Original Article

HRCT Chest in Diagnosis of Covid-19

Accuracy of HRCT Chest in Diagnosis of Covid-19 Pneumonia Against Reverse Transcription Polymerase Chain Reaction

Zafar Tanveer Ahmed[1], Nighat Haroon Khan[3], Saira Bilal[3], Madeeha Tanveer[1], Fareeha Tanveer[3] and Ammar Tahir[2]

ABSTRACT

Objective: To assess the accuracy of high-resolution computed tomography of chest for diagnosis of pneumonia related to corona virus disease taking Reverse transcription polymerase chain reaction as gold standard.

Study Design: Cross Sectional survey

Place and Duration of Study: This study was conducted at the Jinnah Medical Diagnostic Center, Sialkot Pakistan, for 6 months from 1st April 2020- 30th September 2020.

Materials and Methods: 200 patients were included with symptoms of coronavirus pneumonia were included. HRCT chest was done and findings were recorded. Then RT-PCR assays was applied and findings were recorded. Patients were labeled as positive or negative. Data was analyzed using SPSS v.20. Diagnostic accuracy of HRCT Chest was calculated taking RT-PCR as gold standard.

Results: The mean age of patients was 35.69 ± 12.95 years. There were 103 (51.5%) males and 97 (49.5%) females. On HRCT Chest, 121 (60.5%) had ground glass appearance and 108 (54%) had consolidation. The sensitivity of HRCT Chest was 70.1%, specificity was 60.3%, positive and negative predictive values were was 79.3% and 48.1% and diagnostic accuracy was 67%.

Conclusion: HRCT Chest is highly accurate to diagnose the COVID-19 in symptomatic patients and can replace RT-PCR which is expensive than HRCT Chest and not readily available in all set-ups.

Key Words: Corona virus, COVID-19, pneumonia, high resolution computed tomography, Reverse transcription polymerase chain reaction

Citation of article: Ahmed ZT, Khan NH, Bilal S, Tanveer M, Tanveer F, Tahir A. Accuracy of HRCT Chest in Diagnosis of Covid-19 Pneumonia Against Reverse Transcription Polymerase Chain Reaction. Med Forum 2021;32(1):140-144.

INTRODUCTION

Corona virus disease that occurred in 2019 (COVID-19) is the infection that occurs due to entry of corona virus strain in human body. It is identified as the "severe acute respiratory syndrome corona virus 2" (SARSCoV-2). It was first detected in positive patients in Wuhan, China, in late December-2019[1,2]. The frequency of confirmed COVID pneumonia on PCR was reported in 43-70.6% cases[3,4]. Some studies during this time frame of pandemic were conducted throughout the world and findings are quite similar.

[1.] Department of Radiology / Medicine[2], Imran Idris Teaching Hospital Sialkot Medical College, Sialkot.
[3.] Department of Radiology, Lahore General Hospital, Lahore.

Correspondence: Dr. Zafar Tanveer Ahmed, HOD & Professor of Radiology, Imran Idris Teaching Hospital Sialkot Medical College, Sialkot.
Contact No: 03338611766
Email: zafar.tanveer66@gmail.com

Received: October, 2020
Accepted: December, 2020
Printed: January, 2021

At initial stages of COVID-19, the known imaging characteristics are the bilateral multi-lobar ground-glass opacities [5, 6].

The most common symptoms of COVID-19 infection are fever and cough, more specifically dry cough. Other symptoms are quite non-specific including shortness of breath, myalgia, vomiting, headache and fatigue. To make the definite diagnosis, PCR for corona virus is the gold standard, however imaging facilities at tertiary care hospitals also helpful for the definitive diagnosis as well as to assess the complications.[7] Previous sero-prevalence surveys used serological tests to detect the patients of COVID-19 in general population or community, which have antibodies against the COVID-19 infection. The antibodies are particular type of proteins which develop in response to the infections. The antibodies are identified in the serum of patients who were tested after the episode of infection. These people showed the immune response to COVID-19 infection [8].

There is significant cohort of patients in which radiographic findings are not typical or are subtle or are not correlating with clinical condition. Some patients are RT-PCR negative but clinically are strongly suspected to have COVID-19. These all are the patients in which HRCT chest may have a diagnostic

role[9,10]. Most commonly observed findings include ground-glass opacities and consolidation predominantly in peripheral lung distribution. It is essential to know about these findings so that it may be helpful to establish a diagnosis [5, 11, 12].

There is significant number of patients in which radiographic findings are not typical or are subtle or are not correlating with clinical condition. Some patients are RT-PCR negative but clinically are strongly suspected to have COVID-19. These all are the patients in which HRCT chest may have a diagnostic role. Most commonly observed findings include ground-glass opacities, smooth interlobular septal thickenings and consolidations predominantly in peripheral and basal lung distribution. It is essential to know about these findings so that it may be helpful to establish a diagnosis.

MATERIALS AND METHODS

Study Design: Cross Sectional survey.

Place of study: Jinnah Medical Diagnostic Centre, Sialkot Pakistan.

Study Duration: 6 months (1st April 2020- 30th September 2020)

Sample Size: Sample size = 200 patients has been estimated by keeping confidence level as 95%, 7% margin of error and anticipated population proportion of COVID pneumonia i.e. 43%

Sampling Technique: Nonprobability, consecutive sampling

Selection Method:

Inclusion: Patients of age 18 years and above, both genders presenting with symptoms of COVID-19 i.e. severe cough, reduced respiration, chest pain, abdominal pain, right hypochondrial pain, dysgeusia, malaise, anorexia, anosmia, etc. were included in the study.

Exclusion: Patients with chronic respiratory infection, asthma or chronic obstructive pulmonary disease, congestive heart failure (EF<30%), pregnancy, H/O Pulmonary Surgery, H/O Infection, Pleural Effusion, and Poor Respiratory System or duration between RT-PCR and HRCT– Chest >7 days were excluded from the study.

Data Collection Method: 200 patient fulfilling selection criteria were enrolled in the study through outpatient, inpatient and emergency departments of nearby hospitals or who had suspicious opacities of Chest x-rays and referred to our center for HRCT chest. Informed consent was taken from each patient. Following data was collected: patient's name, age, sex, diabetes, smoking history, and presenting symptoms. HRCT chest was done using Light sped 16 slides CT Scanner GE (Germany). HRCT chest was reported by researchers with mutual consensus. Findings on HRCT chest to be collected will include pattern, distribution, laterality and any associated finding including atelectasis, reticulation, architectural distortion, vascular enlargement, cavitation, pneumothorax and pleural effusion. Findings were recorded and patients were labeled as positive or negative (as per operational definition).All HRCT– Chest was performed by researcher under supervision of consultant radiologist having at least four years' experience in HRCT - Chest. Then RT-PCR assays were applied by using the "Taq Man One-Step RT-PCR Kits (Shanghai Huirui Biotechnology [Shanghai, China] or Shanghai Bio Germ Medical Bio-technology [Shanghai, China])," within 3-7 days of HRCT Chest. Sample was taken by nasopharyngeal or oropharyngeal swabs, nasal swabs, or mid-turbinate swabs. All the samples were stored carefully and sent to the laboratory of the hospital for assessment of presence of COVID under RT-PCR. RT-PCR was applied and findings were recorded. Patients were labeled as positive or negative.

Data Analysis: Data was analyzed using SPSS v.20. Numerical variables like age, duration of symptoms, BMI, were calculated as mean ± SD. Categorical variables like gender, diabetes, smoking and positive COVID pneumonia were calculated as frequency (%). 2 x 2 table was developed to determine the sensitivity, specificity, positive & negative predictive values and diagnostic accuracy of HRCT– Chest taking RT-PCR as gold standard.

RESULTS

The mean age of patients was 35.69 ± 12.95 years. There were 103 (51.5%) males and 97 (49.5%) females. Male-to-female ratio was 1.1: 1. The mean BMI of patients was 32.33 ± 8.42 kg/m^2. There were 86 (43%) patients who were smokers. There were 66 (33%) patients who were diabetic, 81 (40.5%) were hypertensive, 23 (11.5%) had asthma and 9 (4.5%) had COPD. The mean duration of symptoms was 12.37 ± 5.61 days. On HRCT Chest, 121 (60.5%) had ground glass appearance and 108 (54%) had consolidation. Table 1.

Table No.1 demographics of patients

n	200
Age (years)	35.69 ± 12.95
Gender	
Male	103 (51.5%)
Female	97 (49.5%)
BMI (kg/m^2)	32.33 ± 8.42
Smoking	86 (43%)
Comorbidities	
Diabetes	66 (33%)
Hypertension	81 (40.5%)
Asthma	23 (11.5%)
COPD	9 (4.5%)
Duration of symptoms (days)	12.37 ± 5.61
Ground glass appearance	121 (60.5%)
Consolidation	108 (54%)

Table No.2: Accuracy of HRCT – Chest takingRT-PCR as gold standard

		RT-PCR		Total
		Positive	Negative	
HRCT	Positive	96	25	121
	Negative	41	38	79
Total		137	63	200

The sensitivity of HRCT– Chest was 70.1%, specificity was 60.3%, positive and predictive values were 79.3% and 48.1% and diagnostic accuracy was 67%. Table 2.

DISCUSSION

Human infection due to corona virus is a deadly infection of respiratory tract. It was first noted in December 2019 all over the world. The group of patients identified with emergent viral pneumonia in Wuhan, China, were first infected patients due to coronavirus, server acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [13-16].On 20th March, 2020, the SARS-CoV-2 was confirmed in 326,558 patients, world widely. Out of these, 14,267 patients dies due to complications of SARS-CoV-2. Epidemiological and clinical features in patients of corona virus disease 2019 (COVID-19) have been described and testified. But the pathogenesis of this infection has not been descried yet [17].

Patients of SARS-CoV primarily have symptoms like headache, myalgia, chills, fever, malaise and subsequently dyspnea, cough and respiratory distress.[18,19]. Diffused alveolar damage, epithelial cell proliferation and the rise in macrophages are also perceived in infected cases[20]. World Health Organization has already confirmed the continuing epidemic of the respiratory tract infections due to SARS-CoV-2 as the Public Health Emergency at International level and also entitled the infection as COVID-19. According to data recorded in March 2020, there were about 90,053 patients have been established all over the world, with the crude fatality rate as 3.4%[21].

In our study, the mean age of patients was 35.69± 12.95 years. There were 103 (51.5%) males and 97 (49.5%) females. Male-to-female ratio was 1.1: 1. The mean BMI of patients was 32.33 ± 8.42 kg/m^2. There were 86 (43%) patients who were smokers. There were 66 (33%) patients who were diabetic, 81 (40.5%) were hypertensive, 23 (11.5%) had asthma and 9 (4.5%) had COPD. The mean duration of symptoms was 12.37 ± 5.61 days. On HRCT - Chest, 121 (60.5%) had ground glass appearance and 108 (54%) had consolidation. The sensitivity of HRCT Chest was 70.1%, specificity was 60.3%, positive predictive value was 79.3% negative predictive value was 48.1% and diagnostic accuracy was 67%.

HRCT chest showed the high sensitivity rate for detection of COVID-19 than RT-PCR done at initial stage by using samples of cotton swabs in the region of COVID-19 epidemic in China.[22] One study found that the sensitivity and specificity of HRCT Chest were 97% and 25% respectively for diagnosis of COVID pneumonia.[23] Another study found that the sensitivity and specificity were 85.71% and 60.94%, while PPV and NPV were 32.40% and 95.12%. The overall diagnostic accuracy of HRCT Chest for confirmation of COVID-19 was 65.38%.[24]

Karam et al., found that the HRCT chest had pooled sensitivity, specificity and accuracy of about 0.91 (95% CI; 0.82-0.98), 0.775 (95% CI; 0.25-1.00) and 0.87 (95% CI; 0.68-0.99), respectively, taking RT-PCR as gold standard. Notably, in initial days, small studies conducted in China favor HRCT chest of diagnosis of COVID-19 as compared to the larger studies conducted later in other regions.[25] Falaschi et al., reported that HRCT Chest had sensitivity, specificity, PPV, NPV, and accuracy for detection of COVID-19 pneumonia were 90.7% [95% CI 87.7-93.2%], 78.8% [95% CI; 73.8-83.2%], 86.4% [95% CI; 76.1-88.9%], 85.1 % [95% CI; 81.0-88.4] and 85.9% [95% CI; 83.2-88.3%], respectively.[26]

Ciccarese et al., found that the COVID-19 was diagnosed in 45.9% cases. “Typical” pattern on HRCT Chest showed the sensitivity of HRCT Chest as 71.6%, while specificity as 91.6%.[27] Qureshi et al., found that HRCT-Thorax revealed sensitivity: 97.41%, specificity: 80%, PPV: 99.12%, NPV: 57.14%, and diagnostic accuracy of 96.69% for COVID-19 pneumonia.[28] While Xu et al., found that HRCT chest showed the higher sensitivity for detection of COVID-19, particularly in the region of severe epidemic condition. But, the specificity is less. In the emergency situation for epidemic control, the HRCT Chest can be a quick, convenient, and effective modality to detect earlier the doubtful cases and may contribute to restrain the epidemic.[29]

CONCLUSION

Thus HRCT Chest is highly accurate to diagnose the COVID-19 in symptomatic patients and can replace RT-PCR which is expensive than HRCTChest and not readily available in all set-ups. So we can replace HRCTChest to confirm the diagnosis of COVID-19 in adults which is cost effective and available in all tertiary level health care centers.

Author’s Contribution:

Concept & Design of Study:	Zafar Tanveer Ahmed
Drafting:	Nighat Haroon Khan, Saira Bilal
Data Analysis:	Madeeha Tanveer, Fareeha Tanveer, Ammar Tahir

Revisiting Critically:	Zafar Tanveer Ahmed, Nighat Haroon Khan, Saira Bilal
Final Approval of version:	Zafar Tanveer Ahmed

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. New England J Med 2020.
2. Tan W, Zhao X, Ma X, Wang W, Niu P, Xu W, et al. A novel coronavirus genome identified in a cluster of pneumonia cases—Wuhan, China 2019− 2020. China CDC Weekly 2020;2(4):61-2.
3. Gietema HA, Zelis N, Nobel JM, Lambriks LJ, van Alphen LB, Lashof AMO, et al. CT in relation to RT-PCR in diagnosing COVID-19 in the Netherlands: a prospective study. Med Rxiv 2020.
4. Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, et al. Sensitivity of Chest CT for COVID-19: Comparison to RT-PCR. Radiol 2020;296(2): E115-E7.
5. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiol 2020:200343.
6. Ng M-Y, Lee EY, Yang J, Yang F, Li X, Wang H, et al. Imaging profile of the COVID-19 infection: radiologic findings and literature review. Radiology: Cardiothoracic Imaging 2020;2(1): e200034.
7. Waggoner JJ, Stittleburg V, Pond R, Saklawi Y, Sahoo MK, Babiker A, et al. Triplex real-time RT-PCR for severe acute respiratory syndrome coronavirus 2. Emerging Infectious Diseases 2020;26(7):1633.
8. CDC. Large-scale Geographic Seroprevalence Surveys. 2020 [cited 2020]; Available from: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/geographic-seroprevalence-surveys.html.
9. Chua F, Armstrong-James D, Desai SR, Barnett J, Kouranos V, Kon OM, et al. The role of CT in case ascertainment and management of COVID-19 pneumonia in the UK: insights from high-incidence regions. The Lancet Respiratory Med 2020;8(5):438-40.
10. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, et al. CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiol 2020;295(1):202-7.
11. Duan Y-n, Qin J. Pre-and posttreatment chest CT findings: 2019 novel coronavirus (2019-nCoV) pneumonia. Radiol 2020;295(1):21.
12. Lei J, Li J, Li X, Qi X. CT imaging of the 2019 novel coronavirus (2019-nCoV) pneumonia. Radiol 2020;295(1):18.
13. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. New England J Med 2020;382:727-33.
14. Armstrong GL, MacCannell DR, Taylor J, Carleton HA, Neuhaus EB, Bradbury RS, et al. Pathogen genomics in public health. New England J Med 2019;381(26):2569-80.
15. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. The Lancet 2020;395(10224):565-74.
16. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. JAMA 2020;323(11):1061-9.
17. Coperchini F, Chiovato L, Croce L, Magri F, Rotondi M. The cytokine storm in COVID-19: an overview of the involvement of the chemokine/chemokine-receptor system. Cytokine & Growth Factor Reviews 2020.
18. Cheng VC, Lau SK, Woo PC, Yuen KY. Severe acute respiratory syndrome coronavirus as an agent of emerging and reemerging infection. Clin Microbiol Reviews 2007;20(4):660-94.
19. Peiris JS, Lai ST, Poon LL, Guan Y, Yam LY, Lim W, et al. Coronavirus as a possible cause of severe acute respiratory syndrome. Lancet (London, England) 2003;361(9366):1319-25.
20. To KK, Hung IF, Chan JF, Yuen KY. From SARS coronavirus to novel animal and human coronaviruses. J Thoracic Dis 2013;5 Suppl 2(Suppl 2):S103-8.
21. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet (London, England) 2020;395(10223):497-506.
22. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiol 2020; 296(2):E32-E40.
23. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiol 2020:200642.
24. Deng M, Sun W, Hu J, Mei L, Weng D, Liu B, et al. Radiological Features on HRCT Chest and RT-PCR Testing for the Diagnosis of Coronavirus

Disease 2019 (COVID-19) in China: A Comparative Study of 78 Cases in Pregnant Women. Research Square 2020:Online.

25. Karam M, Althuwaikh S, Alazemi M, Abul A, Hayre A, Alsaif A, et al. Chest CT versus RT-PCR for the Detection of COVID-19: Systematic Review and Meta-analysis of Comparative Studies. Med Rxiv 2020:2020.06.22.20136846.
26. Falaschi Z, Danna PSC, Arioli R, Pasché A, Zagaria D, Percivale I, et al. Chest CT accuracy in diagnosing COVID-19 during the peak of the Italian epidemic: A retrospective correlation with RT-PCR testing and analysis of discordant cases. Eur J Radiol 2020;130:109192.
27. Ciccarese F, Coppola F, Spinelli D, Galletta GL, Lucidi V, Paccapelo A, et al. Diagnostic Accuracy of North America Expert Consensus Statement on Reporting CT Findings in Patients with Suspected COVID-19 Infection: An Italian Single Center Experience. Radiology: Cardiothoracic Imaging 2020;2(4):e200312.
28. Qureshi AR, Akhtar Z, Irfan M, Sajid M, Ashraf Z. Diagnostic value of HRCT-Thorax for pandemic COVID-19 pneumonia in Pakistan. Journal of Rawalpindi Medical College 2020;24(Supp-1):77-84.
29. Xu B, Xing Y, Peng J, Zheng Z, Tang W, Sun Y, et al. Chest CT for detecting COVID-19: a systematic review and meta-analysis of diagnostic accuracy. Eur Radiol 2020;30(10):5720-7.