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ORIGINAL RESEARCH

A study to evaluate pulmonary changes in post covid patients by high resolution computed tomography

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Abstract

Introduction: About 10 – 20% patients experienced a variety of mid and long-term effects after they recovered from their initial illness which is collectively known as 'Post covid -19 condition'. Clinical complications after the acute phase go beyond the respiratory sphere and can be very diverse. Emerging data on COVID-19 further indicated that the disease can result in prolonged illness and persistent symptoms, with post-acute PFT and imaging findings that possibly imply a varying degree of pulmonary vasculopathy and interstitial lung involvement persisting in the recovery phase of the disease.We aim to evaluate the post COVID pulmonary changes of the disease by follow-up HRCT scan in patients discharged after the treatment for COVID-19.

Materials and Methods: A time bound, hospital based and retrospective observational study, was conducted among 2000 patients out of which total 650 patients who showed any post COVID pulmonary changes were included in our study in the Department of Radio-diagnosis, M.G.M. Medical College and M.Y. Hospital, Indore, Madhya Pradesh, India after receiving approval from Institutional Scientific and Ethical Committee.

Statistics analysis used: All clinical and radiological imaging data were tabulated and comparisons were done usingSPSSsoftware for Windows.The mean and standard deviation of the quantitative variables were calculated. A chi-square test was used for the comparison of categorical variables. (P-values<0.05 – significant)

Results: The mean age of patients was 59.43±13.82 years ranging from 21 to 92 years with male preponderance.GGO were seen in 100% of post COVID patients followed by septal thickening which was seen in 89.6% of the patients (max in group B). Consolidation and Fibro atelectatic opacities were seen in 46.3 % and 43% respectively (max in group A). Fibro atelectatic opacities and parenchymal band were seen in majority of the group C patients while bronchiectasis and honeycombing were seen in majority of group B patients

Conclusion: HRCT chest plays an important role in determining the spectrum of findings in post COVID-19 patients, monitoring the progression and regression of the disease and initial CTSS aid as a predictor of evolving pulmonary changes in post COVID patients.

Key Words: Coronavirus, post-COVID, HRCT (High Resolution Computed Tomography) , GGO (Ground Glass Opacities)

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Introduction

Coronavirus disease 2019 (COVID-19), the viral illness caused by the novel coronavirus SARS-CoV-2 has resulted in significant morbidity and mortality across the world since the first few cases identified in Wuhan China, in December 2019.[1] Thereafter, the disease has rapidly spread worldwide. It was declared as a pandemic by WHO on March 11, 2020. While the vast majority of patients suffered from moderate illness, about 15% developed severe COVID 19 pneumonias, and 5% developed ARDS, leaving almost 4.8 million patients with significant pulmonary involvement.[2] About 10 – 20% patients experienced a variety of mid and long-term effects after they recovered from their initial illness which is collectively known as 'Post covid -19 condition'.

"Post-Covid conditions" are a term coined by the Centers for Disease Control (CDC) to identify health problems that last longer than four weeks after contracting COVID-19. (3)

Clinical complications after the acute phase go beyond the respiratory sphere and can be very diverse. Tiredness, dyspnea, exhaustion, mental fogginess, headache, persistent loss of taste or smell, cough, depression, low-grade fevers, palpitations, disorientation, muscular soreness, and joint pain are the usual clinical signs of "long covid." (3)

Emerging data on COVID-19 further indicated that the disease can result in prolonged illness and persistent symptoms, with post-acute PFT and imaging findings that possibly imply a varying degree of pulmonary vasculopathy and interstitial lung involvement persisting in the recovery phase of the disease. (4)

With the advancement in techniques of Computed Tomography (CT) scanners, there has been significant improvement in the spatial resolution, which can help in detecting even minute parenchymal lung lesions in post COVID-19 patients.

It should be emphasized, however, that there are just a few studies that have looked at serial temporal alterations in individuals who had repeat CT scans (5). Therefore, present study was designed to study the spectrum of computed tomography findings in chest in COVID-2019 infection, and their temporal evolution on long term follow-up scans with respect to time in order to provide a reliable basis for management at every point of disease.

In this study, we aim to evaluate the post COVID pulmonary changes of the disease by follow-up HRCT scan in patients discharged after the treatment for COVID-19.

Methods

A time bound, hospital based and retrospective observational study, was conducted in the Department of Radio-diagnosis, M.G.M. Medical College and M.Y. Hospital, Indore, Madhya Pradesh, India after receiving approval from Institutional Scientific and Ethical Committee. The duration of the study was from April 2021- September 2022. A total of 2000 patients referred to the Department of Radiodiagnosis for subsequent HRCT scan after 1 month of COVID -2019 positive status on RT-PCR and /or rapid antigen test were recruited for the study out of which total 650 patients who showed any post COVID pulmonary changes were included in our study.

Inclusion Criteria: All the COVID positive patients having subsequent HRCT scans after one month of being positive and patients more than 18 years of age were included in our study.

Exclusion Criteria: Pregnant patients and the patients with pre-existing respiratory disorder interstitial lung disease/ chronic lung infection/ neoplastic disease of lung /metastasis of lungs were excluded from our study.

All the detailed information about the study was explained to the patients found eligible for inclusion in the study. Informed consent was taken from all of them.Demographic profiles of the patients were noted and complete details about the clinical diagnosis and laboratory diagnosis was noted. All CT scans were performed on Optimus GE 128 slice CT scanner (GE Healthcare, USA) in MGMMC & MYH Indore. Imaging data were acquired through

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hospital picture archiving and communication system (PACS). Images were analyzed at the workstation and reports were prepared using a dedicated format for COVID-19. Temporal CT scans were studied within a period of 1 year. Patients were categorized into A, B and C groups based on their temporal chest CT scans performed in the interval period of 1 month, 3 months and 6 months respectively. The CT chest images thus obtained were studied by a radiologist and were tabulated for the presence or absence of HRCT findings and CTSS was calculated.An overall lung severity score was all-inclusive of summing the five lobe scores which ranges from of possible score 0 to 25.Radiological imaging and findings of HRCT were recorded and CT severity score were calculated. CT severity score in mild (1-8), moderate (9-15) and severe (16-25).

All clinical and radiological imaging data were tabulated and comparisons were done using IBM Statistical Package for the Social Sciences (SPSS) software for Windows, Version 26.0. Armonk, NY: IBM Corp. The mean and standard deviation of the quantitative variables were calculated. A chi-square test was used for the comparison of categorical variables. P-values less than 0.05 were considered statistically significant.

Results

A total of 2000 patients referred to the Department of Radiodiagnosis for subsequent HRCT scan after 1 month of COVID -2019 positive were recruited for the study. 650 (32.5%) patients who showed any post COVID pulmonary changes were included in our study and 1350 (67.5%) patients with absent post COVID pulmonary findings were excluded from our study.

Table 1: Demographic presentations of the patients

Characteristic	**No. of Patients (%)**	
Total patients	650	
Age (y)	59.43±13.82	
Age bracket, n (%)		
<40	56	8.5%
40-50	108	16.6%
51-60	160	24.7%
61-70	166	25.5%
>70	160	24.7%
Gender		
Male	463	71.2%
Female	187	28.8%

In our study, we found majority 286 (44.4%) of the patients had diabetes as an associated comorbidity followed by hypertension in 242 (37.2%) patients while only 102 (15.80%) patients had other comorbidities.

In our study, we found bilateral involvement in 546 (84%) patients which is more as compared to unilateral lobe of involvement seen in 104 (16%) patients,lower lobes in 98.3% patients were found to be more commonly involved as compared to upper lobes in 91.5% patients.

In our study, we found majority of patients 258 (39.7%) were present in moderate category of CT severity score on initial scan followed by 242 (37.3%) in severe category and 150 (23%) in mild category.

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Fig- 1: Distribution of patients according to spectrum of typical chest ct findings on initial acute scan

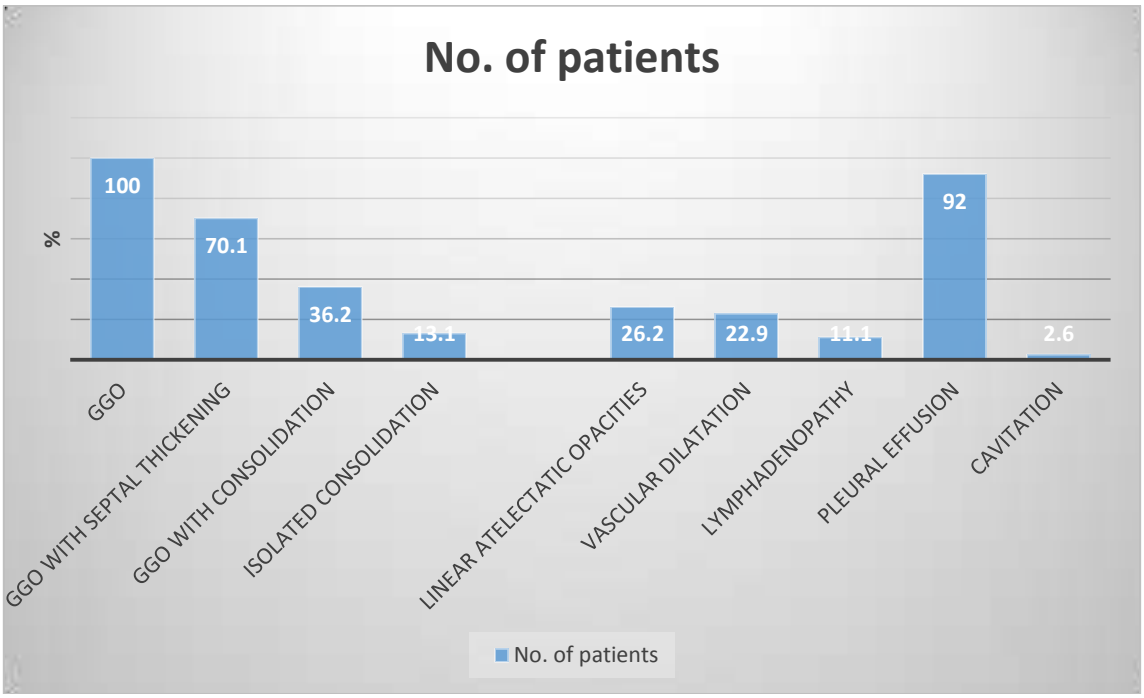

Table 2: Comparison of GGO, Septal thickening and Consolidation among the groups on temporal CT chest

		Total (n=650)		**Group A(n=360)**		**Group B(n=172)**		**Group C(n=118)**		**p-value[1]**
Total GGO in initial scan	GGO in follow up scan	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	
650	Decreased	521	80.1	249	69.3	153	88.9	118	100.0	0.0001*
	Increased	129	19.9	111	30.7	19	11.1	0	0.0	
Total Septal thickening in initial scan	Septalthickening in follow up scan	No.	%	No.	%	No.	%	No.	%	
455	Decreased	235	36.2	92	25.3	76	44.4	67	57.1	0.0001*
	Increased	220	33.9	155	43.3	52	30.6	12	10.2	
	Newappearance	130	19.9	55	15.1	40	23.6	34	28.6	
	Absent	65	10.0	58	16.0	4	1.4	5	4.1	
Total	Consolidation	No	%	No.	%	No.	%	No	%	

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Consolidation in initial scan	in follow up scan	.						.		
234	Decreased	192	29.5	125	34.7	34	19.4	34	28.6	0.0001*
	Increased	42	6.6	28	8.0	10	5.6	5	4.1	
	New appearance	65	10.0	49	13.3	17	9.7	0	0.0	
	Absent	351	53.9	158	44.0	111	65.3	79	67.3	

[1]Chi-squaretesttest *Significant **Insignificant

There was significant (p=0.0001) association between evolution of GGO, septal thickening and consolidation among the groups with respect to time interval.

Fig- 2: Distribution of post covid patients according to spectrum of chest CT findings on follow up scan (post covid scan)

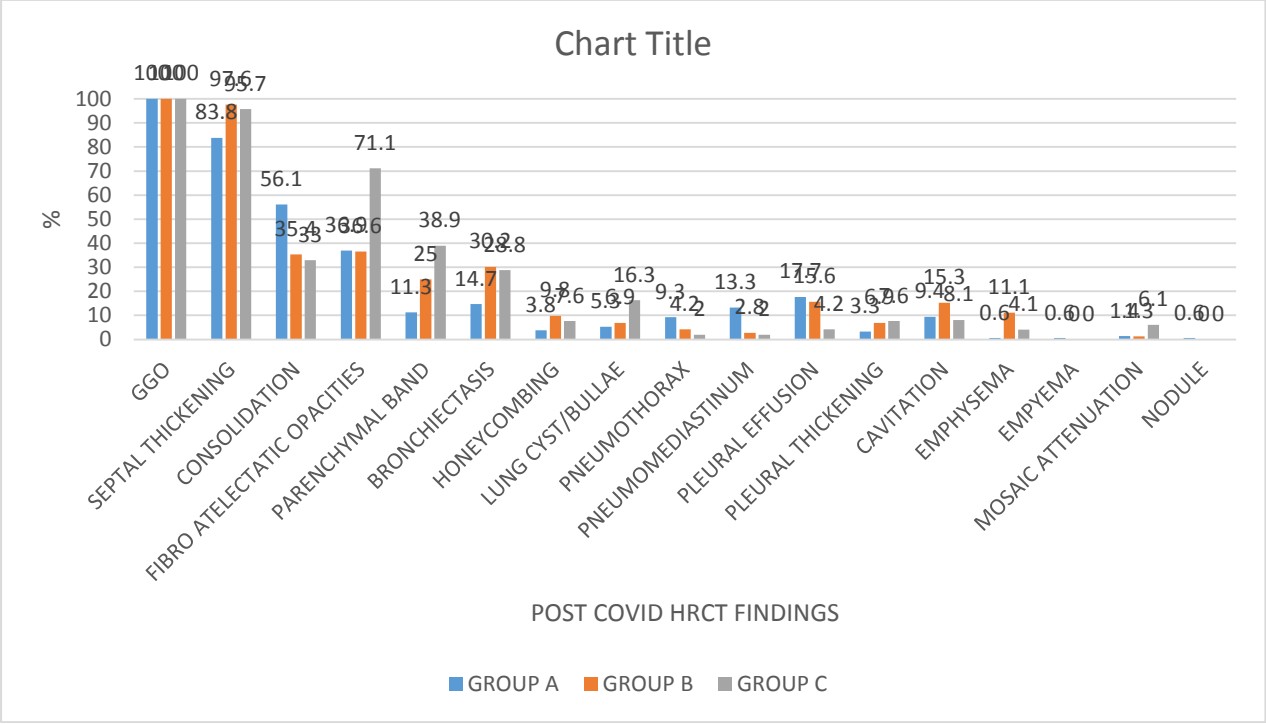

Table 3: Comparison of following post COVID pulmonary changes among the groups on follow up chest HRCT scan

	Total (n=650)		Group A(n=360)		Group B(n=172)		Group C(n=118)		p-value[1]
Fibro-atelectatic reticularopacities	No.	%	No.	%	No.	%	No.	%	
Decreased	521	80.1	249	69.3	153	88.9	118	100.0	0.0001*
Increased	129	19.9	111	30.7	19	11.1	0	0.0	
Parenchymal Bands									
Present	129	19.9	41	11.3	43	25.0	46	38.8	0.0001*
Absent	521	80.1	319	88.7	129	75.0	72	61.2	
Bronchiectasis									

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Present	140	21.4	53	14.7	52	30.6	34	28.6	0.001*
Absent	510	78.6	307	85.3	120	69.4	84	71.4	
Honeycombing									
Present	41	6.3	14	4.0	17	9.7	9	8.2	0.21**
Absent	609	93.7	346	96.0	155	90.3	109	91.8	
Lung cyst/bullae									
Present	50	7.7	19	5.3	11	6.9	19	16.3	0.04*
Absent	600	92.3	340	94.7	161	93.1	99	83.7	
Pneumothorax									
Present	42	6.6	33	9.3	7	4.2	3	2.0	0.04*
Absent	608	93.4	327	90.7	165	95.8	115	98.0	
Pneumomediastinum									
Present	55	8.5	48	13.3	5	2.8	3	2.0	0.006*
Absent	595	91.5	312	86.7	167	97.2	115	98.0	
Pleural Effusion									
Gross	2	0.4	3	0.7	0	0.0	0	0.0	N.A
Mild	81	12.5	53	14.7	25	13.9	5	4.1	
Moderate	12	1.8	8	2.6	2	1.4	0	0.0	
Absent	555	85.3	296	82.0	145	84.7	113	95.9	
Pleural Thickening									
Present	34	5.2	11	3.3	11	6.9	9	8.2	0.30*
Absent	616	94.8	639	96.7	161	93.1	109	91.8	

[1]Chi-squaretesttest*Significant**Insignificant

There was significant (p-value ≤ 0.05) association between evolution of fibro-atelectatic reticular opacities, parenchymal band, bronchiectasis, lung cyst, pneumothorax and pneumomediastinum among the groups with respect to time interval.

Fig 3: Distribution of ancillary complications among the groups on temporal CT chest Cavitation was found in 10.8% (n=70) of total cases. On temporal CT scans, 15.3%(n=27) cases had cavitation among group B followed by 8.1%(n=9) among group A. Highest prevalence of emphysema and mosaic attenuation are maximum amongst group B and group C respectively.

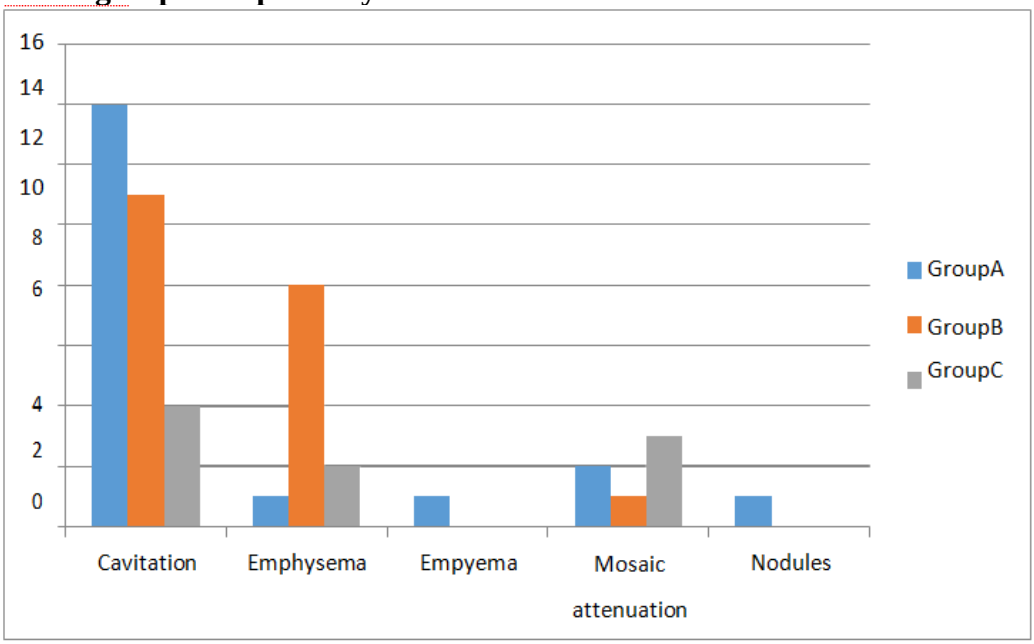

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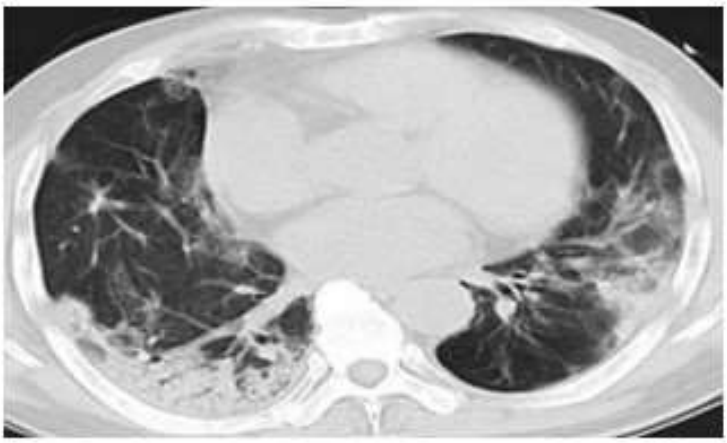
Table 4: Comparison of chronic changes of fibrosis among the patients based on initial CT severity score -categorized as mild to moderate and severe disease.

	Initial (CTSS) - Mildto Moderate disease (n=408)	Initial(CTSS)-Severe disease(n=242)	p-value[1]
Parenchymal bands(present=54)	Present14(3.6%) Absent394(96.4%)	Present111(46.1%) Absent131(53.9%)	<0.001*
Bronchiectasis (present =58)	Present65(15.9%) Absent343(84.1%)	Present75(30.7%) Absent167(69.3%)	0.004*
Honeycombing (present =17)	Present17(4.1%) Absent391(95.9%)	Present24(9.9%) Absent218(90.1%)	0.058**

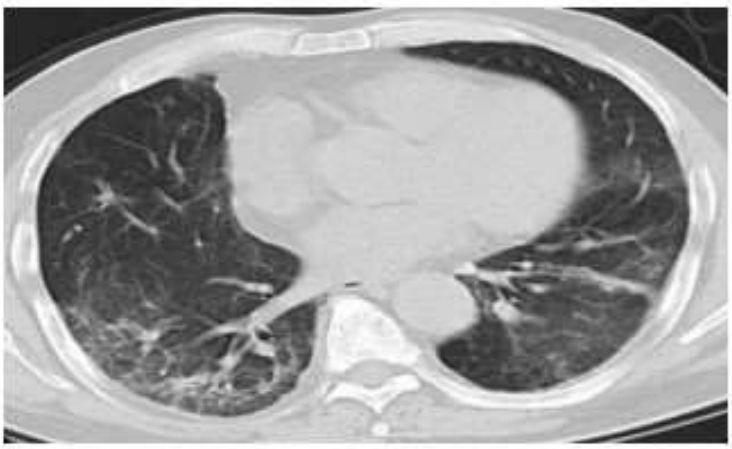
[1]Chi-squaretesttest*Significant**Insignificant

There was significant ($p<0.005$) association between evolution of chronic changes of parenchymal bands and bronchiectasis fibrosis and initial CT severity score.

Fig-4: Serial HRCT imaging of 51-year-old woman with RT-PCR positive COVID19: (a) Initial chest scan at day 14 shows subpleural consolidations with some GGO (CTSS=8) (b) Follow up scan obtained after 3 months showed regression of consolidation and appearance of subpleural reticulations with septal thickening.



(a)



(b)

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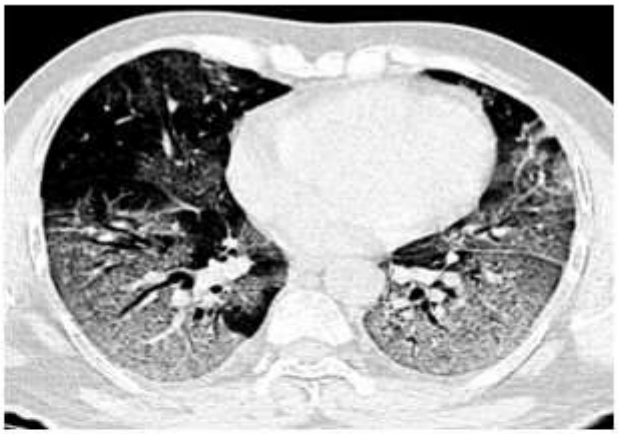
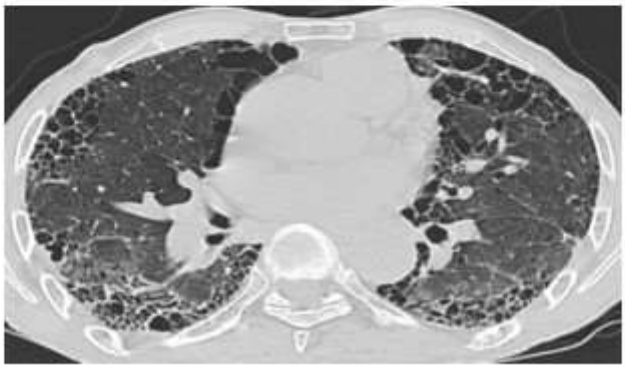
Fig-5: Serial HRCT imaging of COVID positive case: (a) Initial scan shows diffuse bilateral ground glass opacities with consolidations in lower lobes. (CTSS=20) (b) Follow up scan at 6 months showed regression of GGO and consolidation and development of fibrotic changes i.e., sub pleural reticular opacities and honey combing bilaterally.



(a)



(b)

Discussion

COVID 19 pandemic has created an unprecedented loss and disruptions in the healthcare system of India. After battling with COVID 19, a more pressing and challenging issue has emerged in form of post COVID syndromes. Post-COVID conditions, or long COVID refers to the previously infected individuals with SARS-CoV-2, who have reported persistent symptoms, ≥4 weeks after acute COVID-19.

In our study, majority of patients i.e., 166 (25.5%) were in 61-70 years of age group followed by 160 (24.7%) in 51-60 years age group & 160 (24.7%) in >70 years of age group. The mean age of patients was 59.43±13.82 years ranging from 21 to 92 years this is in concordance with study conducted by Minhua Yu et al[6]who found mean age group was 54.0±11.0 years (49.0–65.3).

The majority of patients in our study were males 463 (71.2%). This is in concordance with the study of X. Han et al[7]who also found male predominance in 70% of cases.

In our study, we found majority 286 (44.4%) of the patients had diabetes as an associated comorbidity followed by hypertension in 242 (37.2%) patients while only 102 (15.80%) patients had other comorbidities. This may indicate that poorly controlled blood glucose patients with COVID-19 experienced more severe inflammatory reactions, which may indicate a worse prognosis. This is in concordance with study done by Mithal et al[8]who also observed similar result where diabetes was seen in 47% patients followed by hypertension in 40% patients.

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In our study, we found bilateral involvement in 546 (84%) patients which is more as compared to unilateral lobe of involvement seen in 104 (16%) patients. This is in concordance with study conducted by Saad et al[9]who found Bilateral pulmonary involvement in 74% patients.

In our study, we found majority of patients 258 (39.7%) were present in moderate category of CT severity score on initial scan followed by 242 (37.3%) in severe category and 150 (23%) in mild category while study done by Azab et al[10]found that 14.8% patients in mild category and 33.6% patients in moderate category. This can be explained by a greater number of patients had associated comorbidities and majority of patients belongs to higher age group (>50years).

In our study, on initial HRCT scan GGO was most commonly seen in all patients 100% (n=650) patients (most common), followed by GGO with septal thickening in among 70.1% (n=455) of patients, GGO with consolidation was seen in 36.2 % (n=236) of cases, linear atelectatic opacities were found in 26.2% of patients, vascular dilatation was found in 22.9 % of patients. 13.1% (n=85) showed isolated consolidation.Lymph nodes were in 11.1% of patients. Pleural effusion was an uncommon finding. Pleural effusion was present in 9.2 % (n=59) of patients.

In current study,on follow up scan we found regression of GGO was found in 521 (80.1%) patients. We observed the maximum 118 (100%) regression in group C patients followed by 153 (88.9%) in group B and 249 (69.3%) in group A on temporal CT. There was significant (p=0.0001) association of evolution and proportion of GGO among the groups with respect to time interval. It may also indicate the gradual regression of the inflammation and re-expansion of the alveoli. The results of our study were in accordance with study conducted by Xiaoyu Han et al[7]who found significant regression of GGO which was observed on follow-up CT compared with the initial CT i.e., GGO regressed and seen in 60% patients.

In present study, on follow up scan regression of septal thickening was found in 235 (29.5%) patients. We observed the maximum regression in group C with 67 (57.1%) patients followed by 76 (44.4%) in group B and 92 (25.3%) in group A on temporal CT. Due to infection, infiltration of interlobular septa with fluid and inflammatory cells occurs resulting in thickening of septa. There was significant (p=0.0001) association of evolution of septal thickening among the groups with respect to time interval. This is in accordance with study of M. Liu et al[11]who showed septal thickening is regressed and seen in 29% patients. This study shows that maximum progression of septal thickening was seen in 155 (43.3%) patients in group A followed by group B and group C respectively.

In our study, on follow up scan regression of consolidation was found in 29.5% (n=192) of total patients (n=650). This may be explained by the fact that any consolidation at admission had been gradually absorbed, typically with a “melting sugar” pattern of resorption whereby the density of consolidation gradually decreases to GGO. The results of our study were in accordance with study conducted by Xiaoyu Han et al[7] who found significant regression of consolidation which was observed on follow-up CT compared with the initial CT i.e., consolidation regressed and seen in 24% patients only. The presence of consolidation in follow up scans can also be explained by higher number of patients with associated comorbid condition like diabetes having high blood sugar which will leads to superadded bacterial infection.

In present study,fibro-atelectatic reticular opacities were seen in 324 (49.8%) patients with maximum number i.e., 84 (71.4%) patients in group C followed by 133 (36.7%) patients and 63 (36.7%) patients in group A and group B, respectively. There was significant (p=0.007) association of evolution of fibro-atelectatic reticular opacities among the groups with respect to time. Fibrous stripes may occur during the healing of lung inflammation or proliferative diseases, with scar tissues replacing cellular components gradually. The presence of fibrous

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stripes sometimes indicates the improvement in prognosis of a COVID-19 patient with stabilizing disease status. These findings are in accordance with the study by Zhang et al[12], where the frequency of fibrous stripes was relatively higher in this time period compared with other imaging features, following the frequency of GGO.

In our study, parenchymal bands were seen in 129 (19.9%) patients with maximum number i.e., 46 (38.8 %) patients in group C followed by 43 (25.0%) patients and 41 (11.3%) patients in group B and group A, respectively. Significant differences (p=0.0001) were found among the time intervals in the proportion of these pulmonary lesions. It is a linear opacity, that usually extends to the visceral pleura and whenever there is chronic inflammation it may get thickened and retracted at the site of contact. Pleuro-parenchymal band associated with distortion of the lung architecture was commonly found in group C patients. This is in accordance with the study conducted by Feng Pan et al[13]and B. Vijaykumar et al[14]who found parenchymal bands in 26.7% and 37% of patients respectively.

In our study, bronchiectasis was seen in 140 (21.4%) patients with maximum number i.e., 52 (30.6 %) patients in group B followed by 34 (28.6%) patients and 53 (14.7%) patients in group C and group A, respectively. There was significant (p=0.01) association of evolution of bronchiectasis among the groups with respect to time. It may be caused by peribronchiolar fibrosis, airway obstruction caused by mucus and traction caused by fibrotic band. This is in accordance with study of M. Liu et al[11]who showed bronchiectasis in 29% patients. Maximum occurrence of parenchymal bands and bronchiectasis was found in the late period, suggesting underlying evolving fibrosis.

In present study, honeycombing pattern was seen in 41 (6.3%) patients with maximum number i.e., 17 (9.7 %) patients in group B followed by 9 (8.2%) patients and 14 (4.0%) patients in group C and group A, respectively. There was no significant (p>0.05) association of evolution of honeycombing pattern among the groups. This could be possibly due to very less number of cases of honeycombing on temporal scans and its varied pathogenesis. Honeycombing is hall mark of pulmonary fibrosis produced by dissolution of alveolar wall with the formation of randomly distributed air spaces that are lined by fibrous tissue. The study conducted by Rodriguez et al[15]found the residual honeycombing in 11% of patients on follow up scan which is more as compared to our study.

In our study, lung cysts/ bullae were seen in 50 (7.7%) patients with maximum number i.e., 19 (16.3 %) patients in group C followed by 11 (6.9%) patients and 19 (5.3%) patients in group B and group A, respectively. There was a significant (p=0.04) association of interval development of lung cysts among the groups. The pulmonary cystic changes in post COVID might be secondary to ischemic parenchymal damage, lung fibrosis and low lung compliance suggesting chronic complication of the disease. Another explanation is blockage of the bronchioles by mucus and mucus plugs followed by the overinflation of the alveoli and resultant rupturing of the alveolar septum with subsequent formation of small cysts. The findings of the present study are in accordance with the study done by Gurumurthy B et al[16]who found the above-mentioned changes in 9% patients.

In our study, pneumothorax was present in 42 (6.6%) patients on follow up HRCT scan. Out of 42 patients, 33 (9.3%) patients were in Group A, 7 (4.2%) in Group B and 3 (2%) in Group C. Also, pneumomediastinum was found in 55 (8.5%) patients on follow up HRCT. Out of these, 48 (13.3%) patients were in Group A, 5 (2.8%) in Group B and 3 (2%) in Group C. The association of pneumothorax and pneumomediastinum among the groups was significant (p=0.04). The presumed pathophysiological mechanism is diffuse alveolar damage and alveolar rupture, leading to interstitial emphysema and air tracking along the bronchoalveolar sheath to the mediastinum Pneumothorax and pneumomediastinum. It represents acute complications that could be due to an underlying disease process or barotrauma or iatrogenic injury as a result of mechanical ventilation. Cavitation further increases the chances of

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developing pneumothorax and pneumomediastinum. While the study done by Udwadia et al[17]found pneumothorax was present in 3.2% patients which is low as compared to our study. The study conducted by Lemmers et alfound pneumomediastinum in 13.6% of patients which is concordance with our finding in group A patients.

In our study, we found pleural effusion only in 95 (14.7%) patients. On follow up CT scans, mild pleural effusion was present in 81 (12.5%) patients followed by moderate effusion in 12 (1.8%) patients and gross in 2 (0.4%) patients. Thus, pleural effusion was most commonly seen in 64 (18%) patients of group A with decreasing incidence in further groups. This can be attributed as a response to the disease process and reactionary accumulation of fluid in pleural cavities. The study conducted by X. Han et al[7]showed pleural effusion was present in 8.8% of patients which is less as compared to our study.

In our study, pleural thickening was seen in 31 (4.7%) patients with maximum number i.e., 9 (7.6 %) patients in group C followed by 11 (6.9%) patients and 10 (3.3%) patients in group B and group A, respectively. Thus, predominant involvement of group C patients represents chronic nature of pleural thickening as an underlying adjacent lung disease. There was no significant ($p=0.30$) association between evolution of pleural thickening among the groups with respect to time interval. The proportion of pleural thickening in this study is less as compared to study by Cui et al[18] in which 26.0 % of patients had adjacent pleura thickening on CT.

In our study cavitation was seen in 70 (10.8%) patients with maximum number i.e., 27 (15.3 %) patients in group B followed by 34 (9.4%) patients and 9 (8.1%) patients in group A and group C, respectively. Pulmonary cavities are gas-filled spaces within parenchyma usually associated with adjacent consolidation. The possible cause for developing such cavitation post-COVID could be multifactorial, with contributing factors include: bacterial and fungal co-infection, hypercoagulability, altered immunity secondary to immunosuppressive effects of glucocorticoids and antiviral therapy and COVID specific inflammatory pathways. However, study conducted by Kurys-denis et al[19] found lung cavitation in 3.37% patients.

In our study, emphysema was found in 27 (4%) patients with maximum number i.e., 19 (11.9%) patients in group B followed by 5 (4.1%) patients and 2 (0.6%) patients in group C and group A, respectively. Emphysema represents abnormally enlarged air spaces distal to terminal bronchioles due to the destruction of alveolar walls without frank signs of fibrosis. Prevalence of these complications occurred more frequently among group B and group C suggesting chronicity of complications. However, study conducted by Balbi et al[20] found emphysema in 9% patients on follow up scan which is more as compared to our study.

In our study, empyema and tiny lung nodules both were seen in 2 patients (0.3%) only in group A. However, no patients with such findings were seen in group B and group C. This is in accordance with the study by Gurumurthy B et al[16], in which 0.3% patients had empyema and 0.4% patients shows nodules.

In our study, mosaic attenuation was found in 14 (2.1%) patients with maximum number i.e., 7 (6.1%) patients in group C followed by 5 (1.3%) and 2 (1.2%) patients in group B and group A, respectively. Air trapping in patients recovering from COVID-19 may results into mosaic attenuation pattern. Hochhegger et al[21] found mosaic attenuation in 1 patient on follow up CT scan.

In present study, initial CTSS score acts as a predictor for developing chronic fibrotic changes. Evolution of parenchymal bands and bronchiectasis shows significant association ($p<0.05$) with the initial CTSS. Severe CTSS tends to develop these complications more likely. Therefore, a greater extent of lung injury in the acute phase may be associated with a higher mortality rate and more severe pulmonary sequelae in survivors. This is in concordance with the study of Xiaoyu Han et al[7]who found that a higher CT score (≥ 18) at

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the initial CT examination was an independent prognostic factor for the presence of fibrotic-like changes at the 6-month follow-up examination.

Conclusion

Despite the increasing number of recoveries from COVID-19, there remain concerns about the long-term consequences following the initial illness.This may have resulted into substantial morbidity in survivors. HRCT chest plays an important role in determining the spectrum of findings in post COVID-19 patients, monitoring the progression and regression of the disease and initial CTSS aid as a predictor of evolving pulmonary changes in post COVID patients. The HRCT lesions could be absorbed without any sequelae in many patients with COVID-19 but residual radiographic abnormalities were observed in a large proportion of COVID-19 survivors. Through our study, we conclude that the HRCT evaluation of pulmonary changes provides excellent aid in comprehensive understanding of the longitudinal lung changes in COVID-19 patients during the acute and convalescent periods, which could help in providing early diagnosis, prediction and rehabilitation of post COVID syndrome. We recommend that further studies should be performed to determine whether these chest CT findings found 1 year after the COVID-19 infection are associated with a permanent loss of lung function.

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