

Sensitivity and Specificity of High-Resolution Computed Tomography in Diagnosis of COVID-19 in Emergency Department: A Single Centre Study

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Abstract

Aim: To evaluate the performance of chest computed tomography (CT) scan in the preliminary diagnosis of suspected coronavirus disease 2019 (COVID-19).

Material and methods: Suspected 1149 COVID-19 patients who underwent both chest CT and RT-PCR tests were included. Considering RT-PCR as a reference standard, the performance of chest CT in diagnosing COVID-19 was evaluated. Obtained data was statistically analysed for sensitivity, specificity and accuracy for the diagnosis of COVID-19 cases.

Results: Out of 1149 patients RTPCR was positive in 188 (16.36%) of patients and CT findings were positive in 368 (32.03%) of patients. The majority (21.15%) of the patients' CT scan revealed sub-pleural ground-glass opacities (GGO), consolidation was seen in 76 (6.61%), pleural effusion in 73 (6.35%) and interstitial oedema in 41 (6.35%) respectively. Considering RT-PCR results as the reference standard, the chest CT revealed a sensitivity of 73.40%, specificity of 76.07% and accuracy of 75.63% in identifying COVID 19.

Conclusion: Chest CT revealed diagnostic accuracy (75.63%) in diagnosing COVID-19 and it could be considered as a basic modality for detecting COVID-19 cases early. This can be valuable to initiate early triage and infection control practices and appropriate isolation strategies in Emergency Department.

Keywords: Reverse transcription polymerase chain reaction, chest CT imaging, diagnostics

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Introduction

Infectious diseases impose a significant health threat around the world, leading to an increased mortality rate every year. The assortment and dissemination of infectious diseases have developed over the time, and they are continuing to pose a challenge to the global community. The repeated outbreaks of viral infections remain a constant threat, most of them affecting the humans from contact with animals.^[1]

In a couple of decades' multiple novel, infectious diseases have been recognised, which includes Hantavirus, Zika and Ebola virus. Apart from this, diseases like malaria and tuberculosis which were considered to be reaching near elimination have seen a resurgence. Presently most important and crucial epidemic outbreak that has become a global concern is COVID-19 because the diagnosis and treatment of the patient are not able to cope up with its infectivity.^[2]

With the present Pandemic claiming millions of lives, it is abundantly clear that there is an emergent requirement of developing acceptable and judicious ways to deal with, forestall and alleviate the detrimental outcomes of viral epidemics on mankind. It requires the establishment of strict vigilance programs, integrated with laboratory backup services.^[3] In the case of biohazard situations like viral pandemics, laboratory investigations assume a fundamental part in the timely and precise identification and isolation of unfamiliar microorganisms with the use of molecular diagnostic modalities.^[4]

Timely diagnosis of COVID-19 disease is significant for disease treatment and prevention. The use of rapid molecular diagnostic tools and rapid serological tests have proved beneficial in timely diagnosis, isolation, and management of COVID-19 positive individuals. This illustrates, again, that laboratory investigation procedures are the integral part of the health care systems and will remain so for a long time to come.^[5,6]

With the COVID 19 pandemic peaking the second wave in India, it is relevant to be able to identify and isolate suspected patients accurately to contain the spread and break the chain.

In the present study, we compared the performance of chest CT scan as the reference standard in the preliminary diagnosis of suspected coronavirus disease 2019 (COVID-19) patients in the Emergency Department (ED) in the tertiary care centre.

Material and Methods

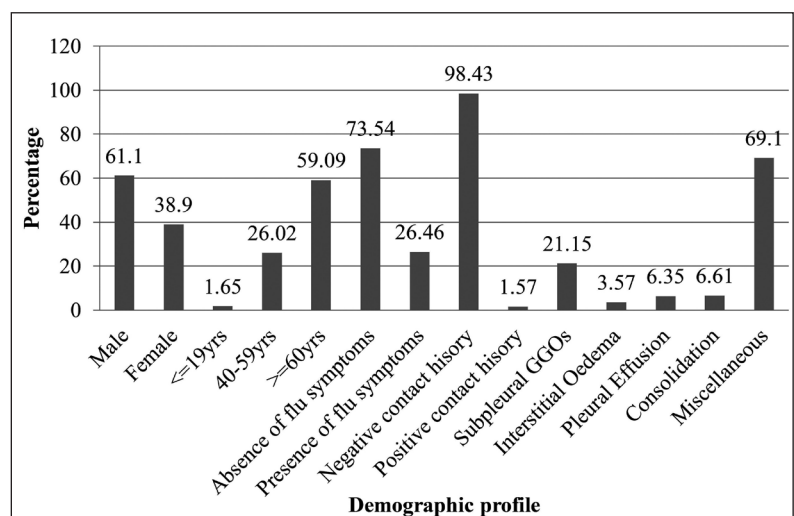
In this single-centre retrospective observational study, data was obtained from electronic medical records for patients admitted to ED. The informed consent was waived by the institutional ethics committee, as it was a retrospective observational study. Following data was collected by independent observers including demographics, any COVID-19 like symptoms, any contact/travel history, RT-PCR reports and CT chest reports carried out in ED of our hospital from 1276 patients. Exclusion criteria was patients of age less than 16years, pregnant females, patients who had positive COVID PCR, CT chest already available (to maintain standardisation in reporting). The patients who met the exclusion criteria were 127, and they were excluded from the study group.

Three qualified and experienced radiologists observed the chest CT scans and interpreted by consensus as positive or negative for COVID-19. The positive scans were then categorised as sub-pleural GGOs, Interstitial Oedema, Pleural Effusion and Consolidation.

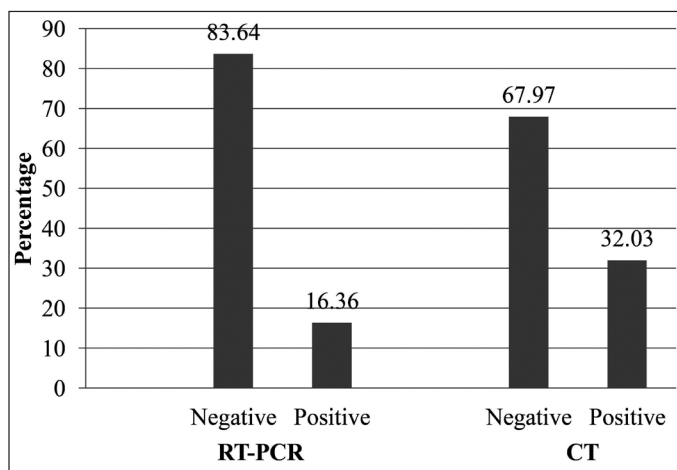
Obtained data was statistically analysed SPSS, version 21.0; SPSS, Chicago, III for sensitivity, specificity and accuracy for the diagnosis of COVID-19 cases.

Results

In the present study, out of 1149 subjects, 702 (61.10%) were males and 447 (38.90%) were females. Most of the patients (59.09%) were above 60 years of age followed by those in age groups of 40-59 years (26.02%), 20-39 years (13.23%) and less than 19 years (1.65%). Almost all the patients (98.45%) were having symptoms of flu but without any contact histo-



Graph 1: Demographic profile of subjects



Graph 2: Findings of RT PCR and CT in our patients

ry (98.43%). The majority (21.15%) of the patients' CT scan revealed sub-pleural GGOs, consolidation was seen in 76 (6.61%), pleural effusion in 73 (6.35%) and interstitial oedema in 41 (6.35%) respectively (Graph 1). Out of 1149 subjects, RT-PCR was positive in 188 (16.36%) patients and CT findings were suggestive of COVID 19 in 368 (32.03%) patients (Graph 2).

Considering RT-PCR results as the reference standard, the chest CT revealed a sensitivity of 73.40%, specificity of 76.07% and diagnostic accuracy of 75.63% in identifying COVID 19. The performance of chest CT in diagnosing COVID-19 and summary of sensitivity and specificity among gender is represented in tables 1 and 2. The specificity ($P = 0.007$) and negative predictive value ($P = 0.02$); of chest CT in diagnosing COVID-19 were greater for males and no significant difference noted with respect to sensitivity ($P = 0.27$), positive predictive value ($P = .53$), and accuracy ($P = 0.76$).

The performance of chest CT in diagnosing COVID-19 and summary of sensitivity and specificity in different age groups is mentioned in tables 3 and 4. The positive predictive values and accuracy of chest CT in diagnosing COVID-19 were higher in patients

Table 2: Summary of Sensitivity and specificity (RTPCR)

| Statistics | Total samples | Males | Females |
|---------------------------|---------------|--------|---------|
| True positive | 138 | 92 | 46 |
| True negative | 731 | 448 | 283 |
| False positive | 230 | 135 | 95 |
| False negative | 50 | 27 | 23 |
| Sensitivity | 73.40% | 77.31% | 66.67% |
| Specificity | 76.07% | 76.84% | 74.87% |
| Positive Predictive Value | 37.50% | 40.53% | 32.62% |
| Negative Predictive Value | 93.60% | 94.32% | 92.48% |
| Accuracy | 75.63% | 76.92% | 73.60% |

who were of less than 60 years of age ($P = 0.04$) as compared with the patients who were aged 60 years and above ($P = 0.003$); and no difference existed with respect to sensitivity ($P = 0.28$), specificity ($P = 0.49$) and negative predictive value ($P = 0.74$).

Table 3: Performance of Chest CT in the Diagnosis of COVID-19 by age groups

| CT findings | RT PCR in <60yrs | | | RT PCR in ≥60 yrs | | |
|-------------|------------------|----------|-------|-------------------|----------|-------|
| | Positive | Negative | Total | Positive | Negative | Total |
| Positive | 54 | 62 | 116 | 84 | 168 | 252 |
| Negative | 18 | 336 | 354 | 32 | 395 | 427 |
| Total | 72 | 398 | 470 | 116 | 563 | 679 |

Table 1: Performance of Chest CT in the Diagnosis of COVID-19 in males and females

| CT findings | RT PCR in Total | | | RT PCR in Male | | | RT PCR in Female | | |
|-------------|-----------------|----------|-------|----------------|----------|-------|------------------|----------|-------|
| | Positive | Negative | Total | Positive | Negative | Total | Positive | Negative | Total |
| Positive | 138 | 230 | 368 | 92 | 135 | 227 | 46 | 95 | 141 |
| Negative | 50 | 731 | 781 | 27 | 448 | 475 | 23 | 283 | 306 |
| Total | 188 | 961 | 1149 | 119 | 583 | 702 | 69 | 378 | 447 |

Discussion

COVID-19 outbreak, along with the atypical nature of the virus, poses significant diagnostic confrontations, thereby limiting the treatment of the infected individuals.^[7] These remonstrations range from perceiving the presenting features in anticipating the possibility of infection, evaluating whether the current imaging modalities and laboratory tests can diagnose infection and individuals requiring special care, and assessing if the advanced diagnostic methods can cater timely and precise point of care testing.^[8]

In comparison with RT-PCR, chest CT is regarded as a non-invasive, more precise, practical, and faster tool for diagnosing and evaluating COVID-19 cases, especially in the regions

Table 4: Summary of sensitivity and specificity by age (RT-PCR)

| Statistics | <60 years | >=60 years |
|---------------------------|-----------|------------|
| True positive | 54 | 84 |
| True negative | 336 | 395 |
| False positive | 62 | 168 |
| False negative | 18 | 32 |
| Sensitivity | 75.00% | 72.41% |
| Specificity | 84.42% | 70.16% |
| Positive Predictive Value | 46.55% | 33.33% |
| Negative Predictive Value | 94.92% | 92.51% |
| Accuracy | 82.98% | 70.54% |

with epidemic outbreaks.^[9] Duarte *et al.*, carried out a systematic review to evaluate the diagnostic efficacy of CT and RT-PCR for COVID 19 and observed that CT exhibits high sensitivity and detection rates, which makes it a significant modality in detecting early cases of COVID-19.^[10]

Literature suggests CT may serve as a non-invasive, superior, rapid and a reliable tool than RT-PCR for diagnosing and evaluating COVID-19 with higher accuracy.^[11] Young *et al.* carried out a meta-analysis and found that a CT chest was more effective than RT-PCR in diagnosing a high proportion of hospitalised COVID-19.^[12] Korevaar *et al.* found that chest CT showed a high probability of COVID-19 in 29.9% of patients with a negative or indeterminate initial RT-PCR result.^[13] In the present study, considering the RT-PCR results as the reference standard, chest CT revealed the sensitivity of 73.40%, specificity of 76.07% and 75.63% of accuracy in identifying COVID-19 infection. The positive predictive value was 37.50% and the negative predictive value was 93.60%.

As per the current diagnostic criteria, viral nucleic acid tests by means of RT-PCR assay play a vital role in determining hospitalization and isolation of individuals infected with COVID-19. However, lower sensitivity rate and relatively long processing time were detrimental to the control of the disease epidemic. In our study, the positive rate of RT-PCR assay was 16.36%

and this finding was lesser as compared to that of Tao Ai *et al.*^[11] and Yang *et al.*^[14] This difference may be seen due to discrepancies in sampling operations, source of the specimen, the timing of the sampling and efficacy of diagnostic kits.

In the present study, 32.03% of cases revealed positive findings on CT scans and this observation was not consistent with the findings of Tao Ai *et al.*, who noted that 60% of patients in their study revealed typical CT features suggesting COVID-19 infection.^[11]

In the present study, 73.40% of subjects who were confirmed with COVID-19 by RT-PCR assays revealed positive findings on chest CT scans. This finding was not in line with Tao Ai *et al.*,^[11] and Guan *et al.*,^[15] who found a higher value of 97% and 86.2% respectively.

In our study, a considerable number of false-positive cases of COVID-19 were identified with chest CT and the possible reason behind this could be the overlap of CT imaging features between COVID-19 and other viral infections. During the phase of emergency disease control, few false-positive cases may be considered as acceptable. Notwithstanding, in the view of the faster spread out of COVID-19, the preference was to detect any CT case doubtful for COVID-19 to isolate the individual, initiate infection control measures and provide relevant therapy with regular follow-up.

Karam *et al.* concluded from their systematic review that a relatively high false positive rate can be expected with chest CT however, it may still be beneficial in individuals with a suspicious manifestation of COVID-19 and negative initial RT-PCR results. In individuals who manifest with the acute respiratory symptom, negative CT scan and RT-PCR tests expected to be promising.^[16]

Overestimation of the sensitivity of chest CT and underestimation of the sensitivity by adapting RT-PCR as a reference standard is one of the limitations of the present study but in the epidemic regions, negative RT-PCR reports and a positive chest CT finding could suggest the presence of COVID-19 infection which will help in timely detection and thereby limiting the spread of the viral infection. Another limitation is the low positivity rate of RTPCR and the unavailability of data of antibody testing. Nevertheless, moderate to high suspicious CT scans in the pandemic scenario will still be considered as COVID and necessary isolation will be required.

Conclusion

The findings of this study confirm that chest CT has a high sensitivity for the diagnosis of COVID-19. Chest

CT should be considered as a mandatory modality for diagnosing, evaluating and follow-up the patients with COVID-19 symptoms. CT scan may be able to detect a high proportion of the COVID-19 cases overall and may be useful when RT-PCR testing is initially negative but clinical suspicion remains high.

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