Three-dimensional (3D) lung segmentation for diagnosis of COVID-19 and the communication of disease impact to the public

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DESCRIPTION

Three individuals were admitted to the hospital (ages 46–56; two men and one woman) with a multiday history of symptoms associated with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and underwent contrast-enhanced thoracic CT due to worsening symptomatology. Three-dimensional (3D) digital models were created to visualise the extent of the disease within the respiratory system (figures 1 and 2) from the thin section (1 mm) data sets. All patients presented emergently with variable pulmonary symptoms ranging from mild to severe, including shortness of breath and all were febrile. Two of the patients...
were reverse transcription polymerase chain reaction (RT-PCR) positive for SARS-CoV-2 (figure 1B,D,F; figure 2C,D,G,H). The third patient was RT-PCR negative for SARS-CoV-2, but this was presumed to be a false-negative result given compelling clinical and imaging features indicative of COVID-19 (figures 1C,E and 2E,F). A fourth patient who presented to the emergency department and was suspected of having COVID-19 also underwent CT to assess for the possibility of pulmonary embolus (figures 1A and 2A,B). This individual tested negative for SARS-CoV-2, and the lungs were normal. All CT examinations were obtained using a Philips iCT 256 or iQon Spectral CT systems. Data were acquired using a 128×0.625 mm or 64×0.625 mm detector configuration with dual sampling, rotation time of 0.33 s (120 kVp 72 mAs).

The full effect of COVID-19 on the respiratory system remains unknown,3 however, the use of 3D digital segmented models from CT data provides the opportunity to evaluate the extent and distribution of the disease in one encapsulated view for clinicians, particularly in the case where RT-PCR for SARS-CoV-2 is negative but there is strong clinical suspicion for COVID-19. The 3D digital surface models (figures 1, 2A,C,E,G) were segmented by hand in the scientific visualisation programme Avizo V7.1 (Thermo Fisher Scientific) following established methods for lungs in non-model organisms.2–4 The utility of CT in the diagnosis of COVID-19 pneumonia has been a focus of recent radiologic literature with specific CT patterns of findings being well documented, including patchy and/or confluent, bandlike ground glass opacity or consolidation in a peripheral and mid-to-lower lung zone distribution.5–12 Given diagnostic challenges with respect to false-negative results by RT-PCR, the gold standard for COVID-19 diagnostic screening, CT can be helpful in establishing this diagnosis.13 Importantly, these CT features can range in morphology and appear to correlate temporally with disease progression.13 14 This allows for 3D segmentation of the data in which lung tissue can be volumetrically quantified,4 or airflow patterns could be modelled.15 Moreover, these models provide for a holistic view of the extent of pulmonary disease that can be appreciated by a wide-range medical imaging viewership.16 17 Unlike simple volume rendered images, these models can be 3D printed, and thus have a much broader functional application that allows for the collaboration between basic and clinical scientists, which is particularly important given the critical nature of COVID-19.2 18–20


