

CT Chest Criteria of COVID-19 Infection: Cross Sectional Study

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Abstract

Background: COVID-19 infection is pandemic with increase mortality and morbidity all over the world, nature of the virus, induced lung changes, and its complications not fully understood. Purpose of the study to assess different CT criteria of suspected COVID-19 patients and its correlation with PCR results.

Aim of Study: Was to recognize different changes of lung parenchyma by CT in suspected COVID-19 patients and correlating these results with PCR results.

Patients and Methods: This study was done between May 2020 to June 2020, proved 26 negative and 52 positive RT-PCR test and their CT chest study was revised in Radiodiagnosis Department, Presenting symptoms were fever, bone aches, fatigue, loss of smell and taste sensation, cough and anorexia, By laboratory tests, raised CRP and ESR, CBC leukopenia and lymphopenia are suggestive of infection.

Results: 78 cases, 32 (41%) females and 46 (59%) males patients were studied, their ages ranged from 25 to 65 years (mean age $45 \pm 0.1y$). Males' patients, PCR was done for all cases, 52 were positive and 26 were negative test, CT was revised to show presence of parenchymal lung abnormalities and correlated with PCR results. Bilateral peripheral lung distribution of the lesions was common. CT findings in PCR positive cases were: 35/52 had ground glass density (GGD), 22/52 consolidation, 24/52 reticular shadows, 8/52 crazy paving, 20/52 nodules and 8/52 bronchiectasis, 26 were negative PCR test showed 2/26 GGD, 1/26 consolidation, 7/26 reticular shadows, 0/26 crazy paving, 5/26 nodules and 4/26 bronchiectasis. Most sensitive CT finding was ground glass opacity, Sensitivity, Specificity, Positive predictive value, Negative predictive value, Accuracy were 67.31%, 92.31%, 94.59%, 58.54% and 75.64% with statistically significant p -value <0.001 . Crazy paving appearance was the most specific finding that showed Sensitivity, Specificity, Positive predictive value, Negative predictive value, Accuracy 15.38%, 100%, 100%, 37.14%, 43.59% with statistically significant p -value <0.002 .

Conclusion: This study clarify the role of CT chest in COVID-19 infection by diagnosis of different CT findings and parenchymal abnormalities also CT findings correlated with PCR results, most of positive PCR test shows GGD.

Key Words: CT chest – COVID-19 – GGD – Crazy paving.

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Introduction

COVID-19 infection is a novel strain of corona virus was started at china whuan and spread all over the world, It is rapidly infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which is strain of corona virus and named COVID-19 [1]. Incubation period of COVID-19 was initially calculated to be about five days [2]. At July 2020, the number of deaths from COVID-19 passed half a million globally. The case fatality rate is 2-3%. It is speculated that the true case fatality rate is lower than this because many mild cases are not being tested, which results in high apparent death rate [3].

COVID-19 is presumed to be transmitted by respiratory droplets, close contacts and self-inoculation to nose, mouth and eyes [4].

It is estimated that in 70% of patients, the disease is asymptomatic or with very mild symptoms while in the remaining 30% there is light respiratory syndrome as fever, cough until severe respiratory failure is reached who may require intensive care unit admission [5].

Clinical manifestations of the disease are different, in mild disease cough, fever, bone aches and mild pneumonia symptoms, Severe form of the disease shows dyspnea, increase respiratory frequency and decrease blood oxygen saturation while critical disease complaints from respiratory failure, septic shock and/or multiple organ dysfunction [6].

Definite diagnosis of COVID-19 requires positive reversible transcription-polymerase chain reaction (RT-PCR) test which was the gold standard for sure diagnosis however other suggesting tests can be used as complete blood count (CBC) showed leukopenia and lymphopenia, raised C-reactive protein (CRP), raised erythrocyte sedimentation

rate (ESR), their CT study were revised to show different lung parenchyma changes.

Chest X ray has no role in early cases with COVID-19 compared with CT that showing any lung parenchymal changes early in the course of the disease, while X-ray has a role in late stages of the disease [7]. In some cases RT-PCR test may be negative in COVID-19 infected cases but CT can show positive criteria [8,9].

COVID-19 outbreak and upgrowing worldwide pandemic with the catastrophic mortality, inclusive understanding and characterization of the diagnostic imaging findings, variable criteria of chest imaging lineaments are crucial for proper patient management and treatment [10].

Aim of this study was to recognize different changes of lung parenchyma by CT in suspected-COVID-19 patients and correlating these results with PCR results.

Patients and Methods

After approval of our Ethical Committee of this cross sectional study including 78 patients, informed consent was taken from all, 32 (41%) females and 46 (59%) males, ages were 25 to 65 year and mean age 45 ± 0.1 y, This study was done between May 2020 to June 2020, proved 26 negative and 52 positive RT-PCR test and their CT chest study were revised in Radiodiagnosis department, Presenting symptoms were fever, bone aches, fatigue, loss of smell and taste sensation, cough and anorexia, By laboratory tests, raised CRP and ESR, CBC leukopenia and lymphopenia are suggestive of infection.

CT protocol: 78 cases were done at our university hospital using 64 detectors high speed scanner. Scanning parameters were, tube voltage, 100-120 kV, tube current 110-280 mA, pitch 1.375 and FOV 350-400 mm. 1.5-mm-thick images were reconstructed, high-frequency reconstruction algorithm used. All examinations were done without contrast injection, pregnant women excluded from this study.

Image viewing and evaluation: CT images revised in multiple planes, each lung assessed individually all lobes with peripheral and central parts, bilateral lung presentation and peripheral involvement were the commonest sites. Degree of lung parenchyma involvement assessed with score as the following: score 1: <25%, score 2: >25% <50%, score 3: >50% <75%, score 4: >75% <100% and score 5: 100%.

Statistical results: Data of 78 cases were recorded within excel sheet 2010 Microsoft office, were analyzed with SPSS version 22 continuous variables used expressed in mean (\pm SD). Chi-square test to compare the nominal variables, sensitivity, specificity, positive predictive value, negative predictive value and accuracy were assessed.

Results

78 cases included in this study, age of the patient range 25:65 years old and mean age 45 ± 0.1 y. 32 (41%) females and 46 (59%) males. Many presenting clinical complaints, 40 cases with fever, 61 fatigues, 22 one aches, 23 taste and smell loss, multiple complaints in most of them, laboratory study proved 26 negative and 52 positive RT-PCR cases.

CT findings of all cases presented with bilateral lung affection, 32(41%) cases with peripheral distribution of the lesions, 20 (25.7%) with both central and peripheral distribution. 27 (34.6%) cases presented with focal pattern of the lesions, 25 (32.1%) diffuse and 14 (17.9%) both focal and diffuse lesions. Score of lung involvement was as the following: score 1 in 2 (2.5%) cases, 2 in 37 (47.4%) cases, 3 in 11(14%) cases, 4 in 4 (5.1%) cases and 5 in 12 (15.4%) cases. Ground glass opacities were seen in 37 (47.4%) cases as shown in Fig. (1), consolidation in 23 (29.5%) cases Fig. (2), reticular shadows in 31 (39.7%) cases Fig. (3), crazy paving in 8 (10.3%) cases Fig. (4), nodules in 25 (32.1%) cases Fig. (5), only one nodule with peripheral halo sign Fig. (6), bronchiectasis seen in 12 (15.4) cases as shown in Fig. (7).

CT findings compared with PCR findings were shown in Table (1).

Most sensitive CT finding was ground glass opacity, Sensitivity Specificity, Positive predictive value, Negative predictive value, Accuracy were 67.31%, 92.31%, 94.59%, 58.54% and 75.64% with statistically significant p -value <0.001. Crazy paving appearance was the most specific finding that showed Sensitivity, Specificity, Positive predictive value, Negative predictive value, Accuracy 15.38%, 100%, 100%, 37.14%, 43.59% with statistically significant p -value <0.002.

Consolidation showed high statistically significant p -value with Sensitivity, Specificity, Positive predictive value, Negative predictive value, Accuracy were 42.31%, 96.15%, 95.65%, 45.45%, 60.26%. Table (2).

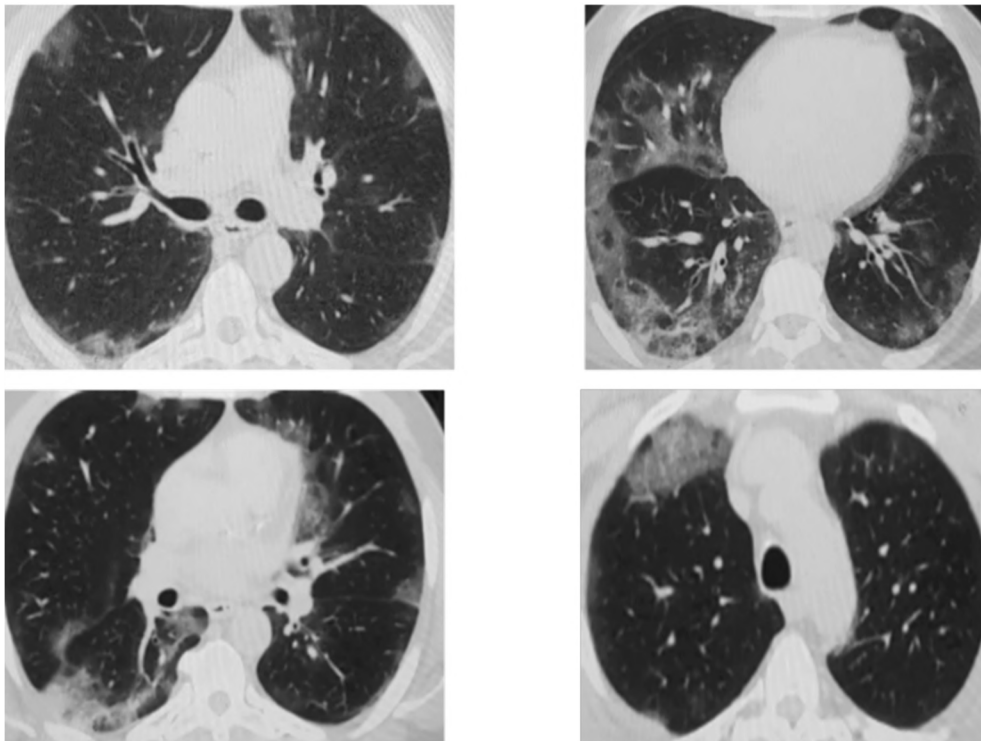


Fig. (1): 32 male patient complaining of fever and cough, Axial CT chest parenchymal window, Ground glass opacities seen in all images, the opacities are seen more peripherally.

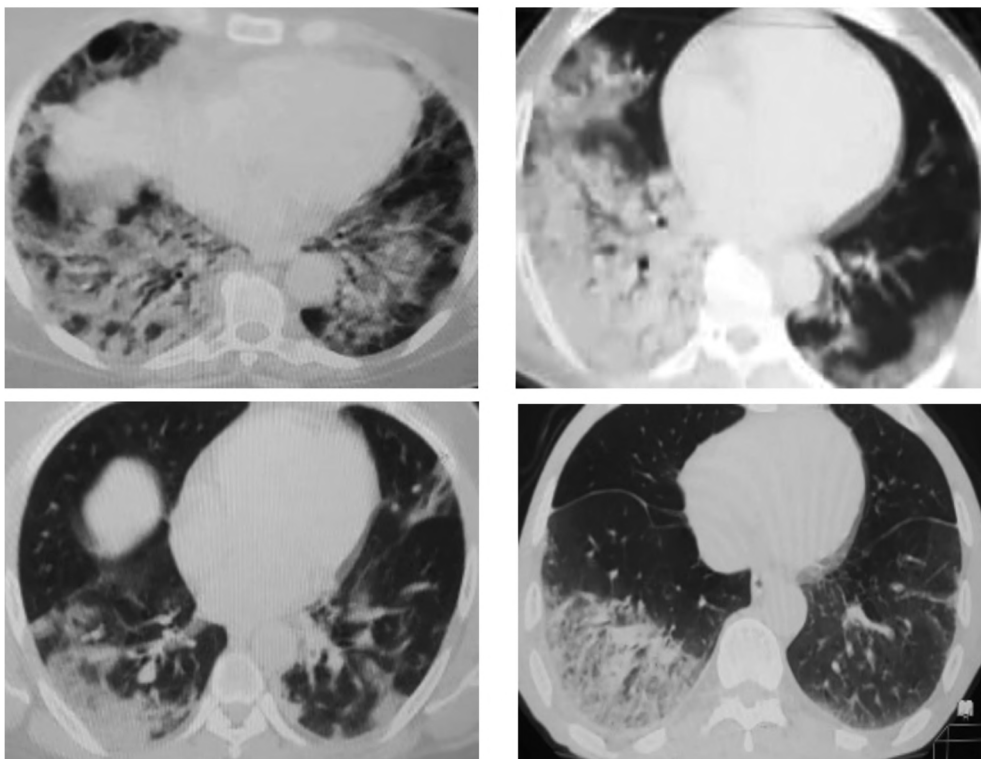


Fig. (2): 42 male patient complaining of fever and expectoration, Axial CT chest parenchymal window, different images of lung consolidation seen as in homogeneous opacity with air bronchogram inside.

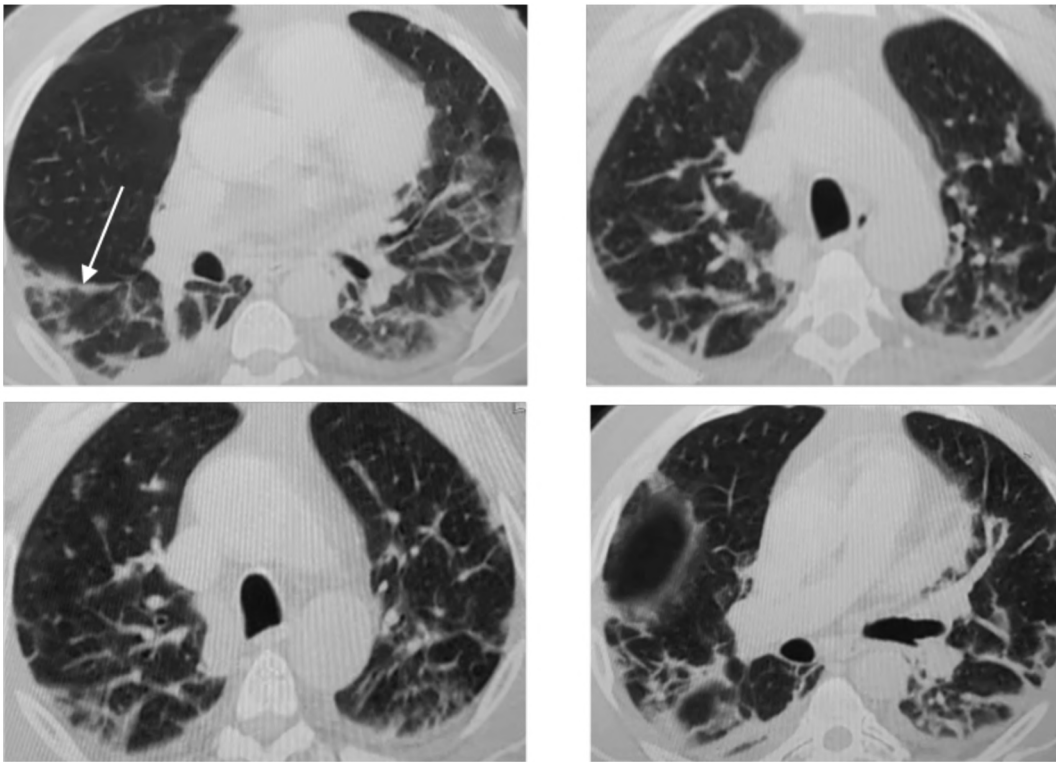


Fig. (3): 50 male patient complaining of fever and dyspnea, Axial CT chest parenchymal window, Bilateral peripherally located reticular shadows.

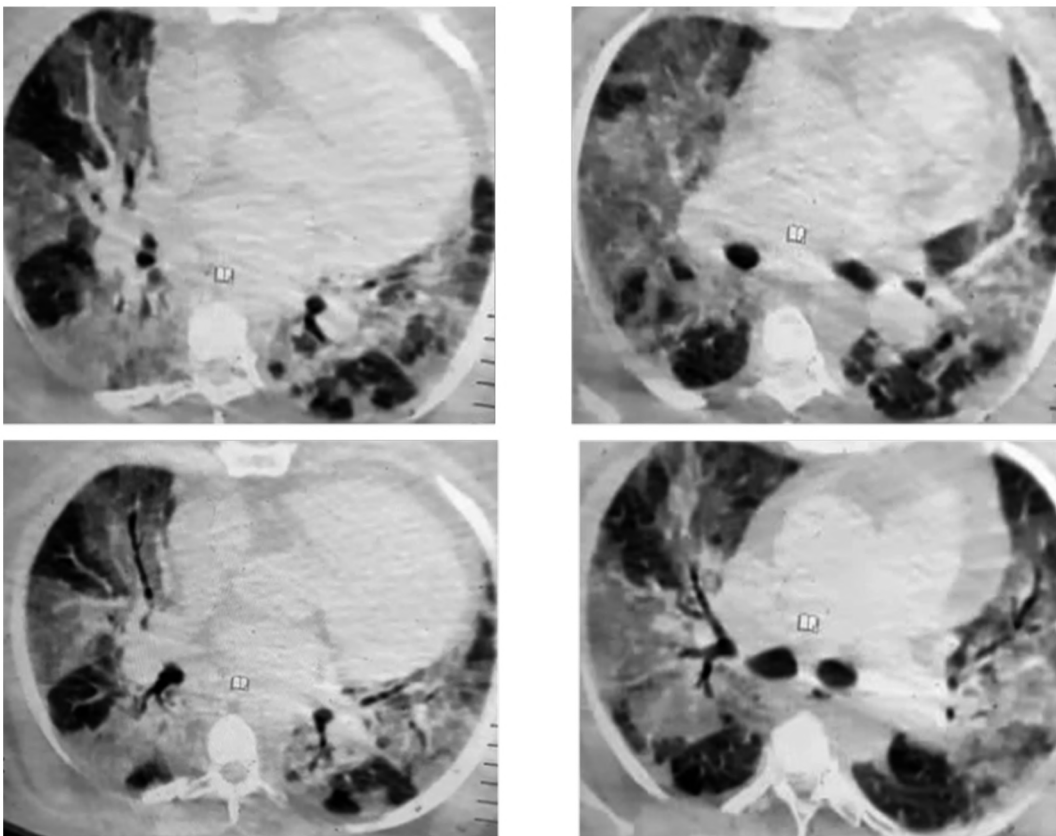


Fig. (4): 21 female patient complaining of fever and dyspnea, Axial CT chest parenchymal window, Crazy paving appearance of lungs formed of ground glass attenuation and thickened interlobular septa.

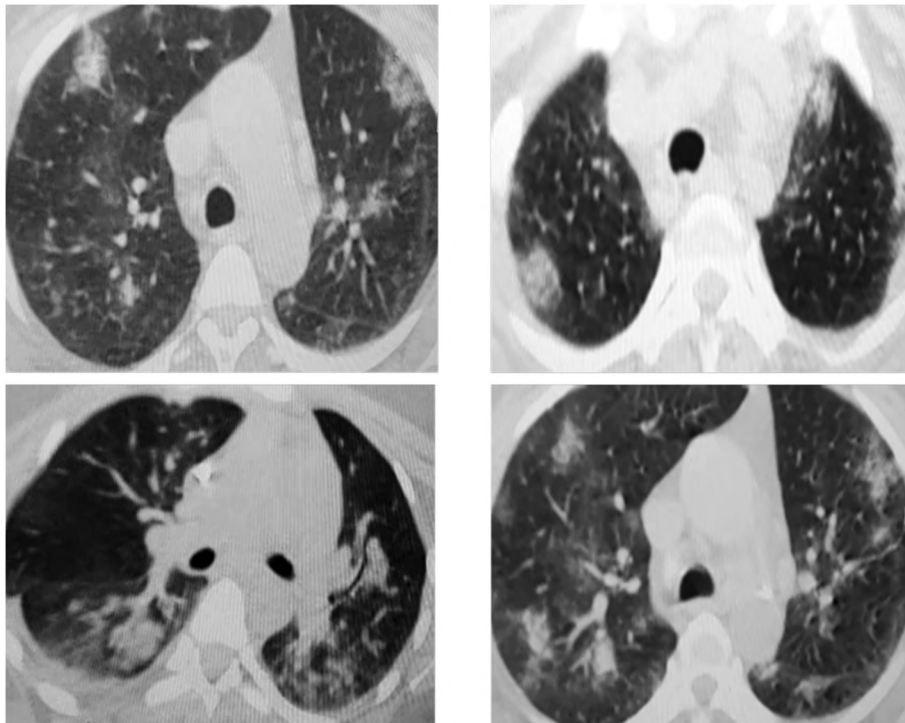


Fig. (5): 38 female patient complaining of fever and chest pain, Axial CT chest parenchymal window, different lung nodular shadows scattered peripherally.

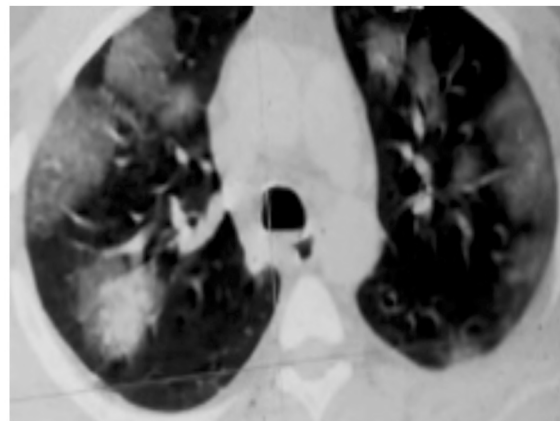


Fig. (6): 57 female patient complaining of fever and cough, Axial CT chest parenchymal window, Lung nodule with halo sign around formed of edema seen at the right lung nodule

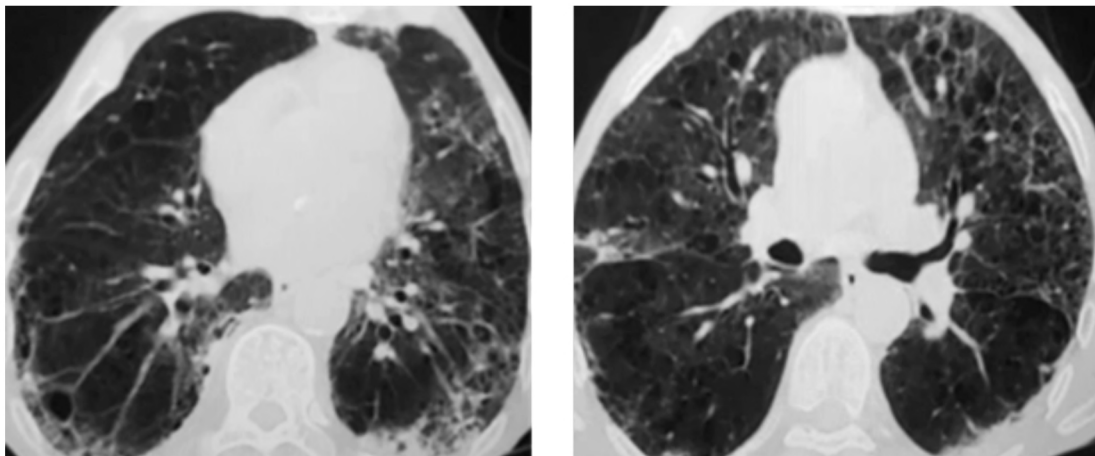


Fig. (7): 67 male patient complaining of fever and cough, Axial CT chest parenchymal window, minimal bronchiectatic changes (white arrows).

Table (1) it shows comparison between CT and PCR results, It showed that GGO, consolidation

and crazy paving appearance had statistically significant results.

Table (1): Showing comparison between CT chest and PCR results.

CT	PCR				p-value
	Positive (n=52)		Negative (n=26)		
<i>Nodules:</i>					
Positive	20	38.5	5	19.2	0.086
Negative	32	61.5	21	80.8	
<i>Ground glass:</i>					
Positive	35	67.3	2	7.7	<0.001
Negative	17	32.7	24	92.3	
<i>Consolidation:</i>					
Positive	22	42.3	1	3.8	<0.001
Negative	30	57.7	25	96.2	
<i>Reticular shadows:</i>					
Positive	24	46.2	7	26.9	0.102
Negative	28	53.8	19	73.1	
<i>Crazy paving:</i>					
Positive	8	15.4	0	0.0	0.035
Negative	44	84.6	26	100.0	
<i>Bronchiectasis:</i>					
Positive	8	15.4	4	15.4	1.000
Negative	44	84.6	22	84.6	

Table (2) Sensitivity, specificity, Positive predictive value, Negative predictive value and Accuracy of different CT findings. Different p-values.

GGO and consolidation most sensitive CT chest criteria while crazy paving was the most specific one.

Table (2): Sensitivity, specificity, Positive predictive value, Negative predictive value and Accuracy of different CT findings. Different p-values.

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy	p-value
Nodules	38.46	80.77	80	39.62	52.56	0.065
Ground glass	67.31	92.31	94.59	58.54	75.64	<0.001
Consolidation	42.31	96.15	95.65	45.45	60.26	<0.001
Reticular shadows	46.15	73.08	77.42	40.43	55.13	0.089
Crazy paving	15.38	100	100	37.14	43.59	0.002
Bronchiectasis	15.38	84.62	66.67	33.33	38.46	1.000

Discussion

COVID-19 is a new highly contagious viral infection caused by a novel coronavirus (SARS-CoV-2) of unclear origin [11]. 78 cases were included in this study and many clinical presentation as following, 40 cases with fever, 61 fatigue, 22 one aches, 23 taste and smell loss. At initial presentation, most cases presented with combined symptoms after days of the course of the disease. In reviewing 78 CT chest studies there were main imaging features of corona virus upon the lung parenchyma, as the following: All cases presented with bilateral lung affection, All cases presented

with bilateral lung affection, 32 (41%) cases with peripheral distribution of the lesions, 20 (25.7%) with both central and peripheral distribution. 27 (34.6%) cases presented with focal pattern of the lesions, 25 (32.1%) diffuse and 14 (17.9%) both focal and diffuse lesions. Ground glass opacities were seen in 37 (47.4%) cases, consolidation in 23 (29.5%) cases, reticular shadows in 31 (39.7%) cases, crazy paving in 8 (10.3%) cases, nodules in 25 (32.1%) cases, only one nodule with peripheral halo sign, bronchiectasis seen in 12 (15.4) cases.

Most sensitive CT finding was ground glass opacity, Sensitivity Specificity, Positive predictive

value, Negative predictive value, Accuracy were 67.31%, 92.31%, 94.59%, 58.54% and 75.64% with statistically significant p -value <0.001.

A study of 30 patients that were tested positive for COVID-19 stated that most common finding were ground glass opacities and this similar to our study, it was seen in 93.3%, consolidation at 23.3%, bronchial thickening at 16.7%, crazy paving appearance at 13.3% and nodule with halo sign about 10% [12].

Similar results stated 2 groups of COVID-19 were studied with their results more with ground glass opacities 88% and 94.3% followed with consolidation bronchovascular thickening, crazy paving appearance, nodules bronchiectasis and effusion [13].

62 patient tested by A study showed peripheral lesions in 70% of patients, Commonest CT pattern was ground glass opacities in 25 (40%) patient, 21 (33.9%), ground glass opacities with reticular shadows 39 (62%), fibrotic streak 35 (56.5%) and effusion in 6 (9.7%) patients. Similar results proved that peripheral distribution of the lesions seen in 71% and most common finding is ground glass opacities. This agreed with our study [14].

Also a study revealed most common CT feature was ground glass opacities seen in 98%, crazy paving 70%, consolidation 64% [15].

It was stated that CT may be helpful in diagnosis but not screening highly suspected cases, that agreed with our study confirmed CT role in diagnosis of different COVID-19 criteria [16].

Our study agreed with a study that showed two cases in the study confirmed that ground glass opacities and consolidation are the most common criteria of COVID-19 [17].

This study stated that bilateral lesions were in all cases similar to a study that showed 10 cases lesions in one lobe, 24 cases in 2 or 3 lobes and 46 cases in 4 or 5 lobes. Ground glass opacities in 90% of patients, ground glass and consolidation in 41%, crazy paving in 40% [18].

Conclusion:

This study clarify the role of CT chest in COVID-19 infection by diagnosis of different CT findings and parenchymal abnormalities also CT findings correlated with PCR results, most of positive PCR test shows GGD.

Declarations:

- *Consent for Publication:* I confirm that all authors accept the manuscript for submission.
- *Availability of data and material:* Available.
- *Competing interests:* None.
- *Funding:* No fund.
- *Conflicts of Interest:* The authors declare no conflicts of interest regarding the publication of this paper.

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معايير التصوير المقطعي المحوسب لعدوى الكوفيد-١٩ : دراسة مقطعية

الخلفية : عدوى كوفيد-١٩ هي جائحة مع زيادة الوفيات والمراضة في جميع أنحاء العالم، وطبيعة الفيروس، والتغيرات الرئوية المستحثة، ومضاعفاته غير مفهومة تماماً.

الغرض من الدراسة : هو تقييم معايير التصوير المقطعي المحوسب المختلفة للمرضى المشتبه في إصابتهم بفيروس كوفيد-١٩ واتباطها بنتائج تفاعل البوليميراز المتسلسل.

الهدف من هذه الدراسة : كان التعرف على التغيرات المختلفة لحمى الرئة بواسطة التصوير المقطعي المحوسب في مرضى كوفيد-١٩ المشتبه بهم وربط هذه النتائج بين نتائج تفاعل البوليميراز المتسلسل.

الطريقة : أجريت هذه الدراسة في الفترة ما بين مايو ٢٠٢٠ إلى يونيو ٢٠٢٠، وأثبتت ٢٦ اختباراً سلبياً و ٥٢ اختباراً إيجابياً لـ التحليل الكمي للفيروسات وتم مراجعة دراسة الصدر بالأشعة المقطعية في قسم التشخيص الإشعاعي، حيث ظهرت الأعراض على أنها الحمى وآلام العظام والإرهاق وفقدان الرائحة والإحساس بالتنوق، السعال وفقدان الشهية، عن طريق الاختبارات المعملية، فإن ارتفاع البروتين التفاعلي سى ومعدل الترسيب، قلة الكريات البيض ونقص كرات الدم البيضاء توحى بالعدوى.

النتائج : تمت دراسة ٧٨ حالة تراوحت أعمارهم بين ٢٥:٦٥ سنة ومتوسط أعمارهم ٥٥±٠.١ سنة. ٣٢ (٤١٪) من الإناث و ٤٦ (٥٩٪) من المرضى الذكور، تم إجراء تفاعل البوليميراز المتسلسل لجميع الحالات، وكانت ٥٢ إيجابية و ٢٦ اختباراً سلبياً، وتمت مراجعة التصوير المقطعي المحوسب لإظهار وجود تشوهات الرئة المتني ومرتبطة بنتائج تفاعل البوليميراز المتسلسل. كان التوزيع الرئوي المحيطي الثنائي للآفات هو الشائع. كانت نتائج التصوير المقطعي المحوسب في الحالات الإيجابية لـ التحليل الكمي ٣/٥/٥٢: كان لديها عتامة الزجاج الأرضي، و ٥٢/٢٤ دمج، و ٥٢/٢٤ ظل شبكي، و ٥٢/٨ رصف مجنون و ٥٢/٢٠ عقيدات و ٥٢/٨ توسع القصب، و ٢٦ كان اختبار التحليل الكمي سلبياً أظهر ٢٦/٢ GGD، توحيد ٢٦/٨، ظلال شبكية ٢٦/٧، رصف مجنون ٢٦/٠، عقيدات ٢٦/٥ وتوسع القصب ٢٦/٤. أكثر نتائج التصوير القطعي حساسية كانت عتامة زجاج الأرض، الحساسية، النوعية، القيمة التنبؤية الإيجابية، القيمة التنبؤية السلبية، الدقة كانت ٩٢.٣١٪، ٩٢.٣١٪، ٩٤.٥٩٪، ٥٨.٥٤٪ و ٧٥.٦٤٪ مع قيمة P ذات دلالة إحصائية > ٠.٠٠٠١. كان المظهر المجنون للرصف هو النتيجة الأكثر تحديداً التي أظهرت الحساسية، والنوعية، والقيمة التنبؤية الإيجابية، والقيمة التنبؤية السلبية، والدقة ٣٧.١٤٪، ٤٣.٥٩٪.

الخلاصة : الهدف الرئيسي من هذه الدراسة هو توضيح دور جهاز التصوير المقطعي المحوسب في كوفيد-١٩ وارتباطه بمختبر تفاعل البوليميراز المتسلسل.