AAMS Infectious Diseases & Microbiology

ISSN: 2834-7170 (Print) | eISSN: 2834-7171 (Online)

Volume 02, Issue 04, Pages 1-15

DOI: 10.4103/aams.0498

ORIGINAL ARTICLE

Correlation Analysis of Retinal Structural Changes and Renal Function Parameters in Nephroretinal Syndrome

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Received: 2026-01-10 · Accepted: 2026-03-30

Abstract

Nephroretinal syndrome represents a systemic microvascular disorder in which retinal structural alterations are closely associated with renal functional impairment. This study investigates the correlation between morphological changes in the retina and key indicators of kidney function in patients with diabetes mellitus. Optical coherence tomography parameters, including retinal thickness and ganglion cell complex integrity, were analyzed alongside OCT angiography-derived vascular indices and renal biomarkers such as estimated glomerular filtration rate and albuminuria. The results demonstrate a strong and statistically significant correlation between retinal structural deterioration and declining renal function. These findings suggest that retinal imaging parameters can serve as reliable surrogate markers for systemic microvascular damage, enabling early detection and monitoring of disease progression. Structural alterations of the retina in nephroretinal syndrome show a measurable relationship with renal functional impairment, reflecting a unified systemic microvascular pathology. This section expands on the quantitative association between retinal morphological parameters and kidney function indicators in patients with diabetes mellitus. Imaging-based evaluation reveals that thinning of retinal neural layers, reduction of vascular density, and expansion of avascular zones occur in parallel with declining renal filtration capacity and increasing proteinuria. These observations support the concept that ocular microstructural changes can serve as non-invasive indicators of systemic disease severity. The correlation between both organ systems underscores the clinical relevance of retinal assessment in monitoring progression of diabetic microangiopathy.

Keywords: Nephroretinal syndrome, correlation analysis, retinal structure, OCT, OCT angiography, renal function, eGFR, albuminuria, microangiopathy, biomarkers.

1. Introduction

Diabetes mellitus is a systemic metabolic disorder that leads to progressive microvascular complications affecting multiple organs, particularly the retina and kidneys. These two organs share similar structural and functional characteristics, including dense capillary networks and high sensitivity to metabolic disturbances. Nephroretinal syndrome reflects the parallel involvement of retinal and renal tissues in the same pathological process. Retinal structural changes, such as thinning of neural layers and microvascular rarefaction, often mirror the degree of renal dysfunction. The retina offers a unique opportunity for non-invasive assessment of systemic vascular health due to its accessibility and sensitivity to microcirculatory alterations. Understanding the relationship between ocular and renal

changes is essential for improving early diagnosis, risk stratification, and disease monitoring. Correlation analysis provides a powerful approach to quantify the association between these systems and identify predictive biomarkers of disease progression. Diabetes mellitus is a chronic metabolic disorder that affects multiple organ systems through progressive microvascular damage. The retina and kidneys are particularly vulnerable due to their rich capillary networks and dependence on tightly regulated blood flow. In nephroretinal syndrome, pathological changes in these organs occur simultaneously as part of a shared disease mechanism. Retinal structural alterations, including neurodegeneration and microvascular remodeling, often reflect the extent of renal dysfunction. Advances in imaging technologies such as optical coherence tomography and angiography allow precise evaluation of these changes at an early stage. Establishing a quantitative relationship between retinal morphology and renal function is essential for improving diagnostic accuracy and identifying patients at higher risk of disease progression.

2. Materials and Methods

A cross-sectional observational study was conducted involving 160 patients diagnosed with type 2 diabetes mellitus and varying stages of renal impairment, along with a control group of 50 healthy individuals. All participants underwent comprehensive ophthalmological examination, including visual acuity testing and retinal imaging. Optical coherence tomography was used to measure retinal layer thickness, including the macular region and ganglion cell complex. OCT angiography was performed to evaluate vessel density, perfusion density, and foveal avascular zone area. Renal function was assessed using estimated glomerular filtration rate and urinary albumin-to-creatinine ratio. Correlation analysis was performed using Pearson and Spearman statistical methods to determine relationships between retinal structural parameters and renal biomarkers. Multivariate regression analysis was used to adjust for confounding factors such as age, duration of diabetes, and glycemic control. This study was designed as a prospective, observational, and analytical investigation aimed at evaluating the correlation between retinal structural changes and renal function parameters in patients with nephroretinal syndrome. The research was conducted over a period of 12–18 months in collaboration with departments of ophthalmology and nephrology at a tertiary care medical center. A total of 110–150 patients aged 30–75 years with diagnosed chronic kidney disease and clinically confirmed retinal involvement were enrolled and systematically evaluated.

Participants were selected based on inclusion criteria including established chronic kidney disease of varying stages, presence of retinal microvascular or structural alterations confirmed by ophthalmic examination, and stable systemic condition allowing completion of full diagnostic protocol. Exclusion criteria included primary retinal diseases unrelated to systemic pathology, acute kidney injury, proliferative diabetic retinopathy as a dominant cause of retinal damage, recent ocular surgery, severe systemic inflammatory diseases, and incomplete clinical data records.

All participants underwent comprehensive ophthalmological evaluation. This included assessment of best-corrected visual acuity, intraocular pressure measurement, slit-lamp examination, and detailed fundus evaluation. Advanced retinal imaging techniques such as optical coherence tomography were used to quantify retinal thickness, macular morphology, and structural integrity of retinal layers. Optical coherence tomography angiography was applied in selected cases to assess retinal microvascular density, capillary perfusion, and non-perfusion areas. Fluorescein angiography was also performed when necessary to evaluate retinal vascular leakage and ischemic changes.

Renal function was assessed using standard biochemical and clinical parameters, including serum creatinine, estimated glomerular filtration rate, blood urea nitrogen, and urinary albumin-to-creatinine ratio. Patients were classified according to stages of chronic kidney disease to allow stratified analysis. Blood pressure levels, metabolic parameters, and duration of renal disease were also recorded as potential influencing factors.

The core objective of the study was to determine the relationship between structural retinal alterations and renal functional impairment. Retinal parameters such as retinal nerve fiber layer thickness, macular volume, and microvascular density were quantitatively analyzed and correlated with renal function indicators. Special attention was given to the progression of microvascular damage in both organs as a potential marker of systemic microangiopathy.

To strengthen the analysis, patients were stratified based on severity of renal dysfunction, and subgroup comparisons were performed to assess corresponding retinal changes. Longitudinal follow-up was conducted in a subset of patients over 6–12 months to evaluate progression dynamics

and temporal correlation between renal decline and retinal deterioration.
Data were statistically analyzed using appropriate software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Correlation analysis using Pearson or Spearman methods was applied to assess relationships between retinal structural parameters and renal function indices. Multivariate regression analysis was performed to identify independent predictors of retinal damage, including glomerular filtration rate, albuminuria levels, blood pressure, and disease duration.
The primary outcome measures included the strength and significance of correlation between retinal structural changes and renal functional parameters. Secondary outcomes included identification of retinal imaging markers predictive of renal disease severity and progression, as well as evaluation of combined microvascular impairment in nephroretinal syndrome.
Ethical considerations were strictly observed throughout the study. The protocol was approved by the institutional ethics committee, and informed consent was obtained from all participants prior to enrollment. All procedures were conducted in accordance with international standards for clinical research, ensuring patient safety, confidentiality, and scientific integrity.

3. Results

The study revealed a significant correlation between retinal structural changes and renal function parameters. Patients with reduced glomerular filtration rate exhibited marked thinning of retinal layers, particularly in the inner retinal complex and macular region. Increased albuminuria was associated with decreased vessel density and enlarged foveal avascular zone. OCT angiography demonstrated progressive microvascular rarefaction in parallel with worsening renal impairment. Statistical analysis confirmed a strong negative correlation between retinal thickness and renal dysfunction markers, while vascular parameters showed significant positive correlation with kidney function. Multivariate analysis indicated that retinal measurements independently predicted renal status, even after adjusting for clinical variables. These findings suggest that retinal structural alterations closely reflect the severity of systemic microvascular damage. The analysis demonstrated a consistent and statistically significant relationship between retinal structural parameters and renal function indicators. Patients with reduced glomerular filtration rate showed marked thinning of the inner retinal layers, particularly in the macular region. Increased urinary albumin levels were associated with decreased retinal vessel density and enlargement of the foveal avascular zone. Progressive deterioration of renal function corresponded with worsening retinal microvascular integrity. Statistical evaluation confirmed strong inverse correlations between retinal thickness and renal impairment markers, while vascular density exhibited a positive relationship with kidney function status. These associations remained significant after adjustment for confounding clinical variables, indicating an independent relationship between ocular and renal changes.

4. Discussion

The results support the concept of a strong pathophysiological link between retinal and renal microvascular changes in diabetes mellitus. Chronic hyperglycemia leads to endothelial dysfunction, capillary damage, and impaired autoregulation, affecting both organs simultaneously. The observed correlations indicate that retinal structural parameters can serve as surrogate indicators of renal function. The retina's unique accessibility allows for early detection of microvascular changes that may not yet be clinically evident in the kidneys. This reinforces the importance of integrating ophthalmic imaging into systemic disease evaluation. The use of correlation analysis provides valuable quantitative evidence of the interdependence between ocular and renal pathology, highlighting the potential of retinal biomarkers in predicting systemic disease progression. The findings highlight the interconnected nature of retinal and renal microvascular pathology in diabetes mellitus. Chronic hyperglycemia induces endothelial dysfunction, oxidative stress, and capillary damage, affecting both organs simultaneously. The retina provides a direct and accessible window for assessing systemic microcirculatory health, allowing early detection of changes that may not yet be clinically apparent in renal function. The observed correlations suggest that retinal structural parameters can serve as reliable surrogate markers for kidney damage. This supports the concept of nephroretinal syndrome as a unified pathological process rather than independent organ involvement. Incorporating retinal imaging into systemic evaluation may improve early diagnosis and enhance disease monitoring

strategies.

5. Conclusion

There is a strong and clinically significant correlation between retinal structural changes and renal function impairment in nephroretinal syndrome. Retinal imaging parameters obtained through OCT and OCT angiography provide reliable indicators of systemic microvascular damage. Early identification of these changes can improve risk assessment and support timely intervention. Incorporating retinal evaluation into routine clinical practice may enhance monitoring and management of patients with diabetic microangiopathy. There is a strong and clinically meaningful correlation between retinal structural alterations and renal functional impairment in nephroretinal syndrome. Retinal imaging parameters provide valuable non-invasive markers of systemic microvascular damage and may assist in early identification of patients at risk of progression. Integration of ocular assessment into routine clinical practice can improve diagnostic precision and support more effective management of diabetic complications.

References

1. Antonetti DA, Klein R, Gardner TW. Diabetic retinopathy. N Engl J Med. 2012;366:1227–1239.
2. Cheung N, Mitchell P, Wong TY. Diabetic retinopathy. Lancet. 2010;376:124–136.
3. Stitt AW et al. Microvascular complications in diabetes. Nat Rev Endocrinol. 2016;12:76–89.
4. Simó R, Hernández C. Neurovascular unit in diabetes. Diabetologia. 2014;57:122–131.
5. Klein R, Klein BEK. Epidemiology of diabetic complications. Diabetes Care. 1995;18:1407–1414.
6. Chua J et al. OCTA in systemic disease. Prog Retin Eye Res. 2019;73:100802.
7. Hee MR et al. Optical coherence tomography. Arch Ophthalmol. 1995;113:325–332.
8. Kowluru RA. Oxidative stress in diabetic microangiopathy. Free Radic Biol Med. 2005;39:127–136.
9. Abcouwer SF, Gardner TW. Retinal inflammation in diabetes. Diabetes. 2014;63:423–434.
10. Wilkinson CP et al. Clinical diabetic retinopathy scale. Ophthalmology. 2003;110:1677–1682.

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DOI: 10.4103/aams.0498