
Pulmonary embolism in COVID-19: Ancillary findings on chest CT angiography

Sir,

Since the beginning of coronavirus disease 2019 (COVID-19)

in Wuhan, Hubei Province, China, many articles have published typical chest computed tomography (CT) patterns including isolated or mixed ground-glass opacity

(GGO), crazy paving and consolidation in COVID-19,^[1,2] improperly attributed to pneumonia.^[3] Enlargement of subsegmental vessels in areas of pulmonary opacity has also been reported.^[2]

In a preliminary retrospective study, we assessed by chest CT angiography the ancillary findings which include parenchymal alterations and enlargement of segmental pulmonary arteries in critically ill COVID-19 patients with pulmonary embolism (PE).

At two institutions in Italy, from March to May 2020, out of 244 COVID-19 patients, 67 (age range 40 to 76 years, mean 63 years) were identified as critically ill. 10 out of 67 patients had clinical and laboratory data which were suspicious for PE and underwent chest CT angiography. 8 out of 10 patients had evidence of pulmonary emboli. Two radiologists (M.S. and F.A.M.) with at least 25 years of experience in chest CT, assessed the PE location in the main, lobar and segmental pulmonary arteries, pleural and parenchymal abnormalities; in addition, the diameter of the artery upstream the luminal defect with respect to the homologous bronchus was measured and compared with the corresponding anatomical structures in the contralateral lobe without PE. The results of parenchymal findings in the lobes and segments with and without PE in eight COVID-19 patients are reported in Table 1.

In eight out of ten patients with PE, intraluminal filling defects in 35 out of 160 segmental arteries were detected (20 segments and 6 lobes for each patient for a total of 48 lobes in eight patients).

PE was observed in 5 out of 16 upper lobes (in seven segments out of 48 upper lobes segments), 10 out of 16 inferior lobes (20 out of 80 segments), and five out of 16 lobes that include medium and lingular lobe (eight out of 32 segments). One patient had massive PE and three patients presented filling defects in lobar pulmonary arteries, whereas there were no filling defects in the main pulmonary arteries.

The diameter of segmental pulmonary arteries up to the clot was larger (ranged from 4 to 11 mm, mean 6.4 mm) compared to the homologous segmental bronchus (diameter ranged from 2.3 to 8.2 mm, mean 4.5 mm). PE was bilateral in five patients, from which in three cases in the corresponding lobes.

The mean diameter of the pulmonary trunk was 28.2 mm (ranged from 21 to 33 mm) and that of the right cardiac chamber was 39.5 mm (ranged from 34.7 to 48 mm).

The parenchymal findings in the lung territories perfused by the pulmonary arteries with a filling defect included GGO in 17/20 lobes ($n = 19$ segments) [Figure 1], consolidation in 12/20 lobes ($n = 24$ segments), crazy-paving in 5/20 lobes ($n = 7$ segments), and atelectasis in 4/20 lobes ($n = 6$ segments). Pleural effusion was noticed in five patients.

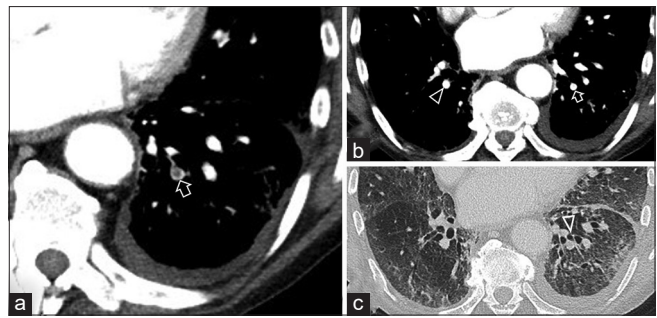


Figure 1: Computed tomography angiography of the chest in a 76-year-old critically ill COVID-19 male patient, shows thrombus in the segmental pulmonary artery in the left lower lobe (arrow in a). The segmental pulmonary artery upstream the thrombus (arrow in b) demonstrates a diameter similar to that of the contralateral artery without thrombus (arrowhead in b). The homologous bronchus at the level of the segmental artery upstream the thrombus has a diameter smaller to that of the artery (arrowhead in c). Note ground-glass opacity in the left lower lobe and homolateral pleural effusion

Table 1: Pulmonary parenchymal findings in lobes and segments with and without PE: results in 8 COVID-19 patients

| Parenchymal findings | PE | | No-PE | |
|----------------------|------------------|--------------|------------------|--------------|
| | Lobes ($n=20$) | Segments (%) | Lobes ($n=10$) | Segments (%) |
| Ground glass | 7 | 54.2% | 3 | 20% |
| Crazy paving | 5 | 20% | 0 | 0% |
| Consolidation | 12 | 68.5% | 6 | 30% |

Percentage in %, PE: pulmonary embolism

In the contralateral pulmonary lobes ($n = 10$ and 20 segments) not affected by PE, the enlargement of all respective segmental arteries was revealed in seven out of eight patients; among these ten lobes GGO, consolidation, and crazy-paving were found in three lobes ($n = 4$ segments), in three lobes ($n = 6$ segments), and no lobe, respectively.

Numerous CT studies in COVID-19 patients merely reported a list of the lung parenchymal changes (most frequently bilateral or not GGO with consolidation and crazy-paving) related to pneumonia and in some cases associated with enlargement of subsegmental vessels until the 89% of cases and attributed to proinflammatory factors or hyperemia.^[1,2] Diagnosis of PE at pulmonary CT angiography is reported in 30% of COVID-19 patients, and it is related to hypercoagulability and diffuse blood clots.^[4,5] In a study by Menter *et al.*^[3] a distinct difference between the “pneumonia, COVID-related” and the signs of diffuse alveolar damage (DAD) on CT imaging is reported, but there is no evidence to suggest suppurative bronchopneumonia on histology; DAD with massive capillary congestion, often is accompanied by microthrombi.^[3]

In our study, the percentage of GGO, consolidation, and crazy-paving in the lobes affected by embolism was higher than in the contralateral pulmonary lobes without embolism (54.2%, 68.5%, and 20% and vs. 20%, 30%, and 0%, respectively). The pulmonary parenchymal lesions in

COVID-19 with PE may be attributable to reduced perfusion in the lung areas, bronchoconstriction, edema, infarction and alveolar hemorrhage.^[3,6]

Our preliminary results demonstrated that the segmental arteries upstream to the endoluminal defect are larger in diameter compared to the homologous segmental bronchus.

However, the limitations of our study are its retrospective nature and the inclusion of a small cohort of patients. Also, there is no histopathology to correlate the pulmonary and vascular changes.

In conclusion, in critically ill COVID-19 patients, the parenchymal changes and enlargement of the segmental vessels on unenhanced chest CT suggest a PE, thus the administration of IV contrast is recommended.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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