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“Covid-19 Breakthrough Infection Among Post-Vaccination - A Retrospective Study”

Chaparala Pravalya¹, Lakshmi Gnana Preeshvitha Gogineni², Pakalapati Sai Sandeep³,
Kalapala Abhilash⁴

¹Post Graduate student, Department of Radio-Diagnosis, Alluri Sitarama Raju Academy of
Medical Sciences, Eluru, A.P, India.

^{2,3}Under Graduate student, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, A.P,
India.

⁴Assistant Professor, Department of Community Medicine, Alluri Sitarama Raju Academy of
Medical Sciences, Eluru, A.P, India.

Corresponding Author: Dr. Kalapala Abhilash, Assistant Professor, Department of
Community Medicine, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, A.P,
India.

Abstract:

Background: The goal of COVID-19 vaccine is to contribute to the equitable protection & promotion of human well-being globally. Vaccination campaign for COVID-19 in India started on January 16, 2021 using two vaccines; COVISHIELD (manufactured by Astra Zeneca) and COVAXIN (manufactured by Bharat Biotech). Now, COVID-19 vaccination is open for all adults (≥ 18 years) in India. Even after vaccination the COVID-19 infection spread continues unabated.

Aim & Objectives: This study aimed to study the post-vaccination lung involvement of COVID-19 positive patients based on HRCT-scores and to compare COVISHIELD and COVAXIN vaccines in relation to the CT severity index among the COVID-19 positive patients' post-vaccination. It also determines the association between patients with pre-existing comorbidities and severity of disease in both COVISHIELD & COVAXIN vaccinated patients.

Methods & Materials: An observational analytical retrospective cross-sectional study conducted at Andhra Pradesh State COVID Hospital in Eluru District, Andhra Pradesh, using the medical records and CT severity reports for a period of 3 months among post-vaccination COVID-19 positive patients. IEC clearance was obtained.

Results: The mean CT score was 6.40 ± 6.5 among the post-vaccination COVID-19 positive patients. There was high mean CT score in Covaxin group (7.78 ± 6.5) when compared to Covishield group (5.39 ± 6.3).

Conclusion: Full immunization with Covishield had minimal lung involvement.

Keywords: Breakthrough, Covaxin, Covid-19, Covishield, CT score, Postvaccination.

Introduction:

The goal of COVID-19 vaccines is to contribute to the equitable protection & promotion of human well-being globally.¹ COVID-19 vaccines are a critical tool for controlling the ongoing global pandemic.² The vaccination campaign for COVID19 in India was started on January 16, 2021 using two vaccines; Covishield-ChAdOx1 nCoV-19(manufactured by Astra Zeneca) and Covaxin-BBV152 (manufactured by Bharat Biotech).³ The beneficiaries of vaccines include health care workers, front-line workers & people with more than 45 years of age with morbidities (like diabetes, coronary artery disease etc.). From May 1st, 2021 onwards vaccination is open to all individuals (>18 years of age) in India.⁴

Computed tomography (CT) has been an important imaging modality in assisting the diagnosis and management of patients with coronavirus disease 2019 (COVID-19) pneumonia, and reports on the radiological appearances of COVID-19 pneumonia are emerging.⁵ CT is a sensitive modality to detect COVID-19 pneumonia, even in asymptomatic individuals, and could be considered as a screening tool together with RT-PCR.⁴ The predominant CT findings included ground-glass opacification, consolidation, bilateral involvement, peripheral and diffuse distribution.⁶

Despite of 14 days waiting period post-vaccination, there were RT-PCR positive SARSCoV2 cases reported.⁷ There were chances of postvaccination breakthrough SARSCoV2 infections because COVID-19 vaccines do not offer 100 percent protection.⁸

Material and Methods:

An institutional based, analytical retrospective cross-sectional study was conducted in the Department of Community Medicine, Department of Radiology and Department of Medical Records. Data regarding patients aged 18 years & above, irrespective of gender and who were admitted at Andhra Pradesh state covid hospital (ASRAMS) Eluru District, Andhra Pradesh during 2nd COVID-19 wave with breakthrough RT-PCR positive COVID-19 symptoms after 14-days of post-vaccination either with single or both doses of covid-19 vaccine (Covishield or Covaxin) was obtained by reviewing the past medical records and those who fulfilled the criteria were included in the study. Permission was obtained from the concerned departments after explaining the study details. Consent from all the department heads involved was obtained.

Permission was obtained from the patients / their family members via telephonic route after explaining the study details. Later data was collected through interview method through telephonic route from all the vaccinated individuals involved in the study. Informed consent of the respondent was obtained before the administration of the schedule. While collecting the data, freedom of expression and strict privacy was ensured. A standardized predesigned proforma was used to collect the data regarding the personal details, history of illness, past medical history, investigations done, and treatment provided were obtained through telephonic interview method and by reviewing medical records. Patients who are not willing to give

consent even after counselling and with serious illness or cognitive disorders excluded from the study. The study conducted for a period of 3 months (1st June to 31st August 2022). Institutional Ethical Committee (IEC) approval was obtained.

During the study period about 687 COVID positive patients were subjected to CT-chest examination. A sample size was calculated considering novel corona virus disease prevalence of 50 %, and an absolute precision of 10 % with 5% α -error at 95% Confidence Interval (C.I). The minimum calculated sample size was 100, in the present study about one hundred and nine (109) patients RT-PCR positive for COVID-19 post-vaccination were included.

Computed tomography (CT) chest scan for the admitted individuals was done using *GE REVOLUTION ACT CT MACHINE (32 SLICE)* with a low dose exposure protocol during the study period. The CT severity score was categorized into three groups i.e., mild (≤ 8); moderate (9-14); severe (≥ 15).⁹ The collected data was entered in Microsoft Excel-2019 and analyzed using statistical package SPSS trial version-23. The data was represented in percentages, tables and figures. Relevant statistical tests like t-test, Chi-square test were applied where necessary.

Results:

In the present study, about 109 post-vaccination breakthrough RT-PCR positive for COVID19 with symptoms were included, among them majority 62.4% were males and 37.6% were females. The mean age among the patients was 51.37 ± 13.8 years, majority 53.2% of the patients were in 45-60 years age group (Table-I). All patients included in the study had received vaccine against novel corona virus disease either with Covishield or Covaxin. Among the 109 patients, 57.8% received Covishield vaccine and 42.2% received Covaxin vaccine (Table-I). Patients with single dose of vaccine or partial immunization were 61.5% and 38.5% were fully immunized (Table-I). Among the patients, 33% were diabetics, 29.4% were hypertensives, 8.3% were with bronchial asthma, 2.8% were with thyroid problems, 2.8% were with cerebral vascular disease, 0.9% were with coronary artery disease and 7.3% of the patients had a harmful habit of smoking (minimum one cigarette per day) (Table-I). The median CT score was 5 (023) among the post-vaccination COVID-19 positive patients. Among males the mean CT score was 6.79 ± 6.7 and females was 5.76 ± 6.2 respectively (Table-II).

The patients were categorized into 3 groups based on CT severity index mild (63.3%), moderate (22.9%), and severe (13.8%) (Figure-I). Age, immunization status, diabetes, and hypertension had statistically significant association with CT severity index (p-value < 0.05) (Table-III). On comparing the CT scores between Covishield and Covaxin groups, there was statistically significant difference between the two vaccine groups. There was high mean CT score in Covaxin group (7.78 ± 6.5) when compared to Covishield group (5.39 ± 6.3). Covishield vaccine reported a better immunogenic response when compared to Covaxin vaccine in relation to CT score (Table-IV). When comparison was made between Covishield and Covaxin group patients based on immunization status in relation to CT score, there was statistically significant difference between fully immunized Covishield and fully immunized Covaxin groups with high mean CT score in Covaxin group (8.85 ± 6.9) when compared to Covishield group (2.50 ± 5.5) (Table-V; Figure-I & II). There was no statistically significant

difference between partially immunized Covishield and partially immunized Covaxin groups in relation to CT score (Table-V; Figure-III & IV).

Discussion:

After adequate vaccinations the emergence of breakthrough infections of SARS-CoV2 are matter of concern, there was no adequate data available regarding these infections in real world setting. The effectiveness of vaccines for COVID-19 varied from 70-90%, even vaccinated people still have a chance of developing COVID-19 infection.

In the present study among 109 Covid-19 positive cases, 57.8% of the patients received Covishield vaccine & 42.2% received Covaxin vaccine and 61.5% of the patients received single dose of vaccine or partial immunization & 38.5% were fully immunized. In a study conducted by Tyagi K *et al.*⁴ 113 subjects were vaccinated for novel corona virus disease, 75.2% of the patients received Covishield vaccine & 24.8% received Covaxin vaccine and 5.3% were partially immunized & 94.7% were fully immunized. In a study conducted by Brinkley-Rubinstein L *et al.*¹⁰ in prison 27 subjects had tested positive for Covid-19, among them 37.1% were partially immunized and 62.9% were fully immunized. In a study conducted by Bergwerk M L *et al.*¹¹ among vaccinated health care workers 39 subjects had tested positive for Covid-19 and all of them were fully immunized. In a study conducted by Dash GC *et al.*¹² among 274 patients with confirmed breakthrough infection, 12.8% individuals received Covaxin and 87.2% individuals received Covishield. These variations in type of vaccine received and immunization status among the studies were due to varied sample size, geographical areas and time of the study conducted.

The mean CT score among the post-vaccination COVID-19 positive patients of the present study was low. The studies conducted by Lakhia RT *et al.*¹³ and Pilishvili T *et al.*¹⁴ stated that complete or partial vaccination had lower CT severity score that attribute to the vaccine effectiveness in preventing the severe lung disease. Kale P *et al.*¹⁵ study stated that the unvaccinated individuals had 1.5 times higher risk of infection compared to partially vaccinated and 2.4 times than fully vaccinated. Many vaccinated individuals had mild to moderate changes in the CT-Chest, occasionally the changes were severe due to co-morbidities like diabetes, hypertension, obesity.

Dash GC *et al.*¹² study reported that the median CT score in covaxin group was 21 and 22 in Covishield group, there was no statistically significant difference between two groups. In the present study there was a statistically significant difference between the covishield and covaxin groups. This difference between the two studies was due to low number of patients in covaxin group in Dash GC *et al.*¹² study.

The individuals with 2 doses of covishield had a low CT score when compared to covaxin with 2 doses. The severity was very minimal in case of fully immunized individuals when compared to partially immunized.

Conclusion:

Complete vaccination among the subjects could be critical in the prevention of severe lung disease development. Full dose of Covishield had reduced the severity to very low compared to Covaxin. The relative morbidity in the Covishield fully vaccinated patients is comparatively low. The individuals with various co-morbidities specifically with HTN, DM, and harmful habit of smoking have to be more cautious even after full immunization as there is increased severity of disease in them when compared to general population. Vaccines may offer protection only after completion of two weeks from full immunization (complete 2-doses) along with adequate precautions. Partial immunization from any vaccine (Covishield & Covaxin) does not offer any kind of protection from the virus.

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TABLE-I DISTRIBUTION OF PATIENTS BASED ON VARIOUS PARAMETERS

Variable		Number of patients	Percentage of patients
Age group	18-44 Years	26	23.90%
	45-60 Years	58	53.20%
	> 60 Years	25	22.90%
Gender	Male	68	62.40%
	Female	41	37.60%
Diabetes	Present	36	33%
	Absent	73	67%
Hypertension	Present	32	29.40%
	Absent	77	70.60%
Bronchial asthma	Present	9	8.30%

	Absent	100	91.70%
Coronary artery disease (CAD)	Present	1	0.90%
	Absent	108	99.10%
Cerebral vascular disease (CVD)	Present	3	2.80%
	Absent	106	97.20%
Thyroid Problem	Present	3	2.80%
	Absent	106	97.20%
Harmful habit of smoking	Present	8	7.30%
	Absent	101	92.70%
Vaccine	Covishield	63	57.80%
	Covaxin	46	42.20%
Immunization status	Partially Immunized	67	61.50%
	Fully Immunized	42	38.50%

TABLE-II CT SCORE IN RELATION TO GENDER

Median CT score	Total	5 (0 – 23)
Mean CT Score	Male	6.79 ± 6.7
	Female	5.76 ± 6.2

TABLE-III: DISTRIBUTION OF PATIENTS BASED ON VARIOUS PARAMETERS IN RELATION TO CT SEVERITY INDEX

Variable		CT Severity Index			2	df	pvalue
		Mild (0-8)	Moderate (9-15)	Severe (>15)			
		Number of patients (%)	Number of patients (%)	Number of patients (%)			
Age group (in years)	18-44	25 (96.2%)	01 (3.8%)	0 (0)	16.393	4	0.003
	45-60	32 (55.2%)	19 (32.8%)	07 (12.1%)			
	>60	12 (48.0%)	09 (36.0%)	4 (16.0%)			
Gender	Male	42 (61.8%)	18 (26.5%)	8 (11.8%)	0.57	2	0.752
	Female	27 (65.9%)	11 (26.8%)	3 (7.3%)			
Immunization status	Fully immunized	34 (81.0%)	7 (16.7%)	01 (2.4%)	9.925	2	0.007
	Partially immunized	35 (52.2%)	22 (32.8%)	10 (14.9%)			
Diabetes	Present	16 (44.4%)	16 (44.4%)	4 (11.2%)	9.505	2	0.009
	Absent	53 (72.6%)	13 (17.8%)	7 (9.6%)			
Hypertension	Present	17 (53.1%)	14 (43.8%)	1 (3.1%)	7.924	2	0.019
	Absent	52 (67.5%)	15 (19.5%)	10 (13.0%)			
Asthma	Present	6 (66.7%)	2 (22.2%)	1 (11.1%)	0.098	2	0.952
	Absent	63 (63%)	27 (27.0%)	10 (10.0%)			
CAD	Present	1 (100%)	0 (0)	0 (0)	0.585	2	0.746
	Absent	68 (63%)	29 (26.9%)	11 (10.2%)			
CVD	Present	2 (66.7%)	1 (33.3%)	0 (0)	0.369	2	0.831
	Absent	67 (63.2%)	28 (26.4%)	11 (10.4%)			
Thyroid	Present	2 (66.7%)	1 (33.3%)	0 (0)	0.369	2	0.831
	Absent	67 (63.2%)	28 (26.4%)	11 (10.4%)			
Smoking	Present	5 (62.5%)	3 (37.5%)	0 (0)	1.257	2	0.533
	Absent	64 (63.4%)	26 (25.7%)	11 (10.9%)			

TABLE-IV: DISTRIBUTION OF PATIENTS BASED ON TYPE OF VACCINE IN RELATION TO CT SCORE

Type of Vaccine	CT SCORE						
	N	Mean	Std. Deviation	t	95% Confidence Interval		p-value
					Lower	Upper	
Covishield	63	5.3968	6.37419	-1.907	-4.865	0.094	0.05
Covaxin	46	7.7826	6.55545				

TABLE-V: DISTRIBUTION OF PATIENTS BASED ON IMMUNIZATION STATUS IN RELATION TO CT SCORE

Immunization status	CT SCORE						
	N	Mean	Std. Deviation	t	95% Confidence Interval		p-value
					Lower	Upper	
Covishield fully immunized	22	2.5000	5.56130	-3.485	-10.018	-2.685	0.001
Covaxin fully immunized	27	8.8519	6.91540				
Covishield partially immunized	41	6.9512	6.29663	0.402	-2.7346	4.1107	0.689
Covaxin partially immunized	19	6.2632	5.84848				

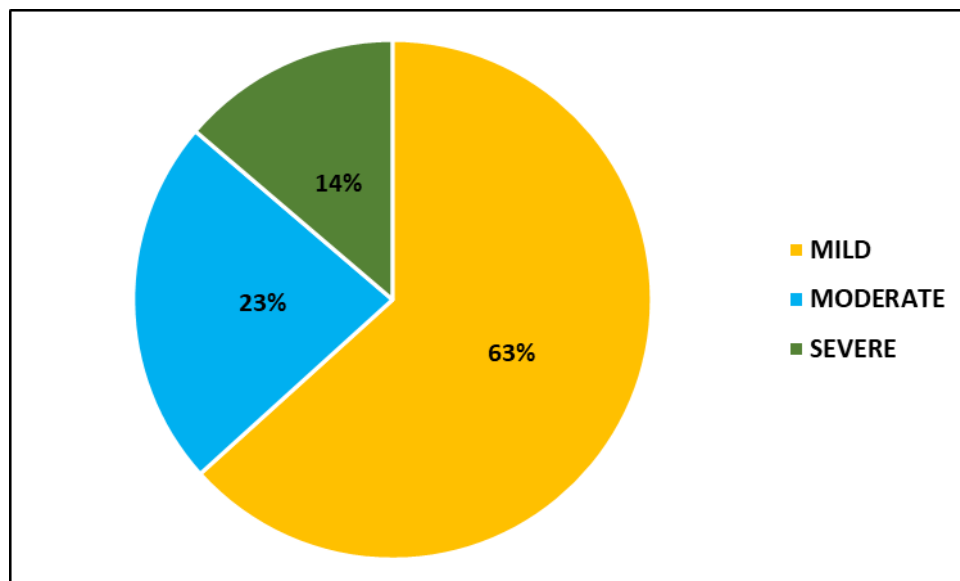
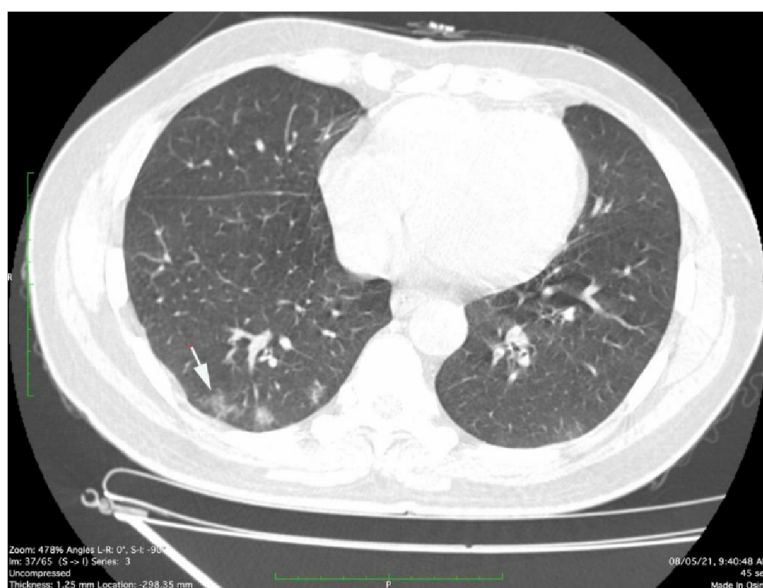
FIGURE-I DISTRIBUTION OF PATIENTS BASED ON CT SEVERITY INDEX**FIGURE-II**

Figure-II: Axial section of HRCT Chest of 56-year-old male after 2 doses of Covishield show focal subpleural ground glass opacities in posterior basal segment of right lower lobe. (CTSI = 2/25)

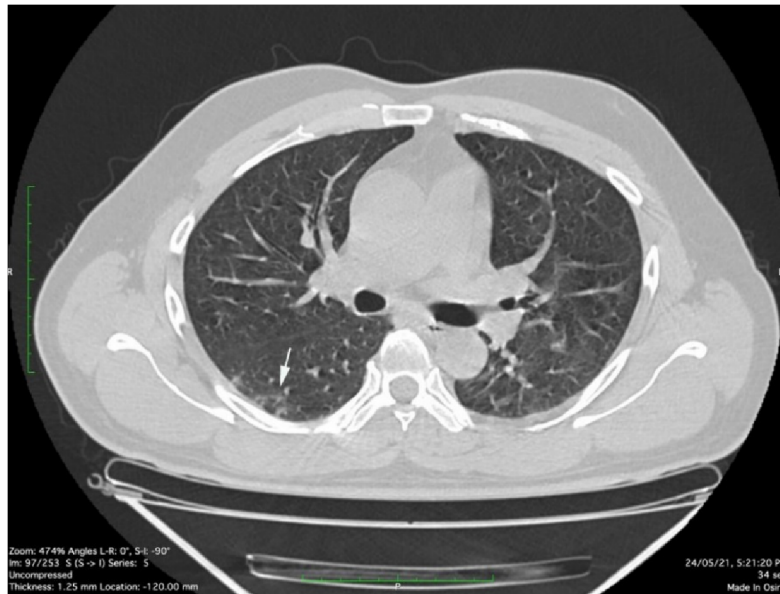
FIGURE-III

Figure-III: Axial section of HRCT Chest of 49-year-old male after 2 doses of Covaxin showing faint ground glass opacities in superior segment of right lower lobe. (CTSI = 6/25)

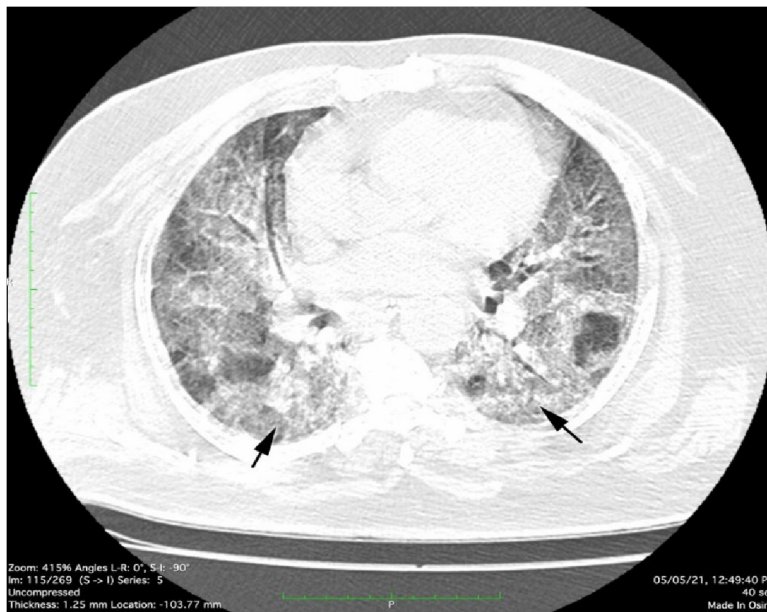
FIGURE-IV

Figure-IV: Axial section of HRCT Chest of 56-year-old male after 1 dose of Covaxin show confluent areas of ground glass opacities with interstitial septal thickening noted diffusely in bilateral lower lobes. (CTSI = 23/25)

FIGURE-V

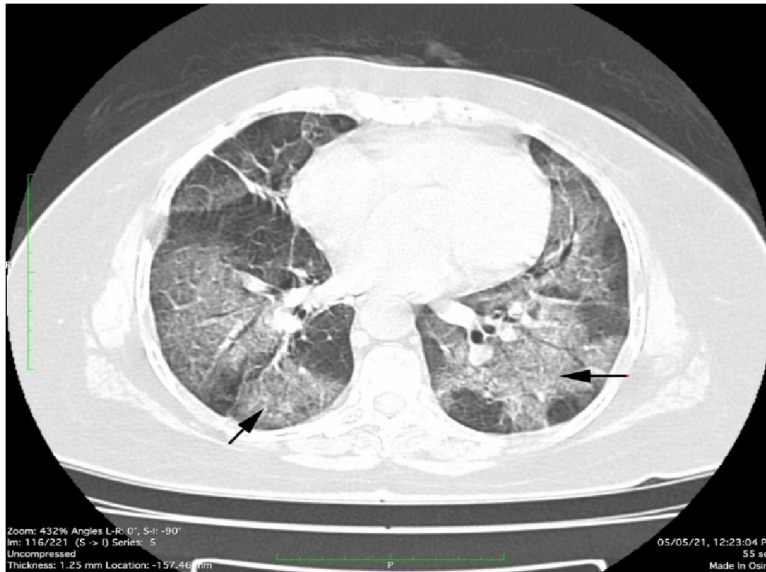


Figure-V: Axial section of HRCT Chest of 61-year-old male after 1 dose of Covishield show confluent areas of ground glass opacities with interstitial septal thickening with peripheral and basal predominance in bilateral lower lobes. (CTSI=21/25)