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ORIGINAL ARTICLE

Correlation of CT Scanning Severity Score with Inflammatory Markers and Blood Picture Among Patients with Severe COVID-19

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Abstract

Background: **Coronaviruses are significant diseases in both humans and animals. The world has experienced a relentless spread of the 2019 new coronavirus (COVID-19), the aim of the study was to assess correlation of computed tomography (CT) scanning severity Score with inflammatory markers and blood picture among patients with severe COVID-19.**

Patients and methods: **50 patients with severe COVID-19 were included in this study. These Patients were isolated and hospitalized in isolation units of Al−Hussin and Bab-Elshaaria University Hospitals, from June 2021 to May 2022. They were diagnosed by positive RT-PCR COVID test.**

Result: **The mean high-resolution CT (HRCT) score of all studied patients was 13.1 ± 5.9 with minimum score of 1 and maximum score of 23. As regard Neutrophil/lymphocyte ratio (NLR%), the mean NLR of all studied patients was 10.3 ± 8.6 with minimum NLR of 2.07 and maximum neutrophil of 44.6. As regard ESR, the mean ESR of all studied patients was 66.4 ± 29.5 with minimum ESR of 12 and maximum ESR of 160. As regard D-Dimer, the mean D-Dimer of all studied patients was 0.7 ± 0.6 with minimum D-Dimer of 0.14 and maximum D-Dimer of 2.8. Highly statistically significant (P value < 0.001) positive correlation ($r = 0.51$) between HRCT score and neutrophil %. Statistically significant (P value = 0.004) Negative correlation ($r = -0.4$) between HRCT score and Lymph %.**

Conclusion: **Most common Respiratory symptom is cough followed by dyspnea. Most common nonrespiratory symptom is fever followed by bony ache. Incidence of diarrhea in our COVID patients may be due to abusing of antibiotics and vitamins. Most common finding in computed tomography pattern in COVID patients was bilateral peripheral graound glass opasity (GGO). Consolidation is not a common finding in COVID patients but sometimes present with GGO.**

Keywords: COVID-19, Computed tomography scanning, Inflammatory markers, Severity score

1. Introduction

In December 2019, a novel Coronavirus (2019-nCoV) is reported to have surfaced from Wuhan in the Hubei region of China. This new variant of coronavirus was named 'severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)' and the disease it causes is referred to as coronavirus disease 2019 (COVID-19).[1]

When a patient has either clinical or radiological signs of pneumonia and displays the clinical symptoms of covid-19 infection, the condition is referred to as covid-19 pneumonia.[2]

The seventh coronavirus in the family is the COVID-19.[3] Mortality from Covid-19 is particularly high among patients with conditions, including hypertension (HTN), diabetes mellitus (DM), and cardiovascular disease (CVD), and among those who reach the point of coexisting requiring invasive MV.[4]

Because COVID-19 has a larger reproduction number than its predecessors, it is far more

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contagious, which places a tremendous strain on global health. The majority of patients have a favourable prognosis and typically only experience minimal clinical symptoms of COVID-19 infection. However, roughly 10–20% of all patients' health can deteriorate, necessitating frequent transfer to the intensive care unit (ICU), which has a very high mortality rate.[5]

Therefore, treatment and early detection are crucial for COVID-19 management. Throat swab testing using nucleic acids produce false-positive results when finding COVID-19.

In contrast, computed tomography (CT) is a more accurate, reproducible, practical, and quick way to identify and evaluate COVID-19, particularly in an epidemic area. 74% of patients with confirmed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections had abnormal CT scans[6] and also the Radiology study authors wrote 'Recent research found that the sensitivity of CT for COVID-19 infection was 98% compared with RT-PCR testing sensitivity of 71%.[7] CT scan is most accessible in Chinese hospitals[8] and can provide timely diagnosis and monitoring of lung lesions.

Because the disease has a latent onset, it is crucial to identify patients who are more likely to have disease progression early on so that therapeutic treatment can be modified before the disease progresses. Since a CT can be negative in the first few days of a mild illness, the interpretation of the CT findings must take the clinical symptoms and the length of the symptoms into consideration.[9]

2. Patients and methods

50 patients with severe COVID-19 were included in this study. These Patients were isolated and hospitalized in isolation units of Al–Hussin and Bab-Elshaaria University Hospitals, from June 2021 to May 2022. They were diagnosed by positive RT-PCR COVID test.

2.1. Ethical considerations

The patients were selected after prior explanation of the aim of the study, and a free-will written approval consent will be taken, and the whole work will do according to the ethical committee, Faculty of Medicine, Al-Azhar University.

2.2. Inclusion criteria include

All patients diagnosed with severe COVID-19 by positive PT-PCR COVID test and had pneumonia manifestations by clinical and radiology examination. These include severe cases and critically ill patients.

Severe cases of Covid 19 were characterized by: RR greater than 30, SaO_2 less than 92 at room air, PaO_2/FiO_2 ratio less than 300 and chest radiology showing more than 50% pneumonic lesion or progressive lesion within 24–48 h.

Critically ill patients: The patients were considered critically ill if SaO_2 less than 92 at room air, or RR greater than 30, or PaO_2/FiO_2 ratio less than 200 despite oxygen therapy and hemodynamically unstable and in need of mechanical ventilation.

2.3. Exclusion criteria include

Patients with any of the following conditions were totally excluded from the study: Mild and moderate cases of COVID 19, Unconfirmed patient with COVID 19, associated acute infections other than pneumonia e.g., abscess, UTI, appendicitis, …etc., known malignant conditions either on chemotherapy/radiotherapy or not, or being recovered from malignancy for less than 6 months, acute/subacute (DVT, deep venous thrombosis) or recent pulmonary embolism, chronic chest conditions or those with known fixed pulmonary shadows and systemic inflammatory diseases e.g., connective tissue diseases, granulomas, vasculitis, inflammatory bowel disease … etc.

2.4. Collection of data

The medical information of all patients was retrieved from their medical records including: demographic data, clinical symptoms, co-morbidities, laboratory results especially (Complete blood count (CBC), ESR, C reactive protein (CRP), D-dimer, and ferritin) and presenting radiological findings.

2.5. Methodology

All studied patients are subjected to the following: full history taking with emphasis on: Epidemiological features (age, sex) and risk factors (smoking, DM, HTN). Clinical presentation COVID related symptoms either respiratory or nonrespiratory (cough, shortness of breath, chest pain, fever, sore throat, malaise, loss of smell, diarrhea), General and Local chest examinations. High resolution CT chest (HRCT): changes ex: presence of ground glass opasity (GGO), consolidation, crazy paving, nodules, pleural effusion … etc. Number of lobes affected and degree of lobe involvement to overall lung to calculate (CT severity index of COVID-19 pulmonary infection). 'total severity score' (TSS).[6] Affected

lung in percentage/lobe- (max. 25 points). Accordingly, severity was classified as: Mild stage (0–7 points), moderate stage (8–16 points), and advanced stage (17–25 points),[6] PCR and laboratory investigations were performed including: complete blood count: including looking for leucopenia, thromboctopenia and lymphopenia, 'lymphocyte neutrophil ratio', inflammatory mediators (CRP), D-Dimer, ferritin, ESR (Erythrocyte Sedimentation Rate): Examination of ESR manually used the Westergren reference method, liver functions testes (ALT- AST- S. albumin as a risk factor and renal function tests (urea –creatinine – s.creatinine) risk factor.

2.6. Statistical analysis

Microsoft Excel 2016 and the IBM SPSS application (Statistical Package for Social Sciences), version 24, were used to tabulate and statistically analyse the gathered data. For numerical parametric data as mean SD (standard deviation), minimum and maximum of the range, and categorical data as number and %, descriptive statistics were performed.

3. Results

Table 1.

As regard age, the mean age of all studied patients was 53.4 ± 13.8 years with minimum age of 29 years and maximum age of 80 years. As regard smoking index, the mean smoking index of all studied patients was 40.2 ± 23.8 with minimum index of 14 and maximum index of 100. As regard BMI, the mean BMI of all studied patients was 32.1 ± 6.2 kg/m^2 with minimum BMI of 19.5 kg/m^2 and maximum BMI of 43.9 kg/m^2 Fig. 1.

The risk factors in all studied patients. There was obesity in 21 patients (42%), DM in 18 patients (36%), HTN in 21 patients (42%), CVD in 12 patients (24%), chest disease in 9 patients (18%), renal disease in 3 patients (6%), hepatic disease in 3 patients (6%) Table 2.

Table 1. Demographic data among all patients.

	Studied patients ($N = 50$)	
Age (years)		
Mean ± SD	53.4 ± 13.8	
Min - Max	29–80	
Sex		
Male	34	68%
Female	16	32%
Smoking		
No	33	66%
Yes	17	34%
Smoking index		
Mean ± SD	40.2 ± 23.8	
Min - Max	14–100	
BMI (kg/m^2)		
Mean ± SD	32.1 ± 6.2	
Min - Max	19.5–43.9	

This table shows the description of Hematological biomarkers among all patients. As regard Neutrophil/lymphocyte ratio (NLR%), the mean NLR of all studied patients was 10.3 ± 8.6 with minimum NLR of 2.07 and maximum neutrophil of 44.6. As regard ESR, the mean ESR of all studied patients was 66.4 ± 29.5 with minimum ESR of 12 and maximum ESR of 160. As regard D-Dimer, the mean D-Dimer of all studied patients was 0.7 ± 0.6 with minimum D-Dimer of 0.14 and maximum D-Dimer of 2.8 Table 3.

This table shows the description of HRCT score in all studied patients. The mean HRCT score of all studied patients was 13.1 ± 5.9 with minimum score of 1 and maximum score of 23 Table 4.

This table shows the description of severity in all studied patients. There were 26 severe patients (52%) and 24 critically ill patients (48%) in the studied patients Table 5.

CT findings were as follows; Both Respiratory and Nonrespiratory manif.: unilateral GGO in 5 patients (13.51%), bil. GGO in 25 patients (67.56%), bil. GGO and consolidation in 2 ps (5.4%), bilateral GGO and Crazy paving in 2 patients (5.4%), consolidation and pl. reaction in 0 patient (0%); bil. GGO and pl. thickening in 1 patient (2.7%), bilateral GGO, crazy paving and consolidation in 1 patient (2.7%), bil. GGO, crazy paving, emphysema and calcified nodule in 1 patient (2.7%) Table 6.

Highly statistically significant (P value < 0.001) positive correlation ($r = 0.51$) between HRCT score and neutrophil %. Statistically significant (P value $= 0.004$) Negative correlation ($r = -0.4$) between HRCT score and Lymph %. Statistically significant (P value $= 0.022$) Positive correlation ($r = 0.32$) between HRCT score and alanine transaminase (ALT). Statistically significant (P value $= 0.022$) Positive correlation ($r = 0.32$) between HRCT score and aspartate transaminase (AST). Statistically significant (P value $= 0.001$) Positive correlation ($r = 0.47$) between HRCT score and ESR. Statistically significant (P value $= 0.016$) Positive correlation ($r = 0.34$) between HRCT score and CRP. Statistically significant (P value $= 0.001$) Positive correlation ($r = 0.47$) between HRCT score and D-Dimer. Statistically significant (P value $= 0.015$) Positive correlation ($r = 0.34$) between HRCT score and ferritin. Statistically significant (P value $= 0.045$) Positive correlation ($r = 0.29$) between HRCT score and NLR % Table 7.

This table shows the description of outcome in all studied patients. There were 43 patients (86%)

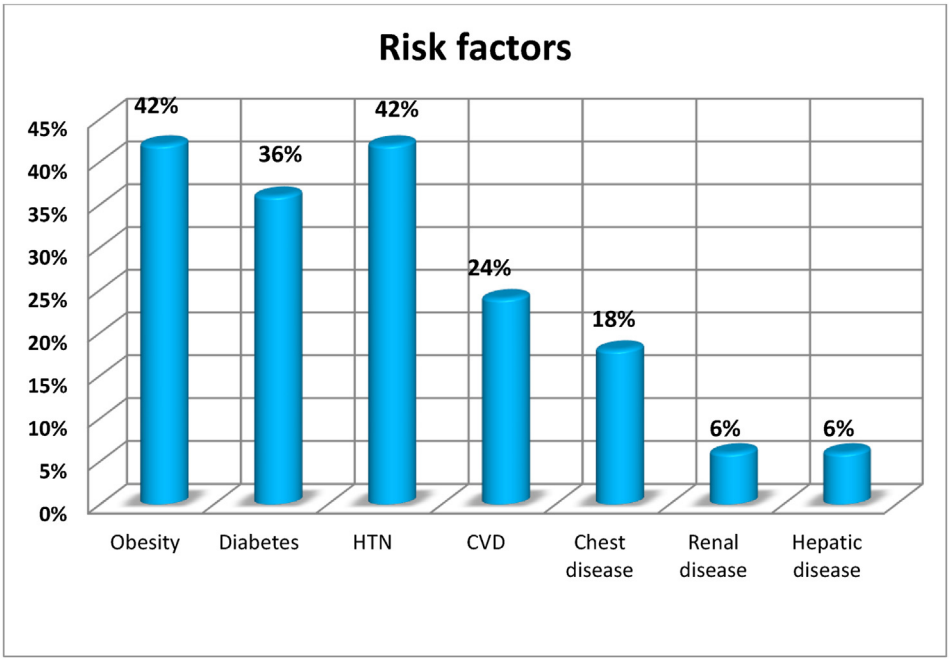

Fig. 1. Risk factors and comorbidities in all patients.

survived and 7 patients (14%) died in the studied patients.

4. Discussion

In the present study, the mean age of all studied patients was 53.4 ± 13.8 years with minimum age of 29 years and maximum age of 80 years. There were 34 males (68%) and 16 females (32%) in the studied patients. These results were similar to Songlin and colleagues[10] who studied correlation between chest CT finding and clinical features of 211 Covid-19 suspected patients in Wuhan, China who found median age of patients was 55 years, but our study did not match results of meta-analysis done by Vaseghi and colleagues,[11] who collected pooled data from all studies published in all languages since the start of COVID−19 pandemic till February 2020, including 293 patients and according to the combined results of this meta-analysis, 55% of patients were males and their mean age was 41.3 years.

This difference might be due to the difference in number of patients enrolled in each study and some social factors as younger age in our community try to treat themselves by communicating their GPs (General practitioners) or even nearby pharmacists, but the elders may be more anxious and go to clinics or hospital once they feel any symptoms.

In a preliminary report of 121 patients admitted to ICU in the USA, 80% of those who died were older than 65 years Catanzaro and colleagues.[12] Comorbidities are more common in older patients, especially CVD and chronic respiratory conditions. These comorbidities may contribute in severe pneumonia and development of ARDS in older patients.

Elderly persons with co-morbid diseases such as, DM, acute kidney injury, cardiovascular diseases, hypertension, and cancer are at higher risk of mortality or may have a more critical COVID-19

Table 2. Hematological biomarkers among all patients.

(n = 50)	Minimum	Maximum	Mean ± SD
WBCs	3.3	33.2	10.3 ± 5.9
Neutrophil (%)	60	96	80.3 ± 10.1
Neutrophil (Abs)	2.1	32.2	8.5 ± 5.6
Lymphocytes (%)	2.1	30	12.2 ± 6.8
Lymphocytes (Abs)	0.2	2.73	0.9 ± 0.5
NLR (%)	2.07	44.6	10.3 ± 8.6
NLR (Abs)	2.07	46	12.5 ± 10.4
Hb	7.06	16.3	12.4 ± 2.4
PLT	92	409	224.4 ± 80.0
ALT	11	210	56.1 ± 46.6
AST	21	318	78.4 ± 68.8
ESR	12	160	66.4 ± 29.5
D-Dimer	0.14	2.8	0.7 ± 0.6

Table 3. HRCT score among all patients.

	Studied patients (N = 50)
HRCT score	
Mean ± SD	13.1 ± 5.9
Min - Max	1–23

Table 4. Classification of patients according to severity.

	Studied patients ($N = 50$)	
Severity		
Severe	26	52%
Critically ill	24	48%

Table 5. Correlation of CT findings and clinical manifestations.

	Respiratory ($N = 7$)	Nonrespiratory ($N = 6$)	Both ($N = 37$)
Severity score			
Min max.	1–20	2–23	1–22
Mean ± SD	9.2 ± 5.52	8.6 ± 7.76	7.66 ± 5.4
CT findings	*N* (%)	*N* (%)	*N* (%)
Unilateral GGO	1 (14.28)	1 (16.66)	5 (13.51)
Bilateral GGO	(42.85)	2 (33.33)	25 (67.56)
Bilateral GGO and consolidation	1 (14.28)	2 (33.33)	2 (5.4)
GGO and Crazy paving	1 (14.28)	1 (16.66)	2 (5.4)
Consolidation and pl. reaction	1 (14.28)	0	0
Bilateral GGO and pl. thickening	0	0	1 (2.7)
Bilateral GGO, crazy paving and consolidation	0	0	1 (2.7)
Bilateral GGO, crazy paving, emphysema and calcified nodule	0	0	1 (2.7)

Yang and colleagues.[13] DM appeared to be a major risk factor for both COVID-19 infection and worse outcomes. DM is already known to be associated with increased mortality from any acute and chronic illness including infection Zoppini and colleagues.[14]

Our results reported that advanced age was associated with high risk of infection with COVID-19, as reported by Zhou and colleagues[15]

Advanced age has been identified as an important predictor of mortality due to SARS and MERS infection.

Table 6. Correlation study between HRCT score and other studied data in studied patients.

HRCT	Studied patients		HRCT	Control	
	r	*P*-value		*r*	*P*-value
WBCs	0.16	0.271 NS	AST	0.32	0.022 S
Neutrophil %	0.51	<0.001 HS	ESR	0.47	0.001 S
neutrophil Abs	0.22	0.121 NS	CRP	0.34	0.016 S
Lymph. %	−0.40	0.004 S	Dimer	0.47	0.001 S
Lymph. Abs	0.11	0.433 NS	ferritin	0.34	0.015 S
Hb	−0.12	0.397 NS	NLR %	0.29	0.045 S
PLT	−0.12	0.414 NS	NLR Abs	0.08	0.571 NS
ALT	0.32	0.022 S			

(r): Pearson correlation coefficient.
S: *P*-value <0.05 is considered significant.
HS: *P*-value <0.001 is considered highly significant.
NS: *P*-value >0.05 is considered nonsignificant.

Table 7. Outcome results among all patients.

	Studied patients ($N = 50$)	
Outcome		
Survived	43	86%
Died	7	14%

Songlin and colleagues,[10] reported different results because they found cough in 57.66% of patients and dyspnea in 20.72% of patients, this may be due to different demographic status of the patients in Songlin's study, because their study was on 211 patients, 100 of them were RT-PCR -ve and 111 patients were RT-PCR + ve.

In their met analysis, Vaseghi and colleagues,[11] mentioned that fever was the most common non-respiratory clinical manifestation in 79.9% of patients; these results matched our results, because we found also fever was the most common non respiratory clinical manifestation in 84% of our patients.

In our study, the most common CT findings were bilateral GGOs 60%, unilateral GGOs 14%, both consolidation and GGOs 10%, while 8% had GGOs and crazy paving.

Zhao and colleagues,[16] in their study found similar as the found GGOs in 86.1% of cases, but their study results were not similar as regard GGOs with consolidation as they found them in 64.4% of cases. Also (Adam's et al. 2020), results disagreed with our results as they found that 41 patients (33.8%) had bilateral GGOs, 6 patients (4.95%) had consolidation, 50 patients (41.3%) had both GGOs with consolidation, and 6 patients (4.95%) had honey combing. This mismatch might be due to difference in number of enrolled patients in each study, preexisting chronic lung disease, timing of CT in relation to onset of symptoms and the severity of the disease.

GGO seen in CT chest has been reported to be a very common finding in COVID-19 pneumonia as 100% of patients whose diagnosis was confirmed by RT-PCR had this finding in a study of 58 patients in Italy.[21]

Caruso et al. (2020)[21] in their study they reported that none of the CT features (i.e., GGO, bilateral distribution of pneumonia, involvement in more than two lobes, consolidation, and lymphadenopathy) were significantly different between those with confirmed COVID-19 who required admission verses those who were discharged for home isolation.

The multivariable logistic regression assay suggested that the decreased lymphocytic count was a risk factor for in-hospital death and further analysis concluded that lymphocytic count was a stronger indicator in predicting in-hospital death of COVID-

19 pneumonia indicated by the ROC assay. Previous studies showed that lymphopenia was a risk factor for increased mortality rate for SARS and COVID-19 Sahu and colleagues.[17]

In our study, NLR%, the mean NLR of all studied patients was 10.3 ± 8.6 with minimum NLR of 2.07 and max. neutrophil of 44.6.

As regard NLR (absolute), the mean NLR of all studied patients was 12.5 ± 10.4 with minimum NLR of 2.07 and maximum neutrophil of 46.

Liu et al.,[19] demonstrated the percentage of lymphocytes LYM [%] was a potential predictor of COVID-19 severity.

A previous study suggested that about 90% of patients with severe pneumonia had increased coagulation activity, marked by the increased D-dimer concentrations.[22]

High levels of D-dimer was proved to be associated with increased mortality rate in patients with sepsis identified in the emergency room[23]. Previous research also demonstrated that D-dimer greater than 1 μg/ml was associated with fatal outcome of COVID-19 Zhou and colleagues.[15]

In this study, D-dimer was also identified as a risk factor The mean D-Dimer of all studied patients was 0.7 ± 0.6 with minimum D-Dimer of 0.14 and maximum D-Dimer of 2.8.

Positive CRP is a predictor of severity in Ruan et al. (2020)[24] study in agreement with previous studies, SARS-CoV-2 infections were associated with a high morbidity rate in cohort study Zheng et al.,[20] Elevated CRP on admission in patients with Covid-19 was associated with higher risk of death.

The mean CRP of all studied patients was 124.7 ± 88.3 with minimum CRP of 3.2 and maximum CRP of 317. We are in accordance with earlier studies which had shown a positive association of CRP levels with the lung lesions and severity of illness Wang and colleagues.[18] Sahu et al., 2020 recorded higher CRP concentrations among patients who died of COVID-19 infection compared with survivors.

4.1. Conclusions

Our data provide insight about CT scanning severity Score with inflammatory markers and blood picture among patients with severe COVID-19 disease in Egypt. Advanced age was more liable for infection with COVID-19. Most common Respiratory symptom is cough followed by dyspnea. Most common nonrespiratory symptom is fever followed by bony ache. Incidence of diarrhea in our COVID patients may be due to abusing of antibiotics and vitamins. Most common finding in CT pattern in COVID patients was bilateral peripheral GGO. Although it is uncommon, GGO can occasionally be present in COVID patients with consolidation.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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