!

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To the Editor,

Acute respiratory disease syndrome (ARDS) related to novel coronavirus-19 disease (COVID-19) is a specific pathological condition characterized, at an early stage, by normal or high respiratory system compliance and hypoxemia [1]. This so-called *"low"* phenotype of ARDS associated to COVID-19 is also characterized by a low lung weight, with ground-glass opacities located in subpleural areas at chest computed tomography scan (CT-scan), and low response to lung recruitment [1]. In case of adverse evolution of COVID-19 pneumonia and high stress ventilation as for patient-self-inflicted lung-injury induced by vigorous negative pressure developed during spontaneous breathing or non-invasively assisted breath, *"low"* phenotype may worsen in *"high"* phenotype with low respiratory system compliance, high right-to-left shunt, high lung weight, and good response to lung recruitment. Thus, while assuring a protective ventilation, a high positive end-expiratory pressure (PEEP) strategy, similar to that employed in managing severe COVID-19-free ARDS, can be pursued when a predominant *"high"* phenotype is observed [1].

In the interesting investigation by Ball and colleagues [2], the authors addressed the effects of PEEP on alveolar recruitment evaluated through CT-scan. They concluded against the adoption of high PEEP strategy because it did not lead to a substantial alveolar recruitment and worsened respiratory mechanics. However, while reading in details the investigation by Ball et all [2], some concerns raise about the modalities of PEEP application proposed. First of all, no lung recruitment maneuver was performed prior to switch from 8 to 16 cmH_2O of PEEP. This might have led to the occurrence of lung overdistention and partial atelectasis resolution, limiting the potential positive effects exerted by PEEP in those circumstances. Indeed, in ARDS patients, lung recruitment maneuver is usually performed to normalize lung volumes both during invasive [3] and non-invasive mechanical ventilation [4]. Lastly, the assessment of lung recruitment through CT-scan was performed 1 min following the application of 16 cmH_2O-PEEP. This time frame might not be enough to induce an improvement in the extent of aerated lung tissue and reduction of poorly/non aerated lung zones. According to Chiumello et al. [5], the evaluation of lung aeration at 5 and 15 cmH_2O of PEEP through CT-scan and lung ultrasound was performed during a 2-h-lasting trial. Also, the changes in respiratory system compliance induced by a PEEP of 15 cmH_2O were clinically relevant at 5 and 15 min from the baseline assessment with a 5 cmH_2O of PEEP in intubated ARDS patients [3].

Reply to: PEEP-induced alveolar recruitment in patients with COVID-19 pneumonia: take the right time!

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We thank Dr. Cammarota and colleagues for their interest in our study [2] and for giving us the opportunity to extend the discussion of our findings through this correspondence. They advocate the use of higher PEEP in patients with high-elastance COVID-19 phenotype and questioned the short time elapsed between the CT scans with PEEP at 8 and 16 cmH_2O in our study.

The fascinating concept of using higher PEEP levels in ARDS to allow a more protective ventilation has been investigated for more than 20 years. However, despite promising initial reports, randomized trials failed to show benefits when compared to strategies aiming at maintaining oxygenation with the use of lower PEEP levels [6, 7]. Therefore, we believe that the use of higher PEEP

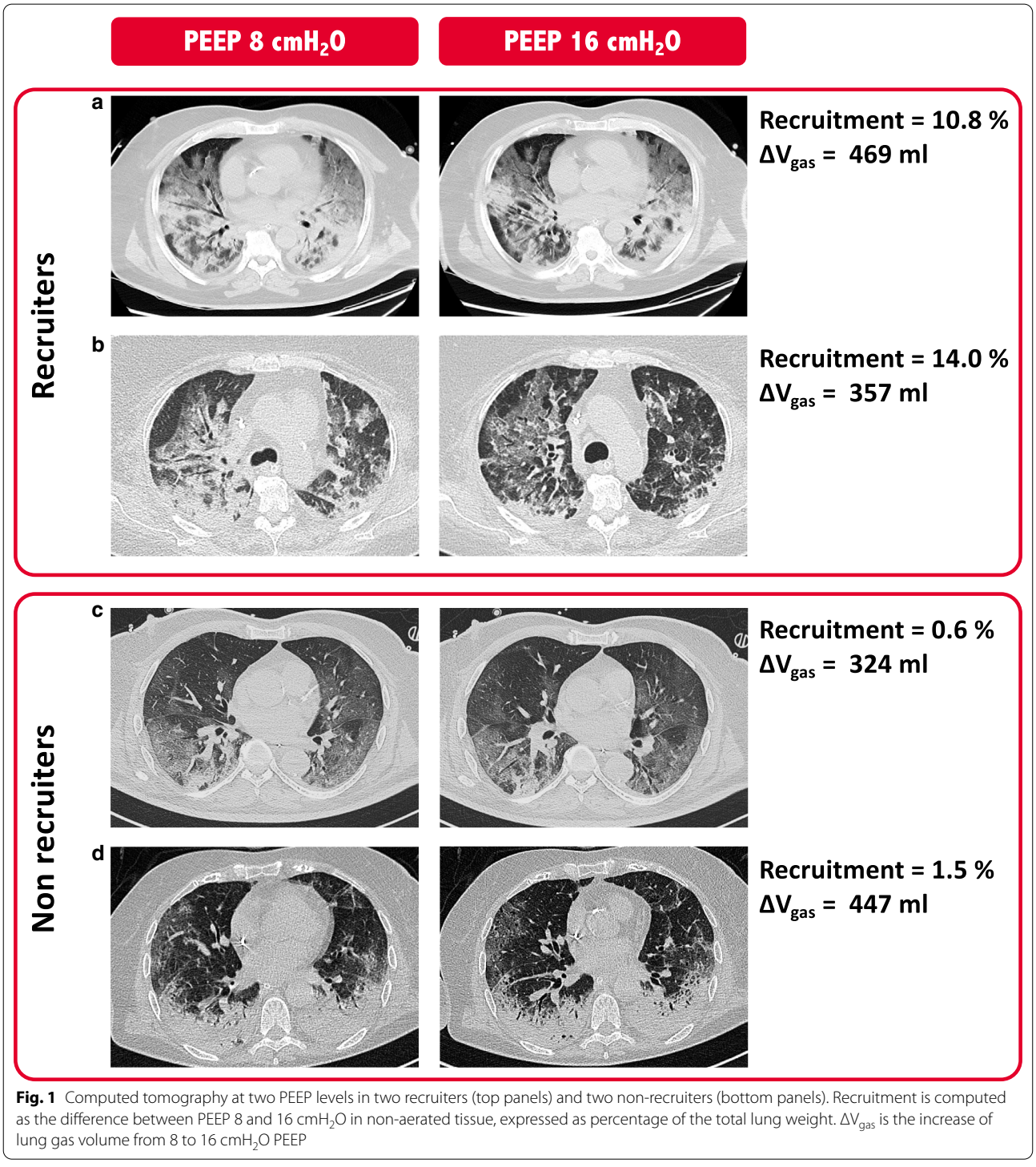

Fig. 1 Computed tomography at two PEEP levels in two recruiters (top panels) and two non-recruiters (bottom panels). Recruitment is computed as the difference between PEEP 8 and 16 cmH_2O in non-aerated tissue, expressed as percentage of the total lung weight. ΔV_{gas} is the increase of lung gas volume from 8 to 16 cmH_2O PEEP

and recruitment maneuvers should be limited to selected patients based on clinical and physiological reasoning [7], including in COVID-19 pneumonia.

Concerning the current study [2], we preferred not performing a recruitment maneuver and limiting the time spent at the CT facility for safety concerns related to the severity of COVID-19 patients. A time around 1 min of ventilation at 16 cmH_2O of PEEP was applied before repeating the CT scan, corresponding to about 20 breaths with a plateau pressures ranging from 25 to 35 cmH_2O. Studies showed that most changes in volume and recruitment occur in this timeframe [8] and that most respiratory units recruit below 30 cmH_2O [9]. In fact, we were able to detect a clear recruitment effect in some patients, as illustrated in Fig. 1a, b. On the other hand, patients with low recruitment had either diffuse ground glass opacities with few non-aerated areas (Fig. 1c) or large opacities with early fibrotic progression (Fig. 1d), two conditions which might explain the lack of response to PEEP. These findings are consistent with the worsening of compliance at higher PEEP level, which we observed using a longer time-window of 5 min.

In conclusion, our method may have underestimated the absolute magnitude of PEEP-induced recruitment in some patients; nevertheless, according to our data, the use of PEEP levels higher than those strictly required to maintain oxygenation should be avoided in severe COVID-19 pneumonia.

Abbreviations
ARDS: Acute respiratory disease syndrome; COVID-19: Novel coronavirus-19 disease; PEEP: Positive end-expiratory pressure; CT-scan: Computed tomography scan.

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