International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s,2025
https://theaspd.com/index.php

Diagnostic And Prognostic Role Of Chest CT In Oncologic Patients With COVID-19 Pneumonia: An Indian Perspective

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Abstract

Background: *In India, cancer patients represent a particularly vulnerable population during the COVID-19 pandemic, owing to compromised immunity and overlapping pulmonary findings from cancer or its treatment. Early and accurate diagnosis of COVID-19 pneumonia in this group is critical but often complicated by pre-existing lung changes. Chest CT, widely used in India as a frontline imaging tool during the pandemic, may provide both diagnostic and prognostic insights.*

Methods: *We retrospectively studied 300 oncologic patients with confirmed COVID-19 between 2020 and 2022 in a tertiary referral hospital in India. Chest CT scans were evaluated using the Radiological Society of North America (RSNA) classification and a CT severity scoring system. Logistic regression was applied to assess the association of CT findings with mortality outcomes.*

Results: *The mean age was 56.5 years, with a slight male predominance (53%). Gastrointestinal (29.3%), hematologic (26.3%), and breast cancers (10.7%) were the most common malignancies. Only 42.8% demonstrated typical COVID-19 imaging features; atypical or indeterminate findings were frequent. Mixed ground-glass opacities with consolidation (44.4%), pleural effusion (33.5%), and pure ground-glass opacities (19.5%) were the most common abnormalities. The overall in-hospital mortality was 27.4%. Mortality risk was higher among patients with typical CT features (OR 3.47; 95% CI 1.14–8.98), CT severity score ≥18 (OR 1.89; 95% CI 1.07–3.34), consolidation ($p=0.040$), pleural effusion ($p<0.001$), centrilobular nodules ($p=0.013$), and architectural distortion ($p=0.005$).*

Conclusion: *In Indian oncologic patients, less than half of COVID-19 cases showed classical CT patterns. Radiologists must remain alert to atypical and subtle features to avoid underdiagnosis. Certain CT findings, particularly consolidation and pleural effusion, are strongly linked to poorer prognosis. In resource-constrained Indian hospitals, CT can serve as both a diagnostic adjunct and a prognostic tool, guiding timely triage and clinical management.*

Keywords*: COVID-19, chest CT, oncologic patients, India, diagnostic imaging, prognosis*

1.INTRODUCTION

India confronts one of the most pressing cancer burdens globally, with nearly 1.46 million new cancer cases estimated in 2022, and projections indicating a continued rise through 2025[1]. This translates to roughly one in every nine Indians being at risk of developing cancer in their lifetime[2]. Coupled with increasing urbanization, pollution, and lifestyle-related risks, cancers of the lung, breast, cervix, oral cavity, and esophagus are among the most prevalent[3,4,5].

Simultaneously, the COVID-19 pandemic added another layer of complexity to cancer care in India. Nationwide lockdowns and healthcare restructuring severely disrupted routine oncology services—patients faced delays in diagnosis, reduced access to treatments, and logistical hurdles such as transportation and limited hospital capacity PMCLippincott Journals. A multicenter study in South India revealed that up to **11**% of cancer patients required reliance on CT imaging to diagnose COVID-19 when RT-PCR results were negative or unavailable Lippincott Journals.

In light of limited resources and the dual burden of cancer and COVID-19, chest CT emerged as a critical diagnostic and triage tool—especially in scenarios demanding rapid decision-making. CT imaging not only aids in identifying COVID-19 pneumonia—when typical RT-PCR may fail—but also helps evaluate disease severity, which is essential for prognosis and management planning.

Yet, in oncologic patients, interpreting CT scans is particularly challenging. Tumor growth, treatment effects like radiation fibrosis or chemotherapy-induced changes, and pre-existing lung involvement (e.g., metastases or effusions) can obscure or mimic viral pneumonia features. This ambiguity may delay appropriate care or result in misclassification.

To date, few studies in India have systematically evaluated the diagnostic landscape of chest CT in cancer patients with COVID-19 or explored its role in prognostication. Our study fills this gap by examining chest CT patterns among oncologic patients with confirmed COVID-19 and evaluating which imaging findings correlate with worse clinical outcomes. By adopting this dual lens—diagnostic clarity and prognostic utility—we aim to better equip Indian radiologists and oncologists in navigating these complex cases, ultimately improving patient care under constrained settings.

METHODS

Study Design and Setting

This was a retrospective observational study conducted between 2020 and 2022 at a tertiary cancer referral hospital in India. The institution is a high-volume center that managed both oncology patients and COVID-19 cases during the pandemic. Ethical approval was obtained from the hospital's institutional review board, and the study was performed in accordance with the Indian Council of Medical Research (ICMR) guidelines for retrospective studies.

Patient Selection

A total of 300 patients with a confirmed history of malignancy and COVID-19 infection were included. COVID-19 was diagnosed based on RT-PCR positivity from nasopharyngeal swabs. Patients were eligible if they:

1. Had a prior diagnosis of cancer (solid or hematologic malignancy).
2. Underwent a chest CT scan within the first 10 days of COVID-19 symptom onset.
3. Had complete clinical and follow-up data available.

Patients were excluded if:

- Their CT images were of poor quality,
- Clinical data were incomplete, or
- They had concurrent severe pulmonary infections other than COVID-19.

CT Acquisition Protocol

All scans were performed on **a** 64-slice multidetector CT scanner, using low-dose protocols wherever feasible to minimize radiation exposure in line with Indian Radiological & Imaging Association (IRIA) recommendations. Standard acquisition parameters included:

- Slice thickness**:** 1–1.25 mm
- Tube voltage**:** 100–120 kVp
- Automatic exposure control to balance radiation dose and image quality
- Breath-hold technique during end-inspiration

Intravenous contrast was not routinely used unless clinically indicated.

Image Interpretation

Two experienced radiologists (with >10 years of thoracic imaging expertise), blinded to patient outcomes, independently reviewed all CT images. Discrepancies were resolved by consensus.

Findings were categorized according to the Radiological Society of North America (RSNA) classification into:

- Typical appearance (peripheral ground-glass opacities ± consolidation, vascular thickening, "crazy paving")
- Indeterminate appearance (non-specific findings)
- Atypical appearance (lobar consolidation, nodules, pleural effusion, cavitation)
- Negative for pneumonia

CT Severity Scoring

A semi-quantitative severity score was assigned based on the extent of lung involvement in each of the five lobes:

- 0 = 0% involvement
- 1 = <5% involvement
- 2 = 5–25%
- 3 = 26–49%
- 4 = 50–75%
- 5 = >75% involvement

The global CT severity score was obtained by summing the lobar scores (range: 0–25). A score >18 was considered severe.

Clinical Data and Outcomes

Demographic data (age, sex), cancer type, ongoing oncologic therapy (chemotherapy, radiotherapy, targeted therapy), comorbidities, and COVID-19–related clinical details were extracted from hospital records.

The primary outcome was in-hospital mortality. Secondary outcomes included ICU admission and need for invasive ventilation.

Statistical Analysis

Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Comparisons between survivors and non-survivors were performed using the chi-square test for categorical variables and t-tests for continuous variables. Logistic regression models were applied to identify CT features independently associated with mortality. A p-value <0.05 was considered statistically significant.

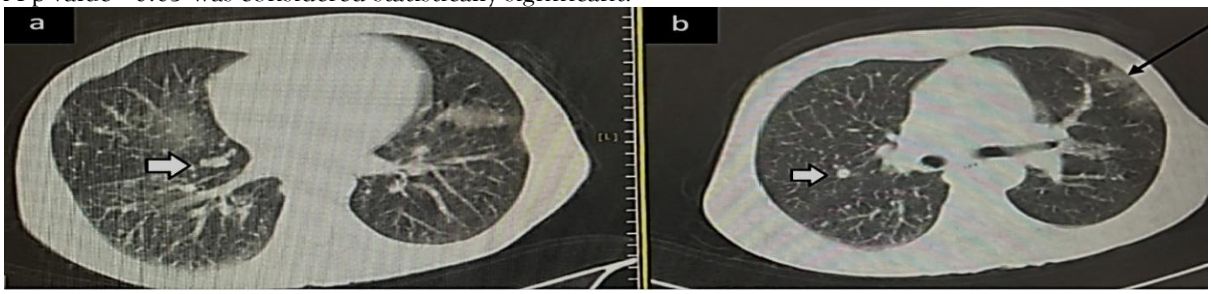
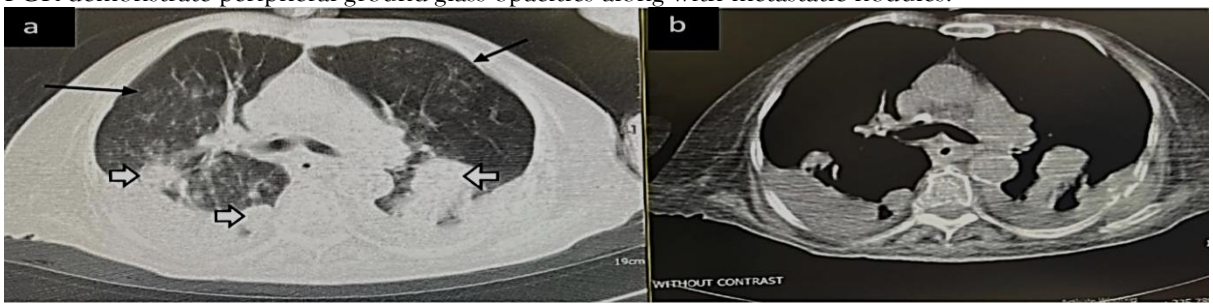


Figure 1: Axial unenhanced CT images of the lungs with hepatocellular carcinoma and positive RT-PCR demonstrate peripheral ground-glass opacities along with metastatic nodules.



Unenhanced axial CT images of the lungs and mediastinum with colon cancer and positive RT-PCR demonstrate a few small ground-glass opacities with non-rounded, non-peripheral distribution, along with metastatic nodules and a mass and associated pleural effusion.

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RESULTS

Patient Characteristics

A total of 300 oncologic patients with confirmed COVID-19 infection were included. The mean age was 56.5 years (range 22–82 years), with a slight male predominance (53%). Most patients were in the middle-aged to elderly group, reflecting both the age distribution of cancer in India and the increased vulnerability to COVID-19 in older populations.

When classified by type of malignancy, the most frequent cancers were gastrointestinal tumors (29.3%), followed by hematologic malignancies (26.3%), and breast cancers (10.7%). Other cancers, including head and neck cancers (9.3%), lung cancers (8.0%), and gynecological or sarcomatous malignancies, formed the remaining group.

Importantly, around 38% of patients were on active oncologic treatment (chemotherapy, radiotherapy, or targeted therapy) at the time of COVID-19 diagnosis, further compromising their immunity. In addition, comorbidities such as diabetes mellitus (32%), hypertension (29%), and chronic kidney disease (7%) were observed, adding to the overall risk profile.

Table 1. Baseline characteristics of the study population

Variable	n (%) or Mean ± SD
Total patients	300
Mean age (years)	56.5 ± 13.8
Male sex	159 (53%)
Female sex	141 (47%)
Cancer type	
Gastrointestinal	88 (29.3%)
Hematologic	79 (26.3%)
Breast	32 (10.7%)
Head and neck	28 (9.3%)
Lung	24 (8.0%)
Others (gynecologic, sarcoma, GU)	49 (16.4%)
Active treatment at COVID dx	114 (38%)
Comorbidities	
Diabetes mellitus	96 (32%)
Hypertension	87 (29%)
Chronic kidney disease	21 (7%)

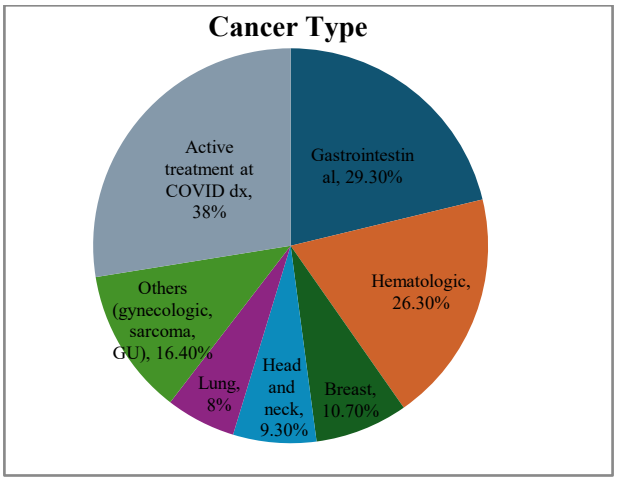

Figure 3: Cancer Type Distribution

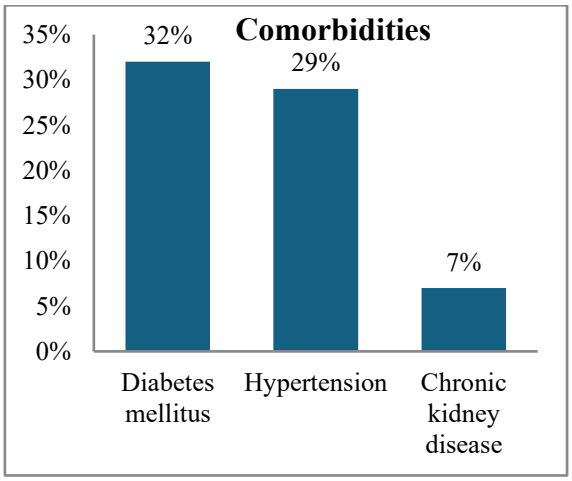

Figure 4: Comorbidity Distribution

CT Imaging Patterns

Chest CT interpretation revealed a wide spectrum of abnormalities. According to the RSNA classification system, only 128 patients (42.8%) showed typical COVID-19 features such as bilateral peripheral ground-glass opacities and "crazy paving." A significant proportion had indeterminate appearances in 64 patients (21.4%) or atypical appearances in 64 patients (21.4%), and 43 patients (14.4%) had scans negative for pneumonia despite being RT-PCR positive.

The most frequent CT abnormalities were:

- Mixed ground-glass opacities with consolidation in 133 patients (44.4%) – reflecting progression to alveolar damage.
- Pleural effusion in 101 patients (33.5%) – an uncommon feature in classical COVID-19, but common in our oncologic cohort, possibly due to cancer-related effusions or secondary infections.
- Pure ground-glass opacities in 59 patients (19.5%) – representing early COVID-19 pneumonia.
- Centrilobular nodules in 34 patients (11.3%) – an unusual feature in viral pneumonia, raising diagnostic confusion with metastases or fungal infections.
- Architectural distortion in 28 patients (9.4%) – reflecting a mix of post-treatment fibrosis, tumor-related scarring, and severe COVID-19 damage.

Table 2. Chest CT patterns in oncologic patients with COVID-19 (N = 300)

CT Pattern (RSNA category)	n (%)
Typical	128 (42.8%)
Indeterminate	64 (21.4%)
Atypical	64 (21.4%)
Negative for pneumonia	43 (14.4%)

Table 3. Common CT abnormalities (N = 300)

Finding	n (%)
Mixed GGO + consolidation	133 (44.4%)
Pleural effusion	101 (33.5%)
Pure ground-glass opacities	59 (19.5%)
Centrilobular nodules	34 (11.3%)
Architectural distortion/fibrosis-like	28 (9.4%)

CT Severity Scores

The mean CT severity score was 14.2 ± 5.7. About 18% of patients had mild disease (score 0–7), 46% had moderate disease (8–17), and 36% had severe disease (≥18). Patients with hematologic malignancies had significantly higher severity scores than those with solid tumors ($p = 0.021$), likely due to their immunosuppressed state and delayed viral clearance.

Table 4. CT severity score distribution (N = 300)

Severity category	Score range	n (%)
Mild	0–7	54 (18%)
Moderate	8–17	138 (46%)
Severe	≥18	108 (36%)

Clinical Outcomes

The overall in-hospital mortality was 27.4% (82 patients). About 34% (102 patients) required ICU admission, and 19% (57 patients) needed mechanical ventilation.

Patients with typical CT patterns, severe CT involvement (score ≥18), and specific findings such as consolidation, pleural effusion, centrilobular nodules, and architectural distortion were more likely to die during hospitalization.

- Typical CT findings increased mortality risk nearly 3.5-fold (OR 3.47; 95% CI 1.14–8.98).
- Severe CT scores (≥18) were strongly associated with death (OR 1.89; 95% CI 1.07–3.34).
- Pleural effusion was the most ominous feature, with $p < 0.001$.

Table 5. CT predictors of mortality

CT Feature	Association with Mortality
Typical CT appearance	OR 3.47 (95% CI 1.14–8.98)
Severity score ≥18	OR 1.89 (95% CI 1.07–3.34)
Consolidation	p = 0.040
Pleural effusion	p < 0.001
Centrilobular nodules	p = 0.013
Architectural distortion	p = 0.005

DISCUSSION

The present study highlights the dual role of chest CT in oncologic patients with COVID-19 pneumonia in India — both as a diagnostic adjunct in a clinically complex group and as a prognostic marker for adverse outcomes. With nearly 27% in-hospital mortality (82 deaths out of 300 patients), these findings underscore the importance of radiological evaluation in timely risk stratification and clinical decision-making.

Diagnostic Role of CT in Oncologic Patients

Interpretation of chest CT scans in cancer patients is uniquely challenging. In our study, only 128 patients (42.8%) demonstrated "typical" COVID-19 patterns, while the remainder showed atypical (21.4%) or indeterminate (21.4%) features. This observation is consistent with both Indian and global reports that oncologic patients frequently present with non-classical CT findings due to coexisting malignancy-related lung changes, prior radiotherapy-induced fibrosis, or opportunistic infections (journals.lww.com).

The relatively high prevalence of pleural effusion (33.5%, 101 patients) in our cohort is particularly noteworthy. While pleural effusion is uncommon in classical COVID-19, it was frequently encountered in our oncologic patients, likely due to malignant pleural involvement, tuberculosis reactivation, or bacterial superinfection. This finding highlights the diagnostic ambiguity faced by radiologists and reinforces the need for careful integration of imaging appearances with clinical and laboratory data.

Another important observation was the presence of centrilobular nodules (11.3%, 34 patients) and architectural distortion (9.4%, 28 patients). These patterns are often misinterpreted as tumor progression or fungal infections; however, in our study, they were significantly associated with mortality. This underlines the importance of radiologists maintaining a broad differential diagnosis and recognizing that COVID-19 pneumonia in oncologic patients can extend beyond "classic" imaging appearances.

Prognostic Role of CT Findings

Beyond diagnosis, our results reaffirm the prognostic utility of CT imaging in cancer patients with COVID-19. We found that:

- Patients with severe CT involvement (score ≥18; 108 patients) had nearly twofold increased risk of death.
- Typical COVID-19 patterns were paradoxically linked with higher mortality, possibly reflecting advanced disease stage rather than early or indeterminate presentations.
- The presence of pleural effusion, consolidation, and architectural distortion strongly correlated with poor outcomes.

These findings align with international studies showing that higher CT severity scores predict ICU admission and mortality (pmc.ncbi.nlm.nih.gov). However, our data uniquely demonstrate that in Indian oncologic patients, pleural effusion and nodular opacities — not traditionally emphasized in COVID-19 — also carry significant prognostic value.

Indian Healthcare Context

The implications of these findings must be understood within the Indian healthcare landscape. During the peak waves of COVID-19, RT-PCR testing capacity was limited, and results were often delayed by 24–48 hours. In this context, CT imaging emerged as a frontline diagnostic tool, particularly in tertiary cancer hospitals where rapid decisions were critical for immunocompromised patients.

In addition, in resource-constrained settings, CT findings helped guide triage by identifying patients at risk of rapid deterioration. For example, patients with severe CT involvement or pleural effusion were prioritized for ICU admission and oxygen therapy, while those with milder changes were managed in

isolation wards. This pragmatic strategy enabled clinicians to optimize scarce ICU resources during crisis periods.

Comparison with Global Studies

Internationally, studies from China, Italy, and the United States have reported typical CT features in up to 75–85% of COVID-19 patients. By contrast, our study found typical features in only 42.8% of oncologic patients. This stark difference emphasizes that Indian oncologic patients form a distinct subgroup, where pre-existing cancer pathology and co-endemic diseases (such as tuberculosis) complicate imaging appearances.

Another key divergence lies in the role of pleural effusion. While considered atypical in Western populations, its high prevalence in our Indian cohort (33.5%) suggests that effusion should not be dismissed as "non-COVID" in oncologic patients. Instead, it should be recognized as a composite marker of poor prognosis, reflecting the combined burden of malignancy, secondary infection, and viral pneumonia.

CONCLUSION

This study demonstrates that in Indian oncologic patients with COVID-19 pneumonia, chest CT plays a vital dual role — as both a diagnostic adjunct and a prognostic marker. Unlike the general population, where typical imaging features dominate, less than half of our patients (42.8%) showed classical CT patterns. Instead, atypical and indeterminate findings were common, largely due to pre-existing cancer-related lung changes, the high background prevalence of tuberculosis, and secondary infections.

Among all CT findings, consolidation, pleural effusion, centrilobular nodules, and architectural distortion emerged as important markers of adverse outcomes. Patients with severe CT involvement (score ≥18; 36% of the cohort) and those with hematologic malignancies were particularly vulnerable, showing significantly higher mortality (27.4%).

Importantly, in the Indian setting — where RT-PCR testing delays and limited ICU capacity posed major challenges — chest CT provided actionable insights for timely triage and clinical decision-making. The findings suggest that CT should not only be viewed as a diagnostic tool but also as a prognostic instrument guiding resource allocation in oncology care during pandemics.

Recommendations for Indian Practice

1. Incorporate CT into oncology–COVID care protocols: For cancer patients presenting with respiratory symptoms, CT should be integrated alongside RT-PCR, especially when results are delayed or inconclusive.
2. Recognize atypical features as significant: Pleural effusion, nodules, or fibrosis-like changes should not automatically be dismissed as "non-COVID." In oncologic patients, these may represent COVID-19 pneumonia or co-existing pathology, both of which worsen prognosis.
3. Use CT severity scoring as a triage tool: A CT severity score ≥18 should alert clinicians to a high risk of mortality. Such patients must be prioritized for ICU admission and aggressive management.
4. Multidisciplinary decision-making: Radiologists, oncologists, pulmonologists, and intensivists must jointly interpret CT findings in the context of each patient's cancer history to avoid misdiagnosis or overtreatment.
5. Strengthen radiology training and awareness: Indian radiologists should be sensitized to the unique CT patterns in oncologic patients with COVID-19, enabling faster and more accurate reporting.
6. Policy-level implications: The Indian healthcare system should consider CT-based risk stratification as part of national oncology and pandemic preparedness protocols, particularly in tertiary cancer centers.

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