**BRIEF COMMUNICATION**

**Thoracic Radiological Characteristics of COVID-19 Patients at the Time of Presentation: A Cross-sectional Study**

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**ABSTRACT**

**Background:** Coronavirus disease 2019 (COVID-19) is a type of pneumonia caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 pneumonia has characteristic radiological features. Recent evidence indicates usefulness of chest X-ray and lung ultrasound (LUS) in detecting COVID-19 pneumonia.

**Materials and methods:** In this prospective observational study, chest X-ray and LUS features of 50 adults with COVID-19 pneumonia at the time of presentation were described.

**Results:** Chest X-ray findings were present in 96% of patients, whereas all patients have ultrasound finding. Proportion (95% CI) of patients having bilateral opacities in chest X-ray was 96% (86.5–98.9%), ground glass opacity 74% (60.5–84.1%), and consolidation 50% (36.7–63.4%). In LUS, shred sign and thickened pleura was present in all patients recruited in this study. Air bronchogram was present in at least one area in 80% of all patients and B-lines score of more than 2 was present in at least one lung area in 84% patients. Number of lung areas with “shred sign” were higher in hypoxemic (p = 0.005) and tachypneic (p = 0.006) patients and pleura line abnormalities were present in more lung areas in hypoxic patients (p = 0.03).

**Conclusion:** According to our study, LUS is a useful tool not only in diagnosing, but it also correlates with requirement of respiratory support in COVID-19 patients.

**Keywords:** Chest X-ray, COVID-19, Lung ultrasound, Severe acute respiratory syndrome coronavirus 2, Shred sign.

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**INTRODUCTION**

In December 2019, a series of pneumonia cases of unknown cause emerged in Wuhan, Hubei, China, which was later found to be a novel coronavirus.\(^1\) Early reports from Wuhan described the associated coronavirus disease 2019 (COVID-19) as an atypical pneumonia in which 26–33% of patients required intensive care and 4–15% mortality.\(^2\) COVID-19 pneumonia has characteristic features that can be studied radiologically. Computer tomography (CT) scan finding has high sensitivity but lacks specificity for COVID-19 and hence has a good screening potential.\(^3\) Signs on chest X-ray and lung ultrasound (LUS) are nonspecific when considered alone; however, combinations of patterns and distribution of signs in different lung field may allow a reliable characterization of the disease.\(^4\)–\(^6\) In this study we investigate the chest X-ray and lung US characteristics of COVID-19 patients at the time of presentation to the hospital and try to find out any association between US characteristics with requirement of respiratory support.

**MATERIALS AND METHODS**

This prospective observational study was conducted at the COVID area and ICU of All India Institute of Medical Sciences, New Delhi, after institute ethical committee clearance. Real-time RT-PCR of 50 adults (aged between 18 and 80 years) confirmed COVID-19 patients were included in the study. Patients who refused to give consent were excluded. Data related to baseline demographics, comorbidities, symptoms, presence of hypoxia (oxygen saturation < 92%), and requirement of organ support (respiratory, hemodynamic, renal) were collected at the time of admission. After confirmation of COVID-19 infection, chest X-ray and point-of-care lung US scanning (12 zones (6 in each lung)) was done in all the patients.\(^7\) The ultrasound parameters were measured using an ultrasound device (Sonosite M-Turbo Ultrasound System, SonoSite, Inc. Bothell, WA, USA).

Chest X-ray was reported in terms of ground glass opacity and consolidations in upper, middle, and lower zones. Each of these zones occupies approximately one-third of the height of the lungs. All lung zones were scanned for B-lines, pleural line abnormalities (irregular and/or thickened pleura), air bronchogram, subpleural consolidation, and pleural effusion. B-line score was recorded as per number of B-lines (0 = <3 per image, 1 = 3–7 per rib space, 2 = >7 per rib space, 3 = confluent B-lines).\(^8\) Interpretation of chest X-ray and lung US scanning were performed by four experienced intensivists involved in the study. Severity of the disease (WHO...
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In this observational study, fifty COVID-19-positive patients’ data were analyzed who have a median interquartile range (IQR) age of 51.5 (42–64) years and 78% of them were male. At the time of presentation, 86% patients were febrile, 84% had shortness of breath, and 68% cough. Median (IQR) duration of symptom was 4.5–9.5 days. Chest pain, myalgia, and fatigue were infrequent and present in 10, 4, and 14% patients, respectively. Hypertension was the commonest associated comorbidity and was present in 32% patients followed by diabetes (22%), chronic kidney disease (16%), and coronary artery disease (10%).

Proportion (95% CI) of patients having bilateral opacities in chest X-ray was 96% (86.5–98.9%), ground glass opacity 74% (60.5–84.1%), and consolidation 50% (36.7–63.4%). Only 6% patients had pleural effusion evident in chest X-ray. Presence of ground glass opacity was similar in hypoxemic and nonhypoxemic patients (p = 0.75) and also in different respiratory support groups (p = 0.08, Fisher exact test). Details of chest X-ray involvement were reported in Table 1.

In lung US, shred sign and thickened pleura were present in all patients recruited in this study. Air bronchogram was present in at least one area in 80% of all patients and B-line score of >2 was present at least one lung area in 84% patients. Pleural effusion was detected in 8% patients with lung US. Details of lung US findings are provided in Table 2. Number of lung areas with “shred sign” was higher in hypoxemic (p = 0.005) and tachypneic (p = 0.006) patients and pleura line abnormalities were present in more lung areas in hypoxemic patients (p = 0.03). Total number of B-lines was higher in patients with tachypnea (p = 0.04). Total number of areas with “shred sign” were higher with increasing degree of respiratory support (p = 0.003). Distribution of US features in different groups of patients has been described in Table 3 and Figure 1. Ordinal logistic regression revealed that presence of thickened pleura was associated with requirement organ support [odds ratio (95% CI) 1.7 (1.19–2.62)].

**Table 1:** Pattern of involvement in chest X-ray [data represented as proportion (95% CI)]

|         | Right | Left |
|---------|-------|------|
| Upper   | 58 (44.2–70.6) | 58 (44.2–70.6) |
| Middle  | 88 (76.2–94.4)  | 76 (64.8–87.3)  |
| Lower   | 88 (76.2–94.4)  | 86 (73.8–93.1)  |

**Table 2:** Pattern of lung ultrasound characteristics [data presented as median (IQR) or proportion (95% CI) as applicable]

| USG findings | Right | Left |
|--------------|-------|------|
| B-lines score | Shred sign | Pleural line abnormalities | Air bronchogram |
| Zone 1      | 0 (0–0) | 50 (36.7–63.4) | 44 (31.2–57.7) | 0 (0–7.1) |
| Zone 2      | 0 (0–1) | 52 (38.5–65.2) | 56 (42.3–68.8) | 6 (2.1–16.2) |
| Zone 3      | 0.5 (0–1) | 62 (48.2–74.1) | 20 (11.2–33) | 12 (5.6–23.8) |
| Zone 4      | 1 (1–2) | 78 (64.8–87.3) | 70 (56.3–80.9) | 36 (24.1–49.9) |
| Zone 5      | 1 (0–2) | 46 (32.9–59.6) | 16 (8.3–28.5) | 20 (11.2–33) |
| Zone 6      | 2 (1–2) | 48 (34.8–61.5) | 42 (29.4–55.8) | 40 (27.6–53.8) |
| Left        | Zone 1 | 0 (0–1) | 54 (40.4–67) | 38 (25.9–51.9) | 0 (0–7.1) |
| Zone 2      | 1 (0–1) | 48 (34.8–61.5) | 66 (52.2–77.6) | 4 (1.1–13.5) |
| Zone 3      | 1 (0–1) | 64 (50.1–75.9) | 14 (6.9–26.2) | 10 (4.4–21.4) |
| Zone 4      | 2 (1–2) | 68 (54.2–79.2) | 52 (38.5–65.2) | 46 (33–59.6) |
| Zone 5      | 1 (1–2) | 46 (33–59.6) | 8 (3.2–18.8) | 14 (6.9–26.2) |
| Zone 6      | 2 (2–3) | 42 (29.4–55.8) | 26 (15.9–39.6) | 58 (44.2–70.6) |
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In summary, lung US signs of COVID-19 are present in all patients at admission to the hospital. The pattern of involvement is specific, mainly manifested by pleural line abnormalities, interstitial lesions, subpleural consolidations, and primarily involve peripheral posterior basal zones, bilaterally. Number of areas with subpleural “shred sign” correlates with severity of disease. According to our study, LUS is a useful tool not only in diagnosing, but it also correlates with requirement of respiratory support in COVID-19 patients.

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Table 3: Pattern of lung ultrasound across different levels of respiratory support

|                        | Without supplementary oxygen (n = 3) | Oxygen by facemask (n = 4) | HFNC/NIV (n = 15) | Mechanically ventilated (n = 28) | p value# |
|------------------------|-------------------------------------|-----------------------------|-------------------|-------------------------------|----------|
| Total B-lines score    | 11 (3–23)                           | 15 (10–18.5)                | 11 (6–17)         | 13 (10–17.5)                  | 0.54     |
| Shred sign             | 2 (2–4)                             | 5.5 (4.5–6)                 | 7 (5–9)           | 6.5 (5.5–8)                   | 0.003    |
| Pleural line abnormalities (PLA) | 2 (2–3)                           | 5 (4–6.5)                   | 4 (3–4)           | 5 (4–6)                      | 0.88     |
| Air bronchogram        | 0 (0–4)                             | 2 (0–4.5)                   | 3 (1–5)           | 2 (1–3.5)                    | 0.23     |

#Number of lung areas involved

Nonparametric test for trend across ordered groups

Last, data related to final outcome of these patients were not collected.

CONCLUSION

In summary, lung US signs of COVID-19 are present in all patients at admission to the hospital. The pattern of involvement is specific, mainly manifested by pleural line abnormalities, interstitial lesions, subpleural consolidations, and primarily involve peripheral posterior basal zones, bilaterally. Number of areas with subpleural “shred sign” correlates with severity of disease. According to the results of our study, LUS is a useful tool not only in diagnosing, but it also correlates with requirement of respiratory support in COVID-19 patients.