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Original Article

Pattern of Urinary Angiostatin Level in Different Class of Lupus Nephritis

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ABSTRACT

Background: Lupus nephritis (LN) is a serious complication of systemic lupus erythematosus (SLE). Renal biopsy is invasive and associated with complications. So there is a critical need for reliable non-invasive biomarkers that can be used as supportive tool for assessment of histological class of LN. Aim of the study: This study aimed to see pattern of urinary Angiostatin level in different class of lupus nephritis. **Methods & Materials**: A total of 49 adult SLE with new biopsy proven class II, class III, class IV, class V and class VI lupus nephritis patients before receiving immunosuppressive therapy were enrolled into study from June 2023-November 2024. Relevant clinical (SLE score), laboratory test (CBC, CRP, S. Creatinine, U.R/M/E, 24 Hours UTP) and serological tests (ANA, Anti-dsDNA, C3 and C4) were done. Activity and chronicity index score were determined by renal biopsy. Urinary Angiostatin assay was done by using human urinary Angiostatin ELISA Kit. **Result**: LN histology classes were II (n=8, 16.3%), III (n= 15, 30.6%), IV(n= 17, 34.7%), V(n=5,10.2%) and VI(n=4,8.2%). Urinary Angiostatin level was 1.90±0.77 ng/ml, 14.33±2.66 ng/ml, 16.0±2.78 ng/ml, 2.92±2.28 ng/ml and 2.88±0.63 ng/ml in class II, III, IV,V and VI respectively (P value < 0.001). Class III and class IV had higher urinary Angiostatin level than other classes of lupus nephritis. Urinary angiostatin levels correlated positively with SLE score (r=+0.938), AntidsDNA (r = + 0.968), serum creatinine (r=+0.38), activity index (r=+0.957) and correlated negatively with C3(r = -0.914), C4(r = -0.761) and eGFR (r=- 0.74). **Conclusion**: Urinary Angiostatin level was significantly elevated in class III and class IV than other classes of lupus nephritis. It was also elevated in those patients who had higher histological activity, but not in those who had higher chronicity.

Keywords: *Lupus nephritis; Urinary angiostatin; Systemic lupus erythematosus; Renal biopsy; Histological class*

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INTRODUCTION

Systemic lupus erythematosus (SLE) is a chronic autoimmune disease characterized by the production of autoantibodies and the deposition of immune complexes, affecting a wide range of organs [1]. Among the various clinical manifestations of SLE, renal involvement is one of the most important causes of morbidity and mortality [2]. Approximately 35% of adults show signs of lupus nephritis at the time of SLE diagnosis, and 50-60% will develop lupus nephritis (LN) during the first 10 years of disease [3]. Despite treatment advances, up to 26% of patients with lupus nephritis still develop end-stage renal disease (ESRD), and the life expectancy of patients with SLE who have renal disease and renal damage is reduced by 15.1 years and 23.7 years, respectively. Lupus nephritis is also more prevalent and more severe in certain ethnic groups, such as African American, Hispanic, and Asian populations [4]. The role of the renal biopsy in diagnosis, treatment, management, and follow-up of lupus nephritis (LN) is critical. Renal biopsy represents the gold standard in management of LN [5]. Lupus nephritis is extremely pleomorphic [6]. The formation of angiostatin from plasmin is a two-step process. First, one or more disulfide bonds in plasmin are reduced by a protein disulfide bond reductase, called plasmin reductase, and a reductase cofactor. Second, reduced plasmin is cleaved by a serine proteinase, producing angiostatin [7]. Kidney biopsy is an invasive, costly, risky procedure, not applicable for all cases as a routine tool for follow-up of disease flare, and lacks the capability to predict patients that will respond well to immunosuppressive drugs. In addition to these, kidney biopsy can be accompanied by significant morbidity and mortality; therefore, it is not usually performed serially [8]. Because of this, several studies focusing on screening and identifying non-invasive biomarkers for early diagnosis and monitoring of SLE and LN are emerging [9]. Previous analyses have documented elevated levels of urinary angiostatin in SLE patients, particularly those with diffuse proliferative or class III and class IV LN [10]. Systemic lupus erythematosus (SLE) is a chronic autoimmune disorder that can progressively involve multiple organ systems. Lupus Nephritis (LN) is a common and critical consequence of Systemic Lupus Erythematosus (SLE), with significant morbidity and mortality. Renal biopsy is still the gold standard for diagnosis and histological classification of LN. For this, repeat renal biopsy is necessary. But it is invasive; in some cases, it is contraindicated. There is some evidence of association of urinary angiostatin levels with histological classes and degree of inflammation in LN. Therefore, this study was undertaken to see the pattern of urinary angiostatin in different classes of lupus nephritis. The study aimed to evaluate the pattern of urinary angiostatin levels across different histological classes of lupus nephritis by measuring urinary angiostatin concentrations and correlating them with renal biopsy-based histological classification.

METHODS & MATERIALS

This cross-sectional study was conducted in the Department of Nephrology, Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh, over a period of 18 months from June 2023 to November 2024. The study included patients with systemic

lupus erythematosus (SLE) who had newly biopsy-proven lupus nephritis prior to receiving immunosuppressive therapy. A purposive sampling technique was employed to recruit eligible participants, and a total of 49 patients were enrolled based on predefined selection criteria, forming the study cohort.

Inclusion Criteria

- SLE with new biopsy proven lupus nephritis patients before receiving immunosuppressive therapy.

Exclusion Criteria

- Patients age less than 18 years
- Suffering from other autoimmune disease such as rheumatoid arthritis, systemic sclerosis, mixed connective tissue disease.
- Hyperthyroidism
- Active malignancy
- Pregnancy
- Active infection (urinary tract or systemic infection)
- Chronic liver disease.

Data Collection

Data were systematically collected using a structured and validated questionnaire following informed written consent from each participant. Demographic information, including age and sex, and clinical characteristics such as body mass index (BMI) and Systemic Lupus Erythematosus Disease Activity Index (SLEDAI) score were recorded. Laboratory investigations included urinary angiostatin, 24-hour urinary total protein, antinuclear antibody (ANA), anti-double-stranded DNA (anti-dsDNA), serum complement C3 and C4, serum creatinine, serum albumin, complete blood count, urine routine and microscopic examination, urine culture and sensitivity, C-reactive protein (CRP), ENA profile, thyroid function tests, liver function tests, coagulation profile, viral serology, ultrasonography of the whole abdomen, and chest radiography. Renal biopsy specimens were examined by light microscopy and direct immunofluorescence, and lupus nephritis was classified according to the International Society of Nephrology/Renal Pathology Society (ISN/RPS) classification. Histopathological parameters, including histological class, activity index, and chronicity index, were documented. Morning mid-stream urine samples were collected before treatment initiation, and urinary angiostatin levels were measured using a commercially available Human Angiostatin ELISA kit following the manufacturer's protocol. Ethical approval was obtained from the Institutional Review Board (IRB) of Dhaka Medical College, and all procedures were performed in accordance with institutional ethical standards.

Statistical Analysis

Statistical analyses were performed using SPSS software (version 26.0). Continuous variables were expressed as mean±standard deviation (SD), whereas categorical variables were summarized as frequencies and percentages. Differences in continuous variables among histological classes were assessed using one-way analysis of variance (ANOVA), while categorical variables were compared using the Chi-square test. Pearson's correlation analysis was performed to evaluate the association between urinary angiostatin levels and relevant laboratory parameters. A p-value of <0.05 was considered statistically significant.

RESULT

A total of 49 patients with biopsy-proven lupus nephritis were included in the study. Histologically, Class IV lupus nephritis was the most prevalent subtype, accounting for 17 (34.7%) patients, followed by Class III in 15 (30.6%), Class II in 8 (16.3%), Class V in 5 (10.2%), and Class VI in 4 (8.2%) patients (*Table I*).

Table I

Distribution of the study subjects according to histological class of lupus nephritis (*n*=49).

Histological class	Frequency (n)	Percentage (%)
II	8	16.3
III	15	30.6
IV	17	34.7
V	5	10.2
VI	4	8.2

The mean age differed significantly among the histological classes (p=0.022), with patients in Class V being the oldest (32.60±5.98 years). Female predominance was observed across all classes (75.0%–100%, p<0.001). Disease duration varied significantly, ranging from 6.45±1.15 months in Class II to 16.33±3.29 months in Class VI (p=0.001). Renal function markers also differed significantly among the classes. Serum creatinine was highest in Class VI (6.85±2.54 mg/dL) and lowest in Class II (0.71±0.18 mg/dL) (p<0.001), while eGFR was highest in Class II (117.13±19.75 mL/min) and lowest in Class VI (9.75±5.56 mL/min) (p<0.001). Complement levels (C3 and C4), anti-dsDNA positivity, SLEDAI score, activity score, and chronicity score all demonstrated statistically significant differences across histological classes (all p<0.001) (*Table II*).

Table II
Baseline Demographic, Clinical, Laboratory, and Histopathological Characteristics of Patients According to Lupus Nephritis ISN/RPS Histological Class (*n*=49).

Parameters	Class II (n=8) n(%)	Class III (n=15) n(%)	Class IV (n=17) n(%)	Class V (n=5) n(%)	Class VI (n=4) n(%)	p-value
Age (year) (Mean±SD)	24.50±5.45	22.47±4.16	23.47±5.86	32.60±5.98	25.00±9.45	0.022
Gender						
Male	1 (12.5)	1 (6.7)	2 (11.76)	0 (0.0)	1 (25.0)	<0.001
Female	7 (87.5)	14 (93.3)	15(88.24)	5 (100)	3 (75.0)	
BMI (Kg/m2) (Mean±SD)	22.06±1.43	22.87±2.32	22.96±1.61	21.70±2.71	24.03±0.79	0.355
Disease duration (months) (Mean±SD)	6.45±1.15	10.06±2.71	10.55±1.98	10.20±2.54	16.33±3.29	0.001
S. creatinine (mg/dL) (Mean±SD)	0.71±0.18	3.16±1.43	3.53±1.22	0.83±0.37	6.85±2.54	<0.001
eGFR (ml/min) (Mean±SD)	117.13±19.75	27.67±18.38	21.53±10.01	104.40±33.11	9.75±5.56	<0.001
24h UTP (gm)	0.69±0.095	1.37±0.54	1.45±0.95	4.27±2.47	0.57±0.35	0.265
C3 (g/L) (Mean±SD)	1.07±0.09	0.51±0.21	0.38±0.16	1.01±0.13	1.01±0.11	<0.001
C4 (g/L) (Mean±SD)	0.43±0.16	0.04±0.03	0.03±0.02	0.32±0.31	0.24±0.14	<0.001
Anti-dsDNA						
Positive	7 (87.5)	12(80)	16(94.12)	3(60.0)	2 (50.0)	<0.001
Negative	1 (12.5)	3 (20)	1 (5.88)	2(40.0)	2 (50.0)	
SLE score/SLEDAI (Mean±SD)	7.75±1.16	19.20±3.73	20.88±2.83	7.60±0.89	6.25±1.26	<0.001
Activity Score (Mean±SD)	1.38±0.74	11.13±2.72	12.35±1.94	1.0±0.71	3.0±0.82	<0.001
Chronicity Score (Mean±SD)	2.38±1.30	1.67±0.72	1.18±0.64	2.60±0.55	7.25±0.50	<0.001

Urinary angiostatin levels differed significantly among histological classes (p<0.001), with the highest concentrations observed in Class IV (16.0±2.78 ng/mL), followed by Class III (14.33±2.66 ng/mL), whereas substantially lower levels were found in Classes II (1.90±0.77 ng/mL), V (2.92±2.28 ng/mL), and VI (2.88±0.63 ng/mL). Urinary angiostatin levels also increased significantly with stronger ANA reactivity (p<0.001) and greater activity index severity (p<0.001). Although patients with moderate proteinuria (1–3.5 g/day) exhibited the highest urinary angiostatin levels (15.67±3.93 ng/mL), differences according to 24-hour urinary protein categories were not statistically significant (p=0.128) (*Table III*).

Table III
Comparison of Urinary Angiostatin Levels According to Histological Class, Proteinuria, ANA Reactivity, Activity Index, and Chronicity Index in Patients with Lupus Nephritis (*n*=49).

Variables	Urinary Angiostatin (ng/mL) (Mean±SD)	p-value
Histological class		
II (n=8)	1.90±0.77 α	<0.001s
III (n=15)	14.33±2.66 β	
IV (n=17)	16.0±2.78 γ	
V (n=5)	2.92±2.28 σ	
VI (n=4)	2.88±0.63 μ	
24-h UTP		
<1 gm (n=14)	2.09±0.73	0.128
1-3.5 gm (n=24)	15.67±3.93	
>3.5 gm (n= 11)	7.67 ±3.10	
ANA		
Weak (n=13)	2.12±0.78α	<0.001s
Moderate (n=12)	10.14±5.37β	
Strong (n=24)	15.79±2.84γ	
Activity index		
Mild (0-5, n=17)	2.43±1.38 α	<0.001s
Moderate (6-11, n=15)	13.07±1.94 β	
Severe (12-24, n=17)	17.12±1.97 γ	
Chronicity index		
Mild (0-2) (n=28)	13.37± 5.49	0.09
Moderate (3-5)(n=15)	4.87 ± 5.09	
Severe (6-12)(n=6)	2.88 ± 0.63	

Correlation analysis revealed that urinary angiostatin was strongly and positively correlated with SLEDAI score (r=0.938, p<0.001) and anti-dsDNA positivity (r=0.968, p<0.001). Significant negative correlations were observed with serum complement C3 (r=-0.914, p<0.001), C4 (r=-0.761, p<0.001), and eGFR (r=-0.740, p<0.001). A moderate positive correlation was identified between urinary angiostatin and serum creatinine (r=0.380, p=0.008) (*Table IV*).

Table IV
Correlation of Urinary Angiostatin with clinical score, 24h- UTP, serological investigations and renal function test (*n*=49).

Variable	r	p-value
SLEDAI	0.938	<0.001
24-hour UTP	0.197	0.117
Anti-dsDNA	0.968	<0.001s
C3	-0.914	<0.001s
C4	-0.761	<0.001s
Serum creatinine	0.38	0.008s
eGFR	-0.74	<0.001s

In *Figure 1*, Pearson correlation model shows that urinary angiostatin had strong positive significant linear correlation with total activity index score (r = +0.957, p value <0.001).

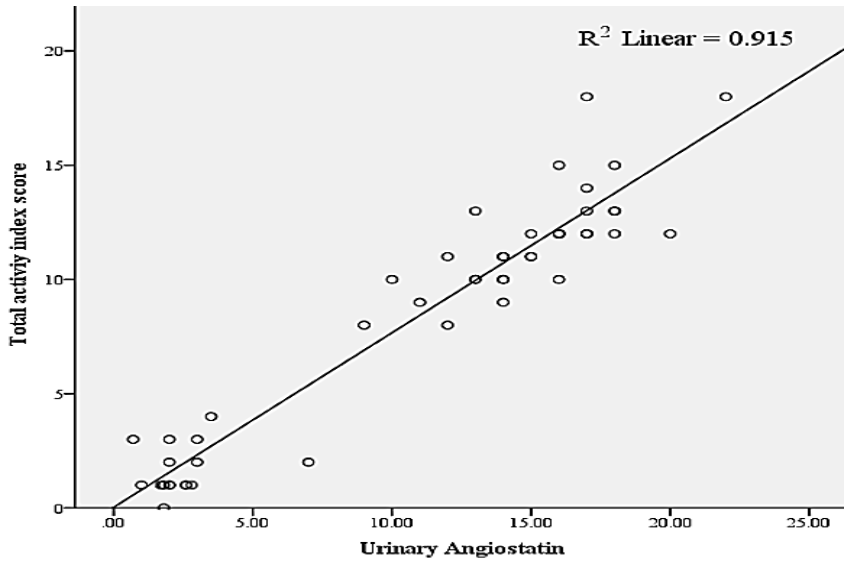

Figure 1 Scatter plot diagram showing correlation between total activity index score and urinary angiostatin (*n*=49).

In *Figure 2*, Pearson correlation model shows that urinary angiostatin had moderate negative non-significant linear correlation with total chronicity index score (r = - 0.546, p value =0.058).

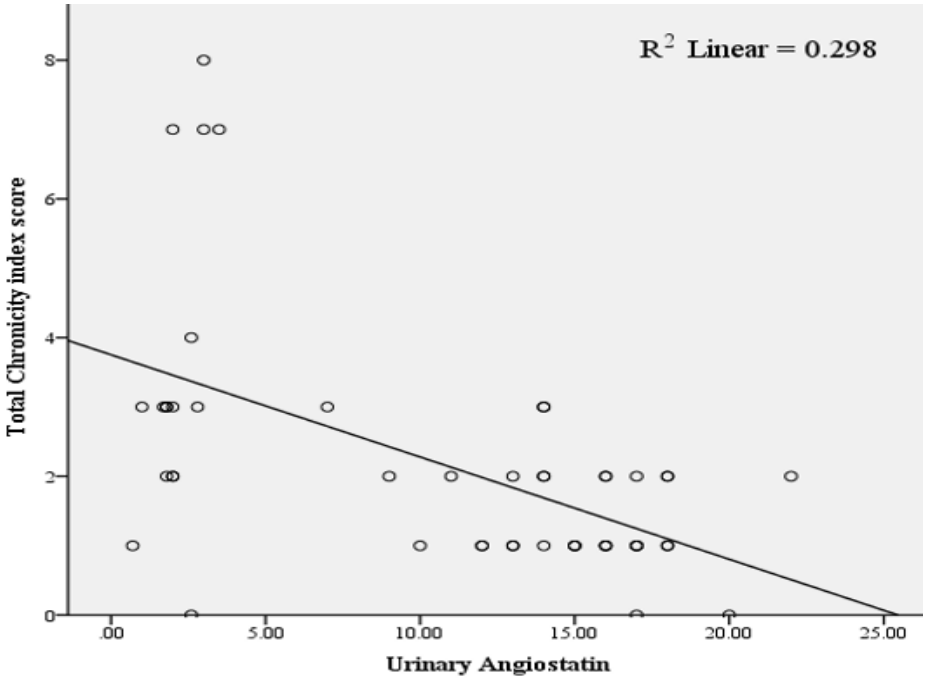

Figure 2 Scatter plot diagram showing correlation between total chronicity index score and urinary angiostatin (*n*=49).

DISCUSSION

Lupus nephritis (LN) is one of the most serious complications of systemic lupus erythematosus (SLE), contributing substantially to morbidity and mortality [11]. Urinary angiostatin has recently emerged as a promising non-invasive biomarker that correlates with renal involvement and histopathological severity [12]. In this study, most participants were in the third decade of life, and the majority were female. Elevated estrogen levels influence immune regulation by altering T-cell signaling pathways, particularly the interferon-α pathway [13]. The present study demonstrated that class IV lupus nephritis was the most frequent histological class, followed by class III. This distribution can be explained by the fact that class III and IV lupus nephritis account for approximately 70-80% of LN cases, and their frequency may vary depending on study population, classification criteria, and timing of diagnosis [14]. SLEDAI scores were higher in class III and class IV lupus nephritis, comparable with Mok et al. (2018) [4]. Similarly, mean anti-dsDNA levels were higher in class III and IV than in other histological classes, which is consistent with Fava et al. (2024) [15]. Mean serum C3 and C4 levels were lower in class III and IV lupus nephritis than in other classes. This reduction is likely due to increased immune complex deposition and complement activation, resulting in greater consumption of complement proteins in proliferative lupus nephritis [16]. Renal function deteriorated significantly in class VI, followed by class III and IV lupus nephritis. This finding reflects extensive glomerular sclerosis and chronic irreversible renal injury associated with advanced disease [17]. The present study demonstrated significantly higher histological activity scores in class IV and class III lupus nephritis. Similar findings were reported by Mok et al. (2018) and Chi et al. (2015). The increase in activity score from class II to class IV and its decline in class V and VI probably reflects variation in disease severity across histological classes [4,18]. The higher activity in class III and IV is attributable to the greater number of active inflammatory lesions present in proliferative lupus nephritis [19]. The chronicity score was highest in class VI, followed by class IV. Extensive glomerulosclerosis in class VI and persistent immune-mediated renal injury in class III and IV contribute to higher chronicity scores [20,21]. Urinary angiostatin levels were significantly higher in class III and IV lupus nephritis than in class II, V, and VI (p=0.001). This finding is consistent with El-Sayed et al. (2021), supporting the role of urinary angiostatin as a potential surrogate biomarker for identifying proliferative lupus nephritis, particularly class III and IV [22]. There was a negligible positive correlation between urinary angiostatin and 24-hour urinary total protein (24 h UTP), although the association was not statistically significant. This finding contrasts with Soliman et al. (2017), who reported a significant positive correlation between urinary angiostatin and proteinuria [23]. Urinary angiostatin showed a positive correlation with SLEDAI score. Similarly, urinary angiostatin correlated positively with anti-dsDNA levels and negatively with serum C3 and C4 levels, in agreement with El-Sayed et al. (2021) [22]. A significant negative correlation was also observed between urinary angiostatin and estimated glomerular filtration rate (eGFR), which is comparable with the findings of Wu et al. (2013) [24]. Urinary angiostatin levels increased significantly with increasing histological activity, with the highest levels observed in patients with severe activity scores (12-24). This finding is consistent with Soliman et al. (2017) and indicates that urinary angiostatin reflects active renal inflammation [23]. In contrast, urinary angiostatin levels decreased with increasing histological chronicity, with the lowest levels observed in patients with severe chronicity scores (6-12). However, the difference was not statistically significant, suggesting that urinary angiostatin is less useful for assessing chronic irreversible renal damage, which is comparable with Mok et al. (2018) and Soliman et al. (2017) [4,23]. Pearson correlation analysis demonstrated a strong positive correlation between urinary angiostatin and the overall histological activity index ($r=0.957$, $p<0.001$). In the case of active inflammation of the glomerulus, the precursor of angiostatin, plasminogen, is increased, and it is converted into angiostatin by matrix metalloproteinases [25,26]. No significant correlation was observed between urinary angiostatin and the overall chronicity index. This finding differs from the observations of Wu et al. (2013) and Elsayed et al. (2021), who reported a significant positive correlation between urinary angiostatin and chronicity index [22,24]. The findings of the present study suggest that urinary angiostatin is closely associated with proliferative lupus nephritis, particularly class III and class IV, and correlates strongly with disease activity rather than chronic renal damage. Therefore, urinary angiostatin may serve as a useful supportive non-invasive biomarker for assessing histological class and disease activity, potentially aiding clinicians in early identification of active lupus nephritis and timely treatment decisions.

LIMITATIONS

- Lack of longitudinal follow-up limits the ability to determine whether urinary angiostatin can predict long-term renal outcomes or treatment responses.
- The study did not evaluate the potential influence of medications or other comorbidities on urinary angiostatin levels.
- Angiostatin levels were measured in isolation, without comparison to other established biomarkers of lupus nephritis activity or damage.

CONCLUSION

This study highlights urinary angiostatin as a promising non-invasive biomarker for lupus nephritis (LN). The findings demonstrate higher urinary angiostatin levels were found in class III and class IV lupus nephritis than other classes. It was also raised in those patients who had histologically active disease, but not in chronic disease.

RECOMMENDATIONS

- Integration into clinical practice: Urinary Angiostatin should be explored further as a non-invasive marker for LN monitoring and treatment response assessment.
- Longitudinal studies: Future research should investigate urinary Angiostatin's role in predicting LN progression and treatment outcomes.

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CONFLICT OF INTEREST

None declared

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

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