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Case Report

Concurrent COVID-19 infection in children with acute appendicitis: A report of three cases ☆

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ABSTRACT

Literature describing patients with concomitant COVID-19 infection with acute appendicitis in pediatric patients is growing, and understanding the clinical picture of such patients is relevant in their treatment. We report 3 male children who were surgically treated for acute appendicitis and had concomitant SARS-CoV-2 infection. Our first patient was a 12-year-old male who presented with symptoms indicative of appendicitis but no respiratory symptoms associated with COVID-19 (eg cough, shortness of breath). Laboratory evaluation revealed leukopenia and an elevated C-reactive protein; imaging was consistent with acute appendicitis and an acute pulmonary viral infection. Though he lacked diffuse peritonitis on physical examination or a leukocytosis, he was found to have perforated appendicitis in the operating room. Our second patient was another 12-year-old male whose suspected appendicitis was confirmed via ultrasound and surgery. He tested positive for COVID-19 1 month prior and he continued to test positive for infection on admission without any associated respiratory symptoms. Our third patient was a 13-year-old patient who also presented with symptomatic acute appendicitis without apparent COVID-19 manifestations. These cases provide further examples of pediatric patients with concomitant acute appendicitis and COVID-19 infection, namely an unusual presentation of perforated appendicitis with asymptomatic COVID-19-related pulmonary infection and the more common acute appendicitis with asymptomatic COVID-19 infection.

☆ Competing Interests: The authors declare that they are unaware of competing personal relationships or financial interests that would influence the work reported in this paper.

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Introduction

Patients infected with the novel coronavirus 2019 (COVID-19) may present with a myriad of symptoms, including fever, cough, anosmia, and more [1,2]. Currently, available studies report that COVID-19 in children, unlike in adults, appears to be milder in presentation and have a lower proportion of symptomatic infection [3,4]. A recent meta-analysis including 5829 pediatric patients indicated that of the children infected with COVID-19, 20% were asymptomatic. In those who were symptomatic, 51% had fever, 41% had cough, 16% had sore throat, 8% had diarrhea, and 7% had vomiting [5], and similar results have been reported in other studies [3,6]. This contrasts with the general population of COVID-19 patients, who may experience GI symptoms up to 20% of the time [7].

Though a relatively small number of COVID-19 pediatric patients may present with gastrointestinal symptoms, it is important for physicians to understand how COVID-19 may interact with the presentation of other common pediatric gastrointestinal pathologies, such as acute appendicitis. Acute appendicitis occurs in pediatric patients with an incidence of 0.97% a year, with the highest incidence occurring in children ages 10-14 (1.64%); within this age group, males have the highest incidence at 2% [8]. Importantly, acute appendicitis is one of the most common pediatric emergencies necessitating surgery [9].

Greater understanding about the clinical presentation of acute appendicitis in COVID-19 infected pediatric patients is still needed. Reports of these cases range from a brief mention within larger datasets [10], to single case reports[11,12], to 2 case series of patients [13,14]. For example, Jones & Slater and Alsuwailem et al. have described patients with typical appendicitis symptomatology, yet Lishman et al. have reported severe cases of patients who initially presented with acute appendicitis who were subsequently diagnosed with Multisystem Inflammatory Syndrome in Children [11–13]. Multisystem Inflammatory Syndrome in Children is a concerning novel disease associated with COVID-19 that frequently presents as fever, fatigue, and gastrointestinal illness [15].

Because the clinical picture of pediatric patients presenting with concurrent acute appendicitis and COVID-19 infection remains unclear, we wish to add to the current knowledge base by reviewing 3 such patients that presented to our institution. All 3 cases occurred early in the pandemic (the fourth month of the pandemic in our state)—prior to any regular genetic testing for the different variants and prior to the vaccination rollout. For additional context, over the 2 weeks these cases occurred, the 7-day moving average of daily new cases ranged between 162 and 221, and the test positivity rate ranged between 3% and 5%.

Cases

Case 1

A 12-year-old Hispanic male was evaluated in our pediatric emergency department with concern for appendicitis. Just 16 h prior to presentation at our children's hospital, he developed periumbilical pain followed just a few hours later with emesis. He first presented to a peripheral hospital where he was noted to be febrile to 39°C and focally tender in the right lower quadrant. Given the concern for appendicitis, he was given ceftriaxone and transferred to our children's hospital for further care. He denied cough, congestion, or rhinorrhea within the previous 2 weeks. Routine screening for COVID-19, per institutional policy, was positive though he lives at home with his biological family and had no potential exposures other than primary caregivers. On examination, he was tachycardic to 130 beats per minute and febrile to 39.4°C. He was focally tender in the right lower quadrant with a positive Rovsing sign but had no rebound tenderness or involuntary guarding. Initial laboratory workup showed a leukopenia with a white blood cell count of 2.61 with 71% neutrophils, a platelet count of 166, and an elevated C-reactive protein (28.4 mg/L). Ultrasound demonstrated a small amount of free fluid in the right lower quadrant as well as a noncompressible appendix measuring 11 mm in diameter; however, the base was atypically more dilated than the tip (Fig. 1A).

Given the uncertainty as to whether this represented peritonitis related to COVID-19 infection or acute appendicitis, additional cross-sectional imaging was obtained. An abdominal and pelvic contrast-enhanced CT revealed a 12 mm, hyperenhancing appendix with mild surrounding fat stranding, consistent with acute appendicitis. (Fig. 1B). He was incidentally noted to have findings in the lung base that were compatible with reported imaging findings of pulmonary manifestations of COVID-19 (Fig. 1C).

He was taken to the operating room approximately 30 h after the presentation to our hospital and underwent a laparoscopic appendectomy. Intraoperatively, he was noted to have perforated appendicitis with purulent peritonitis (Fig. 2A) and a dilated, hyperemic appendix (Fig. 2B). Interestingly, the perforation was at the junction between the appendix and cecum, where there was a focal area of necrosis (Fig. 2C). Postoperatively, he was continued on broad-spectrum antibiotics. He continued to have intermittent fevers and emesis for the first few days following appendectomy, though he was able to be started on a liquid diet on day 3.

On postoperative day 6, he was febrile to 39.4°C—an ultrasound was obtained that did not identify an intraabdominal abscess. Because he continued to have high-grade fevers, a contrast-enhanced CT scan was performed that revealed unorganized fluid but no evidence of a walled-off fluid collection or abscess. Additionally, the CT scan revealed small bilateral pleural effusions—the right mildly greater than left—and right middle lobe and bilateral lower lobe posterior dependent atelectatic changes (Figs. 3A and B). The patient was discharged without other issues.

Case 2

A 12-year-old Hispanic male presented to our pediatric emergency department with 2 days of abdominal pain that began in the periumbilical region and migrated to the right lower quadrant associated with anorexia. He did not report any fevers, chills, nausea, emesis, or diarrhea. On examination, he was afebrile (36.9°C) with normal heart rate and no tachypnea or

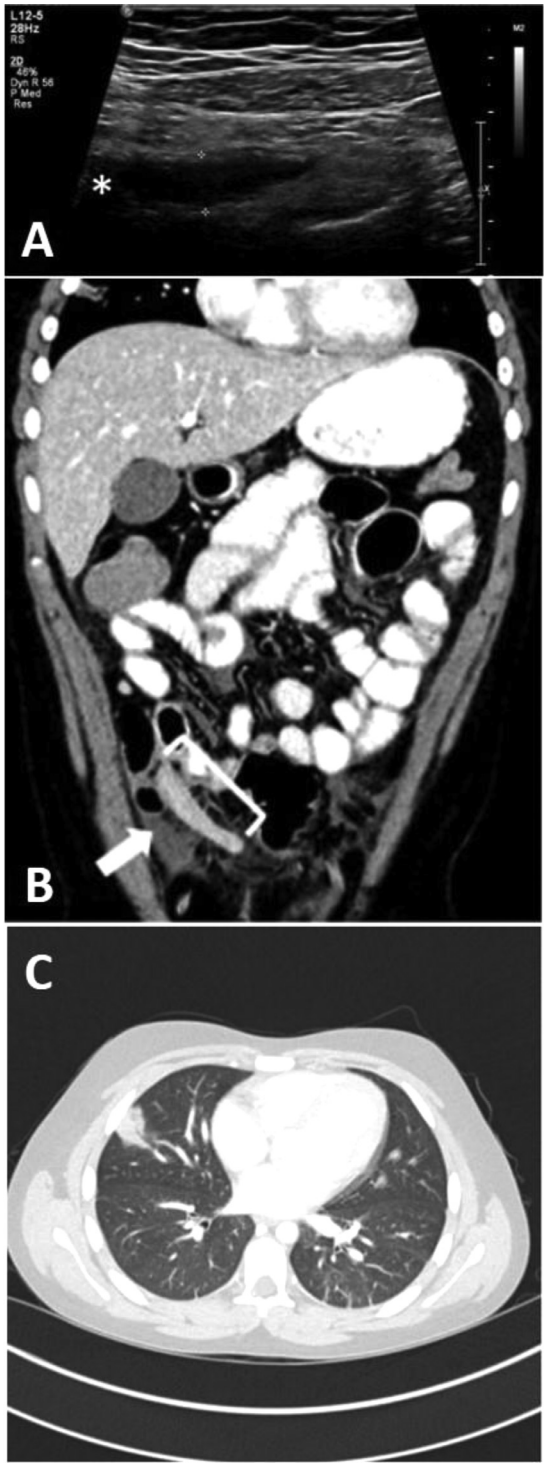

Fig. 1 – Patient 1-12-year-old male: (A) right lower quadrant United States performed with a linear high-resolution probe demonstrating a dilated 11 mm noncompressible appendix, more prominent at the base (*). (B) Coronal contrast enhanced CT with oral contrast demonstrating a dilated appendix (bracket) and fluid in the right lower quadrant (arrow). (C) Axial contrast-enhanced CT displaying nonspecific wedge-shaped region of consolidation with minimal ground glass present on admission imaging; however, the patient had no respiratory symptoms.

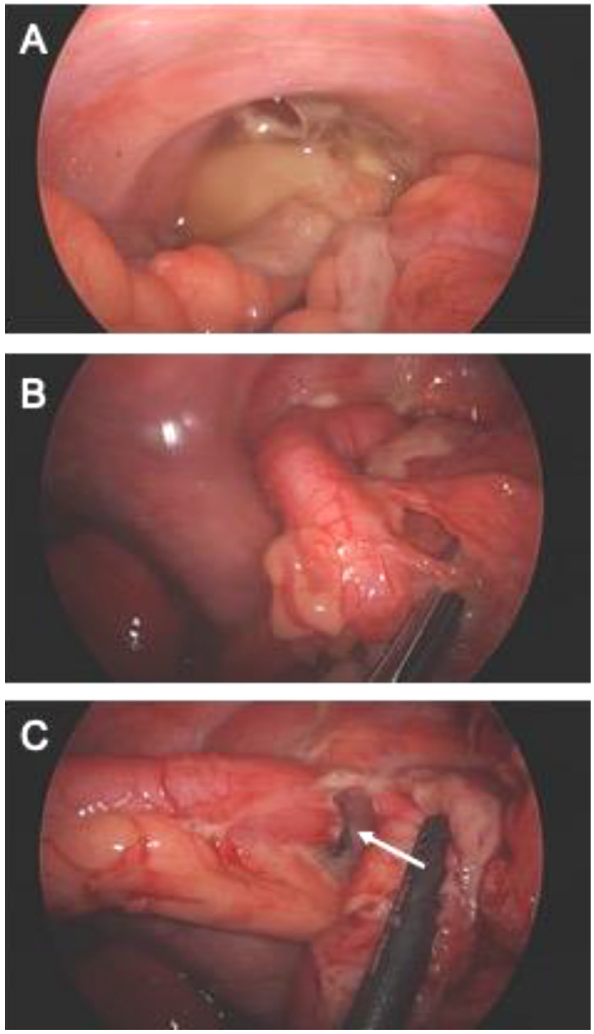

Fig. 2 – Operative images from Case 1 revealing purulent peritonitis visible in the pelvis (A) with a dilated, hyperemic appendiceal tip (B). A focal area of necrosis and perforation (arrow) was identified at the junction of the appendiceal base and cecum (C).

respiratory distress. He was focally tender in the right lower quadrant without any involuntary guarding. Initial laboratory workup showed an elevated white blood cell count (13.6) with 80% neutrophils, as well as an elevated C-reactive protein (29.3 mg/L). On imaging, ultrasound showed an edematous and thickened appendiceal wall, multiple appendicoliths, and an appendiceal diameter measuring approximately 16 mm (Fig. 4).

Of note, the patient was infected with COVID-19 1 month prior to the admission for appendicitis. Per hospital protocol, he was tested at the time of admission and continued to test positive for on-going infection. In addition, his immediate family had been tested with only one other sibling testing positive for infection. COVID-19 symptoms at the time of his initial test 1-month prior included a mild sore throat. However, at the time of presentation to our emergency

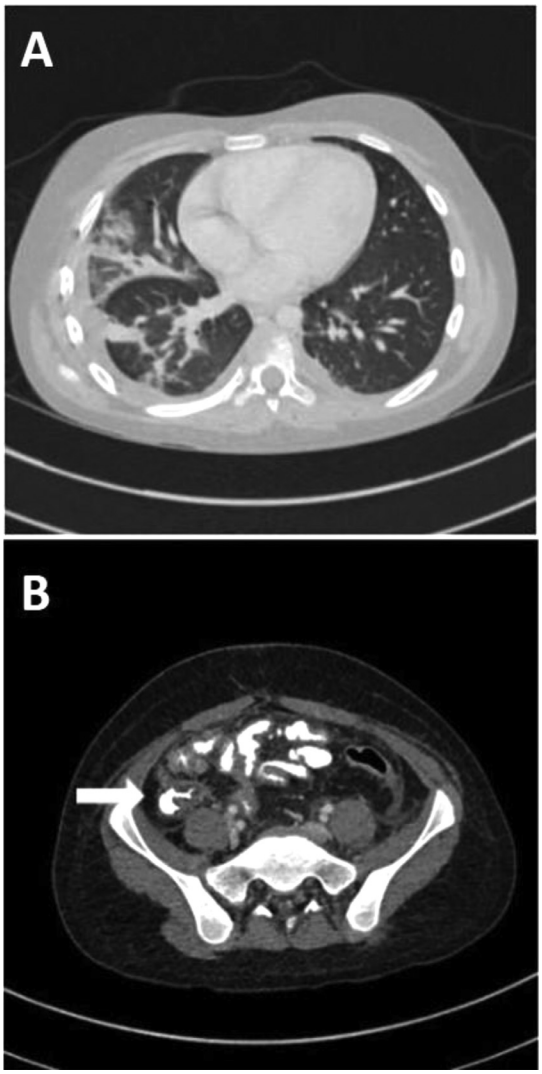

Fig. 3 – (A-B): (A) Axial image of a contrast-enhanced CT on postoperative day 8 demonstrating development of a right pleural effusion and increased areas of ground glass attenuation and parenchyma bands in the right middle lower lobes. New left effusion and minimal ground glass opacity are partially demonstrated. (B) Axial image of a contrast-enhanced CT with intravenous and oral contrast performed on postoperative day 8 showed no evidence of abscess formation, but residual colonic and terminal ileal mural thickening was present (arrow).

department, the patient's mother reported he manifested no recent fevers, chills, coughing, sore throat, headaches, myalgias, or loss of taste or smell.

The patient was taken to the operating room 24 h following presentation and underwent a laparoscopic appendectomy. He was found to have acute, suppurative, but not perforated, appendicitis. His postoperative course was uncomplicated, and he was discharged home on postoperative day 1.

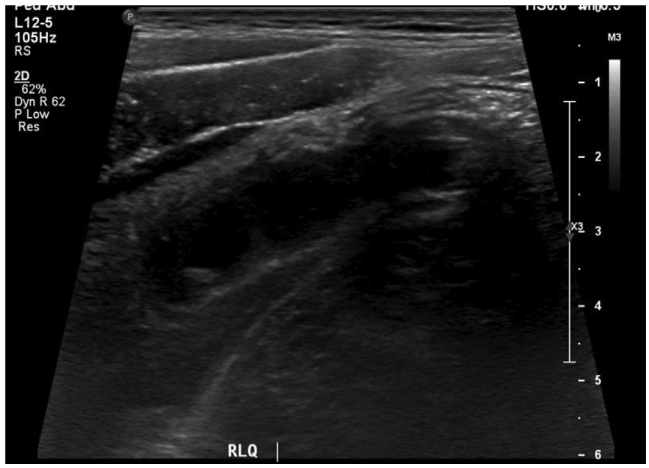

Fig. 4 – Patient 2-12-year-old male right lower quadrant ultrasound demonstrating a dilated, fluid-filled, noncompressible appendix.

Case 3

A 13-year-old white male presented to our pediatric emergency department with 8 h of right-sided abdominal pain, beginning in the periumbilical area and migrating to the right lower quadrant. He denied any fevers, chills, emesis, or diarrhea. On examination, he was afebrile (36.8°C) with normal heart and respiratory rates. He was noted to be focally tender in the right lower quadrant. Initial laboratory workup showed an elevated white blood cell count (14.9) with 71% neutrophils. C-reactive protein level was not obtained. An ultrasound was performed; however, the appendix was not identified. He was admitted for serial examinations and repeat laboratory testing. He remained focally tender on examination and his leukocytosis persisted. Twenty-four hours after presentation, a contrast-enhanced CT of the abdomen and pelvis was performed and revealed acute appendicitis with a retrocecal appendix (Fig. 5).

As part of his preoperative workup, he also tested positive for COVID-19, but had no history of exposure nor was he symptomatic with any of the classic symptoms of COVID-19 in pediatric patients (fever, cough, myalgia, sore throat, shortness of breath, headache, or loss of taste or smell).

The patient was subsequently taken to the operating room 36 hours following presentation and underwent a laparoscopic appendectomy. He was found to have early acute appendicitis in a retrocecal position, without any evidence of perforation. He tolerated the operation well and was discharged on postoperative day 1 without complications.

Discussion

Our 3 cases provide further understanding of pediatric patients with concomitant COVID-19 and acute appendicitis. Of note, our cohort falls within the patient population with the

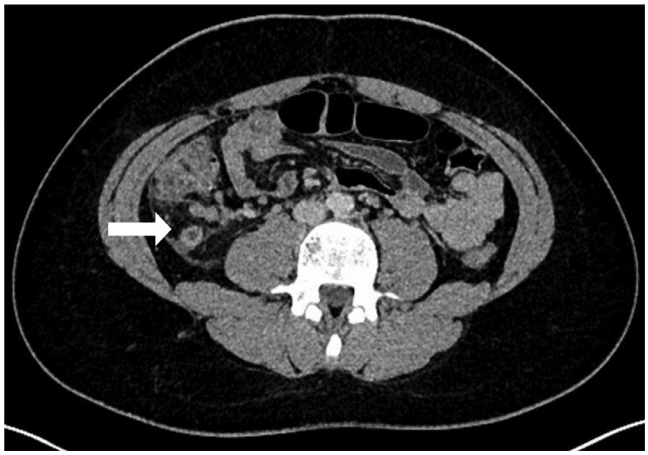

Fig. 5 – Patient 3-13-year-old male axial contrast-enhanced CT shows a dilated, hyperenhancing appendix (arrow) with a small amount of *peri*-appendiceal fluid, compatible with acute appendicitis.

highest incidence of acute appendicitis with 2 of our patients presenting with typical findings of early, uncomplicated, acute appendicitis—both had right lower quadrant abdominal pain, focal tenderness on examination, and leukocytosis.

Our first case, however, is remarkable for several reasons as his presentation was a bit atypical for complicated (perforated) appendicitis. His symptoms began less than 24 h prior to presentation. Though he was focally tender in the right lower quadrant, he did not have diffuse tenderness, guarding, or rebound tenderness that would be expected in a child with perforated appendicitis. His laboratory evaluation was notable for leukopenia, with a lymphocyte count less than 1500 (his was 430), and an elevated C-reactive protein—findings that are consistent with over 90% of adult patients hospitalized with COVID-19 in New York City [16]. Cross-sectional imaging with a CT scan was performed given these unusual findings. It was consistent with acute appendicitis, but it also showed some consolidative changes in the lungs that can be seen with acute viral infections, though minimal ground-glass opacities were seen.

In the operating room, he was found to have purulent peritonitis, a surprising finding given the time course of his abdominal symptoms and his exam findings. In addition, the appendix appeared dilated and hyperemic from base to tip, with just a small area of focal necrosis at the junction between the base and cecum. Though this can be seen with acute appendicitis, it is unusual for the area of necrosis to be so focal and for it to be located at the junction. Taken together, it is unclear whether this presentation of perforated appendicitis was a result of his COVID-19 infection, or whether he had an unusual presentation of complicated appendicitis with concomitant COVID-19 infection. Our case highlights the potential difficulty in diagnosing complicated appendicitis in children with COVID-19 infection and adds to the growing literature of children with both diseases.

Given this report's small sample size and the variability in presentation of the 2 diseases of interest there may be no generalizable conclusion one can draw. Furthermore, the imaging results of these patients were not overly unique. And yet, increasing understanding of patients with both COVID-19 and appendicitis impacts the diagnosis and care of these patients at both a practitioner, institutional, and epidemiologic level.

Given the concern for nosocomial and community-acquired infection of this novel virus, healthcare sites have adjusted the nature of patient interactions and procedures, both elective and emergent. For example, due to the concern for spread of COVID-19, multiple health providers employed non-operative management (NOM) in the hopes of increasing availability of hospital resources and decreasing spread of the disease [11,17–21]. Specifically, NOM has been identified as a possible solution regarding aerosolization of COVID-19 particles during laparoscopic appendectomy, and research suggests that NOM is successful in the majority of cases (albeit with rates of failure and requiring appendectomy ranging between 30% and 40%) [22–24]. However, preliminary findings suggest that COVID-19 may not be present in the peritoneal fluid of COVID-19 positive patients presenting with acute appendicitis [25], calling into question such widespread changes in practice. Ultimately, the decision of whether to proceed with acute appendectomy in COVID-19 positive patients is multifactorial and should consider locoregional and hospital COVID-19 rates, personal protective equipment supply, and a shared decision-making model between the surgeon and patient's family. Finally, as our first cases shows, the diagnosis of complicated appendicitis can be challenging in the setting of COVID-19 infection, further complicating the decision to proceed with NOM vs appendectomy.

Though not directly controlled by institutional practices, patient behavior during the COVID-19 pandemic has also affected management of acute appendicitis. For example, fear related to the COVID-19 pandemic as well as stay-at-home orders and other government mandates may result in patients or their guardians waiting to seek emergency care, leading to increased rates of complicated appendicitis [26–28]. However, certain researchers have also noted a possible trend of *decreasing* rates of overall acute appendicitis during the pandemic [29]. Given that healthcare providers and patients (or caregivers) have changed their medical-related behavior during the pandemic, understanding the presenting symptoms, signs, and imaging of concomitant appendicitis and COVID-19 infection in children is paramount to the care of this population.

Patient Consent Statement

Consent to publish this case series was not obtained, as our Office of Research Integrity deemed this case series as not requiring IRB approval. Importantly, this work does not convey any personal information that would lead to the identification of the patients.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2021.06.067.

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