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# Role of chest computed tomography and chest x-rays in covid-19 patients and correlation with clinical and laboratory findings

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**Abstract**
Present study is an observational retrospective, cross sectional study based upon 200 hospitalized patients in Heritage Institute of Medical Sciences. The purpose of our study was to evaluate the performance of chest CT and X-Rays in the diagnosis and severity of Covid-19, to assess the different findings in chest CT and X-Rays, calculate the CT severity scores and evaluate the common and uncommon findings on CT. Our objective was to correlate the CT score (mild, moderate and severe) with laboratory parameters (especially RT-PCR, CRP,D-dimer,IL-6,Serum Ferritin) and clinical severity of disease. We wanted to compare the sensitivity of HRCT chest and RT-PCR in diagnosing Covid-19 infections. HRCT chest findings were positive in all patients with GGO, consolidation, crazy paving, thickened interlobular septa the most common findings. X-Ray chest was positive in 50% with mild disease and 70%patients with progressive disease with GGO being the commonest finding. The laboratory parameters including CRP,D-dimer,IL-6,S.Ferritin) showed significant increase with increasing CT scores and clinical worsening. Main clinical presentation was dry cough, sore throat,dyspnea&fever. Literature supported our findings in majority of cases.
**Keywords:** COVID-19,High Resolution Computed Tomography(HRCT) Chest, X-Ray Chest, ground glass opacities, consolidation, laboratory tests.

## Introduction

Corona Virus Disease-19(COVID-19) is an viral pandemic that started in December 2019 in Wuhan, China and has spread worldwide. Total number of confirmed cases are more than 492,189,439 with 6,159,474 cumulative deaths. We had a very severe second wave of Covid -19 in India in April to June 2021. Covid-19 is caused by an RNA virus, SARS CoV-2(Severe Acute Respiratory Syndrome Corona Virus2).The virus infects the upper respiratory tract and has human to human transmission.Covid-19 was declared a pandemic by World Health Organization on 11th March,2020.

Typical clinical features include fever, cough and dyspnea with an incubation period of 2-14 days. The gold standard test is RT-PCR (Reverse Transcriptase Polymerase Chain Reaction).CT chest is useful for diagnosing and assessing complications of Covid-19.It provides information on the degree of lung parenchymal involvement .Clinical and laboratory findings together with CT chest findings are extremely useful in grading the level of patho physiological derangements in Covid-19.

## Material and methods

### Ethical Approval

Our research began after approval from Institutional Ethics Committee.Procedures followed were in accordance with the ethical standards of the Institutional Committee.

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### Study Design
Retrospective/ cross sectional
### Study type
Observational
### Setting
Hospital setting involving departments of Radio-Diagnosis, General Medicine, Clinical laboratory and Microbiology in Heritage Institute of
Medical Sciences, Varanasi.
### Age group and gender
All age groups and both genders with confirmed Covid -19 infection.

### Inclusion Criterion
Hospitalized patients with confirmed Covid -19 infection.

### Exclusion Criterion
Patients with non Covid pneumonia.

### Sample size
200 patients admitted in Heritage Institute of Medical Sciences between the period of April 2021 to June 2021.

### Investigations
CT was done on High Resolution Philips 16 Slice CT Machine & X-Rays on 100mA Portable Siemens Machine.RT-PCR done on TruLab-quattro machine (Close system)and Biorad CFX-96 Real time system (Open system). Rest of the blood tests were done on MAGLUM-800 machine.

### Patient Consent
Not applicable.

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**CT structured reporting and retrospective analysis**
Severity score was calculated by visual assessment. Percentages of each of the five lobes involved were calculated.

**CT involvement score**

| Percentage(%) | Score |
|---|---|
| 0 % | 0 |
| <5 % | 1 |
| 5-25% | 2 |
| 26-49 % | 3 |
| 50-75 % | 4 |
| >75 % | 5 |

Total =25
CT score taken as a total of individual lobar scores and can range from 0 (no involvement) to 25 (maximum involvement).

| Score | CT Severity |
|---|---|
| 0-08 | Mild |
| 9-15 | Moderate |
| >15 | Severe |

**Common CT findings**
**GGO**
Seen on CT as hazy areas of increased attenuation with preserved bronchovascular markings and represent partial filling of airways.
**Consolidation**
Seen as increased pulmonary parenchymal attenuation with obliterated bronchovascular markings.

**Crazy Paving**
Defined as GGO combined with interlobular septal thickening.

**Statistical analysis**
The statistical analysis was performed using the SPSS 24.0 software. Measurement data with normal distribution are expressed as mean +_standard deviation [mean+_SD]. Numeration data was analyzed by Fisher Exact test. Correlation was analyzed by Spearman correlation analysis. A P-value below 0.05 was considered statistically significant.

**Results**
In this study total 200 (Covid 19 proven)patients were included.

**Table 1**: **Table Of Gender**

| Gender | Patients | Percentage |
|---|---|---|
| Male | 118 | 59% |
| Female | 82 | 41% |
| Total | 200 | 100% |

Our study group consisted of 118 male patients (59%) and 82 female patients(41%).Mean age of the patients was 58.17+_13.463 years.

**Table2**: **Table Of Infection Rate**

| CT Severity Score | No of patients | Percentage |
|---|---|---|
| MILD (00-08) | 16 | 8% |
| MODERATE (09-15) | 82 | 41% |
| SEVERE (16 & ABOVE) | 102 | 51% |
| TOTAL | 200 | 100% |

16 patients (8%)were in mild category (as per CT severity score).41%(82 patients)in moderate and 51%(102patients) in severe category.

**Table3**: **Table Of Mortality**

| | No of Patients | Percentage |
|---|---|---|
| DISCHARGE | 186 | 93% |
| DEATH | 14 | 7% |
| TOTAL | 200 | 100% |

93%patients were discharged from hospital whereas mortality was 7%.

The mean duration of hospitalization was 14.12+-3.838 days with median of 14 days. Most common symptoms were identified as dry cough (48%)followed by sore throat (47%), dyspnea (45%),fever(38%),weakness(17%) &myalgia(11%).

**TABLE 4: CT findings in covid-19**

| | |
|---|---|
| Ground Glass Opacity | 89% |
| Consolidation | 65% |
| Crazy paving | 62% |
| Interlobular septal thickening | 60% |
| Dilated vessels | 52% |
| Bronchiectasis | 51% |
| Halo sign | 32% |
| Fibrosis | 32% |
| Sub pleural bands | 25% |
| Cystic changes | 12% |
| Pleural effusion | 10% |
| Mediastinal lymphnodes | 10% |
| Pneumomediastinum | 09% |
| Pleural thickening | 06% |
| Centrilobular nodules | 06% |
| Tree in bud | 02% |
| Cavity formation | 02% |
| Pericardial effusion | 02% |
| Pneumothorax | 02% |
| Subcutaneous emphysema | 02% |

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HRCT chest findings were present in all cases.The most common finding on CT was GGO(89%) (Fig.1) followed by consolidation(65%) (Fig. 2),crazy paving(62%) (Fig. 3),interlobular septal thickening(60%) (Fig. 5),dilated vessels(52%) (Fig. 4), bronchiectasis(51%) (Fig. 6), fibrosis (32%) (Fig. 6),subpleural bands (25%) (Fig. 5) & pneumomediastinum (9%) (Fig. 7, 11).
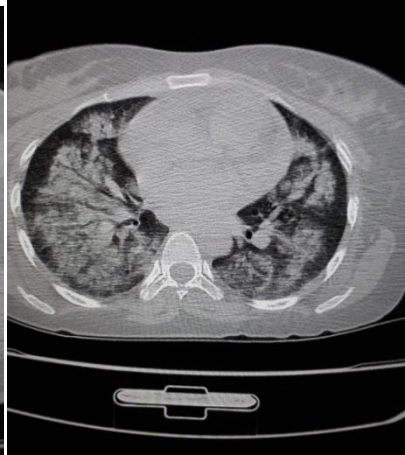


**Fig. 1 Ground Glass Opacity**          **Fig. 2Consolidation**          **Fig. 3Crazy paving with cystic changes**



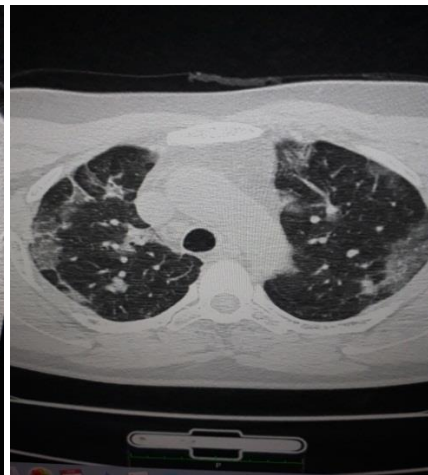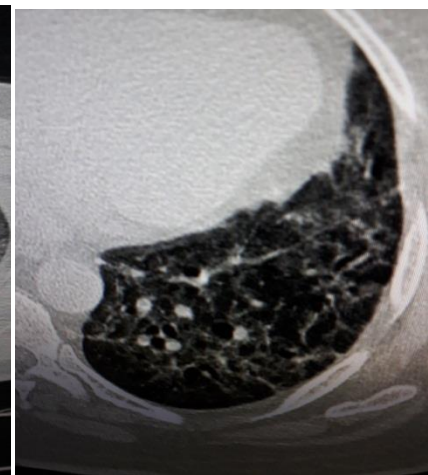**Fig. 4Dilated Vessels**          **Fig. 5Interlobular Septal with subpleural & Bronchiectasis bands.**          **Fig. 6Fibrosis with Nodules Thickening**
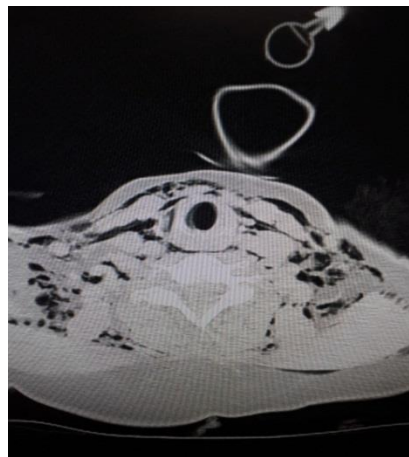


**Fig 7 Subcutaneous Emphysema with Pneumomediastinum**

**X-ray chest findings**

Positive findings noted in 50%patients in early stage with positivity of 70%in progressive stage. Most common findingswere GGO(60%) (Fig. 8) followed by consolidation(40%) (Fig.9),septal thickening(30%). Pleural effusion(10%) bronchiectasis(6%),pneumomediastinum(5%) (Figs.

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10,11) and subcutaneous emphysema(4%).Distribution of pathology in X-Ray was bilateral in 72%patients,peripheral in 60%,unilateral in 28% withperipheral and central distribution in 15% cases.



**Fig. 8 Ground Glass Opacity**          **Fig. 9Consolidation**



**Fig. 10**                          **Fig. 11**
**X-Ray Chest & CT Chest in same patient with pneumomediastinum**
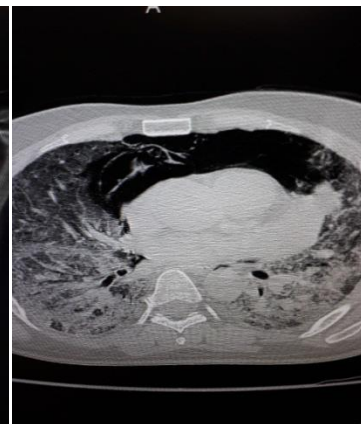
**Table 5: Lung lobes involvement**

| Right lower lobe | 96% |
|---|---|
| Left lower lobe | 95% |
| Right upper lobe | 85% |
| Left upper lobe | 84% |
| Right middle lobe | 78% |

Right lower lobe was most commonly affected(96%) followed by left lower lobe(95%),right upper lobe (85%),left upper lobe(84%)and right middle lobe(78%). Distribution of CT Chest findings was mainly bilateral(89%)and peripheral(64%).

**Table 6: Vitals and lab parameters with respect to ct severity score**

| | CTSS < 15 N = 100 | | CTSS > 15 N = 100 | | P Value |
|---|---|---|---|---|---|
| | Mean ± SD | Median (IQR) | Mean ± SD | Median (IQR) | 0.126 |
| Fever (°C) | 36.8 ± 0.58 | 36.7 (36.4 – 37.2) | 37+0.81 | 36.7 (36.8-37.4) | 0.003 |
| Rate ( per minute ) | 24 ± 7 | 24(18-24) | 26±8 | 29 (20-32 | 0.001 |
| SPO₂% | 94.88±1.92 | 94(93-98) | 90±2.4 | 91 (878-92) | 0.426 |
| Systolic BP (in mm of Hg) | 119.±14.2 | 120 (110-120) | 128±17.8 | 128 (117.2-140) | 0328 |
| DiastolicBP (in mm of Hg) | 76.2± 8.4 | 77(70-80) | 76.8±12.7 | 80(70-88) | 0.314 |
| WBC Count( | 8.2±3.2 | 8.0(7.2-10) | .7.04±2.96 | 5.82(4.2-8.5) | 0.062 |

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| | | | | | |
|---|---|---|---|---|---|
| Haemoglobin (g per dl) | 13.2±3.8 | 13.8(12-15) | 11.2±2.31 | 12.4(12-14.9) | 0.082 |
| Neutrophil % | 60.74±14.9 | 60(51-66.2) | 64.93±18.2 | 64.65(54.8-74.6) | 0.034 |
| NLR | 3.02±3.24 | 2.3 (1.4-2.8) | 1.52±0.82 | 1-72(0.90-1.8) | 0.234 |
| Lymphocyte % | 28.25±12.4 | 31.2 (18.6-34.8) | 25.8± 12.62 | 27.2(17.2-34) | 0.234 |
| Platelet Count | 250±80.7 | 230(200-238) | 217±76.2 | 210(158-270) | 0.001 |
| CRP mg/L | 34.2±24.3 | 10.2(9.2-12.2) | 52±51.11 | 48 (4.5-72.3) | 0.001 |
| D-dimer ng/ml | 340±212 | 248(52-317) | 494±551 | 390(100-580) | 0.001 |
| Ferritin microgram/L | 248±180 | 298(72-300) | -840±729.43 | 462 (100-1200) | 0.001 |
| IL-6 pg/ml | 12±22 | 21 (4-18) | 34±32 | 32(10-40) | 0.001 |
| Hospital stay(days) | 8±5 | 10 (3-14) | 15±7.2 | 14(10-20) | 0.011 |

This table shows the clinical symptoms (fever, spo2, respiratory rate) as well as laboratory parameters as per CT severity score in which significant correlation were depicted as their P valuesderived from Mann-Whitney Score.

**Table 7: Table Of Increased CRP value**

| Covid-19 pneumonia | CRP-VALUE | |
|---|---|---|
| | Normal | Increased |
| Mild | 06 (75%) | 10 (5.20%) |
| Moderate | 02 (25%) | 80 (41.66%) |
| Severe | 00 | 102 (53.14%) |
| Total | 08 (100%) | 192 (100%) |

CRP values are characteristically increased with respect to severity of disease. 53.14% of all 192 patients who had raised CRP values were severely affected.

**Table 8: Table Of Increased D-dimer**

| Covid-19 pneumonia | D-DIMER VALUE | |
|---|---|---|
| | Normal | Increased |
| Mild | 14 (70%) | 02 1.11%) |
| Moderate | 06 (30%) | 76 (42.22%) |
| Severe | 00 | 102 (56.66%) |
| Total | 20 (100%) | 180 (100%) |

D-dimer values are characteristically increased with respect to severity of disease. 56.66% of all 180 patients who had raised D-dimer were severely affected.

**Table9: Relationship Between Ct Scan Value, CRP and D-DIMER**

| Infection as per CT scan value | CRP- VALUE | | D-DIMER VALUE | |
|---|---|---|---|---|
| | Normal | Increased | Normal | Increased |
| Mild | 06 (75%) | 10 (5.20%) | 14 (70%) | 02 (1.11%) |
| Moderate | 02 (25%) | 80 (41.66%) | 6 (30%) | 76 (42.22%) |
| Severe | 00 | 102 (53.14%) | 0 | 102 (56.66%) |
| Total | 08 (100%) | 192 (100%) | 20 (100%) | 180 (100%) |
| | $X^2$=19.575, P-value = 0.001 | | $X^2$=34.278, P-value = 0.001 | |

Mean CT scan values at admission was 15.48 ± 4.648, mean CRP value was 130.91±49.901 and mean D-Dimer value was 877.13 ± 300.286. The above table shows relationship between CT scan value, CRP and D-dimer. It was clearly evident that CRP value and D-dimer values increases significantly in moderate and severe Covid infections ($\chi^2$=19.575, $\chi^2$=34.278 respectively, P-value = 0.001)

**Table 10: Correlation Between Ct Value, CRP Value And D-Dimer Value At Admission**
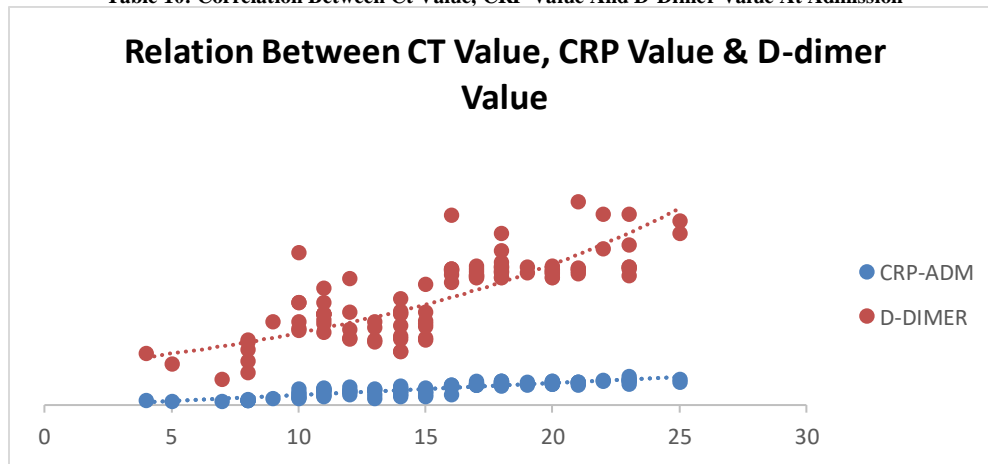


As per the values observed CRP and D-dimer correlated with CT value as per the severity of disease.

In our study, 4 patients with initial mild clinical disease had negative RT-PCR (which turned positive with progressive disease) but had positive CT chest findings in initial stages.

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**Discussion**

Our study is a retrospective cross sectional study with correlation of CT Chest findings, laboratory parameters & clinical findings in 200 patients with diagnosed Covid-19 infection indicating inflammatory response and organ damage. Extension of parenchymal lesions was associated with impaired gas exchange and hypoxemia of affected lung with diffuse alveolar damage and interstitial edema[1]. Hence the association between oxygen saturation (SPO2 and Respiratory Rate) with CT Severity Scores is to be expected.(Table 6).

In a study, sensitivity for chest CT for Covid-19 pneumonia was 91%, whereas RT-PCR had 60% sensitivity 2].In our study 4 patients had negative RT-PCR initially but they had positive CT findings.

CT has a pivotal role for diagnosis and monitoring patients with Covid-19 Pneumonia. CT scans performed were retrospectively reviewed and reproducibility & CT visual scoring was high. In our study GGO was the commonest finding on CT with peripheral location (89%) The other common findings were consolidation (65%) crazy paving (62%), interlobular septal thickening (60%). Bilateral Involvement of lung & right lower lobe involvement most commonly seen (table 5) as in other published study[6].

The Multifocal affection was characteristic of Covid-19 pneumonia with multiple GGO and consolidation patches scattered in involved lobes. This feature helps to diagnose Covid-19 pneumonia from bacterial pneumonia. Characteristics lesions that were predominant on CT and X-Ray's were consistent with that published in Literature[3,4].

Previous study shows most patients have increased CRP and D-dimer levels[5].In our study, increased D-dimer, CRP, IL-6, S-Ferritin were significantly associated with severe disease and corresponding high CT Severity score.(Table 7, 8, 9).

We observed that the extent of lung parenchymal involvement was associated with raised inflammatory response, as suggested by increased circulating inflammatory markers, neutrophil to lymphocyte ratios, Increased CRP concentration. It has been demonstrated that high levels of IL-6 are increased during SARS- CoV-2 infection playing an immunopathologic role causing its over production (so called cytokine storm)[7].

.The lung itself could be the primary site of production of some proinflammatory mediators [8].As to qualitative CT findings, consolidation was independently associated with Increased CRP levels confirming findings of previous study (Table8)[9, 10].

As far as D-dimer is concerned Covid-19 coagulopathy shares similarities with diffuse intravascular coagulation associated with in fibrinolytic activity[11].(Table9).

Finally regarding the other lab parameters like CBC (Complete Blood Count), Haemoglobin, Neutrophil Count, Lymphocyte Count, Serum Creatinine our data failed to demonstrate any significant correlation, though in other published literature there has been an association between measured neutrophil count and progressive reduction in circulating lymphocytes which correlated with clinical severity of Covid-19[12].

Our data is concordant with the most frequent & consistent changes previously reported in association with worsening lung involvement, CT severity, increased CRP, D-dimer, IL-6 and S.Ferritin as well as low saturation levels & length of hospital stay.

In addition we were able to include laboratory tests less frequently reported such as WBC, Hb & Neutrophil Count.We distinguished between patterns and extension of lung involvement with qualitative CT findings (For eg. GGO and consolidation).

Main limitation of this study was we did not have large samples for analysis of some lab tests (eg. Prothrombin Time, Total Bilurubin & LDH). We lacked to include some other sepsis markers like procalcitonin in our study.However CT findings were well related to disease extension and in association with laboratory parameters & imaging findings to know the amount of parenchymal involvement.

**Summary and conclusion**

This is a retrospective study based on 200 patients with COVID-19 infection. Lung parenchymal infectionswere evaluated by HRCT Chest and Chest X-Rays and correlated with clinical and laboratory findings. Commonly seen CT findings were GGO, crazy paving and consolidation with X-Rays used in follow up.  Increased clinical severity of disease was directly proportional to CT scores and increased inflammatory markers (especially CRP, D-dimer). To conclude, HRCT Chest together with X-Rays,laboratory parameters are excellent in diagnosing the severity of COVID-19 infection.

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