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Demographic and Renal Histopathological Profile of Rapidly Progressive Glomerulonephritis in Children

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Abstract

Background:
Rapidly progressive glomerulonephritis (RPGN) is an uncommon but severe pediatric renal disorder, and its incidence and etiological patterns remain poorly defined.

Objective:
This study examined demographic features and renal histopathology among affected children.

Methods:
A prospective observational study was conducted in the Department of Paediatric Nephrology, BICH and Dhaka Shishu Hospital from July 2018 to June 2020, enrolling 28 pediatric cases displaying features of rapidly progressive glomerulonephritisthrough non-probability sampling.

Results:
The mean age was 9.1±1.9 years in children with more than 50% crescents and 8.7±2.2 years in those with fewer crescents. Males predominated in the high-crescent group, and most participants (82%) were from rural areas. Increased cellularity, mesangial expansion, and interstitial inflammation were frequent in both histological categories. Most children presented with acute kidney injury stage 3, with no significant difference between groups.

Conclusion:
RPGN in children appears to predominantly affect rural male patients in late childhood, with severe renal dysfunction and similar histopathological patterns across crescentic categories.

Keywords: Crescentic glomerulonephritis, Pediatric nephrology, Fibrocellular crescents, Acute kidney injury

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Introduction:

Rapidly Progressive Glomerulonephritis (RPGN) or Crescentic Glomerulonephritis (CsGN) is a rare condition in children, accounting for approximately 5% of reported renal biopsies.[1] While the precise incidence remains unknown, studies indicate a lower frequency in children, except in specific geographic regions like Arabia and Asia, where incidence rates range from 7.2-11.6/100,000 per year in Arabia and 6.2-15.6/100,000 per year in Asia.[2] Diseases leading to Glomerulonephritis are typically categorized as primary (where the kidney is the primarily affected organ) or secondary (involving the kidneys along with other organs, such as systemic lupus erythematosus - SLE).[1] Glomerulonephritis is further classified into acute and chronic types based on the duration or nature of the illness.[3] In the United States, RPGN is estimated to have an incidence rate of 7 cases per one million per year. At the same time, a 2010 Saudi Arabian study reported a 3.2% incidence of crescentic glomerulonephritis among 233 renal biopsies in patients aged 17 to 43 years old.[2] Different forms of crescentic Glomerulonephritis (GN) share a similar histology, characterized by crescents, defined as accumulations of two or more layers of cells wholly or partially filling the Bowman space.[4] These crescents can be entirely cellular, demonstrating the proliferation of neutrophils, macrophages, and epithelial cells, or they may exhibit varying degrees of scarring and fibrosis.

Fibrous crescents consist mainly of collagen, while fibrocellular crescents display features of both cellular and fibrous types. Changes in the interstitium range from acute inflammation to chronic interstitial scarring, fibrosis, and tubular atrophy.[5] The compression of glomerular capillary loops by crescents can lead to ischemic changes in the tubules relying on blood flow from the affected efferent arteriole. Vasculitis often manifests as episodic inflammation, as evidenced by crescents at different stages of progression.[5] In early lesions, there may be segmental fibrinoid necrosis with or without an adjacent crescent. Severe acute lesions can display focal or diffuse necrosis, accompanied by circumferential crescents.[6] The presence, location, and nature of immune deposits are crucial for identifying the cause of crescentic GN. For instance, IgA nephropathy and HSP exhibit mesangial deposits of IgA, post-infectious GN is characterized by granular, subepithelial deposits of IgG and C3, MPGN presents with mesangial, subendothelial, and intramembranous deposits of both IgG and C3, and SLE shows "full house" capillary wall and mesangial deposits of granular IgG, IgA, IgM, C3, C4, and C1q. Patients with vasculitis, with or without ANCA positivity, typically have few or no immune deposits in the glomeruli. Anti-GBM disease is characterized by linear staining of the GBM with IgG (rarely IgM and IgA) and C3.[7-9] This study aimed to analyze the demographic and renal histopathological profile of pediatric rapidly progressive glomerulonephritis.

Methods:

This prospective observational study took place at the Department of Paediatric Nephrology, Bangladesh Institute of Child Health (BICH) & Dhaka Shishu (Children) Hospital, Bangladesh. The research spanned from July 2018 to June 2020, involving a total of 28 pediatric cases displaying features of rapidly progressive glomerulonephritis as the study subjects. Approval was taken from the ethical committee of the Bangladesh Institute of Child Health (BICH) at the commencement of the study. The study included patients aged 2 to 18 years who presented with glomerulonephritis exhibiting clinical features consistent with rapidly progressive glomerulonephritis, particularly those demonstrating a rapid rise in serum creatinine beyond the upper limit of the age-matched normal range, and who provided informed consent. Patients were excluded if they had pre-renal or post-renal causes of acute kidney injury, had previously received methylprednisolone therapy, had an established diagnosis of chronic kidney disease, or declined to provide consent for participation.In this study, a non-probability sampling technique was employed. Data were gathered from parents or legal guardians utilizing a structured questionnaire encompassing all the variables of interest. Ethical approval was obtained from the institutional review committee (IRC), and informed written consent was secured from parents or legal guardians prior to data collection. The process included detailed history-taking, thorough clinical examinations, laboratory investigations, and renal biopsy. Subsequently, all the data were input into a computer and analyzed using Statistical Package for Social Science (SPSS) 20.0. Quantitative observations were presented in frequencies and percentages. Associations between variables were assessed using Fisher's exact test for categorical variables and a one-sample t-test for continuous variables, with a p-value of <0.05 considered statistically significant.

Results:

In this observational study, the majority of patients (61%) were male, and a significant proportion were younger than 10 years (75%). The majority (82%) hailed from rural areas. The mean age was 9.1±1.9 years and 8.7±2.2 years in the >50% crescent and <50% crescent groups, respectively. Although there was a male preponderance (88%) in the >50% crescent group, the p-value was not statistically significant (Table-I & Table-II).

Table-I: Demography of study subjects (N=28)

Demography	no. (%)
Age (Year)	
2-10	21(75)
11-18	7(25)
Gender	
Male	17(61)
Female	11(39)
Residence	
Urban	5(18)
Rural	25(82)

Table-II: Association of demographic profile of RPGN with >50% and <50% crescent (N=28)

Variables	With >50% crescent		p-value
	Mean±SD/ no. (%)	Mean±SD/ no. (%)	
Age (Year)	9.1±1.9	8.7±2.2	0.328
Male	7(88)	10(50)	0.066
Female	1(12)	10(50)	0.066

Regarding the light microscopic findings of renal histopathology, increased cellularity, increased mesangial matrix, and interstitial inflammation were observed in most cases in both groups (Table-III).

Table-III: Renal histopathology of the studied patient (N=28)

Light microscopic findings	RPGN with>50% crescent		p-value
	(n=8) no. (%)	(n=20) no. (%)	
Glomerular Crescent			
Cellular	2(25)	9(45)	0.328
Fibro cellular	5(63)	7(35)	0.184
Fibrous	1(12)	4(20)	0.558
Cellularity			
Increased	7(88)	16(80)	0.528
Normal	1(12)	4 (20)	
GBM thickness			
Increased	1(12)	10(50)	0.066
Normal	7(88)	10(50)	
Matrix			
Increased	8(100)	19(95)	0.52
Normal	0	1(5)	
Tubular necrosis/ atrophy			
Yes	3(37)	7(35)	0.901
No	5(63)	13(65)	
Interstitial inflammation/edema			
Yes	6(75)	19(95)	0.122
No	2(25)	1(5)	

In analyzing kidney length by age, we observed that kidney size was larger in all cases, but the difference between groups was not significant (Table-IV).

Table-IV: Comparison of kidney size in >50% and <50% crescentic groups as per age (N=28)

Characteristics	Crescent (%)		p-value
	>50% (n=8)	<50% (n=20)	
	Mean±SD (cm)		
4<6yr			
Right Site	8.1±0.2	8.5±0.1	0.127
Left Site	8.6±0.1	9.4±0.1	0.992
6<8 yr			
Right Site	8.2±0.1	8.41±1.7	0.439
Left Site	8.8±0.1	8.51±1.8	0.42
8<10 yr			
Right Site	9.2±0.6	8.75±1.2	0.301
Left Site	9.3±0.13	8.85±1.1	0.223
10<12 yr			
Right Site	9.1±0.23	8.9±0.5	0.281
Left Site	9.13±0.46	9.1±0.4	0.468
12<18 yr			
Right Site	10.9±0.1	9.1±0.1	0.998
Left Site	10.6±0.1	9.7±0.3	0.148

When analyzing the association of AKI severity with >50% and <50% crescents, we observed that the majority of the patients were in AKI stage 3, but there were no significant differences between the groups (Table-V). Cortical echogenicity was increased in all the patients in both groups (Table-VI).

Regarding sonographic kidney size measurements in the patients studied, there was no significant difference in kidney size between the two groups.

Table-V: Association of AKI severity with >50% crescents and <50% crescents of RPGN (N=28)

Severity	With >50% Crescent no. (%)	With <50% Crescent no. (%)	p-value
AKI stage 2	2(25)	5(25)	1.000
AKI stage 3	6(75)	15(75)	1.000

Table-VI: Association of sonographic measurement with >50% and <50%crescent cases (N=28)

Variables	With >50% Crescent no. (%)	With <50% Crescent no. (%)	p-value
Right kidney size (cm) mean±SD	9.06±0.98	9.12±1.1	0.447
Left kidney size (cm) mean±SD	9.3±0.8	9.36±1.18	0.448
Increased echogenicity no. (%)	8(100)	20(100)	1

Discussion:

In this study, all patients underwent renal biopsy, and the age at disease onset ranged from 2 to 18 years. The mean age was 9.1±1.9 years and 8.7±2.2 years in the >50% crescent and <50% crescent groups, respectively. The demographic characteristics of the study group revealed that the majority of patients were male (61%). A significant proportion of children (75%) were younger than 10 years, and 82% were from rural areas. Post-infectious glomerulonephritis continues to be the most common etiology in developing countries like ours, often affecting children residing in overcrowded places with poor hygiene. The demographic profile found in this study aligns with the findings of Dewan et al.[10] In a study conducted by Chaudhury et al in Bangladesh, which included 34 cases divided into two groups (50% crescents), demographic characteristics also showed a male predominance (61.7%), consistent with our study.[11] Ultrasonographic evidence showed enlarged kidneys with increased echogenicity in both groups, without any significant difference. The present study revealed a high incidence of advanced renal failure, with AKI stage 3 observed in 75% (6/8) of RPGN cases with >50% crescents and 75% (15/20) in RPGN cases with <50% crescents. All patients required dialysis, and histopathological correlation revealed a high frequency of fibrocellular crescents in the majority of patients with crescentic GN, consistent with the findings of the Southwest Pediatric Nephrology Study Group.[12] The light microscopic study demonstrated increased cellularity, mesangial matrix, and interstitial inflammation in both groups. Fibro cellular and fibrous crescents were more prevalent, accounting for 61% (17/28), compared to cellular crescents, which constituted 39% (11/28) in this series. These observations are consistent with previous studies conducted by the Southwest Pediatric Nephrology Study Group and Dewan et al.[10,12] The higher percentages of fibrocellular crescents in this study may be attributed to the greater severity of AKI in both groups. The majority of patients in this study were in stage 3 AKI. Although there were no significant differences between the groups, this finding aligns somewhat with the study conducted by Wu KY et al.[13] In the study by Chaudhury et al, the proportions of glomeruli displaying cellular crescents, fibrous crescents, and fibro cellular crescents were reported as 21%, 7.1%, and 35%, respectively. Interstitial fibrosis and tubular atrophy were noted in 3.5% and 32.1% of biopsies.[11] Zent et al stated in their study that all patients had crescentic nephritis, with crescents ranging from 54% to 86%. Three patients had less than 80% crescents, and the anuric patient had 17 of 37 glomeruli sclerosed, with 100% of the remaining glomeruli having crescents in the biopsy report. This patient had a moderate chronic infiltrate and no evidence of acute tubular necrosis on histology. The immunofluorescence showed classical linear IgG staining.[14] In this study, all patients demonstrated immune deposition on immunofluorescence, indicating immune-complex glomerulonephritis. None of the cases showed pauci-immune glomerulonephritis or anti-GBM glomerulonephritis. This finding contrasts with the study by Sinha et al, which reported that pauci-immune glomerulonephritis constituted one-half of patients with crescentic glomerulonephritis.[15] Therefore, based on the discussion above, crescentic glomerulonephritis should be regarded as a genuine emergency. It is essential to raise awareness of this disease among referring paediatricians to facilitate early diagnosis and prompt treatment.

Limitations:

The study's limitations include its single-hospital setting and a small sample size, which may limit the generalizability of the results to the broader community.

Conclusion:

Male pediatric individuals in rural areas may be mainly prone to rapidly progressive glomerulonephritis. The prevalence of such incidents may be higher between 7 and 9 years of age. The presence of AKI (Acute Kidney Disease) stage 3 may be a common phenomenon. Rapidly progressive glomerulonephritis patients in the >50% crescent and <50% crescent groups exhibit similar mean ages, with a slight numerical increase observed in the former. There is a noticeable male preponderance in the >50% crescent group, although the difference does not reach statistical significance. The majority of participants come from rural areas. Renal histopathological findings indicate increased cellularity, elevated mesangial matrix, and interstitial inflammation in the majority of cases in both crescent groups. Notably,

most patients are in AKI stage 3, with no significant disparity observed between the two groups. These qualitative observations emphasize the need for further investigation into the factors influencing renal health in this demographic.

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