Differential Diagnostic Challenges in the COVID-19 Pandemic: Renal Abscess After SARS-CoV-2 Infection in a Young Adolescent

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Patient: Female, 16-year-old
Final Diagnosis: Renal abscess
Symptoms: Bilateral non-purulent conjunctivitis • cough • fever • general malaise • weight loss • yellow sputum
Medication: —
Clinical Procedure: Intravenous wide-spectrum antibiotic therapy • surgical intervention
Specialty: Urology

Objective: Rare coexistence of disease or pathology
Background: Prolonged fever in pediatric patients is often a diagnostic challenge. Clinicians tend to associate prolonged fever with COVID-19-related diseases in patients with a history of SARS-CoV-2 infection. Here we present a patient who was admitted with a clinical suspicion of multi-inflammatory syndrome in children (MIS-C) and was finally diagnosed with a renal abscess.

Case Report: A 16-year-old girl with prolonged fever, bilateral non-purulent conjunctivitis, weight loss, muscle pain, general malaise, cough, and yellow sputum was admitted to Heim Pál National Pediatric Institute, Budapest, Hungary. She had proven SARS-CoV-2 infection 3 weeks prior to admission. Although inflammatory markers were elevated, repeated urine analyses, aerobic and anaerobic urine cultures, hemoculture, chest X-ray, and otorhinolaryngology examinations were negative. Based on clinical and laboratory criteria, the diagnosis of MIS-C was eventually ruled out. Abdominal ultrasound revealed a 17×20×15 mm simplex cyst at the edge of the parenchyma in the upper third of the left kidney. Magnetic resonance imaging was performed, showing a multicompartment, septated, thick-walled parenchymal lesion of 50×40×52 mm in the upper pole of the right kidney, which showed signal characteristics of an abscess, and 20×16 mm and 8 mm lesions in the upper pole of the left kidney, which appeared to be cysts. After being unresponsive to intravenous wide-spectrum antibiotic therapy (meropenem 2 g tid for 5 days), surgical intervention was needed to remove the abscess.

Conclusions: This case demonstrates that during the COVID-19 pandemic, besides the obvious post-COVID etiology, other life-threatening conditions should be investigated in the first line.

Keywords: Abscess • COVID-19 • Fever of Unknown Origin • Kidney • Pediatric Multisystem Inflammatory Disease, COVID-19 Related • Severe Acute Respiratory Syndrome Coronavirus 2

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Background

Since its start in Wuhan, China, in December 2019, SARS-CoV-2 rapidly spread worldwide and was declared a global pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. At the beginning of 2020, pediatric cases accounted for only 1.1% of total confirmed cases of COVID-19 across all age groups [2]. During the first wave of the pandemic (2019-2020) most pediatric patients were asymptomatic or experienced mild symptoms of infection. In our experience, from the second half of 2020, there has been an increasing number of hospitalizations due to the novel and emerging multisystem inflammatory syndrome in children (MIS-C). According to the Centers for Disease Control and Prevention (CDC), clinical features of MIS-C are characterized by (1) prolonged fever, (2) dysfunction of 2 or more organ systems (cardiac, renal, respiratory, gastrointestinal, hematologic, neurologic, dermatologic), (3) laboratory evidence of inflammation, (4) laboratory or epidemiologic evidence of SARS-CoV-2 exposure, and (5) lack of an alternative diagnosis [3-6]. As symptoms are nonspecific, they might be misleading.

Our institution is the largest pediatric center treating COVID-19 patients and pediatric patients with diseases related to COVID-19 from all over Hungary. As a result, our institution, especially the Internal Medicine Ward, gained significant experience in treating one of the most serious pediatric complications of COVID-19 disease: MIS-C. Our diagnosis and management of MIS-C is based on the recommendations of the CDC, American College of Rheumatology, St. George’s University Hospital, and WHO [7,8]. During the past years, many patients were admitted to our ward with prolonged fever, and from October 2020 to this report, 60 patients (mean age: 9.9 years, SD: 3.74, range: 2-16 years) were treated for MIS-C. In our experience, many MIS-C cases were an atypical course.

Our aim is to draw attention to the constant reevaluation of differential diagnosis, specifically that the presence of other life-threatening conditions cannot be ruled out in patients after SARS-CoV-2 infection. We present a case report of a 16-year old female adolescent who was admitted to the hospital with prolonged fever of an unknown origin and a clinical suspicion of MIS-C but was found to have a rare disease. The study is reported as per the “CARE guidelines for case reports” [9].

Case Report

A 16-year-old female patient with no previous history of major illness experienced a few days of mild fever and loss of taste and smell in the beginning of November 2020. She tested positive for SARS-CoV-2 infection by reverse transcription polymerase chain reaction (RT-PCR) on November 7, 2020. After about a 2-week-long afebrile period, the patient began to experience general malaise, muscle pain, bilateral non-purulent conjunctivitis, peri-oral red macules, and high fever (continuously above 39°C). She was admitted to the Internal Medicine Ward on December 10, 2020. Since the recovery from the SARS-CoV-2 infection, she had experienced fatigue, headache, nocturnal sweating, weight loss of about 6 kg, cough, and yellow sputum. The timeline of the patient’s symptoms is presented in Figure 1.

On physical examination, the patient appeared to be in good general condition, with pale skin and the liver palpable 4 cm beyond the right costal margin without tenderness of the abdomen. Her breath sounds were symmetrical and normal. Her neurological status was without deviation as well. On admission, the patient was subfebrile, with a temperature of 37.5°C. She had tachycardia, with a heart rate of 121 beats/min, non-invasive blood pressure of 118/80 mmHg, capillary refill time of 2 s, respiratory rate of 19 breaths/min, and oxygen saturation measured by pulse oximetry of 98% while breathing room air.

On admission, a nasopharyngeal SARS-CoV-2 antigen rapid test (Abbott – Panbio™) was performed, and there was no evidence

![Timeline of symptoms.](image-url)
Table 1. Laboratory parameters.

| Laboratory parameters | Reference values | On admission (day 1) | Day 4 | At discharge (day 11) | At follow-ups |
|-----------------------|------------------|---------------------|-------|-----------------------|---------------|
| CRP (mg/L)            | <5.0             | 141.74              | 129.31| 71.47                 | 1.42          |
| ESR (Westergren) (mm/h) | <10             | 97                  | 115   | 10                    | 7             |
| WBC (G/L)             | 4.5-15.0         | 12.14               | 11.64 | 6.79                  | 8.19          |
| Absolute neutrophil count (g/L) | 1.8-8       | 8.5                 | 7.7   | 3.9                   | 4.6           |
| Absolute lymphocyte count (g/L) | 1.2-6.0     | 2.6                 | 2.9   | 2.2                   | 2.6           |
| RBC (T/L)             | 3.8-5.8          | 3.61                | 3.42  | 3.13                  | 4.28          |
| Hemoglobin (g/L)      | 119-147          | 107                 | 94    | 86                    | 122           |
| Hematocrit (L/L)      | 0.330-0.450      | 0.310               | 0.294 | 0.275                 | 0.365         |
| Platelet count (g/L)  | 150-550          | 420                 | 536   | 438                   | 329           |
| Blood urea nitrogen (mg/dL) | 2.8-21      | 7.84                | 2.0   | 4.76                  | 12.88         |
| Creatinine (µmol/L)   | 25-90            | 62                  | 62    | 66                    | 79            |
| Uric acid (µmol/L)    | 124-448          |                     |       | 232                   |               |
| Bilirubin (µmol/L)    | 1.0-17.0         |                     |       | 7.4                   |               |
| AST/GOT (U/L)         | 1-40             | 22                  | 17    | 22                    | 16            |
| ALT/GPT (U/L)         | 1-40             | 22                  | 25    | 13                    | 11            |
| GGT (U/L)             | 1-60             | 87                  | 113   | 67                    | 42            |
| LDH (U/L)             | 150-700          | 289                 | 346   |                       |               |
| Ferritin (µg/L)       | 15.0-150.0       | 333.6               |       |                       |               |
| Natrium (mmol/L)      | 130-145          | 137                 |       | 138                   |               |
| Potassium (mmol/L)    | 3.2-5.4          | 4.11                |       |                       |               |
| Chloride (mmol/L)     | 96-111           | 100                 |       | 109                   |               |
| CK (U/L)              | 40-150           | 42                  |       |                       |               |
| Albumin (g/L)         | 35.0-50.0        | 40.8                | 35.6  | 47.7                  |               |
| Serum total protein concentration (g/dL) | 60.0-80.0 | 80.1               | 72.6  | 75.2                  |               |
| IgG (g/L)             | 7.0-15.0         | 17.0                |       |                       |               |
| IgA (g/L)             | 0.90-3.25        | 2.80                |       |                       |               |
| IgM (g/L)             | 0.50-1.80        | 2.60                |       |                       |               |
| D-dimer (ng/mL)       | <500             | 408                 |       |                       |               |
| Fibrinogen (g/L)      | 2.00-4.00        | 7.39                |       |                       |               |
| INR                   | 1.0-1.7          | 1.630               | 1.630 | 1.630                 | 1.630         |
| PI (s)                | 11.90            | 17.60               | 18.40 | 13.20                 |               |
| APTT (s)              | 31.6             | 38.5                | 38.7  | 34.3                  |               |
| SARS-CoV-2 antibody (IgA, IgM, IgG) | COI           | 74.91               |       |                       |               |
| Schwartz GFR (ml/min/1.73 m²) | >60           |                     |       | 75                    |               |

CRP – C-reactive protein; ESR – erythrocyte sedimentation rate; WBC – white blood cell count; RBC – red blood cell count; AST/GOT – aspartate aminotransferase/glutamic-oxaloacetic transaminase; ALT/GPT – alanine aminotransferase/glutamic-pyruvic transaminase; GGT – γ-glutamyl transferase; LDH – lactate dehydrogenase; CK – creatine kinase; INR – international normalized ratio; PI – prothrombin time; APTT – activated partial thromboplastin time, GFR – glomerular filtration rate. Cut-off values were determined by the Department for Laboratory Medicine of Heim Pál National Pediatric Institute, Budapest, Hungary.
of recurrent acute infection. To confirm previous COVID-19 disease, a SARS-CoV-2 antigen-specific antibody assay was performed by using an Elecsys® Anti-SARS-CoV-2 reagent on a Cobas e411 analyzer (Roche, Germany), which is based on electrochemiluminescence technology. Its unit of measurement is the cut-off index. This method detects only mature IgM, IgG, and IgA antibodies, thus minimizing the number of false-positive cases. SARS-CoV-2 serology indicated earlier exposure of COVID-19 disease.

Initial laboratory results showed significantly elevated inflammatory markers and prolonged coagulation. The laboratory parameters during hospitalization are presented in Table 1. Repeated urine analyses (rapid urinary tests and sediments) and aerobe and anaerobe urine cultures were negative, ruling out the suspicion of a urinary tract infection (UTI).

As the patient had been seropositive for COVID-19 and presented with prolonged fever with no obvious source of infection and multiple organ involvement, a possible bacterial infection with an unknown source or atypical MIS-C was suspected as the differential diagnosis. In a search for the origin of the infection, we performed a chest X-ray and otorhinolaryngology examinations, which revealed no signs of pneumonia or acute otitis media, excluding upper and lower respiratory tract infections. A hemoculture test, obtained on admission, showed no growth of bacteria. An abdominal ultrasound was performed in a further search for the source of infection. The scan showed hepatosplenomegaly, with the liver 40 mm beyond the right costal margin and a 41-mm hilar diameter of the spleen, and a 49×38×45-mm thick-walled, irregularly shaped multilocular cystic lesion in the upper pole of the right kidney (the ultrasound images are presented in Figure 2). The lesion was suspicious for abscess or tumor. In the upper third of the left kidney a 17×20×15-mm simplex cyst at the edge of the parenchyma was visible. Based on the diagnostic criteria of MIS-C and the mass found on the abdominal ultrasound, which was suggestive of the source of infection, MIS-C could also be excluded. The differential diagnostic flowchart is shown in Figure 3.
For better characterization of the lesions observed in the kidney, magnetic resonance imaging (MRI) was performed, revealing a multi-compartment, septated, thick-walled parenchymal lesion of 5 cm in size (50×40×52 mm) in the upper pole of the right kidney, which showed signal characteristics of an abscess and 2-cm (20×16 mm) and 8-mm lesions in the upper pole of the left kidney which appeared to be cysts. The MRI images are shown in Figure 4.

Recommendations with a high evidence level are not available for the treatment of cortical renal abscesses in either childhood or adulthood. Based on the international literature and
Figure 4. MRI images of pediatric renal abscess and cysts. (A) On the coronal T1-weighted, contrast-enhanced image the abscess and the cysts cannot be differentiated. (B) On the axial T2-weighted image, high signal intensity can be seen in each fluid-containing mass. (C, D) Information about the nature of the contents can be obtained by comparing diffusion-weighted imagining (DWI) and apparent diffusion coefficient (ADC) measurements: on the DWI series abscess in the right kidney has high signal and low ADC indicating restricted diffusion, while the cysts in the left kidney with clear fluid content have low signal on DWI with high signal on ACD. These measurements suggest that the lesion in the right kidney is an abscess. (E) Coronal magnetic resonance urography measurement was performed, proving that the abscess and cysts were not involving the urinary tract, as the contrast agent was not visible in any of the lesions. The solid white arrows indicate the abscess, the solid white five-pointed stars show the cysts. MRI – magnetic resonance imaging; T1W – T1-weighted; T2W – T2-weighted; DWI – diffusion-weighted imagining; ADC – apparent diffusion coefficient.
our own experience, a conservative antibiotic treatment of an abscess no larger than 3 cm can achieve complete healing. If abscesses between 3 cm and 5 cm or larger do not respond to antibiotic treatment, invasive intervention may be necessary. Ultrasound-guided percutaneous drainage is usually the first choice. Drainage of the abscess cavity by open surgery may be necessary if the size of the abscess exceeds 5 cm or it is multicentric, or minimally invasive accessibility is in doubt based on the previous imaging results [10-17].

Therefore, in our case, owing to the local antibiotic surveillance, broad spectrum antibiotic treatment was started intravenously (meropenem 2 g tid for 5 days). Although the patient became afebrile, her general condition improved, and the recurrent blood tests showed reduced signs of inflammation; the abscess, followed up with ultrasound, did not shrink. Therefore, our multidisciplinary team (involving a nephrologist, urologist, radiologist, and pediatrician) concluded that surgery was necessary. Because an ultrasound-guided minimally invasive technique could not be safely managed owing to the localization of the abscess, we opted for drainage via open surgery. Retroperitoneal exploration is more advantageous than transperitoneal exploration in such cases because it prevents the infection spreading to the abdominal cavity. The lesion was not exophytic and was located high on the upper pole of the kidney, so we localized its exact position with intraoperative ultrasound to prevent unnecessary renal parenchymal damage during drainage. Cytologic examination of the sample presented inflammatory cells and bacteria. Intravenous meropenem was continued (total 12 days) until multi-sensitive Escherichia coli was isolated by microbiological culture from the abscess. According to the resistance profile, meropenem treatment was switched to oral ciprofloxacin (500 mg bid).

After 16 days of antibiotic treatment, a residual cyst containing a coagulum-like solid area was visible on the follow-up ultrasound as a remnant of the inflammation, which raised the question whether it might be a superinfected cyst. During the follow-ups, the laboratory parameters normalized (laboratory parameters are presented in Table 1, and the inflammatory and renal function markers are shown in Figures 5 and 6).

The prevalence of simplex renal cysts in healthy individuals in the overall population is about 10.7% [18]. Since the family history revealed that the patient’s grandmother also had a simplex renal cyst and there was suspicion of autosomal dominant polycystic kidney disease (ADPKD), nephro-genetic testing was performed but had a negative result.

Discussion

Constant reevaluation of a differential diagnosis, especially in the COVID-19 era, is critical since other life-threatening conditions in patients with a history of SARS-CoV-2 infection cannot be underestimated. Therefore, despite the pandemic, we need to apply the same rigorous rules of examination and investigation to every patient with an open and critically acute mind.

To draw attention to the importance of this, we reported this case of a 16-year-old female adolescent with earlier COVID-19 infection and prolonged fever who was found to have a renal abscess.

Prolonged Fever in Pediatric Patients with a History of SARS-CoV2 Infection

Since the start of the COVID-19 pandemic, questions regarding possible ill contacts and anamnesis regarding COVID-19
Renal Abscesses and Urinary Tract Infections

There are 3 pathophysiological pathways that can cause renal abscess: direct spread from an infected area adjoining to the kidney, ascending infection, and hematogenous dissemination [19-22].

UTIs, incorporating cystitis and pyelonephritis, are frequent in pediatric patients [23]; about 6% to 8% of febrile infants are diagnosed with UTIs [24,25]. Approximately 3% of girls and 1% of boys will have a UTI by the age of 11 years. UTI is also common in female adolescents and young women, 3 times more frequent than in young men [26]. Complications of UTI consist of bacteremia, sepsis, acute kidney injury, electrolyte and acid-base disturbances, and renal scarring [23,27,28]. Pyonephrosis, emphysematous pyelonephritis, and xanthogranulomatous pyelonephritis are extremely rare entities [29,30]. Renal abscess is an uncommon complication of UTIs in the pediatric population, caused by bacteria that might imitate intraabdominal inflammation or a tumor.

Fever, flank pain, fatigue, and weight loss are usually the main symptoms of renal abscesses [31]. The classification of intra-renal abscesses consist of acute focal bacterial nephritis, acute multifocal bacterial nephritis, renal cortical abscess, renal corticomedullary abscess, and xanthogranulomatous pyelonephritis [12]. In our case, the patient had a renal cortical abscess. The diagnosis of a renal or perirenal abscess might be challenging since symptoms are often nonspecific. The diagnostic algorithm is based on ultrasound, computed tomography, or diffusion-weighted MRI, which is a novel method in the characterization of focal renal lesions [32]. The cornerstone of the treatment is broad spectrum parenteral antibiotic therapy which covers anaerobic pathogens as well. However, much depends on the size of the abscess. Abscesses less than 3 cm in diameter might be healed with 4 to 6 weeks of antibiotic therapy alone. Medium-large abscesses (greater than 3 cm) might be successfully managed by percutaneous needle aspiration or drainage. Large abscesses (greater than 5 cm), as shown in our case as well, might only be cured by open drainage, renal resection, or nephrectomy [17,33-35]. Therefore, due to the ineffective antibiotic treatment, surgical intervention was performed in our case.

Renal Abscess and ADPKD

ADPKD is a genetic disorder characterized by the development of numerous cystic lesions in the renal parenchyma leading to chronic kidney disease with hypertension and loss of renal function (progressive decline in glomerular filtration rate) [36,37]. The prevalence of ADPKD is 1 in 400 to 1000 live births, or 12.5 million people worldwide [38]. Cyst infection is one of the most common causes of upper UTI in ADPKD, with fever, flank or abdominal pain, and elevated inflammatory markers, which can be detected by computer tomography scan or MRI. Since our patient had multiplex renal cysts, the possibility of ADPKD arose, but the genetic testing ruled it out.

Kidney Involvement in COVID-19

Since COVID-19 is a multi-organ disease, extrapulmonary manifestations, such as kidney involvement, can also be observed [39]. Acute kidney injury, with a variable prevalence of 0.1% to 29% in hospitalized patients, is reported to be the most common renal complication related to the novel coronavirus infection [40,41]. In approximately in 20% of cases of MIS-C, the renal system is compromised [42-44]. Furthermore, increased urinary frequency as a symptom of COVID-19 might be detected [45,46], but renal abscess with COVID-19 infection is a unique phenomenon [47].

Strength of the Study

To date, this is the first case of a pediatric patient with renal abscess after SARS-CoV-2 infection.

During the COVID-19 pandemic, patients with prolonged fever tend to present later for evaluation and might have higher disease severity and longer hospital length of stay than the pre-COVID-19 group of patients with the same pathology. The strength of our case study is the instant diagnosis and treatment of the renal abscess.

Our case of a renal abscess emphasizes that there can still be serious urinary tract abnormalities with negative urine results. It is important not to let negative urine test results mislead clinicians into neglecting the suspicion of a urinary tract abscess. In our opinion, it is important to perform an abdominal ultrasound in search of an abscess if a patient presents with prolonged fever with no obvious source.
Without the correct diagnosis, our patient's disease could have deteriorated into sepsis and even led to renal scarring and failure of the affected kidney.

**Limitations**

The limitation of our study is that the origin of the renal abscess remains unclear.

**Conclusions**

In patients who have a history of COVID-19, other life-threatening conditions should not be underestimated. We underline the importance of critical thinking in such cases.

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**Declaration of Figures’ Authenticity**

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

**Abbreviations**

ADPKD – autosomal dominant polycystic kidney disease; BID – bis in die (twice a day); CDC – Centers for Disease Control and Prevention; COVID-19 – coronavirus disease 2019; MIS-C – multisystem inflammatory syndrome in children; RT-PCR – reverse transcription polymerase chain reaction; SARS-CoV-2 – severe acute respiratory syndrome coronavirus 2; TID – ter in die (three times a day); UTI – urinary tract infection; WHO – World Health Organization.
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