Functional respiratory imaging repurposed for COVID-19

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Thillai and colleagues[1] describe a method of image analysis, functional respiratory imaging (FRI), which creates a three-dimensional reconstruction of both airways and the pulmonary vasculature from CT-scan images, in 10 patients with severe COVID-19 infection. They computed the distribution of pulmonary blood flow according cross-sectional vessel area size and compared the data to age, gender, height and premorbidity matched acute respiratory distress syndrome (ARDS) patients (n=7) and retrospective data from healthy volunteers (n=107).

Their post processing imaging results were interesting as they find that in patients with COVID-19, the blood flow was diminished in the peripheral small calibre vessels and conversely increased in the more centrally located arteries in comparison to both the ARDS and the healthy control group, without differences in right ventricular size.

These data are currently hypothesis generating rather than a basis for clinical interpretations or even therapeutical changes on the current treatment protocol. The authors postulated that the impaired gas exchange seen in COVID-19 may be explained by redistribution due to either micro-thrombi, vasoconstriction of distal pulmonary arteries, or both. Indeed, in patients with COVID-19 admitted on the intensive care unit, the prevalence of (micro)thrombi is unexpectedly high and the prevalence of bacterial and fungal superinfections, in which you might expect secondary vasoconstriction is also considerable, 31% versus 7.2%, respectively.[2 3] Besides (micro)thrombi or vasoconstriction, more mechanisms can be responsible for redistribution of bloodflow, such as increased pulmonary capillary resistance, pulmonary capillary endothelial dysfunction and associated apoptosis (by either direct viral infection of the endothelial cell or immune-mediated diffuse endothelial inflammation), perivascular T-cell infiltration or bradykinin-dependent pulmonary angioedema.[4 5]

However, to correctly interpret the relevance of this loss of vasculature, clinical and extra radiological information is needed, such as the medical history, including pre-existent radiological abnormalities, and the current presence of consolidations, pleural fluid or ground glass opacities, all influencing gas exchange and, especially the latter, often present in severe patients with COVID-19. Next to vessel abnormalities influencing the bloodflow, also alveolar damage can be caused by either (pre-existent) pulmonary comorbidity or by the COVID-19 infection itself with necrosis of alveolar lining cells, pneumocyte type 2 hyperplasia, and linear intra-alveolar fibrin deposition.[4] Based on these findings, therapeutic options such as positive end-expiratory pressure, anticoagulation and vasodilators cannot be recommended. In fact, the latter can even be dangerous in case of hypoxaemia due to non-vascular problems because of the risk of shunting. Furthermore, the study design merits some consideration. First, there were only seven non-COVID-19 ARDS patients, so the representativeness of this group might be questionable. Besides the underlying cause of the ARDS was not known. Second, it is unclear whether the protocol and the quality of the scans of patients with COVID-19 and the control groups were similar and how this could influence FRI measurements.

To conclude, Thillai *et al* showed visibly well that in severe ill patients with COVID-19 have redistribution of the pulmonary blood flow. We are looking forward to hearing more from this FRI technique, ideally combined with more radiological and clinical information and within the context of a well-designed trial.

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