

# Different Radiological Imaging Modalities Using for the Signs and Complications of COVID-19: A Literature Review

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## ABSTRACT

**Background:** The Corona virus disease is a severe infection that causes different serious respiratory diseases. This epidemic starts in mid-December 2019 in Wuhan city, China. The occurrence of corona virus disease has spread worldwide; this incidence is due to SARS-CoV-2.

**Objective:** The objective of our study were to diagnosis the COVID-19 its signs and complications by using different radiological imaging modalities such as CXR, C.T, and USG.

**Methods:** Out research was a conducted using Google Scholar, PubMed, and Scopus database. The keywords are including severe acute respiratory syndrome Coronavirus 2 disease, respiratory diseases, radiological imaging modalities, C.T. and corona virus disease.

**Results:** We review different studies, the most recently published articles information on worldwide to provide material regarded research of COVID-19 correlated to different imaging modalities which includes Ultrasonography, chest X-ray and computed tomography. Moreover, no ethics approval was required. We include only radiological findings related studies in English language. Our search was limited to articles available in 2020.

**Conclusions:** The radiological imaging modalities such as computed tomography and CXR play a significant role in the identification of Corona virus disease. For the detection of Corona virus disease individuals in the primary phases the common radiological demonstration was also determined and this will be useful for the radiologist to identify the Corona virus disease. Follow-up studies are essential for the radiological imaging investigation.

## KEY WORDS

SARS-CoV-2, respiratory diseases, radiological imaging modalities, C.T, and COVID-19

## INTRODUCTION

The Coronavirus disease epidemic starts in early-December 2019 in Wuhan city, Hubei Province, China. The incidence occurs due to SARS-CoV-2 disease<sup>1)</sup>. Almost 81000 individuals have been infected in China<sup>2)</sup>. The WHO confirmed the occurrence a worldwide health emergency on Jan 30, 2020. More than 30 countries approximately 75761 cases had reported at 20 February, 2020<sup>3)</sup>. Chest computed tomography is intensely suggested in suspected Coronavirus disease cases for both early assessment and follow-up, because of the primary envelopment of the respiratory system<sup>4)</sup>. In early stages, the chest radiography is little diagnostic value while the computed tomography outcomes may be present even before the sign of onset<sup>5)</sup>. Chest radiography may show development features of ARDS this will happen in the middle to progressive stages of disease.

COVID-19 epidemic 1<sup>st</sup> time in China, however the border countries of Pakistan are also highly affecting<sup>6)</sup>. Italy was the highest number of Coronavirus disease cases in the west and Iran were also highest number of cases in the north after the Italy. At 26 February, the first case of Coronavirus disease had confirmed by Ministry of Health, Government of Pakistan in Karachi, Sindh province. On the same day a second case was also confirmed in Islamabad, Pakistan<sup>7)</sup>. The number of confirmed cases extended to 20 out of 471 doubted cases within 15 days in the

Gilgit Baltistan and all of these individuals had freshly traveling history from London, Iran and Syria<sup>8)</sup>. The number of infected individuals quickly increasing and the spread of the virus are increase in Pakistan. After its peak, the disease amount start lowing however it might take months for the widespread to finally disappear away with 97.0% recovery happening in August to September 2020<sup>9)</sup>. It is serious disease causing in severe respirational diseases. This epidemic characterizes a severe community health risk. Thus, primary and correct diagnosis is important to control disease development. In the primary identification and organization of infected people, radiological checkups play a key role. The main aim of this study was to deliver an overview of accessible published data on worldwide research on COVID-19 related to radiological modalities and clinical signs that available in the newly published data.

## METHODS

This study was surveyed the presently accessible literature of different imaging modalities and problems of individuals whom established diseases by COVID-19 happened at the time of writing on March and simplified on July 2020. A literature search was achieved spending accessible website info using Google Scholar, Web of Science, Scopus, and PubMed databases. The keywords are including severe acute respiratory syndrome Coronavirus 2 disease, respiratory diseases, radiologi-

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**Table 1: Different Imaging Modalities was used in COVID-19 by different Authors.**

	No.P	Age (Mean)	I.M	USG Findings			CXR Findings			CT Findings				
				Con.	P.E	Pne.	Con.	N	Con.	G.G	P.D	P.E	L.A	CT F.U
<b>Yen et al<sup>5</sup></b>	21	56	C.T, CXR	NA	NA	NA	60%	2	62%	86%	P = 86%, U&L Zone 30%	0%	N/A	4
<b>Chen et al<sup>5</sup></b>	99	55.5	C.T, CXR	NA	NA	NA	100%	0	100%	14%	B/L 75%	0%	NA	1
<b>Huang et al<sup>6</sup></b>	41	49	C.T	NA	NA	NA	NA	0	T.P	T.P	B/L 98%	0%	NA	1
<b>Yao Zhang et al<sup>7</sup></b>	28	59.8	USG	67.90%	NA	NA	NA	NA	N/A	N/A	NA	N/A	NA	N/A
<b>M Chung et al<sup>8</sup></b>	21	51	C.T	NA	NA	NA	NA	0	29%	86%	P=33%, B/L 76%	0%	NA	8
<b>Song et al<sup>9</sup></b>	51	49	C.T	NA	NA	NA	NA	0	59%	77%	B/L 86%	6%	6%	13
<b>Pan et al<sup>9</sup></b>	21	40.5	C.T	NA	NA	NA	NA	NA	41%	75%	B/L 42%	N/A	NA	NA
<b>Bernh-eim et al<sup>1</sup></b>	121	45.3	C.T	NA	NA	NA	NA	NA	34%	24%	B/L 12%	1%	1%	NA
<b>Wang et al<sup>2</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	27%	27%	B/L 5.5%	0.90%	NA	NA
<b>Miao et al<sup>3</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	19%	62.9%	B/L 44.6%	NA	NA	NA
<b>Miao et al<sup>5</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	22.2%	70.2%	B/L 83.3%	5.30%	NA	NA
<b>Song et al<sup>4</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	55%	77%	B/L 39%	8%	6%	NA
<b>Xu et al<sup>5</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	13%	72%	B/L 59%	4%	1%	NA
<b>Lomoro et al<sup>6</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	25.9%	95.2%	B/L 87.7%	7.10%	14.3%	NA
<b>Lu et al<sup>7</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	64.2%	76.9%	NA	NA	NA	NA
<b>Li et al<sup>8</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	63.9%	97.6%	NA	NA	NA	NA
<b>Liu et al<sup>9</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	24%	76%	NA	NA	NA	NA
<b>Xia et al<sup>9</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	50%	60%	NA	NA	NA	NA
<b>Han et al<sup>11</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	41%	86%	NA	NA	NA	NA
<b>Wu et al<sup>12</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	63%	91%	NA	NA	NA	NA
<b>Wu et al<sup>13</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	21.7%	87%	NA	NA	NA	NA
<b>Yoon et al<sup>14</sup></b>	NA	NA	C.T	NA	NA	NA	NA	NA	5%	35%	NA	NA	NA	NA

Abbreviations: No.P = Number of Patients, I.M = Imaging Modality, C.T = Computed Tomography, USG = Ultrasound, CXR = Chest X-Ray, B/L = Bilateral, Con = Consolidation, P.E = Pleural Effusion, Pnc = Pneumothorax, N = Normal, G.G = Ground Glass, P.D = Predominant Distribution, L.A = Lymphadenopathy, CT F.U = Computed Tomography Follow-up.

cal imaging modalities, CT, and Coronavirus disease.

To raise the affectability of the search the Google scholar was utilized with similar keywords, taking the newly available research articles in the medical imaging field for the diagnose of Coronavirus disease. The Google scholar used was limited due to chosen keywords in our research article title because of the huge number of records known from the literature. Our search articles were also limited to articles that are published in 2020, with consideration of the latest date of confirmed Coronavirus disease reports. We included those articles whose are original research work and peer-reviewed written in English.

## RESULT

We study the most recently published articles information on worldwide to provide material regarded research of COVID-19 correlated to different imaging modalities which includes Ultrasonography, chest X-ray and computed tomography. Moreover, no ethics approval was required. We include only radiological findings related studies in English language. Our search was limited to articles published in 2020.

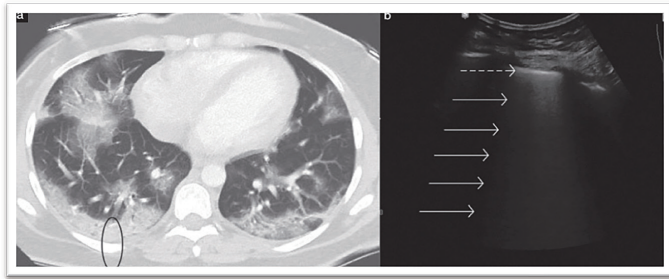
## DICUSSION

We summarized different radiological imaging modalities using for the signs and complication of Coronavirus disease. Moveable CXR is the ideal imaging selection tool and its sensitivity is low<sup>(10)</sup>, while computed tomography image is the favored radiological modality concern-

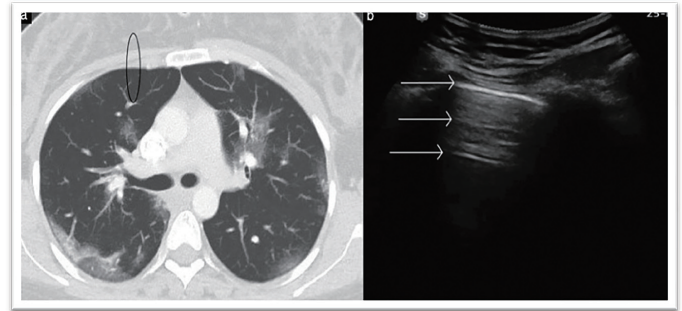
ing primary finding of disease<sup>(10)</sup>. The most important clinical findings of confirmed cases include cough and fever others are headache and diarrhea. There are no individuals which had dyspnea. The radiological outcomes have mostly involved a single /multiple lesions, irregular and reticular marking that is mostly followed peribroncho-vascular and subpleural distributions. Inflamed lymph nodes had hardly seen however, interlobular septal thickening and pleural effusion may be seen. Presently, 90–95% of the radiological imaging investigation for suspected individuals with Coronavirus disease is chest computed tomography, which has a great diagnosing ratio of viral pneumonia.

According to the Xiaofeng Chen et al, the ground glass and consolidation in the lung periphery with lesion size 1 to 3cm are significant for the detection of Coronavirus disease. They include seventy infected individuals and sixty six not infected individuals from 5 hospitals. There is no significant difference found in lung score (P = 0.4)<sup>(11)</sup>. Diagnostic radiology findings play significant role in the treatment course of individuals with Coronavirus disease. LFH Hg et al reported that ninety seven individuals had abnormal outcomes when their 1<sup>st</sup> chest computed tomography was done. Among their findings the most common is ground glass opacity which is finding in ninety five individuals. The second most common was consolidation fifty seven individuals other including septal thickening which was found in twenty eight individuals and linear densities found in eighteen individuals<sup>(12)</sup>. A case study was done by Kalafat et al, a 32 years old pregnant female with gestational age of 35 weeks singleton pregnancy starting symptoms such as cough and shortness of breath. Her husband and father both had respiratory symptoms and nausea. Then she was referred to Coronavirus disease center to determine symptoms and their lung sonography suspicious for viral pneumonia<sup>(13)</sup>.

According to Ivana Blazic et al the majority of institutions chest



**Figure 1: (a) Show computed tomography of right lower lobe basal lung was mostly involved region with peripheral dense ground glass opacities. (b) show ultrasonography of lung revealed thick coalescing B.lines and thickened pleura<sup>13</sup>.**



**Figure 2: (a) show computed tomography of right upper lobe anterior lung segment was relatively spared. (b) show ultrasonography of normal lung pleural line with visible A lines and no wide B lines<sup>13</sup>**

radiological imaging was used in assumed/confirmed individuals with Coronavirus disease 89–94%. The use of radiological imaging is applied in line with standing guidelines and recommendations in ninety eight percent of institutions with structured reporting recorded in fifty eight percent of institutions. The vast common of institutions reported a major impact of the Coronavirus disease epidemic on the radiological departments routine activity 83%<sup>14</sup>. Ming Yen Lo *et al* study imaging profile of Coronavirus disease. According to their study the ground glass opacities and consolidation are detected on computed tomography and sometimes not detectable on CXR however the lymphadenopathy and pleural effusion is not found in any individual. At the end of research they concluded that computed tomography is more sensitive diagnostic imaging modality for the detection of Coronavirus disease<sup>15</sup>. A case report was conducted by Chaisith Sivakorn *et al*, 56 years of female from china have history of travel from Wuhan to Thailand for vocations on 22 Jan 2020. The female history of close contact with one of Coronavirus disease case evident cough noted during physical examination. After her CXR exposed an alveolar opacity in the left middle lung field. Hence, a diagnosis of pneumonia probably due to Coronavirus disease was made. After diagnose of Coronavirus disease she was admitted to an airborne infection isolation room and experimental treatments were started. His family members screened negative remained asymptomatic, but one daughter tested positive for coronaviruses disease<sup>16</sup>. Jason J Naidich *et al* study COVID-19 disease. Radiological imaging volume post 13.6%, late 16.6% and late post 9.6% Coronavirus disease periods in 2020. Statistically important shift  $P < .0001$  in the 2020 conformation combination was detected mostly include imaging 74.3%, which include computed tomography 12.7%, sonography 08%, magnetic resonance imaging 2.4%<sup>17</sup>. According to Huang *et al* reported that seventy six percent of individuals had a cough, however ninety eight percent had fever. The common symptom of these individuals 44.0% had a fever between 38 and 39.0 degree C. Guan *et al* also reported about fever whereby 46.9% of the individuals had fever in this rang as well<sup>18</sup>. According to Lu *et al* lung ultrasonography signs in individuals with COVID-19 were mostly interstitial pulmonary edema and consolidation. The ultrasonography score sensitivity include mild 68.8%, specificity 85.7% and accuracy 76.7%, moderate sensitivity is 77.8%, specificity 76.2% and accuracy 76.7% while in severe sensitivity was 100%, specificity 92.9% and accuracy is 93.3% recorded. The positive predictive value for mild lung lesions due to coronavirus disease was 84.6%, moderate was 58.3% and in severe 50%, however the negative predictive value was reported in mild 70.6%, in moderate was 88.9% and in severe 100%<sup>19</sup>. Pablo Caro Dominguez *et al*, study a thoracic imaging of COVID-19. Ninety-one children were included. Mostly of them have symptom which include cough and fever. Chest radiography was recorded in 89.0% of individuals while 10.0% are normal. Abnormal findings include perihilar bronchial wall thickening which are found in 58.0% and consolidation are found in 35.0%. However, the mostly abnormality was ground glass opacities which are in 88.0%, the second most is consolidation which include 35.0% in the 26.0% of computed tomography scans<sup>20</sup>. There is another cohort study which was conduct in Feb 2020; this study shows computed tomography accuracy 88.0% in Coronavirus disease. The study also suggests that the use of computed tomography imaging in addition to swab-PCR test, due to possible false negative rate of PCR test<sup>21</sup>. Another study was also reported that 50 individuals out of 51 were diagnosed by computed tomography; however 36 individuals were detected with Coronavirus disease from PCR<sup>22</sup>. Xie *et al* also study Coronavirus disease; they include total 167 individuals out of which 05 individuals found positive

in computed tomography while negative tested by PCR<sup>23</sup>. Rajesh Bhayana *et al* studied retrospective cross sectional study of abdominal radiography findings in individuals who had COVID-19. They include 224 individuals; in all of them perform abdominal imaging studies which include radiography in 137 individuals, ultrasonography in 44 individuals, computed tomography in 42 individuals and magnetic resonance imaging in 134 individuals<sup>24</sup>.

## SUMMARY

In the diagnosis of Coronavirus disease the reported sensitivities of computed tomography is 67.0–98.0% and specificities is 24.0–94.0% respectively<sup>45-49</sup>. According to the Raptis *et al*, the computed tomography findings sensitivities may be overvalued by individual's selection bias<sup>50</sup>. Due to lack of singular image features of Coronavirus disease and the lack of objective criteria the specificities may also overvalued for the definition of positive computed tomography outcomes. There is little research work on the diagnostic performance for the detection of Coronavirus disease but a recent study shows the sensitivity of computed tomography in the diagnose of severe critical cases was 82.6% and the specificity was 100.0% demonstrating its probably in the clinical classification of Coronavirus disease<sup>51</sup>. About the diagnostic presentation of lung sonography, the ultrasonography score sensitivity include mild 68.8%, specificity 85.7% and accuracy 76.7%, moderate sensitivity is 77.8%, specificity 76.2% and accuracy 76.7% while in severe sensitivity was 100%, specificity 92.9% and accuracy is 93.3% recorded. The positive predictive value for mild lung lesions due to coronavirus disease was 84.6%, moderate was 58.3% and in severe 50%, however the negative predictive value was reported in mild 70.6%, in moderate was 88.9% and in severe 100%<sup>23</sup>. Thus these outcomes show that diagnostic sonography efficacy is comparatively low for mild to moderate cases however, high for the diagnosis in severe cases.

## CONCLUSION

Radiological studies play significant role in the identification and management of Coronavirus disease. The most common features on chest X-ray was consolidation more found on bilateral however, chest computed tomography is more sensitive than chest X-ray because it is superior and give more information of the pulmonary involvement. The most common findings of Coronavirus disease on chest computed tomography was bilateral peripheral distribution of ground glass opacity with/without consolidation. The study shows the significance of radiological imaging modalities in the diagnosis of the Coronavirus disease.

## COMPETING INTERESTS

There are no competing interests to declare.

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