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Sensitivity of Chest CT for COVID-19: Comparison to RT-PCR

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Conflicts of interest are listed at the end of this article.

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In December 2019, an outbreak of unexplained pneumonia in Wuhan, China (1), was caused by a new coronavirus infection named coronavirus disease 2019 (COVID-19). Unenhanced chest CT may be considered for early diagnosis of viral disease, although viral nucleic acid detection with real-time polymerase chain reaction (RT-PCR) remains the standard of reference. Chung et al (2) reported that chest CT may be negative for viral pneumonia of COVID-19 at initial presentation (three of 21 patients). Recently, Xie et al (3) reported that five of 167 patients (3%) had negative RT-PCR findings for COVID-19 at initial presentation despite chest CT findings typical of viral pneumonia. The purpose of our study was to compare the sensitivity of chest CT with that of viral nucleic acid assay at initial patient presentation.

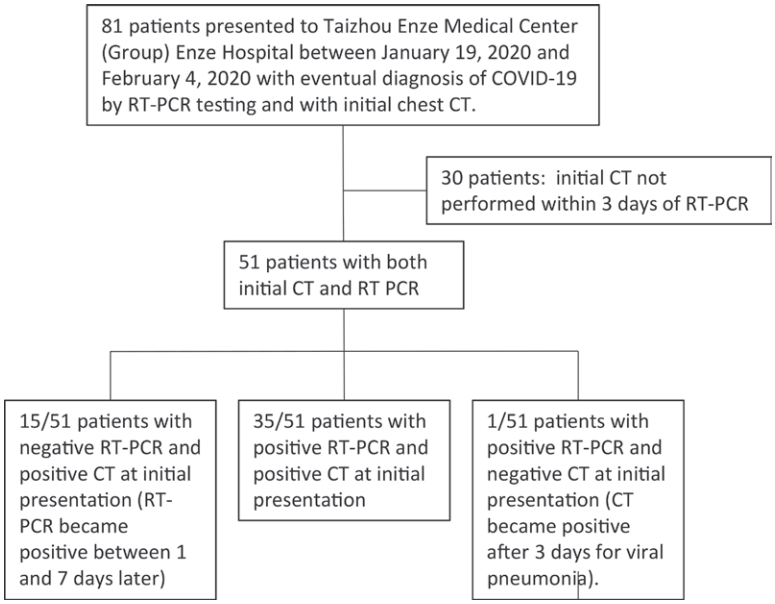

Figure 1: Flowchart for patient inclusion. COVID-19 = coronavirus disease 2019, RT-PCR = real-time polymerase chain reaction.

Materials and Methods

This retrospective analysis was approved by institutional review board. The requirement to obtain patient consent was waived. Patients at Taizhou Enze Medical Center (Group) Enze Hospital were evaluated from January 19, 2020, to February 4, 2020. During this period, chest CT and RT-PCR (Shanghai ZJ Bio-Tech, Shanghai, China) were performed for consecutive patients who presented with *(a)* a travel history to or residential history in Wuhan or local endemic areas or contact with individuals from these areas with fever or respiratory symptoms within 14 days and *(b)* fever or acute respiratory symptoms of unknown cause. In the case of an initial negative RT-PCR test, repeat testing was performed at intervals of 1 day or more. We included all patients who underwent both unenhanced chest CT (slice thickness, 5 mm) and RT-PCR testing within an interval of 3 days or less and in whom COVID-19 infection was eventually diagnosed by means of RT-PCR testing (Fig 1). Typical and atypical chest CT findings were recorded according to CT features previously described for COVID-19 (4,5). The detection rate of COVID-19 infection based on the initial chest CT and RT-PCR findings was compared. Statistical analysis was performed by using the McNemar χ^2 test, with $P < .05$ indicative of a statistically significant difference.

Results

Fifty-one patients (29 men, 22 women) were included. The median patient age was 45 years (interquartile range, 39–55 years). Throat swab (45 patients) or sputum (six patients) samples were obtained in all patients, followed by at least one RT-PCR assay. The average time from initial symptom onset to CT was 3 days ± 3 (standard deviation); the average time from initial symptom onset to RT-PCR testing was 3 days ± 3. Of the 51 patients, 36 had initial positive RT-PCR findings for COVID-19. COVID-19 was confirmed in 12 of the 51 patients with two RT-PCR nucleic acid tests (1–2 days), in two patients with three tests (2–5 days), and in one patient with four tests (7 days) after initial onset.

Fifty of the 51 patients (98%) had evidence of abnormal CT findings compatible with viral pneumonia at baseline; one patient had a normal CT scan. Of the 50 patients with abnormal CT scans, 36 (72%) had typical CT manifestations (eg, peripheral and subpleural ground-glass opacities, often in the lower lobes) (Fig 2), and 14 (28%) had atypical CT manifestations (Fig 3) (2). In this patient sample, the detection rate for initial CT (50 of 51 patients [98%]; 95% confidence interval: 90%, 100%) was greater than that for first RT-PCR (36 of 51 patients [71%]; 95% confidence interval: 56%, 83%) ($P < .001$).

Discussion

In our series, the sensitivity of chest CT was greater than that of RT-PCR (98% vs 71%, respectively; $P < .001$). The

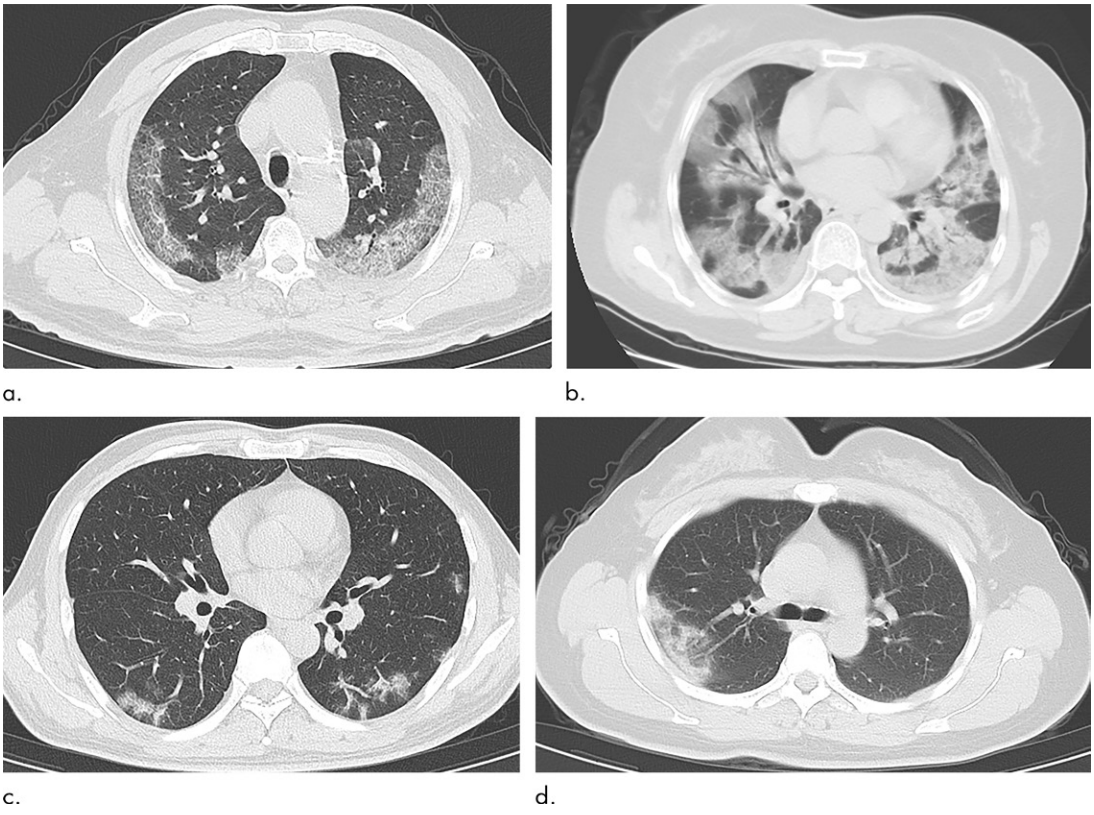

Figure 2: Examples of typical chest CT findings compatible with coronavirus disease 2019 (COVID-19) pneumonia in patients with epidemiologic and clinical presentation suspicious for COVID-19 infection. **(a)** Axial chest CT scan in 74-year-old man with fever and cough for 5 days shows bilateral subpleural ground-glass opacities. **(b)** Axial chest CT scan in 55-year-old woman with fever and cough for 7 days shows extensive bilateral ground-glass opacities and consolidation. **(c)** Axial chest CT scan in 43-year-old man who presented with fever and cough for 1 week shows small bilateral areas of peripheral ground-glass opacity with minimal consolidation. **(d)** Axial chest CT scan in 43-year-old woman who presented with fever with cough for 5 days shows a right lung region of peripheral consolidation.

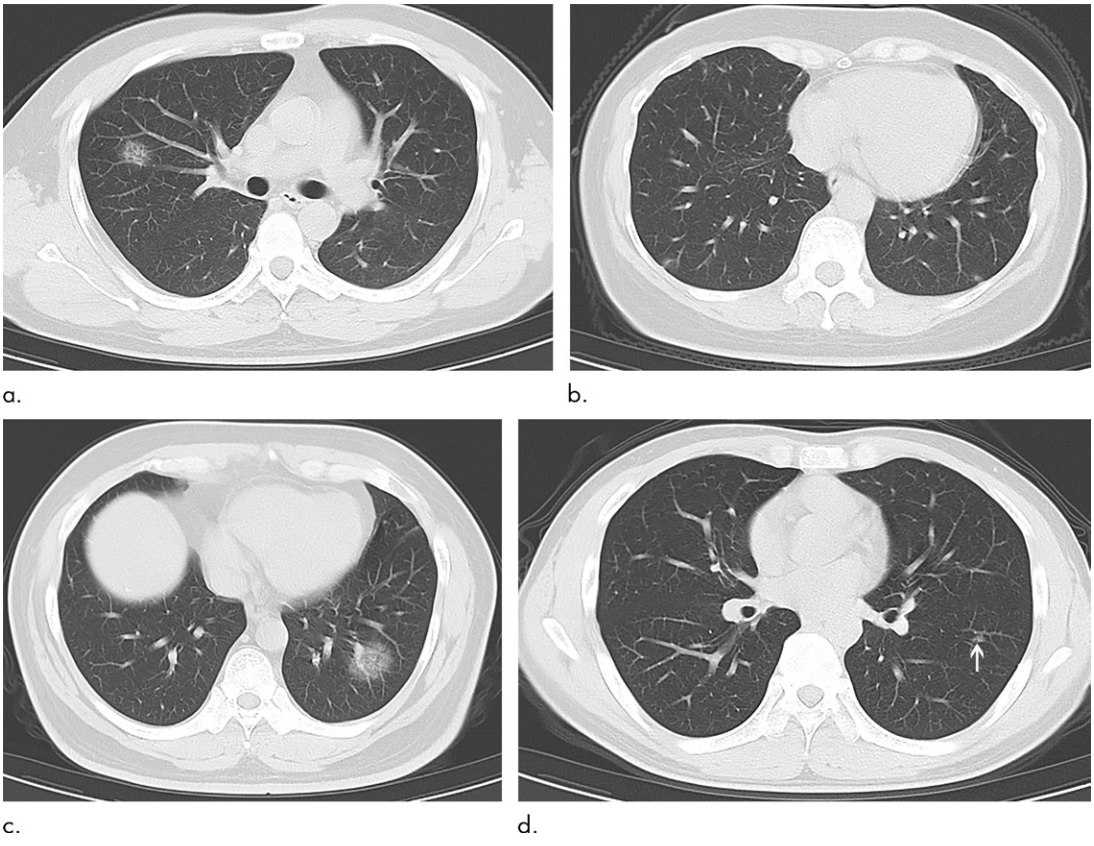

Figure 3: Examples of atypical chest CT findings of coronavirus disease 2019 (COVID-19) infection in patients with epidemiologic and clinical presentation suspicious for COVID-19 infection. **(a)** Axial chest CT scan in 36-year-old man with cough for 3 days shows a small focal and central ground-glass opacity in right upper lobe. **(b)** Axial chest CT scan in 40-year-old woman with fever for 2 days shows small peripheral linear opacities bilaterally. **(c)** Axial chest CT scan in 38-year-old man with fever for 4 days shows a ground-glass opacity in central left lower lobe. **(d)** Axial chest CT scan in 31-year-old man with fever for 1 day shows a linear opacity in left lower lateral mid lung

reasons for the low efficiency of viral nucleic acid detection may include *(a)* immature development of nucleic acid detection technology, *(b)* variation in detection rate from different manufacturers, *(c)* low patient viral load, or *(d)* improper clinical sampling. The reasons for the relatively lower detection rate with RT-PCR in our sample compared with a prior report are unknown (3). Our results support the use of chest CT to screen for COVID-19 in patients with clinical and epidemiologic features compatible with COVID-19 infection, particularly when results of RT-PCR tests are negative.

Author contributions: Guarantors of integrity of entire study, all authors; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; agrees to ensure any questions related to the work are appropriately resolved, all authors; literature research, Y.F., H.Z., J.X., M.L., L.Y., W.J.; clinical studies, Y.F., H.Z., J.X., M.L., L.Y., W.J.; experimental studies, all authors; statistical analysis, Y.F., H.Z., P.P.; and manuscript editing, Y.F., H.Z., P.P

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