Original Article

Assessment of lung involvement using HRCT among vaccinated and non-vaccinated elderly COVID-19 patients admitted in a designated hospital, Tamil Nadu – A retrospective study

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Abstract

Introduction: The COVID-19 pandemic is considered one of the most devastating situations globally, the worst affected were the senior citizens. A number of initiatives were carried out to control the COVID-19 pandemic; one such important measure is the development of COVID-19 vaccines to prevent the disease. But the continuous emergence of new SARS-COV2 variants (antigenic drift) and its demographic variation in virulence makes the vaccine's efficacy questionable. This study is intended to evaluate the association between the degree of lung involvement and the effectiveness of vaccination against the disease in cases admitted to a designated hospital in Tamil Nadu. **Materials and Methods:** A hospital records-based-retrospective research was conducted among COVID-19 patients admitted from the 1st of April 2021 to the 31st of May 2021, and information was gathered regarding their vaccination status, comorbid conditions, and CT severity score (CTSS) in the HRCT lung report. A consecutive sampling technique was used to choose the study participants; about 120 participants were included in the study. The Chi-square test and Fisher's extract test were used to evaluate the hypothesis. The relationship between a dependent variable and independent factors was estimated using multiple linear regression. **Results:** Among 120 participants, about 60.2% were males and 39.8% were females. Vaccination status and comorbid conditions had a significant association with severe lung involvement in COVID-19 patients. **Conclusion:** Non-vaccinated patients had severe lung involvement based on the HRCT lung scan findings than the vaccinated patients. To reduce mortality, it is essential to ensure universal coverage of COVID-19 vaccination.

Keywords: COVID-19 vaccine, CT severity score, geriatric

Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. Worldwide, in early December 2019, an outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) occurred in Wuhan City, Hubei province, China.[1] On 30th January 2020, the World Health Organization (WHO) declared the outbreak as a Public Health Emergency of International concern.[2] In India, the first COVID-19 case was reported in Kerala state on 30th January 2020, and in Tamil Nadu state the first case was reported on 7th March 2020.[3] The infection spreads across the country

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rapidly due to close proximity and frequent exchange of population.

A number of initiatives were carried out to control the COVID-19 pandemic globally, including bolstering medical and healthcare infrastructure, ensuring the availability of essential medical equipment, enhancing human resources and capacity building, information communications and public awareness and restricting public movements.[4] One such important measure is the development of COVID-19 vaccines, which are both safe and efficient. About 12 COVID-19 vaccines have been granted emergency use authorization (EUA) by the World Health Organization (WHO).[5,6] In India, two types of vaccines are commonly used in the adult population, a non-replicating adenovirus vector (COVISHIELD) and an entire inactivated coronavirus (COVAXIN).[7]

Studies conducted in India and other parts of the world[8-10] during the first wave of COVID-19 revealed that the elderly population was hugely affected, they were given priority in the first phase of vaccination in India. A retrospective study by Gurumurthy B[11] in Karnataka among COVID-19 cases who underwent HRCT chest reported that two doses of COVISHIELD and COVAXIN have 81.3% and 93.4% of efficacy in preventing severe forms of disease, respectively. But the continuous emergence of new SARS-COV2 variants (antigenic drift) and its demographic variation in virulence makes the vaccine's efficacy questionable.[12]

According to WHO, the confirmatory test for diagnosing COVID-19 is RT-PCR for persons who were symptomatic or who had been exposed to SARS-CoV-2, and HRCT is recommended to study the degree of lung involvement.[13,14] Primary care physicians can collaborate with the broader healthcare team to ensure comprehensive assessment and management of elderly COVID-19 patients based on HRCT findings. Primary care physicians can use HRCT scans as part of long-term follow-up care for elderly patients recovering from COVID-19. These scans can help monitor the resolution of lung abnormalities over time and guide decisions regarding ongoing care, rehabilitation and support needed for optimal recovery.

This study is intended to evaluate the association between the degree of lung involvement and the effectiveness of the vaccination against the disease in cases admitted to a designated hospital in Tamil Nadu.

Objectives

1. To describe the demographic details of the COVID-19 patients admitted to a designated COVID-19 hospital in Tamil Nadu.
2. To find out the association of degree of lung involvement using HRCT lung report with their demographic profile and vaccination status among COVID-19 patients.

Materials and Methods

Study design and setting

This is a hospital record-based retrospective study done among COVID-19 patients admitted in a designated COVID centre in Chennai, Tamil Nadu during the case surge in the second wave of COVID-19 (1st of April 2021 to 31st of May 2021) in India. A waiver of informed consent has been approved by Institutional Research Committee (IRC) and Institutional Ethics Committee (IEC). The study was conducted after obtaining approval from IEC [IEC NO: 08/SEPT/2022].

Selection criteria

The study participants include COVID-19-positive patients aged 45 years and above with known vaccination status and who had taken HRCT Lung admitted to the COVID-19 ward of the hospital. This age group was selected because the vaccination is provided only for this age during the period of study.[7] Individuals below the age of 45 years, with chronic respiratory tract illness or infection, unknown vaccination status and without HRCT lung report, were excluded from the study.

Around 347 COVID-19-positive patients were admitted (1 April 2021 to 31 May 2021) in the COVID-19 ward. Out of these, only 120 patients were eligible for this study. Later, they were classified into two groups: Non-vaccinated (Group A, $n = 60$) and Vaccinated (Group B, $n = 60$) [Figure 1].

Data collection

All the case sheets of the selected patients were reviewed. The data was obtained with a semi-structured abstraction form consisting of three sections-

- Section-A: Demographic profile of the study population including personal details, that is, MRD no, age, gender, adverse social habits and comorbid illness.
- Section-B: Vaccination status of the study population – The type of COVID-19 vaccine (COVISHIELD or COVAXIN) and the number of doses (one partially vaccinated and two fully vaccinated) taken were recorded.
- Section-C: HRCT lung scan report with CT Severity Score (CTSS) of the study population.
- CT Severity Score (CTSS)- With guidelines of the protocol for COVID-19 management updated to version 2.1 given by AIIMS on 3 May 2021,[15,16] severity of lung involvement using CTSS of HRCT lung report was classified into
  - CTSS <32% as Mild lung involvement,
  - CTSS 36–60% as Moderate lung involvement and
  - CTSS 61% and above as Severe lung involvement.

Data analysis

The raw data collected was directly entered in SPSS version 20. Descriptive statistics were performed for independent variables such as frequency and percentage in a graphical presentation. Inferential statistics such as the Fisher's extract test, Chi-square test and multiple linear regression were done to find out the

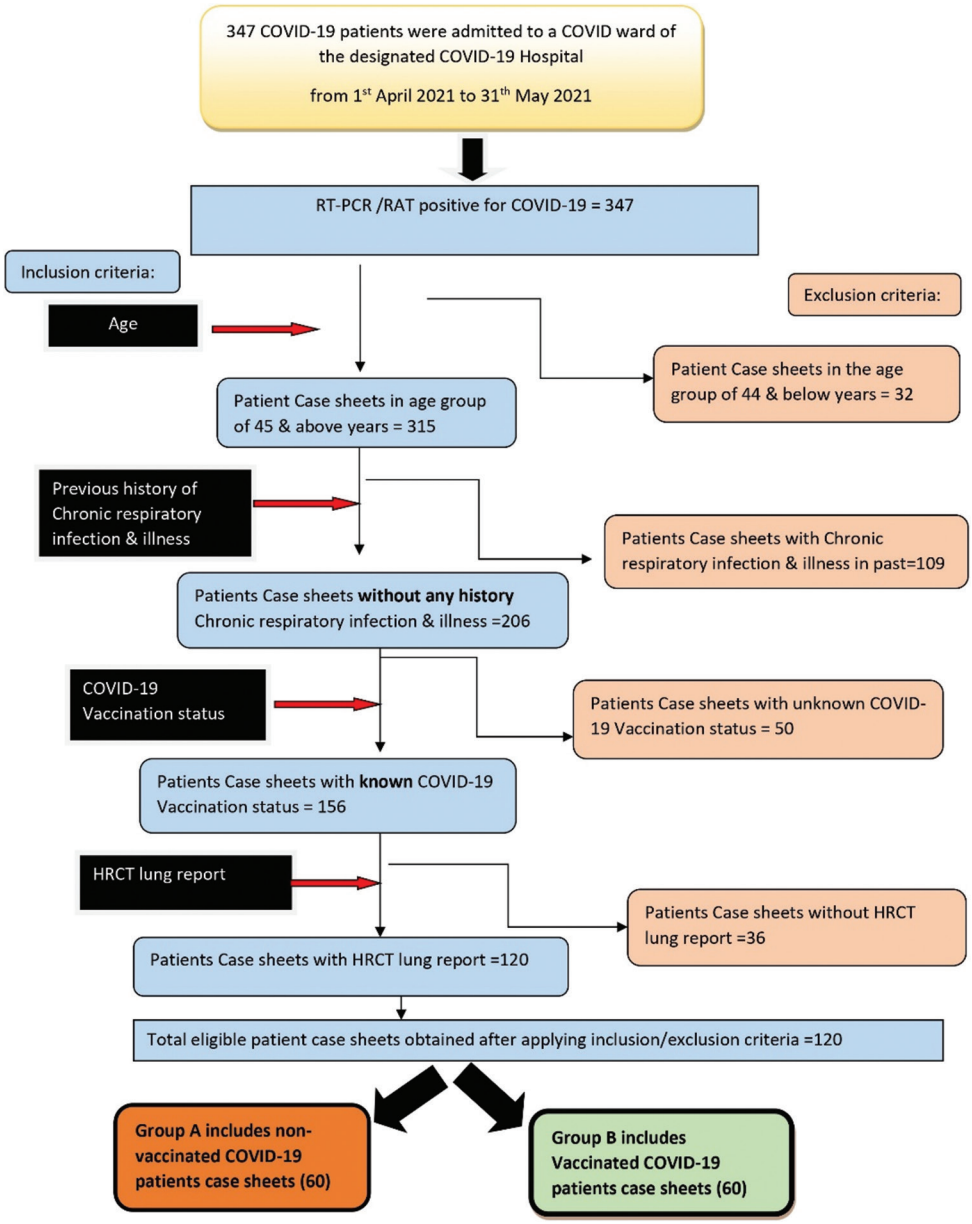

Figure 1: Flowchart showing selection of study participants

association between COVID-19 patients' vaccination status and their prognosis of disease outcome based on the severity of lung involvement. All tests were performed at a 5% level of significance; thus, the *P* value less than 0.05 of an association was considered significant.

Results

Among 120 patients, two-third (65%) were in the age group of 45–60 yrs. The non-vaccinated group (n = 60) had a mean age of 55.45 9 ± 9.7 years, whereas the vaccinated group (n = 60) had a mean age of 60.33 9 ± 9.9 years Overall, the mean age of the study participants was 57.9 ± 9.9 years. About 60.2% (72) of the study participants were males. Group-wise distribution of age, gender and comorbidity status among the study participants were shown in Table 1. About 52% of the study participants were partially vaccinated with COVISHIELD and 27% were partially vaccinated with COVAXIN [Figure 2]. Nearly half of the study participants (50%) in group A and one-third (31.7%) in group B had moderate to severe form of lung involvement [Figure 3]. The mean CTSS was greater in non-vaccinated people (17.2 ± 3.3) and relatively lower in completely vaccinated (9.6 ± 4.5) and partially vaccinated (9.7 ± 4.5) patients.

Association

Fisher's exact test was applied to find out the association between COVID-19 patient's vaccination status and HRCT lung reports. It was observed that vaccinated COVID-19 patients had less lung involvement which was found to be highly statistically significant (P = 0.001). Similarly, COVID-19 patients with past

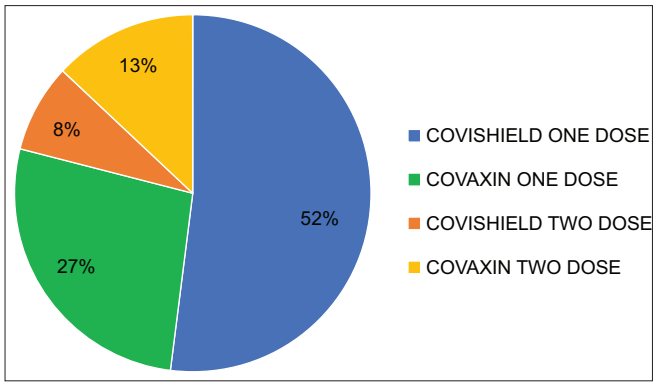

Figure 2: Distribution of study participants based on type of COVID-19 vaccine and number of doses

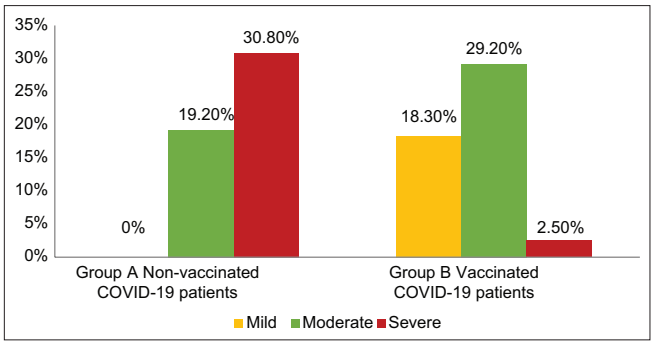

Figure 3: Severity of lung involvement using CT severity score of HRCT lung report of the study participants

H/o comorbidity had moderate to server lung involvement as per the HRCT lung report [Table 2]. Multiple regression was performed to find out the relationship between the severity of lung involvement based on the HRCT report and the age, gender, COVID-19 vaccination status and comorbidity. The overall regression model was statistically significant ($R = 0.763$, $R^2 =$ [0.582] and F (df regression[4] and df residual [115]) = [39.962] and $P =$ [0.001]). R^2 indicates that 58.2% of the variability can be explained by the predictor variables. A summary of the regression coefficients is presented in and in the general form of multiple linear equations, the severity of lung involvement among COVID-19 patients = 4.003 – (0.134 × age) + (0.007 × gender) + (0.332 × COVID-19 vaccination status) + (0.790 × past histories of comorbidity illness). COVID-19 patients with high comorbidity and low vaccination rates have an increased chance of severe lung involvement, the relationship has high statistical significance [Table 3].

Discussion

The present study investigates the relationship between lung involvement using the HRCT report and vaccination status among COVID-19 patients 45 years of age and above admitted to the designated COVID-19 care centres in Chennai, Tamil Nadu.

The participants of the present study have a mean age of 57.9 ± 9.9 years and about 65% of those affected are between the ages of 45 and 60 years with 22.5% of them having severe lung involvement. A similar finding has been reported in a study done in the United Arab Emirates,[16] with about 66% of the study participants in age 40–59 years with a mean age was 44.2 ± 11.9 years and a study done in India[17] reported that the mean age of the COVID-19 infected individuals were 46.1 ± 16.8 years. COVID-19 positivity rate increases as the age of individuals increases and individuals in the age group of 45–60 years were observed with higher positivity, this could be due to outdoor exposure, a decrease in incubation time, exciting comorbidities and age-dependent immune response against viruses.[18,19] Another reason for this trend could the adaptive immunity that plays a significant role in response to viral infection. Compared to the younger age group, adaptive immunity declines as age advances which makes the elderly population vulnerable to infection.

The present study reveals that about 60.2% of patients admitted were males and the severity of illness was also higher among males (18.3%). Similar findings were reported in the studies done by Jin, M., *et al.*,[20] Kushwaha, S., *et al.*[21] and Betron M, *et al.*[22] This variation could be attributed to certain habits such as sharing cigarettes or bidis, infrequent handwashing, and the presence of pre-existing respiratory illnesses. Additionally, in the case of females, the extra X chromosome has been found to enhance humoral immunity, providing significant protective effects.[20-22]

The present study shows that patients with comorbidities had higher CTSS s than non-comorbid individuals which were similar to the findings reported by Guan WJ *et al.*,[23] Bhandari S *et al.*,[24] Agarwal N *et al.*[25] and Xiao J *et al.*[26] Since COVID-19 is a newly emerged disease, the exact mechanism by which the comorbid conditions increase the risk of acquiring the disease, particularly the severe form of the disease is still not known, further research is warranted in this area.

This study also found that patients who had the vaccination, irrespective of the completion status, have less CTSSs than patients who are not vaccinated. Similar findings were reported by studies Russo GM *et al.* in Italy,[27] Tsakok MT *et al.* in North America,[28] Shah PK in Nepal,[29] Guru Murthy B *et al.* in Rajasthan[11] and Ashish Verma *et al.* in Uttar Pradesh.[30] Evidence suggests that COVISHIELD is effective in preventing symptomatic COVID-19 infection even with partial immunization, and COVAXIN might be effective against mutant strains due to its ability to produce multiple antibodies against various epitopes.[31,32] Getting immunized with any of the vaccines definitely reduces the risk of acquiring the severe form of COVID-19.[13] Considering the present situation with another surge of COVID-19 cases in China with a different mutant strain, it is possible to have another case surge in any other country, especially in neighbouring countries like India. Hence it is important to get vaccinated against COVID-19 for reducing the severity and its complications, even if a person is contracting the disease.

Table 1: Group-wise distribution of age, gender and comorbidity status among the study participants

Variable-Column Total		Group-A Non-Vaccinated COVID-19 Patients (*n*=60), (%)	Group-B Vaccinated COVID-19 Patients (*n*=60), (%)
Age	45−60 years	44 (73.3%)	34 (56.7%)
	61 and above years	16 (28.3%)	26 (43.3%)
Gender	Female	26 (43.3%)	22 (36.7%)
	Male	34 (56.7%)	38 (63.3%)
Comorbidity	No	8 (13.3%)	52 (86.7%)
	Yes	52 (86.7%)	8 (13.3%)

Table 2: Associated between severity of lung involvement and socio-demographic factors and vaccination status among COVID-19 patients

Variable		Lung Involvement Based on HRCT Scan			Significant
		<32%	36–60%	61% and above	
Age	45–60 years	10 (8.3%)	41 (34.2%)	27 (22.5%)	Chi-square test value=4.630, *P*=0.09
	61 and above years	12 (10%)	17 (14.2%)	13 (10.8%)	
Gender	Male	14 (11.7%)	36 (30%)	22 (18.3%)	Chi-square test value=0.641, *P*=0.77
	Female	8 (6.7%)	22 (18.3%)	18 (15%)	
Covid-19 vaccination status	No	0	23 (19.2%)	37 (30.8%)	Fisher's exact test value=62.333, *P*=0.001***
	Yes	22 (18.3%)	35 (29.2%)	3 (2.5%)	
Comorbidity	No	22 (18.3%)	38 (31.7%)	0	Fisher's exact test value=83.851, *P*=0.001***
	Yes	0	20 (16.7%)	40 (33.3%)	

Significant *P<0.05, **P<0.01, ***P<0.001

Table 3: Relationship between severity of lung and socio-demographic factors and vaccination status among COVID-19 patients by using multiple linear regression

Variable	B	Exp B	SE	*t*	*P*
Age	−0.134	−0.091	0.093	−1.449	0.15
Gender	0.007	0.005	0.088	0.078	0.94
Comorbidity status	0.790	−0.562	0.127	−6.204	0.001***
COVID-19 Vaccination status	−0.332	−0.236	0.129	−2.568	0.01**
Constant	4.003		0.218	18.323	0.001***
Model		**Value**			***P***
R^2		0.582			
Adjusted R^2		0.567			
Standard error		0.464			
F test		39.963			0.001***

Significant *P<0.05, **P<0.01, ***P<0.001

The present study reports that patients who received vaccination have less CTSS compared to non-vaccinated patients. Since primary care physicians are the initial care providers, they have the responsibility to health educate and act against vaccine hesitancy prevailing in the community. They should bring awareness regarding the critical nature of the illness and the effectiveness of vaccination against the severe form of the disease in the community. The primary care physicians and the family physicians have a pivotal role in enabling community participation in the initiatives of the government to successfully achieve a hundred per cent COVID-19 vaccination target in the country.

Conclusion

SARSCoV-2 has jeopardized the entire world and comorbidity plays a significant role in harbouring COVID-19 infection in the elderly population, vaccination is the only tool that can prevent the transmission and the severe form of disease to date. Hence, in addition to other strategies, like social distancing, using a face mask and hand hygiene, it is important to ensure universal coverage of the COVID-19 vaccination through strategies like mega vaccination camps and door-to-door vaccination camps which may prevent further episodes of pandemic waves.

Limitations

1. This is a small-scale study done in one of the COVID-19-designated hospitals in Tamil Nadu, the results may not be generalizable to different settings in India. Large-scale multicentric prospective studies are required to know about the actual status across the country.
2. Time of the last vaccination is not known hence it is not possible to evaluate the efficacy of the vaccine in preventing severe forms of disease based on the time of immunization.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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