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Original Research Article

Radiological characteristics of COVID-19 patients and correlation of chest CT severity index with different clinical forms of disease in SKIMS medical college and hospital Kashmir, India

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ABSTRACT

Background: The objective of this paper was to study the radiological characteristics of COVID-19 patients and to establish a possible correlation of chest CT severity index (CTSI) with different clinical forms of disease.
Methods: All the patients who routinely underwent non contrast CT chest and tested positive for COVID-19 by RT-PCR of respiratory secretion obtained by broncho alveolar lavage and nasopharyngeal swab test had been included in the given study. The collected data was analyzed to find a possible correlation of chest CTSI with different clinical forms of disease.
Results: COVID-19 patients reflected some interesting radiological features like ground glass opacity (GGO) in (90.1%) followed by consolidation in (70.4%) patients. However, (67.6%) patients reflected both GGO and consolidation features. Peripheral distribution was most common in patients accounting for (90.1%) versus (60.6%) with central distribution but (60.6%) had both peripheral and central distribution. We observed that there is significant correlation (p value <0.001) between severity of disease as per oxygen saturation level and severity of disease on the basis of CTSI.
Conclusions: We concluded that COVID-19 pneumonia patients significantly exhibit some radiological features that include GGO and consolidation with peripheral and central distribution. Therefore in addition to other clinical parameters CT severity score can be treated as a reliable diagnostic tool to determine the severity status of disease.

Keywords: COVID-19, CT score index, Ground glass opacity, Consolidation, Peripheral and central distribution

INTRODUCTION

There is no doubt that healthcare providers face a great deal of challenge to deal with the newly emerged coronavirus disease which is commonly and famously abbreviated as COVID-19. This deadly novel disease has presently engulfed the whole world and has potentially shaken not only the human beings of all ages but also medical practitioners. Due to the excessive contagious competence and mutational behavior of the virus, it has become all the more difficult to contain it, however, some of the precautionary measures like social distancing, wearing of masks and maintenance of utmost hand sanitization has significantly resulted in decreasing the further spread of the virus. Coronavirus disease 2019 is highly fatal and infectious disease caused by severe acute respiratory syndrome virus (SARS-COV2). Its outbreak began in Wuhan, Huba Province in China in December 2019.[1] The common clinical symptoms of patients with COVID-19 vary from mild viral flu, respiratory tract and

abdominal symptoms, to ARDS (MERS-COV) and death.[2] Currently RT-PCR (severe transcriptase polymerase chain reaction) is considered reference standard for screening and diagnosis of COVID-19, however false negatives associated with RT-PCR, provide a clinical challenge and thus making imaging examination crucial.[3]

Aims and objectives

The aim and objective were to study the radiological characteristics of COVID-19 patients and correlation of chest CTSI with different clinical forms (severity) of disease in SKIMS medical college and hospital, Kashmir, India.

METHODS

This retrospective cross-sectional study has been conducted in the department of radiodiagnosis and medicine, SKIMS medical college and hospital, Kashmir, India from April 2020 to September 2020. All COVID-19 positive cases referred to the above mentioned department during the study period have been included in the sample.

Inclusion criteria

All those patients who routinely underwent non contrast CT chest and tested positive for COVID-19 by RT-PCR of respiratory secretion obtained by broncho alveolar lavage and nasopharyngeal swab test had been included in the given study.

Exclusion criteria

All the pregnant women and patients with previous chest disease like ILD, TB, bronchiectasis and COPD have been excluded in the given study.

Methodology

Basic clinical characteristics and imaging CT features have been evaluated and compared between various groups.

All CT examinations were done using a multi detector CT scan 16 slice CT scan (Somaton definition, Siemens Health care, Germany) and under proper infection control measures. Every CT scan have been evaluated for typical and atypical characteristics of COVID-19 pneumonia like presence of GGO, consolidation, axial distribution like peripheral and central location and number of lobes affected and degree of involvement of each lobe by means of total CTSI. The CTSI was defined by summing up 5 lobes scores (range from 0 to 25). Score of mild, moderate and severe CTSI were assigned (mild CTSI: 8/25), (moderate CTSI: (9-15)/25) and (severe CTSI: >15/25). Micro nodules, reverse halo sign, presence of crazy paving.[4-7] The clinical data of all patients was collected and classified as having mild, moderate and severe disease according to government of India, ministry of health and family welfare director general of health services guidelines.

Clinically mild disease was defined as having uncomplicated respiratory tract infection (mild symptoms like fever, cough, sore throat, nasal congestion, malaise and headache) without evidence of hypoxia and of SpO2 more than 94%. Moderate disease was having clinical features of dyspnea or hypoxia, fever, cough and SpO2 <94% (90%-93%) and severe disease characterized by clinical signs of pneumonia, with SpO2 <90% on room air. All CT images have been reviewed by two radiologist independently and final decisions reached by consensus.

Statistical methods

The recorded data was compiled and entered in a spreadsheet (Microsoft excel) and then exported to data editor of SPSS version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as mean±SD and categorical variables were summarized as frequencies and percentages. The correlation of chest CTSI with different forms of disease was established by employing Chi square test. Analysis of variance (ANOVA was applied for comparing continuous variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

In this section, we present results of different parameters in the form of tabulation and graphics.

Table 1 reflects the demographic characteristics of study patients whereby we observe that commonest age group is (50-59) years consisting around (35%) of patients followed by (19.7%) patients aging less than 40 years. Only (12.7%) of patients were falling in the age interval of (40-49) years. However, the mean age of study patients was observed as (53.5±13.79) with minimum and maximum age recorded as 24 years and 80 years old, respectively. The maximum number of patients in the given study were males constituting about (76.1%) of patients, of them (42.3%) were smokers. However, the overall percentage of non-smoker patients was (57.7%).

From Table 2, we observe that fever was most common symptom associated with (80.3%) patients at admission followed by fatigue (71.8%), dry cough (67.6%) , myalgia (60.6%) and breathlessness (52.1%).

Table 3 displays the oxygen saturation level among study patients at admission. We observed that (52.1%) were having hypoxia with less than (90%) oxygen saturation and (28.2%) patients had oxygen saturation in between (90-94)%. Only around (19.7%) patients had their oxygen saturation (>94%) at admission.

Table 4 reflects the radiological features of study patients whereby we came to know that most common contributing radiological characteristic was GGO in (90.1%) followed

by consolidation in (70.4%) patients. However, (67.6%) patients reflected both GGO and consolidation features. Crazy paving appearance and reverse halo sign was seen in (19.7%) and (2.8%) patients, respectively. Only around (1.4%) patients show the features of cavitation.

Table 5 shows the distribution of GGO and consolidation in affected lobes. We observed that peripheral distribution was most common in patients accounting for (90.1%) versus (60.6%) with central distribution. However, (60.6%) had both peripheral and central distribution.

Table 6 displays the other lung findings of study patients, we observed that out of total 71 study patients, (18.3%) had emphysema, (15.5%) showed fibrosis, (14.1%) had micronodules, (8.5%) had effusion and (2.8%) had LAP as other lung diseases.

We categorized patients in terms of mild, moderate and severe disease base on CTSI. We observed that around (39.4%) patients had severe disease, (36.6%) were having moderate disease and (23.9%) had mild disease status.

Table 7 shows the correlation of CT severity index with demographic and clinical characteristics, we observe that significant association between age and severity of disease with a p value of 0.003 which means that severity of disease increases with age of patient. Similarly, severity of disease was found significantly associated with smoking behaviour, fever, cough and breathlessness of patients. However, the severity of disease was found statistically insignificant with respect to gender of patients.

Table 8 displays correlation of oxygen saturation with CT severity index, we observe that there is significant correlation ($p<0.001$) between severity of disease as per oxygen saturation level and severity of disease on the basis of CTSI. Evidently both the indicators infer similar disease status in majority of the cases.

Table 1: Demographic characteristics of study patients.

Parameters		Numbers	Percentage
Age (in years)	<40	14	19.7
	40-49	9	12.7
	50-59	25	35.2
	60-69	10	14.1
	≥70	13	18.3
	Mean±SD (range)	53.5±13.79 (24-80)	
Gender	Male	54	76.1
	Female	17	23.9
Smoking status	Smoker	30	42.3
	Non smoker	41	57.7

Table 2: Clinical signs and symptoms at admission among study patients.

Clinical symptoms	Numbers	Percentage
Fever	57	80.3
Dry cough	48	67.6
Myalgia	43	60.6
Fatigue	51	71.8
Breathlessness	37	52.1

Table 3: Oxygen saturation at admission among study patients.

Oxygen saturation	Numbers	Percentage
Severe disease (<90%)	37	52.1
Moderate disease (90-94%)	20	28.2
Mild disease (>94%)	14	19.7
Total	71	100

Table 4: Radiological characteristics of study patients.

Radiological characteristics	Numbers	Percentage
Ground glass opacity	64	90.1
Consolidation	50	70.4
Both GGO and consolidation	48	67.6
Crazy paving appearance	14	19.7
Reverse halo sign	2	2.8
Cavitation	1	1.4

Table 5: Distribution of GGO and consolidation in affected lobes.

Distributions	Numbers	Percentage
Peripheral	64	90.1
Central	43	60.6
Both peripheral and central	43	60.6

Table 6: Other lung findings of study patients.

Other lung findings	Numbers	Percentage
Emphysema	13	18.3
Fibrosis	11	15.5
Micronodules	10	14.1
Effusion	6	8.5
LAP	2	2.8

Table 7: Correlation CTSI with demographic and clinical characteristics.

Parameters	Mild disease (%)	Moderate disease (%)	Severe disease (%)	P value
Age	45.1±15.47	51.9±13.37	60.4±14.18	0.003*
Male gender	12 (70.6)	19 (73.1)	23 (82.1)	0.723
Smoker	2 (11.8)	9 (34.6)	19 (67.9)	0.001*
Fever	9 (52.9)	21 (80.8)	27 (96.4)	0.002*
Cough	3 (17.6)	20 (76.9)	26 (92.9)	<0.001*
Breathlessness	1 (5.9)	8 (30.8)	28 (100)	<0.001*

*Statistically significant (p value <0.05).

Table 8: Correlation of oxygen saturation with CTSI.

Oxygen saturation	CTSI		
	Mild disease (%)	**Moderate disease (%)**	**Severe disease (%)**
Severe disease (<90%)	1 (5.9)	8 (30.8)	28 (100)
Moderate disease (>90-94%)	2 (11.8)	18 (69.2)	0 (0)
Mild disease (>94%)	14 (82.4)	0 (0)	0 (0)
Chi square=91.12; p<0.001			

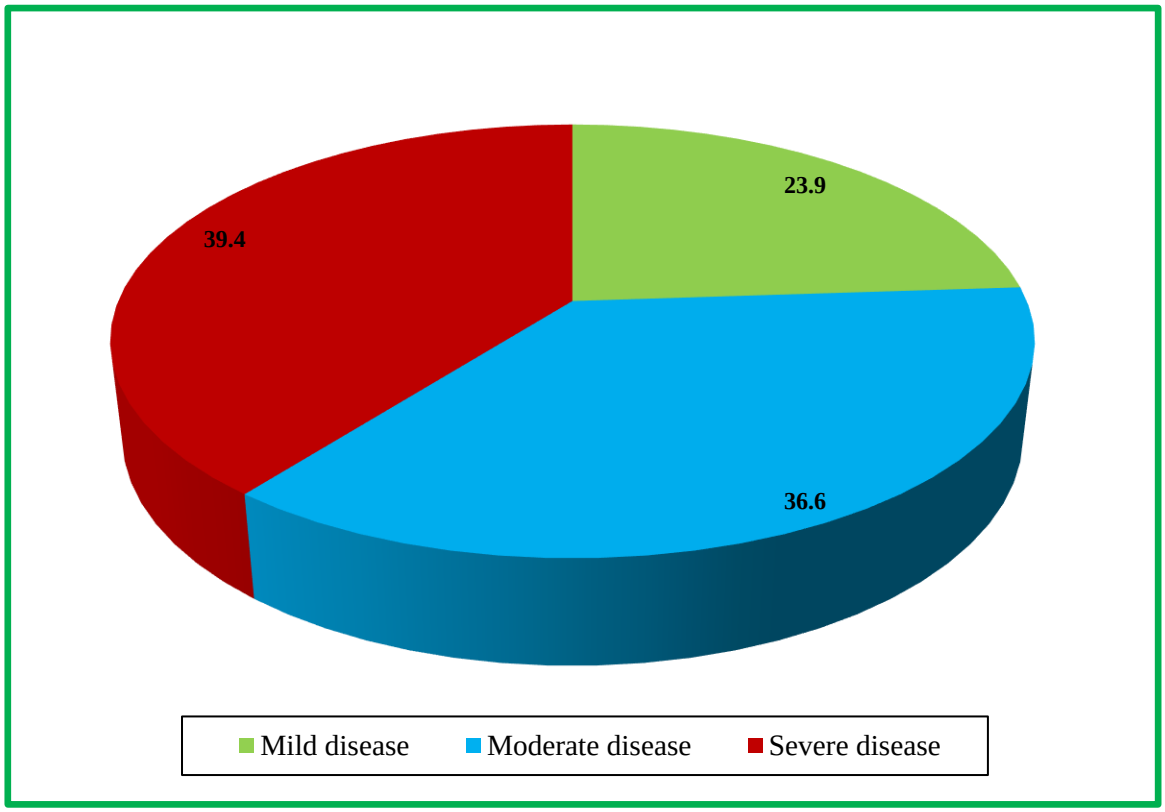

Figure 1: Disease classification on the basis of CTSI.

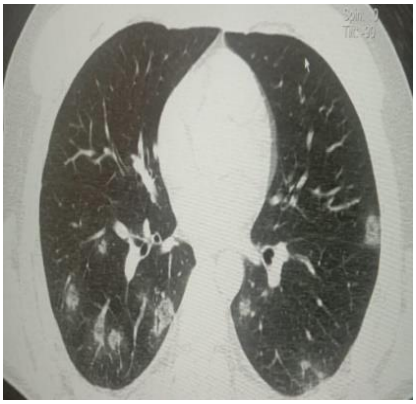

Figure 2: axial CT image with mild CTSI.

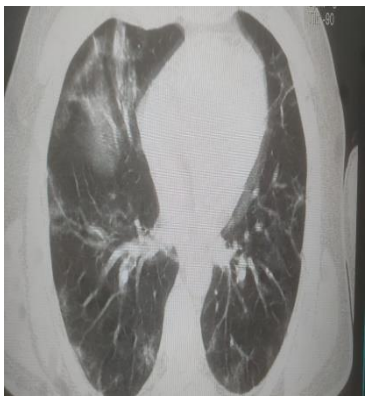

Figure 3: Axial CT image with moderate CTSI

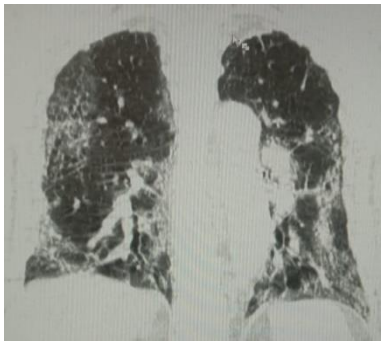

Figure 4: Coronal CT image with severe CTSI.

Figure 2 displays an axial CT image of a 45 year old male with mild CTSI showing well defined rounded GGO in lingular and bilateral lower lobes. Figure 3 shows coronal CT image in a 60 year old male with severe CTSI displaying multiple patchy area of GGO with recticular and intralobular septal thickening in both upper and lower lobes with central and peripheral distribution. Figure 4 shows an axial CT image in a 40 year old male with moderate CTSI showing multiple patches of ground glass haze in both lower lobes and focal consolidation in RML.

DISCUSSION

In the present study on radiological characteristics of COVID-19 patients and correlation of chest CTSI with different clinical forms of disease, we thoroughly analyzed patients data based on demographic, clinical and

radiological aspects. We observed that most of patients in the present study were males constituting about (76.1%) of patients followed by females accounting for only (23.9%) patients. The average age of study patients was observed as (53.5±13.79), however, the range of age distribution among study patients were from 24 years to 80 years old. The commonest age group was observed as (50-59) years consisting around (35%) of patients followed by (19.7%) patients aging less than 40 years. Only (12.7%) of patients were falling in the age interval of (40-49) years. The percentage of patients with smoking habit was (42.3%) versus (57.7%) as non-smokers. Contemporary to the literature, Farghaly et al has made almost similar observations.[8] They found the average age of studied patients as (46.7± 15.18), however, they recorded the age range of patients as 1 to 85 years which in contrast to our study, this difference is because they included a large number of patients of size 574 in their study. Unlike to our observation, the commonest age group that was affected by COVID-19 in their study was (40-49) years old, however, we noticed only (12.7%) patients are falling in this age group. Farghaly et al reported the percentage of male patient's maximum as compared with female patients which is in consonance to our observation.[8] The percentage of smokers (42.3%) in the study patients were seen low as compared with non-smoker (57.7%). Likewise Nadya et al also reported absence of correlation between adult male or female smoking with COVID-19 mortality.[9] However, Gulsen et al reported a significant correlation between active smoking or history of smoking with severe COVID-19 cases.[10] In the present study, we observed that fever was most common symptom associated with (80.3%) patients at admission followed by fatigue (71.8%), dry cough (67.6%), myalgia (60.6%) and breathlessness (52.1%). Similar kind of symptoms has been reported by numerous authors.[11-17] However, the order severity of symptoms may sometimes vary; for example Killerby et al and Tenforde et al reported breathlessness as most common symptom at admission among COVID-19 patients.[18,19] We analyzed patients saturation level at admission and observed that (52.1%) were having hypoxia with less than (90%) oxygen saturation and (28.2%) patients had oxygen saturation in between (90-93%). Only around (19.7%) patients had their oxygen saturation (>93%) at admission. In the present study, we observed that COVID-19 pneumonia exhibit some interesting radiological features like; ground glass opacity (GGO) in (90.1%) and consolidation in (70.4%) patients with peripheral and central distribution. However, (67.6%) patients reflected both GGO and consolidation features. Crazy paving appearance and reverse halo sign was seen in (19.7%) and (2.8%) patients, respectively. Only around (1.4%) patients show the features of cavitation. In agreement to our radiological findings, Ding et al also reported GGO, consolidation, linear opacities and crazy-paving as major radiological patterns of COVID-19 patients.[20] Li et al also recorded GGO, crazy-paving and consolidation as the common CT findings in COVID-19 patients.[21] Severe COVID-19 frequently damages lower lobes of lungs; hence GGO and consolidation in the lung (periphery and central) are the reliable radiological features of COVID-19 infection. In the present study, we found peripheral distribution was most common in patients accounting for (90.1%) versus (60.6%) with central distribution. However, (60.6%) had both peripheral and central distribution. In a similar kind of study, Sultan et al observed ground glass opacity in (94.3%) and consolidation in (25.7%) patients, broncho vascular thickening in around (18.6%) and crazy paving appearance in (15.7%), the authors also reported peripheral distribution in (64.3%), central distribution in (11.4%) and diffuse (central as well as peripheral distribution) in (24.3%) patients.[22] In addition to this, distribution of GGO and consolidation in affected lobes, we also found some other lung involvements in study patients; out of a total of 71 patients, (18.3%) had emphysema, (15.5%) reflected fibrosis, (14.1%) had micro-nodules, (8.5%) show effusion and (2.8%) had LAP as other lung diseases. Yang et al also reported pleura effusion and LAP as secondary CT findings in some severe COVID-19 patients.[23] Chest computed tomography (CT) reasonably plays a significant role in efficient investigations, identification of disease progression and accurate diagnosis of the disease. We categorized patients in terms of mild, moderate and severe disease base on CT severity index, we observed that around (39.4%) patients had severe disease, (36.6%) were having moderate disease and (23.9%) had mild disease status. Farghaly et al also reported the classification of COVID-19 disease in terms of minimal, mild, moderate and severe status based on CT severity index score; the authors reported that (24.7%), (27.7%), (23.7%) and (13.2%) respectively had minimal, mild, moderate and severe disease status.[8] We made a correlation analysis of disease severity index with demographic and clinical characteristics and observed that there is a significant correlation between age and severity of disease with a p value of 0.003 that means severity of disease increases with age of patient which is evident from the differences in associated average ages reflected in mild, moderate and severe category patients. We observed that there is significant correlation ($p<0.001$) between severity of disease as per oxygen saturation level and severity of disease on the basis of CTSI. Evidently both the indicators infer similar disease status in majority of the cases. Similarly, severity of disease was found significantly associated with smoking behavior, fever, cough and breathlessness of patients. These findings are in consonance with the observations made by Farghaly et al, they also found severity of COVID-19 to be significantly correlated with age.[8] Likewise Borghes et al also reported the significant correlation between severity index score and age of patients in both the sexes.[24] In a sensitivity analysis conducted by Zheng et al and Zhang et al it was established that there exists a significant correlation between smoking and COVID-19 severity index.[25,26]

Limitations

Although the present study was carried out in the best scientific way but still it has some limitations that included

small patient population and no follow up CT was not done to assess the progression of disease.

CONCLUSION

In the present study on radiological characteristics of COVID-19 patients and correlation of chest CTSI with different clinical forms of disease, we concluded that COVID-19 pneumonia patients significantly exhibit some radiological features that include GGO and consolidation with peripheral and central distribution. Apart from this, we also observed a statistical significance between age, fever, cough or shortness of breath with the severity index of disease. The present study also revealed a significant correlation between CTSI and some clinical parameters, evidently both the indicators infer similar disease status in majority of the cases. Therefore CT severity score can be treated as a reliable diagnostic tool to determine the severity status of disease.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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