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Diagnostic value of abdominal sonography in confirmed COVID-19 intensive care patients

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Results

Forty-one sonographic examinations were done for 30 confirmed COVID-intensive care patients presented with abdominal symptoms.

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Background

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In December 2019, a large outbreak of a novel coronavirus infection occurred in Wuhan, China. The novel coronavirus was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses [1–3]. The pneumonic disease caused by this virus is called coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO), on January 30, 2020, the WHO declared a global public health emergency against the outbreak of COVID-19. The WHO recognized the coronavirus disease 2019 (COVID-19) as a worldwide pandemic on March 11, 2020 [1, 2].

The classical symptoms of COVID-19 are dry cough and fever and the diagnosis is confirmed by real-time reverse transcription-polymerase chain reaction (RT-PCR) testing for SARS-Cov-2 nucleic acid. Early radiological studies focused on chest imaging with classical high-resolution CT (HRCT) findings of peripheral patches of ground-glass densities with or without consolidations with bilateral basal predominance, organizing pneumonia pattern, crazy paving, mild bronchiectasis, and vascular engorgement may be encountered as well [4, 5].

As case numbers have increased worldwide, gastro-intestinal symptoms like diarrhea, constipation, abdominal pain, and vomiting have been increased; these symptoms are associated with positive laboratory results including abnormal liver function tests, renal function tests, and D-Dimer levels [6, 7].

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B Tailored for the clinical scenario

Liver function tests: especially serum bilirubin, alkaline phosphatase level (ALP)

Renal function tests

D-dimer test

Coagulation profile: INR, partial thromboplastin time, platelet count

Exclusion criteria

- Confirmed COVID-19 infection by positive PCR test for the causative agent (SARS-COV-2 virus) without abdominal manifestations
- Confirmed COVID-19 infection by positive PCR test for the causative agent (SARS-COV-2 virus) with a history of prior chronic disease, e.g., chronic calcular cholecystitis, prior renal, or hepatic disease

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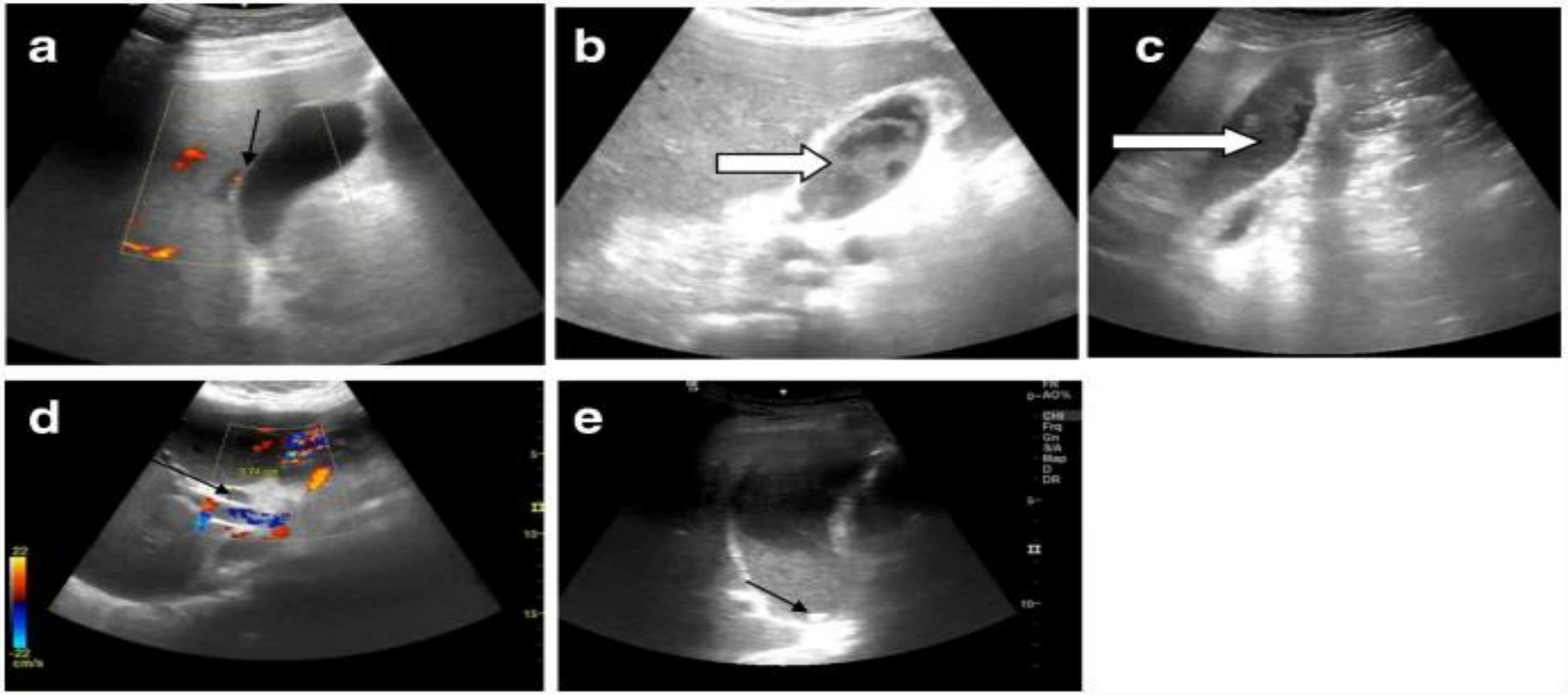
Fig. 1



Biliary system disease in five different COVID-19 intensive care patients: (**a**) the gall bladder shows thickened edematous wall with subtle mural hyperemia (arrow) (**b**) and (**c**) marked intraluminal biliary mud (arrows) sequel to cholestasis (**d**) ectatic CBD (7.4 mm) (black arrow) with no definite obstructive lesions probably due to cholestasis (**e**) distended gall bladder with mud, a subcentimeter gall bladder stone is noted (black arrow)

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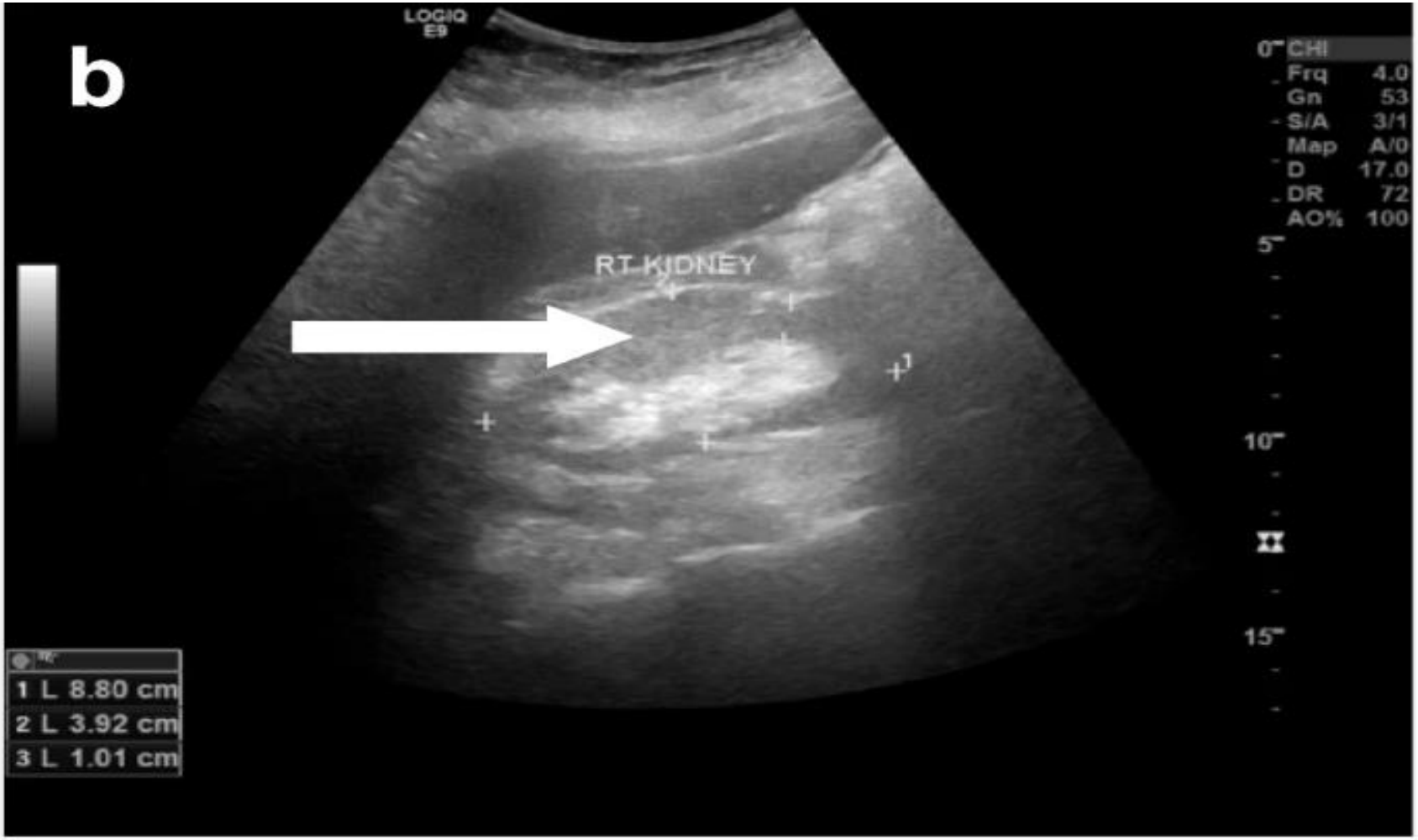

(**a** and **b**) Nephropathy in COVID19 intensive care patient with increased parenchymal echogenicity (open white arrows in **a** and **b**) still with parenchymal thickness and renal measurements within normal range, a midzonal simple cortical cyst is noted in the left kidney (arrow in **a**)

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Table 3

Sonographic imaging findings in the studied patient sample (NB: more than one finding in one examination was noted)

Imaging findings	Examinations for ICU patients	Percentage ($n = 41$)
Biliary system disease	**17**	**41.4%**
Acute calcular cholecystitis	10	
Acute calcular cholecystitis	1	
GB thickened wall with intraluminal mud	4	
Prominent CBD with no obstructive lesions	2	
Hepatomegaly	23	**56.09%**
Vasculopathy		
Spontaneous bleeding	2	4 (9.7%)
Vascular thrombosis	2	
Nephropathy	7	17%
Mild free ascetic fluid	5	12.1%

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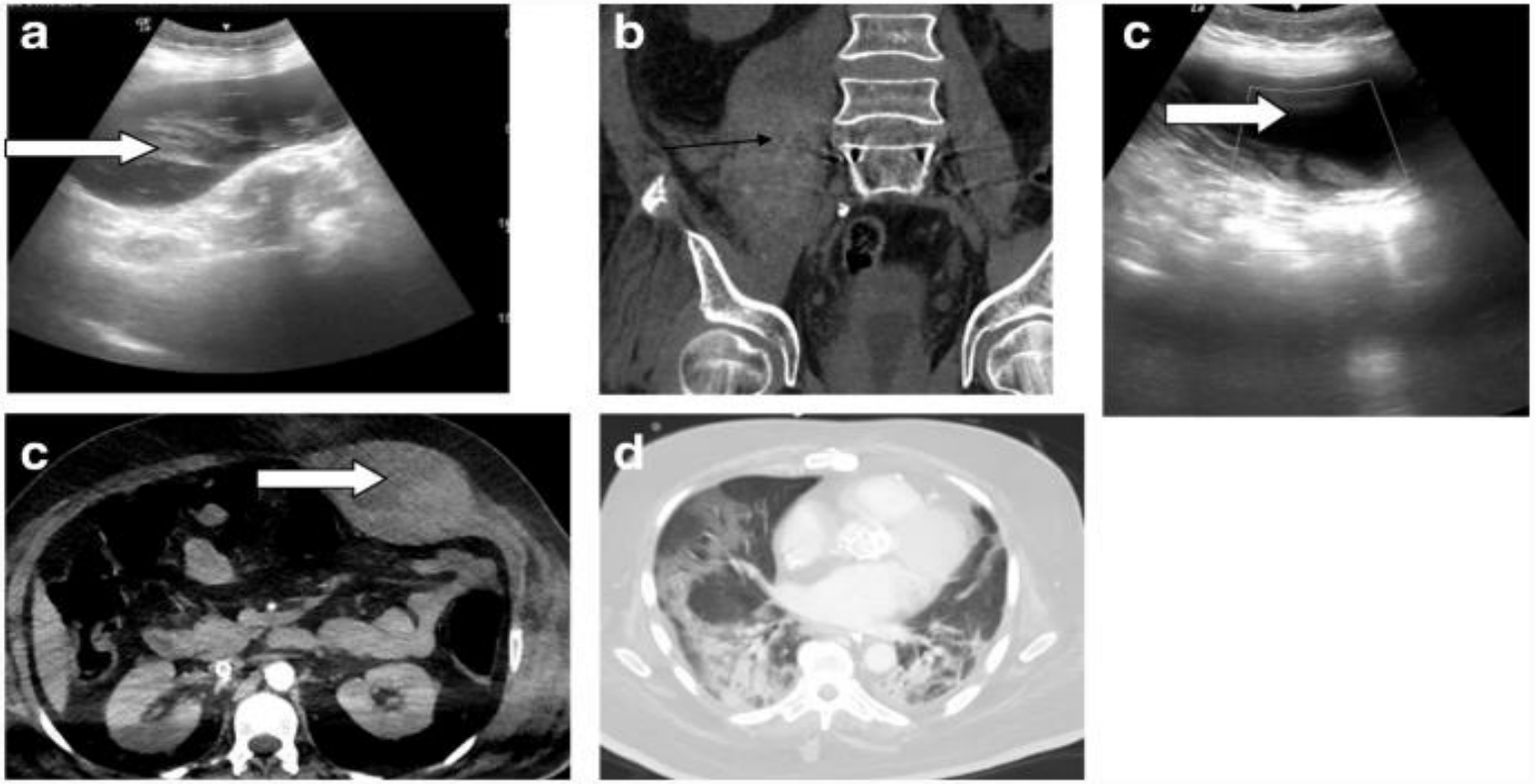
Fig. 3



Two different COVID19 patients with spontaneous hematomas (**a**) sonographic assessment of the right psoas spontaneous hematoma (black arrow in **a** and **b**) in COVID-19 patient with corresponding (**b**) non-contrast CT scan (**c**) left rectus sheath hematoma (white open arrow in **c** and **d**) with (**d**) corresponding CT image in the arterial phase with no contrast extravasation (**e**) basal chest scans in the second patient showing bilateral basal patches of consolidation of COVID-19 pneumonia

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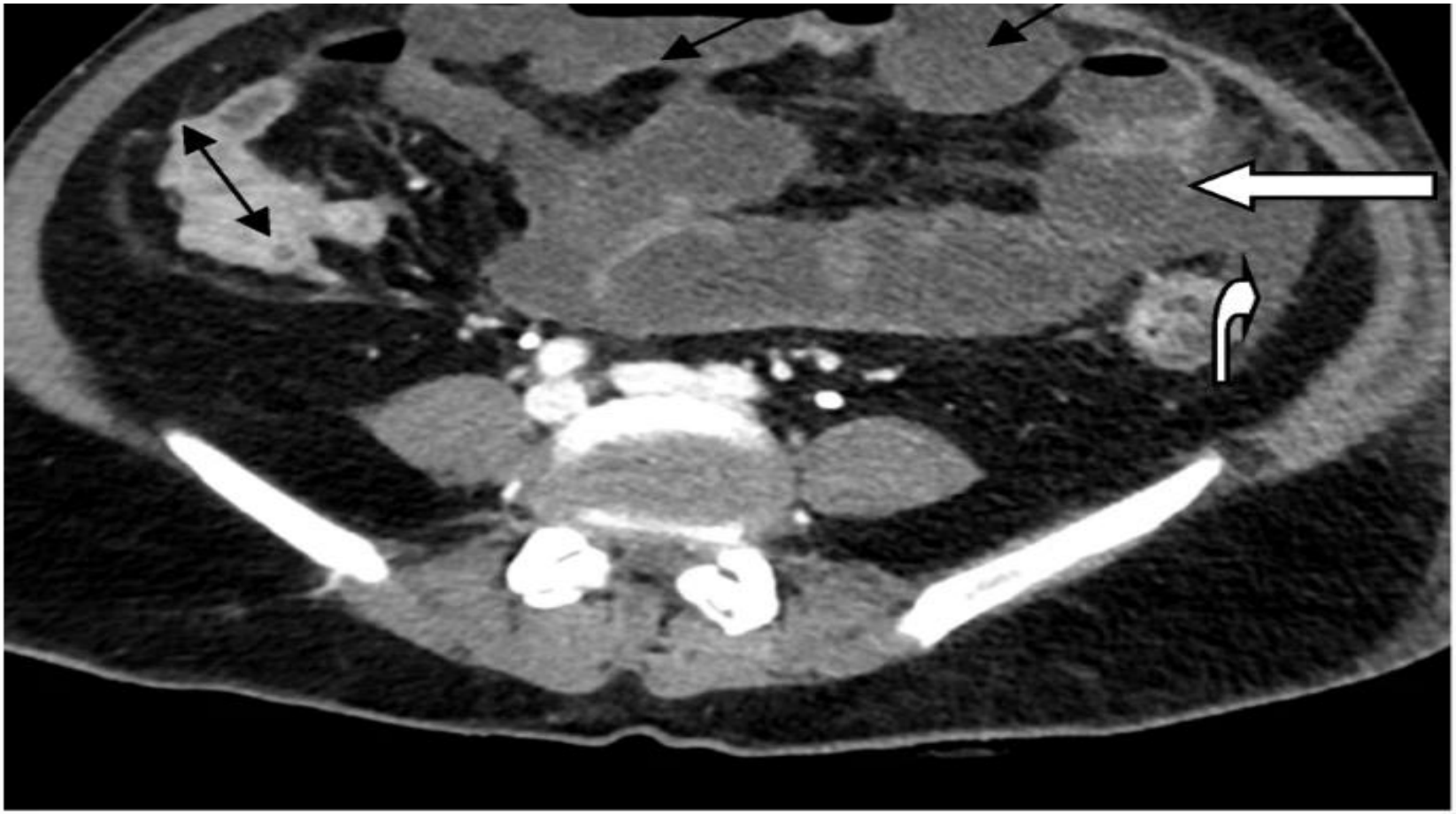

Axial post-contrast CT abdomen done for ICU patient with abdominal distention with limited sonographic assessment with distended small bowel loops (long black arrows), collapsed large bowel loops (double-headed black arrow), there is small bowel segmental mural poor enhancement is noted (straight white open arrow) with related mild collection (curved white open arrow)

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including luminal mud, stone, mural thickening, signs of inflammation with edematous wall, mural hyperemia, and thin rim pericholecystic fluid could be noted, this spectrum of findings is similar to Bhayan et al.'s study with their population sample in their study including ICU and non-ICU patients. SARS-COV2 can bind to the gall bladder epithelial cells leading to mucosal inflammation and this can explain the sonographic observations [14].

SARS-CoV-2 has a direct inflammatory effect on vascular endothelium [15]. Further, systemic coagulopathy is common in critically ill patients with COVID-19 [16, 17]. Tang et al. [16] found that next to an increased risk of thrombosis, patients seem to have an increased risk of bleeding as well, due to imbalances in platelet production and disruption, and disorders of the coagulation system. Coagulopathy sequel in our study was noted in four examinations (9.7%) including spontaneous hematomas noted in two examinations as well as vascular thrombotic sequel noted in two examinations. Major bleeding sequel to COVID-19 was noted in two patients only in Conti C et al.'s published study [17].

Nephropathy was the 3rd most common sonographic observation (*n*, 7/41; 17%) in our study, associated increase in renal function tests was noted. Few studies focused mainly on renal histopathology in COVID-19 patients were published [18, 19]. Further dedicated imaging studies are needed for more clarification.

The authors recommend dealing with COVID-19 as a systemic disease possibly due to possible direct viral cytopathic effect on the ACE-2 receptors rich organs and/or harmful systemic immune-mediated response to SARS-COV 2 infection.

The limitation of this study was that of a single-center retrospective study, which limits its generalizability. Pathologic correlation was not available for many patients with imaging abnormalities.

Conclusions

Go to:

Dedicated sonographic abdominal imaging was often performed for COVID-19 intensive care patients with clinicolaboratory abnormal findings with subsequent improvement of the management plan. Hepatobiliary dysfunction, nephropathy as well as coagulopathy sequel in the abdomen were the most common imaging findings. COVID-19 should be considered as a systemic disease.

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Abdominal Imaging Findings in COVID-19: Preliminary Observations

Rajesh Bhayana, Avik Som, Matthew D. Li, Denston E. Carey, Mark A. Anderson, Michael A. Blake, Onofrio Catalano, Michael S. Gee, Peter F. Hahn, Mukesh Harisinghani, Aoife Kilcoyne, Susanna I. Lee, Amirkasra Mojtahed, Pari V. Pandharipande, ... Show all authors

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Published Online: May 11 2020 | https://doi.org/10.1148/radiol.2020201908

Abstract

Background

Angiotensin-converting enzyme 2, a target of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), demonstrates its highest surface expression in the lung, small bowel, and vasculature, suggesting abdominal viscera may be susceptible to injury.

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Results

A total of 412 patients (average age, 57 years; range, 18 to >90 years; 241 men, 171 women) were evaluated. A total of 224 abdominal imaging studies were performed (radiography, *n* = 137; US, *n* = 44; CT, *n* = 42; MRI, *n* = 1) in 134 patients (33%). Abdominal imaging was associated with age (odds ratio [OR], 1.03 per year of increase; *P* = .001) and intensive care unit (ICU) admission (OR, 17.3; *P* < .001). Bowel-wall abnormalities were seen on 31% of CT images (13 of 42) and were associated with ICU admission (OR, 15.5; *P* = .01). Bowel findings included pneumatosis or portal venous gas, seen on 20% of CT images obtained in patients in the ICU (four of 20). Surgical correlation (*n* = 4) revealed unusual yellow discoloration of the bowel (*n* = 3) and bowel infarction (*n* = 2). Pathologic findings revealed ischemic enteritis with patchy necrosis and fibrin thrombi in arterioles (*n* = 2). Right upper quadrant US examinations were mostly performed because of liver laboratory findings (87%, 32 of 37), and 54% (20 of 37) revealed a dilated sludge-filled gallbladder, suggestive of bile stasis. Patients with a cholecystostomy tube placed (*n* = 4) had negative bacterial cultures.

Conclusion

Bowel abnormalities and gallbladder bile stasis were common findings on abdominal images of patients with coronavirus disease 2019. Patients who underwent laparotomy often had ischemia, possibly due to small-vessel thrombosis.

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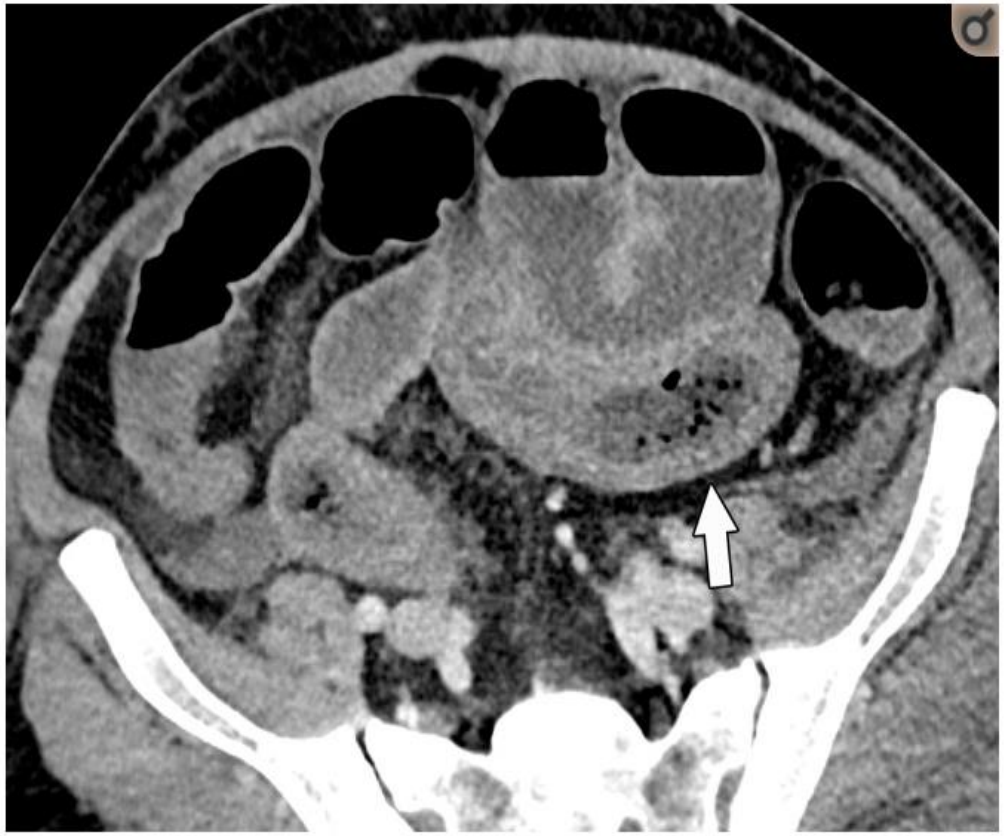

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(a) Axial and **(b)** coronal CT images of the abdomen and pelvis with intravenous contrast material in a 57-year-old man with high clinical suspicion for bowel ischemia. There is generalized small-bowel distension and segmental thickening (white arrows), with adjacent mesenteric congestion (black arrow) and a small volume of ascites (*). Findings are nonspecific but suggestive of early ischemia or infection.

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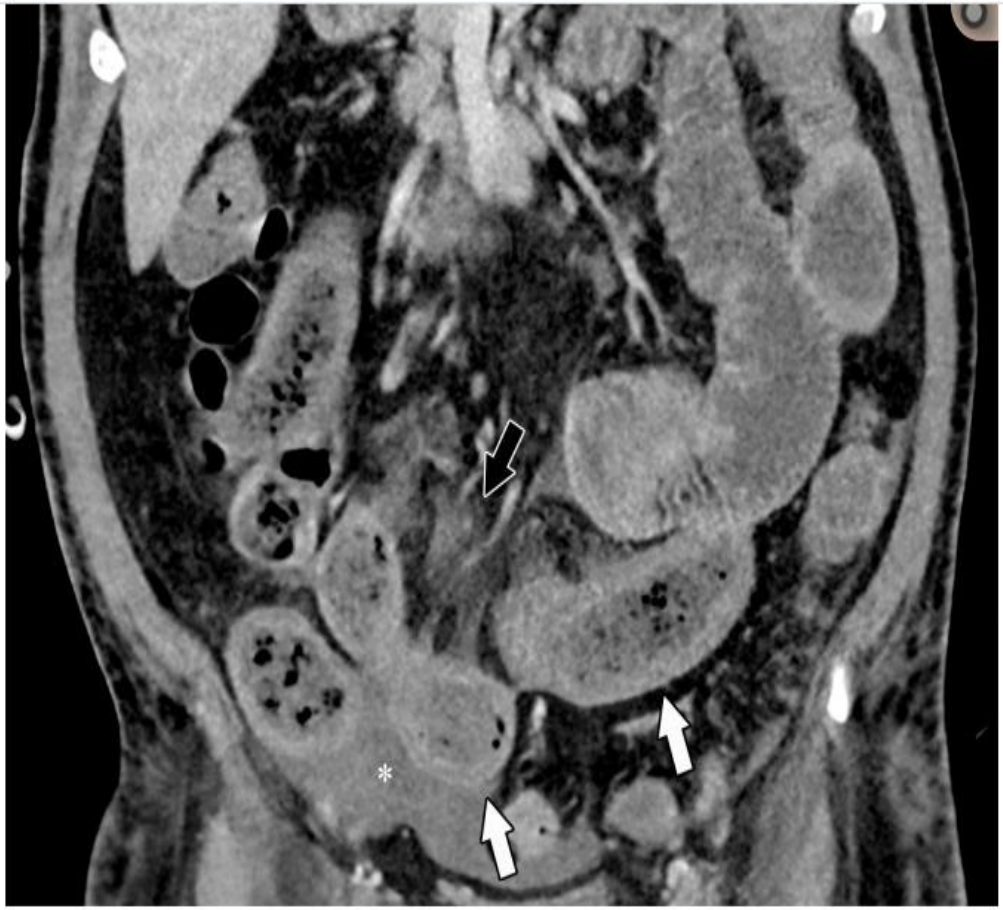

(a) Axial and **(b)** coronal CT images of the abdomen and pelvis with intravenous contrast material in a 57-year-old man with high clinical suspicion for bowel ischemia. There is generalized small-bowel distension and segmental thickening (white arrows), with adjacent mesenteric congestion (black arrow) and a small volume of ascites (*). Findings are nonspecific but suggestive of early ischemia or infection.

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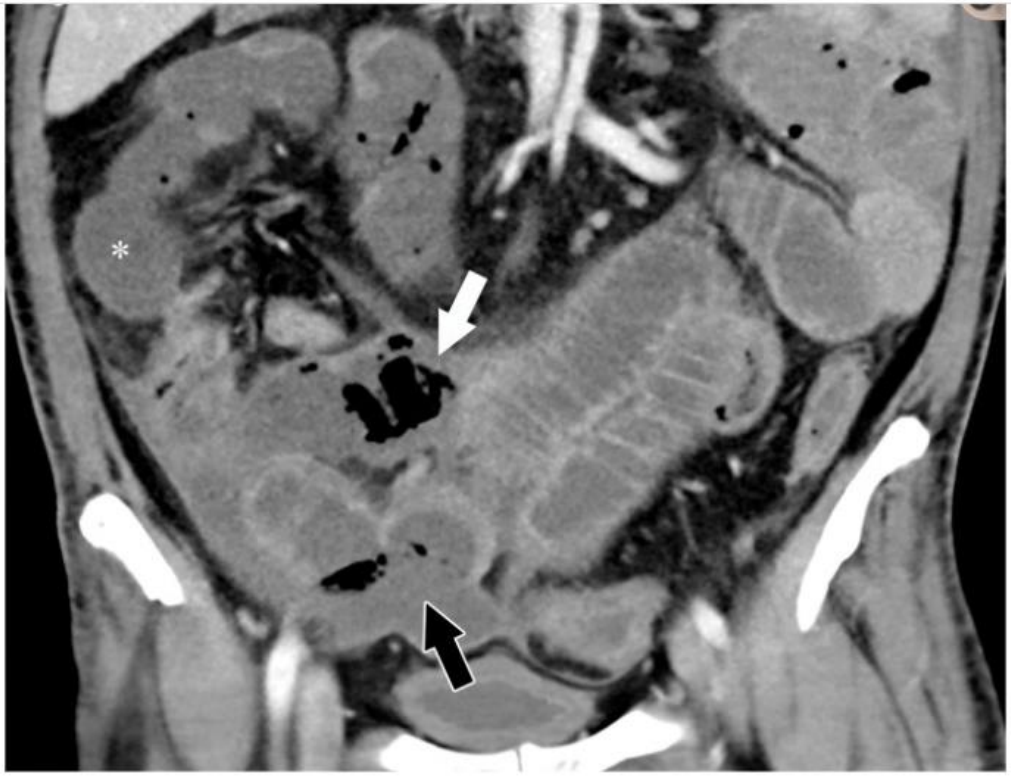

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(a) Coronal CT image of the abdomen and pelvis with intravenous contrast material in a 47-year-old man with abdominal tenderness shows typical findings of mesenteric ischemia and infarction, including pneumatosis intestinalis (white arrow) and nonenhancing bowel (*). Frank discontinuity of a thickened loop of small bowel in the pelvis (black arrow) is in keeping with perforation. **(b)** These findings are confirmed at laparotomy, with the additional observation of an atypical yellow discoloration of the bowel.

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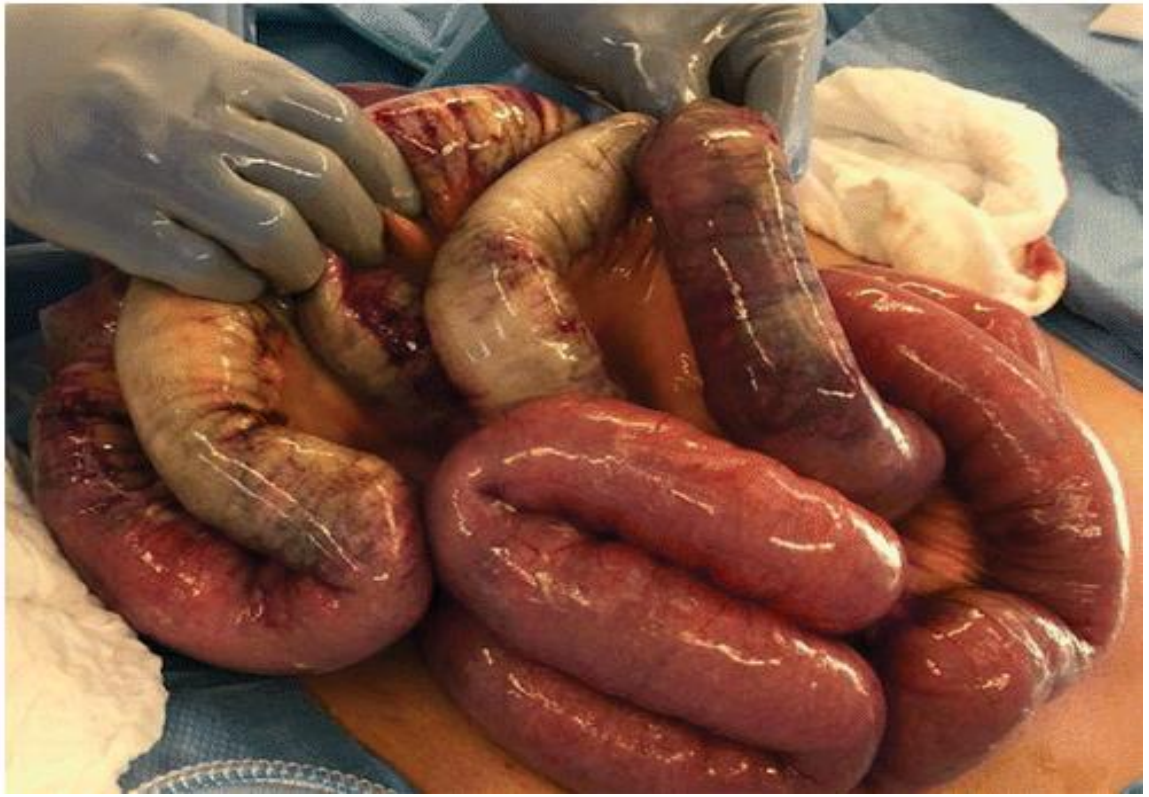

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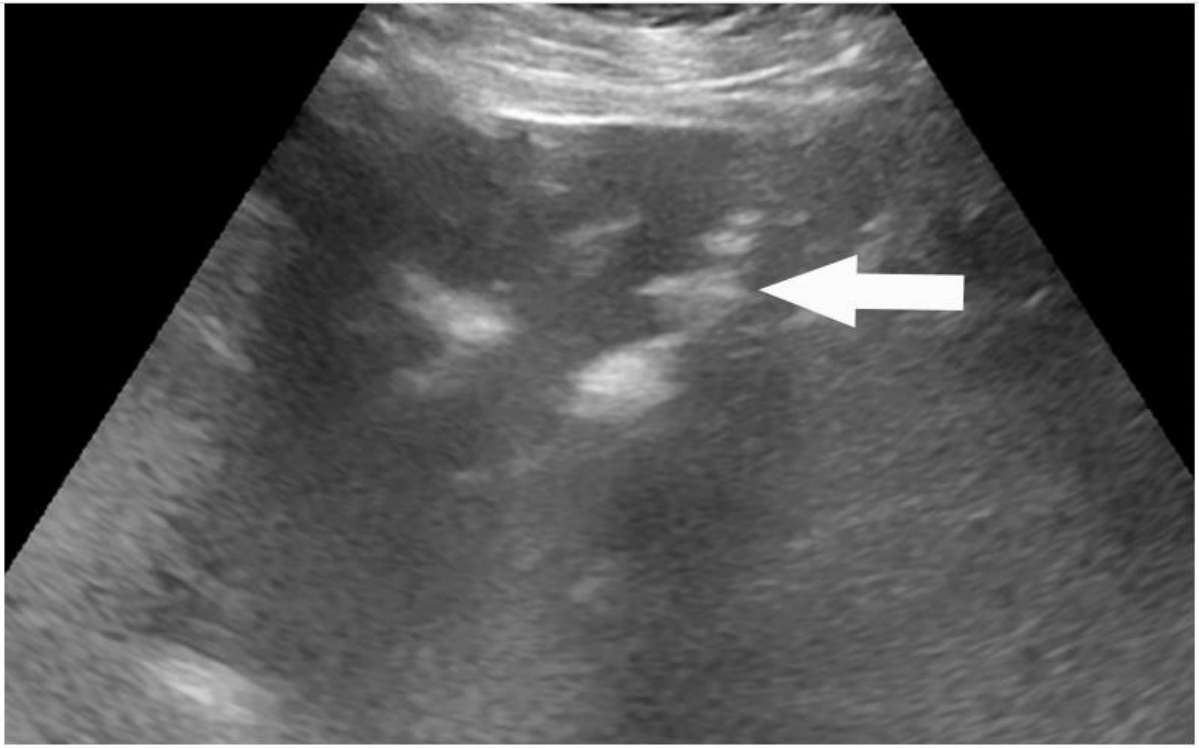

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(a) Abdominal US obtained because of elevated liver enzyme level in a 34-year-old man incidentally shows peripheral echogenic branching foci (arrow) with dirty shadowing (*), in keeping with portal venous gas. **(b)** Subsequent CT image of the abdomen and pelvis with intravenous contrast material enabled confirmation of portal venous gas and shows gas in the transverse mesocolon vasculature (arrow). At laparotomy, patchy areas of yellow discoloration of uncertain origin are identified on the antimesenteric aspect of the transverse colon. Second-look laparotomy shows yellow discoloration of the stomach and no ischemia.

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Radiology

Table 2: CT and Right Upper Quadrant US Imaging Findings in Inpatients Who Tested Positive for SARS-CoV-2

Imaging Findings	All Patients	Patients in the ICU	Patients Not in the ICU	*P* Value
CT of abdomen and pelvis	42	20	22	
Abnormal bowel wall	13 (31)	10 (50)	3 (14)	.02
Colonic or rectal thickening	7 (17)	4 (20)	3 (14)	.69
Small-bowel thickening	5 (12)	5 (25)	0 (0)	.02
Pneumatosis or PV gas	4 (9.5)	4 (20)	0 (0)	.04
Perforation	1 (2.4)	1 (5)	0 (0)	.48
Fluid-filled colon, *n* (%)	18 (43)	13 (65)	5 (23)	.01
Solid organ infarction	2 (4.8)	2 (10)	0 (0)	.22
Pancreatitis	1 (2.4)	0 (0)	1 (4.5)	>.99
Findings suggestive of hepatitis (GB thickening, heterogeneous liver)	1 (2.4)	1 (5)	0 (0)	.48
Right-upper-quadrant US	37	32	5	
GB sludge and distension	20 (54)	19 (59)	1 (20)	.16
GB sludge, nondistended	2 (5.4)	2 (6.3)	0 (0)	>.99
GB wall-thickening	1 (2.7)	1 (3.1)	0 (0)	>.99
Pericholecystic fluid	1 (2.7)	1 (3.1)	0 (0)	>.99
Fatty liver	10 (27)	8 (25)	2 (40)	0.6
PV gas	1 (2.7)	1 (3.1)	0 (0)	>.99
Portal vein thrombosis	0 (0)	0 (0)	0 (0)	...

Note.—Data are numbers of patients, with percentages in parentheses. $P < .05$ indicates a significant difference. GB = gallbladder, ICU = intensive care unit, PV = portal venous, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

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Radiology

SARS-CoV-2 is thought to gain access to cells via surface expression of angiotensin-converting enzyme 2 (ACE2) (7). Thus, tissues with high levels of ACE2 expression are assumed to be susceptible to direct infection (8). ACE2 surface expression is most abundant in lung alveolar epithelial cells, enterocytes of the small intestine, and the vascular endothelium (9). The large amount of ACE2 surface expression in the GI tract and, to a lesser extent, in the biliary epithelium has been offered as a possible explanation for GI symptoms and liver injury (10,11). In addition, SARS-CoV-2 has been identified in stool samples of a substantial proportion of infected patients (12–14).

KẾT LUẬN

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