Case Report

Renal Involvement in a Child with COVID-19 Infection and its Management with CRRT

Abstract

Novel Coronavirus disease (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV 2) presenting mainly as an acute respiratory illness with interstitial and alveolar pneumonia. It can also affect multiple organs such as the kidney, heart, intestinal tract, blood, and nervous system. We report a 10-year-old boy presenting with severe cough, tachypnea, retraction and respiratory distress, fever, myalgia, oliguria, and anuria thereafter. He had no history of diarrhea, vomiting, or a runny nose. Laboratory findings include leukopenia and lymphopenia. CRP, ESR, and procalcitonin levels were high, but serum LDH was normal. RT-PCR test was positive. In the initial days of admission, he needed mechanical ventilation support due to ARDS and received antiviral drugs, renal replacement therapy, hemoperfusion, and other necessary supportive cares. Thirty-five days later, he weaned from the ventilator and discharged from hospital. Two weeks later, COVID-19 specific IgG was found in serologic test.

Keywords: *Acute kidney injury, child, continuous renal replacement therapy, COVID-19*

Bahare Yaghmaii, Fatemeh Nili[1], Zeinab Najafi, Fariba Cheloi[2], Mastaneh Moghtaderi[3]

Department of Intensive Care Unit, Fellowship of Intensive Care Unit, Children Medical Center Hospital, Tehran University of Medical Sciencees, Tehran, Iran, [1]Department of Pathology, Cancer Institute, Tehran University of Medical Sciences, Tehran, Iran, [2]Head Nurse of NICU ward, Children Medical Center Hospital, Tehran University of Medical Sciences, Tehran, Iran, [3]Associate Professor of Pediatric Nephrology, Chronic Kidney disease Research Center, Children Medical Center Hospital, Tehran University of Medical Sciences, Tehran, Iran

Address for correspondence:
Dr. Mastaneh Moghtaderi, Department of Pediatric Nephrology, Chronic Kidney disease Research Center, Children Medical Center Hospital, Tehran University of Medical Sciences, Tehran, Iran. E-mail: drmoghtaderi@gmail.com

Access this article online

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/ijpvm.IJPVM_421_20

Quick Response Code:

Introduction

In the early stages of the epidemic, many children were affected as part of family clusters with COVID- 19. The incubation period in children is usually about 2 days ranging 2–10 days. COVID- 19 is either rare in children or it has not been diagnosed often because it commonly remains asymptomatic in this age group. One study suggested that 86% of all childhood COVID-19 infections in China remained undiagnosed.[1] Children represent 2% of diagnosed cases in China 1.2% of cases in Italy and 5% of COVID-19 positive cases in the US.[2-4] COVID-19 seems to have a much milder course in children than in adults. Several suggestions have been put forward. Children, especially smaller ones, tend to have so many viral infections. It is possible that repeated viral exposures support the immune system when it faces to SARS-CoV-2. There have also been suggestions that the SARS-CoV-2 S protein binds to the angiotensin-converting enzyme 258 and children may be protected against SARS-CoV-2 because this enzyme is less mature in this age group. The immune system also undergoes substantial changes from birth to adulthood.[5] The current pediatric recommendations in China do not include milder disease and different laboratory findings seen in children.[6] In previous reports of SARS and MERS-CoV infections, acute kidney injury (AKI) developed in 5–15% of cases and carried high (60–90%) mortality rate. Early reports suggested lower incidence (3–9%) of AKI in those with COVID- 19 infection. Recent reports, however, suggest higher frequency of renal abnormalities. In study of 59 COVID- 19 patients, 34% developed massive albuminuria on the first day of admission and 63% developed proteinuria during their hospital stay.[7] Cheng *et al*. recently reported proteinuria and hematuria in 44% and hematuria alone in 26.7% among 710 hospitalized patients affected by COVID-19. The prevalence of elevated serum creatinine and blood urea nitrogen was 15.5 and 14.1%, respectively. AKI was an independent risk factor for patients' in-hospital mortality.[8] Continuous renal replacement therapy (CRRT) has been successfully done in treatment of SARS, MERS, and sepsis.[9] High-volume hemofiltration in a dose enough to remove inflammatory cytokines (IL-6) improved the sequential organ failure assessment scores at day 7 in sepsis patients.[10] Therefore, CRRT hemoperfusion may play an important role in patients with COVID- 19. We report

How to cite this article: Yaghmaii B, Nili F, Najafi Z, Cheloi F, Moghtaderi M. Renal involvement in a child with COVID-19 infection and its management with CRRT. Int J Prev Med 2022;13:19.

a 10-year-old boy infected by COVID-19 suffering from respiratory failure, sepsis, and AKI managed successfully with vigorous supportive care and CRRT.

Case Presentation

A 10-year-old boy of nonrelative parents with no history on any underlying disease developed fever, chills, myalgia, weakness, cough, tachycardia, tachypnea, retraction, and crackle in both lungs 5 days after contact with a COVID-19 positive family. At first, he was admitted in a private hospital and as his condition got worse he was referred to our hospital due to hypertension (160/110 mmHg), tachypnea, retraction, oliguria that eventuated to anuria. He was intubated in the second day in ICU and connected to a ventilator machine. Soon after that, he developed a typical bacterial lobar pneumonia treated by systemic antibiotics. The blood pressure was controlled effectively by medications. Laboratory tests revealed elevated CRP, ESR, leukopenia (3200/mL), and lymphopenia (800/mL). Liver enzymes were elevated (SGPT = 800 IU/L, SGOT = 1025 IU/L), and the first nasal RT-PCR was negative. Serum Procalcitonin (42 ng/l) was elevated that may be due to either bacterial pneumonia or the severity of COVID-19 itself. Serum ferritin (780 ng/ml) and LDH (750 IU/L) were also elevated. Other laboratory data such as C3, C4, CH50, CPK, and troponin were normal. ANA titer, ANCA, HBS Ag, HCV Ab, HIV assays were also negative. Repeated echocardiography was reported as normal. There was 4 + proteinuria plus hematuria and pyuria. Typically, 24-h urine protein was 80000 mg/dL. Oxygen saturation was 65% at first. Imaging studies showed white lung in plain chest X ray and typical CT scan findings of COVID-19. Soon, in the next 48 h, CRRT using special adsorbent filters to remove circulating inflammatory mediators was done and repeated every 48 h. Two week later, the second RT-PCR test became positive. Negative RT-PCR test may result from inappropriate technic, poor handling of samples, or poor kits of the earliest days of epidemic. Our patient received oseltamivir, chloroquine, FFP, IVIG, and albumin. Several sessions of platelet and packed cell transfusion were done according to his clinical condition. During hospitalization, he gradually developed leukocytosis up to 41000/mL, rising of blood urea and creatinine and electrolyte disturbances. His course was complicated by sudden onset of unilateral pneumothorax also which subsided under medical supervision.

After 5 weeks of close control and vigorous treatments, he could breathe without respiratory machine assistance. At this time, he underwent renal biopsy, reported as follows: "the specimen for light microscopic examination contains medullary kidney tissue, without cortex and unsatisfactory for histopathological diagnosis. However, interstitial infiltration of mononuclear inflammatory cells including lymphocytes and plasma cells, foci of tubulitis, and vacuolization of the cytoplasm in some tubular epithelial cells were seen [Figure 1]. Immunofluorescence study was also non-diagnostic due to absence of glomeruli. But the tissue which was processed for electron microscopy had 3 glomeruli, all of them showing global sclerosis. Interstitial fibrosis in association with chronic inflammation and tubular atrophy were also identified [Figure 2]. Ultrastructural evaluation of the glomeruli, reveal global obliteration of the capillary lumens by extracellular matrix compatible with global sclerosis. Meanwhile, extensive effacement of visceral foot processes, swelling of endothelial cell and subendothelial accumulation of electron lucent material with extension along the mesangium were noted [Figure 3a-c]. The features of endothelial cell injury were also seen in peritubular capillaries [Figure 3d]. The tubules show atrophic changes [Figure 3e and f]. No obvious viral cytopathic effect was seen in our small specimen. The pathologic findings were not completely diagnostic, due to small amount of cortical tissue. However, overall findings were in favor of acute tubulointerstitial inflammation in the background of chronic kidney disease. Endothelial cell injury and features of

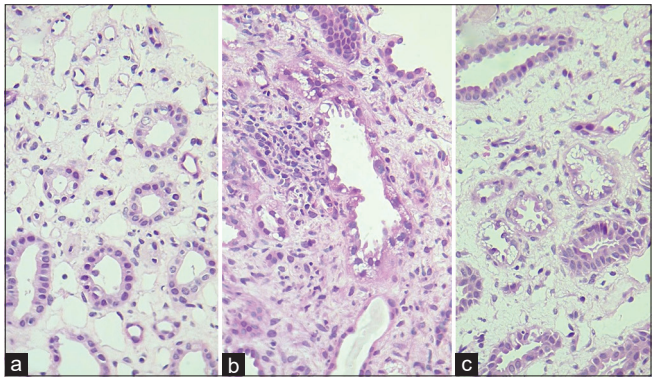

Figure 1: H&E stained sections show (a) medullary kidney tissue (100X), (b) interstitial infiltration of chronic inflammatory cells (400X), (c) tubulitis and vacuolization of the cytoplasm in some tubules (400X)

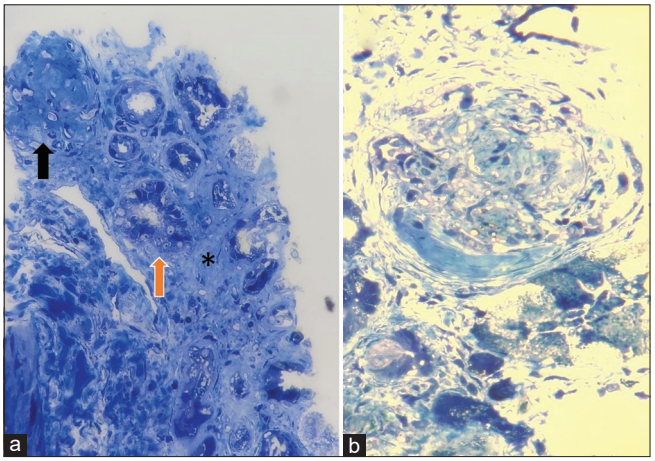

Figure 2: Thick sections of resin-embedded tissue for electron microscopy stained by toluidine blue and evaluated by light microscope show (a) global sclerosis of one glomerulus (arrow), tubular atrophy and interstitial fibrosis (*) (100X), (b) another glomerulus with global sclerosis is seen (400X)

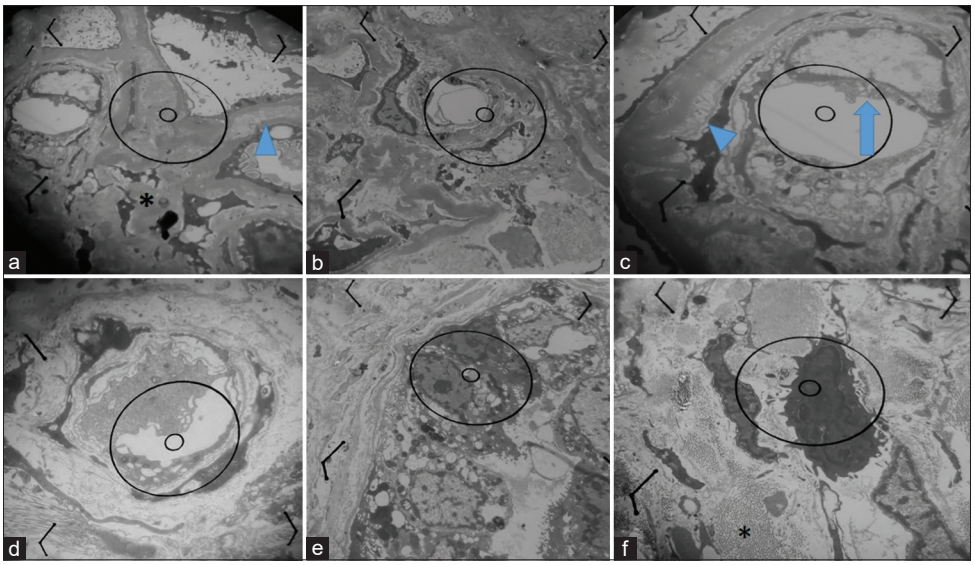

Figure 3: Ultrastructural examination shows (a) extensive deposition of extracellular GBM-like matrix (*) and subendothelial widening (arrow head) (5600X), (b) glomerular sclerosis and endothelial cell injury (8000X), (c) endothelial swelling (arrow), subendothelial widening and accumulation of electron lucent material (arrow head) (11000X), (d) peritubular capillary with endothelial swelling and subendothelial widening (8000X), (e) mildly atrophic proximal tubule show loss of brush border, cytoplasmic vacuolization, open nuclear chromatin and prominent nucleoli (7000X), (f) interstitial collagen bundles (*) and inflammatory cells (8000X)

microvascular damage was the other pathologic finding. Thrombotic microangiopathy, malignant hypertension or complications of coronavirus disease in our patient are the differential diagnosis." Oliguria resolved slowly, 24-h urine protein declined to 770 mg/dL and serum albumin returned to normal. He discharged with the order of hemodialysis twice weekly and continuing corticosteroids. Two weeks later serologic test confirmed COVID-19 IgG specific antibody. The test was performed by a kit with 79.4 and 94.1% sensitivity of IgM and IgG, respectively, and 97.3 and 98.3% specificity for IgM and IgG, respectively.

Discussion

New data on coronavirus disease include some startling revelations. Kidney involvement seems to be more frequent in people who have positive virologic tests and clinical manifestations. Two studies showed a high rate of renal abnormalities in corona-positive patients.[7,8] Acute kidney injury in COVID-19 is not uncommon and may result from a systemic inflammatory syndrome involving kidney and other organs at the same time. According to current data, an excessive immune response might also add to severity through a generalized inflammatory status.[6] In one study, 59 patients (34%) developed massive proteinuria and symptoms of kidney damage. In total, 63% of the studied patients developed proteinuria while in hospital, and many of them had also hematuria.[8] Kidney function was impaired in 27% of the study population and in 66% of the patients who died from the coronavirus infection. Our patient also had massive proteinuria and hematuria and pyuria. We suggest that in this case continues renal replacement therapy with hemofiltration units and specific adsorbent filters to eliminate inflammatory mediators including leukotrienes, TNF-and so on contributed the resolution of multiorgan failure including kidney, liver, and respiratory system. Soon after starting CRRT and hemoperfusion, his breathing state got better obviously. Urine output and serum electrolytes get better after starting corticosteroid drugs, but he still had needed outpatient hemodialysis twice weekly as a regular basis.

Conclusion

COVID-19 infection can be quite aggressive and fulminant in normal children and in such cases (as our case) only appropriate and continued managements can save their lives. This case demonstrates that pediatric population should not be considered just a transmission route of COVID-19.

Compliance with ethical guidelines

All ethical principles were considered for this patient and in this article.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Acknowledgment

Special thanks to Dr. Amirahmad Nasiri (Associate professor of pediatric nephrology, Shahid Beheshti University of Medical Science, Tehran, Iran) who gratefully

helped us in doing CRRT and also to the careful and kind stuff of our ICU ward. We have to express our appreciation to Seyed Abolhassan Alemohammad M.D. (Chief dermatologist of NIOC hospital, Tehran, Iran) for sharing his pearls of wisdom with us. We are also immensely grateful to him for his comments on an earlier version of the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There is no conflict of interest in this case report.

Received: 24 Jul 20 **Accepted:** 28 Jul 20
Published: 08 Feb 22

References

1. Cai J, Xu J, Lin D, Yang Z, Xu L, Qu Z, *et al*. A Case Series of children with 2019 novel coronavirus infection: Clinical and epidemiological features. Clin Infect Dis 2020:ciaa198. doi: 10.1093/cid/ciaa198.
2. Zhang Y. The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID- 19) — China, 2020. Chinese Journal of Epidemiology (by The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team) 2020.
3. Livingston E, Bucher K. Coronavirus Disease 2019 (COVID- 19) in Italy. JAMA 2020 doi: 10.1001/jama.2020.4344.
4. CDC COVID- 19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID- 19) — United States, February 12–March 16, 2020. MMWR Morb Mortal Wkly Rep 2020;69:343-6.
5. Simon AK, Hollander GA, McMichael A. Evolution of the immune system in humans from infancy to old age. Proc Biol Sci 2015;282:20143085. doi: 10.1098/rspb.2014.3085.
6. Henry BM, Lippi G, Plebani M. Laboratory abnormalities in children with novel coronavirus disease 2019. Clin Chem Lab Med 2020;58:1135-8.
7. Li Z, Wu M, Yao J, Guo J, Liao X, Song S, *et al*. Caution on kidney dysfunctions of 2019-nCoV patients. medRxiv 2020. doi: 10.1101/2020.02.08.20021212.
8. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, *et al*. Kidney impairment is associated with in-hospital death of COVID-19 patients. medRxiv 2020. doi: 10.1101/2020.02.18.20023242.
9. Arabi YM, Arifi AA, Balkhy HH, Najm H, Aldawood AS, Ghabashi A, *et al*. Clinical course and outcomes of critically ill patients with Middle East respiratory syndrome coronavirus infection. Ann Intern Med. 2014;160:389-97.
10. Prof. Claudio Ronco & Prof. Jean-Louis Vincent, Hemoperfuison including new sorbent cartridges designed to remove cytokines and other circulating mediators should be considered facing the sepsis like syndrome induced by cytokines, Feb. 6th, 2020, comments on Lancet Respir Med 2020.