

The lung severity score by CT scan and its relation with vaccination status in Covid 19 patients.

¹Dr. Sruthy Prakash, Final year PG resident, Department of Radiodiagnosis, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Trivandrum.

²Dr. Sheeja G, Deputy Director SGMC &RF, Associate Professor, Department of Radiodiagnosis, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Trivandrum.

³Dr. Visakh Prasad, Associate Professor, Department of Radiodiagnosis, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Trivandrum.

⁴Dr. N Roy, Professor and HOD, Department of Radiodiagnosis, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Trivandrum.

Corresponding Author: Dr. Sruthy Prakash, Final year PG resident, Department of Radiodiagnosis, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Trivandrum.

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Conflicts of Interest: Nil

Abstract

Background & objectives: In March 2020, WHO proclaimed COVID 19 to be a pandemic (1) which manifests with CT chest imaging abnormalities in the form of rapid evolution from focal unilateral to diffuse bilateral ground-glass opacities that progressed to or co-existed with consolidations within 1–3 weeks.

Covid 19 vaccination started in India from 16th January 2021. The two vaccines developed in INDIA till now are COVISHIELD and COVAXIN (2). Vaccines work on the principles of inducing immunity by introduction of inactivated virus and spike proteins. Although vaccination does not completely prevent infection or

reinfection, it helps lessen the severity of the symptoms and infectivity and increase patient survival.

The study is done to determine the extent of pulmonary involvement in RT-PCR / Antigen detection rapid diagnostic tests confirmed cases of Covid 19 patients by HRCT and its correlation with vaccination status. The study aims to determine the extent of pulmonary involvement in confirmed cases of COVID-19 patients by HRCT and its correlation with vaccination status and to determine whether there is reduced pulmonary involvement in vaccinated patients as compared to unvaccinated patients.

Materials and methods: A retrospective cross-sectional analysis of CT chest and correlation with the vaccination status in 110 COVID 19 patients, divided into two groups 55 vaccinated (43 Covishield /12 COVAX in) and 55 unvaccinated from 1 st January 2021 to 1st October 2022 at our institution. Study was conducted after getting ethical clearance from the institutional ethics committee and informed consent from the patient. The details like Age, sex, vaccination status, type of vaccine, symptoms, comorbidities were collected. Patients were stratified in to age groups 18- 44, 45-59 and >60 years. CT severity score was calculated in each groups. The data was analyzed by SPSS software. Descriptive statistics were summarized as percentages, mean and standard deviation.

Results: From the analyzed 110 patients, the mean age of study population was 58.2 ± 10.2 years with significant higher males as compared to females with a ratio of 1.8:1. Among the vaccinated individuals 45.5% had mild, 43.6% had moderate and 10.9 % had severe HRCT scoring whereas among unvaccinated individuals 12.7% had mild, 61.8 % had moderate and 25.5% had severe HRCT scoring with significant p value (0.01). Myalgia followed by fever was the most common symptoms seen in the study which was significantly low in the vaccinated group as compared to the unvaccinated group. The CT severity scores, consolidation and ground glass opacities were reduced in both Covishield and COVAX in recipients compared to the non-vaccinated individuals [$\chi^2(2) = 18.32, p < 0.021$] while the CT severity score and lung findings were relatively lesser in Covishield group compared to COVAX in.

Conclusion: Vaccination helped to protect from severe - CoV 2 infection. The extent of pulmonary involvement

was found to be more in unvaccinated patients as compared to vaccinated patients. Vaccinated patients showed mild – moderate pattern of disease whereas unvaccinated patients showed moderate – severe involvement. Thus, a low CT severity score was found in vaccinated group. CT severity score and lung findings were relatively lesser in Covishield group compared to COVAX in.

Keywords: Proclaimed, Summarized, Symptoms

Introduction

COVID 19 has spread quickly over the globe. In March 2020, the WHO proclaimed COVID 19 to be a pandemic (1). This illness has a significant impact on the global health system, economics, and societal advancement. Many nations have created COVID vaccinations to fight the disease. The COVID vaccine can increase immunity and stop the progress of the disease. Although vaccination does not completely prevent infection or reinfection, it helps lessen the severity of the symptoms and infectivity and increase patient survival.

Even in asymptomatic individuals, COVID-19 pneumonia presents as abnormal chest CT features with rapid progression from focal unilateral to diffuse bilateral ground-glass opacities that proceeded to or co-existed with consolidations within 1-3 weeks. The patient's CT score provides a numerical modulus that is comparable to the degree of damage that has occurred.

Covid-19 alters the immune system's reaction abnormally, leading to a rise in the production of the cytokines interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF), collectively known as a "cytokine storm (3)." During this cytokine storm, alveolar epithelial cells are destroyed. An aberrant immunological mechanism that results in a cytokine storm may start and promote lung fibrosis. The dysregulated release of matrix

metalloproteinases in the inflammatory phase of ARDS leads to epithelial and endothelial damage. In addition to VEGF, cytokines including IL-6 and TNF- are also implicated in the fibrosis process.

The two vaccines developed in INDIA till now are COVISHIELD and COVAXIN (2). The 2 vaccines work on the principles inducing immunity by introduction of inactivated virus and spike proteins.

Materials and methods

- Study setting: Gokulam Covid Care and Department of Radiodiagnosis, Sree Medical College and Research Foundation, Venjaramoodu, Thiruvanthapuram.
- Study period: January 2021 – October 2022
- Aims & objectives: AIMS To determine pulmonary involvement in confirmed cases of COVID-19 patients by HRCT and its correlation with vaccination status.
- Primary objective: To determine whether there is reduced pulmonary involvement in vaccinated patients as compared to unvaccinated patients.
- Secondary objective: To find the proportion of low CT severity scores in vaccinated patients
- Study design: Retrospective crosssectional study
- Sample size: 110 patients; 55 in each vaccinated and unvaccinated group.

Study population

Inclusion criteria

- All hospitalized patients 18 years or above with positive Rapid Antigen detection diagnostic test / RT-PCR for Covid 19 and underwent HRCT-THORAX.
- Vaccinated (at least one dose of Covid 19 vaccine 1 week prior to CT scan) and non-vaccinated patients (not receiving any vaccine / within 1week of 1st dose)

Exclusion criteria

- Not giving consent to participate.
- Unable to breath hold.

- Movement artifacts.
- Vaccination status not known
- Pre-existing lung disease.
- Immunosuppressant therapy

Sample size taken in the study: 55 each in vaccinated and unvaccinated groups.

Method of data collection and data analysis

All scans were performed on GE optima 128 slice CT Scanner. With patients in supine position, CT scan acquisition was done on single inspiratory breath hold.

- Scan Parameters: Slice
- Thick ness: 0.625 mm
- Collimation: 128 x 1.00
- Pitch: 0.95, mAS:160
- Kvp: 120 Volumetric data was reconstructed in the multiple planes.

A semi-quantitative CT score was calculated based on the extent of each lobar involvement. The total CT score would be the sum of the individual lobar scores and can range from 0 (No involvement) to 25 (Maximum involvement), when all the five lobes show more than 75% involvement.

- CT Severity index 16 is considered to be SEVERE involvement.
- CT Severity index 8 - 15 is considered to be MODERATE involvement.
- CT Severity index > 16 is considered to be SEVERE involvement.

The data analyzed by SPSS software. Descriptive statistics were summarized as percentages, mean and standard deviation.

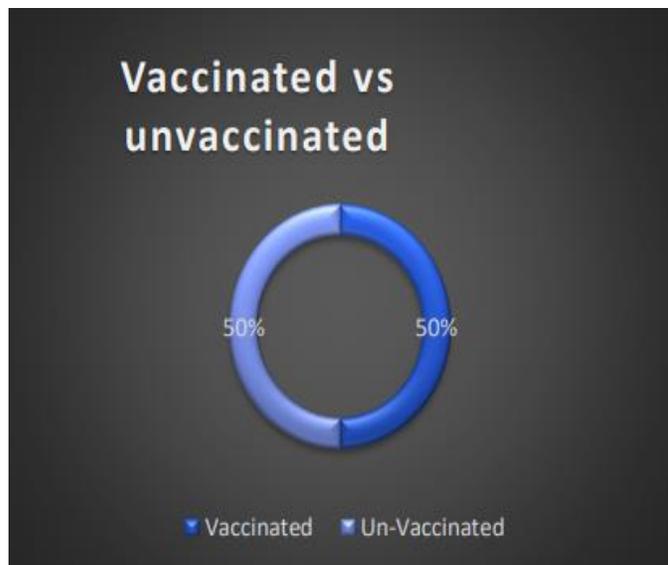
Results

Baseline Demographic Characteristics

A total of 110 patients have been enrolled in the study from January 2021- October 2022 Out of 110 patients

included in the study, 55 patients were vaccinated with at least one dose of COVID -19 vaccine and rest of the 55 patients were unvaccinated.

Graph 1:

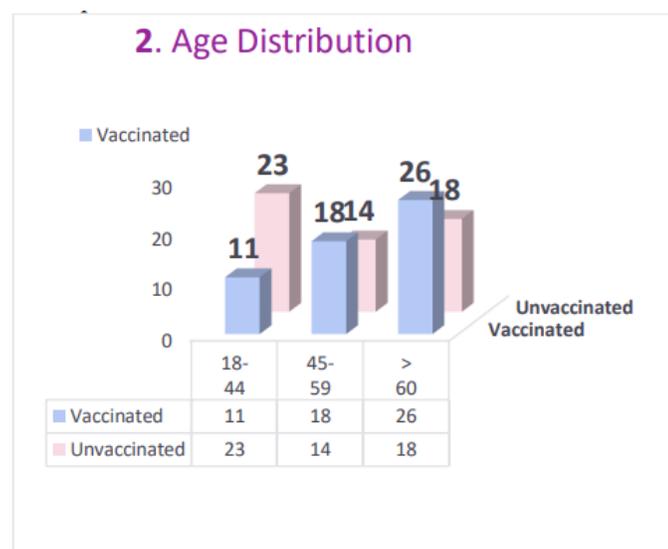


Age distribution based on vaccination status

In this study majority of participants included in the study are more than 60 years of age in both the vaccinated as well as unvaccinated groups.

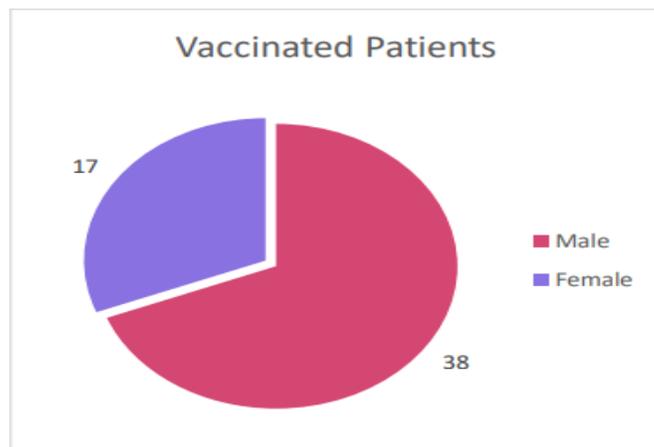
The age groups were matched with a p value of 0.067 as mentioned below.

Graph 2:

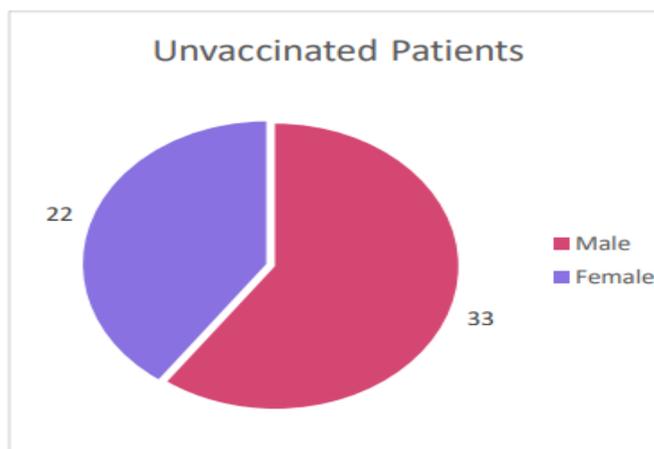


Gender Distribution based on vaccination status.

Graph 3:



Graph 4:



Out of 110 patients included in the study, Majority of the patients in vaccinated as well as unvaccinated groups were Males 38 (69.1 %) and 33 (60 %) respectively.

Table 1: Presenting Clinical Symptoms based on vaccination status.

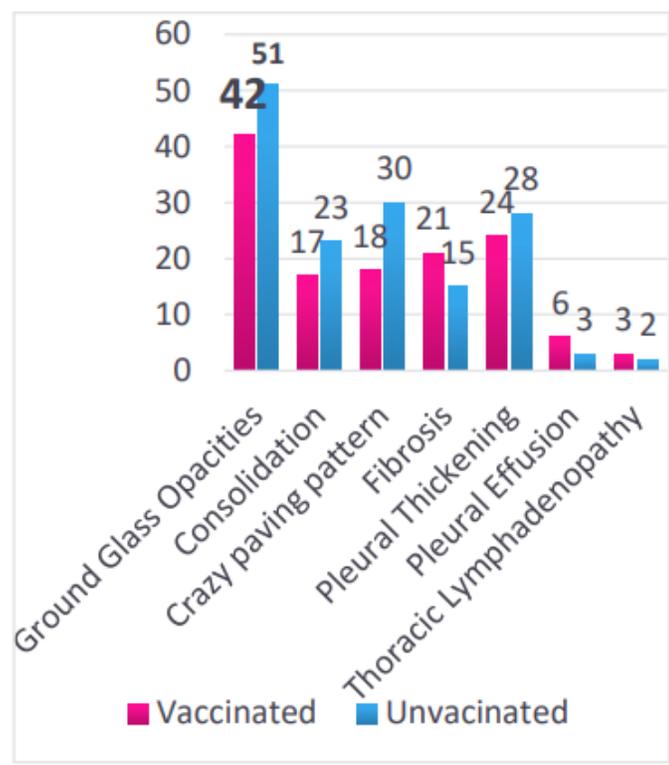
Presenting Symptoms	Vaccinated N=55	Unvaccinated N=55
Myalgia	34 (61 %)	42 (76 %)
Fever	21 (38 %)	33 (60 %)
Cough	13 (24 %)	18 (23 %)
Sore Throat	32 (58 %)	28 (51 %)
Dyspepsia	4 (7 %)	24 (43 %)

Significantly lower presenting symptoms seen in the vaccinated patients in comparison to the unvaccinated patients with Myalgia being most common presenting symptom followed by sore throat in vaccinated group and fever in unvaccinated group.

Table 2: Pattern in HRCT based on vaccination status.

Patterns in HRCT	Vaccinated N=55		Unvaccinated N=55	
	N	%	N	%
GroundGlassOpacities	42	76.4	51	92.7
Consolidation	17	30.9	23	41.8
Crazy paving pattern	18	32.7	30	54.5
Fibrosis	21	38.2	15	27.3
Pleural Thickening	24	43.6	28	50.9
Pleural Effusion	6	10.9	3	5.5
Thoracic Lymphadenopathy	3	5.5	2	3.6

Graph 5:



The patterns observed on HRCT were evaluated and there is significantly ($p < 0.05$) less radiological pattern of involvement seen in vaccinated group as compared to unvaccinated patients.

Majority of the patients in both the groups showed Ground glass opacities as predominant radiological pattern.

Table 3: Lobe involvement based on vaccination status.

Lobe involvement	Vaccinated N=55		Unvaccinated N=55	
	N	%	N	%
Right Upper Lobe	28	50.9	38	69.1
Right Middle Lobe	37	67.3	21	38.2
Right Lower Lobe	52	94.5	51	92.7
Left Upper Lobe	46	83.6	41	74.5
Left Lower Lobe	51	92.7	48	87.3

Majority of patients in both groups showed Bilateral lower lobe involvement: Right: (94.5 %/92.7) Left :(92.7/87.3) in vaccinated as well as unvaccinated respectively.

CT severity score based on vaccination status.

Graph 6:

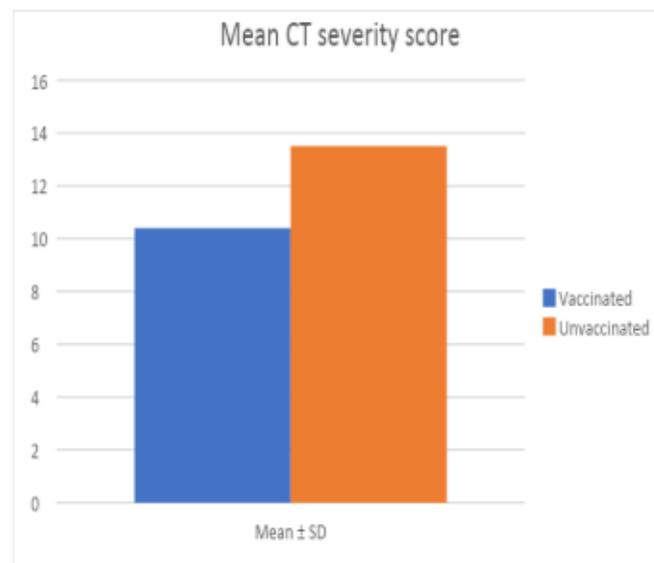


Table 4:

Classification	Vaccinated N=55		Unvaccinated N=55	
	N	%	N	%
Mild (<8)	25	45.5	7	12.7
Moderate (8-15)	24	43.6	34	61.8
Severe (16-25)	6	10.9	14	25.5

CT severity score: Majority of the patients had a Mild CT severity score in vaccinated patients and a moderate CT severity score in unvaccinated patients. P value < 0.05.

Table 5: CT severity scores according to age distribution.

Age Distribution (yrs.)	Vaccinated N=55	Unvaccinated N=55	P value @
18-44	1.9 ± 0.7	4.6 ± 2.9	0.023
45-59	3.9 ± 1.8	8.5 ± 4.9	0.012
> 60	9 ± 4.6	14.1 ± 6.9	0.033
P value #	0.0012	0.012	0.022

The CT severity scores were compared between the two groups based on the age distribution and there is a significantly higher CT severity scores in the elderly age group of >60 years.

On comparing CT severity scores based on vaccination status there is a significantly lower CT severity scores in the vaccinated population.

Table 6: Gender wise Distribution of CT severity scores.

Gender	Vaccinated N=55	Unvaccinated N=55	P value @
Male	8.5 ± 3.8	10.7 ± 4.9	0.001
Female	6.7 ± 4.6	9.2 ± 4.5	0.045

In both the groups the females had a significantly lower CT severity score as compared to males (p value < 0.05).

Table 7: CT severity score according to type of vaccine.

CT severity score	Covishield 43	Covaxin 12
<8 (Mild)	21	4
8-15 (Moderate)	17	7
16-25 (Severe)	5	1

Representative cases.

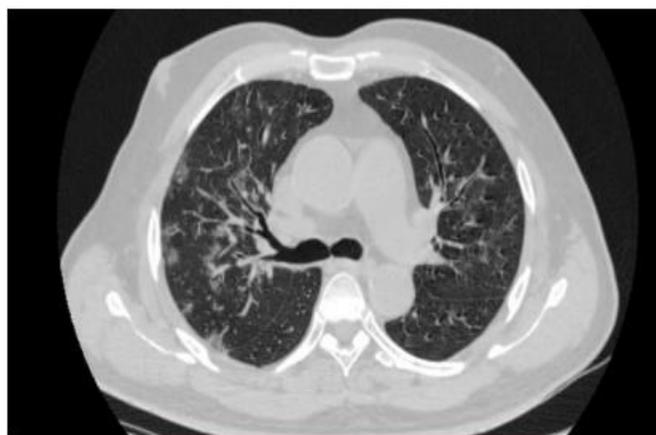


Figure 1: Axial HRCT Thorax lung window in vaccinated patient showing multiple peripherally predominant patchy areas of ground glass opacities in bilateral lung parenchyma, predominantly on right.



Figure 2: Axial HRCT Thorax lung window in vaccinated patient showing patchy areas of ground Glas opacities in the bilateral parenchyma with subpleural fibrotic strands

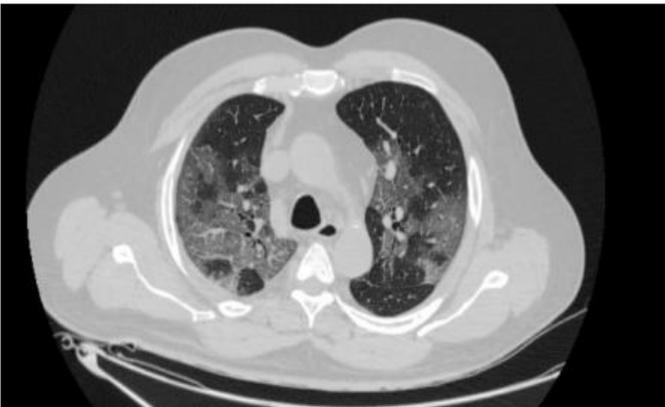


Figure 3: Axial HRCT Thorax lung window in un vaccinated patient showing diffuse areas of ground Glas opacities in the bilateral lung parenchyma.

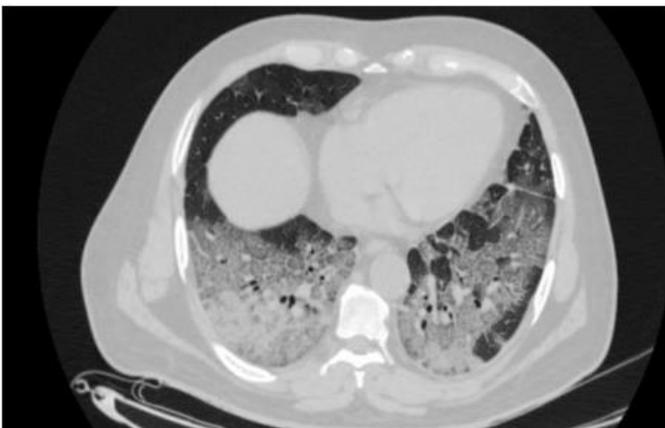


Figure 4: Axial HRCT Thorax lung window in un vaccinated patient showing diffuse areas of ground Glas

opacities with interlobular septal thickening in the bilateral lower lobes, suggestive of crazy paving pattern.

Discussion

Out of 110 patients included in the study, 50% were vaccinated by vaccines like COVAX or Covishield and the other 50% were unvaccinated patients. The mean age of the study population was found to be 58.12 ± 10.2 years. Majority in the vaccinated group above the age of 60 years and unvaccinated group were 18-44 years. Majority of the patients in both groups were males 38 (69.1%) and 33 (60%) respectively with male to female ratio, 1.8:1.

Myalgia was the most common symptom in both the population followed by sore throat and fever in vaccinated and unvaccinated groups respectively. Predominant radiological pattern was found to be ground glass opacities in both groups, but ground glass opacities were lower in the vaccinated patients as compared with unvaccinated patients. Findings such as Consolidation and Crazy paving pattern were also lower in vaccinated groups.

Both vaccinated and unvaccinated groups showed predominant involvement of bilateral lower lobes. The mean CT severity score was lower in vaccinated individuals with CT severity scores less than 8 in majority of the vaccinated population.

The elderly above age of 60 years have a higher CT severity score in both populations. Females had a significantly lower CT severity score as compared to males.

The CT severity scores, consolidation and ground glass opacities were reduced in both Covishield and COVAX recipients compared to the non-vaccinated individuals while the CT severity score and lung findings were

relatively lesser in Covishield group compared to COVAX in.

Conclusion

CT severity score is indirect evidence of Covid 19 burden and outcome. Vaccinated patients showed mild – moderate pattern of disease whereas unvaccinated patients showed moderate – severe involvement.

Reduced pulmonary involvement in vaccinated individuals highlight that vaccines are effective tool against Covid 19, particularly in the time of disinformation regarding vaccine and motivate people in getting vaccinated.

The study proved that vaccines are beneficial in reducing the severity of lung involvement in COVID-19 infected patients, thus vaccines play a crucial role in flattening epidemiological curve of COVID-19 pandemic and saving the mankind.

Limitations

Single center study with limited sample size. Effect of confounding variables such as comorbidities (Diabetes mellitus Hypertension) were not removed. Limited number of COVAX in group.

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