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STUDY OF POST COVID-19 SEQUELAE IN HRCT LUNG

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ABSTRACT

BACKGROUND:

COVID19 outbreak has become a pandemic worldwide. There has been a fairly high rate of clinical recovery among Covid patients but complete resolution or sequelae in terms of radiological findings need to be studied.

AIM OF THE STUDY:

1. To understand the common pulmonary sequalae , time taken for complete resolution and factors affecting the resolution process in covid-19 patients who have been discharged after recovery, with Chest HRCT follow up.

MATERIAL AND METHODS:

This is an observational study which included a total of 100 discharged patients diagnosed with covid-19 by RTPCR at Index Medical College, Hospital & Research Centre, Indore-MP-India, from March 15 to June 30-2021.All the patients underwent an initial chest CT scan done 3-5 days after the onset of symptoms ,followed by serial CT scans done at discharge and at 1st, 2nd and 3rd weeks after discharge. The radiological characteristics and patterns on CT chest were studied and a CT severity scoring was done for all the scans.

RESULTS:

GGO were the most common pattern seen (88%) on chest CT at discharge followed by fibrotic bands (61%) with the right lower lung (85%) most commonly involved.61% of patients showed complete resolution at the end of 3rd week after discharge indicating that COVID 19 induced pulmonary damage is reversible in majority of cases with no long term sequalae. However 39 patients demonstrated residual abnormalities. Older patients are at high risk for residual pulmonary lesions and there is no gender predilection. Patients having comorbidities like hypertension, diabetes or bronchial asthma were not at a higher risk of developing pulmonary sequalae.

CONCLUSION:

The resolution of most lesions by 3 weeks after discharge implies gradual resolution of inflammation with re-expansion of alveoli and perhaps the reversible nature of the lesions of Covid -19.

Key Words: Covid 19, HRCT-Chest, radiological sequelae

INTRODUCTION

COVID19 outbreak has become a pandemic worldwide infecting around 52 million people and causing about 1 million fatalities by the mid November 2020 worldwide. In India, around 87 lakh people have been infected and 1.2 lakh deaths have been reported representing a high capability of transmission and fatality. There have been studies regarding the radiological features at different stages of the disease but studies regarding the radiological features

during the convalescence period are far and few.There may be sequelae in the long run which may affect the pulmonary function and may predispose to other lung diseases. Hence the importance of studying the radiological sequelae or complete resolution of those who recovered from Covid infection cannot be overemphasized.

Further the factors and any co-morbidities which may have had an effect on the complete resolution or otherwise of covid-19 infection also need to be studied. The present study deals with the follow-up of patients who have recovered clinically from covid-19 infection, to study the HRCT findings of the lung at different point of times after clinical recovery and also the factors that may have an effect on the radiological resolution of covid 19 lung infection.

AIMS & OBJECTIVES:

2. To understand the common pulmonary sequalae in covid-19 patients who have been discharged after recovery, with Chest HRCT follow up.
3. To determine the percentage of patients who have had complete resolution at different points of time after discharge
4. To know the relevant factors affecting complete resolution.

MATERIAL AND METHODS:

This is an observational study which included a total of 100 discharged patients diagnosed with covid-19 by RTPCR at Index Medical College, Hospital& Research Centre, Indore-MP-India, from March 15 to June30-2021.The treatment given in the hospital was symptomatic for mild cases along with Tablet Azithromycin 500mg once daily and supplements of vitamin C, Vitamin D and Zinc. If symptoms worsened they were given Injection Clexane - 40 units subcutaneously and Oxygen support as per requirement.

The discharge criteria were as follows: 1) afebrile for more than 3 days; 2) respiratory symptoms significantly improved; and 3) two consecutive negative COVID-19 nucleic acid tests detected at least 24 h apart [1]. Complete radiological resolution was defined as the absence of any chest radiographic abnormality potentially related to infection [2].

INCLUSION CRITERIA

All patients who underwent an initial chest CT scan done 3-5 days after the onset of symptoms followed by serial CT scans done at discharge and at 1st,2nd and 3rd weeks after discharge.

EXCLUSION CRITERIA

1) Patients whose condition worsened and had to be shifted to ICU
2) Patients who were not willing or did not turn up for follow up CT scans.

Imaging techniques:

CT scans were obtained with the patients in supine position at end inspiration. Thin section CT scans were performed on multidetector CT scanner (Siemens healthcare). The tube voltage was set at 120 kV. CT images were reconstructed with a matrix size of 512×512 as axial images (thickness of 1.5mm) with a pulmonary B70F kernel and a mediastinal B30F kernel.

Image Analysis:

The radiological characteristics and patterns on CT chest were studied and a CT severity scoring was done for all the scans. The CT images were assessed for pulmonary parenchymal abnormalities, including

(1) **Location**: the left lung (upper lobe, lower lobe), right lung (upper lobe, middle lobe, lower lobe);

(2) **Distribution**: subpleural, random, peribronchovascular;

(3) **Extent of involvement**: assessed by visually estimating the percentage of pneumonia involvement in each lobe;
(4) **Morphology**: patchy, lobar, segmental, irregular, or nodular;
(5) **Density**: ground-glass opacities (GGO), consolidation, mixed pattern of GGO and consolidation;
(6**) Internal structure**: crazy-paving pattern, interlobular septal thickening, vascular thickening, air bronchogram, and bronchial wall thickening;
(7) **Edge**: well-defined or ill-defined;
(8) **Evolution over time**: for the follow-up chest CT, recognizable pattern of change was evaluated by comparing the overall percentage of lung involvement for each patient on serial chest CT. The CT scans were also assessed for extrapulmonary manifestations, including mediastinal lymphadenopathy, pleural effusion, and pleural thickening.[3]
Each of the 5 lung lobes was visually scored from 0 to 5 as:
Score :
0, no involvement;
1, < 5% involvement;
2, 5–25% involvement;
3, 26–49% involvement;
4, 50–75% involvement;
5, > 75% involvement.
The total CT score was the sum of the individual lobar scores and ranged from 0 (no involvement) to 25 (maximum involvement) [4]
In addition, radiological characteristics at different time points, including GGO, consolidation, fibrotic bands,intralesional vascular dilatation, adjacent pleural thickening, traction bronchiectasis, bronchus distortion, crazy paving pattern and small pleural effusion, were collected and estimated.
The GGO was defined as hazy area of increased attenuation without obscuration of the underlying vasculature [5,6,7].
Crazy paving is defined as thickened interlobular and intra lobular lines in combination with ground glass pattern.
Consolidation is an area of increased attenuation of the lung parenchyma causing obscuration of pulmonary vessels, without significant loss of volume, in the segments affected. Air bronchograms can also be found [8,9]
Vascular dilatation implies widening of the vessels in the area of ground glass opacification.
Traction bronchiectasis is the bronchial distortion in the areas of ground glassopacification.
If complete radiological resolution was reached, no further chest CT scan was performed.

STATISTICAL ANALYSIS:
Statistical analysis was performed using IBM SPSS Statistics Software (version 24; IBM, New York, USA). The counting data are presented as the percentage of the total . The cumulative percentage of the endpoints was calculated. The comparisons of counting data were evaluated using the Chi-square test. A p-value of < 0.05 was defined as statistically significant and < 0.001 as highly significant.

RESULTS:

Clinical Characteristics Of Patients With Covid-19 Infection

A total of 100 patients (58 males and 42 females) were included in the study. The average age was 45 years. 48 patients had history of contact with proven covid-19 cases, 16 had history of travel within 14 days before onset of symptoms and the remaining 36 had no known exposure

history. The main presenting symptoms were fever (94%), cough (68%), comorbidities of hypertension, diabetes, bronchial asthma were reported in 20, 8, 6% of patients respectively**.(Table-1)**

Table 1: CLINICAL CHARACTERISTICS OFPATIENTS WITH COVID-19 INFECTION

	n=100
Gender:	
Male	58
Female	42
Average Age (years):	45
Exposure history:	
Exposure to infected person	48
Travel history	16
Unknown exposure	36
Initial Symptoms of onset:	
Fever	94
Cough	68
Shortness of breath	3
Sore throat	9
Diarrhoea	6
Nausea, vomiting	3
Asymptomatic	2
Comorbidities:	
Hypertension	20
Diabetes	8
Bronchial asthma	6

Ct Severity Score At Different Points Of Time :

The severity of lung involvement decreased gradually with complete resolution in 61% patients and mild involvement (CT score <9) in 39% patients at the end of 3rd week. At the end of 2 weeks after discharge 42% had complete resolution, 56% had mild involvement(CT Score<9) and 2% had moderate involvement (CT score 9-15). At the end of first week 36% had complete resolution,56% had mild involvement(CT score<9) and 8% had moderate involvement(CT score 9-15). At discharge 8% had complete resolution,77% had mild involvement(CT score <9), 12% had moderate involvement(CT score9-15) and 3% had severe involvement(CT score >15). At 5 days after onset of symptoms 63% had mild involvement, 29% had moderate involvement and 8% had severe involvement**.(Table 2)**

Table- 2:CT SEVERITY SCORE AT DIFFERENT POINTS OF TIME

CT Score	5 days after onset of symptoms	At discharge	1 week after discharge	2weeks after discharge	3 weeks after discharge
Complete resolution		8%	36%	42%	61%
< 9 (mild)	63%	77%	56%	56%	39%
9-15 (moderate)	29%	12%	8%	2%	0
> 15 (severe)	8%	3%	0	0	0

Cumulative percentage of complete radiological resolution at different time points:
At discharge, 8 (8%) patients reached complete radiological resolution. The cumulative percentage of complete radiological resolution after discharge, at the end of 1st week was 36%, 2nd week was 42% and 3rd week was 61%.(**Table-3)**

Table 3:- CUMULATIVE PERCENTAGE OF COMPLETE RADIOLOGICAL RESOLUTION AT DIFFERENT TIME POINTS

Chest CT:	n=100
At discharge	8
At the end of 1st week	36
At the end of 2nd week	42
At the end of 3rd week	61

Factors associated with resolution:
Gender: There was no significant difference in complete radiological resolution at the 3 week follow up between males and females**.(Table 4)**
Comorbidities*:* There was no significant difference in complete radiological resolution at the 3 week follow up,in the patients with or without the presence of comorbidities**.(Table 4)**
Age: There was a significant difference between groups with different ages. Among the 56 patients who were below 45 years of age , 39 (69.6%) had complete resolution. Among the 44 patients who were above 45 years, only 14(31.8%) had complete resolution. This difference was statistically significant with a p-value of <0.001(**Table 4)**

Table-4:CORRELATIVE FACTORS WITH RESOLUTION

	Complete radiological resolution(n)		p-value
	Yes	No	
Age (years):			
≤ 45	39(69.6%)	17(30.4%)	<0.001
> 45	14	30	
Gender:			
Male	33	25	>0.05
Female	20	22	
Comorbidities (Hypertension, Diabetes, Asthma):			
Present	19	15	>0.05
Absent	42	24	

Chi square test:
P value < 0.001= very significant
P value >0.05 = not significant

Chest CT manifestations in short term follow up:

The predominant patterns of abnormalities observed at discharge were GGO (88%), fibrotic bands (61%), consolidation (40%), intralesional vascular dilatation (38%) and adjacent pleural thickening (28%). At the end of 3rd week, the cases with the GGO's decreased to 30%, fibrotic bands to 11%, consolidation to 4%, intralesional vascular dilation to 6%, pleural thickening to 3%, pleural effusion resolved completely in all cases and bronchus distortion showed a resolution in 2 cases out of 5 at the end of 3rd week. Crazy paving pattern was found in 10% of patients which decreased to 2% at the end of 3rd week after discharge**(Table-5)**

Table-5:-CHEST CT MANIFESTATIONS IN SHORT TERM FOLLOW UP

CT manifestations	CT at discharge	CT after 1st week	CT after 2nd week	CT after 3rd week
GGO	88%	60%	42%	30%
Consolidation	40%	28%	14%	4%
Fibrotic bands	61%	41%	32%	11%
Intralesional vascular dilatation	38%	26%	18%	6%
Traction bronchiectasis and bronchus distortion	5%	3%	3%	2%
Adjacent pleural thickening	28%	21%	14%	3%
Small pleural effusion	3%	2%	1%	0
Crazy paving pattern	10%	6%	3%	2%

Discussion:

The purpose of this study was to understand the CT manifestations and patterns of evolution at different time points in patients with COVID-19 pneumonia and also to determine the cumulative percentage of complete radiological resolution at each time point. Our results showed that GGO were the most common pattern seen (88%) on chest CT at discharge followed by fibrotic bands (61%) and consolidation (40%) which is similar to Dehan Liu et al [10] where 83.9% had GGO only and fibrous stripes present in 54.4%. The study of Chung et al [11] had GGO in 57% only. The subpleurallocation of opacities was another common CT feature in our study (77%). These findings are consistent with findings by Fu et al [12] where peripheral distribution was found in 45.5% and 54.5% of opacities involved both peripheral and central parenchymas. Our study showed that right lower lung (85%) was most commonly involved which was also found by Zhou et al which showed that middle and lower zones were more commonly involved [13]. In our study pulmonary lesions were found to be completely resolved in 61% of patients at the end of 3rd week after discharge indicating that COVID 19 induced pulmonary damage is reversible in majority of cases with no long term sequalae. However 39 patients demonstrated residual abnormalities in the form of GGO's (30%) and fibrotic bands (11%) and consolidation (4%). These findings were similar to the study by Dehan Liu et al [10] where there was complete resolution in 53% of patients during the 3rd week after discharge and > 40% demonstrated residual abnormalities including GGO and fibrous stripe as the main CT manifestation at 3-week radiological follow up. In our study 2 weeks was the median resolution period which is similar to Dehan Liu et al [10].

When we deal with the factors associated with pulmonary sequalae previous studies have reported that males and older patients are at high risk for residual pulmonary lesions and unfavourable outcomes. [14,15]. However in this study it is observed that males are not at high risk for sequalae as compared to females.

On the other hand,if we take age into consideration our study shows a faster resolution rate and a better outcome for younger age group. This finding is consistent with the study by Dehan et al [10] and another study by Opal et al [16].

In this study we also observed that patients having comorbidities like hypertension, diabetes or bronchial asthma were not at a higher risk of developing pulmonary sequalae due to covid 19 pneumonia.

Various radiological abnormalities are also considered to know the resolution in them. In case of GGO's it has been found that it was present in 88% of patients at the time of discharge and at the end of 3 weeks residual GGO was reported in only 30% of patients. Similarly consolidation was found in 40% of patients at discharge and only 4% patients at the end of 3 weeks. Fibrotic bands were seen in 61% of patients at discharge and in 11% of patients at the end of 3 weeks. Intralesional vascular dilatation was present in 38% of patients at discharge and this resolved so that only 8% had residual lesions 3 weeks later. Adjacent pleural thickening was present in 28% of patients at discharge and 3 weeks later it was found in only 3%. Other lesions like bronchus distortion and crazy paving pattern were found in very few patients (5% and 10% respectively), but these lesions were found in only 2% patients at the end of 3 weeks. Small pleural effusions which was found in 3% of patients at discharge had resolved completely in all of them by the 3rd week after discharge. These findings are consistent with the study of Dehan et al[10]

LIMITATIONS:

1. No critical patients were included in the study as they were still hospitalised at the end of our study.
2. Three weeks time period of follow-up after discharge is a relatively short term for all sequalae to resolve completely and a long term follow-up may give a better result for resolution of pulmonary lesions.

CONCLUSION:

This study shows the various radiological lesion patterns found in Covid-19 pneumonia and their evolution at different time points.

61% of the discharged patients showed no sequelae and had complete resolution by the end of 3 weeks after discharge.

Older age group patients were at a higher risk of developing pulmonary sequelae and poorer outcomes.

The optimal time for follow-up chest CT scan may be at the end of 3 weeks after discharge.

The resolution of most lesions by 3 weeks after discharge implies gradual resolution of inflammation with re-expansion of alveoli and perhaps the reversible nature of the lesions of Covid -19. However a larger cohort and more long term follow-up is required to ascertain if the lesions in Covid -19 pneumonia are completely absorbed or not in the long run.

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