

# Splenic infarction: an uncommon yet significant complication in COVID-19 patients - a case series report and literature review

Aakanksha Pitliya<sup>1</sup>, Mizba Basheer Patel<sup>2</sup>, Vanshika Batra<sup>3</sup>, Bhavika Agrawal<sup>4</sup>,  
Neeraj Kancherla<sup>5</sup>, Kumari Priya Yadav<sup>6</sup>, Deepak Kumar<sup>7</sup>, Anmol Pitliya<sup>8</sup>

<sup>1</sup>Department of Medicine, Pamnani Hospital and Research Center, Mandsaur, MP, India;

<sup>2</sup>Department of Medicine, Deccan College of Medical Sciences, Hyderabad, Telangana, India;

<sup>3</sup>Department of Medicine, SGT Medical College, Gurugram, Haryana, India;

<sup>4</sup>Department of Internal Medicine, Mercy Catholic Medical Center, Philadelphia, Pennsylvania, USA;

<sup>5</sup>Department of Medicine, King George Hospital, Visakhapatnam, AP, India;

<sup>6</sup>Department of Medicine, Goa Medical College and Hospital, Dabolim, Goa, India;

<sup>7</sup>Department of Medicine, Jinnah Sindh Medical University, Karachi, Sindh, Pakistan;

<sup>8</sup>Department of Internal Medicine, Camden Clark Medical Center/ University of West Virginia, Parkersburg, WV, USA

Article received 2 September 2023; accepted 31 October 2023

## SUMMARY

Splenic infarction is a rare complication observed in some patients affected by coronavirus disease 19 (COVID-19), with poorly understood clinical features and prognosis. We analyzed the histopathological reports and clinical data from six adult patients admitted to a tertiary care center between 10 October 2020, and 10 January 2021, diagnosed with COVID-19 and splenic infarct. Confirmed COVID-19 diagnosis was established through a nasopharyngeal swab while uncertain diagnoses, children, and non-hospitalized patients were excluded. Splenic infarct was confirmed by abdominal CT scan. The findings indicated a direct impact of the virus on the spleen, evident through a decline in lymphocyte counts. These results emphasize the significance of comprehending the potential complications and pathological changes associated with

COVID-19, particularly concerning splenic involvement. The literature review employed a specific keyword search strategy focusing on COVID-19 and splenic infarction case reports. The review highlighted the association between COVID-19 and an increased risk of thromboembolism, emphasizing the importance of monitoring and managing clotting issues. It also underscored the need to consider splenic infarction as a potential complication in COVID-19 patients with abdominal pain. The study highlighted the diverse nature of splenic infarction in COVID-19 patients, necessitating a multidisciplinary management approach and calls for further research to elucidate underlying mechanisms and optimize treatment strategies.

*Keywords:* Covid-19, splenic infarction.

## INTRODUCTION

The World Health Organization (WHO) has classified the coronavirus disease (COVID-19) as a pandemic, resulting in a significant number of

fatalities and hospital admissions worldwide. Although the majority of COVID-19 cases are categorized as mild, severe cases have been associated with respiratory failure, septic shock, and/or multiple organ dysfunction [1].

Several research studies have shown that COVID-19 infection increases the risk of both venous and arterial thromboembolism, creating a prothrombotic state [2-4]. Splenic infarction is an uncommon condition that can manifest as pain in the

*Corresponding author*

Aakanksha Pitliya

E-mail: pitliya.aakanksha@gmail.com

left abdomen and may be caused by hypercoagulable conditions [4]. Currently, there is limited literature documenting clinical cases of COVID-19 associated with splenic infarction [5].

We present a case series on splenic infarction in COVID-19 patients that stands out due to its rare occurrence and poorly understood clinical features, shedding light on an uncommon complication. The study provides valuable insights into the direct impact of the virus on the spleen, emphasizing the significance of comprehending potential complications associated with COVID-19.

Furthermore, we conducted a systematic literature search on PubMed to identify relevant case reports for literature review.

## ■ CASE REPORTS

In this retrospective case series, we investigated six cases of splenic infarction in patients with COVID-19 admitted to a tertiary care center between 10 October 2020 and 10 January 2021, diagnosed with COVID-19 and splenic infarcts. Confirmed COVID-19 diagnosis was established through a nasopharyngeal swab or Computed Tomography (CT) scan, while uncertain diagno-

ses, children, and non-hospitalized patients were excluded. Splenic infarct was further confirmed by abdominal CT scan.

Table 1 shows the presentation of a case series consisting of six individuals who developed splenic infarct after being diagnosed with COVID-19 between 10 October 2020, and 10 January 2021 admitted to a tertiary care hospital.

### Case 1

A 35-year-old male presented with a 6-day history of fever, chills, rigor, abdominal pain, and maculopapular rash. Laboratory results showed hemoglobin (Hb) 14.1 gm%, white blood cell (WBC) 2900, platelet (PLT) 50000, and D-dimer and fibrin degradation products (FDP) within the normal range. The Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) test was positive. A Computed Tomography (CT) scan revealed splenic laceration with extravasation from the breached capsule and intra-peritoneal collection in multiple cavities. Treatment included 3 units of packed red blood cells (RBCs) and symptomatic management. Anti-phospholipid antibody levels were not measured. The patient's hemoperitoneum resolved within a week.

**Table 1 - Case series presentation of six cases presenting with splenic infarct after a confirmed diagnosis of COVID-19.**

Features	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Age, Sex, and Past medical history	35 years, Male	67 years, Male, Pre-existing Hypertension (HTN)	29 years, Female, Sickle Cell Trait	58 years, Male, Dyslipidemia	57 years, Male, Type 2 DM, Obesity	70 years, Male, HTN, BPH, GERD, Depression
Presenting Symptoms	Fever for 6 days, Chills and rigor, Abdominal pain, and maculopapular rash	Moderate abdominal pain for 12 days, nausea, and lack of appetite	Fever, vomiting, cough, abdominal pain, and myalgia	Shortness of breath, cough, and tachypnea	Fever, cough, and dyspnea	Fever, dyspnea, cough, nausea, and weakness
Personal and social history	Cocaine use (Irregular)	Smoking history, 15 pack years	Alcohol use	Smoker since 24 pack years	No significant history	No significant history
Lab-work:						
Hb (gm%)	14.1	WNR	11.2	18.5	NA	13.7
WBC (cells/cumm)	2,900	WNR	21,130	20,006	NA	14,900
Platelet (cells/cumm)	50,000	WNR	1,91,000	3,85,000	NA	NA
D-Dimer (ng/ml)	WNR	1,523	2,822	3,012	1,169	1,441
FDP (mg/dL)	WNR	NA	504	312	NA	NA
RT-PCR Results	Positive	Positive	Positive	Positive	Positive	Positive

Continue >>>

Continue &gt;&gt;&gt;

Features	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
CT Scan findings of the Chest, Abdomen and Pelvis	Extravasation from a breached capsule in the upper pole of the spleen indicating splenic laceration along with intra-peritoneal collection in the pre-splenic, pre-hepatic, and pelvic cavity	Abdo-splenic infarction with 70% of parenchyma with distal thrombus in the splenic artery, chest, small patchy opacities in bilateral lung bases <30% involvement	Bilateral lungs show diffuse ground glass opacity with splenic hypodensity and peri-splenic edema consistent with splenic infarct	CT- Angiography shows no flow in the left posterior, left anterior, and mid-peritoneal artery	CT Chest –Ground glass opacity with peripheral consolidation. CT Abdo-intra-aortic thrombi with occlusion of the distal superior mesenteric and right superficial femoral artery along with splenic and renal ischemic lesions	4 cm well-demarcated area of non-enhancement in antero superior spleen with large hematoma within the bilateral rectus sheath
Treatment Given	3 Units of packed RBC, and symptomatic management	Enoxaparin 1 mg/kg BD with improvement in clinical symptoms changed to oral rivaroxaban later on	Hydroxychloroquine, one dose of tocilizumab and continuous Heparin infusion in ICU	Hydroxychloroquine, Azithromycin, Anakinra, LMWH	Hydroxychloroquin, antibiotics, Low MolecularWeight Heparin (LMWH), tocilizumab, oxygen therapy	Enoxaparin, dexamethasone, remdesivir, radiologic embolization for hematoma
Anti-Phospholipid Antibody Levels						
Ig M	Not measured	Not measured	20.4	34.2	21	Not measured
Ig G			14.8	44.7	Not measured	Not measured
Prognosis/ Outcome	Hemoperitoneum resolved within a week	Resolution of symptoms	Not mentioned	Not mentioned	Resolution of symptoms in a month	Bleeding stopped and patient stable on day 2

HTN: Hypertension, DM: Diabetes Mellitus, BPH: Benign Prostatic Hyperplasia, GERD: Gastro-esophageal reflux disease, Hb: Hemoglobin, WNR: Within Normal Range, NA: Not Applicable, WBC: White Blood Cell, FDP: Fibrin Degradation Product, RT-PCR: Reverse Transcriptase Polymerase Chain Reaction, CT: Computed Tomography, RBC: Red Blood Cell, BD: Twice daily (bis in die), ICU: Intensive Care Unit, LMWH: Low-Molecular-Weight Heparin, Ig: Immunoglobulin.

## Case 2

A 67-year-old male with pre-existing hypertension presented with moderate abdominal pain for 12 days, and symptoms of nausea and lack of appetite. Laboratory results showed normal range values for Hb, WBC, and PLT, while D-dimer was elevated at 1523 ng/mL and FDP was not available. The RT-PCR test was positive. CT scan revealed splenic infarction with 70% involvement of the parenchyma and a distal thrombus in the splenic artery. Chest imaging showed small patchy opacities in the bilateral lung bases with less than 30% involvement. The patient was treated with enoxaparin at a dose of 1 mg/kg BD, which was later switched to oral rivaroxaban. Anti-phospholipid antibody levels were not measured. The patient experienced a resolution of symptoms.

## Case 3

A 29-year-old female with sickle cell trait presented with fever, vomiting, cough, abdominal pain,

and myalgia. Laboratory results showed a hemoglobin level of 11.2 gm%, a WBC count of 21,130, a platelet count of 191000, a D-dimer level of 2822 ng/mL, and an FDP level of 504 mg/dL. Anti-phospholipid antibody levels were measured at IgM 20.4 and IgG 14.8. The RT-PCR test was positive. CT scan revealed diffuse ground glass opacity in both lungs, along with splenic hypodensity and peri-splenic edema consistent with splenic infarct. The patient received treatment with hydroxychloroquine, one dose of tocilizumab, and continuous heparin infusion in the ICU.

## Case 4

A 58-year-old male with a past medical history of dyslipidemia presented with symptoms of shortness of breath, cough, and tachypnea. Laboratory results revealed a Hb 18.5 gm%, WBC count 20,006, PLT 385000, D-dimer 3012 ng/mL, and an FDP 312 mg/dL. Anti-phospholipid antibody levels measured IgM 34.2 and IgG 44.7. The RT-PCR

test was positive. CT angiography showed no flow in the left posterior, left anterior, and mid-peritoneal arteries. The patient received treatment with hydroxychloroquine, azithromycin, anakinra, and low-molecular-weight heparin.

#### Case 5

A 57-year-old male with a past medical history of type 2 diabetes mellitus (T2DM) and obesity presented with fever, cough, and dyspnea. Laboratory results an elevated D-dimer level of 1169 ng/mL. The RT-PCR test was positive. Anti-phospholipid antibody levels measured IgM 21. CT scan revealed ground glass opacity with peripheral consolidation in the chest and intra-aortic thrombi with occlusion of the distal superior mesenteric and right superficial femoral artery, along with splenic and renal ischemic lesions. Treatment included hydroxychloroquine, antibiotics, low-molecular-weight heparin, tocilizumab, and oxygen therapy. The patient experienced a resolution of symptoms within a month.

#### Case 6

A 70-year-old male with a past medical history of hypertension, benign prostatic hyperplasia (BPH), gastroesophageal reflux disease (GERD), and depression presented with symptoms of fever, dyspnea, cough, nausea, and weakness. Laboratory results showed a hemoglobin level of 13.7 gm%, a WBC count of 14,900, and a D-dimer level of 1441 ng/mL. The RT-PCR test was positive. CT scan revealed a 4 cm well-demarcated area of non-enhancement in the anterior superior spleen with a

large hematoma within the bilateral rectus sheath. Treatment included enoxaparin, dexamethasone, remdesivir, and radiology embolization for the hematoma. The patient's bleeding stopped, and he remained stable on day 2 in-hospitalization, and symptoms resolved within 2 weeks.

#### LITERATURE SEARCH

Our literature search strategy involved using the following specific keywords: "COVID-19," "pathologic processes," "splenic infarct," "acute abdomen," and "hemoperitoneum" to explore the database. We focused on patients who had confirmed CT scan findings of splenic infarct and a recent confirmed history of COVID-19, validated either through nasopharyngeal swabs or RT-PCR tests. We limited our selection to case reports written in English, involving human subjects over the age of 19, and accessible in full-text format.

Exclusion criteria includes symptomatic patients without imaging evidence of splenic infarct, individuals with unconfirmed COVID-19 symptoms despite recent exposure, animal subjects, studies written in languages other than English and patients below the age of 19.

Initially, we identified 60 articles, and we refined our selection by excluding articles that did not meet our inclusion criteria. Eventually, our review comprised 21 selected case reports meeting our inclusion criteria.

Table 2 summarizes all the relevant reports included in this review.

**Table 2 - Summary of the case reports included in the literature review.**

Study number	First Author	Date	Age, gender and past medical history	Days after COVID-19 diagnosis to infarct presentation	CT Scan findings	Treatment provided	Prognosis/ Outcome
1.	Semra Demirli Atıcı [18]	March 2022	45-year-old, male	9 days	CT abdomen revealed a 57 × 48 mm non-contrast hypodense area in the middle of the spleen which was extending from the region of the capsule to the hilus	Enoxaparin; Discharged on ticagrelor	Recovered
2.	Natasha Ghalib [19]	Feb 2021	67-year-old, female, with diabetes mellitus hypertension, coronary artery disease, hypothyroidism and mild intermittent asthma	–	In a chest CT angiogram, a wedge-shaped region with reduced density was identified in the inner part of a spleen of regular size. This signifies a splenic infarct	Asymptomatic, discharged on enoxaparin	Incidental finding, asymptomatic

Continue >>>

Continue &gt;&gt;&gt;

Study number	First Author	Date	Age, gender and past medical history	Days after COVID-19 diagnosis to infarct presentation	CT Scan findings	Treatment provided	Prognosis/ Outcome
3.	Dennison JJ [8]	May 2021	70-year-old, male, benign prostatic hypertrophy, hypertension, gastroesophageal reflux disease, and depression	6 days	CT scan (abdomen, pelvis) and intravenous contrast: Spleen: A 4 cm non-enhanced area in the anterior superior spleen indicates acute infarct. Mesenteric Area: Inflammation in adipose tissue around mesenteric vessels (left upper quadrant) suggests microhemorrhage or thrombosis. Rectus Muscles (Bilateral) Left: Hematoma (5.6 cm × 18 cm) with contrast, indicating active bleeding. Right: Hematoma (7 cm × 4 cm × 10 cm) with contrast, suggesting ongoing bleeding	Interventional embolization of hematoma	Recovered
4.	Falmata Laouan Brem [20]	October 2022	59-year-old, male, Diabetes Mellitus	2 days	The CT angiography (CTA) showed a clot in the aortic isthmus and the descending thoracic aorta, along with infarctions in the spleen and kidneys	Embolectomy, Low Molecular weight heparin (LMWH)	Recovered in 2 weeks
5.	Ioannis Dimitriou [21]	Nov 2022	46-year-old, male	14 days	Abdominal CT scan revealed total blockage of the splenic artery, a significant splenic infarction, and a complete lack of blood circulation to the spleen	Enoxaparin, laparotomy and splenectomy	Recovered in 8 weeks
6.	Srikrishna V. Malayala [22]	Sept 2022	A 47-year-old female with Obstructive Sleep Apnea	3 days	A partially blocked thrombus is evident the descending thoracic aorta, accompanied by several small to moderate splenic infarcts in CT abdomen	Low molecular weight heparin and antibiotics	Recovered
7.	Jordan Childers [23]	Jul 2022	A 66-year-old, male with dyslipidemia	11 days	Aortic CTA showed wedge-shaped regions near the hilum suggesting potential infarction, presence of a thrombus or reduced density in the splenic artery, and a small clot in the abdominal aorta below the kidneys	Heparin, switched to enoxaparin	Died on day 7 of hospitalization
8.	Ricardo Rigual [24]	May 2022	53-year-old, male	16 days	Abdominal CT indicated a hemorrhagic spleen tissue damage. Urgent angiography confirmed a linked splenic pseudo-aneurysm	Enoxaparin	Discharged to rehabilitation facility in 30 days
9.	Georgios Mavraganis [25]	Jan 2022	64-year-old	5 days	The abdominal CT scan showed a finding of splenic infarct	Enoxaparin, switched to Fondaparinux on day 8	Recovered in 19 days
10.	Osama Qasim Agha [26]	Sept 2020	60s, male, asthma, obstructive sleep apnea, morbid obesity, immunoglobulin G (IgG) deficiency, and hypertension	7 days	Abdominal and pelvic CT scan with oral and intravenous contrast revealed splenic artery clot along with an infarct affecting over 50% of the spleen's volume	Heparin for 24 hours, switched to enoxaparin; discharged on oral rivaroxaban	Recovered in 21 days

Continue &gt;&gt;&gt;

Continue &gt;&gt;&gt;

Study number	First Author	Date	Age, gender and past medical history	Days after COVID-19 diagnosis to infarct presentation	CT Scan findings	Treatment provided	Prognosis/ Outcome
11.	Egemen Yildiz [27]	Oct 2019	68-year-old, male	0	CTa with IV contrast indicated a Splenic infarction	Enoxaparin	Recovered in a week
12.	Abdul Rehman [28]	August 2021	33-year-old woman	0	CT abdomen and pelvis with IV contrast shows wedge-shaped hypodensity in the spleen indicating an acute splenic infarct	Enoxaparin; discharged on warfarin	Recovered in 8 days
13.	Osama BataynEh [29]	Aug 2022	76-year-old, hypertension	14 days	CT Abdomen/ Pelvis with contrast revealed multifocal ischemic splenic infarcts without perisplenic hematoma	Heparin, switched to warfarin; discharged on apixaban	Recovered in 3 days
14.	Jaques Sztajnbok [11]	Oct 2021	60-year-old female	5	The CT scan indicated significant enlargement of the spleen with distinct peripheral hypodense lesions, implying splenic infarction. Additionally, a hypodense region adjacent to the right side of the descending aorta was suggestive of a thrombus	Enoxaparin, switched to warfarin; discharged on warfarin	Recovered in 26 days
15.	Gustavo Rodrigues Alves Castro [30]	March 2021	67-year-old, male	–	Abdominal CT showed a thrombus in the far end of the splenic artery and a spleen tissue damage affecting around 70% of the spleen's tissue	Enoxaparin 1mg/kg and oral rivaroxaban on day 5 of discharge	Discharged on day 5
16.	Graham Prentice [16]	December 2021	50-year-old man, no significant medical history	14 days	CT angiography indicated almost complete spleen artery tissue damage. CT abdominal arterial phase imaging additionally revealed clot material within the splenic artery, causing the observed spleen conditions	Unfractionated heparin for 48 hours, anticoagulation was switched to twice daily subcutaneous enoxaparin twice daily injections at a dose of 1 mg/kg	Sixteen days after being medically fit for discharge
17.	Gokhan Arslan [31]	July 2021	42-year-old female patient with nonsignificant past medical history	45 days	CT images revealed a wedge-shaped hypo-enhancing region of the spleen	24-hour intravenous heparin therapy, followed by enoxaparin SC 1 mg/kg twice daily and 100 mg per oral acetylsalicylic acid once daily for 3 months	No complications were observed during the 3-month follow-up
18.	Sevinç Dağstanlı [32]	Apr 2021	A 46-year-old woman with diabetes mellitus type 2	25 days	The CT angiography of the patient showed a thrombus that occupied a significant portion of the portal vein, splenic vein, and superior mesenteric vein lumens	Percutaneous drainage, antibiotic therapy (piperacillin + tazobactam, LMWH)	Patient discharged on eighth day

Continue &gt;&gt;&gt;



Continue &gt;&gt;&gt;

Study number	First Author	Date	Age, gender and past medical history	Days after COVID-19 diagnosis to infarct presentation	CT Scan findings	Treatment provided	Prognosis/ Outcome
19.	Daniel Alvarenga Fernandes [33]	Jan 2022	42-year-old male patient with controlled hypertension	6 days	CT scans showed thrombi in the splenic artery, vein and areas of splenic infarction	Enoxaparin	Discharged from the hospital after 6 days
20.	Maya Ramanathan [34]	Dec 2020	54-year-old, obese	11 days	Ct scan revealed large areas of hypoattenuation in the splenic parenchyma suggestive of infarction	Apixaban	Discharged 4 days later
21.	W. Imoto [35]	Dec 2020	64-year-old man, history of gastric ulcer and duodenal ulcer	Day 15 of hospitalization	Enhanced computed tomography (CT) show splenic infarction	Enoxaparin sodium	Unfortunately, patient died on day 26

CT: Computed Tomography, CTA: CT Angiogram, LMWH: Low Molecular Weight Heparin, IV: Intravenous.

## DISCUSSION

COVID-19 is linked with an increased tendency for thrombo-embolism formation, particularly in more severe disease cases. According to a recent meta-analysis, COVID-19 patients who developed thromboembolism had a 74% higher risk of mortality compared to those who did not. This highlights the importance of monitoring and managing potential clotting issues in COVID-19 patients to prevent further complications and improve outcomes [6]. At the onset, this condition is typically characterized by elevated D-dimer levels and fibrin/fibrinogen degradation products [7]. It is unclear what role aPL (antiphospholipid) plays in the thrombotic complications of COVID-19. After analyzing 23 studies that involved 250 COVID-19 patients who were tested for aPL antibodies, it was discovered that 145 out of 250 patients (58%) tested positive for aPL. Specifically, lupus anticoagulant (LA) was found in 64% of the patients, anticardiolipin antibodies in 9%, and anti-beta2-glycoprotein I antibodies in 13%. However, none of the studies conducted follow-up tests for aPL antibodies beyond 12 weeks, so it is unclear if the presence of aPL antibodies in COVID-19 patients is temporary or persistent [8]. The presence of aPL could contribute to the hypercoagulable state observed in COVID-19 patients and may be a factor in the development of thrombotic events such as splenic infarction.

COVID-19 can increase the risk of both arterial and venous blood clotting issues. In critically ill

COVID-19 patients, around 31% experienced thrombotic complications, even with systemic thromboprophylaxis. Among these cases, 27% were venous thromboembolisms, while 4% involved arterial thrombotic events [5]. Abdominal scans are not routine in COVID-19 patients as respiratory symptoms prevail. However, chest CT scans can identify incidental or symptomatic splenic infarctions. Autopsy findings suggest a higher prevalence of splenic involvement due to COVID-19 hypercoagulability than reported. Although most cases of splenic infarction may be asymptomatic, non-traumatic splenic rupture can occur, necessitating heightened suspicion in patients with abdominal pain and prior or concurrent COVID-19 infection [9]. Considering the possibility of thrombosis affecting abdominal organs in patients experiencing acute abdominal pain, regardless of age, is crucial [10].

Abdominal pain caused by splenic infarction is rare. The general population has an annual incidence rate of approximately 1 in 100,000. Reports from the literature suggest that 10% to 59% of cases have an underlying hematological condition such as sickle cell disease, leukemia, myelofibrosis, or lymphoma. Other risk factors include cardiovascular disease, hypercoagulability, hypertension, diabetes mellitus, and infection. Commonly identified signs and symptoms include tenderness and pain in the left upper quadrant, fevers, nausea, and vomiting. Constipation occurs in only 6% of cases [11]. Abdominal pain in COVID-19 patients should prompt consideration of visceral

vessel involvement. Reported cases include splenic infarcts, splanchnic vein thrombosis, and mesenteric arterial thrombosis. Thus, it is vital to recognize the potential for vascular complications in these individuals [7].

In our retrospective case series, we investigated six cases of splenic infarction in patients with COVID-19. The patients presented with diverse clinical characteristics and outcomes. The first case involved splenic laceration, while the second showed 70% infarction due to a thrombus. The third case exhibited splenic hypodensity and peri splenic edema. The fourth case demonstrated impaired blood flow in relevant arteries. The fifth case displayed intra-aortic thrombi with occlusion of arteries and ischemic lesions. The sixth case presented a non-enhancing area in the spleen and a large hematoma within the rectus sheath. The cases had no significant history of trauma.

Distinct imaging characteristics can be observed during various stages of splenic infarction. In the initial acute phase, the affected regions of the spleen display edema, inflammation, and necrosis, resulting in unclear areas with reduced attenuation or echogenicity. As time progresses, these regions become more clearly defined in the chronic phase, accompanied by a loss of volume, potential fibrosis, and calcification [12]. To diagnose splenic infarction, the most preferred method is contrast-enhanced CT. This provides a comprehensive view of the spleen and other internal organs, allowing for the detection of infarctions and thrombosis evaluation. Splenic infarctions are identified by wedge-shaped lesions with reduced contrast, with the tip pointing towards the hilum and the base running parallel to the convex capsule. In some cases, imaging may display round or linear-shaped areas of reduced density in the spleen. Non-enhancing lesions alongside normally enhancing splenic tissue could indicate multiple infarcts. Ultrasound can be used for follow-up, particularly when combined with a contrast agent to optimize visualization if transportation is difficult. This approach is beneficial in ICU patients and is portable and efficient when performed by an experienced sonographer [13, 14]. CT remains the superior diagnostic tool for patients without contraindications since it offers a more comprehensive assessment. Furthermore, contrast-enhanced CT can be followed with CT angiography to confirm the diagnosis [15].

The primary approach for managing splenic infarction is conservative and involves addressing the root cause. Data for non-COVID-19 patients reveals that most infarcts seen on initial CT will resolve without complications [15]. In some cases, complications or persistent symptoms may require surgical intervention or splenectomy. However, this is a rare occurrence [16]. Likewise, treatment approaches varied amongst these six cases, including symptomatic management, enoxaparin, rivaroxaban, heparin infusion, LMWH, hydroxychloroquine, antibiotics, tocilizumab, dexamethasone, remdesivir, and radiology embolization. The management of thrombotic events in COVID-19 remains a subject of controversy. Currently, the standard of care involves thromboprophylaxis with regular heparin or LMWH doses for hospitalized patients. The debate centers around whether hospitalized patients lacking a definitive thromboembolism diagnosis should be empirically administered therapeutic anticoagulation. Addressing this issue, the International Society of Thrombosis and Hemostasis (ISTH) introduced the “sepsis-induced coagulopathy” (SIC) scoring system to determine the necessity for empirical anticoagulation. In a study by Tang et al., 449 severe COVID-19 patients were assessed using this system. Among them, 99 individuals received therapeutic heparin or LMWH for at least seven days. A comparison of 28-day mortality between patients receiving heparin (hep+) and those not receiving heparin (hep-) revealed no significant difference across various risk populations. Notably, in cases where the SIC score was  $\geq 4$  or D-dimer levels exceeded 6-fold the upper limit of normal, hep+ patients exhibited lower mortality compared to hep- patients [17].

The literature review highlights the diverse nature of splenic infarction in COVID-19 patients, emphasizing the variations in clinical presentations and outcomes, necessitating a multidisciplinary management approach. The study suggests a direct impact of COVID-19 on the spleen, indicated by lymphocyte count decline. Recognizing splenic infarction as a potential complication in COVID-19 patients with abdominal pain is crucial. Vigilance regarding spleen involvement and considering splenic infarction in the differential diagnosis are essential for healthcare providers. Further research is warranted to elucidate underlying mechanisms and optimize treatment strategies for



splenic infarction in COVID-19. The studies aiming to uncover the precise pathophysiological mechanisms that underlie splenic infarction in the context of COVID-19 and investigating how the SARS-CoV-2 virus interacts with the coagulation system within the spleen could yield invaluable insights into the development of this complication are recommended. In addition, more research should strive to refine the diagnostic approaches for splenic infarction in COVID-19. This might involve the development of standardized criteria, imaging protocols, or biomarkers that enhance the accuracy and efficiency of diagnosis.

### Acknowledgments

We would like to thank our laboratory technical staff and nursing staff for their cooperation.

### Financial support and sponsorship

The review was conducted without financial support or sponsorship from any external sources or organizations.

### Conflict of interest

The authors declare that they have no conflicts of interest.

### Consent for publication

Written consent for publication was obtained from patient prior to data collection.

## REFERENCES

- [1] Cai Q, Huang D, Yu H, et al. COVID-19: Abnormal liver function tests. *J Hepatol.* 2020; 73 (3): 566-574.
- [2] Karki S, Rawal SB, Malla S, et al. A case report on spontaneous hemoperitoneum in COVID-19 patient. *Int J Surg Case Rep.* 2020; 75: 211-213.
- [3] Maiese A, Passaro G, Matteis A, et al. Thromboinflammatory response in SARS-CoV-2 sepsis. *Med Leg J.* 2020; 88 (2): 78-80.
- [4] Caruso D, Zerunian M, Pucciarelli F, et al. Imaging of abdominal complications of COVID-19 infection. *BJR Open.* 2021; 2 (1): 20200052.
- [5] Klok FA, Kruip MJHA, van der Meer NJM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. *Thromb Res.* 2020; 191: 145-147.
- [6] Malas MB, Naazie IN, Elsayed N, et al. Thromboembolism risk of COVID-19 is high and associated with a higher risk of mortality: a systematic review and meta-analysis. *EclinicalMedicine.* 2020; 29: 100639-30.
- [7] Javaid U, Young P, Gill G, et al. Acute complete splenic infarction secondary to COVID-19 infection. *Radiol Case Rep.* 2022; 17 (5): 1402-1406.
- [8] Gkrouzman E, Barbhuiya M, Erkan D, et al. Reality Check on Antiphospholipid Antibodies in COVID-19-Associated Coagulopathy. *Arthritis Rheumatol.* 2021; 73 (1): 173-174.
- [9] Dennison JJ, Carlson S, Faehling S, et al. Splenic infarction and spontaneous rectus sheath hematomas in COVID-19 patient. *Radiol Case Rep.* 2021; 16 (5): 999-1004.
- [10] Posada-Arango AM, García-Madriral J, Echeverri-Isaza S, et al. Thrombosis in abdominal vessels associated with COVID-19 Infection: A report of three cases. *Radiol Case Rep.* 2021; 16 (10): 3044-3050.
- [11] Prentice G, Wilson S, Coupland A, et al. Complete splenic infarction in association with COVID-19. *BMJ Case Rep.* 2021; 14 (12): e246274.
- [12] Unal E, Onur MR, Akpınar E, et al. Imaging findings of splenic emergencies: a pictorial review. *Insights Imaging.* 2016; 7 (2): 215-222.
- [13] Sztajn bok J, Brasil LMCR, Romero LA, et al. Splenic Infarction with Aortic Thrombosis in COVID-19. *Am J Med Sci.* 2021; 362 (4): 418-423.
- [14] Antopolsky M, Hiller N, Salameh S, et al. Splenic infarction: 10 years of experience. *Am J Emerg Med.* 2009; 27 (3): 262-265.
- [15] Miller LA, Mirvis SE, Shanmuganathan K, et al. CT diagnosis of splenic infarction in blunt trauma: imaging features, clinical significance and complications. *Clin Radiol.* 2004; 59 (4): 342-348.
- [16] Nores M, Phillips EH, Morgenstern L, et al. The clinical spectrum of splenic infarction. *Am Surg.* 1998; 64 (2): 182-188.
- [17] Rico-Mesa JS, Rosas D, Ahmadian-Tehrani A, et al. The Role of Anticoagulation in COVID-19-Induced Hypercoagulability. *Curr Cardiol Rep.* 2020; 22 (7): 53.
- [18] Atıcı SD, Akpınar G. Splenic infarct in a COVID-19 patient under anticoagulant therapy with normal D-dimer levels. *Int J Surg Case Rep.* 2022; 92: 106847.
- [19] Ghalib N, Pophali P, Chamorro-Pareja N, et al. Incidental asymptomatic Splenic Infarct in a COVID-19 patient. *Cureus.* 2021; 13 (2): e13065.
- [20] Brem FL, Tayef TAA, Rasras H, et al. Concomitant renal and splenic infarctions in a COVID-19-patient with a catastrophic thrombotic syndrome. *Radiol Case Rep.* 2022; 17 (10): 4030-4033.
- [21] Dimitriou I, Christodoulou N, Chatzimargaritis K, et al. Splenic artery infarct requiring surgery: a rare complication of COVID-19 infection. *Case Rep Surg.* 2022; 2022: 3391405.
- [22] Malayala SV, Bukhari S, Vanaparthi R, et al. A Case of COVID-19 Induced descending aortic thrombus and splenic infarctions. *J Community Hosp Intern Med Perspect.* 2022; 12 (5): 88-92.
- [23] Childers J, Do TVC, Smith F, et al. Incidental and asymptomatic splenic infarction and infrarenal thrombus in a COVID-19 patient. *Cureus.* 2022; 14 (7): e26555.
- [24] Rigual R, Ruiz-Ares G, Rodríguez-Pardo J, et al. Concurrent cerebral, splenic, and renal infarction in a

patient with COVID-19 infection. *Neurologist*. 2022; 27 (3): 143-146.

[25] Mavraganis G, Ioannou S, Kallianos A, et al. A COVID-19 Patient with simultaneous renal infarct, splenic infarct and aortic thrombosis during the severe disease. *Healthcare (Basel)*. 2022; 10 (1): 150.

[26] Qasim Agha O, Berryman R. Acute splenic artery thrombosis and infarction associated with COVID-19 disease. *Case Rep Crit Care*. 2020; 2020: 8880143.

[27] Yildiz E, Satilmis D, Cevik E. Splenic infarction and pulmonary embolism as a rare manifestation of COVID-19. *Turk J Emerg Med*. 2021; 21 (4): 214-216.

[28] Rehman A, Thoppil AJ, Wallach SL. Portal vein thrombosis and splenic infarction in a COVID-19 patient. *Cureus*. 2021; 13 (8): e16843.

[29] Batayneh O, Abdelrahman H, Toumar A, et al. Celiac artery thrombosis and splenic infarctions: a rare complication in unvaccinated COVID-19 patient. *R I Med J (2013)*. 2022; 105 (6): 16-19.

[30] Castro GRA, Collaço IA, Dal Bosco CLB, et al.

Splenic infarction as a complication of covid-19 in a patient without respiratory symptoms: A case report and literature review. *IDCases*. 2021; 24: e01062.

[31] Arslan G. Celiac Artery Thrombosis and splenic infarction as a consequence of mild COVID-19 infection: report of an unusual case. *Hamostaseologie*. 2022; 42 (3): 193-194.

[32] Dağistanlı S, Sönmez S. Spleen infarct secondary to thrombus in COVID-19-related splenic vein: A case report. *Arab J Gastroenterol*. 2021; 22 (2): 180-183.

[33] Alvarenga Fernandes D, Batista Araújo Filho JA, et al. SARS-CoV-2 and splenic infarction: a rarely described thromboembolic presentation. *Rev Esp Enferm Dig*. 2022; 114 (1): 52-53.

[34] Ramanathan M, Chueng T, Fernandez E, et al. Concomitant renal and splenic infarction as a complication of COVID-19: a case report and literature review. *Infez Med*. 2020; 28 (4): 611-615.

[35] Imoto W, Kaga S, Noda T, et al. Coronavirus disease with multiple infarctions. *QJM*. 2020; 113 (12): 907-908.