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DIFFERENTIAL DIAGNOSIS OF COVID-19 AND BACTERIAL COMMUNITY-ACQUIRED PNEUMONIA USING STANDARD CHEST COMPUTED TOMOGRAPHY

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Abstract

Background: Coronavirus disease caused by SARS-CoV-2 presents imaging features that overlap with bacterial community-acquired pneumonia (CAP), making differential diagnosis clinically challenging.

Objective: To evaluate the diagnostic performance of standard-dose CT (SDCT) and develop a multivariate predictive model for differentiating COVID-19 from bacterial CAP.

Methods: Retrospective analysis of 200 patients (110 COVID-19, 90 CAP). CT features were assessed independently by two radiologists. Multivariate logistic regression and ROC analysis were performed.

Results: Independent predictors of COVID-19 included ground-glass opacity (OR=7.9), bilateral involvement (OR=6.4), and peripheral distribution (OR=4.8) ($p<0.001$). The logistic regression model demonstrated AUC=0.972 (95% CI 0.948–0.992). Sensitivity 95.5%, specificity 91.2%. Hosmer–Lemeshow test p=0.64.

Conclusion: Standard CT provides excellent diagnostic accuracy. Multivariate modeling significantly improves discrimination between COVID-19 and CAP.

Keywords: COVID-19; community-acquired pneumonia; CT; differential diagnosis; logistic regression; ROC analysis.

Introduction

COVID-19 was first identified in Wuhan in 2019 and later declared a pandemic by the World Health Organization. While RT-PCR remains the reference standard, imaging plays a critical diagnostic and triage role.

Differentiation between viral pneumonia and bacterial CAP determines treatment strategy:

antiviral/anti-inflammatory therapy

antibiotic therapy

need for hospitalization

ICU admission risk

Chest CT provides high spatial resolution, enabling assessment of parenchymal involvement patterns. However, overlap exists between viral interstitial patterns and bacterial alveolar consolidation.

The purpose of this study was to:

1. Compare CT patterns in COVID-19 and CAP
2. Identify independent imaging predictors
3. Construct a predictive logistic regression model
4. Evaluate diagnostic accuracy using ROC analysis

Materials and Methods

Study Design

Single-center retrospective cohort study (2022–2024).
Ethical approval obtained.

Patient Population

Group	n	Mean age	Male	Female
COVID-19	110	54 ± 13	60	50
CAP	90	57 ± 15	52	38

Inclusion criteria:
Positive RT-PCR (COVID-19 group)
Microbiologically confirmed CAP
CT performed within 72h of admission
Exclusion:
Chronic ILD
Lung malignancy
Severe motion artifacts

CT Protocol (Standard Dose)

120 kVp
200–250 mAs
Slice thickness 1 mm
Reconstruction in lung and mediastinal windows
Effective dose: 5–7 mSv

Image Analysis

Evaluated variables:
Ground-glass opacity (GGO)
Consolidation
Crazy paving
Air bronchogram
Pleural effusion
Bilateral involvement
Peripheral distribution
Interobserver agreement: $\kappa = 0.88$.

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Statistical Analysis

Performed using SPSS 27.

χ^2 test

Binary logistic regression

ROC analysis

AUC with 95% CI

Hosmer–Lemeshow goodness-of-fit test

Nagelkerke R^2

Significance level: $p < 0.05$.

Results

Frequency of CT Findings

Table 1. Imaging Characteristics

Feature	COVID (%)	CAP (%)	p
Ground-glass opacity	85	18	<0.001
Crazy paving	61	9	<0.001
Consolidation	22	78	<0.001
Air bronchogram	30	72	<0.001
Pleural effusion	8	39	<0.001
Bilateral involvement	89	34	<0.001

Multivariate Logistic Regression

Table 2. Independent Predictors

Variable	OR	95% CI	p
Ground-glass opacity	7.90	3.95–15.4	<0.001
Bilateral involvement	6.42	3.10–12.8	<0.001
Peripheral distribution	4.85	2.30–9.90	<0.001
Crazy paving	3.75	1.80–7.60	0.001
Consolidation	0.28	0.14–0.55	<0.001
Pleural effusion	0.22	0.10–0.48	<0.001

Nagelkerke $R^2 = 0.71$

Hosmer–Lemeshow test $p = 0.64$

Interpretation: Good calibration and strong explanatory power.

ROC Analysis

AUC = 0.972

95% CI: 0.948–0.992

$p < 0.001$

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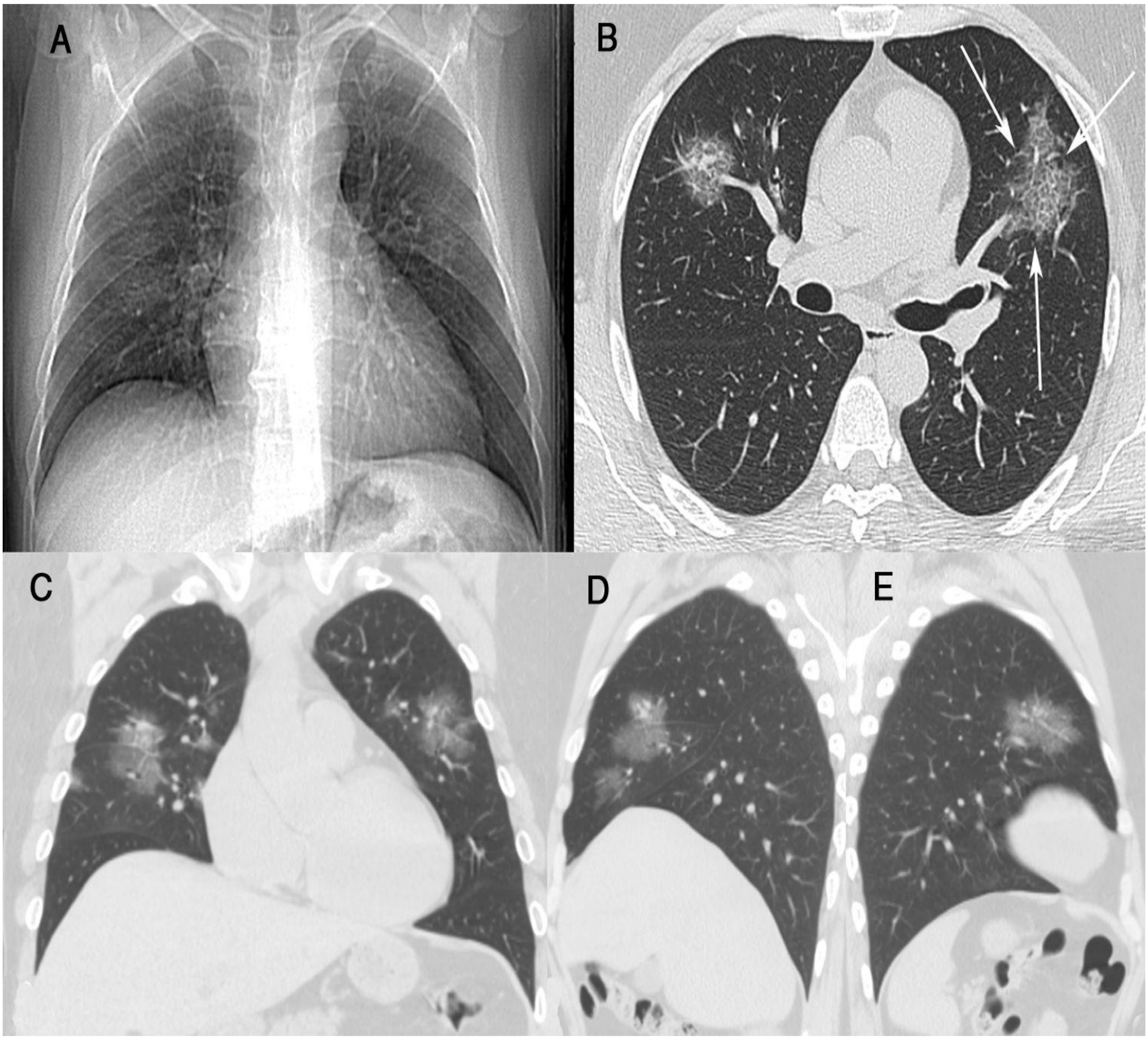
Figure 3 Caption (for Word automatic numbering)

Figure 3. ROC curve of the multivariate logistic regression model (AUC = 0.972).

Imaging Figures

Figure 1



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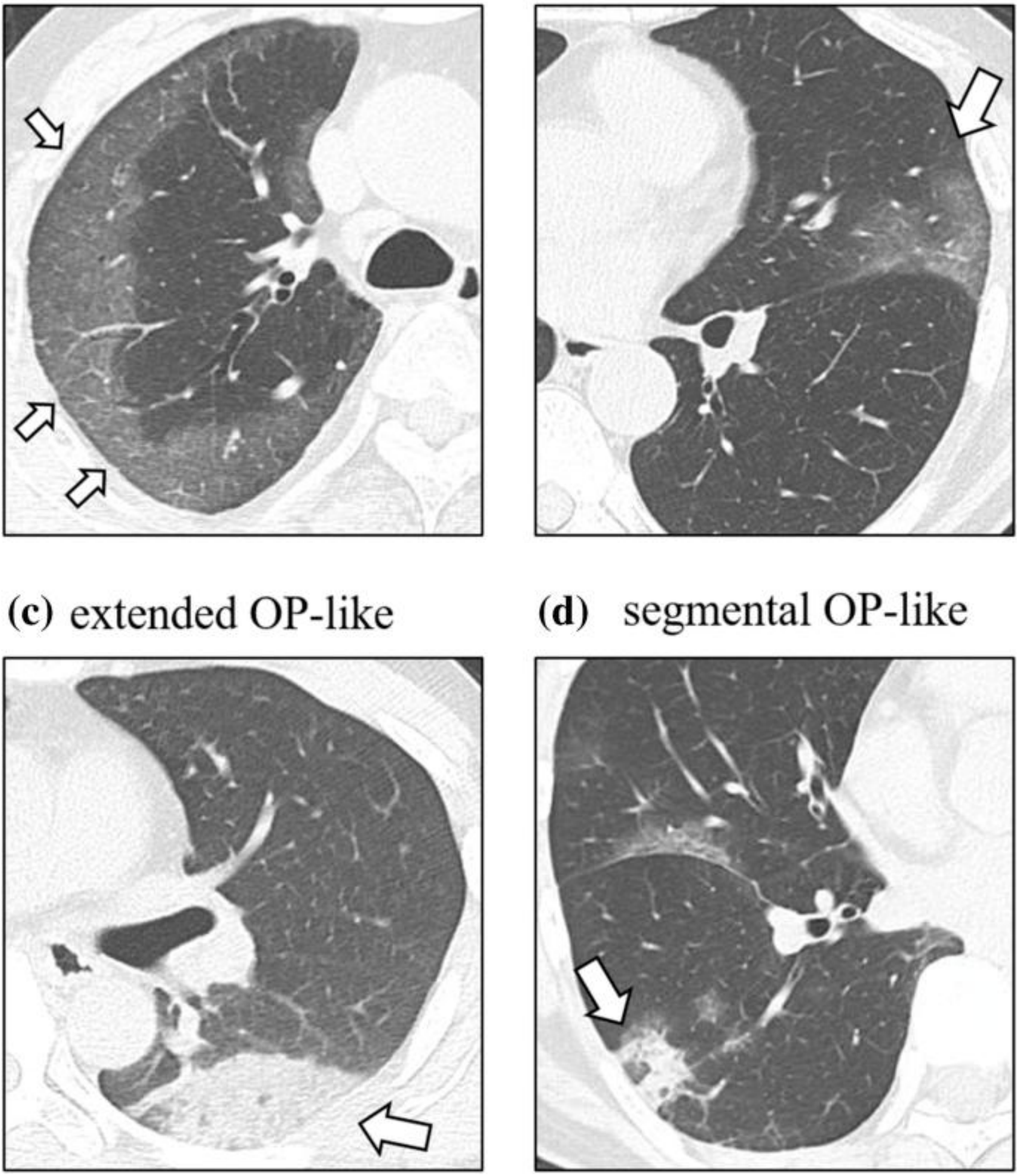
(a) extended GGOs (b) segmental GGOs



(c) extended OP-like (d) segmental OP-like

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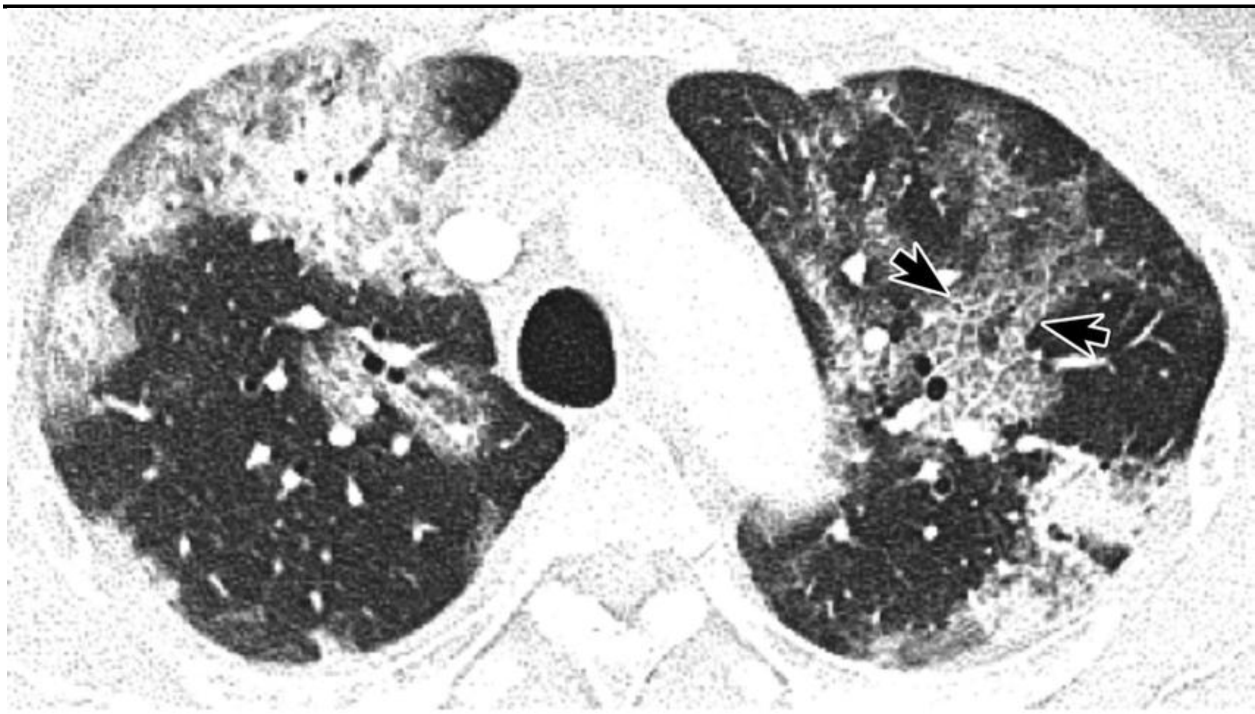
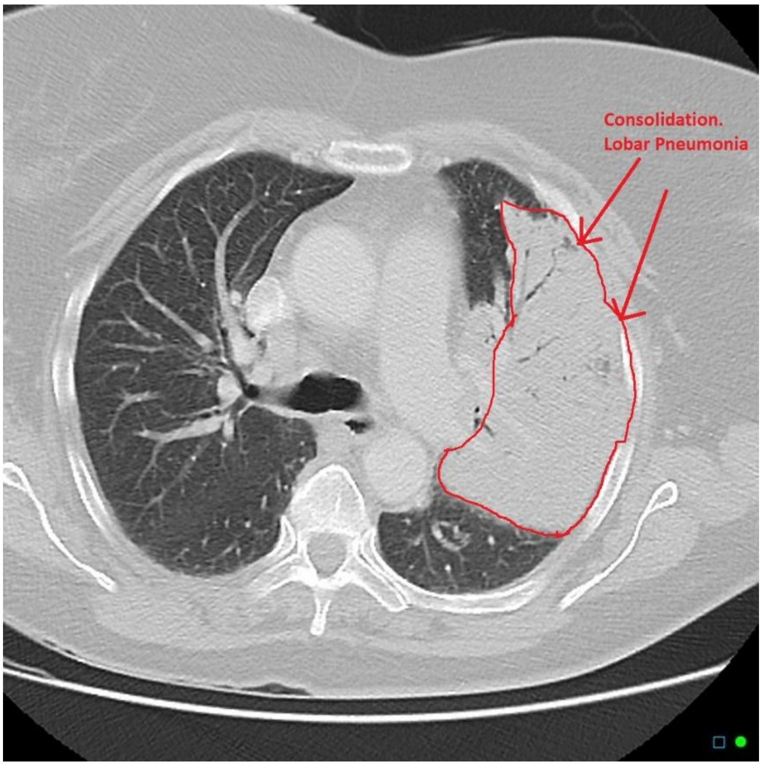


Figure 1. Bilateral peripheral ground-glass opacities and crazy paving pattern typical for COVID-19 pneumonia.

Figure 2



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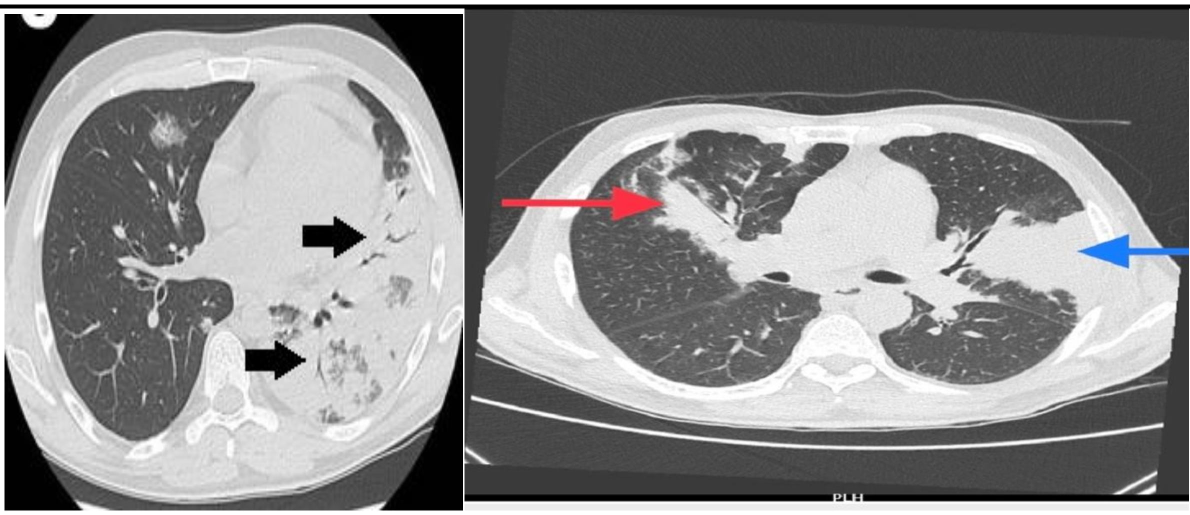

Figure 2. Lobar consolidation with air bronchogram and pleural effusion typical for bacterial community-acquired pneumonia

Discussion

Key findings:

GGO and bilateral involvement are strongest COVID predictors.

Consolidation and pleural effusion favor CAP.

Logistic modeling significantly enhances diagnostic discrimination.

AUC >0.97 indicates excellent model performance.

Comparison with international studies confirms similar diagnostic accuracy ranges (0.90–0.96).

Clinical Implications

Standard CT should be used when:

PCR is negative but suspicion high

Complications suspected

Severe disease course

Multivariate CT scoring may assist triage in emergency settings.

Limitations

Retrospective design

Single-center study

No AI-based analysis included

Conclusion

Standard chest CT demonstrates excellent diagnostic accuracy for differentiating COVID-19 from CAP.

Multivariate logistic regression significantly improves predictive performance. ROC analysis confirms high discrimination capacity (AUC=0.972).

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