Radiological evaluation of patients with post vaccination Covid-19 breakthrough infection - A comparative study between Covishield and COVAX in based on CT severity score.

[1]Dr.Pravalya Chaparala, Postgraduate, Department of Radio- Diagnosis,AlluriSitarama Raju Academy of Medical Sciences, Eluru, AndhraPradesh,534005, India.

[2]Dr. Sriramaneni Venkateswar Rao, Professor and Head of Department, Department of Radio- Diagnosis, Alluri Sitarama Raju Academy of MedicalSciences, Eluru, Andhra Pradesh, 534005, India.

[3]Dr.R.Uma Ravalika, Postgraduate, Department of Radio- Diagnosis, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh,534005, India.

Corresponding Authors: Dr. Pravalya Chaparala, Postgraduate, Department of Radio- Diagnosis, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh,534005, India.

How to citation this article: Dr. Pravalya Chaparala, Dr. Sriramaneni Venkateswar Rao, Dr. R. Uma Ravalika, "Radiological evaluation of patients with post vaccination Covid-19 break through infection - A comparative study between Covishield and COVAX in based on CT severity score", IJMACR- February - 2023, Volume – 6, Issue - 1, P. No. 569 – 577.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

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 was 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 ($\geq$ 18 years) inIndia. Even after vaccination the COVID-19 infection spread continues unabated.The main purpose of this research is to study the post-vaccination lung involvement of COVID-19 positive patients based on CT severity scores and to compare Covishield &Covaxin vaccines in relation to the CT severity scores among the COVID-19 positive patients' post-vaccination. This study also determines the association between patients with pre-existing comorbid dities and severity of disease.

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 COVAX in group (7.78 ± 6.5) when compared to Covishield group (5.39 ± 6.3).

Conclusion: Full immunization with Covishield had minimal lung involvement. Complete vaccination among the subjects could be critical in the prevention of severe lung disease development.Vaccines may offer protection

only after completion of two weeks from full immunization (complete 2-doses) along with adequate precautions. Partial immunization (single dose) from any vaccine (Covishield& COVAX in) does not offer any kind of protection from the virus.

List of abbreviations: CT- Computed tomography, RT-PCR- Reverse transcriptase Polymerase Chain Reaction, SARS-CoV-2-severe acute respiratory syndrome corona virus 2, HTN-hypertension,DM-diabetes.

Keywords: Breakthrough, COVAX in, 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 COVID-19 in India was started on January 16, 2021 using two vaccines; Covishield (manufactured by Astra Zeneca) and COVAX in (manufactured by Bharat Biotech)[3].

Covishield is a recombinant, replication-deficient Chimpan zee adenovirus vector encoding the SARS-CoV-2 Spike (S) glycoprotein.Followingadministration,the genetic material of part of corona virus is expressed which stimulates an immune response.[3].

COVAXincontainswhole-virion inactivated SARSCoV-2 antigen (Strain: NIV-2020-770)[3]. At present (October21,2021) about 709 million population in India had received at least 1st dose of vaccine and 296 million population were fully vaccinated.[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 diseaseetc.).

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]

A vaccine breakthrough infection is defined as the detection of SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person ≥14 days after they have completed all recommended doses.Despite of 14 days waiting period post-vaccination, there were RT-PCR positive SARSCoV2 cases reported.[7] There were chances of post-vaccination breakthrough SARSCoV2 infections because COVID-19 vaccines do not offer 100 percent protection.[8] In the present study an attempt was made to study the post-vaccination lung involvement of COVID-19 positive patients based on CT severity scores, to compare COVISHIELD and COVAXIN vaccines in relation to the CT severity scores among the COVID-19 positive patients' post-vaccination and to determine the association between patients with pre-existing comorbidities and severity of disease.

Methods

A hospital based, analytical retrospective cross-sectional study was conducted in the Department of Radio-diagnosis among patients aged 18 years & above, irrespective of gender and who were admitted at Andhra

Pradesh state covid hospital (ASRAMS, West Godavari District, Andhra Pradesh)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 COVAX in) and persistence of symptoms for more than 5 days before the initial CT examination were included in the study. Patients who are not willing to give consent even after counselling and with serious illness or cognitive disorders were excluded from the study. The study was conducted for a period of 3 months (15[th]April 2021 to 15[th]July 2021). For retrospective review of patients' medical records, no prior Institutional EthicalCommittee (IEC) approval was needed.

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 %. The calculated sample size was $\geq$ 100, in the present study about one hundred and nine (109) patients RT-PCR positive for COVID-19 post-vaccination were included.A written informed consent was obtained from the patients before including their details in the study. Data collection was carried out using a standardized predesigned proforma. Initially, data regarding all the vaccinated patients who were admitted was identified from the medical records, permission was obtained from the concerned departments after explaining the study details. Consent from all the department heads involved was obtained. Later, IEC approval was obtained from Alluri Sitarama Raju Ethics Committee.

Computed tomography (CT) chest scan for the admitted individuals was done using ge revolution act ct machine (32 slice) with a low dose exposure protocolduring the study period.The CT severity score (0-15) was categorized into three groups i.e., mild ($\leq$8); moderate (9-14); severe ($\geq$15).[9]Image Analysis was done by two radiologists (in the fifth year of practice), reviewed the CT chest examinations to identify the observations described in the clinical radiology reports. The collected data was entered in Microsoft Excel-2019 and analyzed using statistical package SPSS trial version-22. The data was represented in percentages, tables and figures. Relevant statistical tests were applied where necessary.

Results

In the present study, about 109 post-vaccination breakthrough RT-PCR positive for COVID-19 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 $\pm$ 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 COVAX in. Among the 109 patients, 57.8% received Covishield vaccine and 42.2% received COVAX in 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 (0-25) among the post-vaccination COVID-19 positive patients. Among males the mean CT score was 6.79 $\pm$ 6.7 and females was 5.76 $\pm$ 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 COVAX in groups, there was statistically significant difference between the two vaccine groups. There was high mean CT score in COVAX in 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 COVAX in group patients based on immunization status in relation to CT score, there was statistically significant difference between fully immunized Covishield and fully immunizedCOVAX in groups with high mean CT score in COVAX in 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 COVAX in groups in relation to CT score (Table-V; Figure-III & IV).

Table 1: 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%
	COVAX in	46	42.20%
Immunization status	Partially Immunized	67	61.50%
	Fully Immunized	42	38.50%

Table 2: ct score in relation to gender

Median CT score	Total	5 (0 – 25)
Mean CT Score	Male	6.79 ± 6.7
	Female	5.76 ± 6.2

Figure 1: distribution of patients based on ct severity index
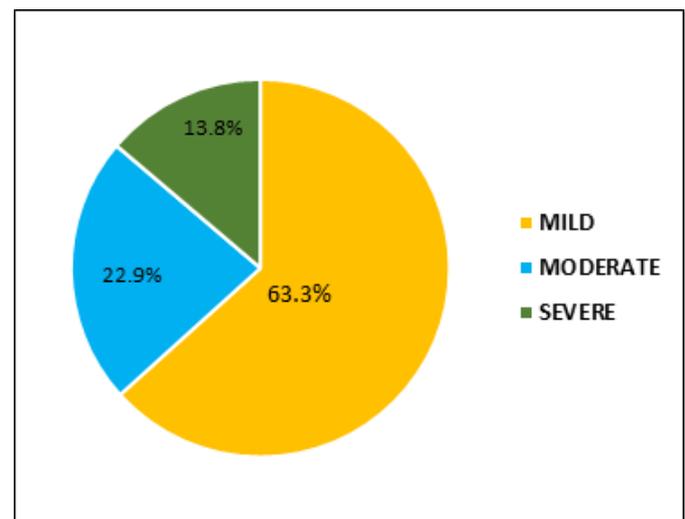
Table 2: distribution of patients based on various parameters in relation to ct severity index

Variable		CT Severity Index			χ^2	df	p-value
		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 3: 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 4: 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
COVAX in fully immunized	27	8.8519	6.91540				
Covishield partially immunized	41	6.9512	6.29663	0.402	-2.7346	4.1107	0.689
COVAX in partially immunized	19	6.2632	5.84848				
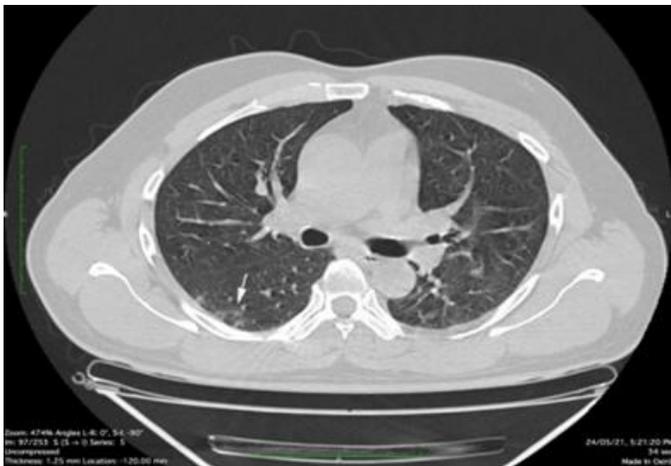
Figure 2: Axial section of HRCT Chest of 49-year-old male after 2 doses of Covishield showing faint ground glass opacities in superior segment of right lower lobe. (CTSI = 2/25).

Figure 3: Axial section of HRCT Chest of 56-year-old

male after 2 doses of Covaxin show focal subpleural ground glass opacities in posterior basal segment of right lower lobe. (CTSI = 6/25)

Figure 4: Axial section of HRCT Chest of 56-year-old male after 1 dose of Covaxinshow confluent areas of ground glass opacities with interstitial septal thickening noted diffusely in bilateral lower lobes. (CTSI = 23/25)

Figure 5: Axial section of HRCT Chest of 61-year-old male after 1 dose of Covishield shows confluent areas of ground glass opacities with interstitial septal thickening with peripheral and basal predominance in bilateral lower lobes. (CTSI=21/25)

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,20.1% of the patients received 2 doses of Covishield vaccine & 24.7% received 2 doses COVAX invaccine; 37.6% of the patients received single dose or partial immunisation of Covishield vaccine & 17.4% received single dose or partial immuneisation of Covaxin vaccine.

In a total of 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 and5.3% 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 ML 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 GCet al.[12] among 274 patients with confirmed breakthrough infections, 12.8%individuals received Covaxin and 87.2% individuals received Covishield. These variations in type of vaccine received and immune zation 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 byLakhia RTet al.[13]and Pilishvili Tet 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 Pet al.[15]studystated 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 COVAX in 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 COVAX in with 2 doses. The severity was very minimal in case of fully immunized individuals when compared to partially immunized.

Limitations

These results represent the sample involved and may not be generalized, as the sample size was minimum.

Conclusions

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.

References

1. Government of India Ministry of Health& Family Welfare. Covid 19 Vaccines Operational Guidelines [Internet]. Covid19vaccineog111chapter16.Pdf. 2020 [Cited 2021jul3]. Available from: https://www.mohfw.gov.in/pdf/COVID19VaccineOG111Chapter16.pdf.

2. Birhane M, Bressler S, Chang G, Clark T, Do rough L, Fischer M, et al. Covid-19 vaccine breakthrough infections reported to CDC — United States, January 1–April 30, 2021. MMWR Morbidity and Mortality Weekly Report. 2021;70(21):792–3.

3. Government of India Ministry of Health & Family Welfare. Cumulative Coverage Report of Covid-19 Vaccination [Internet]. Cumulative Covid Vaccination Report. 2021 [Cited2021 oct]. Available from:https://www.mohfw.gov.in/pdf/CummulativeCovid VaccinationReport21 October 2021.pdf. https://www. serum institute.com/health_ FAQ _ Covi shield.Php#faq1https://www. Bharat biotech.com/images/ COVAX in/ COVAX in – factsheet.pdf

4. Tyagi K, Ghosh A, Nair D, Dutta K, Singh Bhandari P, Ahmed Ansari I, et al. Breakthrough COVID19 infections after vaccinations in healthcare and other workers in a chronic care medical facility in New Delhi, India. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2021;15(3):1007–8.

5. Lee EY, Ng M-Y, Khong P-L. Covid-19 pneumonia: What has CT taught us? The Lancet Infectious Diseases. 2020;20(4):384–5.

6. Ng M-Y, Lee EY, Yang J, Yang F, Li X, Wang H, et al. Imaging profile of the COVID-19 infection: Radiologic findings and literature review. Radiology: Cardiothoracic Imaging. 2020;2(1).

7. Hacisuleyman E, Lifton R, Gaebler C, Muecksch F, DaSilva J, Schaefer-Baba Jew DJ, et al. Vaccine breakthrough infections with SARS-COV-2 variants. New England Journal of Medicine. 2021;385(2).

8. Baden LR, El Sahly HM, Essink B, Kotloff K, Frey S, Novak R, et al. Efficacy and safety of the mrna-1273 SARS-COV-2 vaccine. New England Journal of

Medicine. 2021;384(5):403–16.

9. Sanjay P, Nanjaraj CP, Lingaiah RKN, Moorthy S, Shaji S, Madhu S, et al. Role of Artificial Intelligence in Quantification of Covid 19 Pneumonia [Internet]. ijcmsr_521_v1.pdf. 2021 [cited 2021Jul16]. Available from: https: // www. ijcmsr. Com / uploads /1/0/2/7/102704056 /ijcmsr_521_v1.pdf.

10. Brinkley-Rubinstein L, Peterson M, Martin R, Chan P, Berk J. Breakthrough SARS-CoV-2 infections in prison after vaccination. N Engl J Med. 2021;385(11):1051–2.

11. Bergwerk M, Gonen T, Lustig Y, Amit S, Lips itch M, Cohen C, et al. Covid-19 breakthrough infections in vaccinated health care workers. N Engl J Med [Internet]. 2021;(NEJMoa2109072). Available from: http://dx.doi.org/10.1056/NEJMoa2109072.

12. Dash GC, Subhadra S, Turuk J, Parai D, Rath S, Sabat J, et al. Breakthrough SARS-CoV-2 infections in an eastern state of India: A preliminary report [Internet]. Research Square. 2021. Available from: https://assets. Researchsquare.com/files/rs-649914/v2/31bf21ec-6f3e-47a2-937d-c2bf65628db5.pdf?c=1631885139.

13. Lakhia RTrivedi JR. The CT scan lung severity score and vaccination status in COVID-19 patients in India: Perspective of an independent radiology practice [Internet]. BioRxiv. 2021 [cited 2021 July 8]. p. 2021.07.15.21260597. Available from: https://www.medrxiv.org/content/10.1101/2021.07.15.21 260597v2.full-text.

14. Pilishvili T, Fleming-Dutra KE, Farrar JL, Gierke R, Mohr NM, Talan DA, et al. Interim estimates of vaccine effectiveness of Pfizer-BioNTech and Moderna COVID-19 vaccines among health care personnel - 33 U.s. sites, January-march 2021. MMWR Morb Mortal Wkly Rep. 2021;70(20):753–8.

15. Kale P, Gupta E, Bihari C, Patel N, Rooge S, Pandey A, et al. Clinic genomic analysis of breakthrough infections by SARS CoV2 variants after ChAdOx1 nCoV- 19 vaccination in healthcare workers [Internet]. BioRxiv. 2021 [cited 2021 July 8]. p. 2021.06.28.21259546. Available from: https://www.medrxiv.org/content/10.1101/2021.06.28.21 259546v1.