Original Article

A preliminary case series comparison of chest computerized tomography scan and Polymerase Chain Reaction (PCR) for COVID-19 contact tracing in developing countries with limited resources

Hooman Bahrami-Motlagh[1], Amir Mohammad Papan[2], Zahra Sahraei[3,1], Babak Salevatipour[1], Maryam Haghighimorad[1], Alireza Karami[4], Mana Zaman[4], Rastin Radfar[4], Minoosh Shabani[5,6*]

[1] Department of Radiology, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Department of Emergency Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Khuzestan, Iran
[3] Department of Clinical Pharmacy, School of Pharmacy, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[4] Student Research Committee, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[5] Department of Infectious Diseases and Tropical Medicine, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[6] Infectious Diseases and Tropical Medicine Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
Infectious Diseases and Tropical Medicine Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
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Abstract

Background: Imaging and PCR each have a role in detecting and implementing precautionary measures in isolating individuals with a history of close contact, which helps limit the COVID-19 pandemic. Due to developing countries' difficulties, PCR is limited in Iran. This study seeks to determine the feasibility of early low-dose chest computed tomography (CT) scans substitution with PCR.

Materials and Methods: Asymptomatic participants with a history of close contact with a confirmed case of COVID-19 were enrolled and followed for one week, receiving 2 PCR tests within one week. Initially, a chest CT scan was performed. The second CT scan was performed within one week on two participants. Participants with an initially negative CT scan and participants with a first CT scan compatible with COVID-19 who became symptomatic.

Results: All Participants had an RT-PCR and at least one CT scan. Positive RT-PCR results were reported in 6 and 9 participants initially and within one week, respectively. Chest CT scans favoring COVID-19 infection were initially reported in 4 and 6 participants within one week, respectively. Seventeen participants showed neither symptoms nor positive RT-PCR or chested CT scans favoring COVID-19. Thirteen participants either had positive RT-PCR, a COVID-19 chest CT scan or became symptomatic.

Conclusion: Rapid detection of COVID-19 and subsequent quarantining is crucial in the global fight against this pandemic. Our results showed lower sensitivity for chest CT scans compared to COVID-19 PCR, suggesting that chest CT scans are unsuitable for COVID-19 PCR tests.

Keywords: COVID-19, CT Scan, Polymerase Chain Reaction, Contact Tracing

***Corresponding Author:** Minoosh Shabani, MD**.** Department of Infectious Diseases and Tropical Medicine, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran, Email: shabaniminoosh@gmail.com

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Introduction

Since December 2019, a deadly pandemic has emerged globally, typically as viral pneumonia, with a new betacoronavirus genus known as COVID-19[1]. Despite detecting the virus by real-time RT-PCR, the non-contrast chest computed tomography (CT) scan is also an appropriate diagnostic tool. It can be utilized for the early detection of viral infection[2]. Due to limited resources and insufficient hospital capacity, chest CT scans can be used to admit patients with chief complaints of COVID-19. CT scan changes, like ground glass opacities (GGOs) and consolidations, are not COVID-19 specific in many cases and should be interpreted in clinical settings. Many experts suggest contact tracing and isolating as critical measures of mortality control in this disease[3]. Due to the lack of infrastructure and expertise in third-world countries executing large-scale PCR testing, contact tracing methods other than PCR are needed. A chest CT scan is much more readily available in Iran, with extensive experience using it. Moreover, insurance companies almost entirely cover CT scans, thus making it cost-efficient.

This study aimed to assess the chest CT scan used to screen high-risk COVID-19 individuals. In addition, it investigates the reliability of history, physical exam, and CT scan combination compared to RT-PCR at early COVID-19 infection contact tracing.

Methods

This prospective case series enrolled close contacts of the patients who were referred with COVID-19 infection and was conducted from April 2020 to June 2020 at Loghman-e-Hakim Hospital, Tehran, Iran. Asymptomatic participants 15-65 years with a history of close contact with a confirmed COVID-19 case were included in this study. Thirty asymptomatic participants were selected and underwent a nasopharyngeal swab for real-time RT-PCR and a chest CT scan. Pregnant women, participants with a previous diagnosis of COVID-19, COVID-19 symptoms (dyspnea, anosmia, ageusia, cough), flu-like symptoms, and individuals with a recent travel history were not included in this study. History, physical examinations, chest CT scans, and RT-PCR reports of the patients were extracted using participants' files. The RT-PCR test was carried out using LightMix, SarbecoV E-gene RT-PCR Kits (Roche, Berlin, Germany). Patients underwent low-dose chest CT scans using two CT scan devices (Activion 16, Toshiba, Japan, and Somatom scope power 16, Siemens Healthineers, Germany). Close contact was defined based on the center for disease control and prevention (CDC) definition as contact closer than 6 feet for at least 15 minutes with a confirmed COVID-19 patient in the days before hospitalization or diagnosis of COVID-19 [4]. All participants enrolling in this study were asymptomatic. A nasopharyngeal swab and a non-contrast, low-dose spiral chest CT scan were performed. Laboratory values, including basic metabolic panel (BMP), complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and lactate dehydrogenase (LDH), were also assessed. The participants were subsequently isolated for a week, and their symptoms were checked daily by phone. After a week, the second visit to the clinic and the second RT-PCR test were done. The second chest CT scan was performed in two groups. The first group was participants with an initially negative chest CT scan, whether symptomatic or not. The second group was participants with an initial chest CT scan compatible with COVID-19. Two radiology attendings reported chest CT scans blinded to patients' history and independently following American College of Radiology (ACR) Guidelines on reporting COVID-19 chest CT scans[5-6].

This study was approved by the Shahid Beheshti University of Medical Sciences ethics committee (IR.SBMU.RETECH.REC.1399.583). Written informed consent was acquired.

Results

Fifty-two participants were initially enrolled in this study, twenty-two of whom were excluded on the grounds of being symptomatic. This study included 12 males (40%) and 18 females (60%) participants. The mean age of participants was 43.47±14.87 (mean ±SD) years. Positive real-time RT-PCR test results were reported in 6 (20%) and 9 (30%) participants initially and within one week, respectively. As for chest CT scans, reports favoring COVID-19 infection were

Table 1: Descriptive of Baseline Characteristics. Data are given as mean ±standard deviation (95%confidence interval for mean) and frequency (percentage %).

variables	**Total n=30(100%)**
Age (year)	43.47±14.87 (37.9,48.8)
Gender (male, female)	12 (40%), 18 (60%)
BMI (total)	26 (24,28)
BMI (kg/m^2):	
Below normal weight (<18.5)	1 (3.3%)
Normal weight (18.5-24.9)	11 (36.7%)
Overweight (25-29.9)	14 (46.7%)
Class 1 Obesity (30-40)	3 (10%)
Class 2 Obesity (40.1-50)	1 (3.3%)
Class 3 Obesity (>50)	0
Smoker	11 (36.7%)
Family member (<5)	26 (86.7%)
Symptomatic after one week	6 (20%)
Initial abnormal CT scan	4 (13.3%)
Abnormal CT scan after one week	6 (20%)
Initial positive RT-PCR	6 (20%)
Positive RT-PCR after one week	9 (30%)

reported in 4 (13.3%) and 6 (20%) participants initially and within one week, respectively. In this study sample, real-time RT-PCR could pick up more carriers initially and one week after exposure. Descriptive characteristics are presented in Table 1.

Regarding initial and follow-up studies, 4 participants had a positive COVID-19 PCR in the follow-up test. Only one became symptomatic at the second visit. Two participants had positive CT scans and COVID-19 PCR in the follow-up studies, and neither presented symptoms. Initial and follow-up COVID-19 PCR and CT scan studies were reported positive in 3 participants, and all three presented clinical symptoms at the second visit. Three participants had only positive COVID-19 PCR in the initial study, one of which presented clinical symptoms in the follow-up examination. Just one participant that became symptomatic at the second visit had positive CT scans in the first and second visits without any positive COVID-19 PCR.

Seventeen participants neither showed symptoms nor had positive PCR or CT scans favoring COVID-19 (group A). Thirteen participants had either positive PCR, chest CT scan report in favor of COVID-19 or became symptomatic (group B). Group A had 4 participants (one stroke with breast cancer, one heart failure, one chronic obstructive pulmonary disease(COPD), and one chronic kidney disease (CKD) patient). In contrast, Group B had three patients with underlying complications (two persons with diabetes mellitus (DM) and hypertension (HTN) and one patient with liver disease). The mean ages of groups A and B were 47 and 36, respectively. Among group A participants, 5 (29.41%), while group B had 6 (46.15%) smoker participants. Group A included four males and 13 females.

Group B comprised eight males and five females, with three male and three female participants symptomatic. Group A had a smaller family unit (less than 5), whereas group B had two families with five members each. The body mass index (BMI) was the same between the two groups (26 and 26). Data regarding participants with RT-PCR or chest CT scans or symptoms in favor of COVID-19 are shown in Table 2. Abnormal chest CT scans mainly were pulmonary nodules and ground-glass opacities (GGOs), among which GGO changes were considered in favor of COVID-19 due to the current pandemic. Also, in the second chest CT scan carried out one week after the initial radiologic evaluation, except in one case, no

Table 2: Positive results characteristics.

Participants with positive results in favor of COVID-19						
Both CT normal, second RT-PCR Positive						
Age/ gender	**smoking**	**BMI**	**Notable laboratory data**	**CT Report**	**Symptoms in one week**	**Close contact /family member**
25 y/o woman	-	20	-	WNL	-	3
48 y/o man	-	29	-	WNL	-	3
29 y/o man	+	27	WBC=10000	WNL	Coryza, diarrhea, Headache(day7)	4
49 y/o man	-	24	-	-	-	4
Second CT compatible with COVID-19, second RT-PCR Positive						
Age/ gender	**smoking**	**BMI**	**Notable laboratory data**	**CT Report**	**Symptoms in one week**	**Close contact /family member**
26 y/o man	+	27	CRP=10 WBC=4700	GGO in RLL, Peribronchial cuffing	-	5
47 y/o man	+	26	-	Nodular infiltration in RLL	-	5
Both CT compatible with COVID-19, Both RT-PCR Positive						
Age/ gender	**smoking**	**BMI**	**Notable laboratory data**	**CT Report**	**Symptoms in one week**	**Close contact /family member**
22 y/o woman	+	27	WBC=3700	Scattered GGO both lungs (first) decrease in GGO (second)	Coryza(7^{th} day) Diarrhea Headache Chest pain Rash	5
19 y/o woman	+	16	-	GGO in rt upper lung zone (first CT), no change in the second imaging	Malaise, body ache, diarrhea	3
56 y/o man	-	28	-	Scattered GGO both lungs (first), no change in the second imaging	Malaise, body ache, diarrhea	2
Both CT normal, first RT-PCR Positive						
Age/ gender	**smoking**	**BMI**	**Notable laboratory data**	**CT Report**	**Symptoms in one week**	**Close contact /family member**
45 y/o woman	-	31	-	WNL	-	5
41 y/o man	-	37	-	WNL	-	4
23 y/o woman	-	24	-	WNL	Cough, parosmia within one week	3
Both CT abnormal, both RT-PCR Negative						
Age/ gender	**smoking**	**BMI**	**Notable laboratory data**	**CT Report**	**Symptoms in one week**	**Close contact /family member**

40 y/o male	+	24	-	Scattered GGO both lungs (first), no change in the second imaging	Cough one week after the first visit	3

Seventeen patients had no symptoms, and all the tests were within normal limits.
BMI: Body mass index, WNL: Within normal limits, WBC: White cell count, RLL: Right lower lobe

significant changes were seen regarding GGOs.

Discussion

In our study of asymptomatic patients, the sensitivity of the chest CT scan was compared to real-time RT-PCR in detecting asymptomatic patients. We now know that an RT-PCR has a sensitivity of 70% And specificity of about 100% for COVID-19 when performed correctly[7-10]; however, many reasons are provided in the literature for inaccuracy or low sensitivity of RT-PCR, including but not limited to 1) inexperienced operator 2) immature technology, 3) standard differences among manufacturers, 4) sampling problems[10] including participants' reluctance to cooperate. Based on our experience with the Iranian population, people are more reluctant to undergo nasal swabs than chest CT scans. These problems are much more evident in developing countries with poorer economies and a lack of sufficient workforce in specific high-tech environments like RT-PCR. However, radiology and CT scans are much more readily available in countries like Iran, and the experience of using them is also much more remarkable. Moreover, CT scan results can be reported immediately, which is a considerable advantage for contact tracing.

Our preliminary data suggest a chest CT scan as a possible screening tool for high-risk patients who had close contact with a confirmed COVID-19 patient. Its results are compatible with RT-PCR in the first week. However, despite its advantages, including being fast, reliable, and not operator-dependent, radiation is an essential disadvantage regarding CT scans.

Thirteen participants who had COVID-19 were generally younger and had fewer comorbidities than the seventeen participants who did not have COVID-19. It can be attributed to several factors, like younger participants having more COVID-19 exposure, not using masks, or applying protective protocols around COVID-19-positive patients.

Despite promising results, this study's small sample size is a limitation; thus, calculating sensitivity and specificity would not be reliable. Further studies are recommended to use a larger sample population and longer follow-up duration.

Conclusion

No positive COVID-19 PCR or chest CT scan in more than 50% of our cases can suggest a lower transmission rate of delta variant coronavirus than the new coronavirus variant (Omicron variant). Rapid detection of COVID-19 and subsequent quarantining is vital in the global fight against this deadly pandemic. Overall, a chest CT scan was reliable in only one case without any auxiliary PCR results among these participants. Despite the limited number of participants in this study, our results support the important role of the COVID-19 PCR test for COVID-19 diagnosis.

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