ORIGINAL ARTICLE

# DIAGNOSTIC ACCURACY OF CHEST X-RAY IN COVID-19 PATIENTS TAKING HIGH-RESOLUTION COMPUTED TOMOGRAPHY AS GOLD STANDARD

Uzma Abdullah[1], Nafeesa Tariq[2], Ayesha Rizwan[3], Arooj Zahra[4], Humaira Ali[5], Nain Sukh[6], Manahil Tipu[7], Amna Shoaib[8]

[1]Department of Radiology, Margalla Hospital, Taxila, [2]Department of Gynaecology and Obstetrics, Margalla Hospital, Taxila, [3]Department of Dermatology, Margalla Hospital, Taxila, [4]Department of Medicine, Margalla Hospital, Taxila, [5]Department of Anatomy, Swat Medical College, Swat, [6]Department of Surgery, Margalla Hospital, Taxila, [7]4th Year MBBS Student, Rawalpindi Medical University, Rawalpindi, [8]3rd Year MBBS Student, Al-Nafees Medical College, Islamabad

**ABSTRACT**

**Objective**: To determine sensitivity & specificity of chest X-ray in COVID-19, taking High-Resolution Computed Tomography as gold standard.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** Radiology Deptt, Margalla Hospital, Taxila and Islamabad Diagnostic Centre, Wah. Two years (February 2020 to February 2022).

**Patients and Methods:** The sample comprised 100 COVID-19 patients (Positive Polymerase chain reaction (PCR) test). Their High-Resolution Computed Tomography (HRCT) was done which was considered a gold standard for diagnosing COVID-19. Their Chest X-rays (CXR) were performed, and findings of both modalities were compared. Patients having respiratory tract symptoms but PCR negative for COVID-19 were excluded.

**Results:** The research had 49 males & 51 females having a median (IQR) age of 46.50(35-55.75) years. The minimum & maximum ages were 6 years and 83 years respectively. Among 100 PCR-positive patients, 29 were found normal on HRCT and 30 on CXR. For moderate cases, the chest X-rays were 72% sensitive & 90.67% specific, with Positive Predictive Value (PPV), Negative Predictive Value (NPV) & diagnostic efficacy of 72%,90.67% & 86% respectively. Similarly, other severity levels were assessed.

**Conclusion:** CXR has acceptable diagnostic accuracy for COVID-19 patients, especially with good sensitivity for moderate cases and better specificity for severe cases. A portable chest radiograph might be regarded as an initial alternative imaging modality for patients with COVID-19 signs and symptoms in remote areas.

**Key words:** *COVID-19, CXR , HRCT*

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## INTRODUCTION

Coronavirus disease-19 (COVID-19) first surfaced in Wuhan, China, in 2019, and led to a pandemic, affecting many areas of the world [1]. The maximum number of casualties were observed in the United States and other parts of the world. It urged the medical community to develop and implement different diagnostic and therapeutic options to lessen the burden of this disease [2].

*Correspondence to: Dr. Uzma Abdullah, Radiology Deptt, Margalla Hospital, PMO, Taxila.*

*Email: druzmaabdullah1@gmail.com*

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Throughout the COVID-19 pandemic, global guidelines[3,4] have consistently stressed using viral testing to make the diagnosis instead of using imaging techniques. Real Time Polymerase Chain Reaction (RT-PCR) (throat or nasal swab) is recommended for diagnosis. This test presents a crucial aspect of triaging and monitoring patients suspected of having the virus[5]. However, the reliability of RT-PCR is limited, with sensitivity ranging between 38% and 89% [6,7,8]. Moreover, during the peak of pandemic, the time it took to receive RT-PCR results often prevented appropriate identification and treatment of affected patients who were continuously presenting in hospital emergencies on a large scale [9,10,11]. As a result, imaging was incorporated into the protocol used to diagnose patients to minimize the limitations of RT-PCR including the high probability of false negative results and increased turnaround time[4,12,13].

The development of RT-PCR was made possible by genetic

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sequencing of SARS-CoV-2, which is a gold standard for diagnosis today[14]. The high prevalence of false-negative results and the time it takes, make this serologic test limited. Therefore, it is necessary to perform radiological assessments in clinical-epidemiological suspicion of COVID-19, particularly in emergency, to evaluate the thoracic involvement, while RT-PCR result is awaited. The latest radiological research on COVID-19 primarily focuses on the findings of Computed Tomography (CT), which is superior to chest X-ray (CXR) in sensitivity and specificity. In China, CT is the primary diagnostic method for COVID-19 [15,16]. However, CT scans during this pandemic, present challenges, including excessive exposure to radiation (especially for younger patients), and the standard protocols for disinfecting scanners. Most Italian hospitals use CXR as their major diagnostic tool. It produces faster results than RT-PCR, particularly when employing portable X-ray machines. They minimise patient movement and lower the risk of cross-infection[17,18,19,20]. Our research was undertaken to find CXR's diagnostic accuracy in COVID-19, keeping the High resonance Computed Tomography (HRCT) as gold standard.

**CAPSULE SUMMARY**

This study reveals that chest X-ray has an acceptable sensitivity & specificity for RT-PCR-confirmed COVID-19 patients and can be regarded as an initial or alternate imaging modality in the protocol for patients in remote areas with signs and symptoms of COVID-19.

## PATIENTS AND METHODS

A Cross-sectional, observational study was done in the Radiology Deptt, Margalla Hospital, Taxila in collaboration with Islamabad Diagnostic Centre, Wah. The research work started after the official approval of the Ethical Review Committee of Margalla Hospital. An informed, written consent for the study was taken from the patients. A total of 100 PCR-positive COVID-19 patients of either sex were included. Patients having respiratory symptoms but not having PCR-positive COVID-19 were excluded from the study. HRCT of all PCR-positive COVID-19 patients was done in Islamabad diagnostic centre, Wah, on Toshiba 16 slices CT scan machine. The radiologist reported HRCT and the CT, severity index was calculated for each case. CT severity score was considered mild if <20, moderate if 20-40 and severe if >40. It was requested of the reporting radiologists to check for septal thickening, consolidation, ground glass opacities and nodules. Additionally evaluated were the reverse halo sign and the existence of pleural effusions. The cases to score gradient/ diffuse involvement were additionally evaluated as craniocaudal, anterior/posterior & central/peripheral gradient.

The CXR of the same patients were performed by a portable Toshiba X-ray machine and were reported by the Radiologists. Based on opacities (interstitial, interstitial & airspace, peripheral & diffuse airspace), atelectasis, and lobar consolidation, the main pattern in chest radiographs was assessed, using the CXR. If no such pattern applied, the result was considered "normal." Pleural effusions and a craniocaudal gradient were also evaluated. The CXR findings were given four severity scores: normal, mild, moderate and severe.

A comparison of HRCT and CXR was done, to determine how sensitive & specific CXR is and what Positive Predictive Value(PPV), Negative Predictive Value (NPV) & diagnostic efficacy it has, taking HRCT as the gold standard. The patients having normal CXR & HRCT were labelled normal. Patients having the same degree of lesion on the CXR and HRCT were labelled true cases. Table 1 shows the rubrics used to check the diagnostic accuracy of CXR.

Formulae Used:

"Sensitivity" = a÷(a+c) x 100
"Specificity" = d÷(b+d) x 100
PPV = a÷ (a+b) x 100
NPV = d÷ (c+d) x 100
"Diagnostic Efficacy" = (a+d) ÷ (a+b+c+d) x 100

## RESULTS

Total 49 males and 51 females participated in the study with the median (IQR) age of 46.50 (35-55.75) years. Patients' ages ranged from 6 to 83 years. Out of total of 100 PCR-positive patients, 29 were found normal on HRCT and 30 on CXR.

In mild cases, the sensitivity is 69.2%, the specificity is 87.8%, the positive predictive value is 66.7%, the negative predictive value is 89.04%, and the diagnostic efficacy is 83% (table 2).

In moderate cases, the sensitivity is 72%, the specificity is 90.67%, the positive predictive value is 72%, the negative predictive value is 90.67%, and the diagnostic efficacy is 86% (table 3).

In severe cases, sensitivity is 55%, specificity is 96.2%, PPV is 78.6 %, NPV is 89.5 and diagnostic efficacy is 88%. (Table 4)

**Table 1. Rubrics to determine diagnostic accuracy of chest X-rays (CXR), using HRCT as the gold standard.**

| One severity lesion | | Detected in HRCT (Gold Standard) | |
|---|---|---|---|
| | | Other Severity levels including normal patients | |
| Detected in CXR | One severity lesion | a. True+ve | b. False +ve |
| | Other Severity levels including normal patients | c. False -ve | d. True-ve |

**Table 2. Sensitivity and specificity of mild cases of CXR, using HRCT as the gold standard (n=100).**

| | | Detected in HRCT (Gold Standard) | |
|---|---|---|---|
| | | Mild | Other severity levels |
| Detected in CXR | Mild | 18 | 09 |
| | Other severity levels | 08 | 65 |

**Table 3. Sensitivity and specificity of moderate cases of CXR, using HRCT as the gold standard (n=100).**

| | | Detected in HRCT (Gold Standard) | |
|---|---|---|---|
| | | Moderate | Other Severity levels |
| Detected in CXR | Moderate | 18 | 07 |
| | Other severity levels | 07 | 68 |

**Table 4. Sensitivity and specificity of severe cases of CXR, using HRCT as the gold standard (n=100).**

| | | Detected in HRCT (Gold Standard) | |
|---|---|---|---|
| | | Severe | Other Severity levels |
| Detected in CXR | Severe | 11 | 03 |
| | Other severity levels | 09 | 77 |

## DISCUSSION

In our study, the sensitivity (72%) of CXR increased in moderate cases while a high specificity (96.2%) was observed in patients with severe findings of COVID-19 considering HRCT as a gold standard. In another study conducted in 2020, CXR was found to be a useful portable device with an acceptable sensitivity (61%) and specificity (76%) to diagnose COVID-19 patients compared to RT-PCR [21].

Stephanie S., Shum T., Cleveland H., et al. conducted a retrospective analysis in 02 sizable urban medical academic centres, encompassing 03 tertiary care and 01 community hospital in the United States. According to the study, CXR severity and sensitivity for COVID-19 detection grew with time, rising from 55% at 2 days (or less) to 79% at more than 11 days ($p<0.001$), however, CXR specificity dropped from 83% to 70%($p=0.02$). For COVID-19 detection, the first CXR had 73% sensitivity and 80%specificity, the second CXR had 83% sensitivity and 73% specificity, and the CT had 88% sensitivity and 77% specificity. Most false negative CXRs (normal 40% & combined normal or mild 87%) were caused by normal & mild severity. The false-negative rate was also higher in young people and African Americans. With time, CXR accuracy for COVID-19 detection increases, and in patients who test positive for the virus, repeated CXRs are as accurate as chest CT scans[22].

A study by Borakati A, et al. found that CXR diagnosed COVID-19, with a sensitivity & specificity of 0.56 (with 95% CI 0.51 to 0.60) and 0.60 (with 95% CI 0.54 to 0.65) correspondingly. Whereas, CT, for the same diagnosis, was 0.85 in sensitivity (95% CI 0.79 to 0.90) & 0.50 in specificity (95% CI 0.41 - 0.60). Comparing CT to CXR, there was a statistically significant mean increase of 29% in sensitivity (95% CI 19% to 38%, $p<0.0001$). The two modalities did not significantly differ in terms of specificity[23].

Wong et al. found CT to have a higher sensitivity than CXR. The initial CXR's sensitivity of 69%, according to Wong et al., was much below the 97–98% sensitivity of CT [24].

Another study by Guan et al. also revealed that in order to detect opacifications in COVID-19 patients, CT had a much greater sensitivity (86.2%) than CXR (59.1%)[25].

## CONCLUSION

Chest X-ray has an acceptable sensitivity & specificity for RT-PCR-confirmed COVID-19 patients, especially in patients having moderate and severe conditions respectively considering HRCT as the gold standard. Although CT chest is a superior imaging modality to CXR, a portable chest radiograph can evaluate the severity of the disease course and prognosis. It can be regarded as an initial or alternate imaging modality in the treatment protocol for patients in remote areas with signs and symptoms of COVID-19.

## AUTHORS' CONTRIBUTION

| | |
|---|---|
| Uzma Abdullah, Nafeesa Tariq, Arooj Zahra, Humaira Ali, Nain Sukh, Manahil Tipu, Amna Shoaib | Drafting the Article |
| Uzma Abdullah, Nafeesa Tariq, Ayesha Rizwan, Arooj Zahra, Humaira Ali, Nain Sukh, Manahil Tipu, Amna Shoaib | Analysis and interpretation of data |
| Uzma Abdullah | Conception and design |
| Uzma Abdullah, Ayesha Rizwan, Arooj Zahra | Acquisition of data |
| Uzma Abdullah | Critical revision |

## REFERENCES


1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The lancet. 2020;395(10223):497-506.
2. Sanders JM, Monogue ML, Jodlowski TZ, et al. Pharmacologic treatments for coronavirus disease 2019 (COVID-19): a review. JAMA. 2020;323(18):1824-36.
3. Rubin GD, Ryerson CJ, Haramati LB, et al. The role of chest imaging in patient management during the COVID-19 pandemic: a multinational consensus statement from the Fleischner Society. Radiology. 2020;296(1):172-80.
4. Akl EA, Blažić I, Yaacoub S, et al. Use of chest imaging in the diagnosis and management of COVID-19: a WHO rapid advice guide. Radiology. 2021;298(2):E63-9.
5. Dramé M, Teguo MT, Proye E, et al. Should RT-PCR be considered a gold standard in the diagnosis of Covid-19?. J Med Virol. 2021;93(1):137-138.
6. Liu R, Han H, Liu F, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clinica chimica acta. 2020 ;505:172-175.
7. Long C, Xu H, Shen Q, et al. Diagnosis of the Coronavirus disease (COVID-19): rRT-PCR or CT?. Eur Jo Radiol. 2020;126:108961-108966.
8. Loeffelholz MJ, Tang YW. Laboratory diagnosis of emerging human coronavirus infections–the state of the art. Emerg Microbes Infect. 2020;9(1):747-56.
9. Corman VM, Landt O, Kaiser M,et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill. 2020;25(3):2000045-2000052.
10. Bwire GM, Majigo MV, Njiro BJ, et al. Detection profile of SARS-CoV-2 using RT-PCR in different types of clinical specimens: a systematic review and meta-analysis. J Med Virol. 2021;93(2):719-725.
11. Tahamtan A, Ardebili A. Real-time RT-PCR in COVID-19 detection: issues affecting the results. Expert Rev Mol Diagn. 2020;20(5):453-454.
12. Mossa-Basha M, Meltzer CC, Kim DC, et al. Radiology department preparedness for COVID-19: radiology scientific expert review panel. Radiology. 2020;296(2):E106-112.
13. Sverzellati N, Milanese G, Milone F, et al. Integrated radiologic algorithm for COVID-19 pandemic. J thorac Imaging. 2020;35(4):228-33.
14. Wang C, Horby PW, Hayden FG, et al. A novel coronavirus outbreak of global health concern. The lancet. 2020;395(10223):470-473.
15. Yang W, Sirajuddin A, Zhang X, et al. The role of imaging in 2019 novel coronavirus pneumonia (COVID-19). Eu Radiol. 2020;30:4874-4882.
16. Zhou S, Wang Y, Zhu T, Xia L. CT features of coronavirus disease 2019 (COVID-19) pneumonia in 62 patients in Wuhan, China. Am J Roentgenol. 2020;214(6):1287-94.
17. Giovagnoni A. Facing the COVID-19 emergency: we can and we do. La radiologia medica. 2020;125(4):337.
18. Neri E, Miele V, Coppola F, et al. Use of CT and artificial intelligence in suspected or COVID-19 positive patients: statement of the Italian Society of Medical and Interventional Radiology. La radiologia medica. 2020;125(5):505-8.
19. ACR recommendations for the use of chest radiography and computed tomography (CT) for suspected COVID-19 infection [Inter net]. Reston Varginia (VA):American College of Radiology; 2020 [updated 2020 March 22; cited 2023 June 12]. Available from https://www.acr.org/Advocacy-and-Economics/ACRPosition-Statements/Recommendations-for-Chest-Radiography-andCT-for-Suspected-COVID19-Infection.
20. Garg M, Prabhakar N, Bhalla AS, et al. Computed tomography chest in COVID-19: When & why?. Indian J Med Res. 2021;153(1-2):86-92.
21. Tsakok M, Shaw R, Murchison A, et al. Diagnostic accuracy of initial chest radiograph compared to SARS-CoV-2 PCR in patients with suspected COVID-19. BJR Open. 2020; 2(1): 20200034-20200038.
22. Stephanie S, Shum T, Cleveland H, et al. Determinants of chest radiography sensitivity for COVID-19: a multi-institutional study in the United States. Radiol Cardiothorac Imaging. 2020;2(5):e200337- 200344.
23. Borakati A, Perera A, Johnson J, et al. Diagnostic accuracy of X-ray versus CT in COVID-19: a propensity-matched database study. BMJ open. 2020;10(11):e042946-042959.
24. Wong HY, Lam HY, Fong AH, et al. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. Radiology. 2020;296(2):E72-78.
25. Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med. 2020;382(18):1708-1720.