Radiographical Characteristics of Patients with Post COVID Interstitial Lung Diseases in A Resource-Poor Setting of Central Sri Lanka

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Abstract Introduction
To date, COVID-19 continues to remain at pandemic proportions in some areas of the globe. As of May 11, 2022, COVID-19 has caused over 518 million infections and over 6.28 million deaths around the world. Various long-term sequela of COVID 19; an entity called Long COVID or post COVID syndrome have been recognized worldwide, out of which COVID - 19 associated interstitial lung disease (ILD) stands out as an important complication due to its associated respiratory morbidity and added burden to healthcare. As there is a scarcity of publications locally, describing the radiographical characteristics of patients with COVID-19 associated ILD is a timely need to fill this vacuum in the local literature.

Methodology
A single centre observational study was carried out in the Respiratory Disease Treatment Unit two at National Hospital Kandy, Sri Lanka between 6th January 2021 to12th January 2022. Inclusion and exclusion criteria were applied prior to data collection. Patients' demographic data, X-ray findings and HRCT findings were collected. All patients were examined by an expert respiratory team headed by the chief investigator. COVID associated ILD was diagnosed based on respiratory symptoms and HRCT findings. Statistical analysis was performed using IBM SPSS statistics data editor.

Results
Out of the total 387 COVID-19 confirmed patients, 53 (13.6%) post-COVID ILD cases were identified. Several patterns of abnormalities were observed on chest X-rays, which were bilateral patchy opacities 31(60.3%), ground glass opacity 27 (50.9%), and local patchy opacities 21 (39.6%). Similarly, different pathological patterns, geographical and zonal distributions, and standard patterns were observed in HRCT of patients with COVID-19 associated ILD. In majority of HRCTs, abnormalities were symmetrically distributed (94.2%). More than 80% of HRCT were categorized as generalized, peripheral and posterior geographical distributions. Highest zonal distribution was noted as apicobasal distribution (79.2%). Fibrosis was the most common pathological appearance (98.1%) followed by ground glass opacity (94.3%), traction bronchiectasis (41.5%), linear fibrosis (32%), crazy paving (16.9%), Mosaic (13.2%), and linear atelectasis (7.5%) respectively.

Conclusion
Post COVID-ILD is a unique single disease which encompasses all the pathological types of ILD. Early diagnosis of post COVID-ILD is mandatory to prevent permanent irreversible fibrosis and related sequelae. HRCT imaging and CXR findings are crucial in diagnosing and the progression of the disease. These findings should alert the clinicians to provide prompt and optimized care in order to minimize the long-term complications of post-COVID ILD.

Key words: COVID-19, clinical imaging, interstitial lung disease, Sri Lanka

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS –CoV- 2) or Novel Coronavirus is the causative organism for the COVID-19 pandemic which was first identified in Wuhan, China, in 2019 [1]. As of May 2022, COVID-19 has caused over 518 million infections and over 6.28 million deaths around the world [2]. By May 11, 2022, more than 0.6 million confirmed cases and 16509 deaths were announced by the Health Ministry of Sri Lanka [3].

There is increasing evidence worldwide with long COVID-19 related post-acute and chronic persistent sequela of multi-organ involvement [4].

Secondary interstitial lung disease (ILD) is a well-recognized COVID-19 associated complication adding further burden to pulmonary health [5]. Imaging techniques such as chest radiography and high-resolution computed tomography (HRCT) play a central role in diagnosing and identifying the progression of the interstitial lung disease [6]. As there is a scarcity of publications locally, describing radiographical characteristics of patients with post COVID ILD, our aim was to fill this gap.

Methodology

A single-centre observational study was carried out in the Respiratory Disease Treatment Unit two at National Hospital Kandy, Sri Lanka between 6th January 2021 to12th January 2022.

Inclusion Criteria:

1. Patients ≥ 18 years
2. Confirmed infection with SARS COVID -2.

Exclusion Criteria:

1. Patients who are < 18 years
2. Patients with pre-existing ILD
3. Patients with underlying connective tissue disorders and rheumatological disorders with pre-existing respiratory symptoms.
4. Patients with chronic exposure to environmental and occupational agents and medications with pre-existing respiratory symptoms.
5. Patients with incomplete medical records
6. Patients who did not give consent for the study.

COVID associated ILD was diagnosed in patients who developed persistent or worsening respiratory symptoms and HRCT features favouring ILD pattern at least 4 weeks following the acute COVID infection. Demographic and radiographical data were collected from patients who were diagnosed with COVID-19 associated ILD, using existing medical records. All patients were examined by an expert respiratory team led by respiratory consultants.

Imaging such as chest X-Ray and HRCT chest were jointly interpreted by a consultant respiratory physician and a radiologist. Data analysis was carried out by using the IBM SPSS version 25.00 statistics data editor. The data were presented by using descriptive statistics.

Results

A total of 387 COVID-19 confirmed patients were admitted, out of which, 53 (13.6%) developed COVID associated ILD based on the diagnosis criteria mentioned above. Out of them, the majority 38 (71.7%) were males. The mean age was 59 years with an age range of 27 to 80 years. A little more than half of the patients, 27 (50.9%) were in the age group of 41- 60 years (Table 1).

Age category	Frequency	Percentage(N=53)
01-20	1	1.9
21-40	4	7.5
41-60	27	50.9
61-80	21	39.6

Table 1- Age distribution of patients with COVID-19 related ILD

Chest X ray abnormalities of these patients were recorded (Figure 1-10) and categorized as bilateral patchy opacities 31 (60.3%), ground glass opacity 27(50.9%), and localized patchy opacities 21 (39.6%).

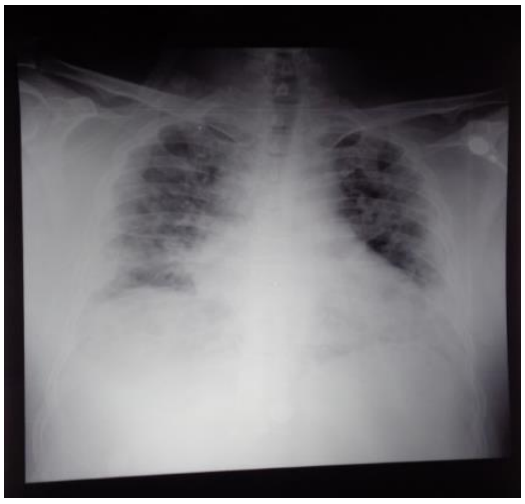


Figure 1: Bilateral symmetrical lower and mid zonal patchy consolidation with fibrosis.

Figure 2: Bilateral multi zonal involvement with nodules, ground glass patchy consolidation with areas of air trapping particularly left upper and mid zone.

Figure 3: Bilateral multi zonal, predominant lower and mid zonal ground glass and fibrosis with scattered nodules.

Figure 4: Asymmetrical multi zonal involvement with consolidation and compensatory air trapping.

Figure 5: Bilateral multi zonal, predominantly lower and mid zonal ground glass consolidation with scattered nodules.

Figure 6: Bilateral multi zonal, predominant lower zone and mid zone, ground glass, fibrosis with upper zonal air trapping

Figure 7: Bilateral diffuse multi zonal nodules, ground glass appearance and fibrous bands

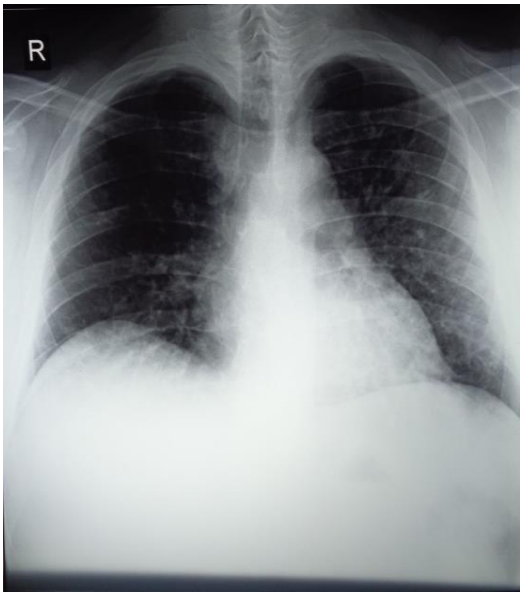


Figure 8: Bilateral multi zonal involvement, predominantly lower zone, and middle zone with minimal fibrosis, ground glass appearance and nodules

Figure 9: Bilateral, multi zonal, asymmetrical with ground glass fibrosis.

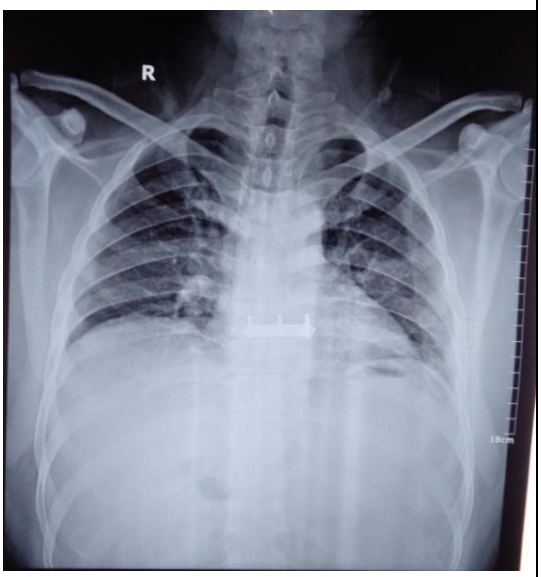


Figure 10: Bilateral, multi zonal, asymmetrical with minimal ground glass opacityfication.

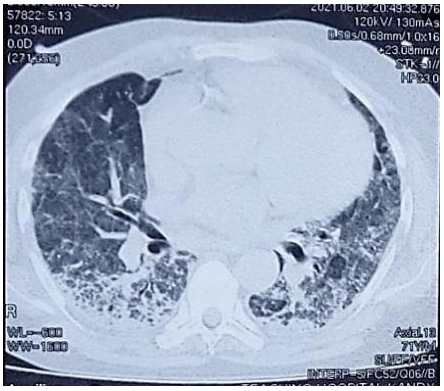
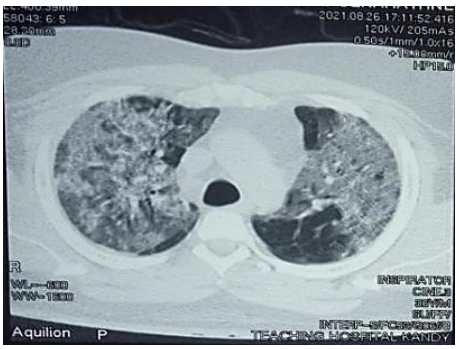
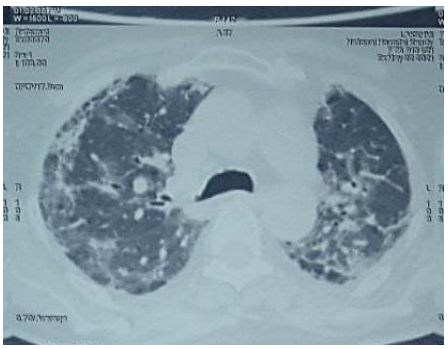
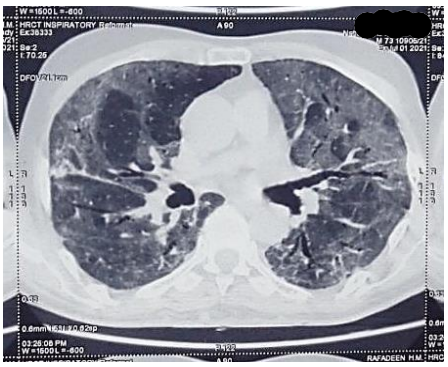
Table 2 illustrates the HRCT findings of the patients diagnosed with post-COVID ILD.

Variables		Frequency (N=53)	Percentage (N=53)
Distribution of Interstitial abnormalities	Asymmetrical	3	5.6%
	Symmetrical	50	94.3%
Geographical distribution	Patchy	2	3.7%
	Generalized	49	92.4%
	Peripheral	51	96.2%
	Central	10	18.8%
	Posterior	47	88.6%
	Lower lobe	14	26.4%
Zonal distribution	Apico basal involvement	42	79.2%
	Lower to mid	11	20.7%
	Upper to mid	4	7.5%
Pathological Appearances	Ground glass opacity	50	94.3%
	Fibrosis	52	98.1%
	Honeycombing	3	5.6%
	Linear fibrosis	17	32.0%
	Linear atelectasis	4	7.5%
	Mosaic appearance	7	13.2%
	Crazy paving	9	16.9%
	Traction bronchiectasis	22	41.5%
Standard Pattern	UIP- Definite Problem	1	1.8%
	NSIP- Definite Problem	13	24.5%
	Organizing pneumonia	1	1.8%
	Mixed	36	67.9%
	DIP- Definite Problem	2	3.7%

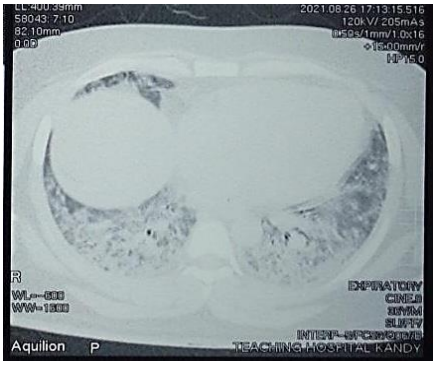
Table 2- HRCT findings of the patients diagnosed with COVID-19 related ILD.

Definition of abbreviations- UIP: Usual interstitial pneumonia, NSIP: Nonspecific interstitial pneumonia, DIP: Desquamative interstitial pneumonia.

Table 3- HRCT images of the patients diagnosed with post-COVID ILD.

 Ground Glass Opacity	 Mosaic appearance
 Peripheral to Central distribution	 Ground Glass Appearance with Peripheral Fibrosis
 Peripheral Distribution	 Generalized Distribution

Crazy Paving appearance



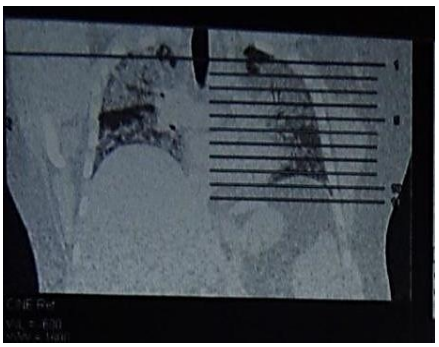
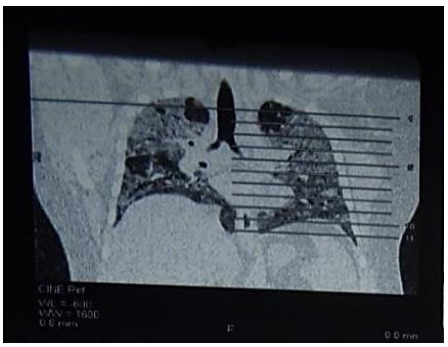
Diffuse Distribution

Predominantly peripheral with ground glass appearance

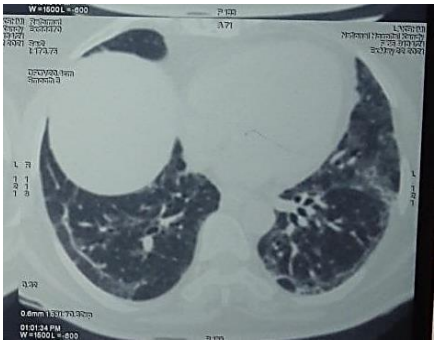
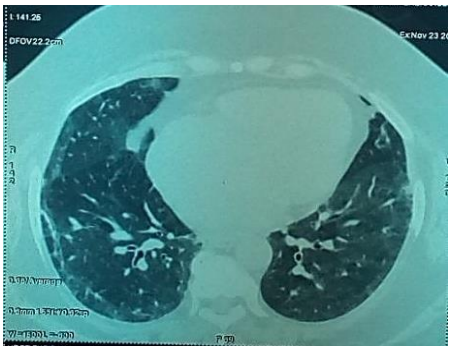
Traction bronchiectasis

Symmetrical Distribution


Asymmetrical Distribution

Apico basal Involvement

Linear Fibrosis

Discussion

This descriptive analysis explored the radiographical characteristics of patients with COVID associated interstitial lung disease (ILD) in a single tertiary care centre in Sri Lanka. HRCT is an effective method to detect progression of viral pneumonia as well as to classify the severity of disease [6].

Different pathological patterns were observed in HRCTs of patients diagnosed with COVID associated ILD. Majority of patients had symmetrically distributed HRCT changes with generalized, peripheral and posterior geographical distributions. A minority had asymmetrical HRCT appearances. Also, a majority of patients had multi zonal involvement, with the highest involvement in apicobasal distribution. However, lower to mid and upper to mid zonal distributions were also observed in this cohort. Fibrosis was the most common pathological appearance followed by ground glass opacity, traction bronchiectasis , linear fibrosis, crazy paving, mosaic, and linear atelectasis. Similar to our findings, other studies have reported similar HRCT abnormalities including ground-glass opacities, consolidations, crazy-paving pattern, and linear opacities (7,8). Furthermore, these studies reported post COVID ILD to primarily affect peripheral areas, lower lobes and display a multilobar distribution [5,7,8]. In our cohort, most patients developed an HRCT pattern consistent with mixed pattern of ILD. It was interesting to note that all definitive patterns

of ILD were observed in this patient cohort, out of which NSIP was the most common.

The main X-Ray findings of the initial phase of COVID associated ILD were bilateral or localized patchy opacities and ground-glass opacities. Therefore, these Chest X-rays findings when supported by suggestive clinical features, may alert clinicians to plan further diagnostic investigations to rule out COVID associated ILD. Thus, it can be used as a useful initial radiological investigation to diagnose COVID associated ILD [9].

Conclusion

HRCT imaging and chest X-ray findings are crucial in diagnosing and identifying the progression of post-COVID complications including interstitial lung disease. There is a diverse pattern and variation of pathological types of post-COVID ILD. Hence, it is unique as it can represent all pathological types of ILD. Early diagnosis of post-COVID ILD is mandatory for prevention of permanent irreversible fibrosis and related sequela. These findings of chest X-ray and HRCT should alert the clinicians to provide prompt and optimized care in order to minimize the long-term complications of post-COVID ILD. The main limitation of this study was the small sample size. Hence, we recommend multicenter studies with a large cohort.

Conflict of interest

There is no financial interest or any conflict of interest related to this paper.

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