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Original Article

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Post-COVID-19 Outcomes of Patients with Primary Glomerular Diseases: A Nationwide Controlled Study

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ABSTRACT

Background: Patients with chronic diseases such as chronic kidney disease (CKD) have been reported to have more adverse outcomes during the coronavirus disease 2019 (COVID-19) pandemic. There are insufficient data on the outcomes of patients with primary glomerular diseases (PGD) after COVID-19.

Methods: We designed a national multicenter observational study that included adult patients with biopsy-proven PGD who survived COVID-19. A control group was created from the same centers, including PGD patients without COVID-19. The clinical and laboratory data of the patients at baseline, first, and third months after COVID-19 were recorded.

Results: A total of 129 patients from 21 centers were included (COVID-19 group, n = 77). Baseline characteristics were almost similar except the ratio of active disease in the non-COVID-19 group was significantly higher than in the COVID-19 group. No patients died during the first and third months. Respiratory symptoms were significantly higher in the COVID-19 group than in the non-COVID-19 group in the first month (7.8% vs. 0%, *P* = .039). All other follow-up outcomes, including initiation of chronic kidney replacement therapy and initiation of new immunosuppressive treatment, and the laboratory data were not different between the groups in the first and third months.

Conclusion: Primary glomerular disease patients in the post-COVID-19 period had more respiratory symptoms than non-COVID-19 PGD patients, but outcomes, including death and initiation of kidney replacement therapy, were not different in the first and third months post COVID-19.
Keywords: Chronic kidney disease, glomerulonephritis, outcome, post-COVID-19

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INTRODUCTION

Patients with chronic kidney disease (CKD) have been reported to have more adverse outcomes, including hospitalization, need for intensive care support, and mortality, during the coronavirus disease 2019 (COVID-19) pandemic.[1-3] In previous studies conducted by our group, we have shown that CKD, including primary glomerular diseases (PGD), is an important risk factor for intensive care unit (ICU) admission and in-hospital mortality.[4,5] Prirmary glomerular disease is one of the common causes of kidney failure, which increases the risk of infections or complications of infections due to immunosuppressives and/or proteinuria.[6] During the pandemic, most of the publications regarding glomerular diseases were related to the new onset of glomerular disease or disease flare after COVID-19 or immunization against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[7-11]

In a multicenter COVID-19 registry of 40 patients with glomerulonephritis from centers in North America and Europe, compared with 80 cases of COVID-19-positive controls from the general population without glomerulonephritis matched for the time of infection, mortality (15% vs. 5%, respectively) and acute kidney injury (AKI) (39% vs. 14%) were significantly higher in patients with glomerulonephritis than in controls, but the need for kidney replacement therapy (KRT) was not statistically different between the two groups.[12] An international collaborative study including 284 kidney biopsies, including COVID-19 patients with kidney disease, showed that the second most common cause of native kidney biopsy was proteinuria (42.6%), and African American patients (44.6%) were more common than patients of other ethnicities. Collapsing glomerulopathy (25.8%) associated with high-risk APOL1 genotypes in 91.7% of patients was the most common diagnosis in native kidney biopsies. Frequency of chronic conditions such as diabetes mellitus, IgA nephropathy, and arterionephrosclerosis has decreased.[13] A registry data study showed significantly high in-hospital mortality among PGD patients compared to general populations (15% vs. 5%, respectively).[12] All these studies associated with PGD are generally related to the active phase of COVID-19 or glomerular diseases associated with COVID-19 or vaccines. Moreover, none of them include patients with PGD. On the other hand, the post-COVID-19 syndrome period is the terminology used to describe the presence and/or persistence of symptoms that cannot be attributed to another disease 8-12 weeks after the onset of COVID-19.[14] This period is considered to be a convalescence period in which organ effects and sequelae due to COVID-19 can continue with different mechanisms. However, there are not enough data on the outcomes of PGD patients after COVID-19, especially on complications and survival.[14]

Here, we aimed to obtain the characteristics and outcome data obtained in the follow-up of COVID-19 surviving patients with PGD and compare these data with a control group with PGD who were COVID-19 naive.

MAIN POINTS

- Coronavirus disease 2019 (COVID-19) has created significant challenges for individuals with chronic diseases, including chronic kidney disease (CKD). Our study highlights that CKD, including primary glomerular diseases (PGD), is a crucial risk factor for severe outcomes during the pandemic.
- Our study is one of the first studies to focus on patients with primary glomerular diseases in the post-COVID-19 period. It sheds light on complications and survival rates in this specific patient population.
- While patients with PGD in the post-COVID-19 period experience more respiratory symptoms, our study reveals no significant difference in mortality rates or need for kidney replacement therapy compared to PGD without COVID-19.
- Our research provides comprehensive data comparing demographics, comorbidities, medications, and baseline laboratory results between COVID-19 and non-COVID-19 groups, which are vital to understanding the differences and similarities between the two groups.
- Our study contributes to the understanding of post-COVID-19 syndrome and its impact on PGD patients. It discusses how certain symptoms, such as breathing problems, may persist but do not significantly affect long-term outcomes.

MATERIAL AND METHODS

The Strengthening Reporting of Observational Studies in Epidemiology statement was followed in this retrospective cohort study.[15] Ethical approval of the study was obtained from the Health Sciences University, Haseki Training and Research Hospital Ethics Committee (Date: April 28, 2021, Protocol number: 12-2021).

Population and Setting

We designed a national multicenter observational study including patients with known PGD aged 18 years or older who had

confirmed COVID-19. We retrieved the data for our study from the databases provided by the Turkish Society of Nephrology, which collects data from 21 nephrology centers across the country in a web-based system. We used the data recorded in the forms prepared for patients with PGD among these databases reported between April 28, 2021, and November 8, 2021. All consecutive patients, with PGD, admitted to the participating centers during the pandemic were evaluated for the study. Among these patients, those in the post-COVID-19 period of a confirmed SARS-CoV-2 infection were recorded as the COVID-19 group. In addition, for each patient included in the COVID-19 group from each center, a PGD patient without COVID-19 followed up at the relevant center was included in the non-COVID-19 group. Patients with known kidney disease other than PGD, patients with secondary glomerular diseases, end-stage kidney disease, patients with active SARS-CoV2 infection (SARS-CoV-2 reverse transcriptase PCR test positive), and patients with missing post-COVID-19 third-month outcome data were excluded.

Measurements and Definitions

From the COVID-19 group, we obtained demographic data, comorbidities, and medications, type of PGD, duration of PGD, the status of the glomerular disease at diagnosis of COVID-19 (active/remission, under/not immunosuppressive), blood pressure, height, weight, systolic and diastolic blood pressures, baseline laboratory test results (glucose, glycated hemoglobin, creatinine, albumin, C-reactive protein (CRP), hemoglobin, proteinuria), urinalysis, and hemogram parameters from hospital records at the last outpatient clinic visit (baseline visit) of the relevant center before the development of COVID-19. The estimated glomerular filtration rate (eGFR) was calculated from the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula.[16] Proteinuria was recorded both qualitatively as measured by dipstick and quantitatively by derived from spot urine–protein creatinine ratio or measured from 24-hour collected urine protein amount. Hematuria was defined as the presence of 5 or more erythrocytes per high-power field. Leukocyturia was defined as 5 or more leukocytes per high-power field. In addition, information about the active period of COVID-19 [symptoms, chest computed tomography (CT), treatments for COVID-19, clinical severity of the disease according to the Ministry of Health guidelines,[17] inpatient or outpatient treatment, need for ICU, dialysis, and the duration of the hospitalization] were obtained. The data of patients included in the non-COVID-19 group were obtained in the same month as the equivalent patients in the COVID-19 group.

Follow-Up and Outcome

Post-COVID-19 first- and third-month mortality, relapse of glomerular disease, initiation of new immunosuppressive treatment (IST), the initiation of chronic KRT, persistent respiratory symptoms (cough and/or shortness of breath), admission to hospital, need for home oxygen therapy, lower respiratory tract infection, urinary system infection, and development of venous or arterial thromboembolic events were recorded. In addition, weight, blood pressure, creatinine, albumin, CRP, hemoglobin, proteinuria (qualitative and quantitative), and hematuria and leukocyturia in urine sediment were obtained at one and three months. Relavent data were gathered also for the non-COVID-19 group.

Statistical Analyses

We used Statistical Package for the Social Sciences Statistics software for Windows, version 26.0 (IBM SPSS Corp.; Armonk, NY, USA) for statistical analyses. The normality of variables was analyzed using Kolmogorov–Smirnov tests. We presented numbers and percentages for categorical variables and median and interquartile ranges (25%-75%) for numerical variables in descriptive statistics. The chi-square test was used to compare categorical variables in two or multiple groups. We used the independent *t*-test or Mann–Whitney *U*-test as appropriate to compare numerical variables. In the multiple group comparisons of numerical variables, we used the analysis of variance test for numerical variables with normal distribution and the Kruskal–Wallis test for numerical variables that were not normally distributed. $P < .05$ was accepted as the significance level.

RESULTS

Demographic and Baseline Characteristics

A total of 136 patients' data were obtained from 21 centers, and 129 were included in the analyses. We excluded 7 patients: 5 patients had RT-PCR-negative COVID-19, 1 patient had inconsistent data regarding SARS-CoV-2 RT-PCR, and 1 patient had missing outcome data.

Pre-Coronavirus Disease 2019 Data and Comparisons

Table 1 represents the demographics, comorbidities, medications, and baseline laboratory tests at the last clinic visit during the pre-COVID-19 period. Age, sex, comorbidities, medications (except anticoagulants), smoking status, body mass index, systolic and diastolic blood pressures, type of PGD, duration of PGD, and clinical presentation of the glomerular disease were not different between the groups. But the ratio of active disease was significantly lower in the COVID-19 group than in the non-COVID-19 group. Consistent with this, the proportion of patients with partial or complete remission in the COVID-19 group was higher than in the non-COVID-19 group. Among the immunosuppressive drugs, the corticosteroid and cyclosporin-A use were significantly higher in the non-COVID-19 group, where the number of active glomerular disease patients was high. Consistently, median proteinuria and the rate of leukocyturia were significantly higher in the non-COVID-19 group than in the COVID-19 group. All other baseline Laboratory tests, including eGFR and serum albumin level were not significantly different between the groups.

Data for the Period of Coronavirus Disease 2019

In the COVID-19 group, the most common symptoms at the time of admission were cough, fever, and sore throat (Supplementary Table 1). In addition, there were pneumonia findings in chest

Table 1. Comparative Presentation of Demographic Characteristics, Medications, Types of Primary Glomerular Diseases (PGD), Immunosuppressives Given for PGD, and Baseline Visit (Before COVID-19) Laboratory Test of Both Groups

	COVID-19 Group N = 77	Non-COVID-19 Group N = 52
Age (year), median (IQR)	45 (39-55)	45 (38-52)
Sex, n (%)		
Male	46 (59.7)	29 (55.8)
Woman	31 (40.3)	23 (44.2)
Glomerulonephritis type, n (%)		
FSGS	20 (26.0)	16 (30.8)
IgA nephropathy	20 (26.0)	12 (23.1)
Membranous nephropathy	24 (31.2)	18 (34.6)
Minimal change disease	4 (5.2)	2 (3.8)
MPGN tip 1 (immunocomplex MPGN)	3 (3.9)	2 (3.8)
Pauci-immune crescentic GN	6 (7.8)	2 (3.8)
PGD duration (months), median (IQR)	40 (14-90)	41 (12-36)
Clinical presentation of GN when diagnosed, n (%)		
Asymptomatic urinary abnormality	3 (3.9)	2 (3.8)
Rapidly progressive GN	6 (7.9)	0 (0)
Nephritic syndrome (except for rapidly progressive GN)	15 (19.7)	13 (25.0)
Nephrotic syndrome	52 (68.4)	37 (71.2)
Status of GN at baseline visit, n (%)		
Active disease under IST*	11 (14.3)	25 (48.1)
Active disease without IST	10 (13.0)	6 (11.5)
Partial or complete remission with IST	29 (37.7)	14 (26.9)
Partial or complete remission without IST*	27 (35.1)	7 (13.5)
Comorbidities, n (%)		
DM type 2	7 (9.2)	9 (17.3)
Hypertension	58 (75.3)	43 (82.7)
COPD	2 (2.7)	5 (9.6)
Ischemic heart disease	10 (13.5)	6 (12.2)
Heart failure	3 (4.3)	2 (4.1)
Cerebrovascular disease	2 (2.7)	1 (1.9)
Malignancy	0 (0)	2 (3.8)
Chronic liver disease	0 (0)	2 (3.8)
Autoimmune/auto inflammatory disease	2 (2.6)	3 (5.8)
Smoking status		
Quit	29 (38.2)	16 (30.8)
Current smoker	5 (6.6)	3 (5.8)
Never smoked	42 (55.3)	33 (63.5)
Medications (%)		
ACE inhibitor	37 (48.1)	30 (57.7)
ARB	30 (39.5)	14 (26.9)
Calcium channel blockers	29 (38.7)	25 (48.1)
Beta-blocker	16 (21.1)	17 (32.7)
Other antihypertensives	15 (19.7)	17 (32.7)
Insulin	2 (2.6)	1 (1.9)
Oral antidiabetic	5 (6.6)	6 (11.5)
Statin	20 (26.3)	18 (34.6)
Antiaggregant	15 (19.7)	15 (28.8)
Anticoagulants*	1 (1.3)	9 (17.3)
Immunosuppressive drugs, n (%)		
Corticosteroid (for GN treatment)*	34 (44.7)	35 (67.3)
Cyclosporin A*	8 (10.5)	14 (26.9)
Tacrolimus	4 (5.3)	6 (11.5)
Azathioprine	2 (2.6)	0 (0)
Cyclophosphamide per oral	2 (2.6)	0 (0)
Cyclophosphamide pulse (last month)	3 (3.9)	2 (3.8)
Rituximabᵠ	4 (5.3)	6 (11.5)

(*Continued*)

Table 1. Comparative Presentation of Demographic Characteristics, Medications, Types of Primary Glomerular Diseases (PGD), Immunosuppressives Given for PGD, and Baseline Visit (Before COVID-19) Laboratory Test of Both Groups (*Continued*)

Table 1. Comparative Presentation of Demographic Characteristics, Medications, Types of Primary Glomerular Diseases (PGD), Immunosuppressives Given for PGD, and Baseline Visit (Before COVID-19) Laboratory Test of Both Groups (*Continued*)

	COVID-19 Group N = 77	Non-COVID-19 Group N = 52
MMF/mycophenolic acid	6 (9.1)	4 (8.3)
Baseline data, median (IQR)		
BMI (kg/m^2)	26.0 (24.3-29.2)	26.5 (24.1-27.9)
Systolic blood pressure (mm Hg)	130 (120-147)	132.3 (120-140)
Diastolic blood pressure (mm Hg)	80 (70-90)	80.9 (76-85)
Creatinine (mg/dL)	1.12 (0.8-1.7)	1.4 (0.8-1.6)
eGFR (ml/min)	67.8 (41.5-102.7)	72.0 (38.0-102.7)
K (mmol/L)	4.5 (4.1-4.72)	4.4 (4.1-4.8)
ALT (U/L)	21 (13-27)	18 (12-23)
Albumin (g/dL)	4 (3.7-4.2)	3.4 (2.9-4.1)
CRP (mg/L)	6 (3-15)	8 (2-6)
Hemoglobin (g/dL)	12.94 (11.63-14)	12.7 (11.6-14.2)
Leukocyte(/mm^3)	8600 (7130-10700)	8836 (6805-10605)
Number of neutrophils (/mm^3)	5455 (4435-7545)	5703 (4120-6620)
Lymphocyte count (/mm^3)	2050 (1550-2755)	2448 (1770-3010)
Proteinuria* (mg/day)	896 (200-2000)	4369 (603-8410)
Proteinuria (qualitative), n (%)	57 (74.0)	41 (78.8)
Hematuria, n (%)	20 (27.8)	11 (22.9)
Leukocyturia*, n (%)	6 (8.3)	10 (20.8)

ACE, angiotensin-converting enzyme; ALT, alanine transaminase; ARB, angiotensin receptor blocker; BMI, body mass index; COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease 2019; CRP, C-reactive protein; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; FSGS, focal segmental sclerosis; GN, glomerulonephritis; IST, immune suppressive treatment; IQR, interquartile range; K, potassium; MMF, mycophenolate mofetil; MPGN, membranoproliferative glomerulonephritis; PGD, primary glomerular diseases.
*P < .05.
ᵠIf it was given in the last 6 months.

CT in 37 (54.4%) patients. The most used drugs were favipiravir [68 (88.3%) patients] and glucocorticoids [24 (31.6%) patients]. Most of the patients (92.2%) had mild disease, and only 1 (1.3%) patient had a serious vital disease and 22 (28.6%) of the patients were hospitalized, and 9 (40.9%) of patients developed in-hospital AKI. None of the hospitalized patients underwent hemodialysis during hospitalization. Four (18.2%) patients required admission to the ICU. Total hospital stay (inpatient clinic + ICU if applicable) was 11.5 (8-16) days.

First- and Third-Month Laboratory Values

When the laboratory data of the COVID-19 and non-COVID-19 groups were compared in the first and third months, the only parameter significantly different was median proteinuria level, which was higher in the non-COVID-19 group (Table 2). The frequency of hematuria and leukocyturia were also not different significantly between the groups. (Figure 1).

First- and Third-Month Outcomes

No patient died in the first and third months. Respiratory symptoms were significantly higher in the COVID-19 group than in the non-COVID-19 group in the first month (7.8% vs. 0%, P = .039). All other follow-up outcomes, including the initiation of chronic KRT and the initiation of new IST, were not different between the groups in the first and third months (Table 2, Figure 2).

DISCUSSION

In this multicenter, retrospective study involving PGD patients in the post-COVID-19 period, we presented the demographic information, kidney functions, symptoms, laboratory tests, and results of these patients in the post-acute COVID-19 syndrome period. In the data of the active COVID-19 period, it was determined that most of the patients were mildly symptomatic. The most striking findings were that in the first month and 3 months after COVID-19, patients in the COVID-19 group had no deaths and never needed KRT. On the other hand, although respiratory symptoms were significantly higher in the COVID-19 group than in the non-COVID-19 group in the first month, they persisted in a very small group of patients (7.8%). On the other hand, this difference did not persist in the third month after COVID-19.

We could not find a study in the literature, especially examining PGD patients in the post-COVID-19 period like ours. Therefore, we compared the findings of our study with some other post-COVID-19 studies, with some limitations. A study of 47 780 people from the United Kingdom showed that all parameters examined (including respiratory disease, cardiovascular disease, readmission, and death rates) were significantly higher than the matched control group in COVID-19 survivors, on average 140 days after discharge.[18] In this study, the investigators did not compare nonhospitalized COVID-19 patients and did not separate outcomes by the presence of PGD. In a study of 143 patients from Italy, at a mean of 60.3 (standard deviation: 13.6) days after the onset of the first COVID-19 symptom, patients had chest pain (21.7%), joint pain (27.3%), and shortness of breath (43.4%).[19] In a study of 538 patients from the city of Wuhan, China, an average of 97.0 (95.0-102.0) days after hospital discharge, persistence of respiratory symptoms (39%), cardiovascular symptoms (n = 70, 13%), psychosocial symptoms (n = 122, 22.7%), and alopecia (n = 154, 28.6%) were reported.[20] In a study conducted in the United Kingdom, 100 survivors of COVID-19 were evaluated between 29 and 71 days (mean 48 days) after hospital discharge; 72% of those requiring ICU and 60.3% of patients hospitalized in the ward reported new fatigue as the most common symptom after COVID-19.

Table 2. Laboratory Data and Outcome of Both Groups in the First and Third months

	COVID-19 Group	Non-COVID-19 Group
Post-COVID-19 first month		
BMI (kg/m^2)	26.4 (24.3-29.4)	25.5 (23.9-27.5)
Systolic blood pressure (mm Hg)	130 (120-142)	132 (120-140)
Diastolic blood pressure (mm Hg)	80 (70-86)	78 (70-85)
Creatinine (mg/dL)	1.02 (0.78-1.8)	1.4 (0.8-1.8)
eGFR (ml/min)	75.3 (40.1-105.7)	71.5 (35.1-101.4)
K (mmol/L)	4.3 (4.08-4.9)	4.5 (4-5)
ALT (U/L)	18.5 (13.5-28)	17.4 (11-20)
Albumin (g/dL)	3.9 (3.6-4.3)	3.5 (2.9-4.2)
CRP (mg/L)	5 (1-9)	6 (1-5)
Hemoglobin (g/dL)	12.75 (11.8-14.4)	12 (12-14)
Leukocyte (/mm^3)	8500 (6700-9860)	8603 (6770-10680)
Number of neutrophils (/mm^3)	5525 (3655-6835)	5534 (3820-6400)
Number of lymphocytes (/mm^3)	2000 (1385-2595)	2316 (1640-3070)
Proteinuria* (mg/day)	775 (260-1910)	4180 (675-7035)
Proteinuria (qualitative)	59 (74.6)	43 (82.4)
Hematuria	11 (15.7)	11 (23.4)
Leukocyturia	5 (7.1)	8 (17.0)
Outcomes at first month, n (%)		
Dead	0 (0)	0 (0)
GN relapse	3 (3.9)	5 (9.6)
New IST initiated	4 (5.2)	5 (9.6)
KRT initiated	2 (2.6)	0 (0)
Respiratory symptoms*	6 (7.8)	0 (0)
Hospitalization	7 (9.1)	2 (3.8)
Need for home oxygen therapy	0 (0)	0 (0)
Lower respiratory tract infection	2 (2.6)	0 (0)
Urinary tract infection	3 (3.9)	1 (1.9)
Thromboembolic event	1 (1.3)	0 (0)
Post-COVID-19 third month		
BMI (kg/m^2)	26.2 (24.2-29.3)	25.4 (23.4-27.6)
Creatinine (mg/dL)	1.1 (0.8-1.9)	1.4 (0.7-1.7)
K (mmol/L)	4.4 (4.1-4.8)	4.5 (4.2-4.8)
ALT (U/L)	18 (14-26)	18 (11-26)
Albumin (g/dL)	4 (3.7-4.3)	3.6 (3.0-4.2)
CRP (mg/L)	4.345 (2-6.45)	4.8 (1.9-6.1)
Hemoglobin (g/dL)	13 (11.8-14.4)	12.7 (11.6-14.1)
Leukocytes (/mm^3)	7820 (6615-9310)	8925 (6790-10425)
Number of neutrophils* (/mm^3)	4535 (3465-6000)	6056 (3900-7230)
Number of lymphocytes (/mm^3)	2120 (1776-2740)	2095 (1430-2630)
Proteinuria* (mg/day)	909 (200-2156)	3981 (454-7044)
Proteinuria (qualitative)	58 (74.3)	40 (86.5)
Hematuria	16 (22.2)	6 (12.0)
Leukocyturia	6 (8.3)	1 (2.0)
Outcomes at third month, n (%)		
Dead	0 (0)	0 (0)
GN relapse	7 (9.1)	5 (9.6)
New IST initiated	5 (6.5)	6 (11.5)
KRT initiated	2 (2.6)	0 (0)
Respiratory symptoms	1 (1.3)	1 (1.9)
Hospitalization	2 (2.6)	3 (5.8)
Need for home oxygen therapy	0 (0)	0 (0)
Lower respiratory tract infection	0 (0)	0 (0)
Urinary tract infection	2 (2.6)	1 (1.9)
Thromboembolic event	0 (0)	0 (0)

ALT, alanine transaminase; BMI, body mass index; COVID-19, coronavirus disease 2019; CRP, C-reactive protein; GN, glomerulonephritis; IST, immunosuppressive treatment; K, potassium; KRT, kidney replacement therapy.
*$P < .05$.

(*Continued*)

(*Contined*)

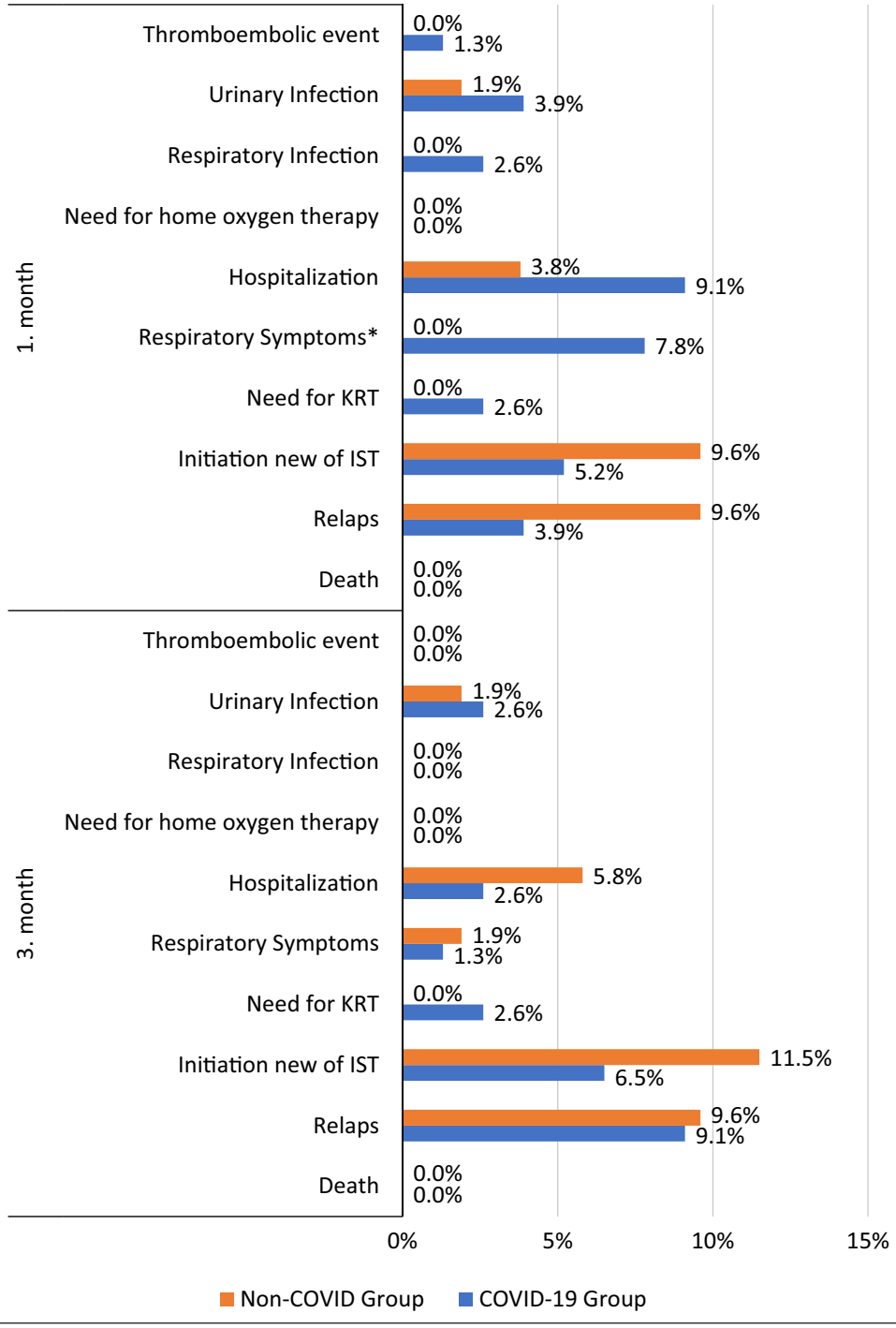

Figure 1. Comparison of the COVID-19 group and the control group in terms of hematuria and leukocyturia rates before COVID-19, in the first and third months after COVID-19. There was no statistically significant difference between these values. KRT: kidney replacement therapy, IST: immunosuppressive treatment.

The next most common symptom was dyspnea (65.6% in the ICU and 42.6% in the ward group).[21] In a French study, 478 people who recovered from COVID-19 4 months after hospital discharge reported at least 1 new-onset symptom, including fatigue in 51%, cognitive symptoms in 21%, and dyspnea in 16%.[22] Respiratory-related symptoms in all these studies were higher than those of our patients. A significant proportion of our COVID-19 patients had mild disease, and these studies did not include a non-COVID-19 control group with the same disease for comparison.

Another important finding of our study is that the biochemical data did not show significant differences in PGD patients who survived COVID-19 in the first and third months after COVID-19 compared to their non-COVID-19 counterparts. Patients with abnormal laboratory tests at diagnosis usually improve during

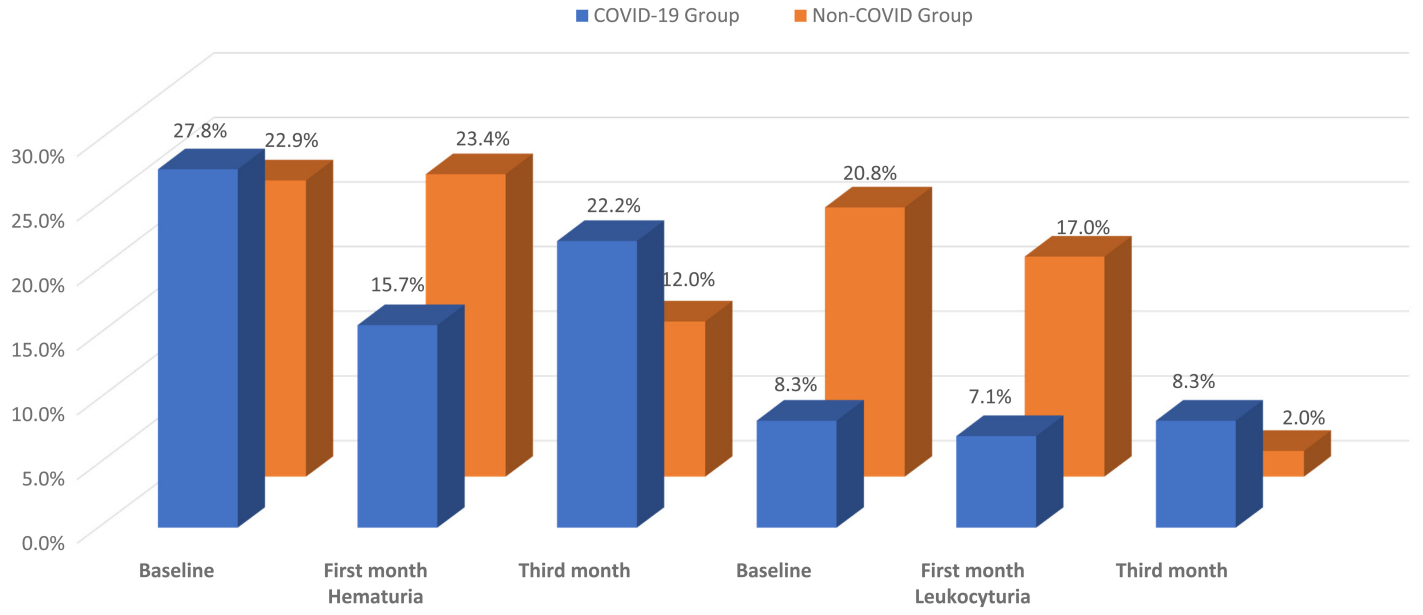

Figure 2. Hematuria and leukocyturia results of both groups at baseline, first and third months.

recovery, even in hospitalized patients.[23] This was consistent with survival and outcome data in the post-COVID-19 period.

Coronavirus disease 2019 patients have various urinary sediment abnormalities, namely proteinuria, hematuria, or leukocyturia, which are associated with disease severity in the active phase of the disease.[24,25] In addition, data show that COVID-19 patients may have different types of glomerular diseases or cause reactivation.[8,26] Therefore, it is impossible to predict whether the urinary sediment findings in PGD patients with COVID-19 are due to the activation of the disease or related to another COVID-19-related glomerular disease. However, the fact that the urinary sediment and proteinuria findings in our study did not show a significant difference between the groups and within each group in the baseline and follow-up evaluations can be interpreted as that PGDN patients who had COVID-19 did not show a significant change in urinary sediment and proteinuria in the post-COVID-19 period.

There are some limitations to our study. The rate of active PGD in the control group was significantly higher than in the COVID-19 group, consisting of patients with more proteinuria and receiving more immunosuppressive therapy. This was probably related to the design of our study because we selected the control group from patients without COVID-19. Active PGD patients had to come to the hospital more often and therefore the control group consisted mostly of them. In addition, the number of patients was fewer in the control group than in the COVID-19 group. Because some of the patients in the post-COVID-19 period included in our study were consecutive, control group patients could not be assigned to these patients separately. Our study includes only the representative of patients in all participating centers and it may not reflect the exact number of all candidate patients in every center in our country. Still it was made sure that there was a patient patient presentation from almost every region in our country.

In conclusion, in the first month post-COVID-19, post-COVID-19 patients with PGD had more respiratory symptoms than control non-COVID-19 PGD patients. However, outcomes, including death and initiation of KRT, were not different from control PGD patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Health Sciences University, Haseki Training and Research Hospital (Date: April 28, 2021, protocol number: 12-2021).

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Supplementary Table 1. Data regarding about active COVID-19 period in the COVID-19 group

Parameter		**N (%)**
Symptoms		
Fever		39 (51.3)
Dyspnea		30 (39.5)
Cough		56 (73.7)
Sore throat		37 (48.7)
Diarrhea		4 (5.5)
Loss of smell		13 (18.1)
Loss of taste		12 (16.7)
Treatments for COVID-19		
Hydroxychloroquine		8 (10.4)
Oseltamivir		2 (2.6)
Macrolide		16 (21.1)
Favipiravir		68 (88.3)
Glucocorticoid (for COVID-19)		24 (31.6)
Convalesce Plasma		2 (2.6)
Anakinra/Canakinumab		1 (1.3)
COVID-19 Related Clinical Picture at the Time of Diagnosis[ψ]	Asymptomatic disease	2 (2.6)
	Mild disease	71 (92.2)
	Moderate-to-Severe disease	3 (3.9)
	Serious-vital disease	1 (1.3)
Patients with signs of CT pneumonia		37 (54.4)
Treatment method	Outpatient	55 (71.4)
	Inpatient	22 (28.6)
Data of Inpatient		
AKI development[¥]		9 (40.9)
Hemodialysis initiated		0 (0)
AKI stage (KDIGO)[¥]	Stage 1	6 (66.7)
	Stage 2	2 (22.2)
	Stage 3	1 (11.1)
ICU admission[¥]		**4 (18.2)**
Non-invasive mechanical ventilation		3 (75)
Mechanical ventilation		1 (25.0)
ECMO		0 (0)
HF/HDF		0 (0)
Length of stay at ICU (days)		6.5 (6-14)
Total hospitalization (ward + and ICU if applicable) (days)		11.5 (8-16)

CT: computerized tomography, AKI: acute kidney injury, KDIGO: Kidney Disease: Improving Global Outcomes, ICU: intensive care unit, ECMO: extracorporeal membrane oxygenation, HF: hemofiltration, HDF: hemodiafiltration

[ψ]Asymptomatic disease: no symptoms and/or detected on screening; Mild disease: fever, cough, etc., no dyspnea-there may be abnormal findings on CT; Moderate to Severe disease: Dyspnea requiring O2 administration – may be associated with other symptoms; Serious-vital disease: saturation <90% despite oxygen support at admission, or hemodynamic impairment requiring ICU follow-up.

[¥]KDIGO definition and stagging of AKI were used. This data was obtained only from the patients who were hospitalized.