

Correlation of Radiological Findings on High-Resolution Computed Tomography Chest in Vaccinated and Unvaccinated COVID-19 Patients from Eastern India

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Abstract

Background: In this coronavirus disease-2019 (COVID-19) pandemic, safe and effective preventative vaccines are essential to contain the pandemic, which has had severe medical, economic, and societal consequences, despite some people still becoming infected after receiving immunisation. **Methods:** A total of 200 patients were examined and split into two groups: (1) 100 consecutive COVID-19-positive cases who had been vaccinated and (2) 100 consecutive COVID-19-positive patients with no vaccination. At the time of the scan, the patient's vaccination status was noted. **Results:** The computed tomography severity score (CTSS) of unvaccinated individuals was found to be considerably greater than that of partly or fully vaccinated patients (median 13 vs. 7, $P < 0.001$). Completely vaccinated individuals had a considerably lower median CTSS than partly vaccinated patients (6 vs. 9, $P < 0.001$). **Conclusions:** Individuals should be thoroughly vaccinated to avoid major lung disease. As a result, stronger dedication and motivating efforts should be made worldwide to improve the COVID-19 vaccination program.

Keywords: Coronavirus disease-2019, high-resolution computed tomography of the thorax, immunization, vaccination

BACKGROUND

After almost 2 years of the coronavirus disease epidemic, the mortality is staggeringly higher, at over 10 million.^[1] Fortunately, there are a number of effective vaccinations available now that might aid in the containment of the coronavirus disease-2019 (COVID-19) epidemic. However, our vaccination efforts must battle the rapidly increasing severe acute respiratory syndrome coronavirus (SARS-CoV-2) strains, which are a huge problem.

SARS-CoV-2 has developed into new fatal strains than their predecessors, the most dangerous of which is the delta type. These mutations are worrisome due to their higher chances of transmission, symptom severity, and immune evasion, creating a risk of reinfection in convalescents or breakthrough infections in vaccinated people.^[2] To limit the epidemic, which has had severe medical, economic, and societal implications, safe and efficient preventive vaccinations are required even though some are still getting infected during postvaccination status.

This research aims to investigate the limits and extents of pulmonary involvement in vaccinated patients of COVID-19

and the relationship between vaccination status and lung severity. Two vaccines were developed in India at the time of this research, both of which required two doses and a booster for full immunization.^[3]

METHODS

We retrospectively analyzed our COVID-19-related high-resolution computed tomography (HRCT) of thorax data from April to August 2021. This was done to identify positive patients on reverse transcription-polymerase chain reaction (RT-PCR) who have undergone a HRCT of the thorax to analyze the extent of pulmonary involvement by applying the computed tomography severity score (CTSS).

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A total of 200 cases were studied, divided into two groups. The first group comprised 100 consecutive vaccinated COVID-19-positive cases, while the other group comprised 100 consecutive unvaccinated COVID-19-positive patients. The vaccination status of the patient was recorded before the scan. Patients who had both doses 1 week before the computed tomography (CT) scan were considered fully vaccinated, but those who underwent the CT scan 2 weeks after the first dose or within 1 week of the second dose were deemed partially vaccinated.^[4]

We divided the cohort into three groups based on vaccine eligibility criteria: 18–44 years, 45–59 years, and more than 59 years. SPSS version 21 (IBM, Chicago IL, USA) was used to conduct the statistical analysis. Basic descriptive statistics were employed (median and percentage [N]), univariate test for continuous variables, and Chi-square test for categorical variables. $P < 0.05$ was considered to be significant.

The study was approved by the Institutional Ethical Committee(IEC), KIMS, KIIT University, Bhubaneswar, Odisha (Ref No.- KIIT/KIMS/IEC/318/2020). An informed consent was taken from all subjects.

RESULTS

Computed tomography severity score analysis of vaccinated (partial or complete) cohort

We identified 100 confirmed COVID-19 (positive RT-PCR) consecutive cases who underwent HRCT of the thorax with a positive history of at least one dose of vaccine. The median age of this group was 54 (14–89) years. Sixty percent of the patients in this group were male. The median CTSS of the whole cohort was 7 (range 0–24). There were 28% ($n = 28$), 43% ($n = 43$), and 29% ($n = 29$) patients in age groups less than 45 years, 45–59 years and more than 59 years, respectively. The median CTSS of patients in the age group <45 years was 4 (range 0–13), 45–60 years was 8 (range 0–19), and more than 60 years was 11 (range 0–24).

The distribution of patients according to severity is shown in Table 1. Out of the total 100 patients, 55/100 (55%) came under either normal or mild category of lung involvement (CTSS <8), while 27/100 (27%) came in the moderate category of lung involvement (CTSS 8–15). Only 18/100 (18%) of the cohort population had gone into severe lung involvement (CTSS >15).

Of the 100 patients, 73 (73%) had complete vaccination and 27 (27%) had partial vaccination. The majority of severe patients (15/18) and a substantial proportion of moderate patients (12/27) were partially immunized.

The median CTSS of fully vaccinated individuals was lower than that of partially vaccinated individuals (6 vs. 9, $P < 0.001$). Higher age and partial vaccination were linked with higher CTSS, while completely vaccinated individuals had lower CTSS.

Table 1: Demographic and computed tomography of thorax characteristics in unvaccinated ($n=100$) and vaccinated ($n=100$) cohorts

Characteristics	Vaccinated COVID-19 patients ($n=100$)	Unvaccinated COVID-19 patients ($n=100$)	P
Age (years), median (range)	54 (14-89)	48 (16-84)	0.05
Male/female ratio	3/2	3/1	0.5
CTSS, median (range)	7 (0-24)	13 (1-25)	<0.001
CT involvement, n (%)			
Normal or mild (CTSS <8)	55 (55)	16 (16)	0.001
Moderate (CTSS 8-15)	27 (27)	42 (42)	0.025
Severe (CTSS >15)	18 (18)	42 (42)	0.01
CT of thorax features			
GGO +/- consolidation	65 (65)	94 (94)	0.5
Crazy paving	8 (8)	14 (14)	0.12
Reverse halo	8 (8)	24 (24)	0.15
Pleural effusion	2 (2)	8 (8)	0.57
Mediastinal lymphadenopathy	7 (7)	18 (18)	1.0
Bronchiectasis	3 (3)	25 (25)	0.7
Cavitary lesions	0	2 (2)	0.09
Lobar involvement			
No lobe or 1 lobe	30 (30)	5 (5)	0.02
2 lobes	5 (5)	7 (7)	0.4
3 lobes	13 (13)	10 (10)	0.09
4 lobes	24 (24)	28 (28)	1.0
All lobes	28 (28)	50 (50)	0.01

CT: Computed tomography, CTSS: CT severity score, GGO: Ground-glass opacity, COVID-19: Coronavirus disease-2019

Computed tomography severity score analysis of unvaccinated cohort

We analyzed another 100 consecutive cases with no history of vaccination. These patients were retrospectively studied in the same time frame, in which vaccinated individuals were studied during the second wave of COVID-19 in India.

The median age of the patients in this group was 48 (16–84) years, with males comprising 74 (74%). The median CTSS of the whole group was 13 (range 1–25). There were 34% ($n = 34$), 31% ($n = 31$), and 35% ($n = 35$) individuals in age groups <45 years, 45–59 years, and more than 59 years, respectively. The median CTSS of individuals in the age group 18–44 years was 12 (range 1–21), 45–60 years was 11 (range 1–23), and >60 years was 15 (range 0–24).

Out of a total of 100 patients, 16/100 (16%) came under the mild category of lung involvement (CTSS <8), while 42/100 (42%) came in the moderate category of lung involvement (CTSS 8–15). A significant proportion 42/100 (42%) of the cohort population had suffered from severe lung involvement (CTSS >15).

Comparison of computed tomography features in vaccinated and unvaccinated population

It was noted that CTSS of unvaccinated patients was

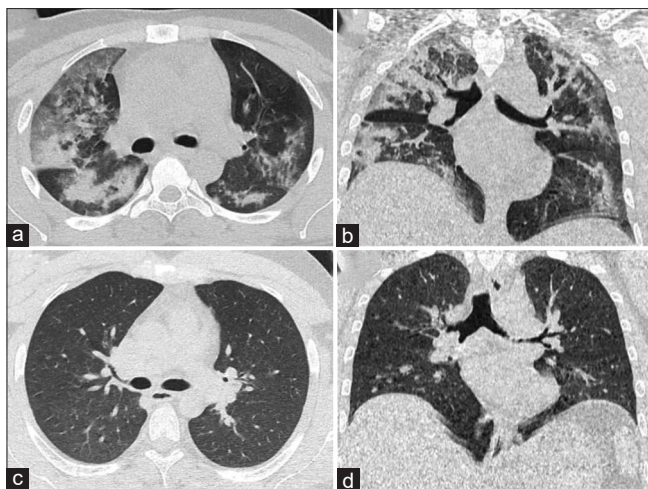


Figure 1: High-resolution computed tomography axial (a) and coronal (b) scans of an unvaccinated 32-year-old male coronavirus disease-2019 patient showed ground-glass opacities and consolidation in bilateral lung fields with computed tomography severity score 17/25. Axial (c) and coronal (d) another coronavirus disease-2019 patient of the same age and sex admitted in the same time frame but with two doses of vaccination showed almost clear lung fields

significantly higher in comparison to partially or fully vaccinated population (median 13 vs. 7, $P < 0.001$) [Figures 1 and 2].

Among the total population of 100 vaccinated RT-PCR positive patients, 26 scans were without any significant abnormality in their lung fields. While among the unvaccinated population of 100 patients, only 4 were normal. This finding was statistically significant with a P value of 0.01.

The rest of the radiological imaging features like ground-glass opacity, consolidation, lobar involvement, mediastinal lymphadenopathy, pleural effusion, nodules, and bronchiectasis were seen more in unvaccinated individuals in comparison to vaccinated ones, but there was no significant statistical correlation.

Various radiological features of both cohorts are shown in Table 1.

DISCUSSION

With the development of new SARSnCOV-2 variants, vaccine efficacy has been questioned. New mutants (like the delta variant) seem to have greater transmission capacity and higher mortality than the virus's unmutated counterpart.^[5,6] Vaccines have already been shown to help avoid serious illness when used against variants.^[7,8] Fully vaccinated individuals could still become infected with the delta strain, although there was no significant fatality.^[9]

In our cohort of 100 vaccinated COVID-19-positive patients, it was observed that the median CTSS was lower in patients aged <45 in comparison to patients having ages between 45 and 60 and more than 60 years (4 vs. 7 vs. 11).

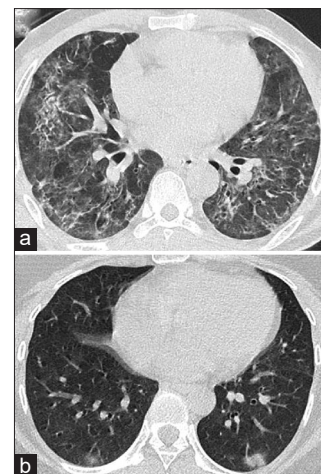


Figure 2: High-resolution computed tomography axial scans of two different male patients of 40 years of age admitted in the same time frame. (a) Diffuse ground-glass opacities in both lungs with computed tomography severity score of 22/25 inpatient have no vaccination history. (b) Subtle patchy ground-glass opacities with a computed tomography severity score of 5/25 in a patient with vaccination history

When both vaccinated and unvaccinated cohorts were compared, the proportion of normal HRCT scans was significantly lower in vaccinated COVID-19-positive individuals than unvaccinated patients (26/100 vs. 4/100, P value 0.01). Similarly, a significantly larger proportion of mild cases was seen in vaccinated COVID-19-positive patients than unvaccinated ones (55/100 vs. 16/100, P value 0.02). The proportion of severe cases was significantly lower in vaccinated patients (18/100 vs. 42/100, P value 0.005). These findings backed up the immunizations' effectiveness in averting the devastating disease.

We discovered that fully or partially vaccinated individuals had a lower CTSS than unvaccinated ones, reinforcing evidence that vaccinations are a helpful strategy in avoiding a severe COVID-19 infection, even if their usefulness in restricting the spread of emerging variants is limited.^[4,8,9] During these times of vaccine misinformation, this outcome of reduced lung involvement with complete or partial vaccination might be crucial in stressing the importance of vaccines as an effective weapon in the fight against COVID-19 to persuade more people to be vaccinated.

Our study has various limitations, and the first is that it is a retrospective single-center study. Second, the lung severity between fully vaccinated and partially vaccinated individuals could not be reliably established due to the smaller sample size of partially vaccinated individuals. And finally, considering the person as fully vaccinated even if the second dose is given just 7 days prior is an issue (it may take a few weeks to develop protective antibodies).

CONCLUSIONS

We provided the actual scenario from eastern India during the

second COVID-19 wave, which revealed that fully or partly vaccinated individuals had considerably lower CTSS than unvaccinated ones. Individuals should be fully vaccinated to prevent serious lung illness. Hence, greater commitment and encouraging efforts should be implemented throughout the world to enhance the COVID-19 immunization program.

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Conflicts of interest

There are no conflicts of interest.

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