Clinical features of acute kidney injury in Coronavirus disease 2019—A case report with review of literature

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Case Report

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Abstract

Background: In December 2019, an outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) occurred in Wuhan, Hubei province, China. We surveyed 91 patients who were diagnosis as coronavirus disease 2019 (COVID-19) in Xiangyang, Hubei province. And we found the incident of acute kidney injury (AKI) was 3.29% (3/91), which was higher than in the whole country but similar in Hubei province.

Case presentation: We describe a case of 58-year-old man who was diagnosis as AKI stage 3 and non-oliguria AKI in the SARS-CoV-2 infection. After antiviral and other supporting treatment, his kidney function improved and he was transferred to normal ward.

Conclusions: This case illustrated that careful management and strict monitoring of kidney function should be employed in COVID-19 patients especially in high incidence area of COVID-19.

Background

Since December 2019, an outbreak of the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV–2) has developed in Wuhan, Hubei province, China, and spread to several other countries. The World Health Organization (WHO) has declared the coronavirus disease 2019 (COVID–19, previously known as 2019-nCoV), which is caused by SARS-CoV–2, a public health emergency of international concern[1]. As of February 18, 2020, a total of 74,185 COVID–19 cases have been confirmed in China, with a total of 2004 deaths.In contrast to severe acute respiratory system coronavirus (SARS-CoV) and Middle East respiratory system coronavirus (MERS-CoV), COVID–19 has caused more deaths by multiple organ dysfunction syndrome, aside from respiratory failure[2]. Both bioinformatics modeling and *in vitro* experiments have indicated that SARS-CoV–2 is more likely to enter target cells via the receptor angiotensin- converting-enzyme 2 (ACE2), which is a cellular mechanism identical to the SARS-CoV[3].A previous report showed that the level of ACE2 expressed in urinary organs was much higher than that in respiratory organs, and ACE2 in the kidney was disturbed within the renal tubular epithelium, vascular smooth muscle cells of the intrarenal arteries, and the glomeruli[4, 5]. This suggests that the kidney is a possible target infected by SARS-CoV–2. Although there have been several publications reporting the occurrence of acute kidney injury (AKI) in COVID–19 patients, clinical information of the SARS-CoV–2-infected patients with AKI is still lacking. Here, we describe one patient with AKI during the course of SARS-CoV–2 infection.

Case Presentation

A 58-year-old man arrived at the hospital presenting with a 4-day history of fever with cough and myalgia. This patient did not have chills, nasal discharge, or diarrhea. He was diagnosed with type 2 diabetes two years prior. His existing treatments included metformin without other significant medical or psychiatric history. The patient had normal renal function, as assessed by physical examination 5 months prior to

hospitalization. At admission, his body temperature was elevated to 37.8°C with normal pulmonary auscultation. His arterial pressure was at 144/83 mm Hg, and pulse oximetry measured his oxygen saturation at 96% on ambient air. He was without swelling in the extremities. Laboratory test results are listed in Table 1. His D-dimer, alanine aminotransferase (ALT), aspartate aminotransferase (AST), prothrombin Time (PT), and activated partial thromboplastin time (APTT) levels were normal. An unenhanced chest computed tomography (CT) showed scattered ground-glass opacities in both lungs (Figure 1a). Real-time polymerase chain reaction (RT-PCR) of the patient's pharyngeal swab was positive for COVID–19 nucleic acid 2 days after hospitalization. The patient was not dehydrated and did not have any urinary tract obstruction as assessed by ultrasound. According to the definition and classification of AKI by the Kidney Disease Improving Global Outcomes (KDIGO), this patient was diagnosed as stage 3 AKI[6]. However, the patient exhibited non-oliguria throughout the whole course of the disease (Table 1). This patient was treated with lopinavir plus ritonavir combined with interferon alfa–2b inhalation as antiviral therapy, ceftazidime to prevent secondary infection, and sodium bicarbonate to correct metabolic acidosis. At day 5 after admission, the patient developed dyspnea. A CT scan of the lungs showed multiple ground-glass opacities in both lungs (Figure 1b). The oxygen requirement of the patient increased daily, peaking at 25 L/min. The serum creatinine (Scr) and blood urea nitrogen (BUN) levels continued to increase after admission (Table 1). This patient was eventually transferred to the intensive-care unit, where non-invasive mechanical ventilation was started, and methylprednisolone was added to attenuate lung inflammation. After the patient received 15 days of treatment, his respiratory symptoms improved, and RT-PCR analysis of a pharyngeal swab from the patient tested negative for COVID–19 nucleic acid. The Scr level decreased from 732 mol/L to 332 mol/L at day 9 after admission. A chest CT analysis show ground-glass opacities were mostly completely resolved (Figure 1c), and the patient was transferred to the normal ward from the intensive-care unit. RT-PCR analysis of a pharyngeal swab from the patient tested negative once again for 2019-nCoV nucleic acid.

	Day 1	Day 5	Day 9	Day 11	Day 13	Day 15	Normal Range
Leucocyte count,× 10^9/L	5.29	6.56	23.4	18.7	9.6	8.6	3.5–9.5
Neutrophils,%	71.1	75.8	92.4	91.9	82.9	77.7	40–75
Lymphocytes,%	16.6	10.5	1.7	2.9	4.3	9.4	20–50
Hemoglobin, g/L	119	128	128	115	102	104	110–130
Procalcitonin, ng/ml	ND	ND	0.23	0.67	ND	ND	0–0.5
Scr, μmol/L	457	620	732	553	384	332	110–130
BUN, mmol/L	24.4	39.6	49.0	38.1	27.6	18.2	3.1–8.0
Potassium, mmol/L	5.3	5.1	5.6	4.4	4.0	4.4	3.5–5.5
Bicarbonate, mmol/L	14	18.6	14.2	13.6	13.5	14.7	23–25
Urine output, ml	1550	1400	1600	1650	1500	1700	
Urine protein	2+	ND	2+	ND	1+	1+	
PH	ND	7.35	ND	7.33	ND	ND	7.35-7.45
CT scan	1^{st} CT	2^{nd} CT			3^{rd} CT		

Table 1. Hematological and blood chemical values for the patient. Scr: serum creatinine; BUN: blood urea nitrogen; CT: computed tomography; ND: not determined.

Discussion And Conclusions

We previously surveyed pharyngeal swab specimens from 91 patients for COVID–19 by RT-PCR in Xiangyang (a city 300 kms away from Wuhan, both of which are in Hubei Province). The incidence of AKI in these patients was 3.29% (3/91). We report here a patient who was diagnosed with stage–3 AKI and non-oliguria AKI. The patient did not use continuous replacement therapies (CRRTs) because there were no emergency hemodialysis indications, such as obvious hyperkalemia and volume overload. After antiviral and other treatments, he was transferred to a normal ward when his kidney function exhibited obvious improvement.

Kidney involvement of human coronaviruses was noticed during the SARS-CoV epidemic, which occurred in early 2003. One study detected SARS-CoV in the distal convoluted renal tubules of four kidney specimens [7]. Further study survey 536 patients with SARS, 6.7% developed AKI and post-mortem study revealed predominantly acute tubular necrosis with no evidence of glomerular pathology. The development of AKI is an important negative prognostic indicator for survival with SARS [8].Another human coronavirus, MERS-CoV, was reported to enter target cells via by binding to dipeptidyl-peptidase 4

(DPP–4), which is one of the major brush border membrane proteins in the kidney and is also present in glomerular podocytes and capillaries, during an outbreak in 2012 [9].A previous report showed that more than one-fourth of MERS-CoV-infected patients developed AKI [10].SARS-CoV–2 was shown to be more likely to use ACE2 as the entry receptor, which is previously known as the receptor for SARS-CoV[11]. However,ACE2 was demonstrated to be more than just a receptor during SARS-CoV–2 infection, as it is also involved in post-infection regulation, including immune response, cytokine secretion, and genome replication [3]. This high degree of similarity in the cellular mechanism of SARS-CoV–2 and SARS-CoV suggests that the risk factors of kidney injury may be similar. A Currently, the pathophysiological mechanisms underlying AKI in COVID–19 remain unclear. However, recently study indicated AKI may develop as a result of direct nephrotoxic effects of the virus or secondary immune activation. First, the direct cytotoxic effect of kidney through ACE2 that are highly expressed in the kidney. Second, Immune activation due to viral infection. SARS-CoV–2 virus induced immune mediators or cytokine storm syndrome have indirect effects on kidney, such as hypoxia and shock [12, 13].

Recently, a study of 138 COVID–19-infected patients in Wuhan showed that 3.6% of the patients had AKI, and their levels of blood urea and creatinine progressively increased before death [13]. In a national retrospective analysis of 1099 COVID–19-infected patients, the incidence of AKI was 0.5%, and the incidence of AKI was significantly different between severe and non-severe patients. In addition, the emergence of AKI was an independent risk factor for death[14]. These studies indicate that AKI potentially influences disease severity. Moreover, kidney dysfunction may be a risk factor for predicting mortality. Thus, it is necessary to monitor the kidney function of COVID–19-infected patients, especially the severely ill patients.

We have summarized the reports regarding the complications of AKI in COVID–19 patients (Table 2). As shown in Table 2, the populations analyzed in the first five articles[12, 13, 15–17]were all from Hubei province, while the population of the study by Guan et al[14] was from the entire nation of China. The incidence of AKI in our study was higher than that found in the whole country, but similar to that found in Hubei province. This may be the proportion of severe patients was lower in the national observational study. Data from the Chinese Center for Disease Control and Prevention (CDC) indicated that COVID–19-infected patients in Hubei province had a 7.3-fold higher case fatality rate compared with COVID–19-infected patients in other provinces of China [1].Therefore, we suggest meticulous evaluation and management of kidney damage during the course of COVID–19 infection, such as frequent monitoring of renal function and avoidance of nephrotoxic drugs, especially in patients within the high incidence area of COVID–19.

Authors	Number of patients	Number of Scr > 133 μmo/L (%)	Number of AKI (%)	Number of CRRT(%)
Huang et al. [15]	41	4 (10%)	3 (7%)	ND
Wang et al. [13]	138	ND	5 (3.6%)	2 (1.45%)
Chen et al. [16]	99	3 (3%)	3 (3%)	9 (9%)
Li et al.[17]	59	11 (19%)	ND	ND
Cheng et al. [12]	710	110 (15,5%)	22(3.2%)	ND
Guan et al. [14]	1099	12/752 (1.6%)	6 (0.5%)	9 (0.8%)
Current study	91	3 (3.3%)	3 (3.3%)	1 (1.1%)

Table 2. A summary of the studies performed on COVID-19-infected patients with acute kidney injury (AKI). Scr: serum creatinine; COVID-19: 2019 novel coronavirus disease; CRRT: continuous replacement therapies; ND: not determined.

Abbreviations

SARS-CoV–2: severe acute respiratory syndrome coronavirus 2; AKI: acute kidney injury; ACE2: angiotensin- converting-enzyme 2; SARS-CoV: severe acute respiratory system; MERS: Middle East respiratory system; Scr: serum creatinine; BUN: blood urea nitrogen; CT: computed tomography; ND: not determined; CDC: Center for Disease Control and Prevention

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written consent for publication was obtained from person presented in this case report.

Availability of data and materials

Not applicable.

Competing interests

All of the authors declared no competing interests.

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Authors' contributions

HY acquisition of data, draft. XHL writing, concept, design. EG participated in the care of the patient. FQH and ZG concept, acquisition of data, interpretation, revision. All authors read and approved the final manuscript.

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Figures

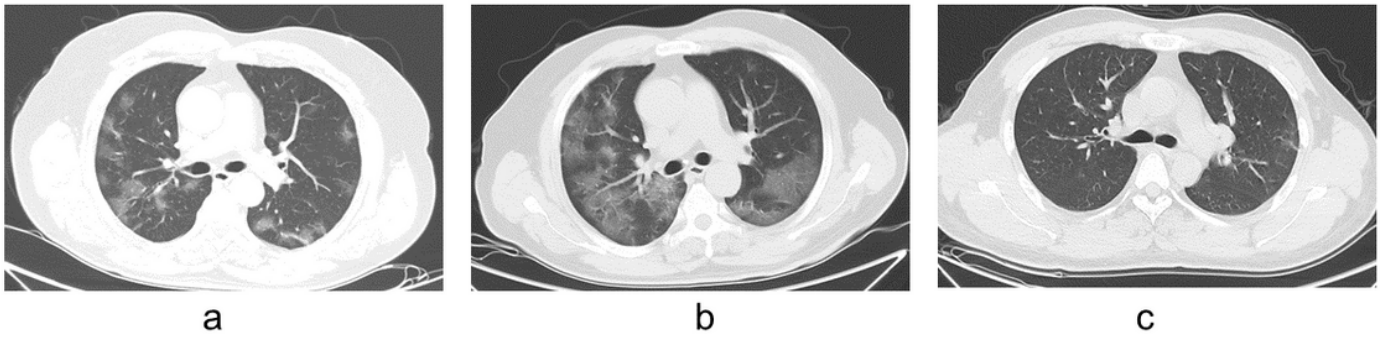

Figure 1

Computed tomography (CT) scans of a COVID-19-infected patient with AKI. (a) A CT scan obtained on the first day after admission showed scattered ground-glass opacities in both lungs. (b) A CT scan obtained on day 5 after admission showed multiple ground-glass opacities in both lungs. (c) A follow-up CT scan obtained on day 13 after admission showed that the ground-glass opacities were mostly completely resolved.