Original Research Article

Evaluation of HRCT chest features in COVID 19 patients with pre-existing comorbidity and clinical correlation

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Abstract

Background: High resolution CT scan of chest has a major role in diagnosis and prognosis of COVID 19 patients. This study attempts to assess the pattern and severityof theCT chest manifestations in COVID patients with pre-existing comorbidity as compared to those without comorbidity. **Methods:**This is a retrospective study. HRCT findings of 572 COVID19 pneumonia patients in the period for 5 months were analysed. And the medical record of the same patients was searched for the presence of any pre-existing comorbidity.The CT severity score and the CT pattern of the two groups of patients (those with comorbidity and those without comorbidity) were compared to find out the severity of HRCT chest manifestation in patients with comorbidity.**Results:** Among them 513 patients were male. The age group in the studied population range between 2-87 years with mean age 38.75 years. Out of 572 patients 22.5% (n- 129) patients had pre-existing comorbidity.Out of 129 patients in the comorbidity group majority (66.6%) showedpositive findings in high resolution CT of chest, but out of 443 patients in the non-comorbidgroup majority (46.8%) had negativechest findings. Severe CT severity score(>15/25) was found in 33.3% of patients with comorbidity while in 2.5% of cases without comorbidity. There was a strong correlation between the clinical and CT severity score.

Conclusion: Larger percentage of Covid patients with comorbidity showed positive chest findings in high resolution CT of chest. And the severe (>15/25) CT severity scorewas seen in increased proportion of Covid patients with comorbidity as compared to those without comorbidity.

Keywords: HRCT chest, Covid19, CT severity score, Clinical severity score, Comorbidity

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Introduction

COVID 19 (corona virus disease) is a rapidly spreading, contagious infection caused by novel corona virus predominantly affecting the respiratory system. It has become a global pandemic[1].There are various research works being done presently all over the world for understanding the pathogenesis, clinical, biochemical, radiological manifestations of the disease, so that proper management can be achieved. Patients suffering from COVID19 having pre-existing comorbidities or of elderly age group have shown worse prognosis [2]. CT has high accuracy for the diagnosis of COVID 19 by revealing the features of viral pneumonia and hence helpful in early diagnosis and proper patient management and follow up[3].In this study we wanted to focus on the HRCT chest findings of COVID 19 patients with pre-existing comorbidities. X-ray of chest appears to be less sensitive and specific as compared to CT scan in COVID 19 patients because of the better spatial resolution of the CT scan.

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Methods

This is a retrospective study. Our institutional review board approved this retrospective study. Informed consent was waived as the study involved no potential risk to patients.

Patients: The HRCT findings of 572 COVID19 pneumonia patients in the period from 1st May 2020 to 1st September 2020 were analysed. And the medical record of the same patients was searched for the presence of any pre-existing comorbidity. The comorbidities taken into account in this study were systemic diseases which include pulmonary diseases like pulmonary tuberculosis (PTB), asthma and non-pulmonary diseases like diabetes mellitus (DM), hypertension (HTN), chronic kidney disease (CKD), cardiac diseases, stroke. The CT severity score and the CT pattern of the two groups of patients (those with comorbidity and those without comorbidity) were compared to find out the severity of HRCT chest manifestation in patients with comorbidity.

Chest CT examination: All the CT scans were done within 48 hrs of admission of patient by a newly installed dedicated 64 slices Siemens 'Soma tomgo. UP' CT scanner with SAFIRE technology. High resolution CT (HRCT) thorax scan were done and slice thickness of 1mm, reconstructed to 0.5 mm. kV and mAs used were 130 and 100 respectively. All the examinations were conducted with the patients in a supine position under single breath-hold at the end of

inspiration. The CT images were reconstructed using iterative reconstruction with a matrix size of 512x512.

Chest CT evaluation: The CT images were reviewed independently by two experienced radiologists with 8 years of experience and the final decision was made by consensus. The following CT characteristics were recorded: 1) The presence of lesion in terms of Fleischer Society: Glossary of Terms for Thoracic Imaging[4] such as ground-glass opacities (GGO), consolidation, linear opacities, pulmonary nodules, crazy paving, reverse halo. 2) The distribution of lesions in terms of upper, lower or middle lobe, unilateral/ bilateral, peripheral or central. 3) presence of underlying lung disease such as emphysema, fibrosis, and calcification. 4) presence of other abnormalities, including pleural effusion, pericardial effusion, and thoracic lymphadenopathy.GGO was defined as hazy increased lung density, with indistinct margins of bronchus and pulmonary vessels. Consolidation was defined as increased pulmonary parenchymal attenuation, with the margins of the bronchus and the pulmonary vessels being obscured. Crazy-paving pattern was defined as GGO combined with reticulation or/and interlobular septal thickening. Thoracic lymphadenopathy was defined as the short-axis dimension of lymph node ≥10 mm.

CT severity scoring[5]based on the percentages of each of the five lobes involved:

1. < 5% involvement
2. 5%-25% involvement
3. 26%-49% involvement
4. 50%-75% involvement
5. > 75% involvements.

The total CT score was the sum of the individual lobar scores and can range from 0 (no involvement) to 25 (maximum involvement), when all the five lobes showed more than 75% involvement. It was divided into mild (0-7), moderate (8-15), severe (16-25).

The pattern of CT changes were broadly divided into four types according to the **RSNA Expert Consensus[6]:**

1.Typical: - Peripheral, bilateral (multilobar) GGO or multifocal GGO of rounded morphology w/ or w/o consolidation or visible intralobular lines (crazy paving)
- Reverse halo sign or other findings of organising pneumonia.

2. Indeterminate: Absence of typical features and the presence of
- Multifocal, diffuse, perihilar or unilateral GGO w/ or w/o consolidation and are non-rounded or non-peripheral.
- Few very small GGO with a non-rounded& non peripheral distribution.

3. Atypical: Absence of typical or indeterminate features and presence of
- Isolated lobar or segmental distribution w/o GGO.
- Discrete small nodules (centrilobular, tree in bud).
- Lung cavitation.
- Smooth interlobular septal thickening w/ pleural effusion

4. Negative: No CT features to suggest pneumonia

Table 1: Clinical severity score was analysed according to Ministry of Health and Family Welfare, Government of India.

Clinical severity	Symptoms/signs	Clinical parameters
Mild	Mild symptoms of URTI	O2 saturation : (95 – 100%)
Moderate	Pneumonia RR >24/min	O2 saturation: (90 – 94%)
Severe	Pneumonia/ARDS/sepsis/shock RR > 30/min	O2 saturation: (< 90%)

Statistical analysis: Analyses were done with Stata 15.1, Statacorp, Texas software.Normally distributed data were presented as mean , and categorical variables as frequency (%)**.** The categorical variables were compared using the Chi Square test to find the association. The correlation between the categorical data was done and the correlation coefficient was calculated.The association is considered statistically significant at p≤0.05.

Results:

Patient characteristics: Total 572 COVID 19 positive patients who were admitted to Odisha COVID Hospital, KIMS included in this study. All these patients had undergone HRCT chest. Among these 513 (89%) patients were male and 58 (10%) patients were female. The age group range between 2 to 87 years. Of all the patients 67 (12%) of patients were of more than 60 years' age group.Pre-existing comorbidity was found in 22.5% (n-129) patients which included diabetes mellitus (DM) (n-98), hypertension (HTN) (n-32), asthma(n-13), chronic kidney disease (CKD) (n-8), pulmonary tuberculosis (PTB) (n-7), cardiac disease (n-5), others including stroke, hypothyroidism (n-5). Diabetes mellitus being the most common pre-existing comorbidity. The distribution of comorbidities in the study population is shown in **figure-1**.

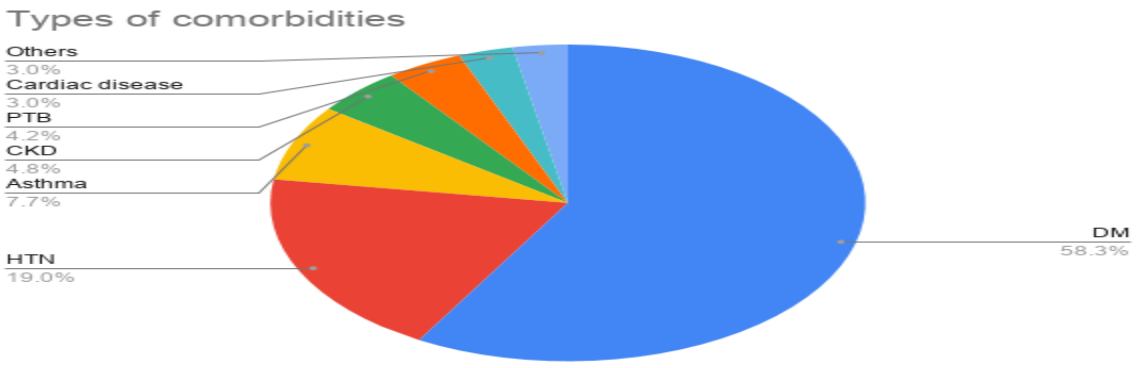

Fig 1: Distribution of comorbidities in Covid patients

Symptoms distribution:The symptoms ranged from asymptomatic (AS) (n-217), fever (n-202), cough (n-147), shortness of breath (SOB) (n- 118). It had been found that 89% of patients with comorbidity were symptomatic while 48 % of patients without comorbidity were symptomatic. Symptomatic patients were seen to be more in the comorbid group (P value < 0.0001).

Laboratory data:In our study the serum CRP level was raised above 10mg/l in 10% of COVID 19 patients without comorbidity while 42% of COVID 19 patients with comorbidity.

Pattern of HRCT chest manifestations:The pattern of HRCT chest findings was divided into four types, they were typical, indeterminate, atypical, negative. Among the patients with comorbidity the predominant CT pattern was typical seen in 66.6% cases. While in case of patients without comorbidity the predominant pattern was negative in 46.8% cases. The typical CT pattern was seen to be predominately associated with the comorbid group (P value < 0.0001).

Table 2: The percentage distribution of the CT patterns in the two groups of patients.

CT pattern	No. of patients with comorbidity	No. of patients without comorbidity
Typical	86 (66.6%)	106 (24%)
Indeterminate	11 (8.6%)	52 (11.8%)
Atypical	17 (13.2%)	78 (17.6%)
Negative	15 (11.6%)	207 (46.8%)
Total	129	443

The additional imaging findings were seen in atypical group of patients. However the clinical outcome was not found to be bad in these group of patients.

CT severity score:The CT severity score was calculated according to the percentage of lobar involvement and categorised into mild, moderate and severe. The group of patients with comorbidity, severe (>15/25) score was seen in 33.3% cases while in non-comorbid group in 2.5% of cases. The CT severity score of >15/25 was seen to be predominately associated comorbid group with p value < 0. 0001.

Table 3: Comparison of CT severity score in patients with comorbidity versus without comorbidity

CT severity score	No. of patients with comorbidity	No. of patients without comorbidity
Mild	60 (46.5%)	408 (92.1%)
Moderate	26 (20.2%)	24 (5.4%)
Severe	43 (33.3%)	11 (2.5%)
Total	129	443

The examples of chest findings graded as mild, moderate and severe by the CT severity score are shown in the **figure-2**.

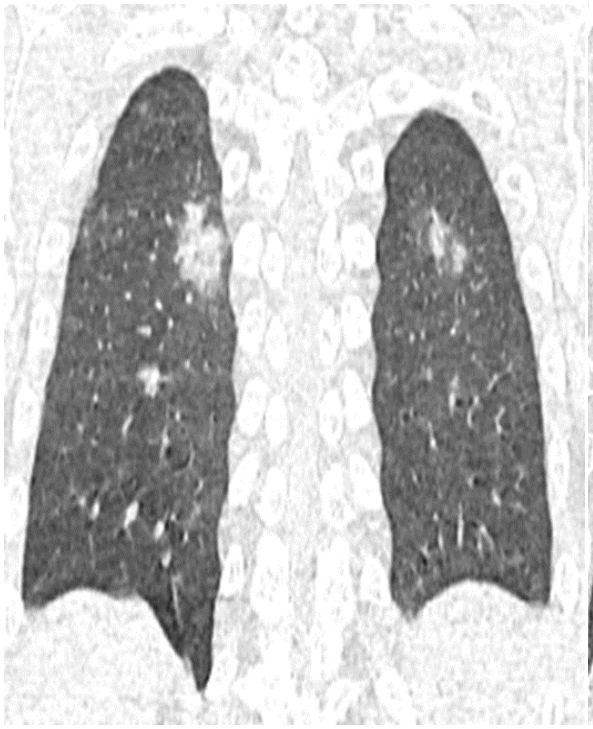

Fig 2(a): HRCT chest showing mild CT severity score (2/25); patchy ground glass opacity or consolidation involving <5% of parenchyma of B/L lower lobes (two lobes among five lobes affected).

Fig 2(b): HRCT chest showing moderate CT severity score (13/25); patchy ground glass opacity or consolidation involving 25-50% of parenchyma of four lobes and <5% of left upper lobe.

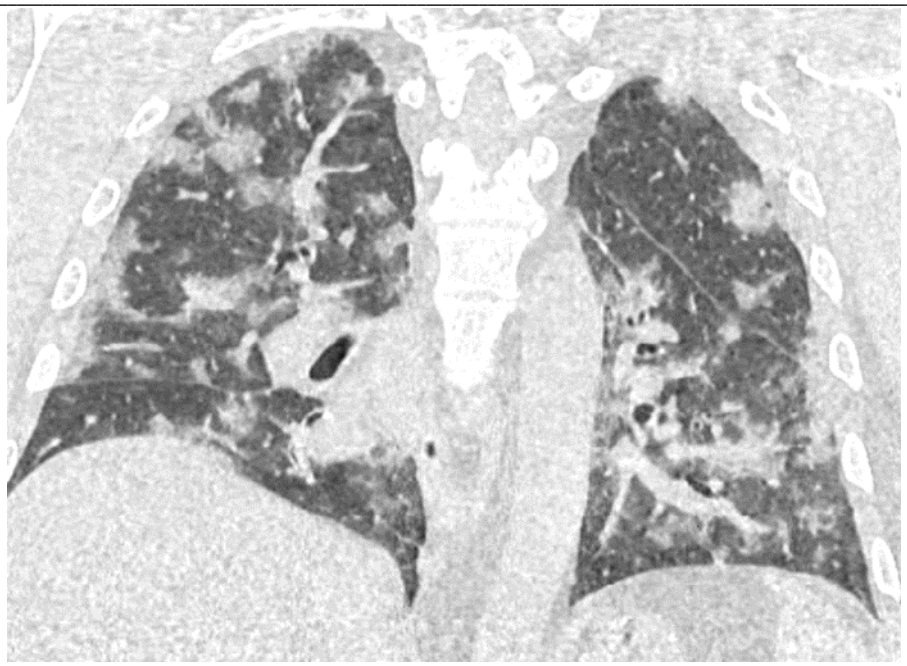

Fig 2(c): HRCT chest showing severe CT severity score (23/25); patchy ground glass opacity or consolidation involving > 75% of parenchyma of four lobes and 5-25% of right middle lobe

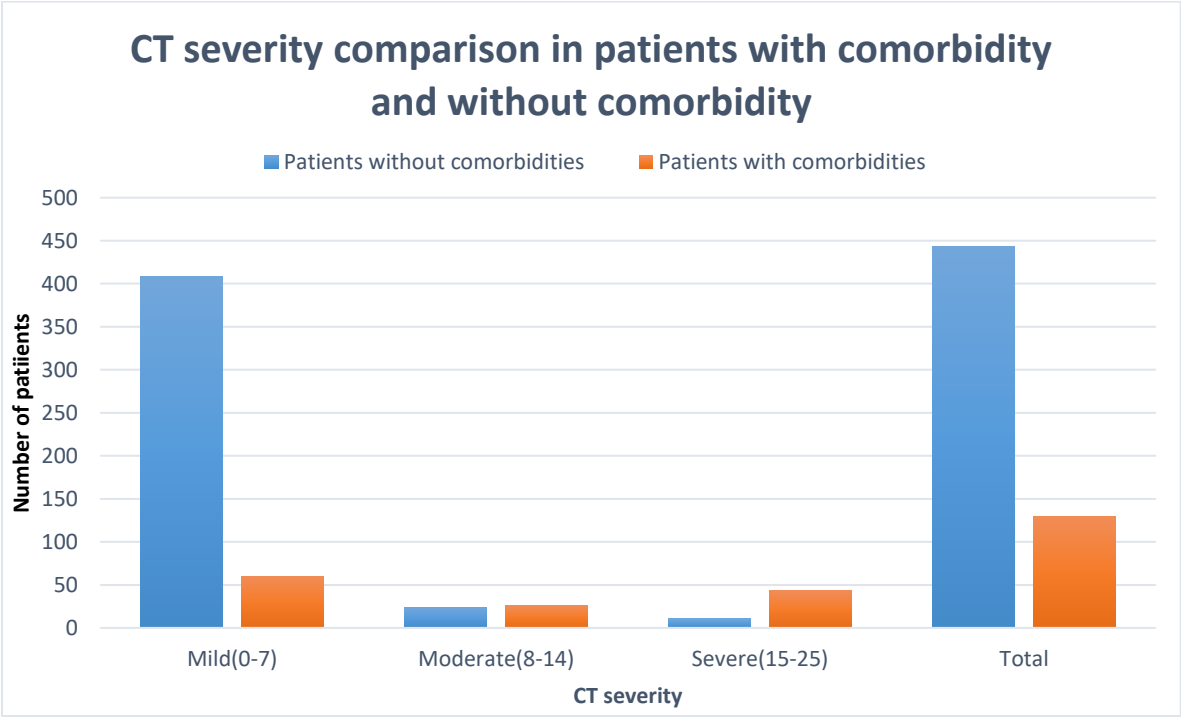

Fig 3:The comparison chart of the CT severity score in these two group of patients

Clinical severity score:The clinical severity score was calculated according to the guidelines of Ministry of health and Family welfare, Govt. of India and categorised into asymptomatic, mild, moderate, severe. The severe clinical severity score was seen to be predominately associated with comorbid group with p value < 0. 0001.

Table 4: The percentage distribution of clinical severity score .

Clinical severity score	No. of patients with comorbidity	No. of patients without comorbidity
Asymptomatic	16 (12.4%)	202 (45.6%)
Mild	62 (48.1%)	166 (37.5%)
Moderate	21 (16.3%)	57 (12.9%)
Severe	30 (23.3%)	18 (4.1%)
Total	129	443

Correlation between CT severity and clinical severity score:The correlation coefficient between the CT severity and clinical severity score of patients with comorbidity is found to be 0.93 and that of patients without comorbidity is found to be 0.99 suggestive of strong correlation

Comparison of CT severity score and clinical severity score in patients above and below 60 years of age:Among the studied population (n-572), 505 (88%) patients were below 60 years of age and 67 (12%) patients were above 60 years of age . It was found that moderate to severe CT severity score as well as clinical severity score associated predominantly with the older population with P value < 0.05.

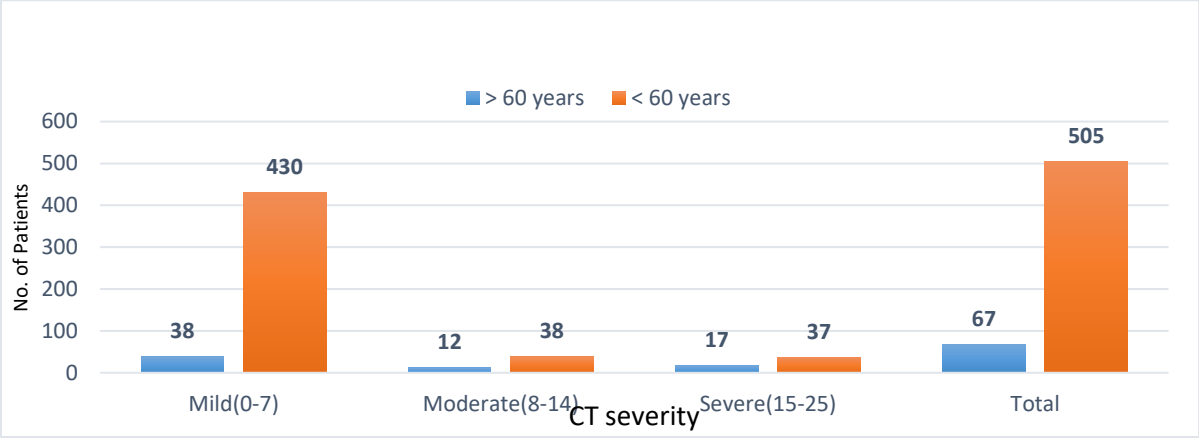

Fig 4:CT severity comparison in patients above and under 60 years

CT severity score as well as clinical severity score associated predominantly with the older population.Association of CT severity with outcome in terms of hospital stay and death:It was found in our study that out of 129 COVID patients with comorbidity, 14 (10%) patients died while out of 443 COVID 19 patients without comorbidity no death was seen.Among the patients who underwent death, the CT severity score varied from mild to severe without any definite predominance.The association between the number of days of hospital stay and the CT severity index of the two group of patients is given in Figure-5. However because of the hospital protocol to keep all the COVID patients for minimum 11 days, there is minimal difference in the duration of hospital stay of all the patients.

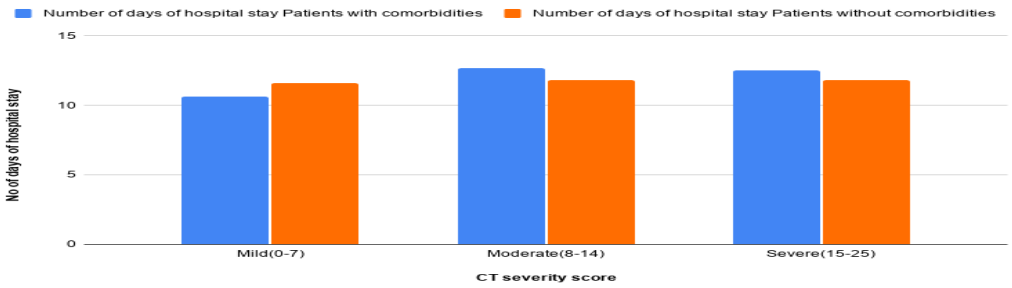

Fig 5:The association between the number of days of hospital stay and the CT severity index of the two group of patients

Discussion

In this study we analysed different parameters which included percentage of COVID 19 infected patients who had pre-existing comorbidity, the different types of comorbidities, the pattern of CT changes of chest of these group of patients and its comparison with those patients without comorbidity, the comparison of CT severity score in these two groups of patients. Finally, the correlation between the CT severity score and the clinical severity score was done to predict the clinical status of the patient by studying the CT scan.In this study total 572 COVID 19 patients were studied among which 513 patients (89%) were male. Previous studies have also shown the male predilection of the disease [7]. The age group in this study range from 2 to 87 years with mean age group 38.73 years.The symptoms ranged from asymptomatic (37%) to fever (35%), cough (25%), shortness of breath (20%). The most common symptom being fever. In the studies conducted by Lauren A Callender et al and Sudhir Bhandari et al, fever, cough, and dyspnoea were the most common symptoms which were lower respiratory tract symptoms.It had been found that 89% of patients with comorbidity were symptomatic while 48% of patients without comorbidity were symptomatic. Among the total studied population 22.5% of patients had pre-existing comorbidity which included diabetes mellitus,hypertension, asthma, chronic kidney disease, pulmonary tuberculosis,cardiac disease, others including stroke, hypothyroidism. Among these DM is the most common followed by hypertension comprising of 58.3% and 19.0% respectively. The various meta-analyses hadidentified

hypertension, cardiovascular diseases, COPD, diabetes, cancer, chronic kidney disease, chronic liver disease as the major comorbidities which increased the severity of covid infection.The impaired immunity due to hyperglycaemia and the chronic inflammatory state in case of diabetes lead to increased risk of development of cytokine storm and severe disease[10-13]. Hypertension also increases the risk of severe infection and mortality.Underlying pathogenesis of chronic kidney disease also subjects to hyper inflammation and cytokine storm resulting in severe disease[14-16].In this study the CRP level was increased in larger proportion of comorbid population as compared to non-comorbid population. Another study had revealed higher level of CRP in asymptomatic patients as compared to symptomatic patients[8]In our study the COVID patients with comorbidity showed most commonly the typical pattern of chest findings in 66.6% cases while atypical pattern (13.2%), indeterminate pattern (8.6%)in lesser percentage of cases. While the COVID 19 patients without comorbidity showed most commonly negative pattern of chest findings in 46.8% of cases. There is scarce literature regarding the pattern of CT chest findings in patients with comorbidity. However, study by Sudhir Bhandari et al had shown that majority of patients (69.23%) who had Typical COVID-19 findings in CT images were symptomatic while it was lower in those with indeterminate and atypical pattern of HRCT findings[9]In our study the percentage of severe CT severity score (>15/25) was seen in a significantly larger percentage of population with comorbidity (33.3%) as compared to the patients without comorbidity (2.5%).There is again scarce literature comparing the CT severity score of these two groups of patients. However, study by Sudhir Bhandari et al had shown that majority of patients who had CT severity index 16-20 (87.50%) were symptomatic.In this study the clinical severity in these two groups of COVID 19 patients was found out to be different with severe clinical score was found in 23.3 % of patients with comorbidity against 4.1% of patients without comorbidity. It was also found in this study that there was strong correlation between the CT severity score of chest and clinical severity of the patient. Study by Nan Zhang et al had found that higher CT scores were directly related to severe or critical illness. So, looking at the CT severity score the clinical severity of the patients can be judged.It was also found in this study that moderate to severe CT severity score as well as clinical severity score was associated predominantly with the older population with P value < 0.05.The death was seen in the comorbid group of COVID 19 patients in the studied population. No specific predominance of degree of CT severity index could be found in the death population.

The limitation of this study is that multiple CT chest of the same patients were not available for temporal correlation of the CT findings and clinical severity.Another limitation is the inability to demonstrate the clinical outcome in the two groups of patients in terms of number of days of hospital stay because of the fixed protocol of the hospital as mentioned.

Conclusion

The COVID 19 patients with pre-existing comorbidity have positive chest CT findings in majority of cases as compared to those without comorbidity. The predominant pattern of chest CT findings in patients with comorbidity wasTypical, while Indeterminate and Atypical in lesser proportion of cases. The severe chest CT severity score (> 15/25) was found in larger proportion of COVID 19 patients with pre-existing comorbidity as compared to the non-comorbid patients. Lastly as there was strong correlation between clinical and CT severity score, prediction of the clinical status could be done from the chest CT of the patient.

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