***Original Research Article***

**Rapidly Progressive Glomerulonephritis in Women: Clinical and histopathological Trends in Northwest Rajasthan, India**

**ABSTRACT-**

 **Background**: This retrospective study assessed the etiology, clinic-histological patterns, and outcomes of Rapidly Progressive Glomerulonephritis (RPGN) in 45 adult female patients from northwest Rajasthan. This study sought to identify the predictors influencing the outcomes of RPGN. Patients were diagnosed with RPGN based on renal biopsy showing crescents in more than 50% of glomeruli.

**Methods**: The cohort was categorized into four groups (Type I, II, III, and IV) based on immunohistochemistry and outcomes were analyzed under four headings- complete remission, partial remission, end stage renal disease and mortality. Data on clinical history and physical examinations were collected.

**Results**: Results revealed that Type II RPGN was the most common (57.77%), followed by Type III (22.22%), Type I (13.33%), and Type IV (6.66%). During follow-up, 12 patients (26.66%) died, and 17 patients (37.77%) progressed to End stage renal disease while 17 patients (37.77%) achieved remission. The ESRD group had presentation of oliguria, serum creatinine, and a need for hemodialysis at presentation (P<0.001 for all).

**Conclusion:** The study found that Type II RPGN was the most prevalent form in this population. Key predictors of End stage renal disease included oliguria, glomerulosclerosis, and the need for hemodialysis at presentation. Respiratory failure, heart failure, and infections were significant mortality risk factors. This research highlights the poor prognosis of RPGN and underscores the need for early identification of high-risk patients to improve management and outcomes. Further studies are needed to confirm these findings and explore additional prognostic factors in this population.

**Keywords:** *End stage renal disease, Glomerulonephritis, Hemodialysis*

**INTRODUCTION-**

“Rapidly progressive glomerulonephritis (RPGN) is a clinical syndrome characterized by a rapid decline in kidney function ie 50% reduction in glomerular filtration rate over three months, accompanied by oliguria or anuria and features of glomerulonephritis, including dysmorphic erythrocyturia, erythrocyte cylindruria, and glomerular proteinuria. It is frequently associated with extensive crescent formation in the glomeruli, leading to its synonymy with crescentic glomerulonephritis. This aggressive pathology results from glomerular capillary rupture promoting inflammatory cell infiltration and if not treated timely and aggressively leads to end stage renal disease. On renal biopsy, the hallmark histopathological finding is cellular crescent formation in the glomeruli with more than 50% crescents leading to presentation of rapidly progressive glomerulonephritis. Crescents result from a proliferative response of parietal epithelial cells within Bowman’s space” [1].

“The terms “crescentic glomerulonephritis” and “rapidly progressive glomerulonephritis” (RPGN) are often used interchangeably, as crescent formation is closely associated with the rapid and often irreversible loss of kidney function. Crescentic glomerulonephritis is typically defined as the presence of crescents in more than 50% of the glomeruli. However, even a single crescent may indicate an underlying pathological process. Early diagnosis and timely intervention are critical to preventing further loss of renal function” [2].

RPGN is broadly classified based on histopathology and the pattern of immune complex deposition observed through immunofluorescence [2]:

 **Type I**: Anti-glomerular basement membrane (GBM) disease, characterized by linear antibody deposition along the GBM.

**Type II**: Granular immune complex deposition disorders, often associated with conditions such as lupus nephritis or post-infectious glomerulonephritis.

**Type III**: Pauci-immune disease, marked by the absence of immune deposits and generally linked to anti-neutrophil cytoplasmic antibody (ANCA)-positive vasculitis.

**Type IV**: Double antibody-positive disease, where both ANCA and anti-GBM antibodies are present.

**Anti-Glomerular Basement Membrane Disease**

“Circulating immunoglobulin G (IgG) antibodies are directed against an antigen normally present in the GBM and alveolar basement membrane, specifically the non-collagenous domain of the α-3 chain of type IV collagen. This anti-GBM antibody deposition accounts for approximately 10% to 15% of diffuse crescentic glomerulonephritis cases. About 40% to 60% of these cases are associated with alveolar hemorrhage, a condition known as Goodpasture syndrome”.[[3]](https://www.ncbi.nlm.nih.gov/books/NBK557430/) Fewer than 10% of anti-GBM disease cases present with isolated pulmonary involvement.[[4]](https://www.ncbi.nlm.nih.gov/books/NBK557430/)

“Immune complex RPGN (type II) which represents 40% of cases occurs in numerous systemic rheumatic diseases such as lupus nephritis and cryoglobulinemic GN. It is also seen in infectious diseases such as post-streptococcal GN, infective endocarditis, visceral abscess and also occurs with other primary glomerular disorders including membranoproliferative glomerulonephritis (MPGN), and IgA nephropathy. IHC staining illustrates granular immunological deposits” [4].

Pauci-immune RPGN (type III) which constitutes 50% of cases is characterised by absence of complement or immune complex deposition on IHC staining. The majority of patients also exhibit systemic vasculitis and high antineutrophil cytoplasmic antibodies (ANCAs), typically myeloperoxidase-ANCA or antiproteinase 3-ANCA.

“There are regional and temporal variations in the prevalence, etiology, and prognosis of RPGN worldwide. RPGN is seen in 4–10% of native kidney biopsies”.[5] Despite immunosuppressive medications, its prognosis is poor, with a higher risk of ESRD and death.[6] “The prognosis is significantly influenced by specific clinicopathological characteristics, such as the subtype, serum creatinine, oliguria, age, and an increased percentage of crescentic glomeruli”.[7] The aim of the present study was to analyze and follow up female patients diagnosed with RPGN. Additionally, efforts were made to identify clinical, biological, histological, and immunohistological factors that could predict treatment response and outcomes.

**MATERIAL AND METHODS**

**STUDY DESIGN AND POPULATION**

This retrospective study was conducted in the Department of Nephrology at a tertiary care hospital in Northwestern Rajasthan, following approval from the Institutional Ethical Committee. Female patients who visited the hospital between July 2022 and January 2024 were evaluated for crescentic glomerulonephritis (GN) and followed up for one year. Informed consent was obtained from all participants. A total of 45 female patients were diagnosed with rapidly progressive glomerulonephritis (RPGN), which was confirmed by renal histopathology showing crescents in ≥ 50% of the glomeruli.

The study included adult female patients over 18 years of age with biopsy-confirmed rapidly progressive glomerulonephritis (RPGN) and rapidly progressing renal failure. Patients with crescents in less than 50% of glomeruli on renal biopsy or those who declined consent for a biopsy were excluded.

**CLINICAL AND LABORATORY DATA**

A thorough clinical history, including symptoms from various organ systems, was obtained, followed by a comprehensive systemic and physical examination. Laboratory test results were recorded, including the 24-hour urine protein or spot protein-to-creatinine ratio, urine microscopy, dipstick analysis, random blood sugar, C-reactive protein, liver function tests, renal function tests, and complete blood count (CBC).

The estimated glomerular filtration rate (eGFR) was calculated using the equation developed by the Chronic Kidney Disease Epidemiology Collaboration. ANCA antibodies were measured using the Dot-blot strip test and indirect immunofluorescence (IF) test/ELISA. Antinuclear antibodies (ANA) and anti-double-stranded DNA antibodies were both assessed using the indirect IF test. Serum complement levels were measured through nephelometry. Additionally, all patients underwent a chest X-ray, electrocardiogram, and abdominal ultrasound.

Each patient underwent a percutaneous kidney biopsy assisted by an automated biopsy gun under ultrasound guidance. The biopsy samples were prepared for immunohistochemistry (IHC) and light microscopy (LM) analysis. For LM, the renal tissue was preserved in 10% neutral buffered formalin, and histological staining was performed on consecutive 3 μm serial sections.

A semiquantitative scoring system was used to assess renal arteriosclerosis based on the degree of vascular occlusion in the most affected vessel. Scores of 0, 1, 2, and 3 represented arterial luminal narrowing of <10%, 10–25%, 26–50%, and >50%, respectively. TLO development was defined as an organized lymphocyte-based cluster, with an arbitrary threshold of 50 cells. Severe tubular atrophy was characterized by the presence of tubular atrophy in more than 50% of the cortical tubules within a specimen.[9]

Thick sections (5 μm) were prepared from the renal biopsy for immunohistochemistry (IHC) analysis. Tissue sections were processed following the routine IHC protocol. Slides were stained with immunoglobulin A (IgA) antibody (polyclonal rabbit antibody, clone 267 A-16, 1mL concentrate, diluted 1:200, incubated for 45 minutes at 4ºC in a humidity chamber, Cell Marque, USA), immunoglobulin G (IgG) antibody (polyclonal rabbit antibody, clone 269 A-16, 1mL concentrate, diluted 1:200, incubated for 45 minutes at 4ºC in a humidity chamber, Cell Marque, USA), and complement 3 (C3) antibody (polyclonal rabbit antibody, 100 µl concentrate, diluted 1:300, incubated for 45 minutes at 4ºC in a humidity chamber). IgG, IgA, and C3 staining were observed along the glomerular basement membrane and mesangium. Based on IHC results, patients were classified into type I, type II, type III, or type IV RPGN.

Depending on the type of RPGN and overall clinical status, the patients were treated for the disease as per standard protocol. in type I RPGN, patients were treated with 3 doses of pulse steroid (0.5 g each) and oral steroids (1 mg/kg/day tapered to 20 mg/ day by 6 weeks) for 6 months along with oral cyclophosphamide 2.5 mg/ kg / day for 12 weeks and plasmapheresis with 50 ml/kg volume exchange with 5% albumin if patient had alveolar hemorrhage, non oliguric disease or creatinine less than 5.7 mg /dl. No maintenance therapy is needed for anti GBM disease. In Anti GBM plus ANCA disease (type IV RPGN ) patient are treated with maintenance therapy as per ANCA disease.

In type II RPGN, Patients were started on induction therapy with three methylprednisolone (0.5 g) pulses followed by oral prednisolone plus six intravenous cyclophosphamide fortnightly pulses (500 mg each). After induction phase, patients were started on maintenance therapy with mycophenolate mofetil (2gm/ day) in lupus nephritis.

In type III RPGN, patients were given induction with iv cyclophosphamide (15mg/kg) every two weeks for three doses followed by every 3 weeks for another three doses followed by maintenance with azathioprine (1-1.5 mg/ kg/ day.) Those patients that do not showed improvement in 8-12 weeks were withdrawn from immunosuppression.

Patients were followed up for a period of twelve months. Complete blood counts, serum creatinine, blood urea nitrogen, urine routine examination, and 24 h urine protein or spot urine to protein creatinine ratio were done according to predefined intervals.

**OUTCOME**

Response to therapy was studied in terms of complete remission, partial remission, end stage renal disease and death.

 Complete remission was defined as 24 h urine protein <500 mg/day and serum creatinine <1.4 mg/dL. Partial remission was defined as stable or decreasing serum creatinine in non-dialysis patients, dialysis independence, and serum creatinine <5.8 mg/dL in dialysis dependents. No response was defined as increasing serum creatinine or dialysis dependency or end stage renal disease in non-dialysis patients and dialysis dependency or serum creatinine >5.8 mg/dL in dialysis dependent patient. Death of a patient during the next six months after enrollment was another primary outcome of the study.

**STATISTICAL ANALYSIS**

Data analysis was performed using SPSS version 25. Continuous data are presented as medians with interquartile ranges (IQR) or means with standard deviations, while categorical data are shown as counts and percentages. The chi-square test was used to compare categorical variables. Spearman's correlation was applied to assess the relationship between categorical and continuous variables or between two categorical variables.

**RESULTS**

Patients with type I, type II, type III, and type IV RPGN had mean ages of 33 ± 13, 28 ± 10.75, 58 ± 10.10, and 65 ± 1.7 years, respectively. Type IV had a significantly higher age compared to both type I and type II (P < 0.001 for each). Type II RPGN was the most common cause of RPGN (57.77%), followed by type III (22.22%), type I (13.33%), and type IV (6.66%). Type II included 14 patients with lupus nephritis (53.84%), 5 with IgA nephropathy (19.23%), and 7 with MPGN (26.92%) (Table 1). Regarding renal and extrarenal manifestations, edema was significantly more prevalent in type II compared to type IV (P = 0.05). Oliguria was significantly more common in patients with type II and type I RPGN compared to those with type IV RPGN (P < 0.05). Skin rash occurred significantly more often in type II RPGN than in type I (P < 0.03) and in type II RPGN compared to type III (P < 0.006). The need for hemodialysis (HD) at presentation was significantly higher in type I RPGN compared to type III (P < 0.03) and in type II RPGN compared to type IV (P < 0.04). Both type II and type III RPGN groups had significantly lower serum creatinine levels compared to type I RPGN (P < 0.05 for each). Serum albumin levels were significantly lower in type I, II, and III RPGN compared to type IV RPGN (P < 0.001). Proteinuria was significantly higher in type II, type III, and type IV RPGN compared to type I RPGN (P < 0.05 for each).

Type I RPGN showed a total of 20 ± 4 glomeruli, with a relatively higher number of sclerotic glomeruli (7 ± 6) and fibrous crescents (3 ± 2). This pattern is consistent with anti-glomerular basement membrane (GBM) disease. The high number of crescentic glomeruli (11.5 ± 4) is also characteristic of this disease. Type II RPGN also showed a high number of crescentic glomeruli (11 ± 3). However, the number of sclerotic glomeruli (4 ± 4) was comparatively lower than that seen in Type I RPGN. Additionally, Type II RPGN had a higher number of cellular crescents (9 ± 4.75). In Type III RPGN, characterized by ANCA-associated vasculitis, the glomerular morphology includes a slightly lower number of total glomeruli (17 ± 8) and a similar number of crescentic glomeruli (12 ± 5.5). The sclerotic glomeruli count was also relatively low (3 ± 6).Type IV RPGN had a similar pattern to Type III RPGN, with a comparable number of crescentic glomeruli (12 ± 4.5). Type I RPGN showed a striking positivity for anti-GBM antibodies in 83.3% of patients. In contrast, Type II RPGN exhibited significant immunological activity, with positive ANA (69.2%) and positive anti-dsDNA (69.2%) antibodies. Type III RPGN and Type IV RPGN, both of which are associated with ANCA-associated vasculitis, had positive results for P-ANCA (50% in Type III and 33.3% in Type IV) and C-ANCA (30% in Type III and 33.3% in Type IV).Low C3 levels were found in 73.07% of Type II RPGN patients, which is consistent with immune complex-mediated diseases such as lupus nephritis. None of the Type III or Type IV RPGN patients exhibited low C3 levels, suggesting that these forms of RPGN may not be as dependent on complement activation via immune complexes.

Mesangial proliferation was observed with the highest percentage in Type II RPGN (53.8%), . Type I RPGN demonstrates 16.6% neutrophilic infiltration, while Type III RPGN shows 20%. Type III RPGN shows a significant percentage of glomerular thrombosis (21.1%) followed by Type I (10%). Moderate to severe IFTA is most prevalent in Type II RPGN (50 %) followed by Type I (33.3%) and Type III (30 %) ,.TLO formation is observed in approximately 50% of Types I, (46.1%) in type II, and (50% ) in type III RPGN. Fibrinoid necrosis was observed in all patients with Type IV RPGN and type III RPGN (100%) and less prominent in Types I (16.6%), II (30%). Severe arteriosclerosis was found in a significant percentage of Type II RPGN (53.8%) and Type IV RPGN (66.6%).

End stage renal disease was the most common primary outcome in our study. Among 45 patients, 17 (37.77%) progressed to End stage renal disease and 12 (26.66%) died during follow-up. Remission occurred in 17 patients (37.77%), with 5 achieving complete remission and 12 experiencing partial remission.

 **DISCUSSION**

The most common cause of RPGN in our study was type II, followed by type III and type I. Type II crescentic GN has been identified as the most prevalent cause in several studies from China, Saudi Arabia, and India. [6, 11-12] Our findings align with those of Mohamed et al. [1], with type II being the most common (57.7%), followed by type III and type I. The most frequent cause of type II RPGN was lupus nephritis (31.1%), followed by IgA nephropathy (30%), post-infectious GN (20%), and MPGN (20%). This is consistent with a large Chinese review that also found lupus nephritis to be the leading cause of crescentic GN (20%). [6] The higher incidence of type II RPGN in these regions is thought to be linked to infection rates and the prevalence of systemic lupus erythematosus (SLE).

The average age of patients with type III RPGN was significantly higher than that of those with type II and type I RPGN. Mohamed et al. also reported that patients with type III RPGN were older than those with type I and type II RPGN (P = 0.03 and P = 0.003, respectively), which is consistent with our findings. Type II RPGN had more patients with oliguria presentation as compared to type III, which contrasts with a study that found no significant difference in oliguria across the groups. [13] The rates of microscopic or gross hematuria were notably higher in the type III and type II RPGN groups in our study, which contradicts the results of Mohamed et al. and Parry et al., who reported no significant differences in hematuria across RPGN types. [1, 13] Hemodialysis requirements were significantly higher in the type I and type II groups compared to the type III group. Parry et al.'s findings, which indicated that type I patients required more hemodialysis sessions than type II patients (P = 0.035), align with our results. Another study also found that type II patients needed more hemodialysis sessions than type III patients (P = 0.01), which is consistent with our observations.[14]

Skin rash was significantly more common in immune complex-mediated RPGN than in type I and type III, which is consistent with findings from Parry et al. and Mohamed et al., who reported that skin rash was more prevalent in type II compared to type III and type I RPGN. [1, 13] Hemoptysis, on the other hand, was notably more common in anti-GBM disease than in type II or type III RPGN. This contrasts with a study that found hemoptysis to be more frequent in type III than in type II and type I RPGN. [1]

Although the average hemoglobin (Hb) levels were lower across all RPGN groups, there was no significant variation in Hb levels among the groups, which aligns with previous studies. [13-14] However, Wu et al. found that patients with type II RPGN had less severe anemia compared to those with type I or type III, which contradicts our findings. [7]

In our study, serum albumin levels were significantly lower in the type II and type III groups compared to the type I group, with type III also having lower albumin levels than type II. Both type II and type III had higher levels of proteinuria compared to type I. These results are consistent with the study by Parry et al., which found that type II crescentic GN had the highest mean proteinuria (P < 0.001) and the lowest mean serum albumin (P = 0.006) [13]. Wu et al.'s findings, which reported lower proteinuria levels in type III patients, are also in line with our results. [7] However, our findings contrast with Wu et al., who observed no significant differences in albumin levels between the groups. [7]

Consistent with previous studies, our current investigation found no significant differences in the percentages of glomeruli with cellular and fibrous crescents across the RPGN groups. [6-7] However, Parry et al. reported conflicting results, finding crescents in 75.1 ± 18.3 percent of glomeruli, with type I RPGN showing the highest percentage (87 ± 15.2, P = 0.04). Additionally, Parry et al. observed that fibrocellular crescents were the most common type in all three RPGN groups. [13]

Endocapillary proliferation was present in all patients with type II RPGN and in two patients with type III RPGN, but it was not observed in anti-GBM disease. Mesangial proliferation was seen in 53.8 % of those with immune complex-mediated RPGN. It was also found in 40% of patients with pauci-immune RPGN. Parry et al. reported similar findings, showing that most type II RPGN patients had mesangial proliferation (69.4%, P < 0.001) and endocapillary proliferation (97.2%, P < 0.001) [1].

Our findings showed that two patients with type I RPGN (10%) and seven patients with type III RPGN (21.1%) had glomerular thrombosis, while no patients with type II RPGN exhibited this condition. In contrast, Mohamed et al. reported that three patients with type II RPGN had glomerular thrombosis, but none of the patients with type I or type III RPGN had it. [1]

We found that 1(16.6%),8(30.7%), 10( 100%) ) and 3(100%) patients with type I, type II, type III and type IV RPGN, respectively, had fibrinoid necrosis. In contrast, Gupta et al. reported fibrinoid necrosis in 54.5%, 23%, and 29% of patients with type I, type II, and type III RPGN, respectively. This differs from the findings of Nagaraju et al., who found no arterial fibrinoid necrosis in RPGN patients.[5]

Complement activation is responsible for the active lesions seen in RPGN, including glomerular leukocytic infiltrates, vascular fibrinoid necrosis, endothelial and mesangial cell proliferation, intravascular neutrophil karyorrhexis or NETosis, immunothrombosis and fibrin deposition, and cellular crescents. ANCA (anti-neutrophil cytoplasmic antibodies) is implicated in 50–80% of cases, targeting either proteinase 3 (PR3), myeloperoxidase (MPO), or both. While the precise mechanism behind ANCA development is not fully understood, autoantibodies are known to activate neutrophils, leading to damage of the glomerular capillary wall. Both systemic and local complement activation occur via different pathways. Furthermore, cytokines like TNF-α play a crucial role in the pathophysiology. Anti-plasminogen and plasminogen activator autoantibodies can impair fibrinolysis, increasing the risk of thrombophilia and fibrinoid necrosis. [15]

End stage renal disease was the most common primary outcome in our study. Of the 45 patients, 12 (26.67%) died during follow-up, and 17 (37.77%) developed ESRD. Twelve patients (26.67%) experienced partial remission, and 5 patients (11.11%) achieved complete remission. Similar findings were reported by Nagaraju et al., who found that 8 of 29 patients (27.6%) died, 30% required continuous hemodialysis due to ESRD, and 34.5% achieved complete or partial remission by the end of the observation period.[5]Rampelli et al. reported that 18.9% of patients died, while 48.6% developed ESRD, which is similar to our results.[11] Sharma et al.'s study also reported comparable findings, with complete and partial remission seen in 12.5% and 22.5% of patients, respectively, and 10 patients dying during follow-up.[2] Erdogmus et al. found that by the end of a 30-month follow-up period, 34% of patients had progressed to ESRD and 13.5% had died.[16] Similar results were observed by Alsuheili et al.[17]

We further separated the patients into following outcomes; complete remission, partial remission, end stage renal disease and death . It was observed that the ESRD group experienced a marked rise in serum creatinine levels at admission, oedema, HTN, oliguria, the need for HD at presentation, and proteinuria. The ESRD group had significantly lower levels of serum albumin and hemoglobin. Sclerotic glomeruli and fibrous crescents were substantially more common in ESRD patients, while cellular crescents were less common.

In Nagaraju et al.'s study, univariate regression analysis identified oliguria, the need for hemodialysis at presentation, and elevated serum creatinine at admission as the primary risk factors for death and renal loss. In contrast to our findings, their results were not influenced by histopathological features such as IFTA or the presence of fibrous/fibrocellular crescents. [5] In Eksin et al.'s study, univariate regression showed that both serum creatinine (P = 0.019) and the requirement for dialysis at the time of diagnosis (P = 0.018) were significant predictors of renal loss.[14] Another study found that a serum creatinine level of ≥3.5 mg/dl and an IFTA score greater than 25% were risk factors for end-stage renal disease.

Mohamed et al.'s study found that univariate logistic regression identified IFTA (P < 0.001), mesangial proliferation (P = 0.01), oliguria (P < 0.001), serum creatinine at presentation (P < 0.001), and the percentage of crescents (P < 0.001) as predictors of ESRD. Multivariate regression revealed that oliguria (P = 0.001), IFTA (P < 0.001), and the percentage of crescents (P = 0.01) were significant ESRD predictors. [1, 3]

In our study, all patients were treated with cyclophosphamide as induction agent. Cyclophosphamide use was found to be an independent predictor of both renal and patient survival in a survival analysis by Lee et al. [21] Furthermore, the positive effect of cyclophosphamide on patient survival is consistent with findings from previous studies. [22-23] In a study by Ishikawa et al., 8.5% of patients in the rituximab group had poor renal outcomes, compared to only 2.4% in the cyclophosphamide group (P < 0.01). [24] Our findings support these results.

**TABLES:**

**Table 1: Demographic and clinical characteristics of the studied RPGN patients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables (%)** | **Type I RPGN*****n* = 6** | **Type II RPGN*****n* = 26** | **Type III RPGN*****n* = 10** | **Type IV RPGN*****n* = 3** |
|
| Age (years) | 33 ±13 | 28 ±10.75 | 58 ±10.10 | 65+1.7 |
| Edema (%) | 2 (33.33%) | 15 (57.69%) | 6 (60.00%) | 0 |
| Microscopic hematuria (%) | 3 (50%) | 22 (84.61%) | 8 (80.00%) | 2 (66.67%) |
| Macroscopic hematuria (%) | 3 (50%) | 4 (15.38%) | 2 (20.00%) | 1 (33.33%) |
| Oliguria (%) | 4 (66.67%) | 16 (61.53%) | 6 (60.00%) | 0 |
| Fever (%) | 1 (16.67%) | 9 (34.61%) | 1 (10.00%) | 0 |
| Skin rash (%) | 1 (16.67%) | 16 (61.53%) | 1 (10.00%) | 1 (33.33%) |
| Serum creatinine at presentation (mg/dL) | 5.32 ±4 | 5.10 ±3.65 | 2.72 ±2.6 | 2.5+0.9 |
| GFR at presentation (ml/min/1.732) | 10.1 ±10 | 13.2 ±18.75 | 20.04 ±14 | 22.1+11.2 |
| Hb (gm/dL) | 8.3 ±1.6 | 8.85 ±1.35 | 8.9 ±2 | 9.2+1.8 |
| Serum albumin (gm/dL) | 3 ±0.2 | 1.9 ±0.4 | 2.1 ±1.0 | 1.5+0.6 |
| Proteinuria (gm/day) | 2.8 ±0.8 | 5.1 ±2.1 | 4.8 ±1.15 | 3.3+1.8 |

**Table 2: Immunological & Histological characteristics of RPGN Patients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables (Mean ± SD)** | **Type I RPGN*****n* = 6** | **Type II RPGN*****n* = 26** | **Type III RPGN*****n* = 10** | **Type IV RPGN*****n*=3** |
|
| Total number of glomeruli | 20 ±4 | 20 ±6.75 | 17 ±8 | 16 ±7.1 |
| Number of normal glomeruli | 3.0 ±1 | 4 ±3 | 4 ±2 | 4.5 ±2.1 |
| Number of sclerotic glomeruli | 7 ±6 | 4 ±4 | 3 ±6 | 3 ±4.8 |
| Number of crescentic glomeruli | 11.5 ±4 | 11 ±3 | 12 ±5.5 | 12 ±4.5 |
| Number of fibrous crescents | 3 ±2 | 2.5 ±1.75 | 2 ±3 | 1.8 ±3 |
| Number of cellular crescents | 8.5 ±3 | 9 ±4.75 | 8 ±6 | 7.75 ±6 |
| Low C3 (%) | 1 (16.7%) | 19 (73.07%) | 0 (0%) | 0 (0%) |
| Low C4 (%) | 0 (0%) | 18 (69.2%) | 0 (0%) | 0 (0%) |
| Positive ANA (%) | 0 (0%) | 18 (69.2%) | 0 (0%) | 0 (0%) |
| Positive Anti dsDNA (%) | 0 (0%) | 18 (69.2%) | 0 (0%) | 0 (0%) |
| Positive Anti GBM Ab (%) | 5 (83.3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Positive P-ANCA (%) | 0 (0%) | 0 (0%) | 5 (50%) | 1 (33.3%) |
| Positive C-ANCA (%) | 0 (0%) | 0 (0%) | 3 (30%) | 1 (33.3%) |

**Table 3: Histological characteristics & treatment of RPGN Patients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables (Mean ± SD)** | **Type I RPGN*****n* = 6** | **Type II RPGN*****n* = 26** | **Type III RPGN*****n* = 10** | **Type IV RPGN*****n*=3** |
|
| **Glomerular lesions (%)** |
| * Mesangial proliferation (%)
 | 1 (16.6%) | 14 (53.8%) | 4 (40%) | 0(0%) |
| * Neutrophilic infiltration (%)
 | 1 (16.6%) | 3 (15.3%) | 2 (20%) | 0(0%) |
| * Glomerular thrombosis (%)
 | 2 (10%) | 0 (0%) | 7 (21.1%) | 0 (%) |
| * Endocapillary proliferation (%)
 | 0 (0%) | 26 (100%) | 2 (20%) | 0 (0%) |
| * Moderate to severe IFTA (%)
 | 2 (33.3%) | 13(50%) | 5 (50%) | 0 (0%) |
| * TLO formation (%)
 | 3 (50%) | 12 (46.1%) | 5 (50%) | 0 (0%) |
| **Vascular lesions** |
| * Fibrinoid necrosis (%)
 | 1 (16.6 %) | 8 (30.7%) | 10 (100 %) | 3 (100%) |
| * Degree of severe arteriosclerosis
 | 2 (33.3%) | 14 (53.8%) | 4 (40%) | 2 (66.6%) |
| **Treatment** |
| * Steroid, CYC as induction then

steroid, AZA as maintenance |  |  | 9(90%) | 2(66.6%) |
| * Steroid, rituximab
 |  | 15 (57.6%) |  |  |
| * Steroid, CYC, plasmapheresis as induction then steroid, AZA as maintenance
 |  |  | 4(40%) | 3(100%) |

**Table 4: Primary and secondary outcomes in the studied RPGN patients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **Total patients*****n = 45*** | **Type I RPGN*****n* = 6** | **Type II RPGN*****n* = 26** | **Type III RPGN*****n* = 10** | **Type IV RPGN*****n*=3** |
| **Primary outcomes** |
| Non ESRD | 16 (35.55%) | 1 (16.66%) | 10 (38.46%) | 2 (20.00%) | 0 |
| ESRD | 17 (37.77%) | 3 (50%) | 10 (38.46%) | 2 (20.00%) | 2 (66.67%) |
| Death | 12 (26.67%) | 2 (33.33%) | 4 (15.38%) | 5 (50%) | 1 (33.33%) |
| Partial remission | 12 (26.67%) | 3 (50%) | 6 (23.07) | 3 (30%) | 0 |
| Complete remission | 5 (11.11%) | 0 (0%) | 3 (11.53%) | 2 (20%) | 0 |

**LIMITATIONS**

Our study did not provide specific data on the prognosis of patients with RPGN. Additionally, the need for prospective multicenter studies, incorporation of socio-demographic data, use of multivariate analysis to identify independent risk factors, and long-term follow-up to assess treatment efficacy across RPGN subtypes.

**CONCLUSION**

This study provides valuable insights into the spectrum of RPGN diseases. The immunological and histological characteristics of RPGN are crucial for understanding the underlying pathophysiology of each subtype. Differentiating between these subtypes based on these markers can guide clinicians in selecting the most appropriate treatment strategies, ultimately improving patient outcomes in this life-threatening condition. The most common types of RPGN were type II, followed by type III, type I, and type IV. Patients with RPGN exhibit a range of clinical characteristics. ESRD, affecting 37.77% of patients, was the primary outcome, and 12 patients (26.67%) died during follow-up. Additionally, 12 patients (26.67%) achieved partial remission, while 5 (11.11%) experienced complete remission. Hence to conclude, To improve outcomes in a patient with a rapidly progressive glomerulonephritis presentation, early referral to a nephrologist for prompt diagnosis and treatment is crucial for both renal and patient survival.

**CONSENT**

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

**ETHICAL APPROVAL**

As per international standards or university standards written ethical approval has been collected and preserved by the author(s)

**Disclaimer (Artificial intelligence)**

**Option 1:**

**Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.**

**Option 2:**

**Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology**

**Details of the AI usage are given below:**

**1.**

**2.**

**3.**

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