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Original Research Article

Comparison of HRCT chest findings among vaccinated and non-vaccinated COVID-19 patients

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ABSTRACT

Background: Coronavirus disease 19 was first reported in Wuhan, China and it was declared a pandemic by WHO in March 12, 2020. Vaccination has provided a very effective way to prevent the spread and reduce the severity of this disease. The two vaccines currently approved by the Government of India are Covaxin and Covishield. HRCT is the most valuable tool available to assess the pulmonary involvement in this disease. The aim of the study was to assess the effect of vaccination on the severity of pulmonary involvement in COVID-19.
Methods: A cross-sectional study was conducted in a department of radio diagnosis of tertiary health care hospital of Bihar for period of 4 months from April 2021 to July 2021.
Results: The study involved a total of 100 patients (74 were males and 26 females), where 50 were (50%) were unvaccinated and 50 (28.6%) were vaccinated with one or both doses Covishield vaccine. The frequency of disease was least in 14 (7.9%) among fully vaccinated subjects. The CT severity score is less in those who took both doses of the vaccine. The mean CT score of all the patients included in the study was 12.64±11.1. However, the patients who received complete vaccination had significantly low mean CT scores (14.18±7.223) in comparison to the non-vaccinated patients (11.1±6.016). Fully vaccinated patients had almost low CT severity score indicating mild form of disease.
Conclusions: HRCT is the most sensitive modality to detect severity of COVID-19 pneumonia. Severe lung involvement is more common in the unvaccinated population (32%) as compared with the vaccinated group, in which only 25% members had severe lung involvement.

Keywords: COVID 19, SARS CoV-2, Covaxin, Covishield, HRCT

INTRODUCTION

COVID-19 is an infectious disease which was first reported in Wuhan, China in December 2019.[1] The disease spreads rapidly and has been declared pandemic by WHO in March 12, 2020.[1] Symptoms of COVID-19 (SARS CoV-2) are non-specific and presentation of disease can be ranged from asymptomatic to severe pneumonia. The mean incubation period of SARS-CoV-2 is 5-6 days but can reach up to 14 days.[2,3] Fever, cough, myalgia, or fatigue are the most common symptoms of COVID-19.[4,5] The severity of COVID-19 symptoms may ranges from mild to severe and some can develop worse symptom like shortness of breath with pneumonia. The severity of pulmonary involvement in COVID-19 can be assessed only by HRCT (High resolution Computed Tomography) of lung.[6] It is the most effective method to evaluate the stage of disease and also useful in RT-PCR negative Covid-19 cases to confirm the diagnosis.[7]

GGO, crazy-paving pattern (GGO with superimposed inter- and intralobular septal thickening), and

consolidation are the most frequent CT findings, especially in mild COVID-19. The CT findings are most prominent at 10 days after the onset of initial symptoms and plateaus decrease afterwards.[8] In India currently Covaxin and Covishield are used for the prevention for the COVID-19 and there is efficacy was 88%. Vaccines are also effective in reducing the disease severity and pulmonary involvement.[9,10] The aim of the study was to access the severity of pulmonary involvement in COVID-19 infection and to compare the CT

METHODS

A cross-sectional study was conducted in a department of radio diagnosis of Narayan Medical College and Hospital, Sasaram, Bihar for period of 4 months from April 2021 to July 2021. Study was approved from institution ethics committee and informed written consent was taken from patient before initiation of HRCT. The patient's information was collected in the form of questionnaire which includes age, gender, family type, symptom, and vaccination status.

Sample size

A total of 100 patients were enrolled in the study after obtaining the written consent from the patient.

Inclusion criteria

Clinically suspected COVID-19 patients who underwent for HRCT irrespective of RT-PCR result and clinically suspected COVID-19 patient who underwent HRCT with positive RTPCR result were included.

Exclusion criteria

Suspected asymptomatic patient with COVID-19 with negative RTPCR result and asymptomatic patient with normal HRCT result irrespective of RTPCR test results were excluded.

HRCT Thorax imaging analysis

All the sanitation measures were followed in CT scan room as per Covid-19 protocol. All healthcare workers involved in the process of CT imaging wore PPE kits and took all other necessary preventive measures. Chest imaging of COVID-19 patients was done using 1.5 mm section thickness, 16 slice CT scanner (Siemens, Sommatom emotion). Standardized protocol was followed for chest imaging. Non-contrast-enhanced CT was done. Lower kilovoltage settings were used so that the radiation dose was less. CT images were acquired during a single inspiratory breath hold to reduce the radiation dose. HRCT images were evaluated by two senior radiologists independently. The images were analyzed and the identified findings were categorized on the basis of (a) type of lesion, (b) involvement of the lobes, (c) distribution of the lesion, and (d) associated findings. The types of lesions were identified as pure Ground glass opacity (GGO), pure consolidation, GGO with consolidation, subpleural fibrotic bands, interstitial thickening, and sequelae of infection/complications like emphysematous changes. Lungs are divided into 5 lobes and 18 segments. The right lung has 3 lobes i.e.; right upper lobe, right middle lobe and right lower lobe whereas the left lung is divided into left upper and lower lobes. CT severity scoring was done on the basis of the area of involvement of lung lobes. Distribution of the lesions was described on the basis of central, peripheral or diffuse involvement. Associated findings included pleural effusion, cardiomegaly, increased pulmonary artery diameter, mediastinal lymphadenopathy, etc.

All the five lung lobes were analysed and weighted based on parenchymal involvement and were scored on a range from 0 to 5, with 0 suggesting no involvement, 1 suggesting less than 5% involvement, 2 suggesting 5-25% involvement, 3 suggesting 26-49% involvement, 4 suggesting 50-75% involvement, and 5 suggesting more than 75% involvement. The total CT severity score are the sum of the individual lobar scores and it can be ranged from 0 (i.e.; no involvement) to 25 (i.e.; maximum involvement), when all the five lobes show more than 75% involvement.[11]

Table 1: CT involvement/severity score.

Percentage involvement score	CT severity score
<5	1
5-25	2
26-49	3
50-75	4
>75	5

CT severity index<8 is considered to be MILD involvement. CT severity index 9-17 is considered to be moderate involvement. CT severity index>18 is considered to be severe involvement. The data was entered in Microsoft excel sheet and were analyzed using appropriate SPSS software (Trial version-21). Descriptive statics of patients like demography details, vaccination status was mention in number and percentage.

RESULTS

A total of 100 COVID-19 patients were included in the study out of which 50 were fully vaccinated and 50 were non-vaccinated. The study included 74 (74%) and 26 (26%) females. The maximum patients was there in age group of 19 to 45 years (Table 2). Of the total 100 patients, 29 patients had clinically severe disease of which 16 were non-vaccinated, 2 were incompletely vaccinated, and 11 were completely vaccinated. Of these 100 patients, a CT score≥18 was seen in 30 patients (Table 4). The Table 4 shows the severity of lung involvement in unvaccinated, partially vaccinated and fully vaccinated patients. The CT severity score is less in those who took both doses of the vaccine. The mean CT score of all the patients included in

the study was 12.64±11.1. However, the patients who received complete vaccination had significantly low mean CT scores (14.18±7.223) in comparison to the non-vaccinated patients (11.1±6.016). CT images of 100 patients were analysed by two experienced and independent radiologists. 84 patients were found to have bilateral lung involvement and 16 patients were found to have unilateral lung involvement. Most of the cases with bilateral ground glass opacities were seen to be involving the lower lobes and peripheral lung fields. 5 patients out of 100 were seen to have pulmonary artery hypertension (main pulmonary artery diameter>29 mm). Bilateral pleural effusion was seen in 9 patients and 1 patient showed atherosclerotic changes of the pulmonary artery. Among the 100 patients, 11 cases were with septal and bronchial wall thickening. According to the findings of HRCT chest, the patients were divided into mild (having CT severity score of less than 8), moderate (CT severity score of 9 to 17) and severe (CT severity score more than 17) categories. In our study, 28 patients had mild involvement, 43 had moderate involvement and 29 patients had severe lung involvement. Vaccinated patients show lower CT severity scores in comparison to non-vaccinated patient.

Table 2: Age and gender distribution of patients.

Age groups (in years)	Male	Female
0-18	0	0
19-45	37	12
46-60	25	7
>60	12	7
Total	74	26

Table 3: Distribution of COVID patients based on vaccination status.

Vaccination status	N	%
Unvaccinated	50	50
Partially vaccinated	6	6
Fully vaccinated	44	44
Total	100	

Table 4: Association between vaccination status and disease severity among COVID patients.

Vaccination	Mild N (%)	Moderate N (%)	Severe N (%)	Total
Non-vaccinated	8 (16.0)	26 (52.0)	16 (32.0)	50
Partially vaccinated (1st dose)	1 (16.7)	3 (50.0)	2 (33.3)	6
Fully vaccinated	19 (43.2)	14 (31.8)	11 (25.0)	44
Total	28 (28.0)	43 (43.0)	29 (29.0)	100

DISCUSSION

COVID-19 is a highly contiguous disease without any completely effective treatment having been developed yet. Hence, the control of this disease relies heavily on early diagnosis, containment measures and other preventive strategies. HRCT is superior in demonstrating lung changes of COVID-19. Thus, it may be implied as first line diagnostic test, especially in times of pandemic.[12] It is more sensitive than plain chest radiographs for detecting theses early changes. It also has lower rate of missed diagnosis of COVID-19.[13] In this study, we performed a cross sectional study of vaccinated and non-vaccinated COVID-19 patients to observe the role of the vaccine on CT severity score.

The assessment of safety and efficacy of vaccines by various studies has led to the conclusion that vaccination reduces pulmonary involvement in COVID-19 and also has an effect on the systemic inflammatory and coagulopathic responses to this disease.[14-18]

In our study we found that the mean CT severity score of the patients those are vaccinated are (14.18±7.223) lower than the patients those are non-vaccinated (11.1±6.016). Verma et al also found that patients receiving SARS-CoV-2 vaccine had lower CT severity scores in comparison to who did not receive. The mean CT score of all the patients included in their study was 9.7±11.1 where as it was 12.64±6.79 in our study. The difference between the mean CT score between the vaccinated and non-vaccinated groups in their study was not significant (p=0.353).[19]

In 100 patients HRCT evaluated and shows 29 patients who had severe involvement in which 16 were non vaccinated, 2 were partially vaccinated and only 11 were completely vaccinated. Naik et al also concluded that CT severity scores were mild in vaccination group compared to unvaccinated group. As chances of getting COVID-19 are low after vaccination as vaccination helps to protect against virus and reduces the severity of lung involvement.[20] The most common finding seen in our study was ground glass opacities (Figure 1 and 2). GGO

more commonly involve the peripheral areas of lung parenchyma. Lower lobes are more frequently involved. In some cases, visible intralobular lines can be seen simultaneously leading to what has been described as crazy paving pattern appearance. This is classified as 'typical appearance' of COVID-19 pneumonia. Absence of typical features and the presence of multifocal, diffuse, perihilar, or unilateral ground-glass opacities with or without consolidation, which lacks a specific distribution and that are non-rounded or non-peripheral, is classified as 'indeterminate appearance'.

COVID-19 pneumonia is described as 'atypical' when there is absence of typical or indeterminate features, but the presence of isolated lobar or segmental consolidation without GGOs; discrete small nodules (centrilobular, 'tree-in-bud' appearance); lung cavitation; smooth interlobular septal thickening with pleural effusion. HRCT also plays a very crucial role in the diagnosis of complications of this disease. Bilateral opacities consistent with pulmonary oedema is considered diagnostic for development of ARDS in a known COVID-19 patient. If lobar consolidation is seen in chest CT, a superimposed bacterial pneumonia is suspected. If pericardial effusion is seen in CT imaging, cardiac injury due to COVID-19 could be a possible reason.[7]

Figure 1: 62 years old male with bilateral central and confluent ground glass opacity with bilateral pleural effusion.

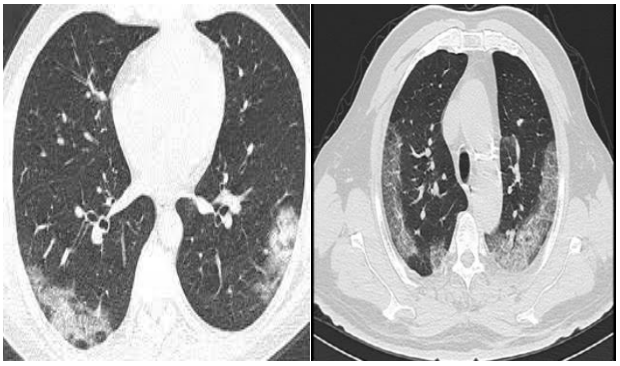

Figure 2: HRCT chest showing bilateral patchy confluent ground glass opacities with peripheral predominance.

In a study done by Modi et al among 274 patients, it was revealed that non-vaccinated patients with comorbidity have higher CT severity scores in comparison to the vaccinated patients with comorbidity. They found that the vaccinated patients have better outcomes in terms of survival than non-vaccinated patients.[21]

In a study done by Kachewar et al showed that post vaccination COVID positives were more frequent in younger population then the elderly patients after vaccination.[22]

Vishwanath et al concluded that HRCT is helpful in quantification of lung involvement and the assessment of disease severity in COVID-19. They found that vaccines help in reducing the severity of lung involvement in these patients.[23]

Joshi et al analyzed 3,235 patients and came to the conclusion that even among the patients who got infected after being vaccinated, the CT severity score was lower than among those who were non-vaccinated. They also concluded that vaccinated group of patients had higher percentage of mild cases than the non-vaccinated group.[24]

Limitations

The limitation of our study were that it did not chart certain other factors like the presence of co-morbidities, follow up patients, and physical activity levels, which could have possibly affected the severity of affliction of pulmonary parenchyma by SARSCoV-2. The mortality of the patients also not included in the study which can show the severity of diseases involvement. Also, patients included in this study belonged mostly to same region. We did not consider the analysis of serial scans.

CONCLUSION

In this cross-sectional study, patients receiving both doses of the SARS-CoV-2 vaccine showed lower CT severity scores in comparison to those who partially vaccinated or those who are non-vaccinated. HRCT is the most sensitive modality to detect severity of COVID-19 pneumonia. Severe lung involvement is more common in the unvaccinated population (32%) as compared with the vaccinated group, in which only 25% members had severe lung involvement.

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