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ORIGINAL ARTICLE

Crescent lesions are not a predictive factor in adult-onset Henoch–Schönlein purpura nephritis

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Abstract

Henoch–Schönlein purpura nephritis (HSPN) is a common secondary glomerulonephritis, and its prognosis mainly depends on the severity of renal impairment. To date, the significance of crescent lesions in adult-onset HSPN is still unclear. Therefore, the purpose of this research was to assess whether crescents could predict the renal outcomes in adult HSPN patients. A total of 188 adult patients with HSPN proven by renal biopsy were enrolled in this prospective study. Patients were divided into three groups based on the proportion of crescents: non-crescent group (C0, $n=110$), crescent $\leq 25\%$ group (C1, $n=50$) and crescent $>25\%$ group (C2, $n=28$). The composited endpoint was defined as eGFR decreased $>50\%$ of baseline level, reached end-stage renal disease and/or death. Among three groups, clinical pathological features, treatment regimens and renal outcomes were compared. During a mean follow-up of 26 months, 78 (42.5%) patients had crescent lesions. A total of ten (9.1%) patients in C0 group and five (17.9%) patients in C2 group reached the combined endpoint, but no patients in C1 group reached endpoint. Renal survival analysis indicated patients in C1 group tended to have the best renal outcome, while patients in C2 group had the poorest renal survival. Moreover, Cox regression analysis revealed crescents were not a predictor of poor developing to renal outcome after adjusting potential confounders [hazard ratio (HR) = 0.28, 95% confidence interval (CI) 0.07–1.18, $P=0.083$]. Crescent formation is not necessarily a predictive factor of poor renal survival in adult HSPN patients who had small proportions of crescents (crescent $\leq 25\%$).

Keywords Crescent lesions · Henoch–Schönlein purpura nephritis (HSPN) · Renal prognosis

Introduction

Henoch–Schönlein purpura (HSP) is one of the most common small vessel vasculitides, characterized by skin purpura, arthritis, abdominal involvement and renal insufficiency [1]. The long-term prognosis of HSP mainly depends on renal impairment, acknowledged as Henoch–Schönlein purpura nephritis (HSPN) [2]. It has been identified that HSPN is a major cause of secondary glomerulonephritis, and children are more likely to suffer from it [3, 4]. Despite a low incidence in adults, renal lesions seem to be more adverse in adults than children [5]. Although mesangial proliferation is the most common pathological characteristics in HSPN, crescents are also frequently appeared. Crescent formation is a result of severe glomerular injury. It has been reported that the number of crescents has been significantly related to the severity of clinical manifestations and worse renal outcome [6, 7]. However, few study focused on the crescent lesions in adult HSPN patients had been reported. Therefore, this study was performed to provide detailed information about the clinical and prognostic values of crescents in adult HSPN.

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Methods

Patients

This prospective and longitudinal study recruited 206 patients (≥ 14 years of age) with HSPN diagnosed in West China Hospital of Sichuan University between October 2010

and June 2017. Diagnostic criteria of HSP were based on guidelines from the American College of Rheumatology (ACR). HSPN was diagnosed by biopsy when HSP impaired kidney, manifested with hematuria, proteinuria and/or renal failure [1]. Patients with systemic diseases (systemic lupus erythematosus, diabetes mellitus, liver cirrhosis, hepatitis B nephritis, malignancy and so on) were excluded. Patients with insufficient clinical and pathologic data, whose renal biopsy contained less than eight glomeruli was excluded from this study. Patients were followed up for at least 6 months or shorter if they reached the endpoint. This study complied with the principles of the Helsinki Declaration and was approved by The Ethics Committee of West China Hospital of Sichuan University.

Analysis of renal pathology data

Renal biopsies from all patients were reviewed by one experienced pathologist and one expert nephrologist. Given no well-accepted pathological classification of adult HSPN, biopsy specimens were graded according to the Oxford classification [8]. Cellular crescent is defined as extracapillary cell proliferation of more than two cell layers with > 50% of the lesion occupied by cells. Fibrocellular crescent is defined as extracapillary lesion comprising cells and extracellular matrix, with < 50% cells and < 90% matrix [9]. According to different percentages of glomeruli that exhibited crescents, patients were categorized into three groups in this study: C0 group (without crescents), C1 group (with crescents ≤ 25%) and C2 group (with crescents > 25%).

Clinical data and treatment

Demographic data and clinical data were recorded, including gender, age, symptoms, mean arterial pressure (MAP), intervals from disease onset to biopsy and follow-up duration. Laboratory findings were also collected including serum albumin, serum creatinine, estimated glomerular filtration rate (eGFR), uric acid, 24-h urinary protein and urine red blood cells counts). Hypertension was defined as blood pressure > 140/90 mmHg or the use of antihypertensive agents. EGFR was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [10].

Treatment modalities were recorded including the use of corticosteroids or other immunosuppressants and renin–angiotensin system inhibitors (RASI). Medication-related adverse events were carefully described to each patient. Patients refusing to take steroids or immunosuppressant were given optimal supportive therapy. Treatment modalities were categorized into four groups: patients in supportive care (SC) group received optimized dose of ACEI or ARB, patients in corticosteroids and immunosuppressive (CS+IT) group received prednisone (1 mg/kg daily, tapering down within 6–8 months) with or without cyclophosphamide (2 mg/kg daily for 3 months), or mycophenolate mofetil (1–2 g daily for 6–8 months) and patients in methylprednisolone pulse (MP) group received intravenous methylprednisolone pulse therapy (10–20 mg/kg/day for three consecutive days) followed by cyclophosphamide pulses (1 g/month for 8 months). The therapeutic regimens of patients were determined by attending physician and based on renal pathology and clinical manifestations. Patients were only given optimal supportive therapy if they rejected to take steroids or immunosuppressive therapies. Written informed consent was acquired from all the patients before treatment.

Outcomes definitions

The composite endpoints of renal outcome were eGFR decreased > 50% the baseline level, end-stage renal disease (ESRD) and/or death. ESRD was defined as eGFR < 15 mL/min/1.73 m^2 or maintenance renal replacement treatment. Responses to therapy included complete remission (CR), partial remission (PR) and no response (NR). CR was defined as urinary protein excretion < 0.5 g/24 h, with eGFR decrease less than 10% baseline. PR was defined as proteinuria decrease by > 50% baseline, with eGFR decrease less than 10% baseline. NR was defined as proteinuria decrease < 50% baseline or eGFR increase > 10% baseline. CR, PR and NR were measured at 6–8 months after the initiation of treatment.

Statistical analysis

SPSS version 22.0 (IBM SPSS, Chicago, IL) was used to carry out statistical analysis. Normally distributed variables were expressed as mean ± standard deviation (SD), compared by analysis of variance (ANOVA). Non-normal distributed variables were presented as median with interquartile range (IQR). Categorical variables were summarized as number and percentage, compared by Chi-squared test or Fischer's exact test. Rates of renal survival were analyzed by Kaplan–Meier method and compared by log-rank test. Besides, a Cox regression analysis was adopted to calculate the hazard ratios (HRs) with their 95% confidence intervals (CIs), trying to find the independent predictors. Two-tailed P value was generated for all variables, and $P < 0.05$ was considered to be significant.

Results

Patients

According to the inclusive and exclusive criteria, 206 patients with HSPN were recruited in our study (Fig. 1).

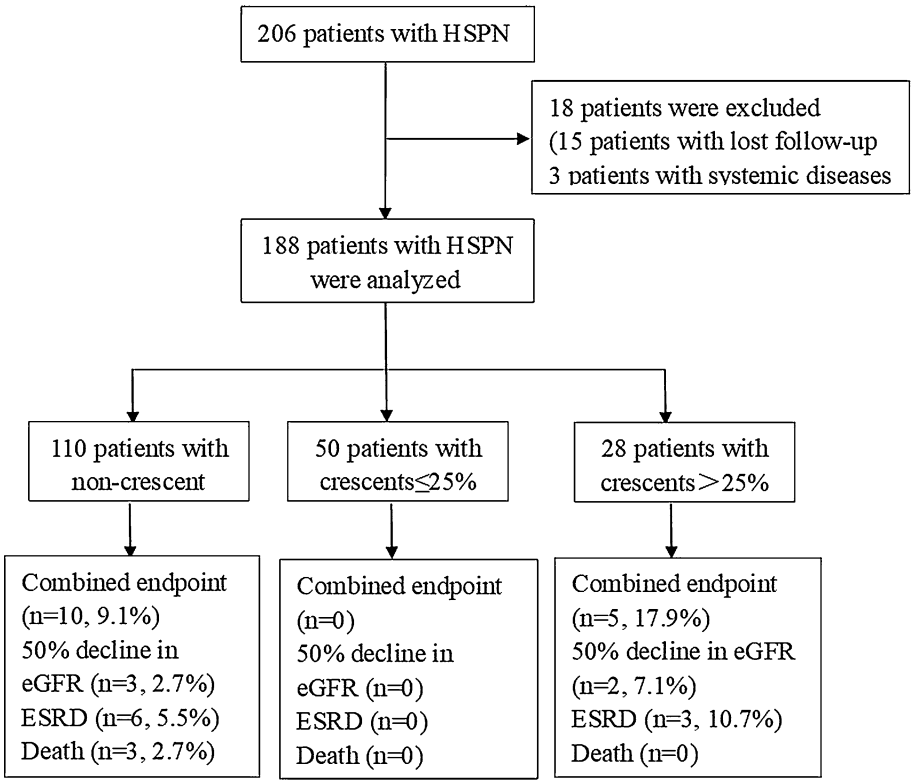

Fig. 1 Flow diagram of patient progress and outcomes

Patients were followed up for 26 (ranged from 6 to 63) months. Fifteen patients (7.28%) were lost during follow-up. Three patients (1.46%) were excluded because of diagnosis of systemic diseases during follow-up. Finally, 188 patients were divided into three groups based on the rates of crescents: non-crescent group (C0 group, $n=110$), crescent $\leq 25\%$ group (C1 group, $n=50$) and crescent $>25\%$ group (C2 group, $n=28$). Of 188 patients, 9.09% (10, 7 reached ESRD/death and 3 reached eGFR decease $>50\%$) patients and 17.86% (5, 3 reached ESRD, 2 reached eGFR decease $>50\%$) patients reached the composite endpoints in C0 and C2 groups, respectively. Three patients (2.73%) died in C0 group, among them, one had severe pathological changes and abandoned treatment, and the other two were elder and treated with glucocorticoids combined with immunosuppressants as well as presented with severe lung infections, whereas no patients in C1 or C2 group. A total of three patients died in our cohort, all of whom were in C0 group. Two patients died from severe lung infection after aggressive immunosuppressive treatment. One patient did not receive the regular treatment due to the poor economic and other family factors. The detailed information is presented in Table 1.

Clinical characteristics of patients at baseline

Clinical manifestations and laboratory data of the 188 patients with HSPN are listed in Table 2. Significant differences were found in serum albumin, proteinuria, serum creatinine and RBC/HP among three groups ($P<0.05$). Patients with higher proportion of crescents tended to present with severer disease (lower level of serum albumin and higher level of proteinuria and hematuria). Although lower serum creatinine level was observed in C1 group, no significant difference was observed in eGFR level among three groups. No significant difference was found in hypertension among groups ($P=0.05$), whereas C0 group (30.90%) was observed with higher proportion. In addition, there were no significant differences in age, gender, clinical symptoms, MAP and uric acid ($P>0.1$).

Renal biopsy results in different groups

The renal pathological features of HSPN patients included light microscopy and immunofluorescence are shown in Table 3. There were markedly differences in endothelial proliferation and glomerular sclerosis among groups. It was noted that patients in C1 group were primarily manifest as cellular crescents and the exact rate of glomeruli with crescents was only 13%. However, patients in C2 group were featured with a considerably high proportion (41%) of glomeruli with crescent (mainly fibrocellular crescents). Moreover, remarkably higher endocapillary hypercellularity (30.00%) rate was observed in C1 group. These findings indicated that C1 group was characterized by early active lesions and low crescent proportion. In contrast, the chronic

Table 1 Detailed information of patients died in study cohort

Characteristics	Patient 1	Patient 2	Patient 3
Age (years)	76	15	56
Bloody stool	+	+	–
Hypertension	No	Yes	Yes
Serum albumin (g/L)	37.70	19.10	17.80
Urine protein (g/L)	1.79	7.10	8.90
Serum creatinine	119	60	93.10
eGFR (mL/min/1.73 m^2)	38.20	142.50	78.70
Follow-up (months)	3	13	12
Pathological grade	I	IIIa	IIIb
Treatment	Glucocorticoids and immunosuppressants	Stop treatment due to poor economic condition	Glucocorticoids and immunosuppressants
Renal replacement therapy	–	–	+
Cause of death	Severe lung infection	Renal failure	Severe lung infection and renal failure

Table 2 Baseline clinical characteristics of HSPN patients

Characteristics	C0 $n=110$	C1 $n=50$	C2 $n=28$	*P*
Age (year)	32.2 ± 14.4	31.2 ± 17.5	26.2 ± 15.8	0.193
Female gender (%)	55 (50.0)	31 (62.0)	16 (57.1)	0.349
Gross hematuria (%)	13 (11.8)	8 (16.0)	1 (3.6)	0.261
Edema (%)	35 (31.8)	23 (46.0)	13 (46.0)	0.136
Skin purpura (%)	103 (93.6)	47 (94.0)	24 (85.7)	0.326
Abdominal pain (%)	27 (24.5)	16 (32.0)	11 (39.3)	0.256
Joint pain (%)	22 (20.0))	11 (22.0)	5 (17.9)	0.906
Bloody stool (%)	13 (11.8)	8 (16.0)	4 (14.3)	0.760
Hypertension (%)	34 (30.90)	8 (16.00)	4(14.30)	0.050
MAP (mmHg)	93.98 ± 13.0	93.6 ± 11.8	95.9 ± 13.0	0.716
Serum albumin (g/L)	37.0 ± 8.1	34.8 ± 7.3	29.3 ± 7.1	< 0.001
Urine protein (g/L)	1.7 (0.7–3.0)	2.47 (1.4–4.4)	4.1 (3.0–6.0)	< 0.001
Serum creatinine (umoL/L)	72.2 (58.2–87.4)	63.0 (52.2–82.5)	78.5 (56.2–150.0)	0.014
eGFR (mL/min/1.73 m^2)	110.1 (87.8–127.9)	119.0 (81.1–136.6)	118.7(47.0–129.9)	0.358
Uric acid (mmol/L)	342.4 ± 103.9	326.3 ± 82.6	368.7 ± 132.5	0.224
U-RBC (/HPF)	25 (7–108)	51 (11–168)	121 (29–316)	0.012
Follow-up	24.0 (12.0–36.3)	18.0 (7.5–47.25)	19.5 (12.8–38.0)	0.871
Interval from disease onset to biopsy (months)	7.4 ± 15.2	6.2 ± 9.9	3.5 ± 9.0	0.376

MAP mean arterial pressure

pathological changes were more common in C0 group with more glomerular sclerosis (50.90%) and segmental sclerosis (38.20%). Nevertheless, no difference in other histopathological features including mesangial proliferation, segmental sclerosis, tubular atrophy/interstitial fibrosis and deposits of IgA, IgG, IgM, C3 and C1q was found ($P > 0.1$).

Treatment regimens and response

The regimens used of HSPN patients are presented in Table 4. It was noted that significantly more patients (14.5%) in C0 group were treated with only optimal supportive care only. However, apparently more patients in C1 (26%) and C2

Table 3 Pathological findings of the HSPN patients

Variables	C0 $n=110$	C1 $n=50$	C2 $n=28$	P
Light microscopy				
Mesangial proliferation (%)	88 (80.00)	44 (88.00)	26 (92.90)	0.170
Endothelial proliferation (%)	10 (9.10)	15 (30.00)	6 (21.40)	0.003
Segmental sclerosis (%)	42 (38.20)	18 (36.00)	6 (21.40)	0.250
Glomerular sclerosis (%)	56 (50.90)	20 (40.00)	8 (28.60)	0.078
Tubular atrophy/interstitial fibrosis (%)	45 (40.90)	16 (32.00)	14 (50.00)	0.281
Immunofluorescence				
IgA (%)	113 (96.36)	44 (92.00)	27 (96.43)	0.195
IgG (%)	8 (7.27)	4 (8.00)	3 (10.71)	0.439
IgM (%)	37 (33.64)	21 (42.00)	15 (53.57)	0.241
C3 (%)	71 (64.55)	34 (68.00)	22 (78.57)	0.766
C1q (%)	11 (10.00)	6 (12.00)	3 (10.71)	0.130

Table 4 Treatments and renal outcomes of HSPN patients during follow-up

Variables	C0 $n=110$	C1 $n=50$	C2 $n=28$
SC (%)	16 (14.50)	0 (0.00)	1 (3.60)
CS + IT (%)	93 (84.50)	37 (74.00)	14 (50.00)
MP + IT (%)	1 (0.90)	13 (26.00)	13 (46.40)

ACEI angiotensin-converting enzyme inhibitors, *ARB* angiotensin receptor blockers

(46.4%) groups received methylprednisolone pulse. Therapy responses for different treatment regimens are showed in Table 5. Of all the 188 patients, 90(47.87%) patients achieved CR, 18(9.57%) patients reached PR, 70(37.23%) patients ended in NR, and 10(5.32%) patients progressed to ESRD during the follow-up period. The highest total response rate was observed in C1 group (CR+PR, 64%), while the lowest was observed in C2 group (46.42%). Moreover, although much more aggressive treatment was applied in patients of C2 group, considerably higher ESRD/death rate was found in C2 group (10.71%) when compared with C0 (6.36%, $P=0.428$) and C1 (0.00%, $P=0.018$) groups.

Table 5 Therapy responses according to different groups of HSPN

	CR 90 (47.87%)	PR 18 (9.58%)	NR 80 (42.55%)	ESRD/death 10 (5.32%)
C0 ($n=110$)	55 (50.00%)	8 (7.27%)	50 (45.45%)	7 (6.36%)
SC ($n=16$)	4 (25.00%)	1 (6.25%)	11 (68.75%)	0 (0.00%)
CS+IT ($n=93$)	51 (54.84%)	7 (7.53%)	28 (30.11%)	7 (7.53%)
MP ($n=1$)	0 (0.00%)	0 (0.00%)	1 (100.00%)	0 (0.00%)
C1 ($n=50$)	24 (48.00%)	8 (16.00%)	18 (36.00%)	0 (0.00%)
SC ($n=0$)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
CS+IT ($n=37$)	19 (51.35%)	5 (13.51%)	13 (35.14%)	0 (0.00%)
MP ($n=13$)	5 (38.46%)	3 (28.03%)	5 (38.46%)	0 (0.00%)
C2 ($n=28$)	11 (39.28%)	2 (7.14%)	12 (42.86%)	3 (10.71%)
SC ($n=1$)	0 (0.00%)	0 (0.00%)	1 (100.00%)	0 (0.00%)
CS + IT ($n=14$)	5 (35.71%)	0 (0.00%)	7 (50.00%)	2 (14.29%)
MP ($n=13$)	6 (46.15%)	2 (15.38%)	4 (30.77%)	1 (7.69%)

CR complete remission, *PR* partial remission, *NR* no response, *ESRD* end-stage renal disease, *SC* supportive care group, *CS + IT* corticosteroids combined with immunosuppressive therapy, *MP* methylprednisolone pulse treatment

Renal survival and risk factors

Renal survival was further analyzed using K–M survival analysis (Fig. 2). The results demonstrated that 9.09% (10 out of 110) patients in C0 group and 17.86% (5 out of 28) patients in C2 group progressed to endpoint (ESRD or eGFR decrease > 50% of baseline level), while no patients reached the endpoints in C1 group during the follow-up, suggesting that the renal outcomes of HSPN patients in C1 group were better than C0 and C2 groups ($P<0.05$). However, there was no statistical significance between C0 and C2 groups ($P=0.31$). Additionally, to confirm the prognostic value of crescent lesions for renal outcomes, Cox proportional hazard models were established (Table 6). Univariate Cox analysis model revealed that tubular atrophy/interstitial fibrosis, serum creatinine, proteinuria, serum albumin, eGFR and RBC/HP were associated with the adverse outcomes. In the multivariate Cox analysis, only tubular atrophy/interstitial fibrosis (HR = 8.15, 95% CI 1.59–41.84; $P=0.012$) and level of serum albumin (HR = 0.89, 95% CI 0.81–0.98; $P=0.015$) could be identified as independent risk predictors of poor renal outcomes in adult HSPN patients. The presence of crescents was not an independent risk factor for poor renal outcomes (HR = 0.28, 95% CI 0.07–1.18; $P=0.083$).

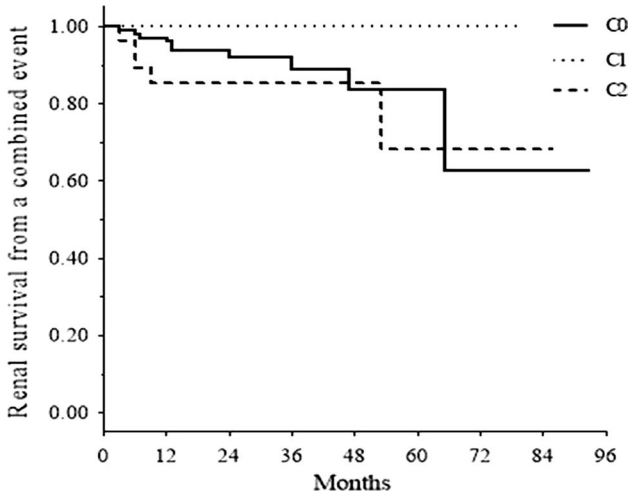

Fig. 2 Kaplan–Meier analysis of renal survival

Discussion

To our knowledge, a majority of previous studies of HSPN mainly focused on clinical characteristics and treatment strategies in pediatric patients. Few researches paid attention to the clinical manifestations of adult HSPN patients with crescent. Generally, crescent formation is a rapidly progressive course and has been confirmed to associate with poor renal outcomes [11]. However, the prognostic value of crescents in adult HSPN has not still been illustrated yet. The aim of this study was to investigate the clinical manifestations and renal outcomes of adult HSPN patients with different proportions of crescent.

Our study indicated that patients who had a higher proportion of crescents tended to present with severer clinical manifestations. It was found that the levels of proteinuria (C0 1.7 vs C1 2.5 vs C2 4.1 g) and hematuria (u-RBC, C0 25 vs C1 51 vs C2 121/HPF) were positively related to the proportion of crescents. Moreover, a negative correlation was found between presentation of crescents and serum albumin (C0 37.0 vs C1 34.8 vs C2 29.3 g/L). Similar results were observed in IgAN patients with crescents had a remarkably increased level of proteinuria than those without crescents [12–15]. We also found greater proportions of hypertension (30.90%), glomerular sclerosis (50.90%) and segmental sclerosis (38.20%) in C0 group, though there is no statistically significant difference among three groups, which manifested that C0 group was characterized by chronic fibrotic changes, while C1 group was featured with early active lesions and C2 group was similar to typical crescentic nephritis.

Apparent difference was observed in renal outcomes among three groups: 9.09% patients in C0 group and 17.86% patients in C2 group progressed to the composite endpoints, whereas no patients in C1 group developed to ESRD ($P < 0.05$). It is well known that renal pathological changes are strongly related to clinical manifestations and prognosis of kidney disease. In the present study, we found that renal pathological changes of patients in C1 group were low proportion (13%) of cellular crescents, while patients in C2 group were featured with high proportion (41%) of fibrocellular crescents. Moreover, remarkably higher endocapillary hypercellularity (30.00%) rate was observed in C1 group. In contrast, the chronic pathological changes were more common in C0 group with more glomerular sclerosis (50.90%) and segmental sclerosis (38.20%). These findings indicated that C0 group was featured with chronic fibrotic changes, C1 group was characterized by early active lesions, and C2 group was similar to typical crescentic nephritis. These remarkable differences among groups may be the

Table 6 Risk factors for renal survival in HSPN

Parameter	Univariate		Multivariate	
	HR (95% CI)	*P*	HR (95% CI)	*P*
Hypertension	2.61 (0.95–7.21)	0.060	1.28 (0.38–4.28)	0.691
C (presence/absence)	0.63 (0.61–1.87)	0.401	0.28 (0.07–1.18)	0.083
M	1.16 (0.26–5.15)	0.847	0.87 (0.11–7.15)	0.899
E	0.85 (0.23–3.16)	0.808	1.39 (0.21–9.04)	0.734
S	2.23 (0.80–6.16)	0.124	2.14 (0.69–6.59)	0.183
T	3.45 (1.16–10.21)	0.026	8.15 (1.59–41.84)	0.012
Serum creatinine	1.00 (1.00–1.02)	0.039	1.00 (0.98–1.03)	0.757
Urine protein	1.16 (1.05–1.28)	0.004	1.03 (0.86–1.22)	0.764
Serum albumin	0.93 (0.87–0.98)	0.009	0.89 (0.81–0.98)	0.015
eGFR	0.99 (0.97–1.00)	0.037	0.99 (0.96–1.03)	0.692
U-RBC	1.00 (1.00–1.00)	0.033	1.00 (1.00–1.00)	0.436

HR hazard ratio, *CI* confidence interval, *C* crescents, *M* mesangial hypercellularity, *E* segmental glomerulosclerosis, *S* segmental glomerulosclerosis, *T* tubular atrophy/interstitial fibrosis

most important reasons of renal outcome we observed. We also found that the number of patients with hypertension was the largest in C0 group. Previous studies have proved that hypertension was a independent risk factor for HSPN progressing to ESRD [16], which could be partially explained why the renal outcomes of C1 group was better than that of C0 group. Moreover, that patients died in C0 group could contribute to the poor outcomes significantly. It was worth mentioning that only three patients died in our cohort and all of them were in C0 group, whose causes of death were related to advanced age, side effects of immunosuppressive therapy, serious infection and severe pathological lesions.

Another reason for the difference of renal outcome may be the treatment strategies. In our cohort, patients in C1 and C2 group were received more aggressive treatment regimens than C0 group in our study. As is known, cellular/ cellular fibrous crescents and endocapillary hypercellularity are active lesions, responding effectively to the immunosuppressant treatment [17, 18]. After immunosuppressive combined with methylprednisolone pulse treatment, the crescents could be reduced dramatically [19].

Conversely, fibrosis crescents, segmental sclerosis, glomerular sclerosis as well as tubular atrophy/interstitial fibrosis were confirmed to be chronic indexes and rejective to immunosuppressive agents, which negatively affected the renal survival [11]. The data of our cohort suggested that patients in C2 group had fibrocellular crescents, which were resistant to immunosuppressant treatment. Therefore, the outcome was poor in this group.

Generally, doctors tacitly believed that patients suffering from crescent nephritis were more likely to progress to ESRD. But the results of K–M survival analysis suggested that the renal outcomes were much better in C1 groups than other two groups ($P=0.024$), and there were no statistical differences in renal survival between C0 group and C2 group ($P=0.312$), C1 instead of C2 might not get a poor renal outcomes. Moreover, Cox proportional hazard models also proved that crescents were not correlation to worse renal outcomes (HR = 0.28, $P=0.083$). Therefore, it is speculated that it is not the presence or absence of crescents but the proportion of crescents in HSPN that makes a difference. Small proportion of cellular crescent formation might not a poor renal prognosis. Some retrospective studies enrolling patients with HSPN demonstrated that crescent lesions did not lead to an adverse renal outcome [16, 20]. Similarly, a recent report also hold the same view that crescent formation might fail to predict the poor prognosis of IgAN [21]. However, these results seemed to be disagreement with other studies of IgAN [7, 22, 23]. Haas et al. [24] identified that patients with higher rates of crescents were at greater risk of progressing to ESRD, and Rianthavorn et al. [22] also reported that crescent formation was positively related to poor outcomes. Although HSPN and IgAN share similar pathogenic mechanisms [9], some differences could not be ignored.

Nevertheless, there are still some limitations in our study. Firstly, the follow-up of our cohort might not be enough. Secondly, this is a single-center study. Hence, further multiple center studies with long-term follow-up are required to confirm our results.

Conclusion

Taken together, the current research demonstrates that although crescents might lead to more severe manifestations, crescent lesions might not be an adverse predictor in adult HSPN patients. It is not the presence or absence of crescents but the proportion of crescents in HSPN that makes a difference. Small proportion of cellular crescent (crescent $\leq 25\%$) formation might not a poor renal prognosis.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ethics Committee of West China Hospital of Sichuan University and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

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