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Original Article

Radiographic Findings of Lung CT Scans of COVID-19 Patients: Delta and Omicron Variants

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ABSTRACT

Objective: The present study was designed with the aim of comparing the radiological findings of the CT scan of the lungs of patients with Delta and Omicron variants of COVID-19 hospitalized in the intensive care unit.
Methods: This was a retrospective comparative study conducted during the fifth peak of COVID-19 in Iran, August to November 2021 (the predominance of Delta variant) and March to April 2022 (the predominance of Omicron variant) in Qom, Iran. Radiologic findings of lung CT scans reported by a single radiologist were compared between these two cohorts. To analyze the collected data, SPSS version 22 statistical software is used through chi-square or fisher exact test, independent t-test, and Mann-Whitney test. A p-value of lower than 0.05 was considered as statistically significant.
Results: The total number of 50 patients in Delta (mean age of 58.68±14.77 years, 56% male) and 46 patients in Omicron (mean age of 70.45±18.02 years, 47% male) periods were included in study. Lesions of Right middle lobe (RML), left upper lobe (LUL), and Lingual lobes were more common in Delta period than Omicron (P<0.05). GGOs were more common in Delta period than in the Omicron (P=0.013). There were no Unilateral GGOs during the Delta period, while 9 of 32 (28.1%) patients having GGO lesions in Omicron era had unilateral ones (P<0.001). Peripheral lesion was not differentiating Omicron from Delta. Crazy Pavings, Parenchymal bands, Halo signs, and Pleural effusions were more common in omicron period than in the Delta (P<0.05). Total Chest CT severity score was statistically higher in Delta period (22.75±5.24 units) than Omicron period (13.97±9 units).
Conclusion: There were the significant differences in the radiologic characteristics between the two variants. This study suggests that with evolving the virus variants, while severity of lung involvement has decreased, GGOs of COVID-19 might have tended to manifest as unilateral lesions with more specific radiographic features.

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GRAPHICAL ABSTRACT

Introduction

More than three years passing the COVID-19 pandemic, SARS-Cov2 variants, population immunity, treatment approaches have gradually evolved and various shapes of disease have emerged during the time. Based on the virus structural proteins, literature has introduced different eras of pandemic like pre-Delta, Delta, and Omicron, as the time points where COVID-19 faces have changed, while recombinant variants were also cited to emerge [1]. COVID-19 variants have evolved during the years passing the pandemic and various differences in pattern of disease with various symptoms ranging from classic symptoms of fever and pulmonary symptoms to extrapulmonary ones [2, 3]. Likewise, its epidemiological findings [4] have been emerged. In case of transmissibility, Omicron variant is more transmissible than the Delta variant [5]. It has shown a rapid surge in cases of Omicron and has become the dominant variant in many regions, including the United States [6]. Both variants of Delta and Omicron have shown some ability to evade immunity conferred by previous infections and vaccinations. However, the level of immune escape may differ between the Omicron and Delta variants [7]. Different patterns of lung damages have been seen in COVID-19 patients [8]. Some studies have illuminated differences in symptoms of COVID-19 during these different periods of COVID-19 pandemic [9, 10]. Upper respiratory symptoms have reported to be increased during the predominance of Omicron variant [9, 10]. In addition, the efficacy of the vaccines might have been changed with conversions of the variants [11] and some reports have demonstrated differed severity of the disease [12]. Our clinical practice, diagnosis, and management of COVID-19 patients have further evolved as the same time with this narration. Although the RT-PCR laboratory test is used as the gold standard for diagnosing COVID-19, imaging methods such as chest x-ray, CT scan, and ultrasound are also used for initial diagnosis, follow-ups, and diagnosing possible complications [13, 14]. The most common radiological findings reported in COVID-19 lung infection are Ground Glass Opacity (GGO) lesions with or without pulmonary consolidation, preferably involving the subpleural areas and the base of the lungs. Other significant radiological findings include Crazy Paving halo sign and reticular infiltrates [15, 16]. As a result, as CT scan of the chest are being frequently used in initial diagnosis of the COVID-19 and its follow-ups, it is necessary to study radiological manifestations of different emerging variants of COVID-19.

Most studies comparing the differences of manifestations of SARS-CoV2 variants infections are based on the initial diagnostic manifestations and less consideration is regarded to differences in manifestations of severe cases of COVID-19. Therefore, the present study aims to compare the radiological findings of CT scan of the lungs of patients with delta variant and Omicron COVID-19 hospitalized in the intensive care unit of Shahid Beheshti-Amirul Mominin Hospital Complex in Qom.

Materials and Methods

This study was a retrospective comparative study conducted during the fifth peak of COVID-19 in Iran, August to November 2021 (the predominance of Delta variant) and March to April 2022 (the predominance of Omicron variant). All patients included in the study or their family members signed the consent form about being acknowledged about purpose of the study. The protocol of the project was approved by the Ethics Committee of the university with no. IR.MUQ.REC.1401.095.

Sampling method was performed by simple available selection method from patients admitted to ICU ward of Shahid Beheshti-Amir al-Momenin Hospital, Qom, during the Delta and Omicron periods. Inclusion criteria include were a positive PCR test and intensive care unit hospitalization. Patient record had to have a primary CT scan to be included in study. All CT scans had to be performed in our hospital for inclusion. Patients with missing data regarding the demographics and ICU hospitalization detail were excluded in this study. As the exclusion criteria, patients who or their families did not want to participate were not included in the study. Patients' hospital records were queried for age, sex, and duration of ICU stay. The CT scans of patients were reviewed and reported by a single radiologist. A pre-designed checklist of reporting radiologic findings of CT scans was provided for the radiologists that included area of lesions, the characteristics of ground glass opacities (GGO) including the area and peripherality, presence of nodules, Crazy paving, Consolidation, Parenchymal band, Halo sign, Spider web sign, Vascular thickening, Pleural effusion, and Lymphadenopathy. Chest CT severity score was calculated based on the degree of involvement.

Statistical analysis

To analyze the collected data, SPSS version 22 statistical software is used through chi-square or fisher exact test, independent t-test, and Mann-Whitney test. A p-value of lower than 0.05 was considered statistically significant.

Results and Discussion

The total number of 96 patients, 50 in Delta and 46 in Omicron periods, were included in study. As listed in Table 1, the mean age range of participants was 70.45±18.02 in Omicron period and 58.68±14.77 in Delta period that showed a statistically significant higher average age of ICU admitted patients during the Omicron period (P=0.001).

Gender was equally distributed between two groups of Omicron and Delta (P=0.276). ICU stay length was not statistically different among the study groups (P=0.161). Lesions of Right middle lobe (RML), left upper lobe (LUL), and Lingual lobes were more common in Delta period than Omicron (P<0.05).

GGOs were more common in Delta period than in the Omicron (P=0.013). All GGOs were multifocal. There were no Unilateral GGOs during the Delta period, while 9 of 32 (28.1%) patients with GGO lesions in Omicron era had unilateral ones (P<0.001). No differences were observed for centrality or peripherality of GGOs in lungs of study groups (P=0.329). Nodule without margins was more prevalent than margin enhanced noodles in all patients, irrespective of the group. Crazy Pavings, Parenchymal bands, Halo signs, and Pleural effusions were more common in omicron period than in the Delta (P<0.05). However, the total Chest CT severity score was statistically higher in Delta period (22.75±5.24 units) than Omicron period (13.97±9 units), with p-value of <0.001, irrespective of the gender.

The current study evaluated the similarities and differences of patients during the delta and omicron periods of the COVID-19 pandemic in terms of radiological findings.

Table 1: The main characteristics of included patients

		Omicron (n=46)		Delta (n=50)		P-value
		mean/n	SD/%	mean/n	SD/%	
Age (years old)		70.45	18.02	58.68	14.77	0.001
Male gender (n)		22	47	28	56	0.276
ICU hospitalization length (days)		4.81	8.01	7.38	9.78	0.161
Area (n)	RLL	36	85.7	46	92	0.335
	RML	30	76.9	46	92	0.046
	RUL	31	77.5	46	92	0.052
	LLL	36	85.7	47	94	0.183
	Lingual	26	66.7	46	92	0.003
	LUL	28	71.8	46	92	0.012
GGO presence (n)		32	69.56	45	90	0.013
GGO side (n)	Unilateral	9	28.1	0	0	<0.001
	Bilateral	23	71.9	45	100	
GGO direction (n)	central	2	6.9	2	4.8	0.329
	Peripheral	8	27.6	6	14.3	
	All three	19	65.5	34	81	
Multifocal GGO (n)		32	100	45	100	-
Nodules (n)	No nodule	24	63.2	38	79.2	0.198
	nodule with margins	3	7.9	1	2.1	
	nodule without margins	11	28.9	9	18.8	
Crazy paving (n)		17	39.5	35	71.4	0.002
Consolidation (n)		32	71.1	38	77.6	0.474
Parenchymal band (n)		31	70.5	23	46	0.017
Halo sign (n)		12	26.7	4	8	0.015
Spider web sign (n)		5	11.1	7	14	0.672
Vascular thickening (n)		16	35.6	14	28.6	0.468
Pleural effusion (n)		17	37.8	4	8	<0.001
Lymphadenopathy (n)		3	7.1	6	12	0.435
Total Chest CT severity score (mean)		13.97	9	22.75	5.24	<0.001*
Male		12.50	9.50^{ns}	22.61 ^{ns}	5.60	<0.001*
Female		15.45	8.43	22.85	5.04	<0.001*

**Mann-Whitney test; NS, there is no significant difference between males and females.*

Instead of radiological findings, the final outcomes are also different in waves of Delta or Omicron [17].

The most similar findings between these two diseases in chest CT scan were presence of GGOs and consolidations. While we did not see any differences in rates of consolidations between delta and omicron periods, GOOs rates decreased after Omicron variant emergence. Some studies have referred to peripheral bilateral GGO as typical manifestation of GGO in COVID-19 [15, 16]. Peripherality was not suggestive of the virus variant in our study but new cases of Omicron showed also cases of unilaterality in our study. This was also cited in Yoon *et al.* study, where typical peripheral bilateral GGO were lower in Omicron than Delta period of COVID-19 [18]. Nontypical peribronchovascular pneumonia was attributed to Omicron CT scans in Yoon *et al.* study [18], while our radiologist did not mention such pattern of involvement; this might be due to use a checklist for collecting the data. An open question about findings of chest CT scan would feet better for data collection of further studies like ours. In a study by Cheng *et al.* in 2021, among 63 children infected with delta variant of

COVID-19, 34 (53.9%) had lung manifestations in CT scan and their CT scan score was significantly lower. The study showed that the initial manifestations of COVID-19 in children were mainly in the form of ground glass, subpleural nodularity, and the lung lesions in the delta variant were milder than the original strain [19].

In contrast to our findings, Omicron admitted patients were younger than Delta ones in Bouzid *et al.* study. This might be due to the severity of disease that we included ICU patients and they evaluated emergency department ones [20]. Similarly, Tsakok *et al.* [21] found that severity index of chest CT scans were lower in Omicron than Delta. Furthermore, in our study, along with the lower severity index of chest CT scans, patients admitted in ICU with Omicron were also older than Delta group. Older population might have higher rates of the pre-existing medical conditions. However, as we could not reach complete reports of the past medical histories of the patients, this remains inconsistent in our study. Moreover, pleural effusion was reported to be statistically higher in Omicron cohort than in the Delta. This might be due to the underlying diseases of the patients that we know normally is correlated with higher age. The older patients admitted to our ICU during the Omicron period, were mostly hospitalized in the ICU due to reasons other than Omicron and lung parenchymal involvement.

Recently, studies have used artificial intelligence to differentiate Delta and Omicron related damages of lung in different imaging modalities. Significantly aided in the early detection of COVID-19 cases, in particular, those linked to the Omicron and Delta variants, surpassing previous models' performance during similar outbreaks [22].

Limitations of the study

In this study, there are some limitations due to the essence of the disease; patients might have different vaccination statuses or history of COVID-19 infections, different treatment protocols [23], and many other known and unknown factors. In addition, it is possible that CT scans were not applied for some patients due to various reasons that they might have further bias on the current knowledge [23]. Furthermore, the progression of the disease might be different in patients that we did not evaluate any further progression in current study [24-27]. As another limitation, being a retrospective study, it is subject to inherent limitations, such as potential selection bias and reliance on existing medical records.

Conclusion

The present study aimed to compare the radiological findings of CT scans of the lungs in patients with Delta and Omicron variants of COVID-19 hospitalized in the intensive care unit. The study found significant differences in the radiologic characteristics between the two variants. Lesions in specific lobes (RML, LUL, and Lingual lobes) were more common in the Delta period, while GGOs and certain radiologic features such as Crazy Pavings, Parenchymal bands, Halo signs, and Pleural effusions were more common in the Omicron period. The total chest CT severity score was higher in the Delta period compared to the Omicron period. Our study suggests that with evolving the virus variants, while severity of lung involvement has decreased, GGOs of COVID-19 might have tended to manifest as unilateral lesions with more specific radiographic features. The rate of pleural effusion has been reported to be higher in Omicron patients, which could be due to the underlying diseases of the patients due to higher age, because these samples were taken from patients hospitalized in the ICU as Omicron patients are mostly hospitalized in ICU due to reasons other than Omicron and lung parenchymal involvement.

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No potential conflict of interest was reported by the authors.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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