Original Article

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Chest HRCT Assessment of COVID-19 Patients in Vaccinated Versus Non-Vaccinated Patients in a Tertiary Care Hospital in Nepal

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Abstract

Background: The World Health Organization (WHO) has recommended the use of chest HRCT as a component of the diagnostic process for COVID-19 disease whenever Reverse Transcription-Polymerase Chain Reaction (RT-PCR) testing is unavailable; in cases of delayed test results; or in suspected cases with initial negative RT-PCR test results. The study's aims were to assess the severity of lung involvement in COVID-19 infection using HRCT scans and to compare the chest CT severity scores in vaccinated and unvaccinated COVID-19 patients in perspective of the usefulness of HRCT scores in doing so. **Subjects and Methods:** This study included imaging and hospital data from COVID 19 patients who were treated at a tertiary hospital's and underwent HRCT in Department of Radiodiagnosis between the months of April and December 2021. The study subjects were the COVID 19 patients with HRCT reports and known COVID vaccination status. The HRCT results of the study population were evaluated and recorded separately by radiologist with a experience in chest radiology. The involvement of the right upper, middle, and lower lobes as well as the left upper and lower lobes was scored separately to get the CT severity score. All patients clinical and demographic profiles were retrieved from the hospital database. The student t test, Chi square test, and Fisher exact test were used to test for associations. P values under 0.05 were regarded as significant. **Results:** In our study, 77.6% of patients non-vaccinated and 22.4% were vaccinated for COVID-19. Out of 195 vaccinated patients, 134 patients had received single dose (15.3%) and 62 have received two doses (7.1%) of COVID-19 vaccine. In our study, the CT severity score, among vaccinated patients was severe, moderate and mild in 12.8%, 23.5% and 20.0% respectively. Also, the CT severity score, among non-vaccinated patients was severe, moderate and mild in 27.9%, 18.9% and 14.8% respectively. The most common finding seen in our study was ground glass opacities among vaccinated patients (30.7%), whereas both (GGO and consolidation) was most common findings in non-vaccinated patients (34.8%). **Conclusion:** In this retrospective study, patients who received the SARS-CoV-2 vaccine (either single or both doses) had lower CT severity scores than non-vaccinated patients. The most accurate method for determining the severity of COVID-19 pneumonia is HRCT.

Keywords: Vaccinated, non-vaccinated, HRCT, COVID-19, retrospective.

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Introduction

The coronavirus strain SARS-CoV-2, which causes the pandemic known as Coronavirus Disease-2019 (COVID-19), ranges from a mild clinical course to severe COVID-19 pneumonia with or without acute respiratory distress syndrome (ARDS).[1] By doing a High Resolution Computed Tomography (HRCT) scan of the lungs, it is possible to assess the degree and severity of pulmonary involvement in COVID-19 pneumonia.[2] The 25-point HRCT score and the clinical severity of COVID-19 infection have a good correlation.[3] Recent evidence suggests that the chest computed tomography (CT) score, in addition to significantly correlating with laboratory measurements and oxygen requirements, can predict the course of COVID-19 disease.[4,5] The World Health Organization (WHO) has recommended the use of chest HRCT as a component of the diagnostic process for COVID-19 disease whenever Reverse Transcription-Polymerase Chain Reaction (RT-PCR) testing is unavailable; in cases of delayed test results; or in suspected cases with initial negative RT-PCR test results. The current global methods emphasize preventing virus transmission through social distance, the use of masks, and the encouragement of widespread vaccination.[5]

There are two major ways that vaccines work. They can either completely stop infection from happening or they can stop the progression of infection into symptomatic disease. A large portion of a vaccine's efficacy may be conclusively evaluated in patients infected with COVID-19 in the postvaccination phase, determining whether vaccinations are useful in preventing infection or are helpful in reducing the disease severity, hence preventing mortality, even though the vaccine efficacy has been examined via vaccine trials prior to general use.[6] The study's aims were to assess the severity of lung involvement in COVID-19 infection using HRCT

scans and to compare the chest CT severity scores in vaccinated and unvaccinated COVID-19 patients in perspective of the usefulness of HRCT scores in doing so.

Subjects and Methods

This study included imaging and hospital data from COVID 19 patients who were treated at a tertiary hospital and underwent HRCT in Department of Radiodiagnosis between the months of April and December 2021. Reverse transcription polymerase chain reaction [RTPCR] positive COVID 19 patients with HRCT data and known COVID vaccination status served as the study's participants. Patients who simultaneously displayed negative HRCT alterations and a negative RTPCR report despite clinical suspicion were not included in the study. This study used data from hospitals and imaging centres. Since the patients had already undertaken the necessary investigations for clinical needs, a consent waiver was acquired. The HRCT results of the study population were evaluated and recorded separately by radiologist with a experience in chest radiology. The senior radiologist's judgement prevailed in cases of disagreement. The main way that HRCT results were recorded was by classifying lung involvement into mild, moderate, and severe categories. The involvement of the right upper, middle, and lower lobes as well as the left upper and lower lobes was scored separately to get the CT severity score. One point was awarded for lobe engagement below 5%, two points for involvement between 6 and 25%, three points for involvement between 26 and 50%, four points for involvement between 51 and 75%, and five points for involvement of more than 75%. A total score of up to eight was designated as a mild disease, nine to eighteen as a moderate disease, and 19 to 25 as a severe disease [4,7]. All patients' clinical and demographic profiles were retrieved from the hospital database. The provisional/final vaccination certificate issued by the Government of Nepal verified the patient's vaccination history.

Statistical analysis

The mean and median were used to measure continuous variables. Frequency and percentages were explored for categorical variables. It was analysed how demographic and radiological characteristics relate to one another. The student t test, Chi square test, and Fisher exact test were used to test for associations. P values under 0.05 were regarded as significant. SPSS 17.0 was used to perform all statistical analyses.

Results & Discussion

In our study, 77.6% of patients non-vaccinated and 22.4% were vaccinated for COVID-19. Out of 195 vaccinated patients, 134 patients had received single dose (15.3%) and 62 have received two doses (7.1%) of COVID-19 vaccine [Table 1].

Table 1. Vaccination status for COVID-19 among enrolled patients.

Vaccination status	Frequency	%
Non-vaccinated	676	77.6
Vaccinated	195	22.4
Single dose	134	15.3
Two doses	62	7.1

In present study, vaccinated and non-vaccinated males were 62.1% and 58.4% respectively. Mean age of the vaccinated and non-vaccinated patients was 48.9±15.6 years and 59.2±11.5 years respectively. Among vaccinated patients, 62.1% were having any comorbidity whereas, 75.3% of non-vaccinated patients were having any comorbidity [Table 2].

Table 2. Baseline characteristics among vaccinated and non-vaccinated patients.

Variables	Vaccinated (n=195)	Non vaccinated (n=676)
	Frequency (%)	Frequency (%)
Gender		
Male	121 (62.1)	395 (58.4)
Female	74 (37.9)	281 (41.6)
Age in years (mean±SD)*	48.9±15.6	59.2±11.5
Age group (in years)*		
<40	13 (6.7)	46 (6.8)
41-50	104 (53.3)	182 (26.9)
50-60	39 (20.0)	134 (19.8)
>60	39 (20.0)	314 (46.5)
Comorbidity*		
Yes	121 (62.1)	509 (75.3)
No	74 (37.9)	167 (24.7)
Type of Comorbidities#*		
Diabetes mellitus	68 (23.5)	189 (27.9)
Hypertension	53 (39.4)	203 (30.1)
COPD/ILD	27 (13.8)	47 (6.9)
Others	10 (5.1)	80 (11.8)

#Multiple responses, *p<0.05

Cough and fever were the most common presenting complaints among vaccinated (52.3% having cough and 24.1% having fever) and non-vaccinated patients (34.1% having cough and 31.3% having fever). The mean duration of illness among vaccinated patients (5.2±3.4 days) was lesser as compared with non-vaccinated patients (8.3±7.6 days) [Table 3].

Table 3. Clinical characteristics among vaccinated and non-vaccinated patients.

Variables	Vaccinated (n=195)	Non vaccinated (n=676)
	Frequency (%)	Frequency (%)
Signs/Symptoms#*		
Fever	47 (24.1)	212 (31.3)
Cough	102 (52.3)	231 (34.1)
Malaise	31 (15.8)	87 (12.8)
Dyspnea	13 (6.6)	112 (16.5)
Others	16 (8.2)	45 (6.6)
Duration of illness in days (mean ± SD)*	5.2±3.4	8.3±7.6

#Multiple responses, *p<0.05

The HRCT showed that lungs were involved bilaterally in

more than half of vaccinated (55.3%) and non-vaccinated patients (61.5%). The HRCT was indeterminate in 28.3% of vaccinated patients and 15.9% of non-vaccinated patients. 12.8% of vaccinated patients with typical HRCT had score as severe whereas 27.9% of non-vaccinated patients with typical HRCT had score as severe. The most common finding seen in our study was ground glass opacities among vaccinated patients (30.7%), whereas both (GGO and consolidation) was most common findings in non-vaccinated patients (34.8%) [Table 4].

Table 4. HRCT findings among vaccinated and non-vaccinated patients.

Variables	Vaccinated (n=195)	Non vaccinated (n=676)
Lungs affected*	Frequency (%)	Frequency (%)
Unilateral	55 (28.0)	108 (15.9)
Bilateral	108 (55.3)	416 (61.5)
Not affected	32 (16.7)	152 (22.6)
Disease severity*		
Typical	108 (55.3)	416 (61.6)
Atypical	23 (11.8)	87 (12.9)
Indeterminate	55 (28.3)	108 (15.9)
Negative	9 (4.6)	65 (9.6)
Severity score in typical disease severity*		
Severe	25 (12.8)	189 (27.9)
Moderate	46 (23.5)	128 (18.9)
Mild	39 (20.0)	99 (14.8)
Pattern in typical disease severity*		
Both	32 (16.4)	234 (34.8)
Consolidation	16 (8.2)	101 (14.9)
GGO	60 (30.7)	81 (11.9)
Lung involvement in typical disease severity		
Diffuse*	42 (21.5)	233 (34.4)
Hilar	10 (5.1)	66 (9.8)
Peripheral	56 (28.7)	117 (17.4)
Axial opacity distribution in typical disease severity*		
Peripheral	42 (21.5)	233 (34.4)
Central	10 (5.1)	66 (9.8)
Both	56 (28.7)	117 (17.4)

*p<0.05

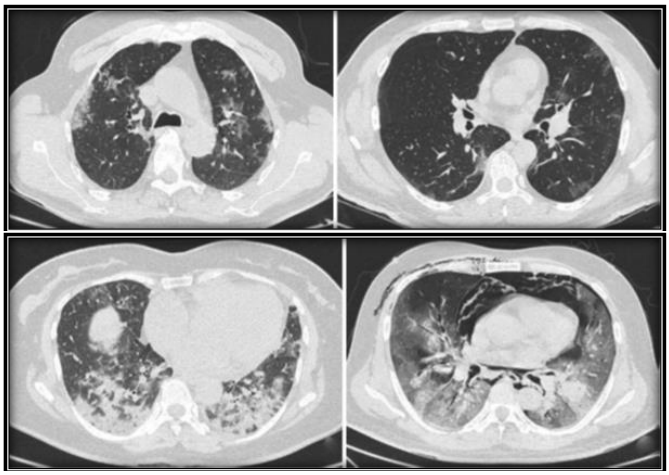

Figure 1: Axial sections of HRCT of the thorax of vaccinated patients (a and b) and non-vaccinated patients (c and d)

[Figure 1] shows peripherally placed ground glass opacities with interstitial thickening among vaccinated patients (a and b), whereas extensive diffuse ground glass opacities with interstitial thickening and peripheral basal consolidations was seen in non-vaccinated patients. Also, associated Pneumomediastinum and subcutaneous emphysema seen was seen in non-vaccinated patients (c and d).

HRCT severity score of severe moderate and mild degree was observed in 4.8%, 12.9% and 29.0% of patients vaccinated with two doses respectively. HRCT severity score of severe moderate and mild degree was observed in 15.7%, 28.3% and 14.9% of patients vaccinated with single dose respectively [Table 5].

Table 4. HRCT findings among vaccinated and non-vaccinated patients.

Severity score in typical disease severity*	Two doses (n=62)	Single dose (n=134)
	Frequency (%)	Frequency (%)
Severe	3 (4.8)	21 (15.7)
Moderate	8 (12.9)	38 (28.3)
Mild	18 (29.0)	20 (14.9)

*p<0.05

There is currently no fully effective treatment for the highly infectious disease COVID-19. Therefore, early diagnosis, containment measures, and other preventive efforts are crucial for the control of this disease. When displaying COVID-19 lung alterations, HRCT is superior. As a result, it might be considered a primary diagnostic test, particularly during pandemics.[8] It is more capable of identifying these subtle changes than plain chest radiography. Additionally, it misses COVID-19 diagnoses less frequently.[9] To observe the impact of the vaccine on the CT severity score, we conducted a cross-sectional research of COVID-19 patients who had received the vaccine and those who had not. In our study, among patients who had received vaccinations, the CT severity score was severe, moderate, and mild in 12.8%, 23.5%, and 20.0% of cases, respectively. Additionally, among non-vaccinated individuals, the CT severity score was severe, moderate, and mild in 27.9%, 18.9%, and 14.8%, respectively. Additionally, Verma et al., reported that patients who received the SARS-CoV-2 vaccine had lower CT severity scores than those who did not. However, in their study, there was no statistically significant difference in the mean CT score between the vaccinated and non-vaccinated groups (p=0.353).[10] In addition, Naik et al., found that the vaccination group's CT severity scores were lower than those of the unvaccinated group. As vaccination helps to defend against the virus and lessens the severity of lung involvement, chances of contracting COVID-19 are decreased.[11] According to a study by Kachewar et al., younger people were more likely than elderly individuals to test positive for COVID following vaccination.[12] Modi et al., found that non-vaccinated patients with comorbidity have higher CT severity scores than vaccinated patients with comorbidities in a study of 274 individuals. They found that

vaccinated patients outlive non-vaccinated individuals in terms of survival.[13] According to Joshi et al., analysis of 3,235 patients, even among patients who contracted the infection after receiving the vaccination, the CT severity score was lower than it was for unvaccinated patients. They also came to the conclusion that patients who had received vaccinations had more mild illnesses than those who had not.[14] According to Vishwanath et al., HRCT is useful for quantifying lung involvement and determining the severity of COVID-19. In these cases, they found that vaccinations assist to lessen the severity of lung involvement.[15] 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. [16,17,18,19,20] In our study, ground glass opacities were the most prevalent finding in vaccinated patients (30.7%), while consolidation and GGO were the most prevalent results in non-vaccinated individuals (34.8%). The outer regions of the lung parenchyma are more frequently affected by GGO. More typically, lower lobes are affected. When intralobular lines are visible and appear at the same time, it can sometimes appear like a crazy paving pattern. This is regarded as the COVID-19 pneumonia's "typical look." The phrase "indeterminate appearance" refers to the lack of distinguishing characteristics as well as the existence of multifocal, diffuse, perihilar, or unilateral ground-glass opacities with or without consolidation that lack a defined distribution and are non-rounded or non-peripheral. When COVID-19 pneumonia exhibits isolated lobar or segmental consolidation without GGOs, discrete small nodules (centrilobular, "tree-in-bud" appearance), lung cavitation, and smooth interlobular septal thickening with pleural effusion, it is referred to as "atypical" COVID-19 pneumonia. The detection of this disease's consequences is another area in which HRCT is absolutely essential. In a confirmed COVID-19 patient, the development of bilateral opacities indicative of pulmonary oedema is thought to be diagnostic for the onset of ARDS. When lobar accumulation is detected on a chest CT, bacterial pneumonia is presumed to be superimposed. A plausible explanation for pericardial effusion on CT imaging could be cardiac injury brought on by COVID-19.[21]

Limitations

Our study was limited as it did not record certain additional characteristics, such as follow-up patients and levels of physical activity, which would have had an impact on how severely SARSCoV-2 impacted the pulmonary parenchyma. The study excluded patient mortality, which can demonstrate the degree of a disease's involvement. Additionally, the majority of the patients in this study were from the same region. The analysis of serial scans was not taken into account.

Conclusion

In this retrospective study, patients who received the SARS-CoV-2 vaccine (either single or both doses) had lower CT severity scores than non-vaccinated patients. The most accurate method for determining the severity of COVID-19 pneumonia is HRCT. When compared to the vaccinated group, where only 12.8% of participants had severe lung involvement, the unvaccinated population has a higher prevalence of severe lung involvement (27.9%).

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