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URINARY ANGIOSTATIN AS AN INDICATOR OF LUPUS NEPHRITIS

By

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ABSTRACT

Background: Systemic lupus erythematosus (SLE) is a chronic autoimmune disease with multi-organ involvement; among which kidney is one of the most commonly affected organs. Approximately, 35% of adults show signs of lupus nephritis (LN) at the time of SLE diagnosis and 50–60% will develop LN during the first 10 years of disease. LN remains the major cause of morbidity and mortality in SLE patients, either as a result of renal failure or secondary to the side effect of aggressive immunosuppressive therapies.

Objective: To early diagnose lupus nephritis, and predict its outcome by assessing urinary level angiostatin.

Patients and methods: This was a cross sectional study on 65 patients at the Nephrology Unit of Internal Medicine Department at Al-Hussein University Hospital and Armed forces hospitals between April 2019 and October 2019. Patients in this study were classified into three groups: Group (A): twenty patients clinically active renal systemic lupus erythematosus, Group (B): twenty patients non-active renal systemic lupus erythematosus and Group (C): 25 healthy subjects as a controls.

Results: There was a statistically significant difference in urinary angiostatin with p value 0.0001, in addition the linear regression model that showed significant correlation with ISN/RPS, SLEDAI score, and number of organ damaged with a p value < 0.05.

Conclusion: Urinary angiotensin can be used as non-invasive method for determination of renal damage in lupus nephritis.

Keywords: Urinary Angiostatin, Renal Affection, Lupus Nephritis.

INTRODUCTION

Lupus nephritis (LN) remains the major cause of morbidity and mortality in systemic lupus erythematosus (SLE) patients, either as a result of renal failure or secondary to the side effect of aggressive immunosuppressive therapies *(Almaani et al., 2017).* Glomerulonephritis in patients with SLE significantly reduces their quality of life and working ability *(Olesińska and Saletra, 2018).* Current guidelines for LN diagnosis and management depend largely upon renal pathology, which requires renal biopsy *(Giannico and Fogo, 2013).*

Although renal biopsy remains the gold standard for the diagnosis and management of LN, it has several disadvantages. Renal biopsy is invasive, with complications such as bleeding and infection. It is also not feasible to perform renal biopsies repeatedly or serially. Last,

but not least, renal biopsy reflects only existing pathology, but cannot predict imminent renal flare in LN patients *(Ding et al., 2017).*

Conventional biomarkers for LN, including anti double stranded DNA antibodies (dsDNA) and complement components 3 and 4 (C3, C4), are neither sensitive nor specific in reflecting concurrent renal activity or predicting impending renal flare *(Birmingham et al., 2017).*

Urinary biomarkers are attractive candidates for tracking LN activity as they are directly excreted from the kidneys and readily available for examination. However, no biomarkers have been adequately validated for routine clinical use in patients with LN *(Goilav et al., 2015).*

Angiostatin is an endogenous angiogenesis inhibitor produced by autoproteolytic cleavage of plasminogen and has been found to inhibit angiogenesis in cancer through the inhibition of endothelial cell migration, proliferation and induction of apoptosis *(Ribatti, 2011).*

Urinary angiostatin has been shown to be elevated in patients with active SLE, particularly those with diffuse proliferative LN. Urinary angiostatin differentiates patients with active SLE from those with inactive SLE and correlated significantly with SLE activity and the renal pathology chronicity index *(Wu et al., 2013).*

The aim of the present study was to early diagnose lupus nephritis and predict its outcome by assessing urinary level angiostatin.

PATIENTS AND METHODS

This study were a cross sectional study on 65 patients at the Nephrology Unit of Internal Medicine Department, Al-Hussein University Hospital and Armed Forces Hospitals between April 2019 and October 2019.

Patients in this study were classified into three groups: Group (A): twenty patients clinically active renal SLE, **Group (B):** twenty patients non-active renal SLE and **Group (C):** twenty five patients healthy controls.

An approval of the study was obtained from Al- Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

The 1982 American College of Rheumatology (ACR) criteria summarized features necessary to diagnose SLE. These criteria were last updated in 2019. The presence of 4 of the 11 criteria yields a sensitivity of 85% and a specificity of 95% for SLE. Keep in mind that individual features are variably sensitive and specific. Patients with SLE may present with any combination of clinical features and serologic evidence of lupus.

SLE disease activity was assessed by the safety of estrogens in lupus erythematosus national assessment (SELENA) version of the SLEDAI (SELENA–SLEDAI), which is a validated tool to assess lupus activity in the multicenter randomized controlled SELENA trial for the safety of estrogen use in patients with SLE. “Clinically inactive SLE” included patients with total clinical SLEDAI = 0 and no clinical activity in other systems that are not

captured by the SLEDAI. "Active renal SLE" was defined as patients with renal SLEDAI ≥ 4, while "active non-renal SLE" included patients with total clinical SLEDAI ≥1 and/or clinical activity in other systems not captured by the SLEDAI, but excluding patients with "active renal SLE" *(Mikdashi and Nived, 2015).*

The physician's global assessment (PGA) of disease activity of SLE (range 0–3) was also performed by the attending rheumatologists to grade their impression of the patient's disease activity at the time of venipuncture *(Zen et al., 2018)*.

Inclusion criteria: Subjects included in this study are patients with age group 18-65 years old, of both sex, diagnosed with systemic lupus erythematosis according to the 1997 American College of Rheumatology (ACR) classification criteria.

Exclusion criteria:

1. Patients with any systemic infection.
2. Patients had renal disease before diagnosed as lupus.
3. Pregnant ladies.
4. Patients with thyrotoxicosis.

All participants were subjected to the following:

- Full history taking.
- Full clinical examination.
- Routine and specific laboratory investigations including:
    1. CBC.
    2. Kidney function tests.
    3. Urine analysis.
    4. Plasma levels of glucose.
    5. Plasma sodium, potassium, albumin and bilirubin.
    6. Anti-Nuclear Antibody level.
    7. Anti-Double Stranded DNA level.
    8. Renal biopsy.
    9. Urinary Angiostatin protein marker levels were compared in these patient groups and controls.

Statistical analysis:

Our data were analyzed by SPSS program version 2 for the following:

- Compare between the groups as regard urinary Angiostatin.
- Comparison between different stages of lupus nephritis based on urinary Angiostatin.
- Urinary Angiostatin level and titer of immunological and active marker.
- Comparison between all data was involved in linear regression model to assess correlations of urinary Angiostatin as a marker of lupus nephritis.
- Descriptive statistics was presented in Mean, Standard deviation (± SD) and range for parametric numerical data, while Median and Inter-quartile range (IQR) for non-parametric numerical data-Frequency and percentage of non-numerical data. P value < 0.05 was considered significant.

RESULTS

A total of 65 individuals were included in our study. They were divided into 3 groups: SLE patient in active status without renal affection (n = 20), SLE patient in active status (n= 20) with renal affection and healthy control group (n =25). All individuals were subjected to complete laboratory test panel aforementioned, also ISN/RPS, organ damage score, SLEDAI score, activity index and chronicity index were assessed for each patient. Females represented the majority of our sample 75% (n=51), while males were 25% (n=14), ratio 3:1 **(Table 1)**.

Table (1): Demographic criteria and laboratory tests for the sample

	Group						P value
	Control		Active non renal		Active renal		
	Mean	SD	Mean	SD	Mean	SD	
Age (Years)	40.8	12.7	36.8	11.0	31.5	6.6	0.02
Disease duration (Months)	0.0	0.0	3.8	3.3	9.8	4.5	0.0001
Age of Onset (Years)	0.0	0.0	17.3	11.1	21.7	6.7	0.0001
Hb (g/dl)	13.4	1.0	11.4	1.3	11.9	1.5	0.0001
PLT (10^3/CC)	235.0	62.1	244.5	41.2	267.4	69.5	0.18
TLC (10^3/CC)	6.8	1.6	7.2	1.5	6.2	2.0	0.14
Creatinine (mg/dl)	0.8	0.2	0.9	0.1	0.9	0.1	0.45
Na (mmol/dl)	138.7	6.8	136.3	3.5	136.7	5.2	0.28
K (mmol/dl)	4.2	0.4	4.2	0.3	4.2	0.5	0.92
Albumin (g/dl)	4.1	0.3	3.7	0.5	2.9	0.3	0.0001
T. Bilirubin (mg/dl)	0.7	0.2	0.9	0.1	0.8	0.2	0.07
HbA1C (%)	5.4	0.6	5.5	0.9	5.7	1.8	0.67
anti DNA (IU/ml)	19.1	4.4	495.3	442.4	551.2	337.7	0.0001
Urinary Angiotensin (ml/min/1.72 m^2)	0.21	0.05	5.00	8.03	30.80	15.96	0.0001

Comparing between three groups, there was a statistically significant difference in age with p value 0.02 as control individuals were older than the other two groups.

Disease duration was statistically significant longer in active renal group with mean 9.8 years and 3.8 years in active non renal group, as well as HB level was significantly higher in control group followed by active renal group and lowest in active non renal group with p value 0.0001 and 0.0001 respectively.

Serum albumin level was significantly lower in active renal group (2.9 gm/dl) followed by active non renal group then highest in control group with p value 0.0001. In addition, Anti DNA antibodies were significantly higher in active renal group when compared to active non renal group with p value 0.0001. Urinary angiostatin level was significantly higher in active renal group when compared to other 2 groups with p value 0.0001 **(Table 2)**.

Table (2): Components of SLEDAI score

SLEDAI components \ Groups		Group						P value
		Control		Active non renal		Active renal		
		N	%	N	%	N	%	
Vasculitis	No	25	100.0%	18	90.0%	20	100.0%	0.09
	Yes	0	0.0%	2	10.0%	0	0.0%	
Arthritis	No	25	100.0%	18	90.0%	18	90.0%	0.26
	Yes	0	0.0%	2	10.0%	2	10.0%	
Urinary Cast	No	25	100.0%	20	100.0%	16	80.0%	0.008
	Yes	0	0.0%	0	0.0%	4	20.0%	
Proteinuria	No	25	100.0%	18	90.0%	0	0.0%	0.0001
	Yes	0	0.0%	2	10.0%	20	100.0%	
Rash	No	25	100.0%	14	70.0%	16	80.0%	0.02
	Mild	0	0.0%	2	10.0%	0	0.0%	
	Moderate	0	0.0%	2	10.0%	4	20.0%	
	Severe	0	0.0%	2	10.0%	0	0.0%	
Alopecia	No	24	96.0%	9	45.0%	16	80.0%	0.0001
	Yes	1	4.0%	11	55.0%	4	20.0%	
Pleurisy	No	21	84.0%	17	85.0%	17	85.0%	0.99
	Yes	4	16.0%	3	15.0%	3	15.0%	
Pericarditis	No	25	100.0%	18	90.0%	19	95.0%	0.28
	Yes	0	0.0%	2	10.0%	1	5.0%	
Low complement	No	25	100.0%	18	90.0%	10	50.0%	0.0001
	Yes	0	0.0%	2	10.0%	10	50.0%	
Increased DNA	No	24	96.0%	7	35.0%	10	50.0%	0.0001
	Yes	1	4.0%	13	65.0%	10	50.0%	
Leucopenia	No	25	100.0%	20	100.0%	19	95.0%	0.31
	Yes	0	0.0%	0	0.0%	1	5.0%	

There was statistically significant difference in patterns of systemic organ affection as urinary casts, proteinuria and low complement level were more common in active renal group with p value 0.008, 0.0001 and 0.0001 respectively. On the other hand, skin rashes, alopecia, increased DNA were more commonly encountered in active non renal group with p value 0.02, 0.0001 and 0.0001 respectively. SLEDAI score was highest in active renal group compared to active non renal group with p value 0.0001 **(Table 3** & **Figure 1)**.

Table (3): Total SLEDAI score in groups

SLEDAI \ Groups	Control (n=25)	Active non renal (n=25)	Active renal (n=25)	P value
	Mean±SD	Mean±SD	Mean±SD	
Score	0.0±0.0	5.5±3.7	8.5±2.0	0.0001

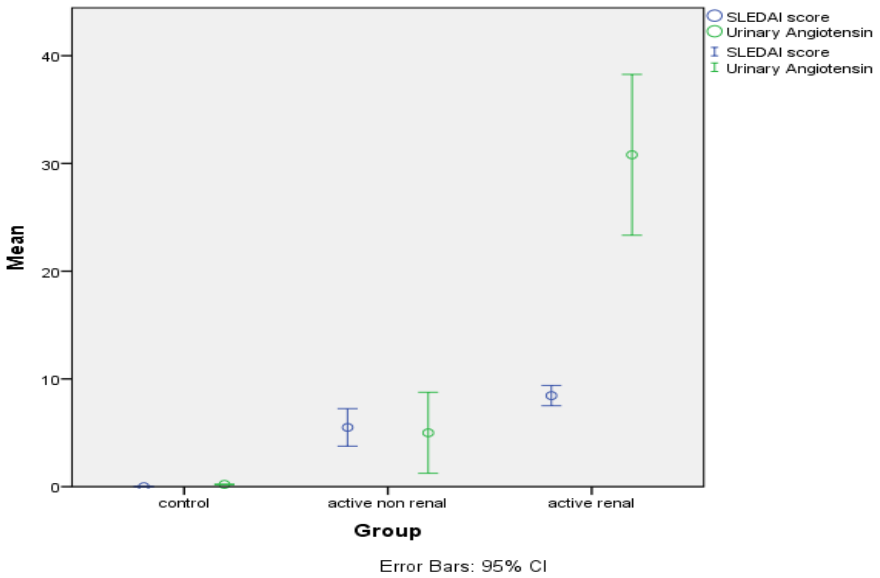

Figure (1): Box plot for mean SLEDAI score and urinary angiostatin in groups

Regarding target organ damage, there was a statistically significant difference in organ damage pattern as active non renal group had higher incidence of ocular damage with p value 0.003, While active renal group hand higher incidence or renal damage with p value 0.0001 **(Table 4)**.

Table (4): Target organ damaged based on group

Parameters \ Groups		Control		active non renal		active renal		P value
		Count	Row %	Count	Row %	Count	Row %	
Ocular	No	25	44.6%	13	23.2%	18	32.1%	0.003
	Yes	0	0.0%	7	77.8%	2	22.2%	
Neuropsychiatric	No	24	39.3%	20	32.8%	17	27.9%	0.12
	Yes	1	25.0%	0	0.0%	3	75.0%	
Renal	No	24	57.1%	18	42.9%	0	0.0%	0.0001
	Yes	1	4.3%	2	8.7%	20	87.0%	
Pulmonary	No	25	39.7%	20	31.7%	18	28.6%	0.09
	Yes	0	0.0%	0	0.0%	2	100.0%	
Cardiovascular	No	25	41.7%	17	28.3%	18	30.0%	0.15
	Yes	0	0.0%	3	60.0%	2	40.0%	
Peripheral vascular	No	25	41.7%	18	30.0%	17	28.3%	0.12
	Mild	0	0.0%	2	66.7%	1	33.3%	
	Sever	0	0.0%	0	0.0%	2	100.0%	
Musculoskeletal	No	25	43.9%	18	31.6%	14	24.6%	0.03
	Mild	0	0.0%	2	33.3%	4	66.7%	
	Sever	0	0.0%	0	0.0%	2	100.0%	
Skin	No	25	42.4%	16	27.1%	18	30.5%	0.07
	Yes	0	0.0%	4	66.7%	2	33.3%	
Diabetes	No	25	42.4%	18	30.5%	16	27.1%	0.07
	Yes	0	0.0%	2	33.3%	4	66.7%	

There was a statistically significant correlation between active renal group and activity index and chronicity index with p value 0.0001 and 0.0001 respectively **(Table 5)**.

Table (5): Activity and chronicity indices in groups

Groups / Parameters	Control	Active non renal	Active renal	P value
	Mean±SD	Mean±SD	Mean±SD	
Activity index	0±0	3.5±3.6	10.7±1.3	0.0001
Chronicity index	0±0	1.2±.8	3.3±1.2	0.0001

ROC analysis of urinary angiostatin level:

Angiostatin level was correlated to group, as it can defraniate between active renal and non- renal groups with p value 0.0001 and AUC 0.97. In addition, urinary angiostatin can predict patients with SLEDAI score >6 with p value 0.002 and AUC 0.77 **(Figure 2)**.

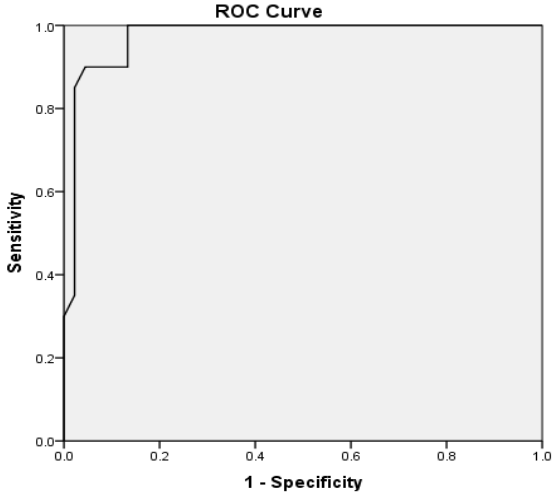

Figure (2): ROC curve for groups and urinary angiostatin.

Moreover, urinary angiostatin level can predict patient with organ damage score >2 with p value 0.001 and AUC 0.78 **(Figure 3)**.

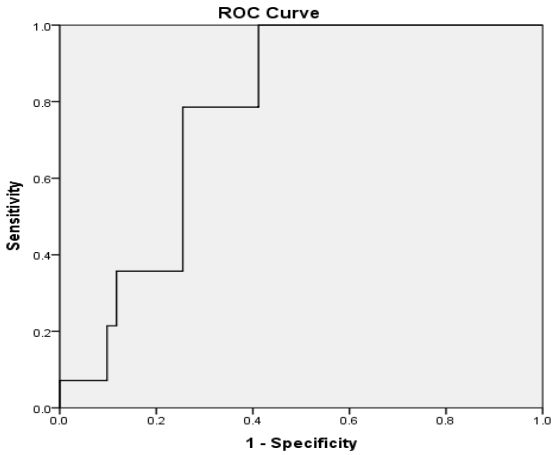

Figure (3): ROC curve for ISN/RPS class and urinary angiostatin

Urinary angiostatin was not correlated to activity index with p value 0.09 and AUC 0.69. However, as well as chronicity index with p value 0.11 and AUC 0.83 **(Figure 4)**.

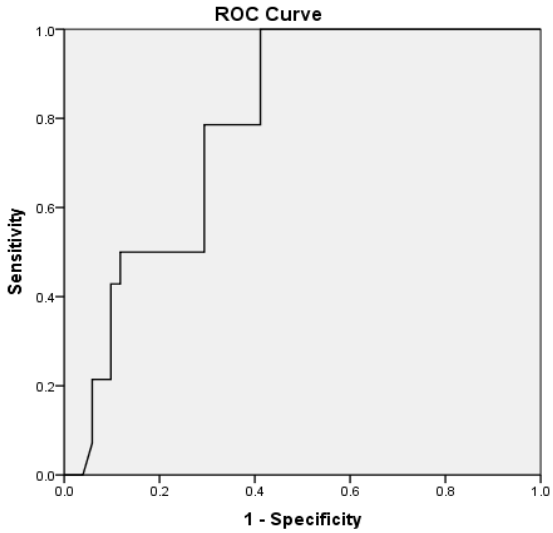

Figure (4): ROC curve for organ damage score and urinary angiostatin

DISCUSSION

In the current study, mean age of our sample was 37 ± SD 11.4 years old, mean disease duration was 3.4 ± SD 4.9 years which came in contrast with average age of a study conducted by *Pedersen et al. (2018)* who reported that, they performed western blot on human urine samples from healthy controls and SLE patients with and without lupus nephritis. Mean age (range) was 41.5 (21–72) in health group, was 49.5 (30–69) in SLE without LN and was 41.7 (20–73) in SLE with LN group.

Females represented the majority of sample with 75.5%, while males were 24.5%. This came in agreement with *El-Sayed et al. (2014)* and *Pedersen et al. (2018).*

Comparison between mean SELDAI score in the three groups, active renal group had higher mean score 8.4, were active non renal had somehow lower mean 7.6, while control group was 0. There was significant difference between the three groups. This came higher than one reported by *El- Sayed et al. (2014).*

Regarding components of SLEDAI score, active non renal group had higher incidence of vasculitis, alopecia and increased Anti-DNA, while active renal group had more incidence of presence of urinary casts, proteinuria and low complement fixation.

Regarding ISN/RPS class there were statistically significant differences in class as active renal group had advanced stage III and IV, while active non renal group had early stage I and II.

Active renal group had the highest activity index with, also it had a higher chronicity index with p value 0.008, which came in agreement with *Brunner et al. (2019),* who stated that, GFR was moderately associated with both chronicity (NIH-CI) and Disease activity.

Regarding ISN/RPS class there were statistically significant differences active renal group had advanced stage III and IV, while active non renal group had early stage I and II, which came in agreement with *El-Sayed et al. (2014)* and *Brunner et al. (2019).*

Using a linear regression model, urinary angiotensin level was significantly correlated to group as urinary angiotensin level was highest in active renal group. Comparative study between the 3 groups revealed; significant increase in urinary angiostatin in active renal group; compared to other groups; with highly significant statistical difference this came in agreement with *Wu et al. (2013)* and *Mohamed et al. (2018).*

Urinary angiotensin level was significantly correlated to SLEDAI score, as there was a direct relation between high urinary angiotensin level and high SLEDAI score. Comparative study between the 3 groups revealed; highly significant increase in SLEDAI scores in active renal group; compared to other groups; with highly significant statistical difference, which came in agreement with *Li et al. (2013).*

Yang et al. (2012) reported that, data reveal that the SLE-renal group had higher SLE Disease Activity Index (SLEDAI) scores than did the SLE-non-renal group.

Urinary angiotensin level was significantly correlated to number of organ damaged as with larger number of organ damage. There was a significant increase in urinary angiotensin level. Urinary angiostatin levels varied significantly and there were significant positive correlation levels, with the activity and choronicty scores of the examined renal biopsies among the histopathological groups. Urinary angiotensin level was significantly correlated to ISN/RPS class, this came in consistant with results of *Algergawy et al. (2013).*

Also, it was correlated significantly to activity index. In addition, urinary angiotensin level was significantly correlated to chronicity index this came in agreement with *Wu et al. (2013)* which reported that urinary angiostatin reflects renal chronicity changes in lupus nephritis in concurrent biopsy samples. In order to evaluate precisely how well urinary angiostatin can predict particular changes in renal pathology, we collected urine samples from the patients on the same day renal biopsies were performed. We then measured urinary angiostatin levels and compared them with the renal pathology activity index and the renal pathology chronicity index in these paired urine/ biopsy samples collected simultaneously. Renal pathology activity and chronicity indices were computed as described by *Wu et al. (2013).*

Mohamed et al. (2018) reported that urine levels of angiostatin in the 4 studies groups of subjects studied was significantly higher in patients with active renal disease than active non-renal disease, inactive SLE or healthy controls.

Aragón et al. (2020) reported that angiostatin levels are higher in SLE patients in remission with a previous LN history, in comparison with SLE patients in remission without prior LN.

Our result came in disagreement with *Mok et al. (2018)* who reported that angiostatin was able to discriminate SLE with disease activity and renal

involvement vs. SLE patients with active disease but no renal compromise, although there was no correlation with the chronicity indexes in the kidney biopsies.

CONCLUSION

Urinary angiostatin level was correlated to renal involvement in SLE patients. Correlated to ISN/RPS class activity score, chronicity index, urinary angiostatin, SLEDAI score and SLE organ damage score.

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الأنجيوستاتين البولي كمؤشر لمرض الذئبة الكلوي

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خلفيـــة البحـــث: الذئبـــة الحماميـــة الجهازيـــة مـــرض منـــاعي ذاتـــي مـــزمن مـــع إصـــابة أعضـــاء متعـــددة. مـــن بينهـــا الكلـــى هـــي واحـــدة مـــن أكثـــر الأعضـــاء إصـــابة. مـــا يقـــرب مـــن 35 ٪ مـــن البـــالغين تظهـــر علـــيهم علامـــات التهـــاب الكليـــة الـــذئبي فـــي وقـــت تشـــخيص مـــرض الذئبـــة الحمـــراء و 50-60 ٪ سيصـــابون بمـــرض التهـــاب الكليـــة الـــذئبي خـــلال الســـنوات العشـــر الأولـــى مـــن المـــرض. يظـــل هـــذا المـــرض هـــو الســـبب الرئيســـي الوفيـــات فـــي مرضـــى الذئبـــة الحمـــراء، إمـــا نتيجـــة للفشـــل الكلـــوي أو ثـــانوي للآثـــار الجانبيـــة للعلاجـــات العدوانيـــة المثبطـــة للمناعة.

الهـــدف مـــن البحـــث: التشـــخيص المبكـــر لالتهـــاب الكليـــة الـــذئبي والتنبـــوء بنتائجـــه مـــن خـــلال تقييم مستوى الأنجيوستاتين البولي.

المرضـــى وطـــرق البحـــث: أجريـــت هـــذه الدراســـة المقطعيـــة علـــى 65 مريضـــاً فـــي وحـــدة أمـــراض الكلـــى فـــي قســـم الطـــب البـــاطني فـــي مستشـــفى الحســـين الجـــامعي ومستشـــفيات القـــوات المســـلحة بـــين أبريـــل 2019 وأكتـــوبر 2019. وتـــم تصـــنيف المرضـــى فـــي هـــذه الدراســـة إلـــى ثـــلاث مجموعـــات: المجموعـــة (أ)) 20 مريضـــا الذئبـــة الحماميـــة الجهازيـــة الكلويـــة النشـــطة ســـريريا ، المجموعـــة (ب) 20 مريضـــا الذئبـــة الحماميـــة الجهازيـــة الكلويـــة غيـــر النشـــطة ومجموعة (ج) 25 شخصا حسب الضوابط الصحية.

نتـــائج البحـــث: أظهـــرت النتـــائج أن هنـــاك فروقـــاً ذات دلالـــة إحصـــائية فـــي أنجيوســـتاتين البـــول، بالإضـــافة إلـــى أن نمـــوذج الانحـــدار الخطـــي أظهـــر ارتباطًـــا مـــع ISN/RPS، SLEDAI وعدد الأعضاء المتضررة.

الاســـتنتاج: يمكـــن اســـتخدام أنجيوتنســـين البـــولي كطريقـــة غيـــر جراحيـــة لتحديـــد الضـــرر الكلوي في إلتهاب الكلية الذئبي.

الكلمات الدالة: أنجيوستاتين البول، المودة الكلوية، التهاب الكلية الذئبي.