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Role of High-Resolution CT Chest in Early Detection and Prognostication of COVID-19 Pneumonia: Insights from the Bangladeshi Population

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Abstract: ***Background:*** High-resolution computed tomography (HRCT) has emerged as a vital imaging modality in the management of COVID-19, offering rapid and detailed visualization of pulmonary involvement. While RT-PCR remains the diagnostic gold standard, HRCT is particularly valuable in early detection, assessment of disease severity, and guiding clinical decisions, especially in resource-limited settings. This study explores the role of HRCT in the early diagnosis and prognostication of COVID-19 pneumonia. ***Methods:*** This cross-sectional observational study was conducted at a tertiary care hospital in Bangladesh between January and December 2021, involving 100 adult patients with confirmed COVID-19 infection based on RT-PCR testing. Data were analyzed using SPSS 26.0. ***Result:*** In this study of 100 COVID-19 patients, HRCT chest revealed ground-glass opacities in 92% and bilateral, peripheral involvement in most cases. CT severity scores correlated strongly with clinical outcomes—higher scores were associated with lower oxygen saturation, elevated inflammatory markers, longer hospital stays, increased need for ICU care and ventilation, and higher mortality. ***Conclusion:*** High-resolution CT (HRCT) chest imaging plays a pivotal role in the early detection and prognostication of COVID-19 pneumonia, particularly in the Bangladeshi population. Our study demonstrated that HRCT not only detects characteristic lung abnormalities such as ground-glass opacities and consolidation in the early stages of infection but also provides a reliable severity score that correlates significantly with clinical outcomes, including oxygen saturation, inflammatory markers, ICU admission, and mortality.

Keywords: High-Resolution CT, Early Detection, COVID-19, Pneumonia.

Original Researcher Article

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Article at a glance:

Study Purpose: *To assess the utility of HRCT in the early diagnosis and prognostication of COVID-19 pneumonia in a tertiary care hospital.*
Key findings: *HRCT revealed ground-glass opacities in 92% of patients, with higher CT severity scores linked to worse clinical outcomes.*
Newer findings: *HRCT provides reliable early detection and severity scoring of COVID-19 pneumonia, correlating strongly with clinical outcomes, especially in resource-limited settings.*
Abbreviations: *HRCT - High-Resolution Computed Tomography. RT-PCR - Reverse Transcription Polymerase Chain Reaction.*

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has posed an unprecedented global public health challenge since its emergence in late 2019. As of mid-2025, the disease continues to impact various regions, including South Asia, with Bangladesh experiencing several waves of infection due to population density, limited healthcare infrastructure, and challenges in testing and isolation measures.[1, 2] Early and accurate diagnosis, along with reliable prognostic tools, remains crucial for effective clinical management and containment of the disease. Reverse transcriptase-polymerase chain reaction (RT-PCR) remains the gold standard for COVID-19 diagnosis; however, its limitations—including false-negative rates and delayed results—have necessitated the integration of

imaging modalities into the diagnostic algorithm.[3] Among these, high-resolution computed tomography (HRCT) of the chest has emerged as a pivotal tool, particularly in scenarios where RT-PCR is inaccessible, delayed, or yields inconclusive results.[4] HRCT allows for rapid visualization of the extent and distribution of pulmonary involvement, offering both diagnostic and prognostic insights in real time. Several studies have highlighted the sensitivity of HRCT in detecting early lung changes even before the onset of clinical symptoms or when RT-PCR results are negative.[5, 6] Typical HRCT findings in COVID-19 pneumonia include bilateral, peripheral ground-glass opacities (GGOs), consolidations, and crazy-paving patterns, which evolve as the disease progresses.[7]

The temporal progression of these radiological changes—classified into early, progressive, peak, and absorption phases—provides clinicians with valuable information about disease severity and potential outcomes.[8] HRCT not only facilitates early detection but also plays a key role in prognostication. Various scoring systems have been developed to quantify the extent of pulmonary involvement, such as the CT severity score (CT-SS) and total lung severity score (TLSS), which correlate with clinical severity, oxygen requirement, ICU admission, and mortality.[9, 10] In resource-limited settings like Bangladesh, where rapid triaging of patients is essential, CT-based severity scoring can guide treatment decisions and optimize resource allocation.[11] Furthermore, studies have demonstrated that HRCT findings often precede hypoxia and other clinical deterioration indicators, allowing for timely intervention.[12] In a country like Bangladesh, where disparities in healthcare access exist between urban and rural areas, HRCT offers a feasible adjunct diagnostic modality, particularly in tertiary centers. Additionally, the integration of artificial intelligence in analyzing HRCT scans is being explored to enhance diagnostic accuracy and reduce inter-observer variability.[13] While the utility of HRCT in COVID-19 management is well-established globally, there remains a paucity of region-specific data from Bangladesh that addresses its role in early detection and prognostication. Given the unique demographic, genetic, and environmental factors in the Bangladeshi population, it is critical to understand how HRCT findings correlate with clinical outcomes in this setting. This study aims to bridge this gap by evaluating the diagnostic and prognostic value of HRCT in Bangladeshi COVID-19 patients, with a focus on early detection, CT severity scoring, and correlation with clinical outcomes such as oxygen requirement, ICU admission, and mortality.

METHODS

This cross-sectional observational study was conducted at a tertiary care hospital in Bangladesh between January and December 2021, involving 100 adult patients with confirmed COVID-19 infection based on RT-PCR testing. All participants underwent high-resolution computed tomography (HRCT) of the chest within 5–10 days of symptom onset. CT scans were performed using a standardized protocol, and images were evaluated by two experienced radiologists blinded to clinical data. A semi-quantitative CT severity score (CT-SS) was calculated by assigning scores (0–5) to each of the five lobes based on the extent of involvement, with a total possible score ranging from 0 to 25. Patients were categorized into mild (0–7), moderate (8–17), and severe (18–25) CT-SS groups. Clinical data including oxygen saturation, C-reactive protein (CRP), D-dimer levels, ICU admission, and in-hospital mortality were recorded and correlated with CT findings using appropriate statistical tests, with p-values <0.05 considered significant. Data were analyzed using SPSS 26.0. Ethical approval was obtained from the institutional review board, and informed consent was taken from all participants.

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of Study Population (n = 100)

Characteristic	Value
Mean Age (years)	52.4 ± 14.2
Sex (Male: Female)	62:38

Common Symptoms	Fever (90%), Cough (76%), Dyspnea (58%)
Comorbidities (any)	68%
– Hypertension	40%
– Diabetes Mellitus	36%
– Ischemic Heart Disease	20%
RT-PCR to CT time (mean)	3.2 ± 1.1 days

Table 1 summarizes the demographic and clinical profile of the study population. A male predominance was observed, and the majority of patients were middle-aged. Fever, cough, and dyspnea were the leading symptoms. Most patients had at least one comorbidity, underscoring the importance of monitoring high-risk individuals. The mean time interval between RT-PCR testing and HRCT imaging was 3.2 days, suggesting early utilization of imaging.

Table 2: HRCT Findings in COVID-19 Patients (n = 100)

HRCT Finding	Frequency (%)
Ground-glass opacities	92
Consolidation	64
Crazy-paving pattern	42
Interlobular septal thickening	38
Vascular enlargement	34
Bilateral involvement	88
Peripheral predominance	82
Central involvement	28

Table 2 outlines the characteristic HRCT findings among the patients. GGOs were nearly universal, while other common features included consolidation and septal thickening. Bilateral and peripheral distribution of lesions, seen in over 80% of cases, aligns with typical COVID-19 radiologic patterns described in earlier literature, reinforcing HRCT's diagnostic utility.

Table 3: Distribution of Patients Based on CT Severity Score (n = 100)

CT Severity Category	Score Range	Number of Patients (%)
Mild	0–7	28
Moderate	8–17	51
Severe	18–25	21
Mean CT Severity Score	—	12.8 ± 5.9

Table 3 displays the distribution of CT severity scores. A majority of patients fell into the moderate category, with over one-fifth having severe pulmonary involvement. The mean severity score serves as a baseline for correlating radiologic findings with clinical severity and prognosis.

Table 4: Clinical Parameters According to CT Severity Categories (n = 100)

Parameter	Mild (n=28)	Moderate (n=51)	Severe (n=21)	p-value
Mean Oxygen Saturation (%)	95.2 ± 1.4	91.6 ± 2.1	85.8 ± 3.3	<0.001
CRP (mg/L)	14.2 ± 6.1	32.1 ± 9.7	58.6 ± 14.3	<0.001
D-dimer (ng/mL)	365 ± 180	612 ± 290	1243 ± 538	<0.001

ICU admission (%)	0	18	81	<0.001
Mortality (%)	0	4	19	<0.001

Table 4 illustrates a stepwise increase in clinical severity markers with rising CT severity scores. Patients with severe CT scores had significantly lower oxygen saturation, higher inflammatory markers, and elevated rates of ICU admission and mortality. These correlations validate the prognostic utility of CT scoring in COVID-19.

Table 5: Prognostic Outcomes Based on CT Severity Score (n = 100)

Outcome	Mild (n=28)	Moderate (n=51)	Severe (n=21)
Mean Hospital Stay (days)	5.2 ± 1.1	8.6 ± 2.4	12.1 ± 3.9
Oxygen Therapy Required (%)	18	66	100
ICU Admission (%)	0	18	81
Mechanical Ventilation (%)	0	4	38
Mortality (%)	0	4	19

Table 5 presents the clinical outcomes across CT severity groups. Hospital stay, oxygen requirement, and ICU support increased proportionally with CT severity. Notably, all mortalities occurred in the moderate and severe groups. These results further emphasize the role of HRCT as a powerful tool not just in early detection, but also in outcome prediction.

DISCUSSION

In our cohort of 100 Bangladeshi COVID-19 patients, HRCT demonstrated high sensitivity for ground-glass opacities (92%) and consolidation (64%), with CT severity scores correlating strongly with clinical indices (oxygen saturation, CRP, D-dimer), ICU admission, and mortality. These findings align closely with international studies that underscore HRCT's dual utility in early detection and outcome prediction. The spectrum of CT patterns we observed—namely bilateral peripheral ground-glass opacities, consolidation, and crazy-paving—mirrors those described in multicenter cohorts from India and Egypt where ground-glass opacities (GGOs) accounted for approximately 90% of findings and were peripherally distributed in 90% of cases.[14] Our mean CT severity score (12.8 ± 5.9) and its stratification into mild, moderate, and severe bands followed a similar trend to Francone *et al.*, who found significant associations between CT-SS and disease severity, ICU requirement, and mortality.[10] While our moderate severity group (51%) and severe group (21%) aligned well with prior distributions, our mortality rate (6%) was comparatively lower, which may reflect differences in healthcare delivery, age distribution, or selection bias. The prognostic value of CT-SS was evident, particularly with increased ICU admissions and mortality in the severe CT-SS category. This parallels a meta-analysis by Saeed *et al.*, which showed that the odds of death increased by 1.24 for every unit increase in CT score.[15] Similarly, Magdy *et al.* established a CT-SS cut-off of 18 as predictive of poor prognosis—closely matching our observed cut-off.[16]

Additionally, our study identified significant inverse correlations between CT-SS and oxygen saturation and positive associations with inflammatory biomarkers like CRP and D-dimer. This is consistent with findings by Saeed *et al.*, both of whom highlighted CT-SS as a non-invasive surrogate for inflammatory burden and hypoxia.[15] Age-related differences were also notable in our study, as increasing age was significantly associated with higher CT scores ($p < 0.001$), consistent with the findings of Farghaly *et al.*, who observed that older age groups had more extensive parenchymal involvement.[17] The regional context adds further value. A study conducted in Sylhet, Bangladesh, found moderate CT-SS in the majority (62%) of RT-PCR–confirmed patients, but without significant correlation with clinical severity.[18] In

contrast, our study demonstrated statistically significant relationships between CT-SS and clinical outcomes, possibly due to methodological differences, inclusion criteria, or local disease dynamics. Integration of CT-SS with clinical scoring systems can further enhance prognostic accuracy. Akdur *et al*., demonstrated improved mortality prediction when CT-SS was combined with tools like NEWS or qSOFA, although such composite scores were beyond the scope of our current analysis.[19] Furthermore, a retrospective study in Egypt by Rahman *et al*., also emphasized the predictive role of HRCT in assessing COVID-19 outcomes.[20] Their findings of higher ICU admission and mortality rates with increasing CT-SS mirror ours, underlining the tool's global reliability.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

High-resolution CT (HRCT) chest imaging plays a pivotal role in the early detection and prognostication of COVID-19 pneumonia, particularly in the Bangladeshi population. Our study demonstrated that HRCT not only detects characteristic lung abnormalities such as ground-glass opacities and consolidation in the early stages of infection but also provides a reliable severity score that correlates significantly with clinical outcomes, including oxygen saturation, inflammatory markers, ICU admission, and mortality.

Recommendation

We recommend the routine use of high-resolution CT (HRCT) chest imaging in the early assessment and risk stratification of patients with suspected or confirmed COVID-19, especially in moderate to severe cases or when RT-PCR results are delayed or inconclusive. CT severity scoring should be integrated into clinical decision-making to guide timely interventions, predict complications, and allocate critical care resources effectively. Further multicenter studies with larger samples are encouraged to validate and standardize CT-based prognostic models in diverse populations.

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