Stroke

BRIEF REPORT

Utility of Apical Lung Assessment on Computed Tomography Angiography as a COVID-19 Screen in Acute Stroke

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BACKGROUND AND PURPOSE: Evaluation of the lung apices using computed tomography angiography of the head and neck during acute ischemic stroke (AIS) can provide the first objective opportunity to screen for coronavirus disease 2019 (COVID-19).

METHODS: We performed an analysis assessing the utility of apical lung exam on computed tomography angiography for COVID-19–specific lung findings in 57 patients presenting with AIS. We measured the diagnostic accuracy of apical lung assessment alone and in combination with patient-reported symptoms and incorporate both to propose a COVID-19 era AIS algorithm.

RESULTS: Apical lung assessment when used in isolation, yielded a sensitivity of 0.67, specificity of 0.93, positive predictive value of 0.19, negative predictive value of 0.99, and accuracy of 0.92 for the diagnosis of COVID-19, in patients presenting to the hospital for AIS. When combined with self-reported clinical symptoms of cough or shortness of breath, sensitivity of apical lung assessment improved to 0.83.

CONCLUSIONS: Apical lung assessment on computed tomography angiography is an accurate screening tool for COVID-19 and can serve as part of a combined screening approach in AIS.

Key Words: computed tomography angiography ■ data collection ■ dyspnea ■ self-report ■ stroke

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has created previously unanticipated challenges to acute ischemic stroke (AIS) management and treatment with mechanical thrombectomy. Guidelines have attempted to improve stroke system preparedness by providing recommendations for COVID-19 era: (1) resource allocation and staffing; (2) indications and safety of mechanical thrombectomy including airway management; (3) postacute care, triaging, and infection control; and (4) staff safety and use of personal protective equipment.[1,2] Despite these advances, the intense time constraints and often limited collateral history make COVID-19 screening during AIS evaluation extremely challenging.[3]

Computed tomography angiography (CTA) of the head and neck done during emergency evaluation for large vessel occlusion typically includes visualization of lung apices, providing the first objective opportunity to screen for peripheral ground-glass and consolidative opacities suggestive of COVID-19–related pneumonia.[4] We hypothesize that radiographic findings in the lung apices can offer the simultaneous advantage of quickly identifying patients with COVID-19. We performed a retrospective analysis assessing the diagnostic accuracy of apical lung exam using a previously reported categorical assessment scheme for COVID-19–specific lung findings in patients emergently presenting to the hospital with AIS and propose a COVID-19 era acute stroke algorithm.[5]

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Nonstandard Abbreviations and Acronyms

AIS	acute ischemic stroke
CO-RADS	coronavirus disease 2019 reporting and data system
COVID-19	coronavirus disease 2019
CTA	computed tomography angiography
PCR	polymerase chain reaction
RT-PCR	real-time reverse transcription polymerase chain reaction
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2

METHODS

The data that support the findings of this study are available from the corresponding author upon reasonable request. We included patients presenting to 3 Montefiore Health System hospitals in Bronx, New York, comprising a community hospital, a primary stroke center, and a comprehensive stroke center, between March 1, 2020, and April 30, 2020. We identified 110 patients with CTA of the head and neck. Of these, 6 incomplete studies were excluded. AIS was defined as hospital presentation for an acute neurological deficit that prompted CTA imaging within 24 hours of hospitalization. We excluded 10 patients who did not meet these criteria and one patient who had a negative polymerase chain reaction (PCR) but was clinically diagnosed with COVID-19. Confirmed COVID-19 was defined as a positive SARS-CoV-2 real-time reverse transcription PCR (RT-PCR) obtained by nasopharyngeal swab using Food and Drug Administration-approved assays (Abbott; Luminex Aries, Cepheid Xpert Xpress SARS-CoV-2, Hologic Panther Fusion real-time RT-PCR SARS-CoV-2 assay). We identified 31 patients who were not tested with RT-PCR, 27 of whom presented before we implemented a systematic screening protocol using RT-PCR for all patients with AIS (Data Supplement). Of the 57 patients included in our final analysis, only 1 RT-PCR negative and 2 RT-PCR positive presented before systematic screening was implemented. Our final cohort, therefore, included a near consecutive group of patients presenting with AIS systematically screened for COVID-19 using RT-PCR.

CTA studies were performed on 64-slice LightSpeed VCT scanners (GE Medical Systems), before and after administration of isovue 370 at 5 cm^3/s. Images were obtained with 0.625-mm slice thickness with additional 2.5-mm reconstructions. The scanning protocol included lung fields beginning at the level of the aortic arch. Lung assessment was, therefore, solely based on lung apices visualized on CTA. The images were evaluated by 1 of 2 fellowship trained radiologists subspecialized in cardiothoracic (A.S.) or body imaging (I.G.), blinded to the patient's COVID-19 status, using the COVID-19 reporting and data system (CO-RADS) scheme—a previously reported computed tomography–based categorical classification system assessing for the presence or absence of pulmonary findings suspicious for COVID-19.[5] CO-RADS classifies lung findings into 5 groups as it relates to findings consistent with COVID-19 pneumonia: (1) very low level of suspicion, (2) low level of suspicion, (3) equivocal suspicion, (4) high level of suspicion, or (5) very high level of suspicion (Data Supplement). CTAs with equivocal findings (CO-RADS of 3; n=4, with 2 in each COVID-19 group) were subsequently blindly reviewed, in consensus, by the two attending radiologists with perfect interobserver agreement and were ultimately excluded from final analyses.

New York City COVID-19 prevalence was estimated based on publicly available data provided by the New York City Department of Health and Mental Hygiene. The significance threshold was set at a 2-sided $P<0.05$. This study was approved by the Albert Einstein College of Medicine/Montefiore Medical Center Institutional Review Board. Informed consent was waived.

RESULTS

Our final analysis included 57 patients, 30 in the COVID-19–positive and 27 in the COVID-19–negative group. The groups were demographically and clinically similar with no statistically significant differences except in presenting oxygen saturation ($P=0.01$). We found 20 (67%) patients in the COVID-19–positive and 2 (7%) in the COVID-19–negative group with lung findings highly or very highly suspicious for COVID-19 pneumonia (CO-RADS, ≥4; $P<0.001$). CO-RADS designation remained significantly different after controlling for age and presenting oxygen saturation ($P=0.02$). Additionally, 13 patients in the COVID-19–positive group had self-reported clinical symptoms of cough or dyspnea, of which 5 did not have evidence of COVID-19 on apical lung assessment (CO-RADS, ≤2; Data Supplement).

CO-RADS score of 4 or 5 (highly or very highly suspicious for COVID-19 pneumonia), when used in isolation, yielded a sensitivity of 0.67, specificity of 0.93, positive predictive value of 0.19, negative predictive value of 0.99, and accuracy of 0.92 for the diagnosis of COVID-19. When apical lung assessment was combined with self-reported clinical symptoms of cough or dyspnea, sensitivity for the diagnosis of COVID-19 in patients presenting to the hospital for AIS increased to 0.83 (Table).

Table. Descriptive Statistics for Diagnosing COVID-19 Using Radiological Features Alone or in Combination With Clinical Features of Cough or Dyspnea

	Sensitivity	Specificity	PPV	NPV	Accuracy	AUC
CO-RADS 4/5	0.67	0.93	0.19*	0.99*	0.92	0.80
CO-RADS 4/5+cough/dyspnea	0.83	0.93	0.22*	0.99*	0.92	0.88

AUC indicates area under the curve; CO-RADS, COVID-19 reporting and data system; COVID-19, coronavirus disease 2019; NPV, negative predictive value; and PPV, positive predictive value.

*Calculated using a community COVID-19 prevalence of 2.5%.

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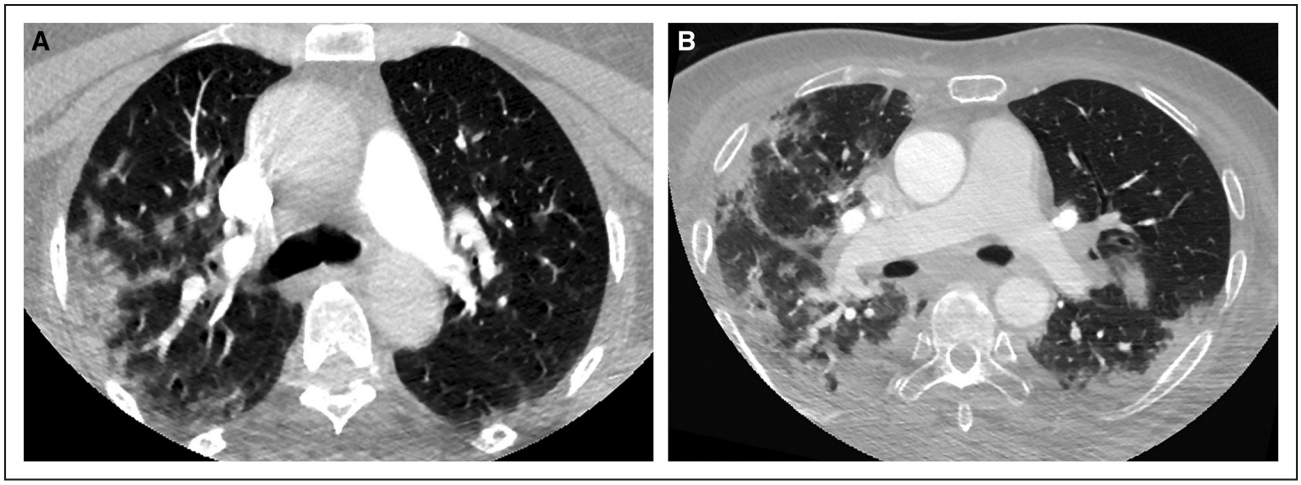

Figure 1. Example of lung findings in coronavirus disease 2019 (COVID-19) reporting and data system (CO-RADS) categories 4 and 5.

Axial computed tomography (CT) images from head and neck CT angiography demonstrate (**A**) predominantly unilateral peripheral patchy ground-glass opacities, highly suspicious for COVID-19 pneumonia (CO-RADS category 4) and (**B**) bilateral and multifocal, predominantly peripheral ground-glass opacities, with subpleural consolidations abutting the visceral pleura, with additional linear opacities, very highly suspicious for COVID-19 pneumonia (CO-RADS category 5).

DISCUSSION

We describe the utility of apical lung exam on CTA performed in the acute stroke setting, as a screen for COVID-19 pneumonia. This is not the first study to report incidental COVID-19–related lung findings. Hossain et al[6] found a substantial number of patients with non-chest computed tomography imaging with evidence of COVID-19 pneumonia, while Kihira et al[7] found a high rate of COVID-19–related lung findings in patients with acute stroke who received head and neck CTA.[6] Like our study, both included patients from the New York City at the height of the local COVID-19 surge. Unlike these, however, we exclude all in-hospital cases and also include a near consecutive cohort of patients presenting from the community with AIS. We thus limit selection bias from an already enriched population and report diagnostic accuracy, making our findings relevant to other stroke centers with high local prevalence of COVID-19.

We show that peripheral ground-glass opacities with or without associated consolidations in the lung apices are highly specific but not sensitive for COVID-19 (Figure 1). When combining radiographic findings with clinical findings of cough or dyspnea, sensitivity increased from 0.67 to 0.83. In comparison, the sensitivity of a 1-time RT-PCR for SARS-CoV-2 has been reported to be 0.72 for sputum and 0.63 for nasal swab in 1 study.[8] Our experience suggests that apical lung assessment may provide similar value to RT-PCR, but with the added benefit of a rapid turnaround time and no additional cost or change to established stroke pathways. Our findings are in-line with analyses that consistently show a high sensitivity for chest computed tomography as a screening tool for COVID-19.[9]

We conclude that while important to recognize when present, apical lung findings when absent cannot be used as the sole screening method for COVID-19 in patients with AIS who require mechanical thrombectomy or rapid triaging. We propose an acute stroke algorithm that incorporates (1) COVID-19 screening questions, (2) apical lung assessment, and (3) systematic SARS-CoV-2 RT-PCR testing, to rapidly identify patients with overt symptoms and pulmonary findings, while simultaneously ensuring early and systematic screening using RT-PCR of otherwise asymptomatic individuals (Figure 2).

Several limitations must be acknowledged. First, there is a lack of gold standard in diagnosing COVID-19. While we defined positivity using RT-PCR, the accuracy of this testing modality varies.[10] As a result, we excluded all patients who did not have RT-PCR performed, the overwhelming majority of whom presented before we implemented standardized screening procedures. Patients included in the final analysis were nearly consecutive, however, limiting selection bias. Second, diagnostic accuracy is affected by local COVID-19 prevalence and should, therefore, be used with caution in places with low prevalence.

ARTICLE INFORMATION

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Sources of Funding

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Disclosures

None.

Supplemental Materials

Tables I–III
Figures I–II

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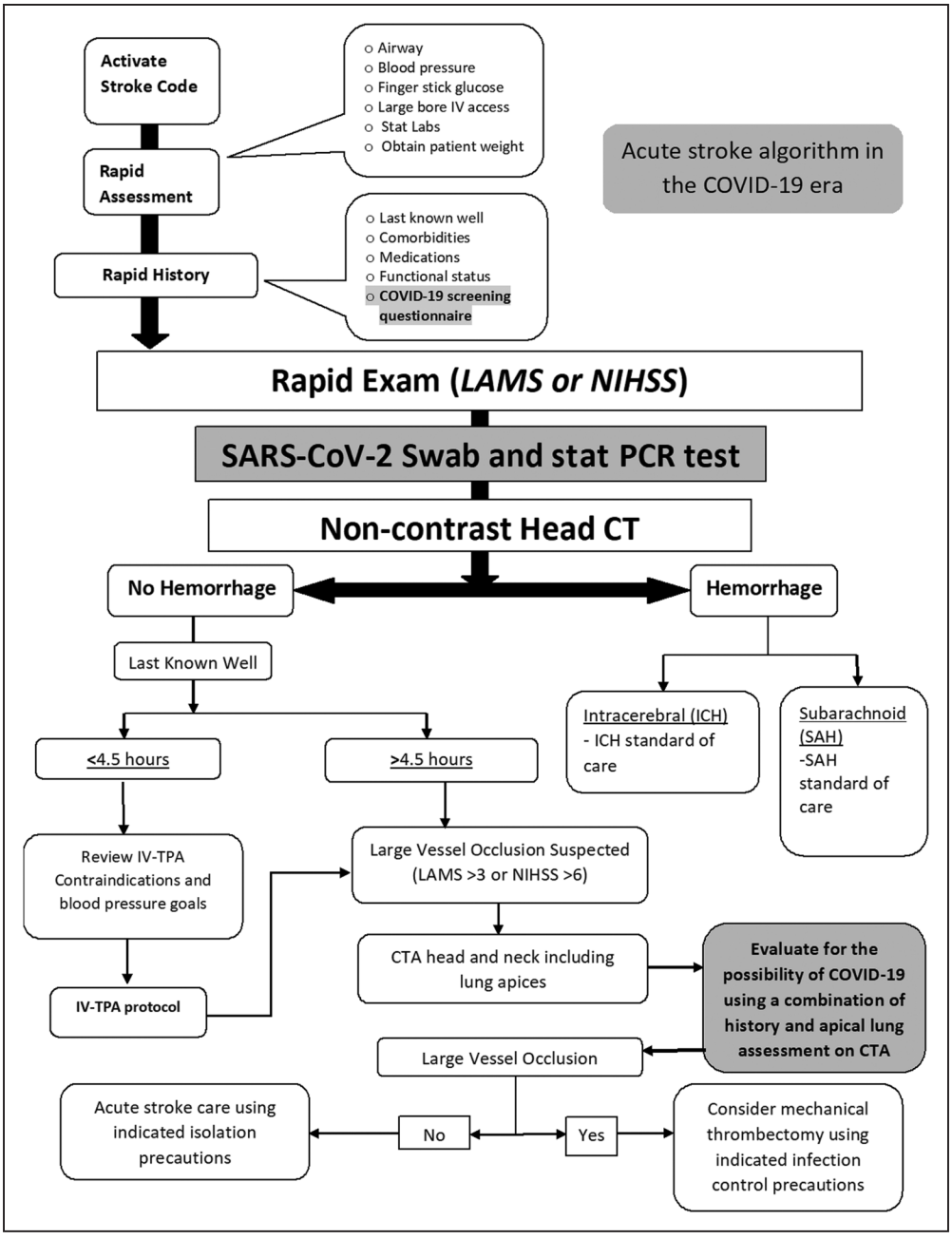

Figure 2. Acute stroke algorithm for the coronavirus disease 2019 (COVID-19) era.
CT indicates computed tomography; CTA, computed tomography angiography; ICH, intracerebral hemorrhage; IV, intravenous; IV-TPA, intravenous tissue-type plasminogen activator; LAMS, Los Angeles Motor Scale; NIHSS, National Institutes of Health Stroke Scale; PCR, polymerase chain reaction; SAH, subarachnoid hemorrhage; and SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.