Correlation of CT Severity Index with Lab Parameters in Covid 19 Infection

Research Article

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Abstract

COVID 19 is one of the globally fatal disease caused by severe acute respiratory syndrome coronavirus –2(SARS-COV2). Its main mode of spread is through respiratory tract by droplets/air born, close contact with infected patients and those travelling to the epidemic country. Radiological imaging plays an imperative part to assess the severity of COVID 19 infection, among which CT is the most important diagnostic tool. Lab parameters like D- Dimer, CRP, S. ferritin and lymphocyte count are evaluated to assess the severity of infection. So the lab parameters are correlated in RT-PCR positive patients undergoing CT chest imaging. Correlation is done for the purpose of repeating the lab parameters to examine the patient's condition, as repeated CTs are not advised. The major focus of this investigation is to assess the chest CT correlation to the lab parameters.

Keywords: COVID; CT scan; SPSS; CRP; D-Dimer; S. Ferritin; Lymphocyte

Introduction

COVID-19 was declared pandemic by the World Health Organization (WHO), following pneumonia infection by a new coronavirus, it has spread rapidly and has become extremely aggressive. The most common clinical symptoms are fever, shortness of breath, dry cough, fatigue, myalgia, and gastrointestinal issues like diarrhoea and vomiting [1,2]. The occurrence of the disease was manifested by decreased blood O_2 saturation, cough, headache, upper airway infection, acute respiratory distress syndrome (ARDS), and lung involvement in imaging studies [3]. In COVID-19-infected patients, lung involvement was identified to be the most important prognostic factor [4]. Reverse Transcription-Polymerase Chain Reaction (RT-PCR) is commonly used to diagnose COVID-19 infection, which is highly specific. Similarly, chest computed tomography (CT),

which is simple and quick, is used to identify COVID 19 [5], but it has low specificity of 25% and very high sensitivity of up to 97.2 %.

Laboratory parameters such as D-dimer, C-reactive protein, serum ferritin and lymphocyte count were also found to be useful in the diagnosing COVID-19 infection

The CT imaging of chest is beneficial for detecting lung abnormalities, screening, diagnosing, and clinically classifying patients who are suspected to have infection. CT scans can also be used to monitor patient's status post discharge from the hospital. The abnormalities such as bilateral and multilobar ground-glass opacities are most common patterns [6]. Other radiographic abnormalities like reverse halo sign, airway changes, and crazy paving pattern have also been observed in COVID-19-infected patients [7].

Some studies have found a correlation between chest CT findings and a patient's laboratory data, suggesting that correlation could help determine the severity of the infection. The CT severity score system is a semi-quantitative scoring system for determining the severity and extent of lung involvement. The scoring system might be used to estimate the degree of COVID-19 pneumonia in their lungs [8].

Methods

Data Collection

The complete analysis was conducted in VIMS &RC, Bangalore. After ethical clearance, the HRCT images of 200 RT-PCR positive COVID patients were collected from the radiology department of VIMS & RC. The corresponding lab parameters for the patients were also collected from the hospital database and data's were correlated.

HRCT

The HRCT thorax was done with a 128 slice Siemens Somatom Scanner using single breath hold. The following scanning parameters were used: tube voltage of 100 – 120 kVp, tube current of 120 mAs, collimation of 1.5 -3mm, slice thickness of 1.0 mm at zero intervals.

HRCT Image Analysis

A team of 4 duty radiologists and two faculty with 7 and 10 years of experience in radio diagnosis evaluated the CT image. The scoring and severity index is based on the data in (Table 1 & 2). CT severity index and score for the lung development was developed by Yang et al [8]. CO-RADS is the method used for CT score calculation is shown in (Table 3).

Lab Parameters

The lab parameters like C-Reactive Protein, D-Dimer, Serum Ferritin, Lymphocyte count obtained on the same day or previous day of CT imaging was used for correlation with CT severity index.

Table 1: CT Score based on lobe involvement.

% of Lobe involvement	Score
Upto 5% or less	1
From 5 to 25%	2
From 25 to 50 %	3
From 50 to 75%	4
More than 75%	5

Table 2: CT severity index.

CT Severity index (Total)	
0-7	Mild
8-15	Moderate
16-25	Severe

Table 3: CORADS based on lung involvement.

	Chance of COVID-19 Infection	CT Findings
CO-RADS 1	No	Normal or non-infectious abnormalities
CO-RADS 2	Low	Abnormalities consistent with infections other than COVID–19
CO-RADS 3	Indeterminate	Unclear whether COVID-19 is present
CO-RADS 4	High	Abnormalities suspicious for COVID-19
CO-RADS 5	Very high	Typical COVID-19
CO-RADS 6	PCR +	

Statistical Analysis

Statistical analysis was done using IBM SPSS 20.0 Software. Pearson correlation coefficient was used to correlate CT Severity index and lab parameters. CT severity index is also correlated with age and gender. The P-value less than 0.05 was considered to be statistically significant.

Results and Discussion

In the analysis of 200 COVID-19 infected patients 54 were females and 146 were males as shown in (Figure 1).

CT score of 1 to 8 was categorized as mild infection with 89 patients [44%], 62 males and 27 females of age 18 to 80 years. CT score of 9 to 15 was categorized as moderate infection with 73 patients [37%], 55 males and 18 females of age 18 to 60 years. CT score of 16 to 25 was categorized as severe infection with 38 patients, [19%] 29 males and 9 females of age 18 to 73 years (Figure 2).

The CT images of patients affected with severe, moderate and mild infections are shown in (Figure 3). The lobar involvement was used to calculate CT score and score of 1 to 5 is given for each lobe. The CT severity score based on the imaging is shown in Table 1 & 2.

Statistical Analysis using SPSS

The statistical analysis was done with SPSS 20.0 software for the correlation of CT severity Score and lab parameters. The overall analysis gives statistical significance with P value < 0.05 and 0.01.

All the parameters are correlated, with the confidence level of 99% for CT score and lab parameters and 95% for CT score and age factor. The Correlation matrix is shown in (Table 3). The overall analysis implies lymphocyte count and serum ferritin are highly correlated compared to other parameters. The other two parameters such as D-Dimer and C-Reactive protein have limited correlation, and it varies with CT score based on age, gender, comorbidities, etc. At last correlation analysis was done between CT Severity Score and Age and it was significant with 95% confidence level.
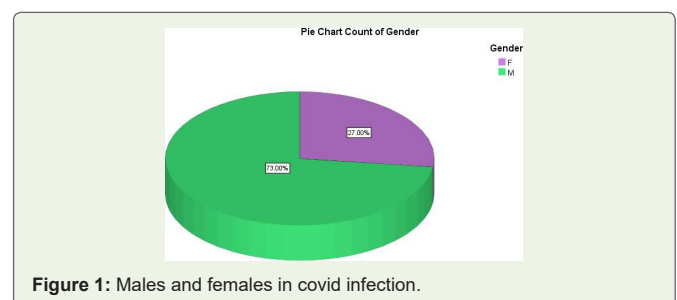

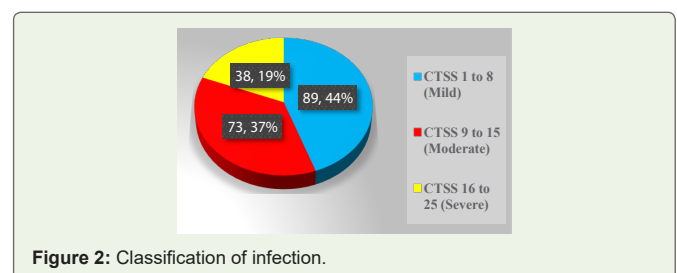**Figure 1:** Males and females in covid infection.

Figure 2: Classification of infection.

Correlation Analysis using SPSS 3.2.1Correlation analysis of Age and Gender

COVID-19 infected patient's CT Severity Score was correlated with Age and correlation was significant at 0.05 level (2-tailed) with a correlation index of 0.168 and a significance of P=0.018 [i.e. <0.05] having a correlation of 95% significant. The CT score along with age and gender category is listed in Table 5.
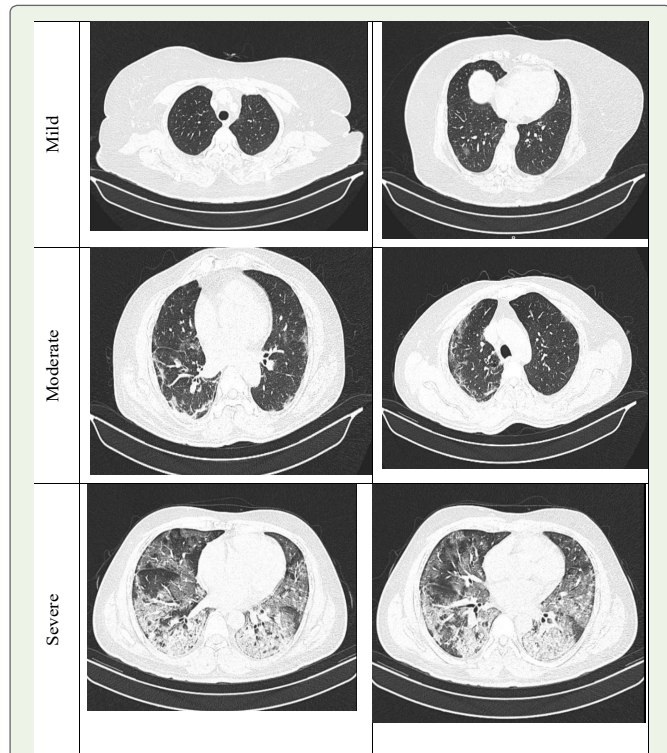

Figure 3: CT image of patients Clustered with different severity index.

Correlation analysis of Lab Parameters: The Pearson correlation analysis for different lab parameters was performed and the correlation had significant P value 0.001 i.e 99% confidence level for all lab parameters such as lymphocyte, serum ferrite, C-reactive protein and D-Dimer. Further simple and mean scatter plot for all 200 patients were plotted to understand the range of lab parameters obtained for different level.

Correlation analysis of CTSS and Lymphocyte Count

The Pearson correlation analysis showed better correlation for CT score and Lymphocyte count compared to other lab parameters. The simple scatter plot and mean scatter plot of 200 patients are shown in (Figure 4.a & b.)

The lymphocyte count for normal patient is 20 to 40 (μL). From the correlation analysis it was found that lymphocyte count decreases as the CT Score increases. The R square value of mean lymphocyte was found to be 0.827 based on linear regression analysis. The Lymphocyte value for patients with mild symptom was in the range of 18 to 35 (μL), for the patients with moderate infection it was 15 to 10 (μL) and for patients with severe infection it is of 10 to 5 (μL) on an average showing drastic reduction from normal value.

Correlation analysis of CTSS and C-Reactive Protein

The Pearson correlation analysis showed better correlation for CT score and CRP after lymphocyte count. The simple scatter plot and mean scatter plot of 200 patients are shown in (Figure 5 a&b). The C-Reactive protein for normal patient was found to be 0 to 4 (mg/dl) for normal patients. From the correlation analysis, the serum ferritin increases as CT score increases and the correlation was found to be significant with the P value of 0.001 having 99% percent correlation.

The R square value of mean C reactive protein was 0.648 based on linear regression analysis. The C Reactive protein for patients with mild symptom was between 0 to 4 (mg/dl), for patients with moderate infection, it was between 4 to 6 (mg/dl) and for patients with severe
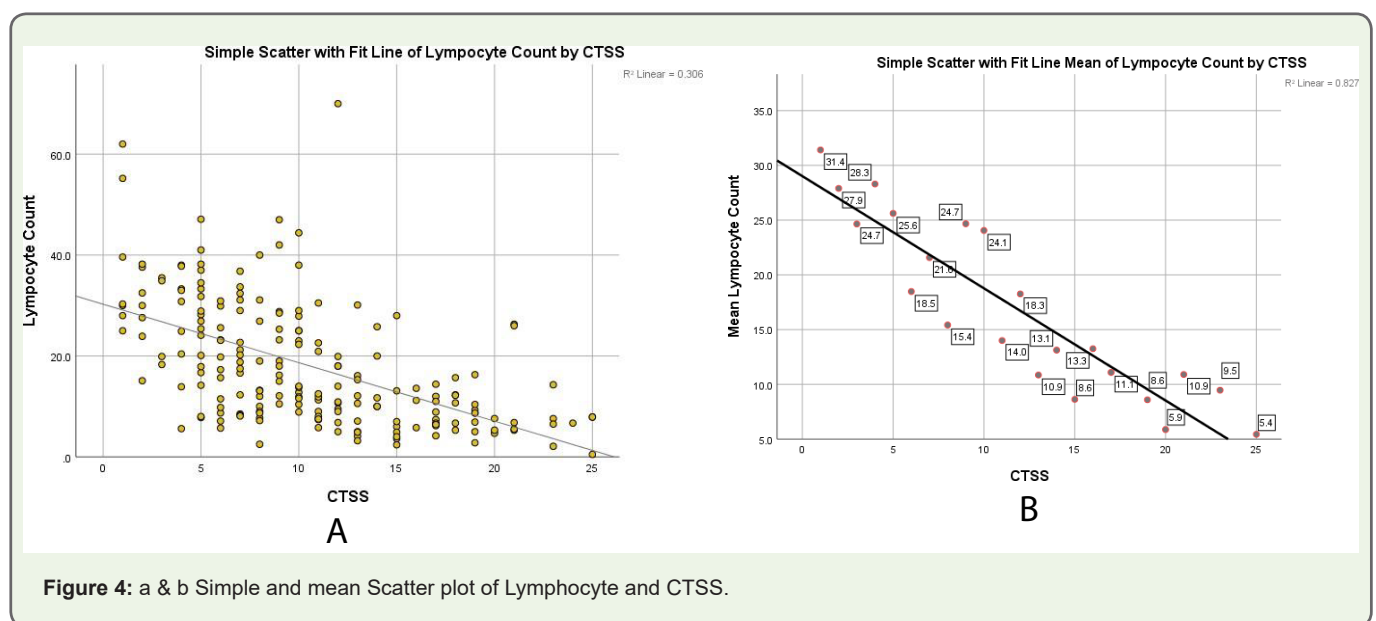

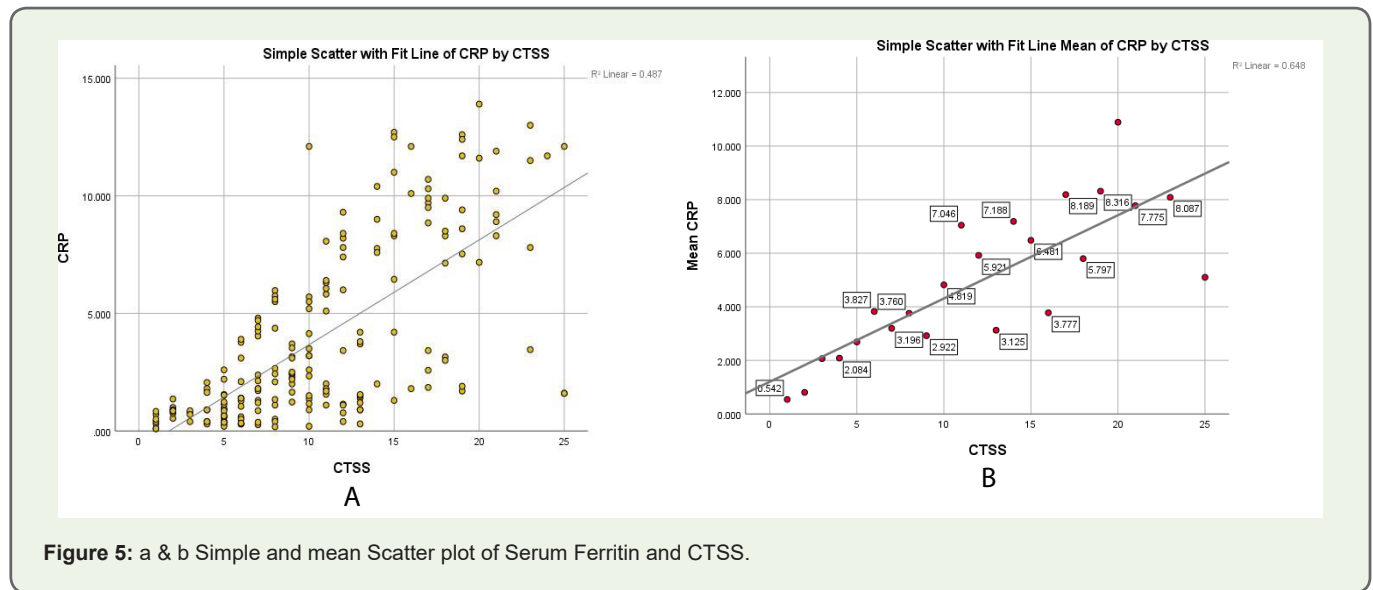**Figure 4:** a & b Simple and mean Scatter plot of Lymphocyte and CTSS.

Figure 5: a & b Simple and mean Scatter plot of Serum Ferritin and CTSS.

Table 4: SPSS Pearson's Correlation matrix.

CTSS		CTSS	CRP	D-Dimer	Serum Ferritin	Lymphoc yte	Age
CTSS	Pearson Correlation	1	.393**	.345**	.402**	-.495**	.168*
	Sig. (2-tailed)		.000	.000	.000	.000	.018
CRP	Pearson Correlation	.393**	1	.136	.216**	-.253**	.213**
	Sig. (2-tailed)	.000		.056	.002	.000	.002
D- Dimer	Pearson Correlation	.345**	.136	1	.109	-.235**	.190**
	Sig. (2-tailed)	.000	.056		.124	.001	.007
Serum Ferritin	Pearson Correlation	.402**	.216**	.109	1	-.163*	.033
	Sig. (2-tailed)	.000	.002	.124		.021	.642
Lymphocyte	Pearson Correlation	-.495**	-.253**	-.235**	-.163*	1	-.174*
	Sig. (2-tailed)	.000	.000	.001	.021		.014
Age	Pearson Correlation	.168*	.213**	.190**	.033	-.174*	1
	Sig. (2-tailed)	.018	.002	.007	.642	.014	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 5: Age and gender category based on CT Score.

CT Severity Score	Total Number of Infected Patients		Age Category							
	Male	Female	< 40		40-50		50-60		>60	
			M	F	M	F	M	F	M	F
1-8 (Mild)	62	27	21	6	17	8	12	8	12	6
9-15 (Moderate)	55	18	21	3	12	3	7	4	15	8
16-25 (Severe)	29	9	7	0	12	6	7	4	10	3

infection, it was between 6 to 10 (mg/dl), with drastic increase from normal value.

Correlation analysis of CTSS and Serum Ferritin

The Pearson correlation analysis showed better correlation for CT score and serum ferritin value next to that of Lymphocyte count and C reactive protein. The simple scatter plot and mean scatter plot of 200 patients are shown in (Figure 6 a & b).

The Serum Ferritin value for normal patient was found to be 200 to 300 (ng/ml). From the correlation analysis it was found that serum ferritin increases as the CT score increases with P value of 0.001

showing 99% percent correlation. The R square value of mean serum ferritin was 0.426 based on linear regression analysis. The serum ferritin value for patients with mild symptom was between 200 to 320 (ng/ml) that falls under the normal range of serum ferritin level, for patients with moderate infection it was between 300 to 450 (ng/ml) and the patients with severe infection it was between 450 to 600 (ng/ml) with drastic increase from normal value.

Correlation analysis of CTSS and D Dimer

The Pearson correlation analysis showed least correlation for CT score and D Dimer value compared to other lab parameters such
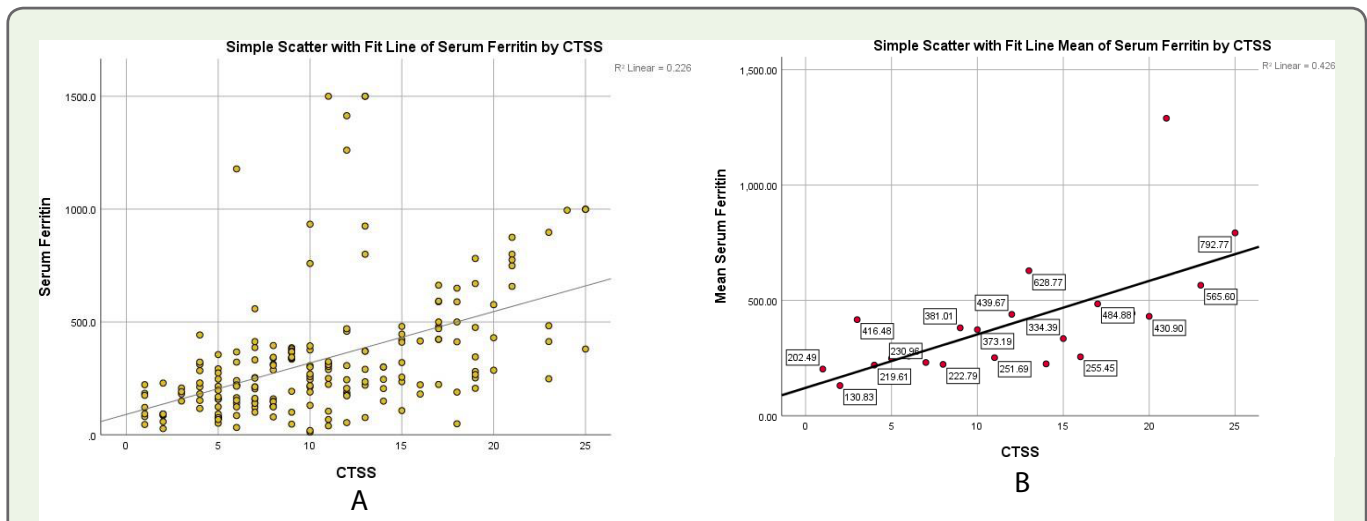
Figure 6: a & b Simple and mean Scatter plot of Serum Ferritin and CTSS.
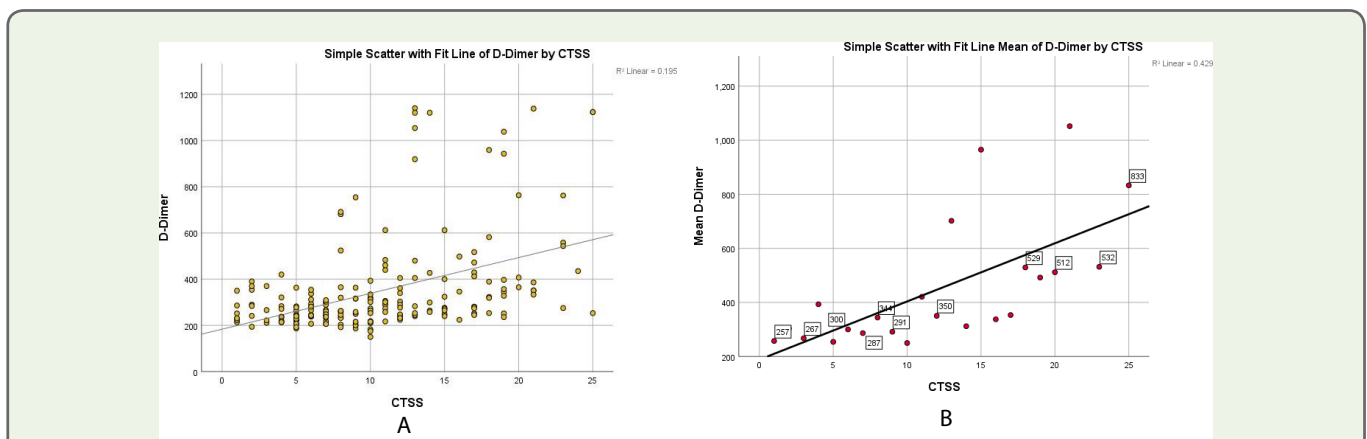

Figure 7: a & b Simple and mean Scatter plot of D-Dimer and CTSS.

as Lymphocyte count, C Reactive protein and Serum Ferritin. The simple scatter plot and mean scatter plot of 200 patients are shown in (Figure 7 a & b).

The D-Dimer value for normal patient was 200 to 300 (ng/ml). From the correlation analysis it was found that D-Dimer was increasing as the CT score increases with P value of 0.001 showing 99% percent correlation. The R square value of mean serum ferritin was 0.429 based on linear regression analysis. The D Dimer value for patients with mild symptom was between 200 to 300 (ng/ml), for patients with moderate infection it is between 300 to 400 (ng/ml) and for patients with severe infection it is between 400 to 800 (ng/ml) with drastic increase from normal value.

Discussion

Coronavirus disease 2019 (COVID-19) is a highly infectious viral respiratory disease that has recently emerged from China and has become a pandemic [9].

In the present study, an attempt was made to outline distribution of laboratory features at presentation, severity of patients based on CT imaging, and their correlation with clinical and laboratory parameters of patients to put diagnostic, therapeutic, and prognostic tools for COVID-19 disease.

Majority of cases were aged between 40 - 50 years in our study. Among previous studies, Bhandari S et al. [10] reported that the mean age of the patients was 50 - 40 years, which is very similar to our study.

CT score of 1 to 8 was categorized as mild infection with 89 patients [44%], 62 males and 27 females of age 18 to 80 years. CT score of 9 to 15 was categorized as moderate infection with 73 patients [37%], 55 males and 18 females of age 18 to 60 years. CT score of 16 to 25 was categorized as severe infection with 38 patients, [19%] 29 males and 9 females of age 18 to 73 years. This can be affected by different factors like the stage of the pandemic when the study was carried,

presence of patients' comorbidities, maturity and preparation of the healthcare system, and existence of elderly nursing homes services where disease can spread faster.

In our observation., The lymphocyte count for normal patient is 20 to 40 (µL). From the correlation analysis it was found that lymphocyte count decreases as the CT Score increases. Swati Sharma et al., showed that comparison with disease severity as per CTSS, mean of lymphocyte count shows decreasing trend with increasing disease severity with significant statistical correlation [11]. However, no statistically significant correlation was observed between CT score and lymphocyte count was observed according to Marco Francone et al [12].

In our study, the Pearson correlation analysis showed better correlation for CT score and CRP after lymphocyte count. Swati Sharma et al., also reported that mean of CRP was significantly higher in severe group. Their finding was also found to have positive statistically significant correlation with CTSS [11].

From the correlation analysis, the serum ferritin increases as CT score increases and the correlation was found to be significant with the P value of 0.001 having 99% percent correlation. Many previous studies have suggested alterations of laboratory parameters in COVID-19 patients with greater frequency such as lymphocyte count, CRP, D-dimer, and serum ferritin [13,14] Similarly, serum ferritin acts as a vital mediator of immune dysregulation as shown in this study where serum ferritin level was closely correlated with severity of disease. Saeed et al and Yilmaz et al in their study found a positive correlation between S. Ferritin levels and CT severity score (p<0.0001 and p –0.0001 respectively) [15,16] . El Bakry et al in their study found that S. Ferritin was significantly elevated in critically ill patients and it can be used to predict short term outcome in them [17]. These findings were similar to our study in which more severe the disease higher was the S. Ferritin level.

In the same way., from the correlation analysis it was found that D-Dimer was increasing as the CT score increases with P value of 0.001 showing 99% percent correlation. Francone et al and Yilmaz et al in their studies have shown significant correlation between CT or disease severity with d-dimer values [12,18].

Conclusion

The results of the analysed data showed strong correlation between CT severity index and lab parameters. Among the lab parameters, C Reactive protein and Lymphocyte count was found to have maximum correlation with 99% confidence level. The other two parameter such as Serum Ferritin and D Dimer was also found to be highly significant with P value <0.001 but had less correlation compared to C Reactive protein and lymphocyte count.

Ethical Clearance

Ethical clearance was obtained from medical ethical committee in Vydehi Institute of Medical Science for this study

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