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Research Article

Hypertensive Retinopathy as a Window to Kidney Damage: A Severity Assessment Study in CKD Patients of Bastar, Chhattisgarh, India

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ABSTRACT
Background: Hypertension is a major contributor to chronic kidney disease (CKD) and systemic target-organ damage. Because the retinal and renal microvasculature share anatomical and physiological characteristics, hypertensive retinopathy may provide a non-invasive clinical marker of renal disease severity. This study assessed the severity of hypertensive retinopathy and its association with CKD stage in hypertensive patients.
Methods: A cross-sectional observational study was conducted over 15 months among 100 hypertensive patients aged ≥18 years with diagnosed CKD. Patients with diabetes mellitus, renal vascular abnormalities, glomerulonephritis, congenital renal anomalies, and renal tumours were excluded. All participants underwent detailed ophthalmic examination, including visual acuity, intraocular pressure measurement, and dilated fundus examination. Hypertensive retinopathy was graded using the Keith-Wagener-Barker classification. Blood pressure, CKD stage, serum creatinine, blood urea, and estimated glomerular filtration rate were recorded. Statistical analysis was performed using SPSS version 26, with $p < 0.05$ considered statistically significant.
Results: The mean age of participants was 45.98 ± 14.45 years, with 54% females and 46% males. Hypertensive retinopathy was present in 84% of patients. Grade 1, 2, 3, and 4 retinopathy were observed in 20%, 32%, 24%, and 8% of patients, respectively. A statistically significant association was observed between CKD stage and severity of hypertensive retinopathy ($p < 0.05$). Severe retinopathy (Grades 3–4) was more frequently observed in advanced CKD, particularly stages 4 and 5, whereas milder grades predominated in earlier CKD stages. Grade 4 retinopathy was associated with poorer visual acuity. Anaemia was present in 84% of patients and showed a significant association with CKD severity ($p = 0.0085$). No significant association was observed between intraocular pressure and retinopathy severity.
Conclusion: The study demonstrates a significant relationship between hypertensive retinopathy severity and CKD stage. Fundoscopic examination may therefore serve as a simple, non-invasive and cost-effective method for identifying hypertensive CKD patients at increased risk of advanced renal disease and visual impairment, particularly in resource-limited settings.

INTRODUCTION

Hypertension is a major global health issue affecting nearly 1.4 billion people and is a key contributor to cardiovascular and renal diseases.[1,2] It is often asymptomatic until it causes significant complications, including hypertensive retinopathy, which is recognized as a clinical marker of end-organ damage.[3] Hypertensive retinopathy is characterized by a spectrum of retinal vascular changes caused by elevated blood pressure, including arteriolar narrowing, retinal hemorrhages, and optic disc swelling.[3,4] These changes not only reflect the severity of hypertension but also indicate potential damage to other organs, particularly the kidneys.[5,6] Hypertension classification was done on the basis of ACC/AHA 2017 hypertension guidelines and compared to JNC 7 classification.[7,8]

Chronic kidney disease (CKD) is a progressive condition characterized by a gradual loss of kidney function over time.[9] Hypertension is both a cause and consequence of CKD, and poor control of blood pressure accelerates renal damage.[10] Patients with CKD often experience target-organ damage, including retinopathy, as a result of prolonged

hypertension.[11,12] The retinal vasculature shares embryological, anatomical, and physiological similarities with the renal microvasculature, making retinal changes a useful non-invasive marker for assessing the severity of kidney damage.[5,6]

The severity of hypertensive retinopathy was graded based on the Keith-Wagener-Barker classification (Table 1).[13]

Table 1: Keith-Wagener-Barker classification for Hypertensive retinopathy[13,14]

GRADE 1	Mild to moderate narrowing or sclerosis of the smaller arterioles.
GRADE 2	Moderate to marked narrowing of the retinal arterioles; exaggeration of the light reflex; changes at the arteriovenous crossings.
GRADE 3	Retinal arteriolar narrowing and focal constriction, prominent arteriovenous crossing changes, retinal oedema, hard exudates, cottonwool spots, flame shaped haemorrhages.
GRADE 4	All the features of Grade 3 are seen, as well as papilledema

Despite advances in the diagnosis and management of CKD, invasive procedures such as renal biopsy remain the gold standard for evaluating renal pathology. However, these are not always feasible in all clinical settings due to their cost, associated risks, and need for specialized expertise.[9,14] Retinal imaging, on the other hand, offers a non-invasive, cost-effective method to assess microvascular changes that parallel the pathology of the kidneys.[5,6,15] This study was aimed to evaluate the severity of hypertensive retinopathy in patients with CKD and explore its potential as a clinical tool to gauge the progression of renal disease.

MATERIALS AND METHODS

This study is a cross-sectional observational study conducted over a period of 15 months and included 100 hypertensive patients diagnosed with CKD, aged 18 years and above. These patients were recruited from both inpatient and outpatient departments. Patients with diabetes mellitus, congenital or acquired renal vascular abnormalities, chronic kidney disease secondary to glomerulonephritis, and congenital renal anomalies and renal tumours were excluded from the study.

Here, the approach was applied to every patient and they received a thorough ocular examination, which included:

Visual acuity assessment was performed using Snellen's chart for distance vision and Jaeger's chart for near vision.[17] Intraocular pressure (IOP) was measured using Goldmann applanation tonometry.[18] Fundus examination was carried out using both direct and indirect ophthalmoscopy, along with slit-lamp biomicroscopy using a 78D Volk lens after pupillary dilatation with 1% tropicamide eye drops.[9,18] Retinopathy grading was based on fundoscopic findings and classified according to the Keith-Wagener-Barker classification system.[13,14]

Demographic details, duration of morbidity, CKD stage, and relevant clinical findings were recorded for each patient. Three blood pressure measurements were obtained and averaged to improve accuracy.[7,8] Routine laboratory investigations, including serum creatinine and blood urea levels, were performed to assess kidney function.[9] Glomerular filtration rate (GFR) was calculated using the Cockcroft-Gault formula.[14-18]

$$GFR_{male} = \frac{(140 - \text{age in years}) \times \text{weight in kg}}{72 \times \text{serum creatinine (mg/dL)}} \times CF$$

For females, the GFR calculation is multiplied by a correction factor (CF) of 0.85 and for male its 1.

For statistical analysis the software SPSS version 26 was used for analysis and interpreted with the following tests, like Chi-square test and Fisher's exact test for categorical data and the student's t-test for continuous variables. Here a p-value of <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

The age distribution ranged from 22 to 77 years, with a mean age of 45.98 ± 14.45 years. The majority of patients (57%) were aged 45 years and above. The gender distribution revealed that 46% of the participants were male and 54% were female, with no statistically significant difference between age groups and gender ($p = 0.059$).

Prevalence of Hypertensive Retinopathy

The prevalence was 84% that is patients having hypertensive retinopathy, while 16% had no retinopathy. Among those with hypertensive retinopathy, 11% were in 15-29 age group, 30% were in the age group of 30-44 years, 30% in the 45-59 age group, and 29% were above 60 years. The prevalence of hypertensive retinopathy was higher in females (58%) than in males (42%).

The severity of hypertensive retinopathy was graded based on the Keith-Wagener-Barker classification (Table 1):

Grade 1: 20% of patients, **Grade 2**: 32% of patients,

Grade 3: 24% of patients, **Grade 4**: 8% of patients.

Correlation between CKD Staging and Severity of Hypertensive Retinopathy

A significant correlation was observed between the stages of chronic kidney disease and the severity of hypertensive retinopathy ($p < 0.05$). Patients with advanced CKD (stages 4 and 5) were more likely to have severe hypertensive retinopathy (Grades 3 and 4), while those in the earlier stages of CKD (stages 1 and 2) predominantly had mild to moderate retinopathy (Grades 1 and 2). Grade 0 not showing hypertensive retinopathy while Grade 1 to Grade 4 having hypertensive retinopathy.

Table 2: CKD Staging * Hypertensive Retinopathy Grading Crosstabulation Visual Outcomes

		Hypertensive Retinopathy Grading					Total
		Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	
CKD Staging	Stage I	4	2	0	0	0	6
	Stage II	2	1	1	1	0	5
	Stage III	5	10	16	2	1	34
	Stage IV	5	10	10	12	0	37
	Stage V	0	1	11	3	3	18
Total		**16**	**24**	**38**	**18**	**4**	**100**

Visual acuity was measured for all participants, and it was found that in right eye, total 71 patients of hypertensive retinopathy were having 6/18 or better best corrected visual acuity whereas in left eye, total 69 patients of hypertensive retinopathy were having 6/18 or better best corrected visual acuity. Patients having significantly worse visual acuity in both eyes belongs to Grade 4 hypertensive retinopathy compared to those with Grade 1 or no retinopathy. There was no significant correlation found between intraocular pressure (IOP) and the severity of retinopathy ($p > 0.05$).

Prevalence of Anaemia in CKD Patients

Table 3 dedicated to correlate anaemia and CKD, anaemia was present in 84% of patients. The prevalence of anaemia increased with the severity of CKD, with 86% of Stage 4 CKD patients and 100% of Stage 5 CKD patients exhibiting anaemia. A statistically significant association was observed between CKD severity and the presence of anaemia ($X2 = 1.619$, p value = 0.0085).

Table 3: Crosstabulation of Anaemia and CKD Staging

		CKD Staging					Total
		Stage I	Stage II	Stage III	Stage IV	Stage V	
Anaemia Present	yes	4	4	29	32	15	84
	no	2	1	5	5	3	16
Total		**6**	**5**	**34**	**37**	**18**	**100**

DISCUSSION

In this study, we aimed to assess the severity of hypertensive retinopathy in patients with chronic kidney disease (CKD) and to explore the correlation between retinopathy grading and CKD progression. The findings suggest a strong association between hypertensive retinopathy and the severity of CKD, reinforcing the importance of ophthalmic examination as part of routine care for hypertensive patients with CKD. Similar observations were reported by Grunwald JE et al. and Deva R et al., who demonstrated significant retinal abnormalities among CKD patients.[5,11,12]

Hypertensive Retinopathy as a Marker of CKD Severity

The results of this study demonstrated that 84% of patients with CKD exhibited varying degrees of hypertensive retinopathy. As CKD advanced from Stage 3 to Stage 5, there was a notable increase in the prevalence and severity of retinopathy, with 100% of Stage 5 CKD patients having hypertensive retinopathy. Similar findings were observed by Grunwald JE et al., Deva R et al., and Chillo P et al., who reported a higher prevalence of retinal vascular abnormalities in advanced CKD.[5,11,12,16]

These findings are consistent with studies by Sabanayagam C et al. and Bodaghi B et al., indicating that microvascular changes in the retina reflect the severity of systemic hypertension and kidney damage.[5,6,15,16] The observed correlation suggests that retinal examination may serve as a non-invasive marker for assessing the progression of kidney disease, especially in settings where access to renal biopsies or advanced imaging techniques is limited.[14,15]

Retinopathy and Visual Outcomes

Patients with Grade 4 retinopathy experienced significantly worse visual outcomes compared to those with mild or no retinopathy. This is likely due to structural changes in the retinal vasculature, including arteriolar narrowing, haemorrhages, and optic disc swelling, which impair retinal function.[3,4] These findings align with previous research by Deva R et al., Zhu Z et al., and Goyal JL et al., which identified hypertensive retinopathy as an important cause of visual impairment in hypertensive and CKD patients.[12,17,18]

Interestingly, no significant correlation was found between intraocular pressure (IOP) and the severity of hypertensive retinopathy. This suggests that while elevated blood pressure contributes to retinal damage, it does not directly influence IOP in the same way. Therefore, the impact of hypertension on the eye is more likely related to microvascular damage rather than increased intraocular pressure.[18]

Anaemia and CKD Progression

A significant association was observed between the presence of anaemia and the severity of CKD. Anaemia is a well-established complication of CKD, primarily due to decreased erythropoietin production by failing kidneys.[9] In our study, 84% of patients were anaemic, with the prevalence increasing as CKD progressed. Similar findings were reported by Tedla FM et al., who highlighted the systemic complications associated with progressive renal dysfunction.[10] This high prevalence highlights the need for early diagnosis and treatment of anaemia in CKD patients to improve their quality of life and reduce morbidity.[9,10]

Clinical Implications

The findings of this study underscore the clinical value of fundoscopic examination in hypertensive patients with CKD. Routine retinal screening can help identify patients at risk of severe hypertensive complications and CKD progression. Given that retinal vessels can be examined non-invasively, this method could serve as a practical and cost-effective tool for monitoring disease severity, particularly in resource-limited settings where access to advanced renal diagnostic tools is limited.

Additionally, the correlation between socioeconomic status (SES) and retinopathy severity, though not statistically significant, suggests that patients from lower SES backgrounds may be at higher risk for more severe retinopathy. This may be related to factors such as poor access to healthcare, suboptimal management of hypertension, and delayed diagnosis of CKD. Further research is needed to explore this relationship and to develop targeted interventions aimed at improving outcomes for socioeconomically disadvantaged populations.

Limitations of the Study

This study had some limitations. First, it was conducted in a single hospital, which may limit the generalizability of the findings to other populations. Secondly, the cross-sectional design of the study precludes establishing a cause-and-effect relationship between hypertensive retinopathy and CKD progression.

Longitudinal studies are required to better understand how changes in the retina parallel the deterioration of kidney function over time.

CONCLUSION

This study demonstrates a strong correlation between the severity of hypertensive retinopathy and the progression of chronic kidney disease (CKD). As CKD advances, the prevalence and severity of hypertensive retinopathy increase, suggesting that retinal examination can serve as a valuable non-invasive tool for monitoring CKD progression. Additionally, the findings emphasize the impact of hypertensive retinopathy on visual outcomes as well as significant association between CKD and anaemia, further highlighting the importance of early detection and management.

Routine fundoscopic screening should be considered in hypertensive CKD patients to facilitate early identification of microvascular complications, potentially preventing further systemic damage and improving patient prognosis. By integrating retinal examination into the routine care of CKD patients, healthcare providers can more effectively monitor disease progression and implement timely interventions. Further longitudinal studies are recommended to explore whether early detection of hypertensive retinopathy can predict the long-term trajectory of CKD and improve outcomes in this patient population.

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