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Research Article

Abdominal Computed Tomography Findings in Patients with COVID-19

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Abstract

Objectives: COVID-19 is a viral pneumonia epidemic that has become a global health crisis. Apart from pneumonia symptoms, it may present with many different clinical findings. In this study, our aim was to evaluate the intraabdominal organs and the major abdominal vascular structures in abdominal Computed Tomography (CT) obtained from COVID-19 patients.

Methods: This retrospective study was conducted between March 2020 and March 2021, between patients admitted to our hospital with visceral symptoms within 3 months of SARS-CoV-2 infection and the control group. Abdominal CT findings, laboratory values and demographic characteristics of these patients were compared with the control group.

Results: In cases with COVID-19, the most common findings were corads-5 (n = 53, 53%) and the second most common was corads-1 (n = 21, 21%) findings on CT of the thorax. On abdominal CT, dilated - loop was observed in 4 (4%) patients, and perforation was observed in 2 (2.0%) patients. Cholelithiasis in 8 (8.0%) patients, intrahepatic bile duct dilatation in 2 (2.0%) patients, hepatomegaly in 36 (36%) patients, and splenomegaly in 12 (12%) patients were determined as gallbladder pathology. In the comparative evaluation of the vascular diameter measurements obtained from abdominal CT, the diameter of the portal vein and left renal artery were found to be significantly lower in the patient group (p = 0.018, p = 0.015, respectively).

Conclusions: In SARS-CoV-2 infection, visceral symptoms may occur during the onset of disease symptoms, while symptomatic, or after clinical improvement. Evaluation of the main vascular structures together with the intra-abdominal organs for ischemia and thrombus in abdominal CT, and the radiologists meticulously measuring the diameters of the abdominal main vascular structures can give the clinician important information about possible vasoconstriction.

Key words: COVID-19, abdominal vessels, computed tomography, vasoconstriction

Introduction

The recent pandemic initiated by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pathogen, which leads to Coronavirus disease 2019 (COVID-19), has had a profound impact on the lives of countless individuals[1]. The disease may present with typical findings or atypical findings of the respiratory system. SARS-CoV-2 is a quite contagious virus through an extreme propensity for not only severe lower respiratory tract involvement but also different coagulation disorders[2, 3].

The virus acts by targeting angiotensin-converting enzyme 2 (ACE-2) receptors expressed by type 2 alveolar cells that abundantly, which commonly found respiratory system, cardiac tissue, blood vessels, and intestinal system[4,6]. Gastrointestinal (GI) involvement was demonstrated by Xiao et al. firstly, viral ribonucleic acid in stool samples of COVID-19 patients[5]. In the context of COVID-19, SARS-CoV-2, the pathogen responsible for the disease, affects the intracellular ACE2, which serves as a regulator for two contrasting pathways within the renin-angiotensin system (RAS): the ACE-Ang-2-AT1R axis and the ACE2-Ang 1-7-Mas axis. The Ang 2-AT1R axis has prothrombotic, profibrotic, proinflammatory, and vasoconstrictive effects. In contrast, the ACE2-Ang 1-7-Mas axis holds anti-inflammatory, antithrombotic, antifibrotic, and vasodilatory properties. Therefore, the ACE-Ang 2-AT1R axis is responsible for the proinflammatory, prothrombotic, and vasoconstrictive effects in severe SARS-CoV-2 infection[7- 9].

Increased Ang II concentration because of the downregulation of ACE2; causes severe acute pulmonary damage, obesity-related hypertension, endothelial and myocardial dysfunction, increased inflammation, vasoconstriction, oxidative stress, and hypercoagulative status[10, 11]. Knowing the disease-causing mechanisms of COVID-19 once again reveals the importance of radiological imaging in our better understanding of organ involvement and in demonstrating these involvements.

In this study, it was pointed to assess visceral organs and their vascular structures in terms of ischemia, thrombus, and vasoconstriction on abdominal CT in patients with COVID-19.

Methods

Patient selection

A total of 100 patients (46 women, 54 men) with COVID-19 and 80 individuals in control groups (31 women, 49 men) were involved in the current study, retrospectively. The first group consisted of individuals who exhibited visceral symptoms within one day to three months following a positive SARS-CoV-2 PCR test result and underwent both abdominal and thoracic CT examinations. Patients were evaluated by dividing the patients into three groups according to COVID-19 PCR test positivity and the time of appearance of visceral symptoms: first day to first month, first month to second month, and second month to third month. The control group comprised individuals of identical age and sex to those who test negative for SARS-CoV-2 PCR, identified from the hospital database.

This retrospective, single-center, case-control study was conducted in accordance with the Declaration of Helsinki. Local ethics approval was obtained from our institution with reference number 2021-194 on 11th of November 2021.

Exclusion Criteria

The study excluded individuals with systemic diseases such as cancer, primary liver mass, metastatic liver disease, chronic arterial disease, severe heart, and kidney failure, those who had abdominal operations and trauma, intensive care patients, and pediatric patients.

***Abdominal CT*:** The studies were conducted using a 64-MDCT scanner (Discovery CT750 HD, GE Healthcare) with collimated slice thickness of 0.625 mm at the isocenter and an operating voltage of 120 kVp. All examinations were evaluated by two experienced radiologists of 12 and 15 years of expertise, along with four research assistants radiology utilizing the workstations of the radiology department on reformated images. Since the difference between portal vein diameter measurement in contrast-enhanced and non-contrast CT is negligible[12], abdominal CT examinations obtained with and without contrast were included in the study. Contrast and non-contrast CT ratios obtained from patients with COVID-19 and contrast and non-contrast CT ratios obtained from the control group were 53 (50.5%), 47 (62.7%), 52 (49.5%), and 28 (37.3%), respectively. Abdominal aorta diameters (subdiaphragmatic, renal artery, and pre-bifurcation), superior mesenteric artery, portal vein, celiac trunk, right and left renal arteries were measured from axial sections.

The radiological findings as well as clinical and laboratory findings obtained through the hospital information system were recorded.

Statistical analysis

The statistical analysis of the obtained data was performed using SPSS (Statistical Package for the Social Sciences) version 22.0 software program (IBM Corporation, Armonk, New York, USA)., While continuous variables are expressed as mean±standard deviation, categorical variables were given in percentages scheme. The chi-squared test was used to compare categorical variables between groups. Kolmogorov-Smirnov test was used to check the normality of distribution. Normal distributed continuous parameters were assessed by Student's t test, whereas non-normally distributed continuous variables were evaluated by Mann-Whitney U test. A p value of <0.05 was considered significant.

Results

In COVID-19 patients, the most common findings were corads-5 (n = 53, 53%), and the second most common was corads-1 (n = 21, 21%) findings on thorax CT. On abdominal CT, dilated loop was observed in 4 (4%) patients and perforation was observed in 2 (2%) patients. Cholelithiasis in 8 (8%) patients, intrahepatic bile duct dilatation in 2 (2%) patients, hepatomegaly in 36 (36%) patients, and splenomegaly in 12 (12%) patients were determined. Abdominal symptoms were the most common visceral pang.

When abdominal CT findings and vessel diameters were compared between the groups, it was seen that the portal vein diameter and left renal artery diameter were significantly smaller in the patient group (p=0.018, p=0.015, respectively). The results are shown in Table 1.

Table 1. Comparison of vascular diameter findings in Covid-19 group and control group

In the patient group, celiac trunk, abdominal aorta, bilateral renal artery, portal vein, superior mesenteric artery diameter and laboratory values were compared between patients with and without hepatomegaly and between patients with and without splenomegaly; It was observed that portal vein diameter in patients with splenomegaly and ALT values in patients with hepatomegaly were statistically significantly higher (p <0.001, p=0.047) (Table 2).

Table 2. Comparison of liver and spleen dimensions with portal vein and laboratory findings.

In cases with COVID-19, the most common findings were corads-5 (n = 53, 53%) and the second most common finding was corads-1 (n = 21, 21%) on thorax CT, and no significant association was found with visceral symptoms.

Discussion

In the literature, cases with abdominal vascular causes are presented as case reports or case series. However, we could not find any other studies specifically investigating abdominal vascular diameters in COVID-19 patients. The gastrointestinal appearances of COVID-19 are increasingly recognized, and also, pathophysiological mechanisms are clearly revealed. The most common finding was the thickening of the intestinal wall in abdominal images. Thrombosis of the splanchnic vasculature, intestinal ischemia, pancreatitis, solid organ infarction, and hepatosteatosis are other imaging findings recorded. Fluid-filled colon, pneumoperitoneum, intussusception, pneumatosis, and ascites are rarely present[13, 14]. In our study, our findings were hepatosplenomegaly, cholelithiasis, dilatedloop, intestinal perforation and intrahepatic bile duct dilatation, respectively. Due to the wide spectrum of findings, imaging findings of solid organs and vascular structures should be actively investigated in COVID-19 patients who present with visceral pang[15, 16]. Thromboembolism was not encountered in our study because we included patients retrospectively and randomly.

Previous studies evaluating abdominal CT findings in COVID-19 showed an association with low hemoglobin levels in hospitalized patients and a correlation with small vessel thrombosis[3, 13, 17.] While combining the tests for pulmonary embolism and deep vein thrombosis detection has been suggested in patients with COVID-19, minor caution has been paid to splanchnic venous system thrombosis. In COVID-19 patients who exhibit unexplained visceral pain, clinicians should consider including visceral organ infarction in the list of potential diagnoses. It is important for healthcare providers to be aware of the thrombotic manifestations associated with COVID-19, and radiologists should closely monitor patients for any signs of thrombosis to facilitate early detection[18]. Intestinal abnormalities have been shown to be directly (ileocolitis) or indirectly related to the theory of inflammation (mesenteric lymphadenitis). Intestinal ischemia secondary to vascular thrombosis should be suspected in case of the presence of thickening in intestinal wall. Procoagulant state and the existence of ACE-2 receptors in the GI tract may be cause of the intestinal involvement in COVID-19[19-21]. CT has replaced angiography owing to highly sensitive (93.3%) and specific (95.9%) features[22]. At present, CT is the preferred imaging modality for assessing patients who are clinically suspected of having arterial or venous thrombosis[23]. Abdominal vessel thrombosis, particularly acute mesenteric ischemia, is the primary cause of this condition. Tomography can reveal arterial and/or venous vascular filling defects as one of the observed findings in such case[23, 24]. The severity of mesenteric ischemia typically varies, ranging from temporary superficial alterations in the intestinal mucosa to transmural necrosis[25]. It is crucial to recognize that ischemia caused by thrombosis can result in reactive mesenteric vasoconstriction, compromised compensatory collateral blood flow, and worsening ischemic injury[26].

Portal vein thrombosis has been reported rarely, but a decrease in vessel diameter is expected in the chronic period[23]. Our study found that the diameter of the portal vein and the diameter of the left renal artery are lower in the group with COVID-19. We did not find any study in the literature on vascular diameter measurement in COVID-19 patients. The observed findings could potentially attributed to vasoconstrictive mechanisms secondary to the increase in Ang II[11].

In our study, although the most common corads-5 findings were found on thorax CT in cases with COVID-19, there was no correlation between visceral symptoms. Abdominal symptoms were not associated with the presence of pulmonary findings. This once again reveals the importance of abdominal CT examination.

Limitations

Intravenous and oral contrast material standardization could not be achieved in all patients in abdominal CT examinations.

Conclusion

Ang II increase has been held responsible for morbidity and mortality in the pathophysiology of SARS-CoV-2. With the increase of Ang II, we can detect intra-abdominal and vascular pathologies that may occur because of proinflammatory, profibrotic, prothrombotic and vasoconstrictive mechanisms with abdominal CT. In the presence of visceral symptoms in patients with COVID-19, abdominal CT with iv contrast will be more helpful to the clinician as radiologists will more clearly evaluate the intra-abdominal organs and vascular structures. Furthermore, we believe that the fact that hepatomegaly was the most common finding in our study may attract the attention of researchers in future studies.

Highlight key points

- In COVID-19, it is frequently seen in pathologies of other organs other than pneumonia.
- Vasoconstriction due to endothelial damage in SARS-CoV-2 may lead to abdominal symptoms.
- Abdominal vascular structures and parenchymal organs can be clearly evaluated by computed tomography.

Compliance with ethical standards

Conflicts of interest: The authors have no relevant conflicts of interest to declare.

Ethics Committee Approval: This study was approved by Ethics committee of Recep Tayyip Erdoğan University (Approval number: 11/11/2021, 2021-194).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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*Artificial intelligence (AI) assisted technologies (such as Large Language Models [LLMs], chatbots or image generators, ChatGPT) were not used in our study.

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Table 1. Comparison of vascular diameter findings in Covid-19 group and control group

	Covid-19 n=100 (%)	**Control n=80 (%)**	**P value**
Age (year)	68±16	65±16	0.195
Sex			0.329
Male	54 (52.4%)	49 (47.6%)	
Female	46 (59.7%)	31 (40.3%)	
Liver size			0.836
<160 mm	64 (56.1%)	50 (43.9%)	
>160 mm	36 (54.5%)	30 (45.5%)	
Spleen size			0.645
<130 mm	88 (54.7%)	73 (45.3%)	
>130 mm	12 (63.2%)	7 (36.8%)	
Celiac trunk diameter (mm)	7.59±1.35	7.54±1.56	0.819
Abdominal aorta diameter at subdiaphragmatic level (mm)	24.68±4.79	25.49±4.46	0.249
Diameter of the abdominal aorta at the level of the renal artery (mm)	20.27±4.09	20.35±3.56	0.893
Diameter of the abdominal aorta at the level of the iliac bifurcation (mm)	18.06±4.52	17.67±2.90	0.486
Portal vein diameter (mm)	11.21±2.02	14.11±11.99	***0.018***
Superior mesenteric artery diameter (mm)	6.93±1.25	7.14±1.34	0.281
Right renal artery diameter (mm)	4.78±1.16	4.99±0.97	0.198
Left renal artery diameter (mm)	5.02±1.24	5.4±0.84	***0.015***

Categorical variables were evaluated with chi-square. Quantitative data are shown as mean±standard deviation and compared with Student's t-test.

Table 2. Comparison of liver and spleen dimensions with portal vein and laboratory findings.

	Liver<160 mm (n=64)	**Liver>160 mm (n=36)**	**P value**
Celiac trunk diameter (mm)	7.49±1.31	7.77 ±1.42	0.320
Portal vein diameter (mm)	10.93±2.13	11.69±1.75	0.072
Albumine (g/dL)	30.9±7.0	33.2±7.7	0.150
ALT (u/L)	23 (3-562)	26 (5-514)	**0.047**
AST (u/L)	28 (9-1165)	31 (7- 267)	0.522
GGT (u/L)	39(8-457)	43 (10-731)	0.056
Total bilirubin (mg/dL)	0.68 (0.23-5.24)	0.6 (0.19-6.4)	0.436
Direct bilirubin (mg/dL)	0.14 (0.02-3.14)	0.13 (0.01-3.76)	0.405
LDH (u/L)	290 (114-2412)	263 (129-1277)	0.183
	Spleen<130 mm (n=88)	**Spleen >130 mm (n=12)**	**P value**
Portal vein diameter (mm)	10.94±1.90	13.13±1.90	**0.001**

Continuous variables are expressed as mean±standard deviation, categorical variables were given in percentages scheme. No statistically significant findings were found when the time elapsed after COVID-19 PCR positivity was compared with the vessel diameters on abdominal CT.