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Use of radiological tests in COVID-19 positive child cases: Is chest computed tomography necessary?

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Abstract

Objective: This study aimed to correlate the radiographic findings of the coronavirus disease 2019 (COVID-19) positive children with their clinical and laboratory findings and discuss the frequency and necessity of chest computed tomography (CT) used for the radiological imaging in paediatric patients with COVID-19 infection.

Materials and methods: Sixty-nine paediatric inpatient cases were retrospectively analysed using their clinical, laboratory and imaging features. The National Public Health Guide was used in the diagnosis and treatment of paediatric patients. COVID-19 infections for all patients were confirmed by the COVID-19 nucleic acid test using a pharyngeal swab.

Results: The median age of the patients was 11 years [3-15]. The most common clinical symptoms were fever (40.6%) and cough (33.3%). When the laboratory findings of patients were examined, the median white blood cell (WBC) count was 5.8/mm^3 (4.8-8.05/mm^3), median lymphocyte count was 2.3/mm^3 (1.7-3.55/mm^3) and median C-reactive protein (CRP) level was 2.3/mm^3 (1-2.1/mm^3). All patients had chest radiographs (CRXs), while only 44.9% of the patients underwent a chest CT. The 8.7% of CXRs and 12.8% of chest CT findings were found as pathological. Ground-glass opacity was the most frequent finding. In the tomography group, the count of lymphocytes was lower, and creatine kinase (CK) and lactate dehydrogenase (LDH) levels were significantly higher. The patients with pathological tomography findings demonstrated no statistically significant difference in lymphocyte count and CK and LDH levels; however, their CRP value was significantly higher.

Conclusion: In this study, it is emphasised that chest CT should be requested by considering the underlying diseases and severity of clinical findings in paediatric patients. In this way, unnecessary chest CT could be prevented in the paediatric population.

1 | INTRODUCTION

The coronavirus disease 2019 (COVID-19) is caused by a recently discovered novel enveloped RNA beta coronavirus called severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The very first COVID-19 patient was reported at the end of 2019. The disease rapidly spread worldwide in a few months and was declared as a worldwide pandemic by World Health Organisation (WHO) in March 2020. The disease's spectrum, caused by COVID-19, varies from mild upper respiratory tract infection to severe lower respiratory tract infection and death. As the majority of adults infected with COVID-19 had chest computed tomography (CT) abnormalities, chest CT has become an essential imaging method for the early diagnosis of COVID-19 and monitoring the disease progression.[1,2] Chest radiographs (CXRs) and chest CT have been widely used for evaluating COVID-19 patients. However, CXRs may appear

nonpathological during the early stage of the disease and, therefore, are not recommended as the first-line imaging tool.[3-5] Generally, COVID-19 seems to have a less severe clinical presentation for children than adults. The most common CT findings are unilateral or bilateral subpleural ground-glass opacities and consolidations with surrounding halo sign in paediatric patients. Additional findings may include peribronchial opacities and bronchial wall thickening. As the disease progresses, the consolidations can extend diffusely, presenting a "white lung" appearance, accompanied by air-bronchogram signs.[6-9]

Especially in Turkey, where the pandemic is well controlled, COVID-19 occurs as asymptomatic or with mild clinical symptoms in children. At the same time, children with other comorbid diseases (such as immunosuppressive patients, congenital heart, lung and airway diseases and tumours) are more vulnerable to infection with COVID-19 than healthy children.[10,11] We aim to correlate the radiographic findings of the COVID-19 positive children with clinical and laboratory findings. We presented a series of 69 paediatric cases with clinical and imaging features and evaluated the unnecessary chest CT.

What's known

- The risk of developing complications, severe pneumonia in previously healthy children is significantly lower than in adults.
- Tomography shows more specific and early diagnosis.
- Routine use of tomography in children due to mild clinical course is controversial.

What's new

- In this study, it is emphasised that chest CT should be requested by considering the underlying diseases and severity of clinical findings in paediatric patients.
- In this way, unnecessary chest CT should be prevented in the paediatric population.

2 | MATERIALS AND METHODS

2.1 | Subjects

Sixty-nine paediatric inpatients with COVID-19 infection, confirmed by COVID-19 nucleic acid test using a pharyngeal swab, admitted into our hospital within the duration of 2 months were included in this study. Patients were diagnosed either from the contact screening or the admission to the hospital with symptomatic presence. The National Public Health Guide was used in the diagnosis and treatment of paediatric patients.[12] The criteria for the diagnosis of COVID-19 in children were combined with the epidemiology and clinical manifestations. Epidemiological history is the cornerstone of diagnosis in children.

2.2 | Data collection

Data of patients hospitalised within 2 months were recorded using the medical database. We analysed demographic characteristics, contact history, previous medical history, clinical symptoms, laboratory findings and radiological tests. The patients' radiological images were obtained by CXRs and chest CT methods. Noncontrast multislice chest CT images were taken by using GE Healthcare Revolution ACT CT Scanner, under free-breathing in the supine position, according to the parameters as a slice thickness of 5 mm, average tube current modulation of 41 mA and tube voltage 2-18 years of 100 kVp. and 0-2 years of 80 kVp. The radiation dosage of chest CT parameters is determined by the device according to age and weight. The CXR images were obtained by using SG Healthcare Jumond Mobile device. All patients had CXRs, especially those without symptoms and with mild symptoms, and chest CT was less preferred. All the images were stored in picture archiving and communication system (PACS) and reviewed by two experienced radiologists.

Pharyngeal swab samples of all the cases in this group were collected, and a reverse transcription polymerase chain reaction (RT-PCR) identified the COVID-19 RNA.

The protocol for this retrospective study was approved by the Ministry of Health, Turkey, and the Ethics Committee of Harran University Medical School. The written informed consent was waived for emerging infectious diseases.

2.3 | Statistical analyses

Statistical analyses of the data were performed using SPSS 20.0 for Windows (IBM Corp., Armonk, NY, USA). Distribution of data was evaluated using the Kolmogorov-Smirnov test. Differences in the means of variables were tested using both parametric and nonparametric tests, depending on the distribution of the variables. Categorical variables across groups were compared using the chi-square test or Fisher's exact test (if a cell number was 5 or less). For numerical comparisons, Student's *t* test or Mann-Whitney *U* tests were used to assess differences between two groups according to the normal distribution of the measured parameters. Mean values and standard errors were used as descriptive statistics. Data were presented as mean ± standard deviation (SD) or median and interquartile range (IQR, 25th-75th percentile). In all statistical tests, $P < .05$ was considered as statistically significant.

3 | RESULTS

Sixty-nine children with COVID-19 positive were admitted to the hospital in April and May 2020. The patients' median age was

11 years (2 month-17 years).[3-15] In our case series, 13% of patients were <1 year of age, 15.9% were between 1 and 5 years, 20.3% were 6 and 10 years, 50.7% were ≥10 years; 36 (52.2%) of the patients were female. The most common clinical symptoms were fever (40.6%) and cough (33.3%). Less frequent symptoms were sore throat, abdominal pain, myalgia and shortness of breath. The characteristics of paediatric patients with COVID-19 infection were presented in Table 1. The laboratory findings of the patients revealed that white blood cell counts of 48 (69.6%) patients were between 4 and 10.000/mm^3, and lymphocyte count of 44 (68.1%) patients was <3.000/mm^3. CRP value was <3 mg/L in 85.5% of patients. There was an increase in alanine aminotransferase (ALT) level in one case (1.4%), lactate dehydrogenase (LDH) levels in 18 cases (26.1%) and creatine kinase (CK) levels in 12 cases (17.4%). Laboratory findings were shown in Table 2.

One of our patients, who was 16 years old, had an underlying disease and underwent allogeneic haematopoietic stem cell transplantation for thalassemia major. Only this immunosuppressive patient was admitted to the paediatric intensive care unit. Other patients were hospitalised in the paediatric pandemic department. Hydroxychloroquine was used in the treatment of 12.8% of COVID-19 positive patients.

The CXRs were obtained from all patients. There was a pathological presence in 6 (8.7%) of the CXRs. Pathological findings included consolidations, peribronchial opacities and bronchial wall thickening. According to their clinical and laboratory findings, 31 patients (44.9%) had chest CT scans. Among them, nine patients' (12.8%) CT images were accepted as pathological, which included millimetric nodules, parenchymal nodular consolidations, ground-glass opacities and consolidations, consolidations with surrounding halo sign, dilated bronchus, bronchial wall thickening and subpleural nodular consolidations (Figures 1-4). The ground-glass opacities were the most frequent, and the least was the air-bronchogram sign, which was observed in immunosuppressive patients. The median age of patients who underwent chest CT was 15 years.[12-16] The majority of these patients were men. When the frequency of fever and cough of the patients who underwent chest CT was examined, there was no statistically significant difference compared to patients without chest CT. However, when the laboratory findings were examined, the count of lymphocytes was lower in patients with tomography, which was statistically significant. CK and LDH values were also significantly higher in the tomography group (Table 3). When the

TABLE 1 The characteristics of paediatric patients with COVID-19 infection

Characteristic	Number (n, %)
Gender	
Female	36 (52.2%)
Male	33 (47.8%)
Age	
<1 y	9 (13%)
1-6 y	11 (15.9%)
6-10 y	14 (20.3%)
>10 y	35 (50.7%)
Symptom	
Fever	28 (40.6%)
Cough	23 (33.3%)
Sore throat	6 (8.7%)
Abdominal pain	4 (5.8%)
Myalgia	2 (2.9%)
Shortness of breath	1 (1.4%)
Radiological tests	
CXRs	69 (100%)
Chest CT	31 (44.9%)
Contact history in family	
Yes	64 (98.4%)

Abbreviations: CT, computed tomography; CXRs, chest radiographs.

TABLE 2 Laboratory and radiological findings were shown

Laboratory information	Number (n, %)
WBC, 10^3/mm^3	
<4000	10 (14.5%)
4000-10 000	48 (69.6%)
>10 000	11 (15.9%)
LYM, 10^3/mm^3	
<1500	7 (10.1%)
1500-3000	40 (58%)
>3000	22 (31.9%)
CRP, mg/L	
<3	59 (85.5%)
≥3	10 (14.5%)
LDH, U/L	
<300	51 (73.9%)
≥300	18 (26.1%)
CK, U/L	
<145	57 (82.6%)
≥145	12 (17.4%)
Radiological test result	
CXRs	
Consolidations	5 (7.2%)
Peribronchial distribution	3 (4.3%)
Bronchial wall thickening	3 (4.3%)
Chest CT	
Ground-glass opacities	6 (8.6%)
Consolidations	5 (7.2%)
Dilated bronchuses and bronchial wall thickening	2 (2.8%)
Subpleural nodulary consolidations	4 (5.7%)

Abbreviations: CK, creatine kinase; CRP, C-reactive protein; CT, computed tomography; CXRs, chest radiographs; LDH, lactate dehydrogenase; WBC, white blood cell.

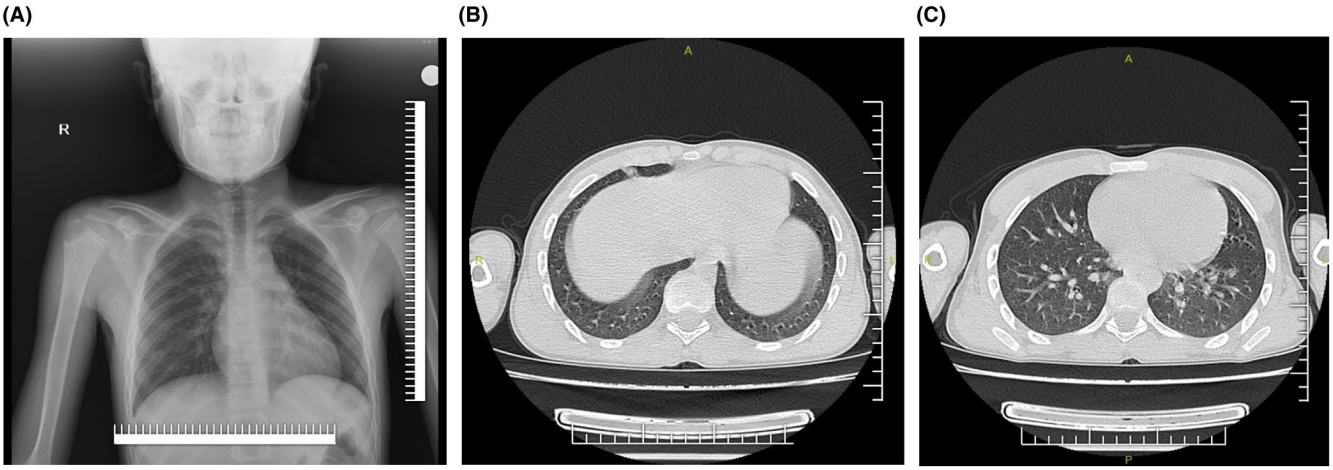

FIGURE 1 Chest radiographs (CRXs) and chest computed tomography (CT) images from 13-y-old boy. A, Normal CRXs on admission; B, nodular consolidation in the right lung median lobe; C, mm-sized ground-glass nodule ın the left lung ınferıor lobe

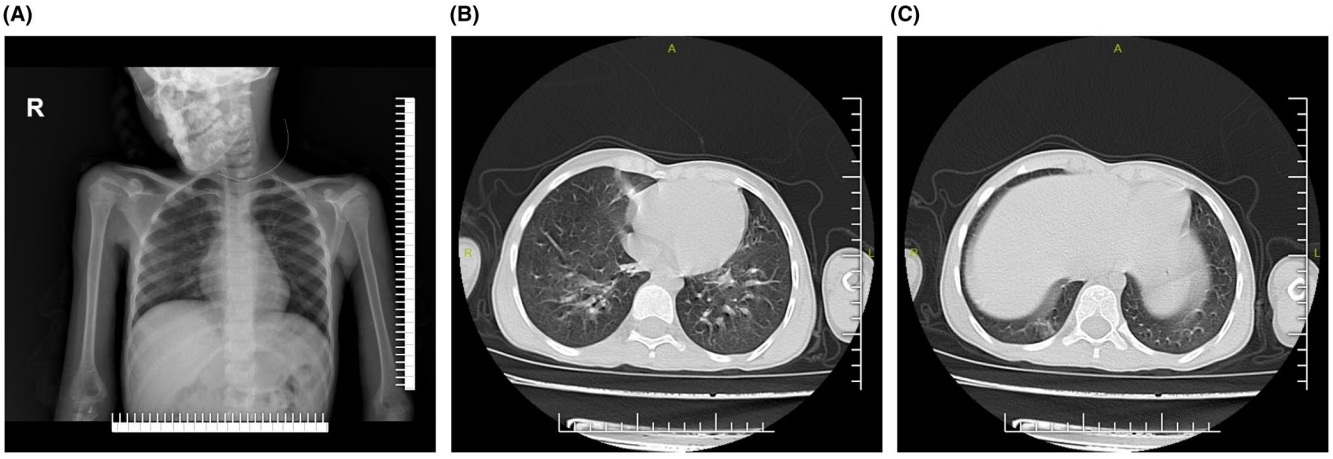

FIGURE 2 Chest radiographs (CRXs) and chest computed tomography (CT) images from 14-y-old girl. A, Perihillar dilated bronchus in the right lung parenchyma and suspected opacities related to infiltration on admission; B, dilated bronchus, peribronchial septal thickenıng and ground-glass opacities in the right lung inferior lobe; C, ground-glass opacity in the right lung inferior lobe's posterior-basal segment

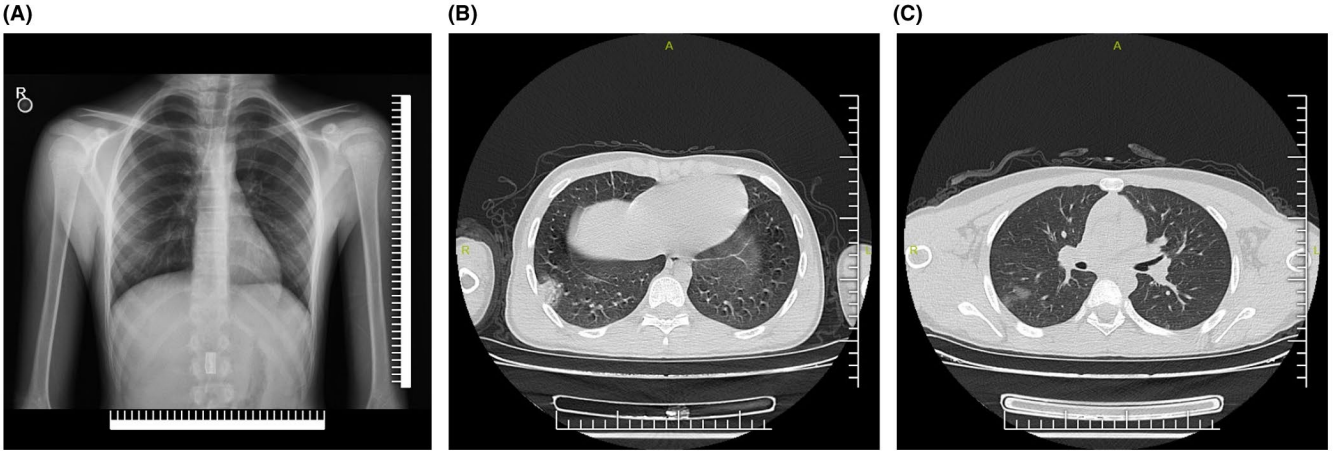

FIGURE 3 Chest radiographs (CRXs) and chest computed tomography (CT) images from 10-y-old girl. A, Suspected images related to infiltration in the right lung medial and inferior lobes, on admission; B, subplevral localised central consolidation surrounded by ground-glass opacity (halo sıgn); C, multiple ground-glass nodules in the right lung inferior lobe

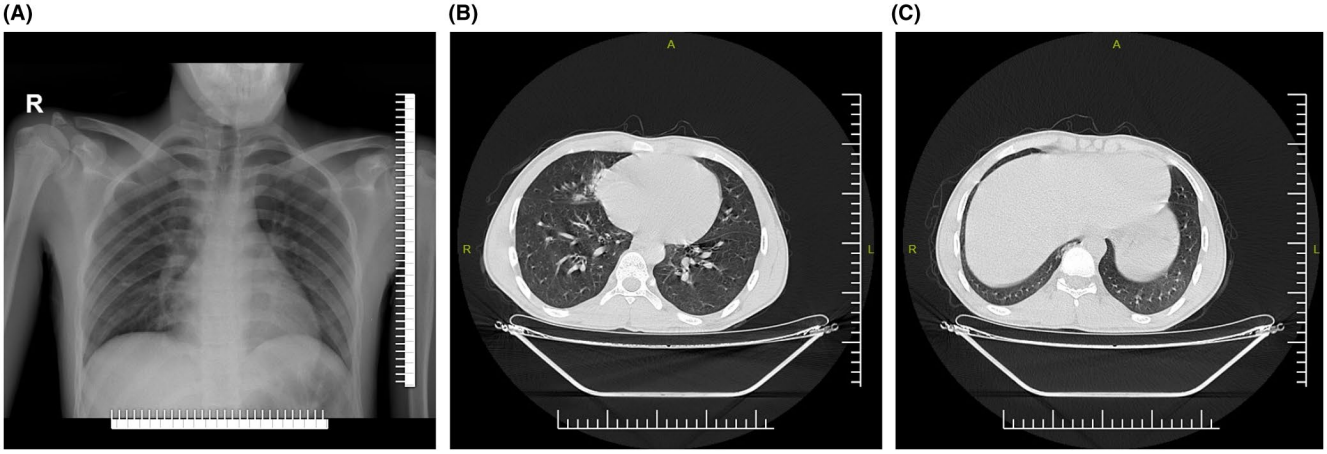

FIGURE 4 Chest radiographs (CRXs) and chest computed tomography (CT) images from 17-y-old boy. A, Dilated bronchus and opacity in the right lung medial segment; B, consolidation and dilated bronchus in the right lung medial segment; C, consolidation in the right lung inferior lobe posterior-basal area

TABLE 3 Features of patients who underwent chest CT and without Chest CT

	Chest CT taken group	Chest CT not taken group	*P*
Age, y	15 (12-16)	6 (2-9)	.01
Male/Female, n	17/14	15/17	.33
WBC, $10^3/mm^3$	5.4 (4.8-7.1)	6.75 (4.875-9.125)	.08
LYM, $10^3/mm^3$	1.9 (1.5-2.3)	2.4 (1.975-4.7)	.004
CK, U/L	81 (73-106)	110 (90.7-163)	.01
LDH, U/L	260 (208-272)	273 (243-315)	.04
CRP, mg/L	1 (1-3.5)	1 (1-2)	.49

Abbreviations: CK, creatine kinase; CRP, C-reactive protein; CT, computed tomography; CXRs, chest radiographs; LDH, lactate dehydrogenase; WBC, white blood cell.

patients with pathological tomography findings were examined, only the CRP value was significantly higher than the group with normal tomography. There was no statistically significant difference in age, gender, lymphocyte count, CK and LDH values (Table 4).

Except for the immunosuppressive patient, most of the patients were hospitalised for approximately 3-5 days. None of the patients developed severe pneumonia or were hospitalised in the paediatric intensive care unit, except the immunosuppressive patient. Death was not observed in any of our patients; 98.4% of paediatric patients had an identified history of close contact with COVID-19, diagnosed in their family members.

4 | DISCUSSION

Current data regarding COVID-19 in paediatrics is similar to SARS and MERS in terms of disease severity and mortality and shows that children of all ages could get COVID-19, but they seem to be affected less commonly than adults.[1,13]

In Dong's study, there were 728 confirmed cases and 1407 suspected cases; 17.6% of paediatric cases were <1 year of age, 23% were between 1 and 5 years, 24.5% were 6 and 10 years, 19.3% were 11 and 15 years, and 15.6% were >15 years.[13] There are other studies in the literature with similar age distribution.[14,15] Although the age distribution in general of our patients showed similarity, 50.7% of our patients were over 10 years old. The clinical, laboratory and radiological presences of all our patients were monitored as the clinical features, laboratory testing and chest radiograph imaging state the severity of COVID-19. According to Dong et al's report regarding severity, cases were diagnosed as asymptomatic, mild, moderate and severe. Severe cases were reported to be at a rate of 6.7%. Similar clinical manifestations were reported in other series. Studies and clinical experiences have shown that the symptomatic clinical presence is less common in children.[13,16-18]

According to Turkey's surveillance data, 50.4% of paediatric cases had mild disease, and 0.8% had severe disease.[19] The majority of children in our study also had mild clinical feature.

In our 69 cases of children whose information of exposure was available, 4.2% had a history of contact with a person who had been to the Umrah, and 98.4% had a history of contact with a COVID-19 patient in their household or community. Chen et al reported similar contact rates in the literatüre.[14]

As the coronavirus disease-19 (COVID-19) global pandemic progresses, many physicians in a wide variety of specialties continue to play pivotal roles in diagnosis and management. Much of the literature has focused on chest CT manifestations of COVID-19[20-22] in radiology. Follow-up imaging, in COVID-19 patients, often demonstrated the disease progression, and this progression is of great importance for early warning of disease aggravation of COVID-19 patients, which could help clinicians to manage quickly and accurately. For these reasons, the chest CT was used in the foreground for adults. However, the necessity of chest CT should be requestioned by paediatricians due to the milder clinical course in paediatric patients. Chest CT scans were taken in 44.9% of our patients,

TABLE 4 Comparison of the group with pathological findings and the group without pathological findings in chest CT

	Pathological sign of Chest CT	Normal Chest CT	*P*
Age, y	16 (10-16.5)	14.5 (11.75-16.25)	.69
Male/Female	6/3	11/11	.39
WBC, $10^3/mm^3$	5.45 (4.275-10.05)	5.4 (4.8-6)	.572
LYM, $10^3/mm^3$	2.3 (1.375-3.550)	1.8 (1.700-2.2)	.684
CK, U/L	88.5 (69-111)	81 (67-92)	.309
LDH, U/L	265 (175-274)	257 (208-272)	.735
CRP, mg/L	5 (1-89.5)	1 (1-2)	.005

Abbreviations: chest CT, chest computed tomography; CK, creatine kinase; COVID-19, coronavirus disease 2019; CRP, C-reactive protein; CRXs, chest radiographs; LDH, lactate dehydrogenase; RT-PCR, real-time reverse transcription polymerase chain reaction.

and 12.8% of these chest CTs were pathological. As in other studies, ground-glass images were the most common findings in our patients. Radiological findings reported in paediatric cases were bilateral ground-glass opacity, patchy local shadowing, patchy bilateral shadowing and interstitial abnormalities.[15]

Lymphopenia is one of the cautionary findings in the literature. In our study, although tomography was preferred in lymphopenic patients, lymphopenia was not detected as a significant indicator of the pathological findings of patients with a tomography.

During the hospitalisation, there was no worsening in clinical presentation of pneumonia; therefore, chest CT was not performed in patients for a second time. The early diagnosis and more common radiological findings of chest CT do not provide additional advantages in monitoring the previously healthy children's clinic. Besides, we did not need to perform chest CT in any of our patients who were followed up with CXRs.

Patients were hospitalised approximately for 3-5 days. The COVID-19 positive patients were followed up by the provincial public health directorate after discharge and isolated for 14 days, and the isolation was terminated with being asymptomatic and RT-PCR negativity. Except for the immunosuppressive patient, there was no clinical deterioration in these patients.

Due to the high dose of radiation administered during chest CT scanning, even though we used thin slice and low dose high-resolution computed tomography (HRCT), each scanning is equal to 25-30 CXRs on average, and it should be applied according to clinical necessity, especially in the paediatric population.

CONFLICT OF INTEREST

We have no potential conflicts of interest to disclose.

ETHICS APPROVAL

The protocol for this retrospective study was approved by the Ministry of Health, Turkey, and the Ethics Committee of Harran University Medical School.

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