

Diagnostic Performance of HRCT Scan of Chest in the Evaluation of COVID-19 Pneumonia: Comparison to RT-PCR

Md. Hafizur Rahman^{1,*}, Nashid Amir¹, Md. Anisur Rahman¹, Zakir Hossain ASM²

¹Department of Radiology & Imaging, Rajshahi Medical College, Rajshahi, Bangladesh

²Department of Radiology & Imaging, National Institute of Diseases of the Chest and Hospital, Dhaka, Bangladesh

Email address:

hafizdr66@yahoo.com (Md. H. Rahman)

*Corresponding author

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Abstract: *Background & purpose:* This study was designed to evaluate the diagnostic performance of HRCT scan of chest in comparison to RT-PCR in the diagnosis of coronavirus disease 2019 (COVID-19). *Materials & Methods:* This study was conducted in the Department of Radiology & Imaging, Rajshahi Medical College Hospital, Rajshahi that included 150 patients over a period of eight months from April, 2020 to December, 2020. Using RT-PCR as the reference standard, the performance of HRCT scan of chest in the diagnosis of COVID-19 was assessed. In addition, the common HRCT findings, CT severity, demographic distribution of the disease were also analyzed. *Results:* The mean age of patients was 51.8±14.5 years, age range was from 24 to 82 years. There was a male predominance with 1.58:1. Cough (86.7%) & dyspnoea (74.7%) were the predominant clinical symptoms. Commonest CT features were GGO (97.1%) & GGO with consolidation (49.0%) followed by fibrosis (48%). Majority of the patients had all five lobes involved (51%) & CT severity showed majority with 25-50% involvement (28%) followed by 50-75% involvement in 22.3% patients. Specificity, sensitivity, positive predictive value, negative predictive value, accuracy & reliability were 97%, 43.7%, 93.5%, 63.6%, 91.3% & 0.88 respectively. *Conclusion:* HRCT chest has a very high sensitivity for diagnosis of COVID-19. HRCT chest should be considered as complementary to RT-PCR & a primary tool for detection of COVID-19 in this pandemic situation.

Keywords: HRCT, RT-PCR, COVID-19, Diagnostic Performance, CT Severity, Sensitivity

1. Introduction

The coronavirus COVID-19 pandemic is the defining global health crisis of present time and is the greatest challenge that mankind has faced since a long time. Since its emergence in Asia in December, 2019, the virus has spread to every continent. The current death toll is staggering and the health crisis & socio-economic impact of this pandemic is both unprecedented and devastating. The novel coronavirus (nCoV-2) outbreak was declared a pandemic & a global health emergency by World Health Organization on 11th March 2020. The first confirmed case of COVID-19 in Bangladesh was reported on 7th March, 2020 & since then the virus has infected hundreds of thousands of people taking

thousands of lives.

Since the outbreak of COVID-19 (coronavirus disease 2019), physicians have been struggling with the optimal diagnostic approach of suspected patients. RT-PCR (real time reverse transcriptase-polymerase chain reaction) testing of respiratory samples is generally being considered as the reference standard for diagnosing novel coronavirus infection. However, RT-PCR results take hours to days to become available & although highly specific, sensitivity is moderate. [1, 2] This delay and relative low sensitivity of RT-PCR is suboptimal for clinical decision making and appropriate patient isolation and management.

An early and rapid detection of COVID-19 is crucial for timely treatment, contact tracing and limit the chain of social transmission of disease. Though viral nucleic acid RT-PCR remains the gold standard tool for confirming COVID-19 pneumonia, incorporating multiple repeated RT-PCR testing are often required as the sensitivity of RT-PCR is found to be around 50 to 62%. [3] CT scan of chest has been an important imaging modality in the diagnosis & management of patients with viral pneumonia, as demonstrated in large scale outbreak in SARS (severe acute respiratory syndrome) & MERS (Middle East respiratory syndrome). Since the coronavirus disease causes alveolar cell damage, High Resolution Computed Tomography (HRCT) is useful in detection and assessment of degree of damage & monitoring the disease progression and outcome. CT changes can be identified before patients become symptomatic and RT-PCR becomes positive. [4] As various recent studies show, HRCT scan of chest demonstrates typical radiological features in almost all patients of COVID-19 pneumonia, including ground glass opacities (GGO), multifocal patchy consolidation, interstitial changes in a peripheral subpleural & subfissural distribution. These typical chest CT findings are also observed in patients with negative RT-PCR results but positive clinical symptoms.

To better understand the diagnostic value of HRCT scan of Chest compared with RT-PCR testing, we conducted a study in the Department of Radiology & Imaging, Rajshahi Medical College Hospital, Rajshahi on 150 suspected COVID-19 pneumonia patients. HRCT features were identified and severity of lung involvement were described. HRCT chest reports were then compared with RT-PCR results and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy and agreement (reliability) between HRCT Chest & RT-PCR was obtained.

2. Materials & Methods

2.1. Place & Duration of Study

This study was conducted at Department of Radiology & Imaging, Rajshahi Medical College Hospital, Rajshahi on 150 suspected COVID-19 patients who were sent for performing HRCT Scan of chest from April, 2020 to December, 2020 for a period of 08 (eight) months. These patients underwent both RT-PCR assay & HRCT Scan of chest. For initial RT-PCR negative patients, a repeat RT-PCR testing was done within 3 days. Informed consent were taken from patients by standardized questionnaire.

2.2. Inclusion & Exclusion Criteria

2.2.1. Inclusion Criteria

- 1) Patients of all ages & both sexes.
- 2) Patients with clinical symptoms of COVID-19 pneumonia irrespective of RT-PCR status.

2.2.2. Exclusion Criteria

- 1) Patients with other explained / pre-existing cause of cough & dyspnoea (COPD, Heart failure).
- 2) Patient's refusal to participate in study.
- 3) Poor quality of image due breathing artifact & restless patients.

2.3. HRCT Chest Protocols

All the images were obtained with 64 slice Philips brilliance CT scanner with patients in the supine position. The main scanning parameters were as follows: tube voltage: 120 kVp; automatic tube current modulation; tube current: 30-70 mAs; pitch: 0.99-1.22mm; matrix: 512x512; slice thickness 10mm; FOV: 350mm x 350mm. All the images were then reconstructed with a slice thickness of 1.250-3.00mm with the same increment. Both lung parenchymal window & mediastinal windows were studied.

2.4. Image Analysis

Six radiologists of varying years of experience of interpreting HRCT Scan of Chest reviewed all CT images. RT-PCR assay of all the patients were not available at the time of image interpretation. The radiologists classified CT findings as positive or negative for COVID-19 by consensus. The lesion characteristics (GGO, consolidation, crazy paving, fibrosis/reticulation, vascular dilatation, and nodule), distribution (lobar/segmental, right/left, central/peripheral), any associated complication (pleural effusion, bronchiectasis etc) were described.

2.5. Statistical Analysis

The statistical analysis was performed with SPSS software. Continuous variables are displayed as means \pm standard deviation and categorical variables as counts and percentage.

3. Results

The present study was carried out in the Department of Radiology & Imaging, Rajshahi Medical College Hospital, Rajshahi on 150 suspected COVID-19 patients who were sent for performing HRCT Scan of chest from April, 2020 to December, 2020 for a period of 08 (eight) months. The mean age of patients was 51.8 years with a standard deviation of ± 14.5 . Age range was from 24 to 82 years. There was a male predominance with 1.58:1 ratio being 92 male & 58 female patients. Maximum number of patients were within 50-70 years age range. Cough (86.7%) & dyspnoea (74.7%) were the predominant clinical symptoms followed by Fever (58.7%), Chest pain (52.7%) & others (19.3%). Most of the patients presented with typical CT feature of GGO (97.1%) & GGO with consolidation (49.0%) followed by fibrosis (48%) & interstitial thickening (43.8%). Majority of the patients had all five lobes involved (51%) followed by bilateral upper & lower lobar involvement (36%). CT severity of the disease expressed as percent of lung parenchymal involvement was described. Majority had 25-

50% involvement (28%) followed by 50-75% involvement in 22.3% patients. 139 out of 150 patients had positive findings in HRCT, among which 09 patients had initial negative RT-PCR result & were lost to follow up. 04 patients had normal

HRCT but positive RT-PCR results. Specificity, sensitivity, positive predictive value, negative predictive value, accuracy & reliability were 97%, 43.7%, 93.5%, 63.6%, 91.3% & 0.88 respectively.

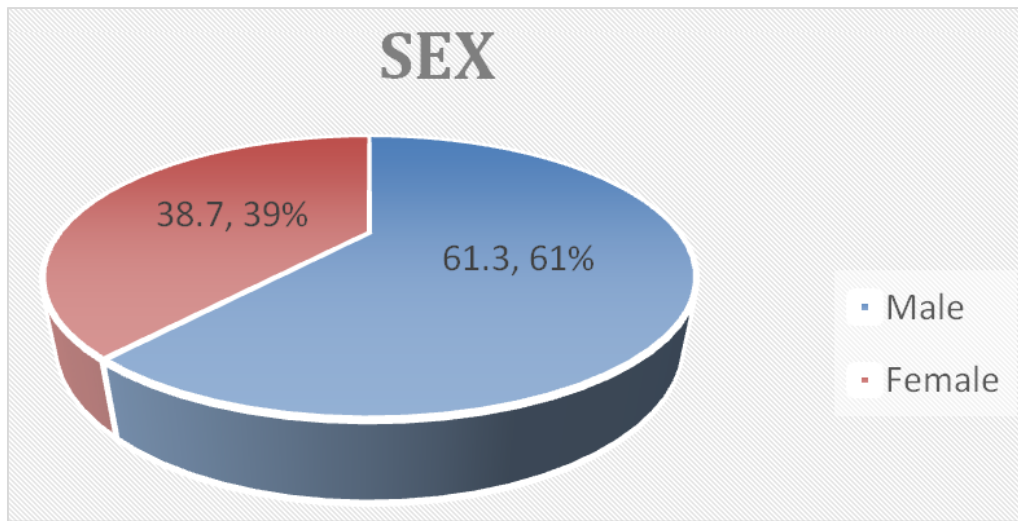


Figure 1. Distribution according to sex.

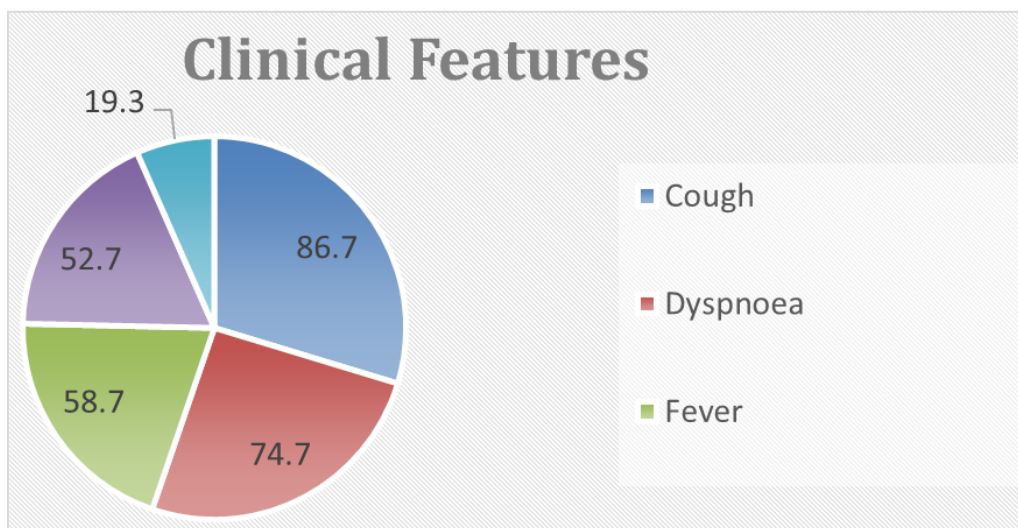


Figure 2. Distribution of Clinical Features.

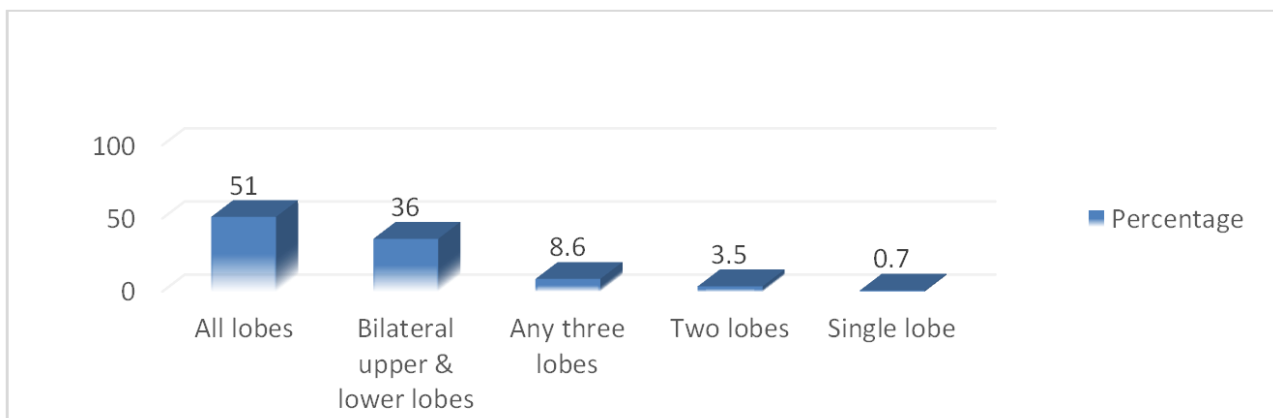
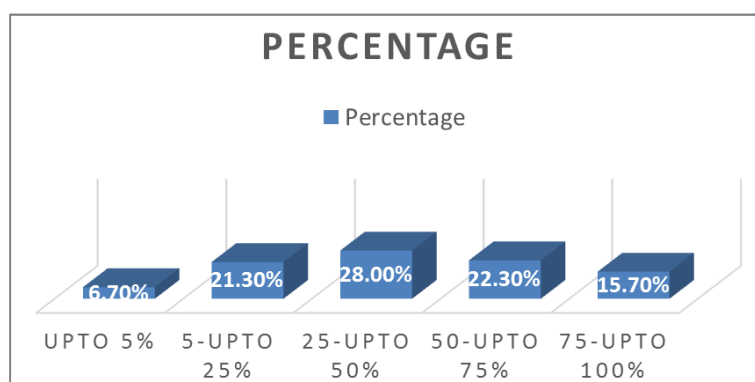


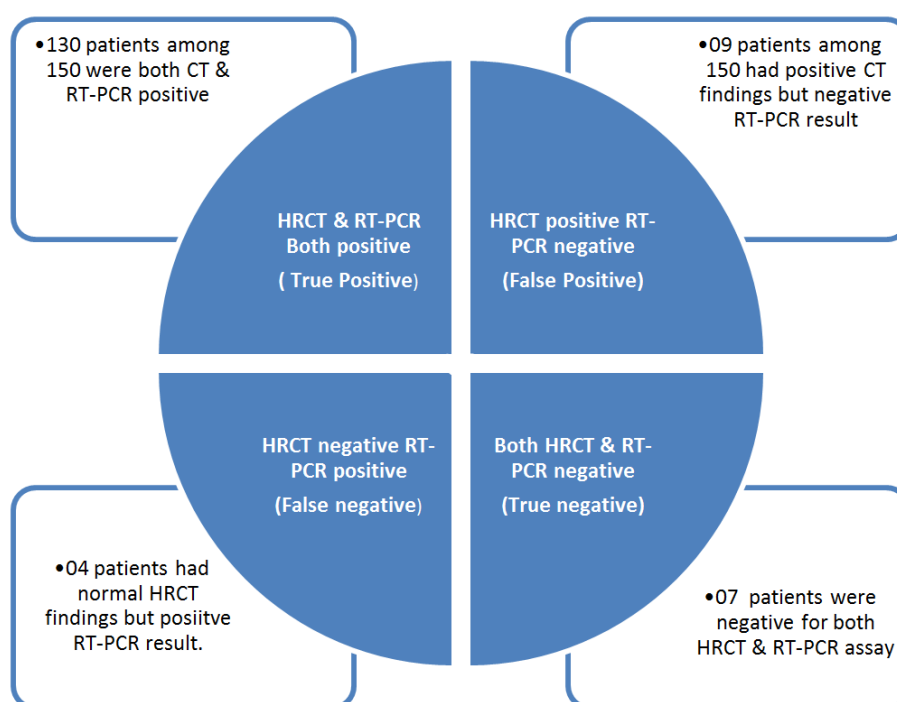
Figure 3. Distribution of lobar involvement.

Table 1. Predominant HRCT features.

Feature	Number	Percentage
Ground glass opacity (GGO)	135	97.1%
GGO with consolidation	68	49.0%
Fibrosis	72	48.0%
Septal (Interstitial) thickening	61	43.8%
Crazy paving	33	23.7%
Reverse halo sign	26	18.7%
Pleural thickening	52	37.4%
Pleural effusion	17	12.2%
ARDS	11	7.9%
Others	08	5.7%

**Figure 4.** CT severity (percentage of lung involvement).**Table 2.** Diagnostic performance of HRCT Scan of Chest in comparison to RT-PCR.

Variables	Percentage
Sensitivity	97%
Specificity	43.7%
Positive predictive value	93.5%
Negative predictive value	63.6%
Accuracy	91.3%
Agreement (reliability)	0.88 (Very good agreement)

**Figure 5.** Study flowchart.

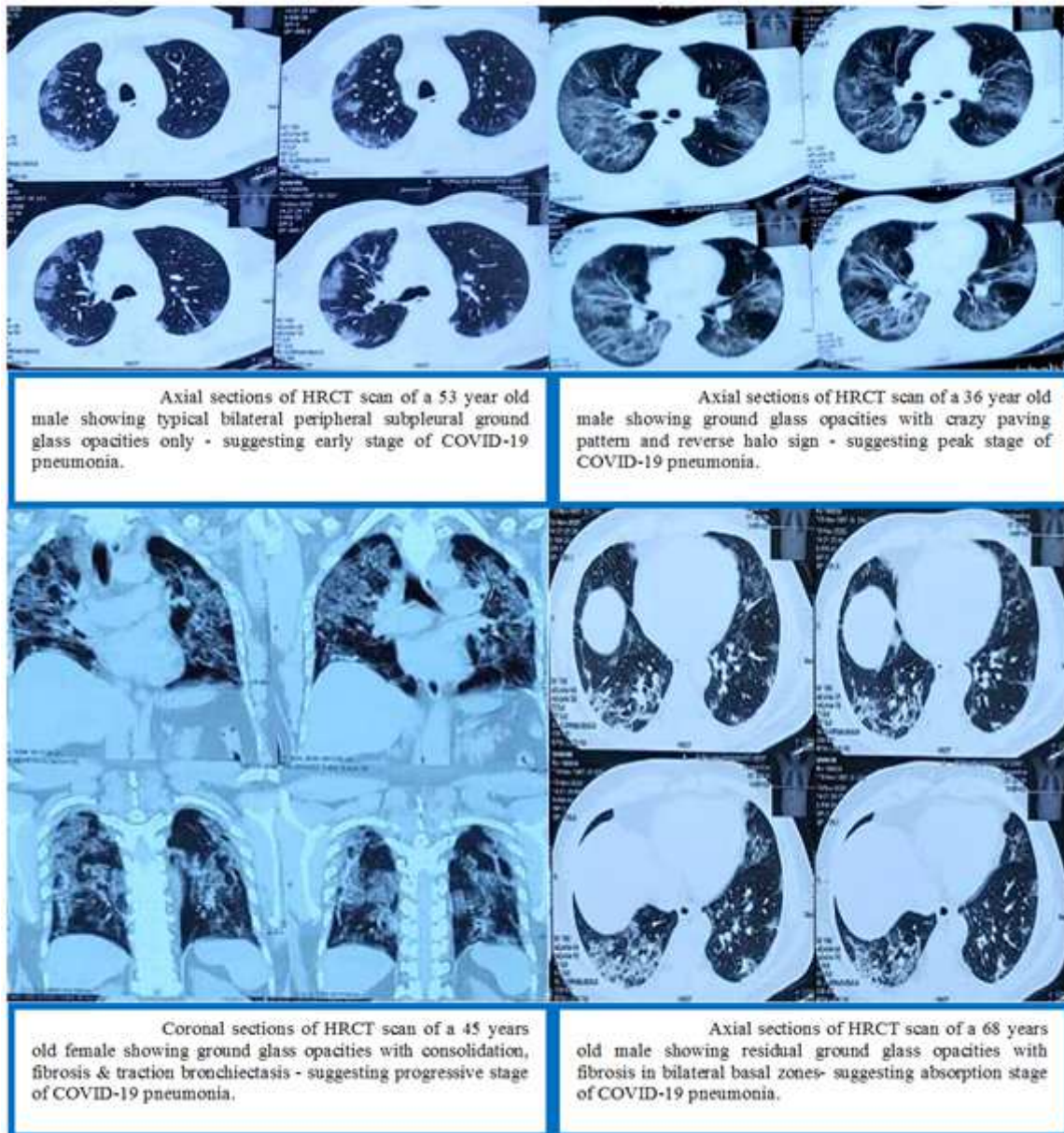


Figure 6. Pictorial Review.

4. Discussion

Early diagnosis of coronavirus disease is crucial for disease treatment, containment, surveillance & control. Compared with RT-PCR, chest HRCT is a more rapid, reliable, practical and sensitive tool to diagnose and assess COVID-19 in this global health emergency setting. According to current diagnostic criteria, viral nucleic acid tests by means of RT-PCR assay play a crucial role in determining isolation & hospitalization of affected individuals. [5]

This present study was conducted on 150 patients over a period of eight months. The mean age of patients was 51.8 years with a standard deviation of ± 14.5 . Age range was from 24 to 82 years. There was a male predominance with 1.58:1 ratio being 92 male & 58 female patients. Maximum number

of patients were within 50-70 years age range. This age range was similar to the study conducted by Ashraf et al, in Pakistan. Mean age of that study was 57 ± 17 years, ranging from 18-89 years. With a male predominance (182/134). [6] Their study also showed commonest symptom to be fever (60%) followed by cough (54%) whereas our study showed cough (86.7%) & dyspnoea (74.7%) being the commonest presenting complaints.

In present study the commonest HRCT feature of COVID-19 pneumonia was ground glass opacity (97.1%) & ground glass opacity with consolidation (49%). Bilateral multilobar involvement was a remarkable feature & involvement of all 5 lobes was predominant (51%). These results were quite similar to the study conducted by Alam et al. [7] Ground glass opacity was found in 96.9% cases & 63.28% had combined GGO with consolidation. All lobar involvement was found in 75% patients. Their study also showed majority

of the patient was 1-25% lung involvement (29.6%) followed by 25-50% (25.7%), whereas our study showed maximum patients (28%) in 25-50% involvement followed by 50-75% (22.3%). This may be due to delayed presentation and seeking of medical attention of our patients where disease had already progressed.

In the current study, 139 out of 150 patients had positive findings in HRCT, among which 09 patients had initial negative RT-PCR result & were lost to follow up. 04 patients had normal HRCT but positive RT-PCR results. The discrepant RT-PCR & HRCT findings could be explained as the reported sensitivity of RT-PCR is 50-62%, which is acceptable but still there is a moderate proportion of missed diagnosis (false negative). The RT-PCR testing accuracy is affected by a number of factors including viral load in respiratory tract sample, specimen source, sampling technique & timing, quality control of the test and inherent performance of testing kits. [8] Moreover, in this pandemic situation, the testing kits are not readily available in many parts of the world. In many cases, repeated RT-PCR testing is required for a strong suspected patient to be tested positive. On the other hand, the non-invasiveness, rapidity & high sensitivity makes HRCT chest an excellent diagnostic tool of COVID-19 pneumonia. The false positive cases in our study had typical CT findings but initial negative RT-PCR result & those patients were lost to follow up. False negative cases had normal HRCT chest findings as very initial stage of the disease may have a negative CT.

Specificity, sensitivity, positive predictive value, negative predictive value, accuracy & reliability were 97%, 43.7%, 93.5%, 63.6%, 91.3% & 0.88 respectively in our study. The reported sensitivity of CT in COVID-19 is as high as 98% by Fang *et al.* [9] Another study by Ai *et al.* showed a sensitivity of 97% for chest CT with 308/601 (51.2%) patients showing typical CT manifestations before RT-PCR test was positive. [10] Our study showed a very high sensitivity, positive predictive value & accuracy with a moderate specificity & negative predictive value. Both RT-PCR & HRCT had a very good agreeability (0.88) meaning both these tests are comparable & equally useful in detection of coronavirus disease. Our study result demonstrated that the combined strategy of initial RT-PCR following with HRCT yield a remarkably improved sensitivity. Given the high sensitivity of HRCT & High specificity of RT-PCR (around 95%), combining these two as a comprehensive screening strategy is highly recommended.

5. Conclusion

HRCT scan of chest is a more sensitive & quicker alternative to RT-PCR although RT-PCR is currently regarded as gold standard. Early disease recognition by CT

scan can speed up treatment and prompt early patient isolation. Normal CT scan can be found in RT-PCR positive COVID-19 cases, and typical CT manifestations can be found in RT-PCR negative cases. To compensate the potential risk of false negative result in initial screening RT-PCR, HRCT scan of chest should be applied in clinically suspected COVID-19 cases to alleviate the burden of missed diagnoses. This will allow for early implementation of public health surveillance, containment and response to this communicable disease.

References

- [1] Wang W, Xu Y, Gao R, Lu R, Han K, Wu G, Tan W. Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *JAMA* 2020.
- [2] Long C, Xu H, Shen Q, Zhang X, Fan B, Wang C, Zeng B, Li Z, Li X, Li H. Diagnosis of the Coronavirus disease (COVID-19): rRT-PCR or CT? *European journal of radiology* 2020; 126: 108961.
- [3] Guan W., Ni Z., Hu Y. Clinical characteristics of coronavirus disease 2019 in China. *N. Engl. J. Med.* 2020 doi: 10.1056/NEJMoa2002032.
- [4] 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. *Radiology*. 2020 doi: 10.1148/radiol.2020200343.
- [5] Tao Ai, Zhenlu Yang, Hongyan Hou, Chenao Zhan, Chong Chen, Wenzhi Lv, Qian Tao, Ziyong Sun, Liming Xia. Original research; Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. *Thoracic Imaging Radiology; Radiology* 2020; 296: E32–E40.
- [6] Ashraf V, Chaudhry S, Yousaf KR, Chatha AA, Khalid A. Spectrum of High Resolution Computed Tomography Findings in COVID-19 Infection. *Annals of King Edward Medical University*, 2020, 26 (Special Issue), 187-191.
- [7] Alam SZ, Muid SMAA, Akhter A, Rahman AKMS, Emran MA, Mostakim MTA. HRCT Chest Evaluation of COVID-19 Patients: Experience in Combined Military Hospital, Dhaka, Bangladesh. *Journal of Bangladesh College of Physicians and Surgeons*; Vol. 38, COVID-19 (Supplement Issue), July 2020.
- [8] Chan J. F., Yip C. C., To K. K. Improved molecular diagnosis of COVID-19 by the novel, highly sensitive and specific COVID-19-RdRp/Hel real-time reverse transcription-polymerase chain reaction assay validated in vitro and with clinical specimens. *J. Clin. Microbiol.* 2020.
- [9] Fang Y., Zhang H., Xie J. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. *Radiology*. 2020.
- [10] Ai T., Yang Z., Hou H. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. *Radiology*. 2020.