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ORIGINAL ARTICLE

Correlation of Oxford Classification Score with Early Response to Treatment in IgA Nephropathy: A Cross-Sectional Study

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ABSTRACT

Objective: To evaluate the correlation between the Oxford classification score and early response to treatment in Immunoglobulin A nephropathy (IgAN) in a single-center study in northern Pakistan.

Methods: This cross-sectional study was conducted at the Department of Nephrology, Shifa International Hospital, Islamabad, from July 2024 to January 2025. Patients aged 18 to 65 years with biopsy-proven primary IgAN were included. Baseline demographic, clinical, and laboratory data, including serum creatinine, estimated Glomerular Filtration Rate (eGFR), and proteinuria, were recorded. Renal biopsies were assessed using the Oxford classification, evaluating mesangial hypercellularity (M), endocapillary hypercellularity (E), segmental glomerulosclerosis (S), tubular atrophy/interstitial fibrosis (T) and crescents (C). Early treatment response was defined as a ≥50% reduction in proteinuria after three months.

Results: Of total 30 patients, the median age was 30.5 (24.5 – 43.5) years. The Oxford classification revealed that 19 (63.3%) patients had M1 and S1 lesions, 16 (53.3%) had E0 lesions, and 12 (40.0%) exhibited T0 lesions. A significant reduction in proteinuria was observed after treatment (p-value < 0.001), with eGFR and serum albumin levels improving significantly (p-value 0.003 and p-value 0.023) respectively. T1-2 lesions demonstrated a strong negative correlation with eGFR (ρ = -0.760, p-value < 0.001), and E1 lesions were moderately correlated with proteinuria (ρ = 0.378, p-value 0.039). Treatment response was observed in 12 (40%) patients, but no significant associations were found with individual Oxford classification scores.

Conclusion: A significant reduction in proteinuria and improvement in eGFR and albumin were observed post-treatment. Histopathological features correlated with renal outcomes, emphasizing their significance in predicting early treatment outcomes.

Keywords: IgA Nephropathy, Interstitial Fibrosis, Oxford Classification, Proteinuria, Tubular Atrophy.

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INTRODUCTION

Immunoglobulin A nephropathy (IgAN) represents the most prevalent primary glomerular disease, characterized by the deposition of IgA in the glomerular mesangium.[1] In addition to milder cases with abnormal urine findings, IgAN manifests a broad clinical spectrum, including instances of rapidly progressive renal failure.[2] Over a span of 20 to 30 years, approximately one-third of cases progress to end-stage renal disease. Recent attention has shifted to the Oxford score, also termed the Mesangial hypercellularity, Endocapillary hypercellularity, Segmental sclerosis, Tubular Atrophy/ interstitial fibrosis, Crescents (MEST-C) score, alongside proteinuria, high blood pressure, and low glomerular filtration rate (e-GFR), as significant indicators of IgAN progression.[3,4] The MEST-C score describes deposits in various anatomical sections: mesangial hypercellularity (M), endocapillary hypercellularity (E), segmental glomerulosclerosis (S), tubular atrophy/interstitial fibrosis (T) and crescents (C). An increased total score observed correlates with a poorer prognosis, with each element of the Oxford score exerting distinctive effects on prognosis.[4]

The pathogenesis and clinical presentation strongly hinge on glomerular and systemic complement activation, as reflected by serum complement levels.[1] The most recent 4-hit hypothesis underscores the pivotal role of autoimmunity in this context.[5] Treatment in IgAN is focused around optimal blood pressure management, lifestyle modification, reduction of proteinuria by renin angiotensin aldosterone system

blockade, sodium restriction, smoking cessation and dyslipidemia management.[6,7] Sodium glucose transporter 2 inhibitor (SGLT2i) and endothelin receptor A (ETRA) antagonists have also been recently incorporated in IgAN management for their anti-proteinuric and reno-protective effects.[8] Steroids have been seen to be beneficial especially in Chinese population as per the TESTING trial.[9] Mycophenolate Mofetil has also been seen to be efficacious in the same population.[10] Cyclophosphamide is recommended by kidney disease: improving global outcomes (KDIGO) to be used along with steroids in cases of rapidly progressive glomerulonephritis with biopsy showing cellular crescents.[11] Targeted release formulation of the oral steroid budesonide (Nefecon) has also been recently developed and successfully used in IgAN.[12]

The rationale for exploring the correlation between the Oxford Classification score and proteinuria in patients with IgAN in Pakistan is rooted in the increasing frequency of this disease in the country. The Oxford classification score is being increasingly recognized as a prognostic indicator of the disease. However, there is a lack of research in the Pakistani population that assesses how the variables of the Oxford classification score, individually and cumulatively, are related to the early treatment outcome. By addressing this research gap between Oxford Classification Score which provides histological insights into the disease, with treatment response, we can offer the patient an early effective treatment intervention focused on reduction of proteinuria, improving of renal functions, halting and even reversal of disease progression. Therefore, the aim of this current study is to determine the correlation of oxford classification with early response to treatment in IgAN.

METHODS

This cross-sectional study was conducted at the Department of Nephrology, Shifa International Hospital, Islamabad, Pakistan from July 2024 to January 2025. The ethical letter was approved by Research & Ethical Committee of Shifa International Hospital (IRB # 0443-23). Informed consent was obtained from all participants meeting the inclusion criteria.

Patients aged between 18 and 65 years with biopsy-proven primary IgAN were enrolled consecutively through a non-probability consecutive sampling method. By using sample-size.net calculator taking correlation between proteinuria and E1 0.52,[13] with a 5% level of significance and 80% power. The estimated sample size was 27. However, to overcome the issue of missing data we enrolled 30 patients. Patients with secondary IgAN, Henoch-Schonlein purpura, liver diseases, coexisting renal pathology (e.g., diabetic nephropathy), or kidney biopsies containing fewer than ten glomeruli were excluded.

Key parameters were defined to ensure uniformity. Acute kidney injury (AKI) was characterized by an increase in serum creatinine of at least 0.3 mg/dL within 48 hours, a 50% increase in serum creatinine within seven days, or urine output less than 0.5 mL/kg/h for six or more hours. Proteinuria was assessed using the spot urine protein-to-creatinine ratio, with values greater than 150 mg/day considered significant. The Oxford Classification score is a simple system used to predict renal prognosis and differentiate between ongoing and persistent renal abnormalities. It consists of five key components: M classified as M0 (absent) or M1 (≥50% of glomeruli with >3 cells per mesangial area); E scored as E0 (absent) or E1 (present); S scored as S0 (absent) or S1 (present); T categorized as T0 (0–25% of the cortical area), T1 (26–50%), or T2 (>50%); and C classified as C0 (absent), C1 (crescents in <25% of glomeruli), or C2 (crescents in >25% of glomeruli). Early response to treatment was defined as a reduction in proteinuria of at least 50% from baseline after three months of treatment.

Baseline demographic data, including age, sex, body mass index (BMI), and mean arterial pressure (MAP), were recorded. MAP was calculated using the formula: MAP = diastolic blood pressure + 1/3 (systolic blood pressure – diastolic blood pressure). Laboratory evaluations included measurements of serum creatinine (mg/dl), serum albumin (g/L), estimated Glomerular Filtration Rate (eGFR) (ml/min), and the spot urine protein-to-creatinine ratio, which was calculated by dividing spot urinary protein by spot urinary creatinine of a urine sample. Renal biopsy specimens were assessed for Oxford classification parameters by a single histopathologist to ensure consistency and minimize bias.

Patients were stratified into two groups based on baseline proteinuria levels. Patients with proteinuria equal to or greater than 1 g/day were treated with immunosuppressive therapy, consisting of steroids and mycophenolate mofetil. Patients with proteinuria less than 1 g/day were managed with supportive therapy only, including dietary modifications and renin-angiotensin-aldosterone system blockade. These treatment regimens adhered to standard clinical guidelines for IgAN. Early treatment response was evaluated after three months by measuring proteinuria levels. Serum creatinine, serum albumin, and MAP were

re-assessed at follow-up.

The primary outcome of the study was the correlation between Oxford classification scores and early treatment response. Secondary outcomes included changes in serum creatinine, serum albumin, and MAP at follow-up.

Data entry and analysis were performed using the Statistical Package for Social Sciences (SPSS) version 20.0. Median (IQR) was computed for quantitative variables like age, weight, height, BMI, MAP, spot UPCR, creatinine, e-GFR, and albumin while frequency and percentages were computed for categorical variables like gender, oxford classification score, and treatment response. Inferential statistics were explored using Wilcoxon Signed Ranks test to compare pre and post clinical indicators of patients, Spearman correlation (ρ) to identify the relationship between oxford classification score and clinical indicators, and Chi-square/Fisher exact test to identify the association between oxford classification score and treatment response. The p-value of ≤0.05 was considered statistically significant.

RESULTS

Of total 30 patients, the median age, weight, height, and BMI were 30.5 (24.5 – 43.5) years, 74.5 (63.0 – 82.2) kg, 164.5 (157.5 – 172.0) cm, and 26.7 (23.6 – 30.1) kg/m^2 respectively. There were 20 (66.7%) males and 10 (33.3%) females. Based on oxford classification score most of the patients showed M1 19 (63.3%), E0 16 (53.3%), S1 19 (63.3%), and T0 12 (40.0%) while all patients showed C0 30 (100.0%). Majority of the patients had proteinuria >1 g/day i.e., 20 (66.7%).

Spot UPCR showed a significant reduction at 3 months compared to baseline i.e., 1.3 (0.4 – 2.9) vs. 2.7 (0.3 - 3.8) (p-value <0.001). Conversely, both eGFR and albumin levels significantly increased at 3 months as compared to baseline i.e., 55.2 (20.5 – 93.6) ml/min vs. 30.7 (13.3 - 49.5) ml/min (p-value 0.003) and 3.9 (3.5 – 4.2) g/L vs. 3.7 (3.3 – 4.0) g/L (p-value 0.023) (Table 1). Correlation between oxford classification score and clinical indicators showed a significantly moderate negative correlation between eGFR and S1 (ρ = -0.496, p-value 0.005) and a strong negative correlation between eGFR and T1-2 (ρ = -0.760, p-value < 0.001). While, a significantly moderate positive correlation was observed between proteinuria and E1 (ρ = 0.378, p = 0.039) (Table 2).

Treatment response was observed in 12 (40.0 %) patients. An insignificantly higher association of treatment response found with mesangial hypercellularity M1 (p-value 0.279), endocapillary hypercellularity E1 (p-value 0.296), segmental glomerulosclerosis S1 (p-value 0.757), and tubular atrophy T1 (p-value 0.455) (Table 3).

DISCUSSION

This study explored the correlation between the Oxford classification score and early treatment response in IgAN, a disease with significant variability in progression and therapeutic outcomes. The findings contribute to the ongoing discussion about the prognostic utility of histopathological features in IgAN management, with results comparable to and divergent from previous landmark studies.

The correlation between T lesions and a decline in eGFR

Table 1: Comparison of pre and post clinical indicators in patients with IgA nephropathy (n = 30)

Indicators	Median (IQR)	Minimum - Maximum	p-value
Spot UPCR at 0 months	2.7 (0.3 - 3.8)	0.1 - 9.7	<0.001*
Spot UPCR at 3 months	1.3 (0.4 – 2.9)	0.0 – 9.0	
MAP at 0 months (mmhg)	103.0 (95.5 - 111.7)	80.3 - 129.0	0.057
MAP at 3 months (mmhg)	96.5 (92.0 – 104.5)	76.6 – 130.0	
Creatinine at 0 months (mg/dl)	2.2 (1.5 - 3.9)	0.7 - 18.7	0.052
Creatinine at 3 months (mg/dl)	1.3 (0.9 – 3.2)	0.6 – 12.4	
eGFR at 0 months (ml/min)	30.7 (13.3 - 49.5)	2.9 - 132.0	0.003*
eGFR at 3 months (ml/min)	55.2 (20.5 – 93.6)	2.9 – 165.7	
Albumin at 0 months (g/L)	3.7 (3.3 – 4.0)	1.6 – 4.5	0.023*
Albumin at 3 months (g/L)	3.9 (3.5 – 4.2)	2.1 – 5.1	

- UPCR: Urine protein to creatinine ratio, MAP: Mean arterial pressure, eGFR: Estimated glomerular filtration rate, IgA: immunoglobulin A, IQR: Inter quartile range

***** p-value ≤ 0.05 (Wilcoxon Signed Ranks test)

Table 2: Correlation between oxford classification score and clinical indicators in patients with IgA nephropathy (n = 30)

	MAP (mmhg) ρ (p-value)	eGFR (ml/min) ρ (p-value)	Proteinuria (mg/day) ρ (p-value)
M1	-0.068 (0.721)	-0.236 (0.210)	0.342 (0.064)
E1	0.019 (0.919)	-0.004 (0.984)	0.378 (0.039)*
S1	0.168 (0.374)	-0.496 (0.005)*	0.342 (0.064)
T1-2	0.277 (0.138)	-0.760 (<0.001)*	-0.052 (0.783)

-MAP: Mean arterial pressure, eGFR: Estimated glomerular filtration rate, IgA: immunoglobulin A
M1: Mesangial hypercellularity (≥50% of glomeruli with >3 cells per mesangial area), E1: Endocapillary hypercellularity (present), S1: Segmental glomerulosclerosis (present), T1: Tubular atrophy/interstitial fibrosis (26–50%), or T2 (>50%), *p-value ≤ 0.05 (Spearman's rank correlation test)

Table 3: Association between treatment response and oxford classification score (n= 30)

Oxford Classification Score	Total	Treatment Response		p-value
		Yes (n= 12)	No (n= 18)	
Mesangial Hypercellularity				
M0	11	3 (27.3)	8 (72.7)	0.279~
M1	19	9 (47.4)	10 (52.6)	
Endocapillary Hypercellularity				
E0	16	5 (31.3)	11 (68.8)	0.296^
E1	14	7 (50.0)	7 (50.0)	
Segmental Glomerulosclerosis				
S0	11	4 (36.4)	7 (63.6)	0.757~
S1	19	8 (42.1)	11 (57.9)	
Tubular Atrophy				
T0	12	4 (33.3)	8 (66.7)	0.455~
T1	11	6 (54.5)	5 (45.5)	
T2	7	2 (28.6)	5 (71.4)	
Cellular Fibrocellular				
C0	30	12 (40.0)	18 (60.0)	N/A

M: Mesangial hypercellularity, M0 (absent) or M1 (≥50% of glomeruli with >3 cells per mesangial area), E: Endocapillary hypercellularity, E0 (absent) or E1 (present), S: Segmental glomerulosclerosis, S0 (absent) or S1 (present), T: Tubular atrophy/interstitial fibrosis, T0 (0–25% of the cortical area), T1 (26–50%), or T2 (>50%), C: Crescents, C0 (absent), ^Chi-Square/~Fisher Exact test

observed in this study underscores the well-established role of T lesions as critical predictors of renal function deterioration. This aligns with the findings of Moriyama *et al*. who reported that T scores were the most significant predictors of long-term renal prognosis, especially in patients receiving immunosuppressive therapy.[14] Similarly, the Coppo *et al.* study validated that T scores significantly predict renal survival and disease progression across a wide spectrum of IgAN patients.[15] A study in Turkey found that T lesions on biopsy were a poor marker to treatment response with steroids in terms of reduction to proteinuria.[16] Another study in Norway associated T lesions with poorer prognosis.[17]

The strong negative correlation in this study between T lesions and eGFR reinforces the notion that early identification and management of interstitial fibrosis and tubular atrophy are vital to mitigating renal function loss.

The study also observed a moderate positive correlation between E1 and proteinuria, consistent with findings by Trimarchi *et al.* who suggested that E lesions are significant predictors of proteinuria, particularly in patients without immunosuppression.[18] However, discrepancies exist as Yoon *et al*. noted a diminished prognostic value of lesions in immunosuppressed cohorts, suggesting that treatment may modulate the impact of these lesions.[19]

Interestingly, this study found no significant association between treatment response and M or S, contrasting with observations by Coppo *et al* who highlighted M

and S lesions as significant predictors of renal outcomes in untreated cohorts.[15] The lack of significance in the present study may stem from the small sample size and shorter follow-up and study duration, which limit the power to detect subtle associations.

The observed decrease in proteinuria after three months of treatment, particularly in patients with more severe histological scores, aligns with findings from the validation of the oxford classification of IgAN (VALIGA) and VALIGA Extension studies, which reported improved renal outcomes with tailored therapeutic strategies.[15,20]

The clinical implication of the current study is that there is a strong negative correlation between eGFR and T1-2 lesions emphasizes the need for early intervention to prevent irreversible fibrosis. Moreover, the association of E1 lesions with proteinuria underscores the role of inflammation in disease progression, highlighting the potential utility of targeted anti-inflammatory therapies. The positive correlation of E1 lesions with proteinuria highlights the potential benefit of adjunctive anti-inflammatory therapies in patients with significant E1. The lack of significant association between M and S scores with treatment response raises questions about their standalone utility in guiding therapeutic decisions and underscores the importance of integrating clinical features with histological findings. Additionally, this study reinforces the need for personalized therapeutic approaches. While patients with proteinuria ≥1 g/day benefitted from immunosuppressive therapy, those with lower levels responded well to supportive care. These findings align with the principles outlined by International IgAN Network, emphasizing risk-based approach to treatment.[15]

There are some limitations in this study. Firstly, small sample size and single-center design limits its generalizability. Additionally, the short follow-up period precludes an assessment of long-term renal outcomes. Future multicenter studies with larger cohorts and extended follow-ups are needed to validate these findings and explore the impact of integrating clinical and histopathological data for more precise risk stratification and treatment planning. Also the unavailability of newly introduced drugs in Pakistan, namely Nefecon and Sparsentan, which have recently been included in IgAN treatment regimes, limits this study's generalizability.

CONCLUSION

This study reported that a significant reduction in proteinuria and improvement in both eGFR and albumin levels were observed at 3 months post-treatment. Correlation analysis indicated a strong negative association between eGFR and both S1 and T1-2, while proteinuria showed a moderate positive correlation with E1. Treatment response was observed in 40% of patients, though no significant associations were found with Oxford classification parameters. These findings highlight the prognostic value of histopathological features in assessing renal outcomes and guiding treatment strategies.

ETHICAL APPROVAL: Ethical approval was acquired from the Institutional Review Board & Ethics Committee of Shifa International Hospital, Islamabad on (IRB#0443-23, dated: 23-Jan-2024).

AUTHORS' CONTRIBUTIONS: MA: Substantial contributions to the conception or design of the work, acquisition, analysis, and interpretation of data, methodology, drafting the manuscript or revising it critically for important intellectual content. SNM: Provided supervision and/or project administration, including oversight of the research activity planning and execution. Both authors have approved the final version of the manuscript to be published.

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