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Relationship between CT-finding, degree of lung involvement and oxygen saturation in hospitalized patients with COVID19

Ala Hussian Haider[11], Fadhil Kadhim Jasim Alsultani[2], Usama Khalaf Mohan[3]

[1] *College of medicine, University of Babylon, Iraq*
[2, 3] *Merjan teaching hospital Babylon/ Iraq*

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Abstract

objective :With the pandemic of COVID-19 and increasing number of patients all over the world including our country (Iraq) , there is a need to study the relationship between the CT_ finding and the saturation of oxygen in hospitalized patient.Methods :A prospective study involved hospitalized patients (diagnosed by PCR) admitted to merjan teaching hospital between 15 july and 30 october 2020 , history was taken regarding age, gender, symptoms ,presence of comorbidities , body mass index was measured ,CT was done to all patients ,degree of lung involvement was assessed for every patient , O_2 saturation was measured.Results :cross sectional study involved 150 patients, (40.7%) females and (59.3%) males, (76.0%) had history of contact , (4.7%) had history of travel, symptoms were fever (81.3%) , cough (64%) , fatigue (56.7%) , shortness of breath (44.7%) , chest pain (27.3%), headache (26.7%),sore throat (18.0%) , loss of smell and taste (11.3%) , abdominal pain (4%),comorbidities were as follows hypertension (39.3%) , diabetes (33.3%) ,ischemic heart disease (4.0%) , rheumatoid arthritis (1.3%) , smoker (8.7%). Regarding CT-finding (99.3%) had ground glass appearance , bilateral lesion occurred in 94%, 23.3% crazy paving and 14% had consolidation , (0.67%) had grade1 , (26%) grade 2 , (32.67%) grade 3 ,(30.67%) grade 4 and (10%) grade 5, (13.33%) had normal oxygen saturation, (11.33%) mild hypoxia, (23.33%) moderate hypoxia , (52%) had severe hypoxia.Conclusion : There was significant association between involvement of lung tissue by CT and body mass index ,also significant association between lung involvement and oxygen saturation ,while there was no significant association between lung involvement with respiratory rate and gender.

Keywords

CT-finding; hospitalized patients; COVID19

Covid19 is an virus that connected to a nucleoprotein surrounded by a matrix protein based capsid (De Haan et al., 1998; Koetzner et al., 1992).

Coronaviruses (CoVs) belong to the subfamily Orthocoronavirinae in the family Coronaviridae, Order Nidovirales. There are four genera within the subfamily Orthocoronavirinae, namely Alphacoronavirus (α-CoV), Betacoronavirus (β-CoV), Gammacoronavirus (γ-CoV) and Deltacoronavirus (δ-CoV). (Banerjee et al., 2019; X. Xu et al., 2020)

The first identification and outbreak from a cluster of novel human pneumonia cases occurred

in Wuhan City, China, since late December 2019. The earliest date of symptom onset was 1 December 2019 ,although SARS-CoV-2 is alleged to have been originated from an animal host (zoonotic origin) with further human-to-human transmission ,in general patients show symptoms of COVID-19 result from spread of the disease to those in close contact .respiratory secretions are known to spread in daily activities (e.g. exhaling, talking, coughing, and sneezing) and other procedures (e.g. tracheal intubation, non-invasive ventilation ,bronchoscopy, and tracheotomy), nosocomial infections through aerosols can occur when they perform procedures on the respiratory pathway (Huang et al., 2020; Peng et al., 2020; Rodriguez-Morales et al., 2020; She et al., 2020; Zietsman, Phan, & Jones, 2019).

The inhaled virus SARS-CoV-2 may bind to epithelial cells in the nasal route and begin replicating. ACE2 receptor is the main site for SARS-CoV2 ,The pathogenesis involves two factors, the lung inflammation of are related to high immunologic response and over-production of inflammatory cytokines , The step of the viral multiplication is the attachment to the surface of respiratory cells mediated by the spikes viral protein principally can lead to modulating host responses to infection (Y. Xu et al., 2020). Chest CT finding of COVID-19 infection is typical to be multiple bilateral ground-glass opacities (GGOs) with a predominantly peripheral distribution. The general finding of COVID-19 disease can be with a variety of CT findings , the most common findings in general are GGO (68.1%), crazy-paving pattern (35.6%), and consolidation (32.0%), respectively , pleural thickening (27.1%), and rarely pleural effusion is present in 5.3% of patients (Kim, 2020; J. Zhu et al., 2020).

Aim of study

COVID19 is pandemic disease and the aim is to study the relationship between the CT-finding, degree of lung involvement and oxygen saturation in hospitalized patient with covid19.

Patients and methods

A cross sectional study had been made for hospitalized 150 patients in Marjan teaching hospital(infectious ward) after permission diagnosed as covid19 with positive PCR between 15 of july to 30 of October 2020.History was taken from these patients regarding duration of illness including age ,gender ,travel history ,contact with covid19 patients, duration of illness and symptoms including(fever ,cough dry/productive ,shortness of breath ,fatigue ,loss of smell ,abdominal pain ,headache ,sore throat) as well as history of chronic illnesses(diabetic mellitus ,hypertension ,rheumatoid arthritis ,malignancy ,ischemic heart disease), history of significant smoking was taken, patients with heart failure, asthma, chronic obstructive pulmonary airway disease were excluded because of admitted patients in infectious wards and intersect with CT-scan finding of covid19 patients ,oxygen saturation was measured with fingertip pulse Oximeter -jumber (FDA approved) at index finger after cleaning with 70% ethanol , Body mass index was calculated by LCD personal scale and tape measure for length ,respiratory rate was measured for every patient . All patients were symptomatic and admitted to hospital, CT-chest (native) without contrast was done in the first day of admission after sending them for PCR and laboratory investigations and calculated the percentage of CT- chest with radiologist. CT-Finding involvement was classified into: - (Salehi et al., 2020)

Grade1: <5% involvement
Grade2: 5-25 % involvement
Grade3: 26-49% involvement
Grade4: 50-75% involvement
Grade5: >75% involvement

Hypoxia was classified as follows:- (Berrizbeitia, 2014; Johnson & Theurer, 2014)

1.Normal spo_2 100-95%
2.Mild hypoxia spo_2 94-90%
3.Moderate hypoxia spo_2 89-85%

4.Sever hypoxia spo_2 <85%

BMI(body mass index) : - (Hales et al., 2018)

- Underweight - BMI under 18.5 kg/m^2
- Normal weight - BMI greater than or equal to 18.5 to 24.9 kg/m^2
- Overweight – BMI greater than or equal to 25 to 29.9 kg/m^2
- Obesity – BMI greater than or equal to 30 kg/m^2

Respiratory rate was classified as :(normal <20 breath/minute ,abnormal >20 breath/minute) (Muntner et al., 2019).

Data analysis

Statistical analysis was done by SPSS 22, frequency and percentage used for categorical data, mean, median and SD for continuous data. Chi-square was used for assessing association between variables, person correlation show the correlation between continuous data. P-value less or equal to 0.05 was considered significant.

Results

The study involved 150 patients, (40.7%)were females and (59.3%) were males, (76.0%) of patients had contact with covid19 positive cases and (4.7%) of them had history of travel, (81.3) of them had fever and the study showed cough occurred in (64%) of patients and productive cough occurred in (14%) , the study also showed fatigue and shortness of breath occurred in (56.7%) and (44.7%) of patients respectively , the study showed that chest pain occurred in (27.3%), headache (26.7%),sore throat (18.0%) ,the study also showed loss of smell and taste occurred in (11.3%) while abdominal pain occurred in (4%) as show in table (1) below.

Table 1: distribution of gender, contact, travel and symptoms.

Variables	Frequency	Percentage
Female	61	40.7
Male	89	59.3
Contact	114	76.0
Travel	7	4.7
Fever	122	81.3
Cough	96	64.0
Fatigue	85	56.7
SOB	67	44.7
chest pain	41	27.3
Headache	40	26.7
sore throat	27	18.0
Productive cough	21	14.0
loss of smell	17	11.3
Abdominal pain	6	4.0

Table 2 shows comorbidities like hypertension occurred in 59 patients (39.3%), diabetes 50 patients (33.3%), IHD 6 patients (4.0%), rheumatoid arthritis and malignancy 2 patients (1.3%) and 0 patients (0%) respectively, finally the smokers were 13 patients (8.7%).

Table 2: distribution of comorbidities and smoking among covid19 patients:

Variables	Frequency	Percentage
Hypertension	59	39.3

Diabetic mellitus	50	33.3
Smoking	13	8.7
Rheumatoid arthritis	2	1.3
Malignancy	0	0
Ischemic heart disease	6	4.0

The CT- finding showed ground glass occurred in149 (99%), crazy paving occurred in 35 patients (23.3%) and consolidation occurred in 21 patients (14.0%), both involvements occurred in 141(94%) and unilateral lung occurred in 9 patients (6.0%), (3.3% for left and 2.7% for right) and the distribution in bilateral involvement include: inferior 38(26.0%), central 29(19.3%). peripheral 39(26.4%) and posterior 44(29.3%) as shown in table 3,4.

Table 3: Pattren of CT-finding.

	Frequency	Percentage
G. glass	149	99.3
Crazy paving	35	23.3
Consolidation	21	14.0

Table 4: distribution of CT finding.

Variables	Frequency	Percentage
Bilateral	141	94.0
Posterior	44	29.3
Peripheral	39	26.4
Inferior	38	26.0
Central	29	19.3
Unilateral	9	6.0
Left	5	3.3
Right	4	2.7

The duration of illness before hospital admission; 70(47.33%) of patients arrived within 5 days and less, 60(44%) of them within 6-10 days duration and 30(8.67%) of more than 10days.The BMI 8patients (5.33%) were underweight ,45 patients(30%) were normal,51 patients (34%) were overweight and46 patients(30.67%) was obese .Respiratory rate increased above 20 breath\minute in 135(90%) and normal in 15(10%).About the involvement level of lung tissue parenchyma in CT scan 1 patient(0.67%) of patients had grade1 involvement , 39 patients(26%) of patients had grade 2 involvement , 49 patients (32.67%) of patients had grade 3 involvement ,46 patients(30.67%) of them had grade 4 involvement and 15 patients(10%) of patients had grade 5 involvement. While Spo_2 level of patients as follows (13.33%) normal spo_2, (11.33%) mild hypoxia, (23.33%) moderate hypoxia and (52%) of them with severe hypoxia. All these are shown in figures (1,2,3,4,5).

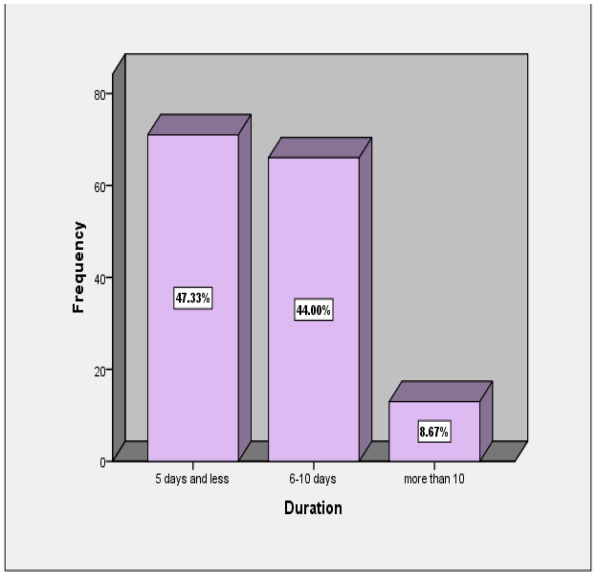

Fig (1): distribution of duration of illness before hospital admission.

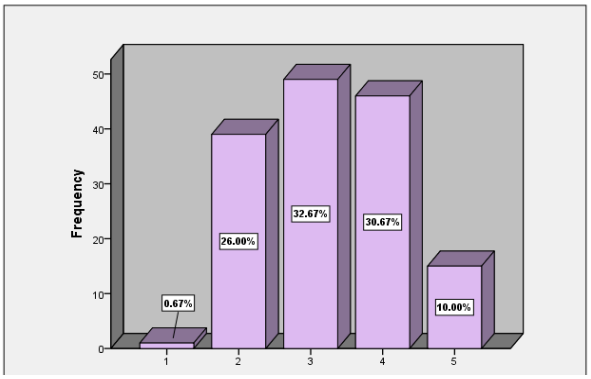

Fig (4): distribution of involvement level of lung tissue under CT scan. grade 1: <5% involvement. grade 2: 5-25% involvement grade. 3: 26-49% involvement grade. 4: 50 involvement level of lung tissue under CT scan -75% involvement grade. 5: more than 75 % involvement.

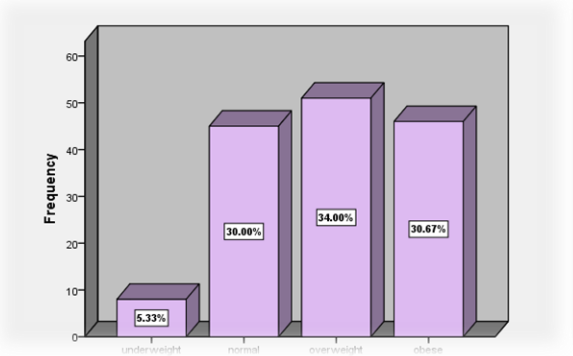

Fig (2): distribution of patients according to BMI.

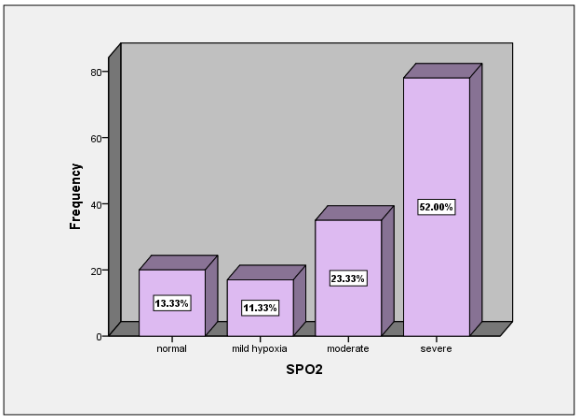

Fig (5): distribution of patients' Spo2 level.

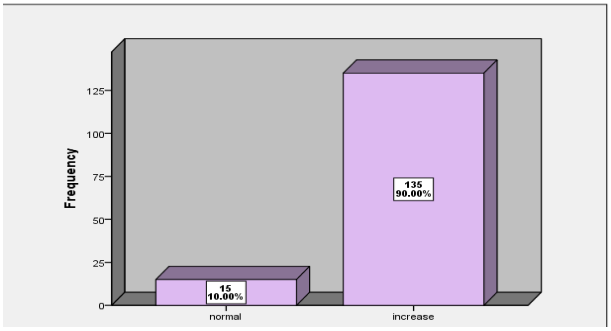

Fig (3): distribution of patients according to respiratory rate.

According to table 5: there was significant association between involvement level of lung tissue by CT scan and BMI of patients; 46.7% of patients in grade 5 involvement were overweight and 40% of them in grade 5 involvement were obese.

In addition, there was significant association between involvement level of lung tissue by CT scan and Spo_2 level of patients; 80% of patients in grade 5 involvement had severe drop in Spo_2 and 63% of them in grade 4 involvement had severe drop in Spo_2.

There was no significant association between involvement level of lung tissue by CT scan with gender and respiratory rate.

Table (5): distribution between involvement level of lung tissue in CT scan and (gender, BMI, respiratory rate and Spo2).

Variables				CT			P-value
		1	*2*	*3*	*4*	*5*	
Gender	**Female**	0	19	23	16	3	
	%	0.0%	48.7%	46.9%	34.8%	20.0%	0.21
	Male	1	20	26	30	12	
	%	100.0%	51.3%	53.1%	65.2%	80.0%	
	Total	1	39	49	46	15	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Underweight	1	2	2	2	1	
	%	100.0%	5.1%	4.1%	4.3%	6.7%	
BMI	**Normal**	0	9	16	19	1	**0.009**
	%	0.0%	23.1%	32.7%	41.3%	6.7%	
	Overweight	0	16	14	14	7	
	%	0.0%	41.0%	28.6%	30.4%	46.7%	
	Obese	0	12	17	11	6	
	%	0.0%	30.8%	34.7%	23.9%	40.0%	
	Total	1	39	49	46	15	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	
Respiratory rate	**Normal**	0	4	8	2	1	0.39
	%	0.0%	10.3%	16.3%	4.3%	6.7%	
	Increase	1	35	41	44	14	
	%	100.0%	89.7%	83.7%	95.7%	93.3%	
	Total	1	39	49	46	15	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	
	Normal 95-100mmhg	0	6	12	2	0	
	%	0.0%	15.4%	24.5%	4.3%	0.0%	
SPO2	**mild hypoxia 94-90mmhg**	1	6	6	3	1	**0.007**
	%	100.0%	15.4%	12.2%	6.5%	6.7%	
	Moderate 89-85mmhg	0	7	14	12	2	
	%	0.0%	17.9%	28.6%	26.1%	13.3%	
	Severe <85mmhg	0	20	17	29	12	
	%	0.0%	51.3%	34.7%	63.0%	80.0%	
	Total	1	39	49	46	15	
	%	100.0%	100.0%	100.0%	100.0%	100.0%	

P-value less than 0.05 (significant).

Discussion

This study showed the gender of patients was 89(59.3%) male and 61(40.7%) female, other study showed men and women as 55% and 45%, respectively, men are most likely to be infected with covid19 than women ,may be due to that men are more outdoors and thus more chance to be infected , they may have poorer outcome (Alon et al., 2020).

The study also showed that 114 (76%) of patient had history of contact with infected patients, those who didn't give history properly they were not aware about contacts or contact with asymptomatic patients .Aerosols are large in concentration in people whose in close contact leads to fast viral transmission but it can occur at far distances in places that are poorly ventilated (Burke et al., 2020; Rambaut et al., 2020; Wang et al., 2021).

This study showed that fever occurred in

122(81.3%) of patients and it was_the most common symptoms in patients while other studies shows variable results 88.7% ,79.43% , 70%, 98%, 82.7%, 85% and 88.7% (all of them are high percent) (Guan et al., 2020; Hui & Zumla, 2019; Z. Zhu et al., 2020).

This result makes fever as the most common symptom but in this study the absence of fever didn't exclude covid19 for this reason 28(18.7%) of patients had no fever.

The study showed that cough occurred in 96(64%) of patients and productive cough occurred in 21(14%) while other studies shows cough to occurred in about 50% of patients with covid19, Patients recognized with COVID-19 in China had a cough in up to 80% of patient and mostly dry cough in 60% of patients while cough occurred in 48%, 83%, 72%, 82.6% and 67.8% in different studies so generally cough is common symptom and is usually dry (Chan et al., 2020; Chen et al., 2020; J. Liu et al., 2020; Menni et al., 2020).

The study also showed that fatigue and shortness of breath occurred in 85(56.7%) and 67(44.7%) of patients respectively while other studies shows_Fatigue 38.5% , 44% and Dyspnea: 26.1%, (55%),42%, of patients with covid19 (Assiri et al., 2013; Huang et al., 2020; Lechien et al., 2020; Wang et al., 2020).

The study showed that chest pain occurred in 41(27.3%) ,headache occurred in 40 (26.7%) and sore throat occurred in 27(18.0%) while other studies showed chest pain (10.4%), headache (35.4%,55.8%), sore throat (12.5%,23.2%) of patients (Booth et al., 2003; Huang et al., 2020; Wu & McGoogan, 2020). There are multiple explanations for chest pain in patients with covid19 may be due to cough, pulmonary embolism, pleurisy, cardiac and possible other causes.

The study also showed loss of smell and taste occurred in 17 (11.3%), abdominal pain occurred in 6(4%) other studies shows variable results 19%,58% of patients having loss or alter of smell and/or taste and abdominal pain (17%,3.5%) of patients (Chan et al., 2020; Moein et al., 2020; Zhang et al., 2020). The abdominal pain was infrequent symptom of covid19 may be related to radiation from lower lung lobe infection and could be pancreatitis, the loss of smell and taste always came together in different studies.

The study showed that travel was found in 4.7 % of patients including the travel outside the country other study shows 3.7% (Li et al., 2020). The travel was restricted because of closed boundaries with other countries and this probably explain the low percentage of travellers.

The study showed comorbidities like hypertension occurred in 59(39.3%) , diabetes occurred in 50(33.3%) , IHD occurred in 6(4.0%) , rheumatoid occurred in 2 (1.3%) and malignancy occurred in 0 (0%) , other study shows variable results Zhang et al studied 140 patients with COVID-19 and (37.9%,30.0%) of those had history of hypertension and ischemic heart disease (16.4%), and DM (9.7%,12.1%) and other studies in Hong Kong showed 0.0126% of cases with rheumatoid arthritis and reported a cancer incidence of 1.13% among 1,590 cases of COVID-19 in China. The varieties in incidence of comorbidities may be related to variable prevalence of the these diseases in different societies. There was no number of patient with malignancy in this study and this properly related to low number of patients in this study (Giannakoulis, Papoutsi, & Siempos, 2020; Ho et al., 2020; Parascandola & Xiao, 2019; Patanavanich & Glantz, 2020).

The study showed that 13(8.7%) of patient were smokers in comparison with others studies there were different figures in incidence of a smoking history, ranging from (1.4% to 26.9%) (Menni et al., 2020; Wong et al., 2020).

The CT- finding showed that ground glass occurred in149 (99%), crazy paving occurred in 35(23.3%), consolidation occurred in 21 (14.0%),

bilateral involvement occurred in 141(94%), unilateral lung occurred in 9(6.0%), (3.3%for left and 2.7%for right) and the distribution in both involvement included: inferior 38 (26.0%), central 29(19.3%). peripheral 39(26.4%) and posterior 44(29.3%) while other study showed GGO (77.18%) , consolidation (35.56%) , crazy-paving pattern (35.6%) and (6.6%) unilateral in all cases (4% on the right side and 2.6% on the left side) most cases had bilateral involvement of lungs in (75.72%) and most of the lesions were peripherally distributed (65.64%), inferior lobe (53.8%) and central involvement is (7.7%) (Bai et al., 2020; Linton et al., 2020). The vast majority of patients with covid19 in this study had bilateral involvement which occurred in most hospitalized patient because they were advanced thus unilateral was low, also the inferior and peripheral distribution was hallmark of primary disease site and the central is not common site. The GGO is the most common finding in covid19 followed by crazy paving that usually appears later in the disease while the consolidation appears as early presentation and decrease later on.

Regarding the duration of illness this study showed that (70)47.33% of patients arrived within 5 days while (60)44% of patients came after 6-10 days of starting the symptoms other study shows 50% median delay of 1-6 days, with a 25% of the patients having a delay longer than5 days. this showed that the patients came late (Piva et al., 2020).

About the BMI 8patients (5.33%) were underweight ,45 patients(30%) were normal,51 patients (34%) were overweight and46 patients(30.67%) was obese while other study shows obese patients present in 31% of patients, with an additional 58% being overweight and (11%)are normal weight and this may be related to different BMI levels in different population (Y. Liu et al., 2020).

In this study the respiratory rate in 90% of patients was increased (rate >20 breath/minute) and 10% of patients with normal respiratory (rate <20 breath/minute) while other studies found that (60%) had increased respiratory rates in the 14th day of infection (Fu et al., 2020). This study showed high number increased of respiratory rate this may be related to high number of severe cases being all patients are hospitalized.

In this study the grades of involvement of lung tissue by CT scan. were Grade1:<5%involvement(0.67%), Grade 2: 5-25% involvement(26%),Grade 3: 26-49% involvement(32%), Grade 4: 50%-75% involvement (30.6%), Grade 5: more than 75 % involvement(10%) ,while other study shows the degree of involvement in score 0 (0% or none)(25.8%), score 1 (1–5% or minimal)(22.1%), score 2 (6–25% or mild)(25.8%), score 3 (26–49% or moderate)(14.6%), score 4 (50–74% or severe)(8.5%), and score 5 (⩾ 75% or extensive)(3.2%).Most patient in this study were late and so more patients had 26%-75% involvement (Kang et al., 2020).

There was significant association between involvement level of lung tissue in CT scan and BMI , p-value (**0.009)** , patients(46.7%) of patients in grade 5 involvement were overweight and (40%) of them in grade 5 involvement were obese in other study 91.7% of cases with severe involvement were obese (Zhao et al., 2020). There is association between the obesity and severity of disease may be related to metabolic abnormalities like diabetes mellitus which is more in obese patients and thus this is reflected on the CT-involvement.

In this study there was significant association between involvement level of lung tissue by CT scan and Spo2 level of patients; p-value (**0.007)** ,80% of patients in level 5 involvement were severe hypoxia and 63% of them in level 4 involvement were severe hypoxia. Other study showed that resting oxygen saturation <93% associated with higher CT severity score. This indicates the higher

CT severity score is related to severe clinical condition (Yang et al., 2020).

In this study there was no significant association between CT-involvement and respiratory rate for the increase in respiratory rate occurred in (35%) in grade 2, (41%) in grade 3, (44%) in grade 4 and (14%) in grade 5 and didn't reflect the severity score in CT- finding.

Conclusion

1.Fever is the most common symptom of covid19 followed by cough and fatigue.
2.Abscence of fever doesn't exclude the disease.
3.Most common CT –finding is ground glass appearance followed by crazy paving and consolidation.
4.Most CT-finding occurs bilaterally and peripherally.
5.There is significant association between degree of lung involvement and body mass index.
6.There is significant association between the degree of lung involvement and oxygen saturation.
7.There is no significant association between the lung involvement with gender and respiratory rate.

Recommendation

1. Encourge patients to consult doctors when symptoms occurred.
2.Special care needs to be given for obese patients because they are more liable to get severe illness.
3.Special care needs to be given to a higher grades of lung involvement by CT because they are more liable to be hypoxic and poor prognosis.

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