Prognostic Factors in Crescentic Glomerulonephritis
A Single-Center Experience

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Introduction. Crescentic glomerulonephritis (CGN) is a fatal disease, rapidly leading to end-stage renal disease. Diagnosis should be accurate and treatment should be started immediately. We investigated the factors associated with the renal prognosis in CGN patients.

Materials and Methods. Forty-one patients with CGN who were followed up at the Nephrology Clinic of Ankara Numune Education and Research Hospital were divided into 2 arms of the dialysis-dependent group after treatment and the group that was followed up without dialysis. Demographic and clinical features along with biopsy findings during time of diagnosis were evaluated for both groups.

Results. The mean age was 41.3 ± 17.2 years old and 26 were men. Twenty patients developed end-stage renal disease, requiring long-term dialysis. The dialysis-dependent group had higher serum creatinine levels (8.2 ± 3.6 mg/dL versus 2.6 ± 2.5 mg/dL) and percentages of glomeruli with crescent (83.1 ± 19.1% versus 56.4 ± 11.9%), were more likely to have oligoruia-anuria (90.5% versus 9.5%) and be dialysis-dependent at admission (86.4% versus 13.6%), and had longer elapsed time until the beginning of treatment (18.9 ± 10.4 days versus 10.6 ± 3.0 days) after treatment. At admission, their serum creatinine was greater than 4.2 mg/dL and the rate of crescentic glomeruli was greater than 63%.

Conclusions. In patients with CGN, renal prognosis is poor and the time of admission to the hospital, degree of renal insufficiency, presence of oligo-anuria, dialysis requirement, and the percentage of crescentic glomeruli on biopsy are closely related to progression to end-stage renal disease.

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INTRODUCTION

Crescentic glomerulonephritis (CGN) is a critical diagnosis in pathology with heterogeneous clinical implications and needs rapid therapeutic interventions. It is defined as the presence of crescents in more than 50% of glomeruli sampled and examined. Crescentic glomerulonephritis histopathologically consists of 3 types on immunofluorescent microscopy[1]: type 1, linear immune accumulation throughout glomerular basement membrane (GBM; anti-GBM disease); type 2, immune accumulation in granular manner (immune complex disease); and type 3, no immune accumulation (pauci-immune).

Crescentic glomerulonephritis can lead to end-stage renal disease (ESRD) within a few days, weeks, or months and can end up with death when not treated. Therefore, the process from

diagnosis to treatment must be rapidly and carefully planned. However, despite aggressive treatment, development of ESRD and dependence on dialysis are likely to occur. The question "should every patient with CGN diagnosis be treated?" comes to mind. The literature knowledge about the factors affecting renal prognosis guides the physicians to further individualize the treatment options and this way treatment-related morbidity and mortality can be decreased. Factors deemed to be predictive of prognosis are time interval from the beginning of complaints to diagnosis, presence of oligo-anuria, rise of serum creatinine level to above 5.65 mg/dL at admission, dialysis dependence on admission, a crescent rate higher than 80% of glomeruli, fibrinoid necrosis, anti-GBM antibodies in GBM, tubular atrophy, and interstitial fibrosis.[1-3] However, there is no certain consensus on prognostic factors that would show renal outcome.

In the present study, we analyzed etiologic factors causing CGN, presentation of CGN, clinical and laboratory features of CGN, and histopathological findings proven by biopsy on patients with CGN who have been followed up at our clinic. Risk factors that would help us detect the progression to ESRD and renal outcome were investigated during the course of disease.

MATERIALS AND METHODS

Patients

Patients diagnosed as CGN on renal biopsy between January 2006 and June 2010 at the Nephrology Clinic of Ankara Numune Education and Research Hospital, Ankara, Turkey, were included in the study. All of the patients were given immunosuppressive treatment and data regarding these patients were analyzed retrospectively. Patients who had crescents below 50% of glomeruli sampled on renal biopsy, patients who were not given immunosuppressive treatment, or those who failed to complete the treatment were excluded.

Measurements

Crescent rate in glomerulus and immune staining characteristics were recorded. Crescent occurrence rate was calculated by dividing the number of crescentic glomeruli by the total number of nonsclerosing glomeruli. Renal failure was defined as a serum creatinine level above 1.3 mg/dL. End-stage renal disease was defined as a continuous need for renal replacement treatment after follow-up or a glomerular filtration rate (GFR) less than 15 mL/min for at least 3 months. The amount of daily urine being below 100 mL was defined as "anuria" and below 500 mL as "oliguria."

Parameters including demographic features (age and sex), time interval from hospital admission to the beginning of treatment, need for dialysis on admission, presence of oligo-anuria, laboratory results of sedimentation, leukocyte and thrombocyte counts, hemoglobin level, and blood levels of urea nitrogen, creatinine, sodium, potassium, total protein, albumin, calcium, phosphorus, C-reactive protein, perinuclear and cytoplasmic antineutrophil cytoplasmic antibodies (pANCA and cANCA) and anti-GBM antibody, complement C3 and C4 were recorded. In addition, the degree of proteinuria, renal biopsy report (date of biopsy, light and immunofluorescent microscopy results), and final status of patients (renal outcome) were recorded for every patient individually.

Blood and urine samples were analyzed on the same day without delay. Total protein-creatinine ratio in spot urine was used for the measurement of protein excretion rate. C-reactive protein, C3, and C4 levels were measured by the nephelometric method. By indirect immunofluorescence method, pANCA, cANCA, and anti-GBM antibody tests were analyzed. Glomerular filtration rate was calculated by using the Modification of Diet in Renal Disease formula.[4]

Treatment Protocol

Based on the study of the European Vasculitis Study Group (EUVAS),[5] by adjusting the dose according to GFR, once a month a high dose of intravenous pulse cyclophosphamide (7 mg/kg to 15 mg/kg per day) and 3-day pulse methylprednisolone were administered during induction of treatment to patients who had diffuse crescents (50% and more) on biopsy. Oral prednisolone was continued in a dose of 0.5 1mg/kg/d for about 4 to 6 weeks and treatment was carried out with a low dose afterwards. Cyclophosphamide was given once a month until remission was achieved in 6 to 12 courses. Plasmapheresis was used in anti-GBM-positive patients, in patients with Goodpasture syndrome or vasculitis accompanied by hemoptysis, or in those with immune complex-mediated CGNs showing a progressive course (presence of daily rapid decrease

in kidney function and inclusion of hemoptysis to the clinic picture). These patients received plasmapheresis for 7 to 14 sessions and it was continued until anti-GBM antibodies disappeared in serum or until hemoptysis was recovered.

Statistical Analysis

Statistical analyses were performed by the SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Ill, USA). Normality analysis of data was performed by the Kolmogorov-Smirnov test. Numeric data were presented as mean ± standard deviation. Either the Student *t* test or the Mann Whitney U test was used for comparing the two groups. For comparison of the averages of more than two groups, the ANOVA test and for post hoc evaluation the Bonferoni test were used. Qualitative data was defined as frequency (%) and for statistical significance the Fisher exact test was used. The correlation between qualitative data was examined using the Pearson correlation test. The receiver operating characteristic curve analysis was used for the calculation of the threshold values for serum creatinine levels and number of crescentic glomeruli. A *P* value less than .05 was considered significant.

RESULTS

A total of 41 patients (26 men and 15 women) whose mean age was 41.3 ± 17.2 years old were enrolled in the study. The number of patients older than 60 years of age was 6 (14.6%). Primary diseases causing CGN were listed in Table 1. At the time of hospital admission, 21 patients (51.2%) had oliguria-anuria and 22 (53.7%) were on dialysis because of acute clinical and laboratory indications. All patients had hematuria and proteinuria in urine tests.

The majority of patients were in the type 3 group ($P < .001$), and these patients were significantly older ($P = .01$). In patients with type 1 CGN, the mean serum creatinine level (8.4 ± 1.7 mg/dL) and the rate of crescentic glomeruli (96.8 ± 5.7%) were significantly higher and the hemoglobin concentration (7.2 ± 0.7 g/dL) was lower ($P < .05$). However, no significant difference was detected between the groups in terms of serum albumin, protein, urea, GFR, sedimentation, C-reactive protein, and proteinuria.

Presence of oliguria-anuria, immediate need for dialysis on admission, and ESRD development at the end of treatment were more frequent in type 1 CGN ($P < .05$). At the end of the treatment, ESRD development rate was 100% in patients with type 1, 16.7% in patients with type 2, and 57.7% in patients with type 3 CGN ($P < .05$; Table 2).

Table 1. Underlying Primary Diseases in Patients With Crescentic Glomerulonephritis

Diagnosis	Number of Patients (%)
Anti-GBM disease (type 1)	3 (7.3)
Goodpasture Syndrome	3 (7.3)
Immune complex mediated (type 2)	12 (29.3)
IgA nephropathy	2 (4.9)
Systemic lupus erythematosus	4 (9.8)
Postinfectious glomerulonephritis	2 (4.9)
Membranoproliferative glomerulonephritis	1 (2.4)
Henoch-Schoenlein purpura	3 (7.3)
Pauci-immune (type 3)	26 (63.4)
Wegener granulomatosis	9 (22)
Microscopic poliangitis	7 (17.07)
Antinetrophil cytoplasmic antibody-negative pauci-immune glomerulonephritis	10 (24.4)

At the hospital admission, 22 of 41 patients (58.6%) were assessed for the need of dialysis. Nineteen (86%) of them did not respond to treatment and were taken into permanent dialysis program. One of the remaining 3 patients had been followed up for 6 months without dialysis when the study was designed and the latest creatinine level was 5.5 mg/dL. The other two patients had been followed up for 2 years and their latest creatinine levels were 2.2 mg/dL and 1.5 mg/dL. Only 1 of 19 patients who did not need dialysis at admission did not respond to treatment and developed ESRD and was taken into permanent dialysis program. The patients who became dependent on dialysis were mostly men and older. While serum hemoglobin levels ($P = .004$) and GFR levels ($P < .001$) were significantly lower, mean serum creatinine ($P < .001$), complement C4 level ($P = .03$), sedimentation levels ($P = .02$), number of patients with oligoruia-anuria ($P < .001$), number of patients who were dialysis-dependent at admission ($P < .001$), time interval until the beginning of treatment ($P < .001$), and mean crescent percentage ($P < .001$) were significantly higher in patients who did not respond to treatment in comparison to patients who responded (Table 3). Eighteen patients (86%) of those who needed dialysis at the beginning were still on dialysis at the end of treatment and dialysis requirement at the beginning

Table 2. Clinical and Pathologic Evaluation of Patients With Crescentic Glomerulonephritis

Characteristic	Crescentic Glomerulonephritis			*P*
	Type 1	Type 2	Type 3	
Number of patients (%)	3 (7.3)	12 (29.3)†	26 (63.4)‡	< .001
Mean age, y	20.7 ± 2.3†	35.4 ± 14.0	46.5 ± 17.2†	.01
Sex				
Male (%)	3 (11.5)	7 (25)	16 (61.5)	> .05
Female (%)	0	5 (33.3)	10 (66.7)	> .05
Hypertension (%)	0	3 (15.8)†	16 (84.2)†	.03
Oligo-anuria (%)	3 (14.3)†	3 (14.3)‡	15 (71.4)†‡	.03
Mean elapsed time until diagnosis, d	12.3 ± 7.5	11.2 ± 3.1	16.5 ± 9.9	> .05
Dialysis dependence at diagnosis (%)	3 (100)†	3 (25)‡	16 (61)†‡	.03
Mean hemoglobin, g/dL	7.2 ± 0.7†	1.9 ± 2.5†	9.6 ± 2.5	.03
Mean blood urea, mg/dL	129.3 ± 30.6	88.1 ± 59.5	140 ± 91.5	> .05
Mean serum creatinine (mg/dL	8.4 ± 1.7†	3.0 ± 2.4†	5.9 ± 4.5	.04
Mean serum protein, mg/dL	4.9 ± 0.7	5.2 ± .68	5.6 ± 1.2	> .05
Mean serum albumin, mg/dL	2.1 ± 0.2	2.6 ± .7	2.7 ± 0.8	> .05
Mean glomerular filtration rate, mL/min/1.73 m^2	28.0 ± 36.4	35.0 ± 24.0	18.8 ± 17.8	> .05
Mean urine protein, g/d	3.3 ± 1.2	6.2 ± 7.3	5.6 ± 4.9	> .05
Mean erythrocyte sedimentation rate, mm/h	50 ± 25	68 ± 34	84 ± 31	> .05
Mean C-reactive protein, mg/dL	7 ± 6	20 ± 28	44 ± 56	> .05
Mean crescent rate, %	96.8 ± 5.7†	59.0 ± 17.0†	71.0 ± 21.4	.01
Mean glomerulosclerosis rate, %	0 (0.0)	5.4 ± 9.5†	31.1 ± 33.0†	.04
End-stage renal disease development, %	3 (100)†	2 (16.7)‡	15 (57.7)†‡	.01

†‡Statistical significance is valid among parameters shown with the same symbols.

Table 3. Comparison of Patients Who Did and Did not Develop End-stage Renal Disease (ESRD) in Terms of Clinical, Laboratory, and Biopsy Data

Characteristic	ESRD	No ESRD	*P*
Number of patients (%)	20 (48.8)	21 (51.2)	> .05
Mean age, y	46.5 ± 17.9	36.4 ± 15.4	> .05
Male patients (%)	16 (61.5)	10 (38.5)	.03
Hypertension (%)	11 (57.9)	8 (42.1)	> .05
Oligo-anuria (%)	19 (90.5)	2 (9.5)	< .001
Mean elapsed time until diagnosis, d	18.9 ± 10.4	10.6 ± 3.0	< .001
Dialysis dependence at diagnosis (%)	19 (86.4)	3 (13.6)	< .001
Mean hemoglobin, g/dL	8.4 ± 2.0	10.0 ± 2.5	.004
Mean blood urea, mg/dL	173.2 ± 79.8	78.1 ± 54.7	< .001
Mean serum creatinine mg/dL	8.2 ± 3.6	2.6 ± 2.5	< .001
Mean serum protein, mg/dL	5.7 ± 0.9	5.2 ± 1.2	> .05
Mean serum albumin, mg/dL	2.6 ± 0.6	2.7 ± 0.9	> .05
Mean glomerular filtration rate, mL/min/1.73 m^2	10.3 ± 14.4	36.0 ± 20.1	< .001
Mean serum C4, mg/dL	29.7 ± 10.1	20.9 ± 12.2	.03
Mean erythrocyte sedimentation rate, mm/h	89.0 ± 29.5	66.0 ± 32.0	.02
Mean C-reactive protein, mg/dL	45.6 ± 60.3	21.5 ± 27.3	> .05
Mean serum potassium, mEq/L	4.9 ± 0.6	4.4 ± 0.7	.02
Mean serum phosphorus, mg/dL	6.9 ± 1.6	4.7 ± 1.0	< .001
Mean serum parathyroid hormone, pmol/mL	17.6 ± 4.8	8.1 ± 5.1	< .001
Mean urine protein, g/d	6.0 ± 4.5	5.3 ± 6.1	> .05
Mean crescent rate, %	83.1 ± 19.1	56.4 ± 11.9	< .001

was identified as the significant indicator of ESRD development ($P < .001$). All of the patients whose anti-GBM antibody was positive became dependent on dialysis at the end of treatment and despite the small number of patients, presence of anti-GBM antibody was deemed as the significant indicator of progression to the ESRD ($P = .03$).

By means of the receiver operating characteristic

curve analysis, the threshold value of serum creatinine level at admission was found to be 4.2 mg/dL with 95% sensitivity and 86% specificity. Presence of oliguria-anuria, dialysis dependence at admission, mean crescent rate, time interval until treatment, and permanent dialysis requirement at the end of treatment were found to be significantly higher in patients with initial serum creatinine level greater than 4.2 mg/dL when compared to patients with lower creatinine values. Mean GFR at the time of admission, hemoglobin concentration, and serum calcium concentration of patients with initial serum creatinine level greater than 4.2 mg/dL were found to be significantly lower (Table 4).

The receiver operating characteristic curve analysis also showed that the threshold value of crescentic glomerulus percentage at admission of patients was 63% with 80% sensitivity and 80% specificity. While mean GFR and hemoglobin concentration were found to be significantly lower, mean serum creatinine and parathyroid hormone levels at admission, time interval until treatment, dialysis dependence, and presence of oliguria-anuria at the time of diagnosis, dialysis dependence at the end of treatment, and presence of ANCA positivity were found to be significantly higher in patients with a crescentic glomerulus rate higher than 63% when compared to those with a crescentic glomerulus rate lower than 63% (Table 5).

Treatment of three patients was discontinued for 1 month due to pneumonia, urinary tract infection, and fever of unknown cause.

DISCUSSION

Crescentic glomerulonephritis is a heterogeneous group of diseases that affects men twice more frequently than women, and its incidence among all renal biopsies is between 4% and 10%.[1,2,6-8] Prevalence has been reported between 10% to 30% for type 1 CGN, 20% to 30% for type 2, and 40% to 50% for type 3.[1] In Turkey, according to data from 2 different centers, CGN has been detected in 11% to 17% of the patients for type 1, 40% to 56% for type 2, and 33% to 37% for type 3.[9,10] Age at diagnosis is advanced and the percentage of patients aged 60 years and older was reported to be 40%

Table 4. Comparison of Patients With High and Low Serum Creatinine Levels at Admission

Characteristic	Serum Creatinine		*P*
	≤ 4.2 mg/dL	> 4.2 mg/dL	
Mean age, y	36.74 ± 14.98	45.32 ± 18.31	> .05
Male patients (%)	8 (30,8)	18 (69,2)	.008
Hypertension (%)	7 (36.8)	11 (63.2)	> .05
Oligo-anuria (%)	0	21 (100)	< .001
Mean elapsed time until diagnosis, d	10.47 ± 3.04	18.3 ± 1.11	.002
Dialysis dependence at diagnosis (%)	1 (4.5)	21 (95.5)	.001
Mean hemoglobin, g/dL	11.3 ± 1.9	8.1 ± 2.03	.001
Mean blood urea, mg/dL	66.9 ± 44.0	174 ± 76	.001
Mean serum protein, mg/dL	5.28 ± 1.28	5.58 ± .81	> .05
Mean serum albumin, mg/dL	2.68 ± 0.89	2.57 ± 0.66	> .05
Mean glomerular filtration rate, mL/min/1.73 m^2	40.3 ± 17.6	9.58 ± 13.7	.001
Mean serum sodium, mEq/L	138 ± 5	129 ± 26	.02
Mean serum potassium, mEq/L	4.3 ± 0.5	5.0 ± 0.6	.001
Mean serum calcium, mg/dL	8.6 ± 0.7	8.0 ± 0.7	.03
Mean serum phosphorus, mg/dL	4.7 ± 1.0	6.7 ± 1.5	.001
Leucocyte count, $\times 10^9$/L	9.9 ± 3.6	1.9 ± 5.7	> .05
Mean serum C3, mg/dL	96.5 ± 52.4	112.7 ± 25.1	> .05
Mean serum C4, mg/dL	21.4 ± 12.6	28.3 ± 1.7	> .05
Mean erythrocyte sedimentation rate, mm/h	69 ± 29	89 ± 31	.01
Mean C-reactive protein, mg/dL	18 ± 22	45 ± 58	> .05
Mean serum parathyroid hormone, pmol/mL	7.2 ± 4.8	16.9 ± 4.9	.001
Mean urine protein, g/d	4.5 ± 4.5	6.7 ± 6.1	> .05
Positive antinetrophil cytoplasmic antibody (%)	8 (38.1)	13 (61.9)	> .05
Mean glomerulosclerosis rate, %	14.4 ± 20.6	3.2 ± 35.9	> .05
Mean crescent rate, %	56 ± 12	69 ± 21	.001
End-stage renal disease development, %	1 (5)	19 (95)	.001

Table 5. Comparison of Patients With High and Low Crescentic Glomerulus Rates at Admission

Characteristic	Crescent Rate		*P*
	≤ %63	> 63%	
Mean age, y	42.4 ± 17.8	4.2 ± 16.9	> .05
Sex			
Male (%)	11 (42.3)	15 (57.7)	
Female (%)	10 (66.7)	5 (33.3)	> .05
Hypertension (%)	11 (57.9)	8 (42.1)	> .05
Oligo-anuria (%)	5 (23.8)	16 (76.2)	< .001
Mean elapsed time until diagnosis, d	11.8 ± 8.5	17.7 ± 7.6	.002
Dialysis dependence at diagnosis (%)	6 (27.3)	16 (72.7)	< .001
Mean hemoglobin, g/dL	10.7 ± 2.5	8.4 ± 1.9	.002
Mean blood urea, mg/dL	99.3 ± 87.3	151.0 ± 70.0	.02
Mean serum creatinine (mg/dL	3.01 ± 3.5	7.5 ± 3.7	< .001
Mean serum protein, mg/dL	5.3 ± 1.2	5.6 ± .8	> .05
Mean serum albumin, mg/dL	2.60 ± 0.90	2.65 ± .57	> .05
Leucocyte count, $\times 10^9$/L	10.3 ± 6.0	11.5 ± 5.6	> .05
Mean glomerular filtration rate, mL/min/1.73 m^2	34.7 ± 22.2	12.4 ± 14.8	.004
Mean serum sodium, mEq/L	131 ± 27	133 ± 18	> .05
Mean serum potassium, mEq/L	4.4 ± 0.8	4.9 ± 0.5	.004
Mean urine protein, g/d	5.8 ± 6.1	5.4 ± 4.6	> .05
Mean serum C3, mg/dL	22 ± 13	29 ± 10	> .05
Mean serum C4, mg/dL	92 ± 49	120 ± 22	> .05
Mean erythrocyte sedimentation rate, mm/h	70 ± 32	84 ± 31	> .05
Mean C-reactive protein, mg/dL	40 ± 52	27 ± 44	> .05
Positive antinetrophil cytoplasmic antibody (%)	7 (33.3)	14 (66.7)	.02
Mean serum parathyroid hormone, pmol/mL	9.4 ± 6.8	16 ± 5	.02
Mean glomerulosclerosis rate, %	12 ± 16	34 ± 38	> .05
End-stage renal disease development, %	4 (20)	16 (80)	< .001

in certain series.[2] Our cases consisted of 7.3% type 1, 29.3% type 2, and 63.4% type 3 CGN patients and only 6% of them were over 60 years old. We believe that while the distribution of subgroups were similar, the reason why the percentage of elderly patients was low is that the elderly patients die before applying to the nephrology clinic due to abundance of comorbid diseases, performing renal biopsy is limited due to poor general status, making a diagnosis is challenging due to detecting more than 1 reasons (medication use, performing contrast, and infections) which might cause kidney failure, and also the elderly patients refuse renal biopsy.

Hematuria, proteinuria, and oliguria are frequently detected In patients with CGN.[11] When CGN subgroups were assessed, daily protein excretion was reported as 1.67 ± 3.35 g/d in type 1, 4.39 ± 4.77 g/d in type 2, and 1.94 ± 2.95 g/d in type 3.[2] We detected daily protein excretion as 3.33 ± 1.15 g/d for type 1, 6.2 ± 7.3 g/d for type 2, and 5.6 ± 4.9 g/d for type 3. The reason for high proteinuria values in our series could be the decreased reliability of protein-creatinine ratio in the presence of low GFR and calculation of proteinuria by spot urine method. Glomerular filtration rate was relatively well preserved in a substantial number of patients, and half of them were not oligo-anuric.

Pauci-immune CGN is a renal manifestation of small-vessel vasculitides with involvement of small arteries, arterioles, venules, and capillaries (and thus glomeruli). Antineutrophil cytoplasmic antibodies were positive in approximately 80% of patients (10% pANCA and 90% cANCA) and thus it is called ANCA-associated CGN.[12] Antineutrophil cytoplasmic antibodies was positive in 58% of our patients with pauci-immune CGN. It is known that ANCA is permanently negative in approximately 38% of pauci-immune CGN patients.[8] Biopsy findings showed more chronic findings and more severe glomerular lesions in ANCA-negative patients.[13] In 42% of our pauci-immune CGN patients, ANCA was negative and during the follow-up period, 6 of 11 patients (55%) developed ESRD.

Anti-GBM antibody related CGN is the type of glomerulonephritis with a higher rate of dialysis

dependence at admission, higher ESRD development, and the highest rate of crescentic glomeruli at the time of diagnosis in comparison with other types. About half of anti-GBM glomerulonephritis has pulmonary hemorrhage (Goodpasture syndrome). High anti-GBM antibody titer and exposure to cigarettes and other hydrocarbons are risk factors for pulmonary hemorrhage.[14] About 20% to 30% of anti-GBM-antibody patients might have a coexisting ANCA positivity. It has been suggested that patients with double antibody positivity are more likely progress to vasculitis rather than patients with a positive anti-GBM and treatment response is better.[15] Crescents were present in 96% of glomeruli in 3 patients with anti-GBM disease in our study. All of the patients were dialysis-dependent at admission and they all developed ESRD during their follow-up period. None of the patients had both pANCA and anti-GBM antibody positivity. Goodpasture syndrome was present in all of our patients with anti-GBM disease and all of them were smokers.

In CGN, the most important prognostic factors that also show renal outcome are serum creatinine levels and severity of kidney failure at the time of diagnosis.[16-18] It has been reported that if serum creatinine level is below 5.7 mg/dL, 1-year patient and kidney survival rates would be 100% and 95%, respectively; if serum creatinine level is above 5.7 mg/dL, the rates are 83% and 82%; and if dialysis dependence is present at the beginning, those are 65% and 8%, respectively.[19] Ninety-five percent of our 19 patients whose creatinine levels at admission were over 5.65 mg/dL developed ESRD. It is clear from these data that patients with high creatinine levels at admission would not benefit from immunsuppressive treatment. In such cases, immunosuppressive treatment should be withheld to prefer patient survival over kidney survival.

It was shown that in patients with a crescentic glomeruli percentage over 80%, creatinine level was high, hypertension was more frequent, and ESRD development was more likely.[16,20] Also, it was found that recovery of kidney function was 55% in patients in whom the percentage of crescentic glomeruli was 60% to 69%, and only 15% in those whose crescent rate was 100%.[21] Mean percentage of crescentic glomeruli was 58% in patients who responded the treatment and 84% in nonresponders in our study. Also, when we grouped the patients by creatinine levels greater than versus 4.2 mg/dL and less, the percentages of crescentic glomeruli in patients with high serum creatinine levels were higher at the time of admission, and 86% of these patients had developed ESRD during the study period. Likewise, in patients with at least 63% crescentic glomeruli rate prior to treatment, oligouria-anuria frequency, dialysis dependence at the time of admission, and ESRD development rate were significantly higher, whereas GFR and hemoglobin levels were significantly lower.

Presence of dialysis dependence at the time of diagnosis is also important for kidney survival, and in various studies, varying rates such as 53% and 69.5% have been reported.[22,23] In these patients, percentage of kidney survival was around 40%.[22,23] Twenty of the patients (58.6%) included in the study were dialysis dependent at admission and only 3 (14%) were followed up without dialysis after treatment. When the entire group of patients was evaluated, 20 (48.8%) developed dialysis dependence at the end of treatment, whereas 21 (51.2%) responded to treatment and were followed up without dialysis. Response rates to treatment for patients who were dialysis dependent at admission were low in our patient group. This can be explained by a long time interval from the beginning of symptoms until admission to hospital, presence of coexisting diseases, and individual differences for treatment response rate.

In our study, the time interval from admission to hospital to diagnosis was found to be significantly long in those who developed ESRD, compared to those who did not develop ESRD (18.9 ± 10.4 days versus 10.6 ± 3.0 days; $P < .001$). Reasons for delay in diagnosis may be older patient age, abundance of comorbid diseases, and late performed biopsy because of poor general condition. Diagnostic delay affects kidney function negatively and blokes initiating immunosuppressive treatment early.

In various studies, 1-year kidney survival rate in CGN has been reported to be 52% to 72%.[21,24] We have found that 1-year kidney survival rate of our patients was 51% and our patient survival rate was 90%.

CONCLUSIONS

Rapidly progressing glomerulonephritis is an entity that typically progresses to irreversible renal damage in patients with acute kidney failure. Early diagnosis with renal biopsy and serologic

testing and early initiation of appropriate therapy is essential to minimize the degree of irreversible renal injury. We have shown that the degree of kidney failure, hemodialysis dependence, and high serum creatinine level at admission, along with the percentage of crescentic glomeruli on biopsy are closely related to ESRD progression. We have determined that renal survival was poor in patients with creatinine levels greater than 4.2 mg/dL and crescentic glomerulus rate above 63%. As a conclusion, starting early empirical treatment without waiting for serologic diagnosis and histopathology in patients with clinical manifestations strongly suggesting CGN is highly crucial for patient and kidney survival.

CONFLICT OF INTERETS

None declared.

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