

## SYSTEMIC REVIEW

# Chest x-ray Findings in the Diagnosis and Evaluation of Covid-19 Patients – A Systematic Review

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## ABSTRACT

**Aim:** To assess the main radiological feature of chest radiography for diagnosis and evaluation of COVID-19 patients.

**Methodology:** A literature search was performed with the use of search engines. The following search engines provided us articles for this systematic review from until 27 February 2021: PubMed, NCBI, Medline, Medscape, and Google Scholar. We included only those articles in which CXR was performed on infected patients for the detection and evaluation of COVID-19.

**Results:** out of eighty (80) articles, only twelve (12) were included in this review to assess the main radiological feature of chest radiography of COVID-19 patients. Patients who went for chest x-ray have shown following radiographic features with pooled percentages as mentioned GGO 32.38%, consolidation 35.15%, vascular congestion sign 7.92%, nodules 33.57% whereas pleural effusion accounts 19.36%, pneumothorax 18.55%, and lymphadenopathy was noted on 1.96%. Pooled Percentages of radiographic features of COVID-19 patients in right lung, left lung or both affected lungs were 21.32%, 5.77% and 47.78% respectively. This calculation is showing B/L lung involvement is more dominant as compare to right and left lung independently.

**Conclusion:** Chest radiograph can be helpful modality in the diagnosis, evaluation and follow-up of SARS- CoV 2 pneumonia patients. Consolidation, GGO with peripheral distribution of lesion and bilateral pneumonia are most common findings of COVID-19 on chest X-ray. Chest x-ray are the baseline/first line approach for COVID-19 as it is easily available. Moreover, in late stages multiple radiological findings are quite helpful.

**Keywords:** COVID-19, Chest X-Ray, Ground Glass Opacities, Consolidation.

## INTRODUCTION

The thoracic X-Ray imaging presented opaque patches in the alveolar parenchyma, and the infection was also confirmed by the nucleic acid testing among patients with COVID-19.<sup>1</sup>The 2019-nCoV is an enveloped RNA virus that belongs to the family of  $\beta$ -coronavirus with a diameter that ranges from 60-125 nm. According to recent literature even after the invasion of the respiratory tract with the coronavirus the infected individual could be clinically silent for a period of 1-14 days, up to 24 days, and in most cases for 3-7 days.<sup>2</sup> RNA of 2019-nCoV can be found in the sputum, nasopharyngeal swabs, secretions of the lower respiratory tract, blood, and stool of infected individuals. The better sample to detect the RNA particles in the infected individual is to examine the sputum as well as the secretions of the lower respiratory tract in critically ill individuals with tracheal intubation<sup>3</sup>.

Based on data collection during clinical practice the sufferers of COVID-19 presented with the following characteristics: 2019-nCoV infection was positive in earlier nucleic acid testing but the radiologists did not find any particular clinical features with the help of imaging modalities. Although in the subsequent imaging sessions, clinical features were quite obvious in radiological examination. The infected individuals were not having the symptoms of coronavirus infection but they have exposure to the infected individual.<sup>4</sup> Although, the scan characteristics that are manifested in COVID-19 show a lot of variation and ambiguity due to the huge resemblance to the characteristics of MERS as well as SARS. According to the thoracic Radiography data of early phases of infection, eighty-five percent of the COVID-19 sufferers present abnormal thoracic scan and seventy-five percent of the sufferers in the early stages of infection present the characteristic involvement of both lungs, with opaque patches with distortion and convergence most commonly in peripheral and sub-pleural areas of the lungs<sup>1</sup>.

Current researches of the radiology on the malady of COVID-19 prioritized HRCT thoracic imaging because of the better sensitivity of this imaging modality, although, thoracic X-ray scanning for the detection of COVID-19 has the ability to outdo the

sensitivity of chest HRCT for many reasons. As compared to chest CT-imaging, CXR is less harmful, less expensive and easier to execute.<sup>5</sup> In developing countries, the availability of X-ray machines is more common than the CT machines. The CT-scanners are not portable and need to be designated room for them; in the case of COVID-19 infected individuals, the transportation of infected individuals to the scanner room increased the risk of infection transmission. This transportation issue can easily be resolved with the use of portable CXR equipment. This portable CXR use can also help the medical staff to perform the scanning even in the isolation rooms of the infected individuals and remove the trouble to disinfect the CT-equipment with each use<sup>6</sup>.

## METHODOLOGY

**Search strategy:** PubMed, NCBI, Medline, Medscape, and Google Scholar databases were used for the search of relevant studies for the year 2020 for names or abbreviations: COVID-19, SARS-COV-2, 2019-nCoV, CXR, chest X-ray, thoracic X-ray, novel infection, imaging pattern, GGO, pneumonia, lungs, and imaging in COVID-19.

**Selection criteria:** Only those articles were included in which patients were infected with SARS-COV-2 infection and the infected population consisted of adults whether male or female. The minimum required data was COVID-19, SARS-COV-2, 2019-nCoV, CXR, chest X-ray, thoracic X-ray, novel infection, imaging pattern, GGO, pneumonia, lungs, and imaging in COVID-19. Extraction of data was done from full journal articles. Raw data were used for summary statistics if they were not reported. If numerical values were not found in the text of the articles they were obtained from bar-charts or graphs.

**Data synthesis and analysis procedure:** The 12 eligible researches were included for the extraction of data. Data was extracted for following characteristics: Author, year of publication, number of patients, ground-glass opacities (GGO), consolidation, pleural effusion, pneumothorax, nodules, lymphadenopathy, diffuse involvement, peripheral involvement, bilateral involvement, perihilar lung involvement, left lobe involvement and left lung involvement<sup>7</sup>.

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**RESULTS**

Eighty (80) articles were found on 5 search engines and eight (8) were found through other sources by using the above mentioned keywords. Twenty Eight (28) articles were removed because of duplication. Twenty two (22) articles were not containing required information, in Four (4) studies Chest X-ray was not used, Three (3) articles were providing insufficient data, and in Six (6) articles language was not English. So in the end, twelve (12) articles were used for the extraction of data related to role of chest X-ray findings for the diagnosis of covid-19 patient. The whole process of searching is depicted in Fig.1. The qualitative variables (author details and number of patients) and exact percentages of patients, who presented with specific features of COVID-19, of 12-screened

studies were shown in Table 1. The mean age of coronavirus disease patients is 54.29 years with a standard deviation of 10.159 years. The maximum-recorded age in this review is 71 whereas the minimum age is 39 years

The percentages of patients who came for chest x-ray and those radiographic films has shown following features with pooled percentages as mentioned GGO 32.38%, consolidation was 35.15%, vascular congestion sign 7.92%, nodules were 33.57% whereas pleural effusion accounts 19.36%, pneumothorax 18.55%, and lymphadenopathy was noted on 1.96%. Pooled Percentages of radiographic features of COVID-19 patients in right lung, left lung or both affected lungs were 21.32%, 5.77% and 47.78% respectively.

Table 1: Comparison of different study variables on chest x ray among patients with COVID-19

Authors Names	n	GGO	Consolidation	Vascular congestion sign	Nodules	Pleural effusion	Pneumothorax	Lymphadenopathy	Right lung	Left lung	B/L Lung	Diffuse Lung Involvement	Peripheral Lung Involvement	Perihilar Predominant
Adam Jacobi, 2020 <sup>6</sup>	11	NA	NA	NA	NA	NA	NA	NA	54.55%	45.45%	0%	27.27%	81.82%	NA
Nasir Khan, 2020 <sup>8</sup>	294	5.78%	28.57%	NA	NA	1.70%	NA	NA	14.29%	0.00%	0%	0.00%	24.49%	0.68%
Diletta Cozzi, 2020 <sup>9</sup>	234	62.82%	57.69%	39.32%	23.50%	16.67%	2.14%	0.00%	12.39%	8.97%	69.23%	42.31%	57.69%	21.79%
Rowa Aljondi, 2020 <sup>10</sup>	50	40%	20.00%	22%	66%	52%	78%	NA	0.00%	0.00%	0%	NA	NA	NA
Misbah Durrani, 2020 <sup>11</sup>	30	3.33%	66.67%	NA	NA	13.33%	NA	3.33%	0.00%	66.67%	66.67%	10.00%	60.00%	6.67%
Ho Yuen Frank Won, 2020 <sup>12</sup>	64	32.81%	46.88%	50.00%	NA	3.13%	NA	NA	15.63%	14.06%	50%	NA	40.63%	29.69%
Alfonso J Rodriguez-Morales, 2020 <sup>13</sup>	660	51.36%	32.58%	0.00%	87.58%	42.12%	36.06%	4.24%	6.36%	0.00%	58.94%	NA	33.33%	18.94%
Wenjing Yang, 2020 <sup>14</sup>	36	80.56%	33.33%	5.56%	33.33%	88.89%	NA	33.33%	0.00%	0.00%	0%	NA	NA	NA
Rabab Yasin, 2020 <sup>15</sup>	350	24.86%	62.29%	8.29%	7.14%	5.71%	30.57%	0.00%	12.00%	12.86%	51.71%	23.14%	44.57%	8.86%
Joanne Cleverley, 2020 <sup>16</sup>	20	NA	NA	NA	NA	NA	NA	NA	55.00%	80%	95%	60%	45.00%	0.00%
Danielle Toussie, 2020 <sup>17</sup>	338	NA	NA	NA	NA	NA	NA	NA	76.04%	0.00%	53.85%	0%	67.16%	88.17%
Ming-Yen NG, 2020 <sup>18</sup>	21	85.71%	61.90%	0.00%	4.76%	NA	NA	NA	66.67%	47.62%	80.95%	14.29%	85.71%	4.76%
Current Studies (Average %ages)	12	43.03%	45.54%	17.88%	37.05%	27.94%	36.69%	8.18%	23.49%	20.93%	47.85%	21.39%	50.95%	19.95%
Pooled Percentages		32.38%	35.15%	7.92%	33.57%	19.36%	18.55%	1.96%	21.32%	5.77%	47.78%	9.44%	42.01%	25.23%

**DISCUSSION**

Thoracic X-rays can play an important part in the diagnosis and management of SARS-CoV-2 infection. The current review reveals that Consolidation, Ground Glass Opacities, Nodules, Pneumothorax, Pleural effusion, vascular congestion signs, Lymphadenopathy respectively are noteworthy findings among COVID-19 patients.

The consolidation and hazy increased opacities were common in the thoracic X-rays of infected individuals.<sup>19</sup> But literature reports that the chest x-ray has low sensitivity in detecting early lesions of COVID-19. On a contrary, Durrani et al reveals that patchy nodular opacities in peripheral distribution can be observed in patients with COVID-19 Ground-glass opacities are very common imaging characteristics to be found in thoracic X-ray of SARS-CoV-2 infected individuals<sup>20</sup>. In our review, GGO was found in wide range of percentages i.e. 3% to 86% respectively. The reason could be that most of the studies were presenting initial CXR findings and follow ups were not observed as well as small sample size were considered. It was also found that the appearance of consolidation appears on CXR even before the appearance of GGO<sup>8,11,18</sup>. In most SARS-CoV-2, infected individuals both lungs were infiltrated by infection with the percentage of 93%.<sup>17</sup> Among unilateral lung involvement right lung was more common to be found infected as compared to the left lung<sup>21</sup>.

Nodules & Pneumothorax were equally common among COVID-19 patients but they are not among the most common features of infection. Pneumothorax were more common in those individuals who are mechanically ventilated<sup>22</sup>.

Pleural effusion is not a classical imaging feature of COVID-19 but in some infected individuals, it could be detected on X-ray films<sup>16</sup>. Only three studies of our review presented a few COVID-19 infected patients in whom lymphadenopathy was found. Vascular congestion sign<sup>9</sup> was also not one of the classical characteristics during imaging of COVID-19 infected patients with the help of an X-ray machine.

In Pakistani literature it has been observed that in addition to British Society of Thoracic Imaging (BSTI) classification for pure & mixed ground glass opacities , consolidation in bilateral peripheral middle and lower zone were common<sup>23</sup>. Similarly another study showed that the alveolar opacities with predominant peripheral distribution either unilateral or more frequently bilateral, starting from the lower and mid zones extending to the upper zones and becoming diffuse with disease progression<sup>24</sup>,

**CONCLUSION**

Chest radiograph can be used as helpful modality in the diagnosis, evaluation and follow-up of SARS-CoV-2 pneumonia patients. Consolidation, GGO with peripheral distribution of lesion and bilateral pneumonia are most common findings of COVID-19 on chest x ray. Chest x-ray is the baseline line approach for COVID-19 as it is easily available. Moreover, in late stages multiple radiological findings on chest radiography are quite helpful.

**Conflict of interest:** Nil

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**REFERENCES**

- Schiaffino S, Tritella S, Cozzi A, Carriero S, Blandi L, Ferraris L, Sardanelli F. Diagnostic performance of chest X-ray for COVID-19 pneumonia during the SARS-CoV-2 pandemic in Lombardy, Italy. *Journal of thoracic imaging.* 2020 Jul 1;35(4):W105-6.
- Ishfaq A, Farooq SM, Goraya A, Yousaf M, Gilani SA, Kiran A, et al. Role of High Resolution Computed Tomography chest in the diagnosis and evaluation of COVID-19 patients-A systematic review and meta-analysis. 2021; 8:100350.
- Petruzzi G, De Virgilio A, Pichi B, Mazzola F, Zocchi J, Mercante G, Spriano G, Pellini R. COVID- 19: Nasal and oropharyngeal swab. *Head & neck.* 2020 Jun;42(6):1303-4.

4. Mossa-Basha M, Meltzer CC, Kim DC, Tuite MJ, Kolli KP, Tan BS. Radiology department preparedness for COVID-19: radiology scientific expert review panel. *Li X, Li C, Zhu D. Covid-mobilexpert: On-device covid-19 screening using snapshots of chest x-ray. arXiv preprint arXiv:2004.03042. 2020 Apr.*
5. Jacobi A, Chung M, Bernheim A, Eber C. Portable chest X-ray in coronavirus disease-19 (COVID-19): A pictorial review. *Clinical imaging. 2020 Apr 8.*
6. Prisma. PRISMA 2020 Checklist Oxford university: Equator; 2015 [updated 2015; cited 2022 Feb 9]. Available from: <http://www.prisma-statement.org/>.
7. Khan N, Umar M, Khaliq M, Hanif H, Durrani M, Raja R. Chest X-ray findings in COVID-19: A Pictorial Review. *Journal of Rawalpindi Medical College. 2020 Aug 11;24(Supp-1):44-9.*
8. Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvarà S, Lucarini S, Busoni S, Mazzoni LN, Miele V. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. *La radiologia medica. 2020 Aug;125:730-7.*
9. Aljondi R, Alghamdi S. Diagnostic value of imaging modalities for COVID-19: scoping review. *Journal of medical Internet research. 2020;22(8):e19673.*
10. Durrani M, Inam ul Haq UK, Yousaf A. Chest X-rays findings in COVID 19 patients at a University Teaching Hospital-A descriptive study. *Pakistan Journal of Medical Sciences. 2020 May;36(COVID19-S4):S22.*
11. Wong HY, Lam HY, Fong AH, Leung ST, Chin TW, Lo CS, Lui MM, Lee JC, Chiu KW, Chung TW, Lee EY. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. *Radiology. 2020 Aug;296(2):E72-8.*
12. Rodriguez-Morales AJ, Cardona-Ospina JA, Gutiérrez-Ocampo E, Villamizar-Peña R, Holguin-Rivera Y, Escalera-Antezana JP, et al. Clinical, laboratory and imaging features of. *12;13.*
13. Yang W, Sirajuddin A, Zhang X, Liu G, Teng Z, Zhao S, Lu M. The role of imaging in 2019 novel coronavirus pneumonia (COVID-19). *European radiology. 2020 Apr 15:1-9.*
14. Yasin R, Gouda W. Chest X-ray findings monitoring COVID-19 disease course and severity. *Egyptian Journal of Radiology and Nuclear Medicine. 2020 Dec;51(1):1-8.*
15. Cleverley J, Piper J, Jones MM. The role of chest radiography in confirming covid-19 pneumonia. *bmj. 2020 Jul 16;370.*
16. Toussie D, Voutsinas N, Finkelstein M, Cedillo MA, Manna S, Maron SZ, Jacobi A, Chung M, Bernheim A, Eber C, Concepcion J. Clinical and chest radiography features determine patient outcomes in young and middle-aged adults with COVID-19. *Radiology. 2020 Oct;297(1):E197-206.*
17. Ng MY, Lee EY, Yang J, Yang F, Li X, Wang H, Lui MM, Lo CS, Leung B, Khong PL, Hui CK. Imaging profile of the COVID-19 infection: radiologic findings and literature review. *Radiology: Cardiothoracic Imaging. 2020 Feb 13;2(1):e200034.*
18. Lomoro P, Verde F, Zerboni F, Simonetti I, Borghi C, Fachinetti C, Natalizi A, Martegani A. COVID-19 pneumonia manifestations at the admission on chest ultrasound, radiographs, and CT: single-center study and comprehensive radiologic literature review. *European journal of radiology open. 2020 Jan 1;7:100231.*
19. Sahin AR, Erdogan A, Agaoglu PM, Dineri Y, Cakirci AY, Senel ME, Okyay RA, Tasdogan AM. 2019 novel coronavirus (COVID-19) outbreak: a review of the current literature. *EJMO. 2020;4(1):1-7.*
20. Borghesi A, Maroldi R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. *La radiologia medica. 2020 May;125(5):509-13.*
21. Edwards JA, Breitman I, Bienstock J, Badami A, Kovatch I, Dresner L, Schwartzman A. Pulmonary barotrauma in mechanically ventilated coronavirus disease 2019 patients: a case series. *Annals of Medicine and Surgery. 2021 Jan 1;61:24-9.*
22. Nishtar T, Noor N, Khan SL. X-ray patterns of COVID-19 in patients presenting to Lady Reading Hospital, Peshawar, Pakistan. *Pakistan Journal of Medical Sciences. 2021 Jan;37(1):28.*
23. Masood L, Zafar SB, Wahla MS, Gul S, Akhtar S, Rana AI. Progression and Resolution of COVID-19 Pneumonia on Chest Radiograph. *J Coll Physicians Surg Pak. 2021 Mar 1:258-61.*