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Radiological comparison of the Wuhan and B.1.1.7 variant COVID-19 infection; are there any differences in chest CT scans?

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ABSTRACT

Aim: In September 2020, a variant of the SARS-CoV-2 virus was detected in England and it became the dominant type in most of the countries. The clinical behavior of the B.1.1.7 variant COVID-19 infectionis different from the Wuhan type.So we aimed to investigate whether there are any differences in computed tomography (CT) imaging findings of pneumonia caused by COVID-19 variants.

Material and Method: 340 patients who admitted to the emergency departmentwith symptoms of dyspnea and chest pain suspecting COVID-19 pneumonia and pulmonary embolism were included in the study. Oncology (n:12) and pediatric (n:8) patients, patients with negative PCR test (n:56), and patients infected with different variant (n:6) were excluded leaving 258 patients grouped into two (B.1.1.7 and Wuhan type) for evaluation of CT findings such as pleural thickening,pleural and pericardial effusion, consolidation, GGO presence and distribution, upper lobe involvement, pulmonary embolism, tree in bud pattern, centrilobuler nodule, revers halo sign, and hepatosteatosis.

Results: A statistically significant difference was obtained between the two groups in terms of pleural thickening (p=0.020), upper lobe involvement (p=0.037), localization of GGO (p=0.001), presence of pleural effusion (p=0.025), embolism (p=0.011) and presence of consolidation (p=0.042). However, no significant difference was found for the development of hepatosteatosis (p=0.520).

Conclusion: There aredifferences in radiological findings between B.1.1.7 variant and Wuhan type. In our study atypical radiological findings are more common in B.1.1.7 type. In addition, radiological findings that seen in severe COVID-19 pneumonia are more common in B.1.1.7.

Keywords: COVID-19, Wuhan type, B.1.1.7 variant, tomographic differences, tomography

INTRODUCTION

In September 2020, a variant of the SARS-CoV-2 virus was detected in South East England. It was named B.1.1.7 and became the dominant lineage in just a few months (1). Despite the restrictions of travel from the UK, this variant was seen for the first time in January 2021 in our country. Also, it has spread to at least 114 countries worldwide since that time (2).

B.1.1.7 variant has 17 mutations, including eight in the spike protein. Mutations affect the binding affinity to human angiotensin-converting enzyme 2 (ACE2) and entry into human cells which increase the infectivity (2-4) and changed the clinical presentation, morbidity and mortality of the disease (2,5,6). Due to the worse clinical presentation, we think that there may be differences in the radiological findings of the B.1.1.7 variant induced pneumonia compared to the Wuhan type. Therefore we investigate the literature, but we did not find a study about the radiological differences in pneumonia caused by COVID-19 variants.

As is known, typical CT findings of COVID-19 pneumonia are bilateral lower lobe and peripherally predominant ground glass opacities (GGO) whereas

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pleural effusion, pulmonary embolia, centrally located GGO and consolidations, upper lobe involvement are reported to be atypical CT findings (7-9). Consequently we aimed to compare CT findings of Wuhan type and B.1.1.7 variant induced pneumonia.

MATERIAL AND METHOD

The study was approved by the Marmara University Faculty of Medicine Clinical Researches Ethics Committee (Date: 07.06.2021, Decision No: 09.2021.734). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Participants

The study was conducted at our hospital in Turkey between February and April 2021. 340 patients who admitted to the emergency department with symptoms of dyspnea and chest pain suspecting COVID-19 pneumonia and pulmonary embolism were included in the study. Oncology (n:12) and pediatric (n:8) patients, patients with negative polymerase chain reaction(PCR) test (n:56), and patients infected with South Africa-Brazil variant (n:6) were excluded leaving 258 patients grouped into two (B.1.1.7 variant and Wuhan type) for evaluation of CT findings.Since the radiological imaging of the patients included in the study was evaluated retrospectively, informed consent could not be obtained from them.

Pulmonary CT Angiography Protocol

All examinations were performed on a 128-slice scanner (Ingenuity Core 128, Philips Healthcare) with the following scan parameters: tube voltage 120 kV and effective tube current 50 mAs, slices acquired with 128×0.6 mm setting in the caudocranial direction, 0.5 pitch, and 0.28-second rotation time. Field of view was adjusted to patient size, 512×512 matrix was used, and mean scan time was 4.2 s. Bolus tracking software was used with ROI cursor placed on RV with a setting of 50 HU and delay time of 3 s, using 0.8 ml/kg contrast (350 mg I/ml) with 5 ml/s delivery rate via antecubital line, followed by 20 cm^3 saline injection. The patient was instructed to hold her breath for 5 seconds just before starting the scan. The resulting images were reconstructed with 0.75 mm and 5 mm collimation.

Chest CT evaluation

The tomographic findings of the patients were evaluated by a radiologists experienced in chest radiology. The radiologist was blind to the PCR findings.

Pleural thickening, pleural and pericardial effusion were evaluated in mediastinal window. Consolidation (**Figure 1**), distribution of paranchymal changes like upper lobe involvement (**Figure 2**), presence and distribution of GGO (**Figure 3**), reverse halo sign, centrilobular nodule, tree-in-bud pattern and cavitation were evaluated in the lung window. Presence of pulmonary emboli was evaluated in pulmonary CT angiogram (PCTA) slides. GGO located in the subpleural area was accepted as peripheral, and those located adjacent to the bronchovascular tree as central distribution. Liver parenchyma density included in the non-contrast chest CT was measured. If liver attenuation was less than 10 HU that of spleen, it was accepted as fatty liver (**Figure 4**).

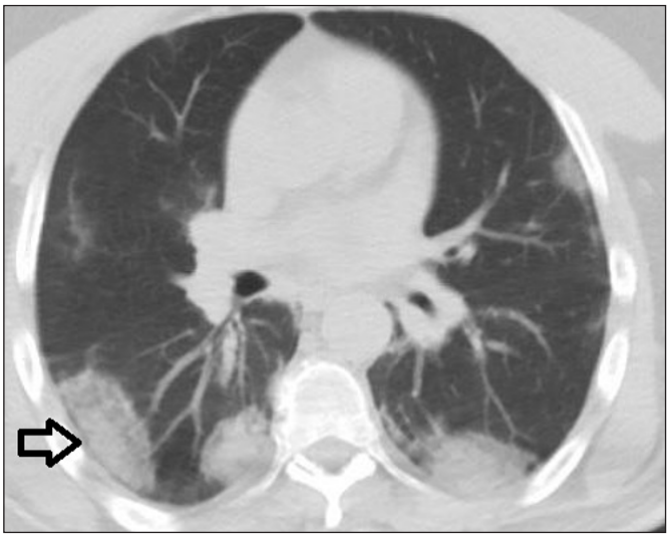

Figure 1. CT image shows round peripheral consolidation with GGOs in the bilateral lower lobe

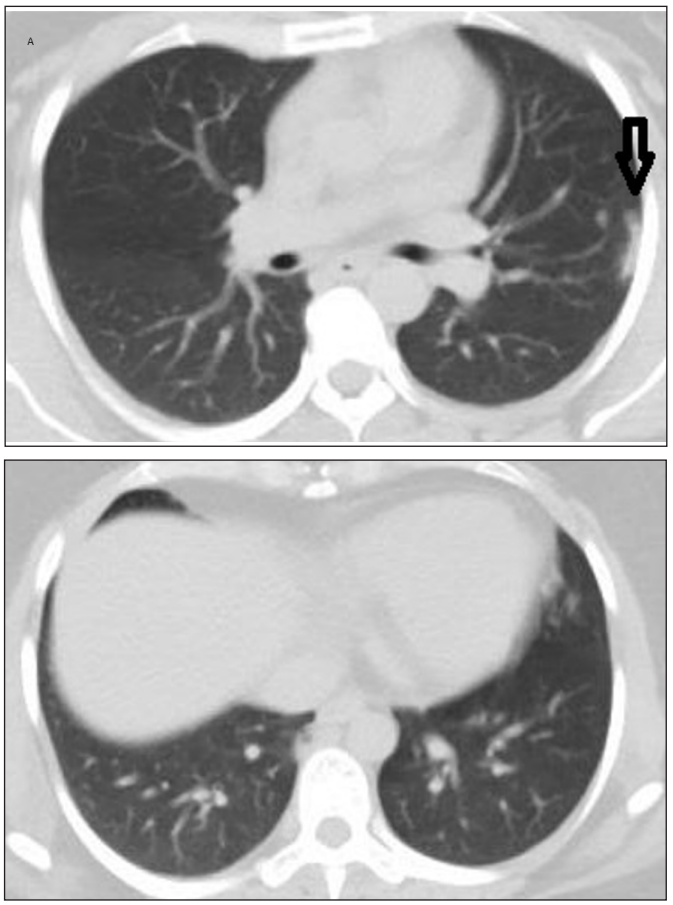

Figure 2. Isolated upper lobe involvement. **a.** Unenhanced chest CT shows ground glass opacities in the left upper lobe. **b.** Bilateral lower lobes appear protected

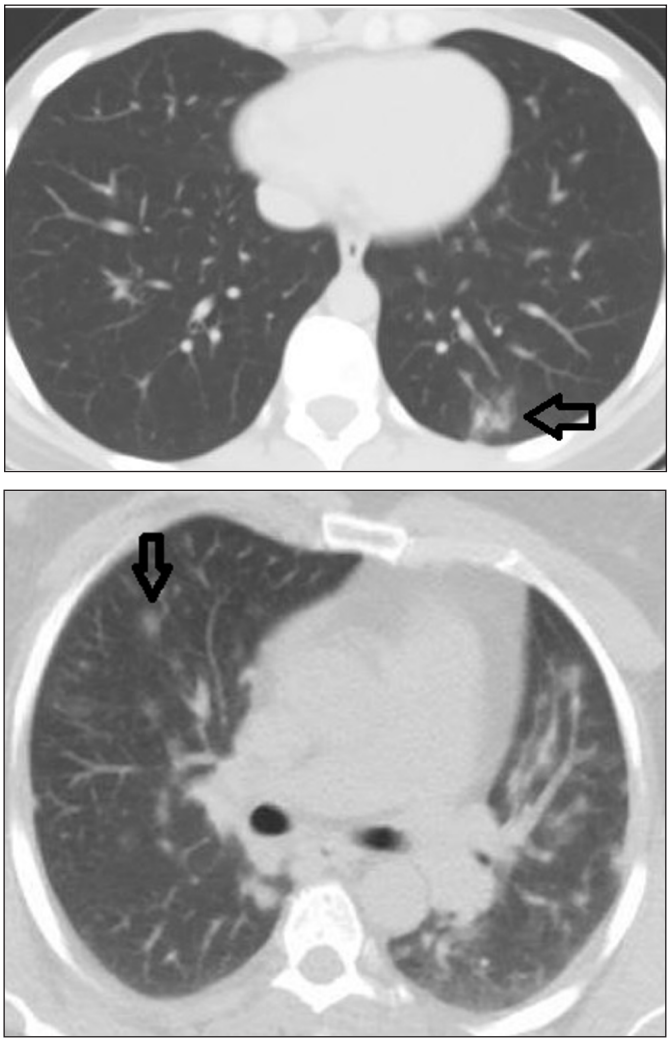

Figure 3. a. Axial unenhanced chest CT image of 35 year old patiet with Wuhan Type COVID-19 pneumonia shows peripheral GGOs **b.** Axial unenhanced chest CT image of patient with infected with B.1.1.7 variant shows noduler and patcy GGOs in central peribroncovascular area.

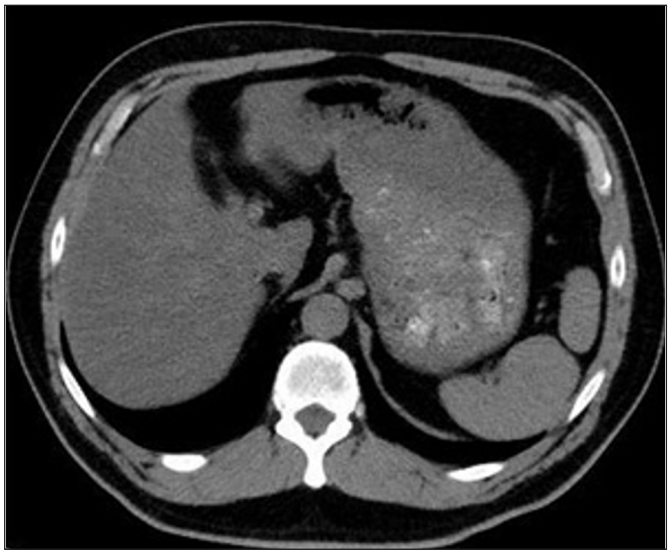

Figure 4. Axial chest CT image demonstrates hepatosteatosis (mediastinal window). Mean liver attenuation is 13 HU and mean splenic attenuation is 46 HU

Reticulation, subpleural band and architectural distortion, which are late findings of COVID pneumonia, could not be evaluated because the CT scans at the time of admission were examined in the study.

PCR

Combined nasopharyngeal and oropharyngeal swab samples were collected from individuals suspected of COVID-19. Viral RNA was extracted by using Bio-speedy® viral nucleic acid buffer (Bioexen LTD, Istanbul, Turkey). Specific kits were used for screening Wuhan, British, and South Africa Brazilian variants.

Statistical analysis

Descriptive statistics were made in the form of mean and standard deviation for age in both between two variants and gender differences. Then, all patients were divided into two groups as the Wuhan and B.1.1.7 variants. The data of presence of pleural involvement, upper lobe involvement, presence of pleural effusion, pulmonary embolism, consolidation and hepatosteatosis were recorded in categorical form. After that, chi-square test was used to determine the relationship of these independent samples in terms of variants. Since the minimum expected count was greater than 5 in the analyzes, the p values of the pearson chi-square value were recorded. A <0.05 p value indicated a statistically significant difference between the groups in terms of the relevant parameters.The IBM SPSS version 21.0 (IBM, Armonk, NY, USA) statistical package was used for the analysis of the study.

RESULTS

There were 113 patients in Wuhan type and 145 patients in B.1.1.7 variant group.Wuhan type group consisted of 61 male and 52 female patients andB.1.1.7 variant group consisted of 85 male and 60 female patients. The age of patients ranged from 28 years to 82 years in the group infected with the B.1.1.7 variant (mean 52.8±SD: 12.4 years) and ranged from 22 years to 90 years in the group infected with the Wuhan type (mean 53.1±SD: 14.2 years).

Out of 113 patients in Wuhan type group, 67% had consolidation, 70% peripheral GGO, 30% central GGO, 91% upper lobe involvement, 42% pleural thickening, 6% pleural effusion, 3% pulmonary emboli, 56% hepatosteatosis. One patient had pericardial effusion, and one showed tree in bud pattern (**Table**).

Out of 145 patients in B.1.1.7 variant group, 74% had consolidation, 19% peripheral GGO, 81% central GGO, 86% upper lobe involvement, 52% pleural thickening, 10% pleural effusion, 11% pulmonary emboli, 52% hepatosteatosis, 1% centrilobuler nodule. One patient had reverse halo sign (**Table**).

Table. The statistical comparison and the ratios of radiological findings according to Wuhan type and B.1.1.7 variant

	Mutation		P value	Value (Pearson Chi-Square)	df
	Wuhan n=113	B.1.1.7 n=145			
Pleural thickening					
Count	42	75			
% within mutation	37.2%	51.7%	0.020	5.429	1
% of Total	16.3%	29.1%			
Pleural effusion					
Count	6	14			
% within mutation	5.3%	9.7%	0.025	4.992	1
% of Total	2.3%	5.4%			
Pulmonary embolism					
Count	3	16			
% within mutation	2.7%	11.0%	0.011	6.537	1
% of Total	1.2%	6.2%			
Consolidation					
Count	76	107			
% within mutation	67.3%	73.8%	0.042	4.138	1
% of Total	29.5%	41.5%			
Upper lobe involvement					
Count	91	125			
% within mutation	80.5%	86.2%	0.037	4.349	1
% of Total	35.3%	48.4%			
Central ground glass opacity					
Count	34	118			
% within mutation	30.1%	81.4%	0.001	69.023	1
% of Total	13.2%	45.7%			
Peripheral ground glass opacity					
Count	79	27			
% within mutation	69.9%	18.6%	0.001	69.023	1
% of Total	30.6%	10.5%			
Hepatosteatosis					
Count	63	75			
% within mutation	55.8%	51.7%	0.520	0.414	1
% of Total	24.4%	29.1%			
Revers halo					
Count	0	1			
% within mutation	0%	0.69%	–	–	–
% of Total	0%	0.39%			
Centrilobuler nodule					
Count	0	2			
% within mutation	0%	1.38%	–	–	–
% of Total	0%	0.78%			
Pericardial effusion					
Count	1	0			
% within mutation	0.88%	0%	–	–	–
% of Total	0.39%	0%			
Tree in bud					
Count	1	0			
% within mutation	0.88%	0%	–	–	–
% of Total	0.39%	0%			

Pleural thickening, pleural effusion, pulmoner embolism, consolidation, upper lobe involment, central GGO were more common in patients infected with B.1.1.7 variant; hepatosteatosis, peripheral GGO were more common in patients infected with Wuhan type.

A statistically significant difference was obtained in chi-square test between the two groups in terms of pleural involvement (p=0.020), upper lobe involvement (p=0.037), localization of GGO (p=0.001), presence of pleural effusion (p=0.025), embolism (p=0.011) and presence of consolidation (p=0.042). However,no significant difference was found for the development of hepatosteatosis (p=0.520). The data of the statistical analysis are given in **Table**.

DISCUSSION

To our knowledge, this is the first study that suggests comparing tomographic findings of Wuhan type and B.1.1.7 variant induced COVID-19 pneumonias. As more information was started to share about this new type of virus, it was stated that the clinical course of pneumonia caused by the variant virus was much severe (2). For example one of our patients was infected with COVID-19 pneumonia with Wuhan type and B.1.1.7 variat virus at different times. In Wuhan type she did not hospitalized and the chest CT finding was only patchy GGO in inferior lingular segment. However in B.1.1.7 variant infection, she was hospitalized for 10 days and her CT finding was widespread GGO in both lung, distributed in the subpleural and central areas (**Figure 5**).

However, there is no information about the differences of radiological findings of the two type of virus. Chest CT findings of Wuhan type COVID-19 pneumonia have been described in many publications (10-13). Our experience from chest CTin our clinic was that atypical radiological findings are more common in the B.1.1.7 variant than Wuhan type COVID-19 pneumonia. In Wuhan type COVİD-19 pneumonia, peripheral-predominant GGO and consolidation are reported as the most common findings (14). Previously, Ceylan et al. (9) described centrally located GGO as atypical radiological findings in COVID-19 pneumonia before the definition of this variant in our country. In our clinic, we started to observe central or peribronchovascular located GGOs more frequently in COVID-19 pneumonia infected with B.1.1.7 variant compared to patients infected with Wuhan type. We found a significant statistical difference for the localization of GGO in the group of infected with B.1.1.7 variant in our study. This pattern can be confused with parenchymal involvement of diseases that may have peribronchovascular involvement, such as organized pneumonia. Due to this distribution pattern, we started to be more indecisive in the radiological differential diagnosis of patients infected with B.1.1.7 variant while comparing Wuhan type COVID-19 pneumonia. In addition, the difficulty we faces to obtain information about the PCR results of many patients and often their clinics during daily reporting made this differential diagnosis even more difficult.

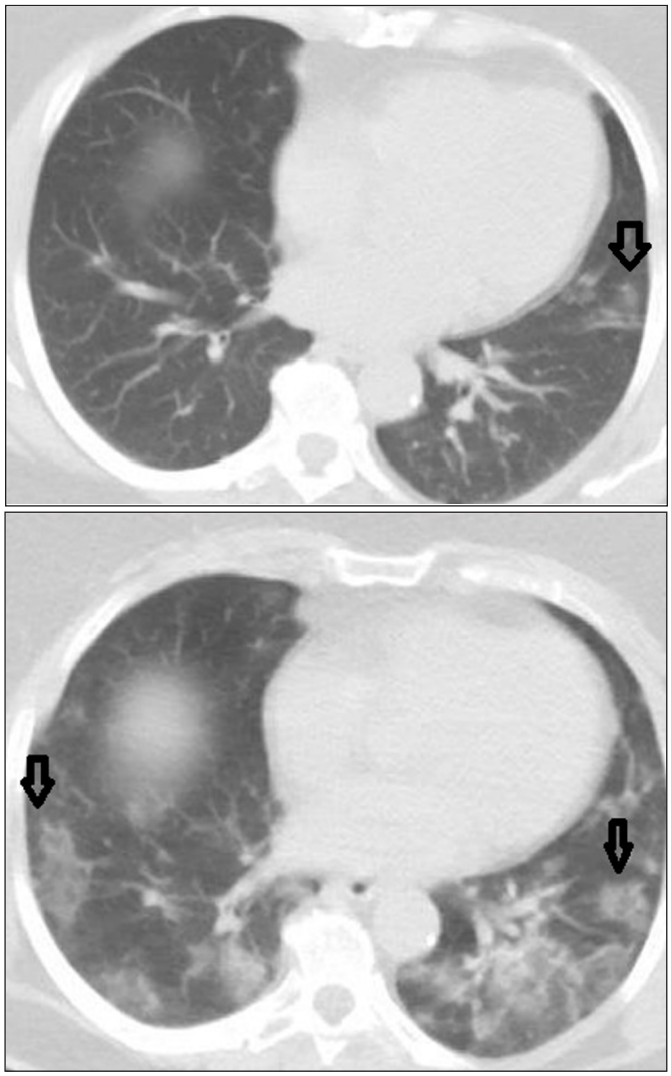

Figure 5. a. Chest CT image of a 61-year-old woman, who was infected with Wuhan Type COVID-19 virus in April 2020, shows patcy GGO only in the inferior linguler segment. **b.** Same patient was infected with B.1.1.7 variant in April 2021 again and her CT image shows widespread GGO in both lung, distributed in the subpleural and central areas

In the comparative evaluation of patch-style or lobar consolidated areas which are the other radiological findings can be detected in COVID-19 pneumonia; we found a significantly more in B.1.1.7 variant group.

In general, lower lobe predominant involvement has been reported in the COVID-19 pneumonia (15). On the other hand, Ceylan et al. (9) reported that; isolated upper lobe involvement can also be seen in Wuhan type COVID-19 pneumonia as an atypical sign. In our study, upper lobe involvement in infected group with B.1.1.7 variant wasstatistically significant higher than Wuhan type.

Pleural effusion, thickening and sometimes pericardial effusion may accompany parenchymal findings in COVID-19 pneumonia. Kunhua et al. (15) reported that; severe-critical patients showed higher incidences of pericardial effusion, and pleural effusion than ordinary patients. In our study, the incidence of pleural effusion was statistically higher in B.1.1.7 variant. Pleural thickening was also significantly more common in B.1.1.7 variant. Pericardial effusion was detected in only 1 patient infected with Wuhan type, and was not detected in the group infected with B.1.1.7 variant, that is because, statistical comparison could not be made.

Pulmonary embolism is relatively common complication in COVID-19 pneumonia and associated with increased mortality risk (16). All of our patients admitted to the ED with symptoms of dyspnea and chest pain suspecting COVID-19 pneumonia and pulmonary embolism. Also patients have high D-dimer levels. They underwent PCTA. In our study while pulmonary embolism was detected in only 3 patients in the Wuhan type, it was observed in 16 patients in the B.1.1.7 variant, and a statistically significant difference was obtained.

Finally, the prevalence of steatosis was high in COVID-19 patients (17) and fatty liver is an important sign for a poor prognosis (18) and can easily be detected on chest CT scans.In our study, although hepatosteatosis was more common in the B.1.1.7 variant than the Wuhan type, no statistical significant difference was found.

There were some limitations to the present study. The sample size was relatively smallbecause in patients with suspected COVID-19, chest radiograph is primarily preferred radiological examination and in addition, the patients included in the study had both chest CT and CT angiography. Second, this study used a retrospective approach. Studies conducted by including other variants and increasing the number of patients will contribute to literature in future.

In conclusion, similar to the differences in the clinical course and infectivity of B.1.1.7 variant and Wuhan type, this study showed differences in CT findings between these groups as well. Reported radiological findings that seen in severe COVID-pneumonia like consolidation, pleural effusion, pulmonary embolism, and atypical CT findings such as pleural effusion, central GGO, and upper lobe involvement which were more commonly seen in B.1.1.7could give the clinician an idea about the course of the disease.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by the Marmara University Faculty of Medicine Clinical Researches Ethics Committee (Date: 07.06.2021, Decision No: 09.2021.734).

Informed Consent: No written informed consent form was obtained from patients because the study was designed retrospectively.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors declerate that there were no conflicts of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have read and approved the final versionof the manuscript.

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