ORIGINAL RESEARCH PAPER

Severity assessment of COVID-19 pneumonia using chest radiographic severity scoring: Concordance with clinical severity grading

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Abstract

The need for a quick diagnosis and accurate stratification of COVID-19 patients by severity of their conditions is of paramount importance in order to ensure the right management of the patients and correct allocation of resources. The radiological grading was performed on chest radiographs of COVID-19 positive patients admitted in St. John's Medical College using the scoring system used by Wong *et al*., adapted from the Radiographic Assessment of Lung Edema (RALE) score. A total of 200 patients with 54.5% males and mean age of 58.2 years, were included in the study. The worst or the highest-grade chest radiograph was chosen for grading of those patients who had more than one chest radiograph taken over the course of their hospital stay. Diagnosis of severe COVID with high sensitivity and specificity is extremely beneficial in management of patients as these are the ones who will need continuous monitoring and intensive care. Correct categorization of mild and "not mild" disease is also equally important as mild patients can be managed at home or regular wards/rooms and the limited resources can rightly be re-allocated for sick patients.

Keywords: COVID-19 pneumonia, chest radiographic severity scoring, clinical severity grading

Introduction

A novel human coronavirus (SARS-CoV-2) causing severe acute respiratory syndrome was identified as the causative agent of coronavirus disease 2019 (COVID-19) in December 2019 at Wuhan, China. On March 11, 2020, the World Health Organization declared this potentially fatal disease as a pandemic [1]. The need for a quick diagnosis and accurate stratification of COVID-19 patients by severity of their conditions is of paramount importance in order to ensure the right management of the patients and correct allocation of resources. While chest radiograph is a cost-effective imaging modality for developing countries like India, their utility for the prognostication of COVID-19 has been under-explored. Attaining this objective with chest radiographs can add to the diagnostic value of clinical parameters in stratifying patients according to disease severity, potentially further

curtailing the use of chest CT.

Objective: To estimate the concordance between chest radiographic severity scoring and clinical severity grading of COVID-19 pneumonia.

Methodology

- The radiological grading was performed on chest radiographs of COVID-19 positive patients admitted in St. John's Medical College using the scoring system used by Wong *et al*., adapted from the Radiographic Assessment of Lung Edema (RALE) score [2, 3].
- A total of 200 patients with 54.5% males and mean age of 58.2 years, were included in the study.
- The worst or the highest-grade chest radiograph was chosen for grading of those patients who had more than one chest radiograph taken over the course of their hospital stay.
- The radiological severity grading of COVID-19 pneumonia using chest radiographs was correlated with the corresponding clinical grading of same patients [4, 5].

Clinically, COVID-19 pneumonia is classified based on the following criteria:
- **Mild:** Patients with signs and symptoms of COVID-19 but do not have shortness of breath, dyspnea, or abnormal chest imaging.
- **Moderate:** Patients with evidence of lower respiratory disease and have an oxygen saturation (SpO2) ≥94% on room air at sea level.
- **Severe:** Patients with SpO2 <94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mm Hg, a respiratory rate >30 breaths/min, or lung infiltrates >50% [6].
- A score of 0-4 was assigned to each lung depending on the percentage of involvement with airspace ground glass opacities or consolidation (0 for no involvement; 1 for <25%; 2 for 25-50%; 3 for 50-75%; 4 for 75-100%).
- The scores for each lung were added together to give a final severity score out of 8. In this grading, mild was defined as a score of 0-2, moderate as 3-5 and severe as 6-8 [2,7].

Results

Table 1: Comparison of classification of mild, moderate and severe COVID according to clinical and chest radiographic grading

Clinical Grading	Chest Radiograph Grading	Patients in each category	Male	Female
Mild (93)	Mild	82	43	39
	Moderate	7	3	4
	Severe	4	2	2
Moderate (58)	Mild	20	9	11
	Moderate	27	18	9
	Severe	11	7	4
Severe (49)	Mild	1	-	1
	Moderate	9	5	4
	Severe	39	22	17
Total		200	109 (54.5%)	91 (45.5%)

Table 2: The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of chest radiographic scoring system for detection of mild, moderate and severe COVID in tabular format

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Mild COVID	88.2	80.4	79.6	88.7
Moderate COVID	46.6	88.7	62.8	80.3
Severe COVID	79.6	90.1	72.2	93.2

Table 3: The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of chest radiographic scoring system for detection of mild and not mild

COVID Classification	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Mild	88.2	80.4	79.6	88.7
Not Mild	80.4	88.2	88.7	79.6

For clinical decision-making, it is helpful to classify COVID cases as "mild" or "not mild" (i.e., moderate or severe) as these are the patients who need admission and close monitoring. Hence, we also assessed the sensitivity, specificity, PPV and NPV of chest radiographic severity scoring for the diagnosis of moderate and severe disease combined (i.e., "not mild") which was found to be 80.4%, 88.2%, 88.7% and 79.6% respectively.

Both clinical and radiographic grading showed statistically significant concordance in classification of mild and "not mild" COVID (P value<0.001*).
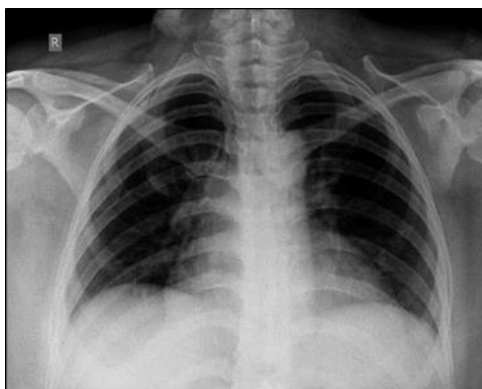
Discussion

Fig 1: Frontal chest radiograph of 50 year old female with mild COVID pneumonia
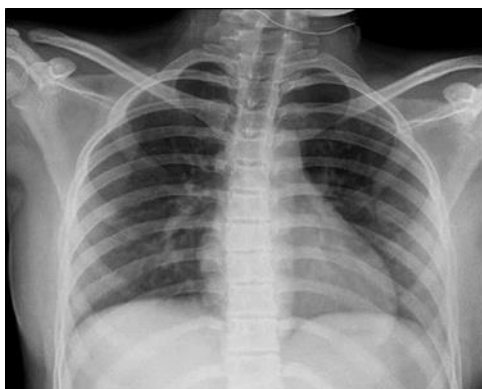

Fig 2: Frontal chest radiograph of 39 year old female with mild COVID pneumonia

- The benefits of radiographic severity scoring lies in its simplicity, reproducibility, short learning curve and feasibility in resource- constrained settings.
- The chest radiographic scoring system categorized mild and severe cases with high sensitivity, specificity, positive predictive value and accuracy.

- Radiographic scoring showed high specificity and relatively low sensitivity in diagnosis of moderate COVID.

Fig 3: Frontal chest radiograph of 46 year old male with moderate COVID pneumonia
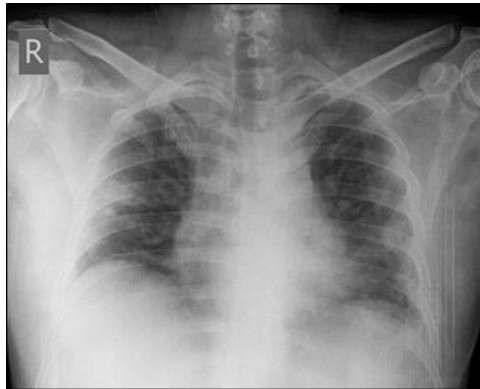

Fig 4: Frontal chest radiograph of 67 year old male with moderate COVID pneumonia

- Diagnosis of severe COVID with high sensitivity and specificity is extremely beneficial in management of patients as these are the ones who will need continuous monitoring and intensive care.
- Correct categorization of mild and "not mild" disease is also equally important as mild patients can be managed at home or regular wards/rooms and the limited resources can rightly be re-allocated for sick patients.
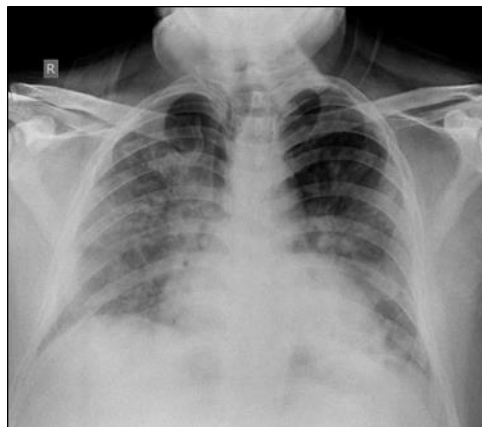

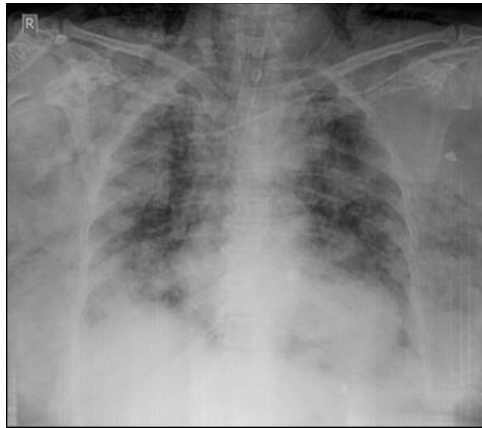**Fig 5:** Frontal chest radiograph of 55 year old male with severe COVID pneumonia

Fig 6: Frontal chest radiograph of 66 year old female with severe COVID pneumonia

Conclusion

- Chest radiographic severity scoring of COVID pneumonia showed good concordance with the clinical severity grading of patients.
- In a resource-constrained country like India, chest x-ray severity scoring system has valuable prognostic utility in COVID-19, especially in the prediction of mild and severe disease.

References

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