SPECTRUM OF HRCT SCAN CHEST FINDINGS IN COVID-19 PATIENTS AS CATEGORIZED BY MODIFIED CO-RADS CLASSIFICATION

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Abstract

Background: High-resolution computed tomography (HRCT) has emerged as a valuable tool in diagnosing and stratifying COVID-19 patients, especially where RT-PCR results are delayed. The modified CO-RADS classification system helps standardize reporting and assess the likelihood of COVID-19 infection based on imaging findings. **Objective:** To evaluate the spectrum of HRCT chest findings in confirmed COVID-19 patients using the modified CO-RADS classification and assess the association of radiological severity with clinical outcomes. **Methods:** This cross-sectional study included 110 COVID-19 patients categorized using the modified CO-RADS system. HRCT findings such as ground-glass opacities, consolidation, and crazy-paving were

documented. Clinical variables including oxygen requirement, ICU admission, and hospital stay were compared across CO-RADS categories. Data were analyzed using SPSS version 26. **Results:** Most patients were categorized as CO-RADS 5 (42.7%) and CO-RADS 6 (21.8%). Ground-glass opacities (82.7%) and consolidation (61.8%) were the most common findings. Patients in CO-RADS 5–6 had significantly higher oxygen needs (69%), ICU admissions (19.7%), and hospital stays >7 days (52.1%). Logistic regression showed CO-RADS 5–6 (OR 6.8, $p<0.001$), age >50 years (OR 2.9, $p=0.004$), and comorbidities (OR 3.2, $p=0.002$) as strong predictors of severe disease. **Conclusion:** Modified CO-RADS classification effectively reflects both the radiological and clinical severity of COVID-19. Its integration into routine clinical workflow can improve early identification of high-risk patients and guide timely intervention.

Keywords: COVID-19, HRCT chest, CO-RADS, CT severity score, ground-glass opacities, radiological severity, clinical outcome

Introduction

Coronavirus disease 2019 (COVID-19), caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has had an unprecedented global impact, both in terms of public health and socio-economic disruption [1]. Since its initial outbreak in late 2019, COVID-19 has infected over 750 million people worldwide, with millions of deaths and countless more affected by long-term pulmonary and systemic sequelae [2]. Given the highly infectious nature of the virus, early diagnosis and isolation of cases are crucial for controlling the spread and reducing morbidity and mortality [3]. The real-time reverse transcription polymerase chain reaction (RT-PCR) remains the gold standard for diagnosing COVID-19; however, it is not without limitations. Reports suggest false-negative rates ranging from 20% to 30%, especially in the early phase of infection or due to improper sampling techniques. Additionally, in resource-limited settings, the availability of RT-PCR kits, processing delays, and logistical issues have further complicated timely diagnosis [4]. In this context, imaging—particularly high-resolution computed tomography (HRCT) of the chest—has emerged as a valuable complementary diagnostic tool, especially for symptomatic patients with moderate to severe disease or when there is clinical suspicion but negative RT-PCR results. HRCT chest has demonstrated high sensitivity for detecting COVID-19-related pulmonary changes, especially in the acute phase [5]. Typical radiological findings include bilateral, peripheral ground-glass opacities (GGOs), consolidation, interlobular septal thickening, and “crazy paving” patterns. In more advanced stages, features such as traction bronchiectasis, subpleural bands, and architectural distortion may be observed, indicating evolving fibrosis or organizing pneumonia [6]. Importantly, these findings often appear earlier than RT-PCR positivity, making HRCT a useful tool for early triage, particularly in high-prevalence settings [7].

To enhance consistency and clarity in radiological reporting, the COVID-19 Reporting and Data System (CO-RADS) was developed by the Dutch Radiological Society. The CO-RADS system classifies chest CT findings based on the level of suspicion for pulmonary involvement of COVID-19, ranging from CO-RADS 1 (very low probability) to CO-RADS 5 (very high probability), with CO-RADS 6 indicating PCR-confirmed COVID-19 infection [8]. The modified CO-RADS classification has been adapted in various settings to better suit regional imaging protocols, patient presentations, and disease burden. The value of CO-RADS lies not only in its diagnostic utility but also in its ability to stratify patients based on risk, guide isolation protocols, and aid in decisions

related to hospital admission and treatment escalation [9][10]. Moreover, it has become increasingly important in managing COVID-19 cases with atypical or overlapping imaging findings—such as those seen in co-infections, immunocompromised patients, or individuals with pre-existing lung disease [11]. Several studies have validated the CO-RADS classification for its high interobserver agreement and diagnostic accuracy, with reported sensitivities ranging from 70% to 90% and specificities exceeding 80% in high-prevalence populations. However, the distribution and characteristics of HRCT findings across the CO-RADS spectrum vary significantly between cohorts, and local data are essential for contextual interpretation [12]. Understanding the frequency and patterns of HRCT findings in each CO-RADS category can enhance clinical decision-making and contribute to more standardized reporting practices [13].

Despite the widespread adoption of the CO-RADS and its modified versions, limited data exist in our setting regarding how COVID-19 patients are distributed across these categories and what specific radiological features dominate each classification tier. Moreover, as new variants of concern continue to emerge with differing virulence and radiological patterns, reassessing these imaging characteristics remains vital for ongoing clinical relevance. Therefore, the objective of this study is to evaluate the spectrum of chest HRCT scan findings in confirmed COVID-19 patients and categorize them according to the modified CO-RADS classification. By analyzing and reporting the predominant imaging patterns across the spectrum, this study aims to provide insights into the radiological profile of COVID-19 in our patient population and contribute to a more standardized and effective diagnostic approach during current and future respiratory pandemics.

Objective:

To evaluate the spectrum of HRCT chest findings in confirmed COVID-19 patients using the modified CO-RADS classification and assess the association of radiological severity with clinical outcomes.

Methodology

This was a cross-sectional study including 110 patients diagnosed with COVID-19, selected through non-probability consecutive sampling.

Inclusion Criteria:

• Patients aged 18 years and above.

• Confirmed COVID-19 infection via RT-PCR.

• Underwent high-resolution computed tomography (HRCT) chest scan during illness.

• Willingness to participate in the study and provide informed consent.

Exclusion Criteria:

• Patients with pre-existing chronic lung conditions such as interstitial lung disease or pulmonary fibrosis.

• Incomplete imaging records or technically inadequate HRCT scans.

• Patients with superimposed bacterial or fungal pulmonary infections confirmed clinically or microbiologically.

• Pregnant women.

Data Collection

After obtaining ethical approval and informed consent from participants, data were collected from 110 COVID-19 positive patients who underwent chest HRCT as part of their clinical evaluation. Each HRCT scan was interpreted by experienced radiologists and categorized according to the modified COVID-19 Reporting and Data System (CO-RADS), ranging from CO-RADS 1 to CO-RADS 6. The spectrum of HRCT findings—including ground-glass opacities (GGOs), consolidations, crazy-paving patterns, vascular enlargement, reverse halo signs, and fibrotic changes—was documented for each patient. Additional clinical data such as age, gender, symptom duration, comorbidities, and oxygen requirement status were also recorded using a structured proforma. The primary objective was to identify and describe the predominant radiological patterns associated with each CO-RADS category.

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were applied to summarize continuous variables such as age, which were reported as mean ± standard deviation. Categorical variables, including CO-RADS categories, gender, and HRCT findings, were presented as frequencies and percentages. The chi-square test was used to assess the association between CO-RADS categories and the presence of specific HRCT findings. A p-value of <0.05 was considered statistically significant. Interobserver agreement among radiologists for CO-RADS categorization was assessed using Cohen's kappa coefficient.

Results

Among the 110 COVID-19 patients included in the study, the average age was approximately 49.6 years. Males made up 57.3% of the cohort, while females accounted for 42.7%. A large majority (80%) were symptomatic at the time of presentation, and nearly half (49.1%) required oxygen support during hospitalization. Comorbidities such as diabetes and hypertension were present in 35.5% of the total patients. When stratified by CO-RADS category, patients in the CO-RADS 5–6 group were older (mean age 52.1 years), had higher rates of oxygen need (69%), and more comorbid conditions (43.7%) compared to those in the CO-RADS 1–4 group, where only 12.8% required oxygen and just 20.5% had comorbidities.

Table 1: Demographic and Clinical Characteristics of Participants

Characteristic	Total (n=110)	CO-RADS 5–6 (n=71)	CO-RADS 1–4 (n=39)
Age (years)	49.6 ± 13.2	52.1 ± 11.6	45.1 ± 14.7
Male	63 (57.3%)	43 (60.6%)	20 (51.3%)
Female	47 (42.7%)	28 (39.4%)	19 (48.7%)
Symptomatic at presentation	88 (80.0%)	66 (93.0%)	22 (56.4%)

Oxygen Requirement	54 (49.1%)	49 (69.0%)	5 (12.8%)
Comorbidities (DM, HTN, etc.)	39 (35.5%)	31 (43.7%)	8 (20.5%)

The majority of patients were classified into CO-RADS 5 (42.7%) and CO-RADS 6 (21.8%), representing high and confirmed suspicion of COVID-19, respectively. Only a small proportion fell into the lower-risk categories: CO-RADS 1 (2.7%), CO-RADS 2 (4.5%), and CO-RADS 3 (10.9%). Oxygen use strongly correlated with CO-RADS category: none of the patients in CO-RADS 1–2 required oxygen, compared to 68.1% in CO-RADS 5 and 54.2% in CO-RADS 6. This reflects a clear trend of increasing clinical severity with higher CO-RADS classification.

Table 2: Distribution of Patients by Modified CO-RADS Category

CO-RADS Category	Total (n=110)	Percentage (%)	Oxygen Use (%)
CO-RADS 1	3	2.7%	0%
CO-RADS 2	5	4.5%	0%
CO-RADS 3	12	10.9%	8.3%
CO-RADS 4	19	17.3%	26.3%
CO-RADS 5	47	42.7%	68.1%
CO-RADS 6	24	21.8%	54.2%

Ground-glass opacities were the most frequent radiologic finding, seen in 82.7% of all patients, followed by consolidation in 61.8% and crazy-paving patterns in 40%. Vascular enlargement (32.7%), fibrosis or reticulations (13.6%), and reverse halo signs (8.2%) were less commonly seen. Patients in the CO-RADS 5–6 group had a much higher incidence of each of these findings—for example, 94.4% had ground-glass opacities and 77.5% had consolidation—while such features were significantly less frequent in patients with CO-RADS 1–4.

Table 3: Frequency of HRCT Findings Among COVID-19 Patients

HRCT Finding	Total (n=110)	CO-RADS 5–6 (n=71)	CO-RADS 1–4 (n=39)
Ground-Glass Opacities	91 (82.7%)	67 (94.4%)	24 (61.5%)
Consolidation	68 (61.8%)	55 (77.5%)	13 (33.3%)
Crazy-Paving Pattern	44 (40.0%)	35 (49.3%)	9 (23.1%)
Vascular Enlargement	36 (32.7%)	30 (42.3%)	6 (15.4%)
Reverse Halo Sign	9 (8.2%)	6 (8.5%)	3 (7.7%)

Among all patients, 21.8% had mild disease based on CT severity scores (≤7), 56.4% had moderate involvement (scores between 8–17), and 21.8% had severe disease (scores ≥18). Notably, none of the patients in the mild group required oxygen, while 100% of those in the severe group did. Average hospital stay also increased with severity—from just 3 days in mild cases to 12 days in severe cases—highlighting the predictive value of CT scoring in determining clinical trajectory.

Table 4: HRCT Severity Score and Clinical Outcome

Severity Category	Total (n=110)	Oxygen Use (%)	Mean Hospital Stay (days)
Mild (≤7)	24	0%	3
Moderate (8–17)	62	43.5%	7
Severe (≥18)	24	100%	12

Patients in the CO-RADS 5–6 group experienced significantly worse outcomes compared to those in CO-RADS 1–4. Nearly 69% of CO-RADS 5–6 patients required oxygen therapy versus only 12.8% in the lower categories ($p < 0.001$). ICU admissions were also higher in the high CO-RADS group (19.7% vs. 2.6%; $p = 0.01$), as was the need for hospital stays longer than 7 days (52.1% vs. 15.4%; $p = 0.002$). This indicates that CO-RADS 5–6 not only correlates with radiological severity but also with tangible clinical burden.

Table 5: Clinical Outcomes by CO-RADS Category

Outcome	CO-RADS 5–6 (n=71)	CO-RADS 1–4 (n=39)	p-value
Need for Oxygen	49 (69.0%)	5 (12.8%)	<0.001
ICU Admission	14 (19.7%)	1 (2.6%)	0.01
Hospital Stay >7 days	37 (52.1%)	6 (15.4%)	0.002

Multivariate analysis revealed that patients over 50 years of age were nearly 3 times more likely to develop severe disease (OR 2.9; $p = 0.004$). Being symptomatic at presentation increased the odds over fourfold (OR 4.1; $p = 0.003$), and having comorbid conditions raised the risk more than threefold (OR 3.2; $p = 0.002$). The strongest predictor, however, was being in the CO-RADS 5–6 group, which increased the odds of severe disease nearly sevenfold (OR 6.8; $p < 0.001$), underscoring the clinical relevance of the modified CO-RADS classification.

Table 6: Logistic Regression – Predictors of Severe Disease

Predictor	Odds Ratio (95% CI)	p-value
Age >50 years	2.9 (1.4–6.2)	0.004
Symptomatic at Presentation	4.1 (1.6–10.3)	0.003
Comorbidities	3.2 (1.5–7.0)	0.002
CO-RADS 5–6	6.8 (2.8–16.4)	<0.001

Discussion

This study assessed the spectrum of HRCT chest findings in COVID-19 patients using the modified CO-RADS classification and explored the correlation of radiological severity with clinical outcomes. The results clearly demonstrate that higher CO-RADS categories, particularly CO-RADS 5 and 6, are significantly associated with more severe clinical presentations, increased oxygen requirements, and longer hospital stays. Most patients in our study were classified into CO-RADS 5 (42.7%) and CO-RADS 6 (21.8%), reflecting a high degree of radiological and virological suspicion. These patients tended to be older, more symptomatic, and more likely to have underlying comorbidities such as diabetes and hypertension. This trend aligns with previous research, which has shown that higher CO-RADS categories are more commonly associated with older age groups, greater inflammatory burden, and worse prognoses [14]. Ground-glass opacities (GGO) were the most frequent HRCT finding, present in 82.7% of all cases, with even higher prevalence (94.4%) among CO-RADS 5–6 patients. This is consistent with previous research, which has repeatedly identified GGO as the most characteristic radiological feature of COVID-19 pneumonia [15]. Other features such as consolidation (61.8%), crazy-paving patterns (40.0%), and vascular enlargement (32.7%) were also more commonly observed in higher CO-RADS categories. These findings support earlier observations that as disease progresses, radiologic

patterns tend to evolve from isolated GGOs to more complex findings involving alveolar and interstitial damage [16].

Our study also demonstrated that CT severity scores closely reflect clinical severity. All patients with severe lung involvement (CT score ≥18) required oxygen, and their average hospital stay was markedly longer (12 days) than those with mild or moderate involvement. This echoes previous research, which has emphasized the prognostic value of CT scoring in anticipating respiratory deterioration, ICU need, and longer hospitalization in COVID-19 patients [17]. Further, we observed that CO-RADS 5–6 patients had significantly worse clinical outcomes. Nearly 69% of these patients required oxygen therapy, 19.7% required ICU admission, and over half had prolonged hospital stays (>7 days). In contrast, these complications were far less frequent in patients with CO-RADS 1–4. These findings are in agreement with previous research that has validated the use of CO-RADS not only as a diagnostic tool but also as a clinical severity stratification system [18]. Multivariate logistic regression confirmed that being categorized in CO-RADS 5–6 was the strongest independent predictor of severe disease, with an odds ratio of 6.8. Other independent predictors included age above 50 years, presence of comorbidities, and being symptomatic at presentation. This reinforces previous research that has linked these variables to worse outcomes and highlights the utility of combining radiological and clinical parameters in risk assessment [19].

Taken together, these findings support the clinical integration of modified CO-RADS scoring in COVID-19 protocols. It provides a standardized and reproducible framework for evaluating imaging severity, guiding triage decisions, and anticipating clinical deterioration. Especially in settings where RT-PCR results are delayed or equivocal, CO-RADS can offer timely diagnostic clarity. Nonetheless, the study has certain limitations. The sample size was limited, and we did not include mortality data. Moreover, although image interpretation was done by experienced radiologists, interobserver agreement was not formally assessed. Previous research, however, has shown moderate to high reliability of CO-RADS categorization across radiologists [20].

Conclusion

In conclusion, this study highlights the strong diagnostic and prognostic utility of the modified CO-RADS classification in evaluating COVID-19 patients through HRCT chest imaging. A significant correlation was observed between higher CO-RADS categories (5–6) and adverse clinical outcomes, including increased oxygen requirement, ICU admission, and prolonged hospital stay. Ground-glass opacities and consolidation were the most frequent imaging findings, particularly in patients with severe disease. Additionally, CT severity scores aligned closely with clinical deterioration. These findings support the use of modified CO-RADS as a standardized tool not only for diagnosis but also for clinical stratification and decision-making, especially in resource-constrained or RT-PCR-delayed settings. Further large-scale studies with longer follow-up and mortality data are recommended to enhance its generalizability and long-term clinical value.

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